CHAPTER 6 Alternatives to the Project

The proposed Project was developed to improve the level of safety performance and service within this corridor, while considering of a number of factors, including funding; consultation with the public; safety needs within the Project area; and minimizing effects to the environment. The following outlines alternatives to the Project that were assessed as part of the Project development and the Environmental Assessment.

6.1 Alternatives to the Project

Alternatives to the Project were considered during Project planning and included the following:

- Null alternative, i.e., no changes to the existing Highway 104 alignment;
- Alternative modes of transportation; and
- Highway 104 safety improvements.

To be identified as viable alternative to the Project, a given project would need to satisfy the following criteria:

- Provide access to communities within regional area; and
- Improve the level of safety performance and service.

Alternative alignments and design elements are further described in Section 6.2.

Null Alternative: The null alternative, i.e., no changes to the existing Highway 104 alignment, was determined to not be a viable, suitable alternative to the Project as it does not improve existing conditions and does not address the traffic and safety concerns identified as concerns of both the general public and local stakeholders. In addition, this alternative does not align with NSTIR's mandate to provide safe and efficient movement of people and goods (NSTIR, 2017). As a result, this alternative was not considered further.

Alternative modes of transportation: Alternative modes of transportation was identified as a potential alternatives as it could be is possible to divert traffic off Highway 104, such as shipping of goods via trains. These alternative modes of transportation could reduce the amount of truck traffic along the existing Highway 104; however, this alternative does not improve the existing highway

safety conditions, such as improving sightlines or roadway geometry to current standards. Therefore, it did not fit the criteria of a viable alternative, and no further consideration was given to this alternative.

Highway 104 safety improvements: Implementation of safety improvement within the existing Highway 104 was identified as one viable alternative to the Project. NSTIR investigated the safety improvement alternative and, in 2015, OPUS completed an operations and safety review of this section of highway, because of public concern over recent collisions and fatalities. The study identified and prioritized a series of mitigation measures which would foreseeably have a positive impact on safety (OPUS, 2015). There were 42 safety measures that were identified which ranged from 'Category 1 Improvements' which included low cost, minimal engineering solutions which are easiest to implement (i.e. sign replacements and sightlines), as well as 'Category 2 Improvements' which are more comprehensive measures and may require more developed design and planning, and associated higher cost (i.e., roadway realigned and grade separation structures). For the purpose of alternatives, 'Category 2 Improvements' were considered as potential alternatives for this Environmental Assessment. There were 12 'Category 2 Improvements' which were:

- Realignment at the east end of the corridor at the current transition between the two-lane and four-lane sections;
- Adjust roadside slope to 4:1 or less in areas where this would be more cost effective than installation of a new guard rail;
- Increase the paved shoulder to a minimum of 2.0 m and install shoulder rumble strips;
- Realign the curve at Barneys River (km 198.1-198.5) to accommodate a 100 km/h design speed;
- Correct superelevations at James River Interchange (km 208.7-209.7) and east of Barneys River (km 199.3 – 199.8);
- Complete a review of horizontal curves and upgrade to accommodate 10 km/h above the posted speed on curved section;
- Investigate replacement of at-grade crossings with grade separation structures;
- Investigation addition of full ramp movements at one of the two overpass locations with Trunk 4;
- Review and extend climbing lanes;
- Review all opposing climbing lanes;
- Provide a left-turn lane to John Munroe Road from Highway 104; and
- Investigate alternative road configuration such as 2+1 road cross-section within the vicinity Marshy Hope.

The 12 'Category 2 Improvements' were identified to be interim measures, to be employed until such time the Highway could be twinned (OPUS, 2015). When the Safety Improvement alternative option is compared to the proposed Project, it does not account for the added safety due to twinning, which is mainly due to reduction of collisions (CBCL, 2016, 2017). The proposed Project provides necessary safety improvement such as:

- Four-lane divided highway;
- Replacement of at grade structures with grade separation structures; and

- Increased marking and signage.

Therefore, the proposed Project of twinning was ultimately selected as it addressed many of the existing concerns for operations and safety (OPUS, 2015).

6.2 Project Alternatives Assessment

Operational and safety studies identified other alternatives as incremental improvements to road safety, until such time that a divided four-lane highway could be constructed (OPUS, 2015). Only twinning options were selected as Project Alternatives, as they have been identified as the best option for the reduction of collisions. The following alignments were selected for evaluation:

- *Option 1:* Twinning of the existing highway from Sutherlands River to Barneys River Station and James River to Antigonish, with a new four-lane divided highway alignment south of the existing highway between Barneys River Station and James River (i.e., the current Project); and
- *Option 2:* Twinning of the existing highway from Sutherlands River to Antigonish.

Option 1: The first option, twinning of the existing highway from Sutherlands River to Barneys River Station and James River to Antigonish, with a new four-lane divided highway alignment south of the existing highway between Barneys River Station and James River was investigated as it use already construction infrastructure and minimized environmental impact by twining approximately 60% of the existing alignment and would provide additional space to design a new highway which meet NSTIR's current design requirements. The new alignment would provide:

- Reduced potential for head on collisions due to 4 lane divided highway;
- Reduced potential for right angle and rear end type collisions with removal of at-grade accesses and installation of grade separation structures; and
- The ability to close portions of the highway vehicle during bad weather and notify road users in advance with variable message signs.

The twinned highway and new alignment would also provide improved emergency response time for incidents as a result of the twinning, and provide the ability to reroute traffic on a reconnected Trunk 4 for incident management.

Option 2: The second option included the twinning or alignment widening of the existing Highway 104 Alignment from Sutherlands River to Antigonish, including the portion through Barneys River and Marshy Hope. The alignment was found to have inadequate space through the Marshy Hope section to support a four-lane divided highway, as a result of the location of the existing infrastructure (i.e., Trunk 4, and railroad) and an existing watercourse, Barneys River. Other configuration alternatives, such as 2+1 road cross-section were also identified as a potential alternative; however, due to road geometry, space limitations, and safety considerations, this option was not investigated further.

The ‘Option1’ twinning alignment was ultimately selected, as it allows for the implementation of safety improvements, such as twinning, as identified within the operational and safety reviews, and additional improvement (i.e., upgrading substandard highway geometry and removal of obstructed sightlines). The proposed alignment was refined throughout the Preliminary Screening and Feasibility Phases. Highway division such as cable or jersey barriers were not considered due to the risk collisions with the added barriers and potential for habitat fragmentation as a result of their installation. The various interchange design options and median widths have been considered during design. The final design will be determined during the DBFOM phase, and will meet NSTIR approved standards, minimize the Project footprint, as well as maximize traffic efficiency and safety. As a result of the alternatives assessment, the Project as described in Chapter 2, was selected as the preferred Project.

CHAPTER 7

Accidents and Malfunctions

The proposed Project activities through Site Preparation, Construction, and Operation and Maintenance phases creates the potential for malfunctions and accidents. The most likely accidents and malfunctions include: spills, erosion and sediment control failure, fires, and vehicular collisions.

The nature and severity of malfunctions and accidental events are difficult to predict. Preparedness and pre-planning are fundamental in the case of a serious incident in order to minimize confusion, maximize personal safety, and control potential damage to property and the environment.

Precautionary and preventative measures will facilitate the reduction in the likelihood of accidents and malfunctions having the potential to occur during the lifecycle of the Project. The likelihood and magnitude of serious effects resulting from accidents and malfunctions can be low, following the implementation of environmental protection and contingency and emergency response plans throughout the Site Preparation, Construction, and Operation and Maintenance phases of the Project.

All Project-related operations, plans, policies, protocols and guidelines will be conducted in accordance with relevant legislation, regulations, guidelines and accepted industry practice.

A site-specific contingency plan will be developed prior to construction in accordance with NSE's *Contingency Planning Guidelines*, in the unlikely event of an unplanned situation that could pose a risk to health, safety, or the environment (NSE, 2016). This plan will provide response procedures for accidents and malfunctions that can be reasonably anticipated throughout the Project including (but not limited to) events such as spills, erosion and sediment control failures, fires, and vehicular collisions. This plan will be reviewed at least annually and updated as required. Adhering to precautionary and preventative measures will limit the risk of these incidents.

7.1 Spills

Spills which could occur as a result of the Project include, but are not limited to the following:

- Spills from containers, including drums and tanks;

- Spills resulting from traffic accidents and firefighting; and
- Spills resulting from breaks in hydraulic or transfer hoses or piping.

The size and type of a spill will determine its effect on the surrounding environment. Even small spills can have an adverse effect on aquatic habitats, wetlands, and wildlife (i.e., mammals, reptiles and amphibians, and migratory birds). Larger spills present the potential to negatively impact the quality of soils, surface water, groundwater, wetland habitat, fish and fish habitat, and facilitate uptake and ingestion by wildlife.

During construction and operation of the Project, accidents and malfunctions may result in spills of a variety of substances, such as oils, lubricants, and petroleum. These spills are most likely to be incurred during refuelling, maintenance activities, or by leaks from fuel or hydraulic lines.

The responsibility of spill prevention and mitigation resides with the owner or controller of the products that can be spilled (NS Transportation and Public Works, 2007). NSTIR or their representatives, have an obligation to prevent, eliminate or remediate adverse effects resulting from a spill, and to report all spills to the applicable organizations.

All spills will be cleaned up immediately using spill containment and remediation equipment which will be made available on site. Contaminated materials or soil or water which comes into contact with oils, lubricants, and petroleum or hazardous materials will be handled in accordance with applicable regulations and in compliance with the *Generic EPP* and other best management practices.

NSTIRs *Generic EPP* for 100 series highways contains best practice preventative measures for spills and leaks, which will be followed and adapted for a site-specific plan. For a detailed description of all precautions refer to the NSTIR *Generic EPP* (NS Transportation and Public Works, 2007). Safe handling practices include:

- Spill clean-up materials shall be accessible and maintained in the areas of fuel and chemical storage. Any spilled fuel or lubricants shall be promptly cleaned up and disposed of in accordance with NSE instructions;
- Fuelling, storage and servicing of vehicles and construction equipment is not allowed within 30 m of a watercourse, drainage ditch, area with a high water table, or exposed and shallow bedrock;
- All tanks shall be protected from collision damage by the use of snow fencing to alert operators, or by the placement of barriers to impede equipment movement near the tank;
- Equipment will be regularly inspected and maintained in good working order. Any leaks will be repaired as soon as possible. Drip pans or alternative containments will be used to prevent the introduction of fluids such as oils, lubricants, and petroleum into the environment;
- Fuel storage areas and transfer lines shall be clearly marked or barricaded to prevent damage from vehicles; and

- Waste oils and lubricants will be retained in a closed container, and disposed of in an environmentally acceptable manner at an approved facility.

Following the implementation of mitigation measures, the risk of significant spills during the Project operation is expected to be low. During construction, the risk of leaks and spills will be reduced by adherence to the *Generic EPP* and site-specific plans for safe handling procedures and spill response. The effects of spills as a result of accidents and malfunctions is not expected to be significant.

7.2 Erosion and Sediment Control Failure

Erosion and sediment control (ESC) failures can be caused by scenarios such as precipitation events. The resulting increased sediment load in watercourses and wetlands resulting from these events can have negative impacts on fish and other wildlife. The degree of the adverse effects depends on the amount of sediment transported, time of year, and location. If sediment is deposited on spawning beds during spawning season, the effects could be significant as the eggs may suffocate.

NSTIR recommends these seven principles for reducing erosion and sedimentation at construction sites (per *Principles of Erosion and Sediment Control*; NSTIR, 2016):

- Go gently into the site and prevent erosion until permanent ground cover is re-established;
- Keep clean water clean;
- Minimize the amount of exposed soil;
- Minimize the time of exposure;
- Keep the sediment on site;
- Avoid steep slopes; and
- Have a contingency plan and the resources for emergencies.

The Proponent will be required to be appropriately trained in NSTIRs erosion and sediment control protocols, and will implement any appropriate mitigation measures within their ESC planning. These mitigation measures may include NSTIR's *Generic EPP*, NSE *Watercourse Alteration Standards*, site-specific contingency plans, and any Proponent-specific environmental plans and practices. According to the *Generic EPP* (NS Transportation and Public Works, 2007) the most common erosion control practices include:

- Sediment barriers;
- Flow checks;
- Erosion banks; and
- Straw/ hay, compost, and bark mulch (for surface protection).

In the event of failure of the ESC measures there will be a site-specific contingency plan that will be implemented immediately. The construction of the Project will be halted until acceptable conditions are restored. Remedial activities will be employed as soon as possible, and such activities may include pumping of stored water, run-off collection or diversion, and other control measures. The implementation of best management practices will mitigate significant adverse effects caused by

failure of ESC measures. The environmental risk of ESC failure is expected to be low because of the application of mitigation measures and best management practices.

7.3 Fires

A fire onsite, depending on the size, may cause mortality of humans or wildlife, habitat damage or loss, property damage or loss, reduced air quality, and sensory disturbance. Fires are most likely to occur during construction due to sparks, hot exhaust, refuelling, machine malfunction, or careless disposal of hot or ignited materials (e.g., cigarettes). During operation of the highway, fires may result from vehicular collisions. Firefighting chemicals may enter the surrounding environment as a result of improper storage or use on a fire. In the event of a fire, air quality may be temporarily reduced and may occur throughout the lifetime of the project.

To reduce the risk of fire, a site-specific fire prevention plan will be developed and included in the EPP. Protocols for safe practices, such as designated smoking areas, procedures for welding, regular equipment inspections, storage of flammable materials and designated refuelling locations will be put into place. Safe handling and storage practices will be in place for all firefighting chemicals and equipment. An emergency fire response plan will be in place for the unlikely occurrence of a fire. Emergency responders will be contacted immediately and mitigate damage by controlling and extinguishing the flames.

All regulated burns will be done so in compliance with conditions of burning permits and specific mitigation such as proper supervision of brush fires, provision of fire-fighting equipment, and burning on the ROW will only be approved on a case by case basis.

With quick emergency response, the fire should be controlled rapidly and the effect on air quality should not be significant. Following the implementation of mitigation measures, the risk of fire during construction or operation is considered to be low.

7.4 Vehicular Collisions

Traffic volume growth is expected to be minimal within the Highway 104 corridor; and therefore, is not expected to increase as a result of the twinning Project (CBCL, 2017). Safety improvement within the Project design will be important for the reduction of vehicular collisions. Over a 9 year period from 2007 to 2015, 444 collisions were recorded for this segment of the Highway 104. These included 299 property damage only (PDO) collisions, 11 fatal collisions, 133 injury collisions, and 1 other. The collision rates ranged from 20.4 to 50.9 (number of collisions per HMVK) annually, and the average of the period was calculated to be 38.6; (Table 1.1). During 2001 to 2005, the average rate of fatal collisions on this segment of Highway 104 was 1.4 collisions per HMVK. In comparison, the provincial average on divided highways is 0.3 collisions per HMVK (Opus, 2015).

Twinning the highway and creating the new alignment section south of the existing highway will increase road safety compared to the existing highway. The Project will provide the following improvements:

- Four-lane divided highway;
- Grade separation structures;
- Additional highway routes; and
- Increased marking and signage.

Divided medians and twinning highways for passing will provide safety improvements. Both are anticipated to result in fewer vehicular collisions. Highway Twinning Feasibility Studies reported that an approximately 30-35% reduction in collisions could be achieved by twinning; this reduction is based on elimination of intersection-related, angle, and head-on collisions and some reduction in single vehicle, rear-end, and sideswipe collisions (CBCL, 2016; CBCL, 2017). In addition, the twinned highway will facilitate improved emergency response time, in the event of incidents such as vehicular collisions.

At-grade accesses can lead to a potential for right angle and rear-end type collisions. The implementation of grade separation structures and removal of at-grade accesses will reduce the interaction and vehicles crossing Highway 104 and restricted access and potential turn movements along the alignment.

The proposed new alignment portion of the Project will also provide safety improvements. The new alignment will provide the ability to reroute traffic on a reconnected Trunk 4 for incident management. The diversion potential, will also be useful if incidents were to occur on other highways, such as Trunk 4.

Improved signage and marking will be implemented within the proposed Project. This will provide the ability to close the highway (or portions thereof) to vehicles during bad weather and notify road users in advance with variable message signs. Improvements may include installation of variable message signs, rumble strips, pavement markings, and increased sign size.

Implementing proper guidelines and regulations for the Project will contribute to reduced driver risk. During construction, the appropriate signs, speed limits, and barriers will be in place to increase driver awareness and safety. The highway will be constructed following the Nova Scotia standards for highway design (NSTIR, 2015). These guidelines manage the following standards:

- Posted speed;
- Maximum gradient;
- Minimum lane width;
- Minimum shoulder width;
- Minimum radius for horizontal curve;
- Minimum stopping sight distance;
- Minimum vertical crest curved; and
- Minimum passing sight distance.

Following the implementation of the design elements identified in this section, the effects of collisions are not expected to be significant.

7.5 Vehicle – Wildlife Collisions

During the period of 2007 to 2015, of the 444 collisions recorded, 97 collisions were noted as having an animal in the roadway. Of the 625 vehicles involved in the collisions, 81 vehicles hit a deer and 9 hit another animal (Table 1.2; Appendix A). NSDNR, Wildlife Division collects information on vehicle - wildlife animal interactions. From 2003 to 2018, 184 animals were identified as being involved in a collision or wildlife strike within 1,500 m of the LAA. Species reported as included in the vehicle - wildlife interactions within this area in Antigonish or Pictou County included the following species, reported within 1,500 m of the LAA:

- American black bear;
- Eastern Cougar*;
- Coyote;
- Bald Eagle;
- Racoon;
- Common snapping turtle; and
- White-tailed deer.

* Presence and status of this species in the Province remains unconfirmed as the animal was not recovered. DNA testing was to be completed; however, results were not available at the time of this report.

To reduce the potential of vehicle - wildlife interactions, the following approaches and practices will be used in addition to the NSTIR *Generic EPP*.

- Wildlife passage infrastructure;
- Increasing sightlines; and
- Lighting at Interchanges.

Physical barriers and wildlife crossing structures, such as wildlife overpasses, underpasses, and fencing, will be used as warranted along portions of the highways where elevated risk of collisions are present, such as known vehicle - wildlife interactions areas and sensitive habitat such as deer wintering areas. Sight lines will be maintained and clearing of ditches and vegetation will be implemented following the *Generic EPP*, such as clearing outside of the general nesting periods of migratory birds (ECCC, 2018b). Infrastructure, such as interchanges, will have lighting to increase visibility at these areas.

Following the implementation of the mitigations and design elements identified in this section, the effects of vehicle - wildlife interactions are not expected to be significant.

7.6 Summary

With any project involving highway construction and use, there is a risk of accidents and malfunctions. In the unlikely event of an accident or malfunction, emergency response protocols and contingency plans will be followed. The risk of spills, erosion and sediment control failure, fires, and vehicular collisions are considered possible; however, with the implementation of plans, policies, and protocols, such as the *Generic EPP*, site-specific preventative protocols, and management plans, the likelihood of accidents and malfunctions can be reduced and managed.

CHAPTER 8

Environmental Effects Assessment

This Chapter considers how Project Components and Project Activities could potentially interact with the potential VECs. The environmental effects are determined using the existing conditions (as defined in Chapter 5), and the methodologies referenced in Chapter 4.

The following VECs identified in Table 8.1 were selected to facilitate a focused and efficient evaluation using the criteria outlined in Chapter 4.

Table 8.1 Valued Environmental Components (VEC) Identification

	VEC
Atmospheric Environment	Air quality
	Noise
	Climate and Greenhouse Gas Emissions
Physical Environment	Geology and Soil Quality
	Surface Water Quality
	Hydrogeology and Groundwater Quality
Biological Environment	Flora
	Wildlife and Wildlife Habitat
	Wetlands
	Fish and Fish Habitat
	Species at Risk
Socio-Economic Environment	Land Use
	Human Health and Safety
Cultural Resources	Heritage and Archaeological Resources

Section 8.1 provides a discussion of the identified interactions and describes how the various Project activities may impact each affected VEC. Potential interactions between Project Components / Project Activities and VECs are identified to indicate which activities during each project phase (i.e., Site Preparation, Construction, and Operation and Maintenance) interact to create an effect within

the Project boundaries. The effects will be documented as positive or negative, depending on the VEC and the Project activity that interacts with the VEC.

Mitigation measures to reduce or eliminate negative impacts on VECs are identified in Section 8.2. Following the implementation of these mitigation measures, any residual effects will be further assessed to determine their significance (Section 8.3). Follow-up and monitoring requirements will be recommended for any residual effects that are identified as significant (Section 8.4).

Effects as a result of accidents and malfunctions are assessed separately in Chapter 7.

A summary of the Environmental Effect Analysis is included in Table 8.2.

Table 8.2 Environmental Effects Analysis

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
All VECs	• All Project Components	• All Potential Environmental Effects	**Section 8.2 - General Mitigation for the Entire Project (General)** • Project activities will be conducted in compliance with all relevant legalisation and regulatory approvals • NSTIR's *Generic EPP for the Construction of 100 Series Highways* • Emergency Response Plan • Site-specific Spill Response Plan • Site-specific EPP • Regular vehicle maintenance • NSTIR's *Spill Contingency Plan* • Best Management Practices • Spills of hazardous materials must be reported to the appropriate regulatory authorities (i.e., DFO and NSE)							
Air Quality	• Vegetation clearing	• Reduced air quality	**Section 8.2 - Project General (listed in Table 8.2 - All VECs)** **Section 8.2.1.1 - Air Quality, Climate Change and Greenhouse Gases** • No grubbing will occur during Vegetation Clearing activities • Regular maintenance of vehicles and equipment • Loads on vehicles will be covered and secured during transportation • Dust suppression and abatement techniques will be utilized if necessary • All blasting regulations will be followed. Notice of blasting will be provided to local land users, when necessary • If material is tracked from the construction site onto roadways used by the public. As soon as reasonably possible, the proponent shall remove all material from the affected roadway • Natural vegetation shall be preserved wherever where possible. • Cleared areas will be reseeded and revegetated	M/L	M	H/M	H	M	M	NS
	• Excavation • Blasting • Fill placement and compaction • Ditch construction • Installation of highway infrastructure • Removal of existing infrastructure	• Reduced air quality • Emission exceedances above *Air Quality Regulations* • Emission exceedances above CAAQS								
	• Paving	• Reduced air quality • Emission exceedances above *Air Quality Regulations* • Emission exceedances above CAAQS								
	• Rehabilitation / Site Restoration	• Reduced air quality								
	• Revegetation	• Improved air quality relative to site clearing and construction activities								
	• Highway operation	• Reduced air quality								
	• Use of heavy equipment (all activities)	• Reduced air quality • Emission exceedances above Air Quality Regulations • Emission exceedances above CAAQS								
Noise	• Vegetation clearing	• Decrease in 'dampening' effect on existing highway noise, leading to an increase in noise levels above background levels • Sound levels (dBA) exceeding provincial guidelines and municipal by-laws	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.1.2 - Noise** • Regular maintenance of vehicles and equipment • Equipment and vehicles equipped with noise controls	H	M	H/M	H	M/H	M	PS
	• Grubbing and soil management • Removal of existing infrastructure • Excavation • Blasting									

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
	• Fill placement and compaction • Ditch construction • Bridge and grade separation structure construction • Installation of highway infrastructure • Installation of watercourse crossings and diversions • Wetland alteration • Paving • Rehabilitation / site restoration • Revegetation		• Notice of blasting will be provided to local land users, when necessary • Noise monitoring will be conducted if complaints arise							
	• Highway operation	• Increase in sound levels above background levels								
	• Highway maintenance	• Sound levels (dBA) exceeding provincial guidelines and municipal by-laws								
	• Infrastructure maintenance and vegetation control	• Increase in sound levels above background levels								
	• Use of heavy equipment (all activities)	• Increase in noise levels above background levels • Sound levels (dBA) exceeding provincial guidelines and municipal by-laws								
Climate Change and Greenhouse Gases	• Vegetation clearing	• Minimal changes to the GHG net balance in the local area	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.1.1 - Air Quality, Climate Change and Greenhouse Gases (as listed in Table 8.2 - Air Quality)**	L	M	H/M	H	M	M	NS
	• Grubbing and soil management • Removal of wetlands									
	• Paving									
	• Highway operation	• Increase in provincial and national GHG emissions								
	• Infrastructure maintenance									
	• Use of heavy equipment									
Geology and Soil Quality	• Vegetation clearing	• Changes in sediment deposition patterns • Decreased soil quality	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.2 - Physical Environment General** • All fuels, gases, and potentially harmful substances will be stored appropriately, in compliance with applicable legalisation • No bulk storage of fuel products on site • Regular maintenance of vehicles and equipment • Vegetation clearing to be kept to a minimum • Hazardous materials stored at least 30 m from any watercourses	L	L	H	L/H	H	L/M	NS
	• Grubbing and soil management • Wetland alteration and removal • Removal of existing infrastructure • Fill placement and compaction • Ditch construction	• Changes in sediment deposition patterns • Decreased soil quality • Decreased asphalt leachate into soils (deactivated highway section)								
	• Excavation • Blasting	• Alteration of bedrock layers • Changes in sediment deposition patterns • Soil erosion and sedimentation issues								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Decreased soil quality	• Vehicles and machinery shall be fuelled and serviced at least 30 m from any watercourses, and on a hardened, impermeable, and level surface • Secondary containment shall be used whenever possible for equipment **Section 8.2.2.1 - Geology and Soil Quality** • Spills and releases handled in accordance with applicable environmental regulations and legislation • NSTIR's *Salt Management Plan* (SMP) • All material used will be clean and devoid of contamination • All material shall be handled and stored in a manner applicable to relevant regulatory requirements • Areas of potential contamination identified before ground disturbance, and site-specific mitigative actions enacted • Herbicides will be used only if manual or mechanical vegetation control measures are insufficient • All debris material shall be removed and disposed of after blasting • All waste materials shall be disposed of appropriately							
	• Installation of watercourse crossings and diversions • Bridge and grade separation structure construction	• Decreased soil quality								
	• Paving	• Effects to local soil characteristics via redirection of surface water runoff								
	• Rehabilitation / site restoration of affected areas	• Temporary increase in erosion and sedimentation levels								
	• Revegetation	• Permanent decrease in erosion and sedimentation levels								
	• Highway maintenance	• Increased salinity of roadside soils • Decreased soil quality • Altered soil characteristics on roadsides								
	• Infrastructure maintenance	• Changes in sediment deposition patterns								
	• Vegetation management	• Decreased soil quality								
	• Use of heavy equipment (all activities)	• Soil contamination								
Surface Water Quality	• Vegetation clearing	• Increased run-off into watercourses and wetlands • Alteration of surface water flow patterns • Increased sediment load to watercourses	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.2 - Physical Environment General (as listed in Table 8.2 - Geology and Soil Quality)** **Section 8.2.2.2 - Surface Water Quality and Groundwater Quality** • Project-specific *Surface Water Management Plan* • Engineered *Sediment and Erosion Control Plan* (SECP) • Culverts will be designed following applicable legislation, guidelines and standards • Well decommissioning activities to follow *Well Construction Regulations* • Meet the objectives of NSE Wetland and Watercourse Alteration specifications; • Fueling and maintenance will occur in designated refueling area at least 30 m from any waterbody or wetland • Construction activities conducted outside of extreme weather • Excess construction materials will be disposed of appropriately. Temporary onsite storage at least 30 m from waterbodies and 60 m from wells	L	M	L/M	L/H	L	L/M	NS
	• Grubbing and soil management • Wetland alteration and removal • Removal of existing infrastructure • Excavation • Blasting • Fill placement and compaction • Ditch construction	• Alteration of surface water flow patterns • Increased sediment load to watercourses • Loss of aquatic habitat • Modified flow volumes • Modified stream velocity • Changes in sediment bed loads • Flooding • Decreased water quality								
	• Bridge and grade separation structure construction • Installation of watercourse crossings and diversions	• Decreased water quality via increased sediment load or contaminants • Habitat degradation								
	• Paving	• Alteration of local surface water hydrology								
	• Rehabilitation / site restoration of affected areas	• Increased sediment load into watercourses								
	• Revegetation	• Stabilization of bare soils								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Decreased sediment flow into watercourses	• Best management practices to reduce erosion and promote groundwater recharge • Surface water quality monitoring program • Appropriate approvals will be obtained for activities that have the potential to negatively impact watercourses • Construction zones will have buffer zones and erosion control structures in place • Regular maintenance of drainage infrastructure during low flow conditions • Vehicles shall not ford watercourses • Sedimentation and erosion control structures will stay in place until vegetation is established. Areas should be assessed in late spring or early summer of the year following construction. If banks and soils are fully established with successful vegetation re-growth, then the sediment erosion control measures may be removed. If erosion and sedimentation is still an issue, sediment erosion control will need to stay in place and then additional measures must be implemented to stabilize soils.							
	• Highway maintenance	• Increased salinity of roadside watercourses (water and sediments) • Decreased water quality • Decreased water quality after spring snowmelt								
	• Infrastructure maintenance	• Increased sediment load into watercourses								
	• Vegetation management	• Decreased water quality • Localized nutrient inputs								
	• Use of heavy equipment (all activities)	• Surface water contamination								
Hydro-Geology And Ground-Water Quality	• Vegetation clearing	• Decreased infiltration to groundwater table • Changes to ambient water temperature of receiving surface water • Increased nutrients / biological oxygen demand in surface water resulting from impacts to groundwater	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.2 - Physical Environment General (as listed in Table 8.2 - Geology and Soil Quality)** **Section 8.2.2.2 - Surface Water Quality and Groundwater Quality (as listed in Table 8.2 - Surface Water Quality)**	L	L	L	L/H	L	L/M	NS
	• Grubbing and soil management • Excavation • Bridge and grade separation structure construction • Fill placement and compaction for the highways and access roads • Removal of existing infrastructure	• Reduced quantity of water flowing to well or GDE • Lowered water table • Stream flow not sustained / periodic drying • Redirection of groundwater discharge to new areas • Changes to ambient water temperature of receiving surface water • Increased nutrients / biological oxygen demand in surface water • Changes to redox conditions • Erosion of bare soil Increased sediment load into watercourses								
	• Installation of watercourse crossings and diversions • Wetland alterations									
	• Blasting	• Reduced quantity of water flowing to wells • Increased loading of ammonium to groundwater and eventually aquatic habitats, resulting in fish toxicity								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Ammonium and/or nitrate in well water • Acid generation, toxicity to biota in streams and wetlands								
	• Paving	• Reduced quantity of water flowing to well or GDE • Lowered water table • Stream flow not sustained / periodic drying • Redirection of groundwater discharge to new areas • Groundwater contaminant concentrations exceed GCDWQ or CCME *Guidelines for Protection of Aquatic Life*								
	• Rehabilitation / site restoration of affected areas	• Increased sediment load into watercourses								
	• Revegetation	• Decreased sediment load into watercourses • Increased infiltration of surface water into groundwater reserves								
	• Highway maintenance	• Salinity increase in groundwater								
	• Use of heavy equipment (all activities)	• Groundwater contaminant concentrations exceed GCDWQ or CCME *Guidelines for Protection of Aquatic Life*								
Flora Species and Habitats	• Vegetation clearing	• Loss of specimens, including some SOCC • Loss and alteration of habitat for some species • Creation of habitat opportunities for other species • Increased habitat fragmentation.	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General** • Best management practices • Compliance with NSESA, SARA, and associated regulations • Cleared or grubbed areas to be managed to reduce potential of sedimentation and erosion • The seed mixture(s) will be similar to NS Highway Mix, unless otherwise approved and certified free of all prohibited noxious weed varieties identified applicable legalisation and related regulations and policies; **Section 8.2.3.1 - Flora** • Natural vegetation, top-soil and useable grubbings will be preserved, retained and reused, where feasible • Site clearing activities kept to a minimum	L	L	H	L	H	L/M	NS
	• Grubbing and soil management • Wetland alteration • Removal of existing infrastructure • Excavation • Blasting • Fill placement and compaction • Ditch construction	• Loss of specimens, including some SOCC • Unintentional introduction of non-native or invasive plant species via machinery • Loss and alteration of habitat for some species • Creation of habitat opportunities for other species • Increased habitat fragmentation. • Habitat creation (deactivated highway section) • Decreased habitat fragmentation (deactivated highway section)								
	• Rehabilitation and restoration of disturbed areas • Revegetation	• Habitat creation • Intentional introduction of non-native plant species via hydro-seed mixes • Unintentional introduction of non-native or invasive plant species via machinery								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Changes in community composition within and beyond maintained Right-of-Way	• Herbicides will only be used according to NSTIR's *Integrated Roadside Vegetation Maintenance Program*, including application of buffers; 30 m to watercourses and 60 m to sensitive areas, such as wetlands • Cleared areas will be re-seeded and re-vegetated as soon as feasible • Vegetation management will be executed per NSTIR's *Integrated Roadside Vegetation Management Manual* • All wetland and watercourse alteration will adhere to permit approval conditions • All equipment used on site must be cleaned thoroughly prior to arriving at the Project Area to avoid spreading invasive species • NS Highway Seed Mix will be used in revegetation activities unless otherwise approved; and • NSTIR's *Salt Management Plan*							
	• Highway operation	• Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way								
	• Vegetation management • Infrastructure maintenance	• Loss of flora specimens • Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way • Loss and alteration of habitat for some species								
	• Highway maintenance	• Damage to flora specimens • Habitat alteration • Changes in community composition within maintained Right-of-Way								
	• Use of heavy equipment (all activities)	• Loss and alteration of habitat • Loss of flora specimens, including some SOCC • Air quality impacts on sensitive lichens								
Wildlife: Mammals	• Vegetation clearing	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes) • Displacement of mammals • Direct mortality	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Flora Species and Habitats)** **Section 8.2.3.2 - Wildlife** • Wildlife Management Plan • Installation of wildlife passages as per Chapter 2 • Wetland compensation plan • NSDNR notified of any wildlife collisions during the Construction • Ensure vehicles and equipment are adequately muffled and in good working order • Site lighting shall be minimized, • Existing access roads and cleared areas shall be utilized to reduce unnecessary disturbance • *Spill Response Plan* • Compliance with all federal and provincial legislation, permits, approvals and guidelines relevant to wildlife • Any required surveys should be completed by a qualified biologist	L	L	H/L	L/H	H/L	L/M	NS
	• Grubbing and soil management • Wetland alteration (i.e. removal and infilling • Excavation • Fill placement and compaction • Paving • Ditch construction • Removal of existing infrastructure	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes along twinned section • Displacement of mammals • Direct mortality • Habitat creation (deactivated highway section) • Decreased habitat fragmentation / interruption of travel routes along deactivated highway section								
	• Blasting	• Disturbance of mammals								
	• Rehabilitation and restoration of disturbed areas	• Establishment of non-native species, leading to effects on mammal habitat								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
	• Revegetation of disturbed areas	• Changes in plant species communities, leading to effects on mammal habitat								
	• Highway operation	• Direct mortality via vehicle collisions • Disturbance of mammals • Habitat fragmentation								
	• Highway maintenance	• Damage to vegetated habitats • Attraction of mammals to salt pools								
	• Vegetation management	• Loss of foraging habitat • Mortality of mammals								
	• Infrastructure maintenance	• Mortality of mammals								
	• Use of heavy equipment (all activities)	• Collisions with vehicles/ Direct mortality • Disturbance of mammals/behavioural effects								
Wildlife: Birds	• Vegetation clearing	• Permanent and temporary loss of bird habitat • Permanent and temporary alteration and disruption of bird habitat • Habitat fragmentation • Nest (including eggs, nestling) destruction, disturbance, or abandonment • Disturbance of birds • Accidental mortality	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Flora Species and Habitats)** **Section 8.2.3.2 - Wildlife (as listed in Table 8.2 - Wildlife: Mammals)** • Activities potentially disruptive to birds or their nests will be avoided during the mid-April to end of August bird breeding period • Consultation with authorities must occur if disruptive clearing activities are planned within the breeding window • Prior to maintenance work, bridges should be inspected for nesting birds, and, if present, activities delayed until nesting is complete	L	L	H/L	L/H	H/L	L/M	NS
	• Grubbing and soil management • Wetland alteration • Excavation • Fill placement and compaction • Blasting • Ditch construction • Removal of existing infrastructure • Bridge and grade separation structure construction • Paving • Installation of highway infrastructure • Installation of watercourse crossings and diversions	• Permanent and temporary loss of bird habitat • Permanent and temporary alteration and disruption of bird habitat • Habitat fragmentation • Nest (including eggs, nestling) destruction, disturbance, or abandonment • Disturbance of birds • Temporary displacement of birds • Accidental mortality								
	• Rehabilitation and Restoration of disturbed areas • Revegetation of disturbed areas	• Establishment of non-native species • Changes in plant species communities								
	• Highway operation	• Permanent and temporary loss of bird habitat								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
	• Infrastructure maintenance • Vegetation management	• Habitat fragmentation • Nest (including eggs, nestling) destruction, disturbance, or abandonment • Temporary displacement of birds • Accidental mortality • Disturbance of birds/behavioural effects								
	• Use of heavy equipment (all activities)	• Direct mortality • Disturbance of birds/behavioural effects								
Wildlife: Reptiles and Amphibians	• Vegetation clearing	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation • Displacement of reptiles and amphibians • Mortality of reptiles and amphibians	**Section 8.2 - General (as listed in Table 8.2 – All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Wildlife: mammals)** **Section 8.2.3.2 - Wildlife (as listed in Table 8.2 - Wildlife: mammals)** **<u>Reptiles and Amphibians</u>** • Stream crossing structures to be properly designed to maintain habitat on either side of the stream	L	L	H/L	L/H	H/L	L/M	NS
	• Grubbing and soil management • Wetland removal • Fill placement and compaction • Excavation • Wetland alteration • Ditch construction • Removal of infrastructure	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation • Temporary and permanent displacement of reptiles and amphibians • Accidental mortality of reptiles and amphibians • Decreased habitat fragmentation (section of existing highway to be deactivated) • Habitat creation (section of existing highway to be deactivated)								
	• Rehabilitation and Restoration of disturbed areas • Revegetation of disturbed areas	• Establishment of non-native species • Changes in plant species communities, affecting reptiles and amphibians • Habitat creation (section of existing highway to be deactivated)								
	• Highway operation	• Direct mortality (roadkill) • Avoidance of area • Disturbance of wildlife								
	• Highway maintenance	• Contamination of watercourses/wetlands • Impacts of salt on larval amphibians								
	• Vegetation management	• Loss of foraging habitat • Displacement of reptiles and amphibians • Mortality of reptiles and amphibians								
	• Infrastructure maintenance	• Loss of foraging and breeding habitat								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Displacement of reptiles and amphibians • Mortality of reptiles and amphibians								
	• Use of heavy equipment (all activities)	• Collisions with vehicles/Mortality of reptiles and amphibians • Disturbance of reptiles and amphibians /behavioural effects								
Wetlands	• Vegetation clearing	• Changes to wetland functions (ecological/habitat functions and hydrologic functions) • Changes to plant community composition/reduction in wetland plant diversity	**Section 8.2 - General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Wildlife: mammals)** **Section 8.2.3.4 - Wetlands** • Wetland compensation program in consultation with NSE and NSDNR • Clearing operations in wetlands will conducted on frozen ground where possible • Manual clearing where ground conditions are not suitable for heavy equipment • Sediment fencing will be erected around construction areas prior to commencement of Site Preparation and Construction • A buffer of 5 m will be maintained adjacent to wetlands to be preserved, where possible • Sediment and erosion control measures • Runoff from stockpiled material to be directed away from wetlands and into settling basins • Temporary ancillary elements will avoid wetlands • Cleared areas within and immediately adjacent to wetlands should be re-seeded or otherwise re-vegetated in order to reduce erosion • Work to be stopped during periods of inclement weather (e.g., high winds, high rainfall) • Quarried, crushed material to be used for road building in and near wetlands to be preserved, to minimize introduction or spread of non-native or invasive plant species.	L	L	H	L	H	L/M	NS
	• Grubbing and soil management • Excavation • Blasting • Fill placement and compaction • Wetland alteration • Removal of existing infrastructure	• Loss of wetland area • Changes to wetland functions (ecological/habitat functions and hydrologic functions) • Changes to plant community composition/reduction in wetland plant diversity • Introduction and establishment of non-native plant species. Decline in native wetland plant diversity • Changes water quality and fish habitat quality • Loss of wildlife that inhabit or rely on wetlands for resources • Reduction in overall biodiversity								
	• Bridge and grade separation structure placement • Installation of watercourse crossings and diversions	• Changes to functions of wetlands associated with watercourses • Decreased surface water quality in wetlands and downstream • Reduced fish habitat downstream of wetlands								
	• Rehabilitation and restoration of disturbed areas	• Increased sedimentation into wetlands								
	• Revegetation	• Changes to biological processes (e.g., nutrient uptake by plants, decomposition rates) • Changes to wetland plant communities and diversity								
	• Infrastructure maintenance	• Changes to functions of wetlands associated with watercourses • Sediment loading in adjacent watercourses • Decreased surface water quality in wetlands and downstream • Reduced fish habitat downstream of wetlands								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
	• Vegetation management	• Reduction in wetland plant abundance • Reduction in surface water quality in wetlands • Reduction in fish habitat quality • Changes to plant community composition/reduction in wetland plant diversity • Introduction and establishment of non-native species. • Decline in native wetland plant diversity								
	• Highway maintenance	• Changes to salinity in wetland surface water and soils • Changes to vegetation communities								
	• Use of heavy equipment (all activities)	• Contamination of wetland water or soils								
Fish and Fish Habitat	• Vegetation clearing	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and/or displacement • Loss of fish	**Section 8.2 - General (as listed in Table 8.2 – All VECs)** **Section 8.2.2.2 - Surface Water and Groundwater Quality (as listed in Table 8.2 - Surface Water)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Wildlife: mammals)** **Section 8.2.3.3 - Fish and Fish Habitat** • Any 'serious harm' to fish and fish habitat shall be compensated for when required by DFO • Instream works timing window restrictions to be followed • If work is required outside of window, approval by both NSE and DFO to be obtained • Culverts and bridges designed to allow for fish passage for all watercourses crossings identified as having fish potential • Culvert crossings will meet the objectives of the *Guidelines for the Design of Fish Passage for Culverts in Nova Scotia* (DFO, 2015) • If sedimentation and erosion is an issue, potential impacts to fish and fish habitat further downstream of the site should be assessed • Mitigation measures for culvert and bridge replacements, modifications or extensions will follow the mitigation measures for construction activities. • Fish salvages to be conducted prior to dewatering activities during construction	L	L	H	L/H	H/L	L/M	NS
	• Grubbing and soil management • Excavation • Fill placement and compaction • Ditch construction • Removal of existing infrastructure	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and/or displacement • Loss of fish								
	• Installation of watercourse crossings, and diversions	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and/or displacement • Loss of fish								
	• Blasting	• Temporary loss of habitat • Temporary fish disruption and/or displacement								
	• Highway maintenance	• Change in water quality and invertebrate biodiversity due to salt in freshwater streams may limit fish species presence and abundance • Impacts to fish species' presence and abundance • Impacts on invertebrate biodiversity and abundance in freshwater streams								
	• Infrastructure maintenance at watercourse crossings	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and displacement • Loss of fish								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
	• Use of heavy equipment (all activities)	• Temporary loss of habitat • Temporary fish disruption and displacement	• Approval will be obtained from DFO prior to any blasting in or near watercourses and will be in compliance with the *Guidelines for Use of Explosives in or Near Canadian Fisheries Waters* • NSTIR's *Salt Management Plan*							
Species at Risk (SAR): Flora	• Vegetation clearing	• Loss of black ash specimens. • Loss and alteration of habitat for some species Increased habitat fragmentation • Unintentional introduction of non-native or invasive plant species via machinery	**Section 8.2 - General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Flora Species and Habitats)** **Section 8.2.3.1 - Flora (as listed in Table 8.2 - Flora Species and Habitats)** **Section 8.2.3.5 - Species at Risk (SAR) General** • NSDNR to be notified of any SAR observations during Construction phase • Best management practices • Compliance with *Endangered Species Act* and its regulations • Installation of wildlife crossing structures • Spans of bridges or culverts to be wide enough to permit wildlife passage • Watercourse crossing structures to be optimally designed and properly installed to reduce habitat fragmentation **<u>Flora</u>** • Herbicide use to be avoided near SAR and SOCC • Implement a black ash management and monitoring plan • Vegetated buffer to be maintained around SAR species observations, with post-construction monitoring of SAR observations to evaluate efficacy of the buffer	L/M	L	H	L/M	H	L/M	NS
	• Grubbing and soil management • Wetland removal • Wetland alteration • Excavation • Blasting • Fill placement and compaction • Ditch construction • Removal of existing infrastructure	• Loss and alteration of habitat for some species • Increased habitat fragmentation • Unintentional introduction of non-native or invasive plant species via machinery • Habitat creation (highway section to be deactivated) • Decreased habitat fragmentation (highway section to be deactivated)								
	• Rehabilitation and Restoration of disturbed areas • Revegetation	• Habitat creation • Intentional introduction of non-native plant species via hydro-seed mixes • Unintentional introduction of non-native or invasive plant species via machinery • Changes in community composition within and beyond maintained Right-of-Way								
	• Highway operation	• Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way								
	• Vegetation management • Infrastructure maintenance	• Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way • Loss and alteration of habitat for some species								
	• Highway maintenance	• Salinity impacts on black ash specimens • Habitat alteration • Changes in community composition within maintained Right-of-Way								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
	• Use of heavy equipment (all activities)	• Loss and alteration of habitat • Air quality impacts on sensitive lichens								
SAR: Mainland Moose	• Vegetation clearing	• Loss of foraging habitat • Loss of forested cover for shelter • Local level changes in abundance and distribution	**Section 8.2 - General (as listed in Table 8.2 – All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Flora Species and Habitats)** **Section 8.2.3.2 - Wildlife (as listed in Table 8.2 - Wildlife: Mammals)** **Section 8.2.3.5 - SAR General (as listed in Table 8.2 - SAR: Flora)** **<u>Mainland Moose</u>** • Fencing to be erected with wildlife crossing structures to facilitate the passage of moose across the highway • Buffer zones to be established and maintained between natural areas and new alignment • Passive warning signs and reduced speed limits in areas where moose may be present • Brush free zone maintained adjacent to the highway to reduce risk of collisions.	L	L	H	L/H	H	M	NS
	• Grubbing and soil management, • Excavation • Blasting • Fill placement and compaction • Ditch construction • Wetland alterations	• Loss of habitat suitable for thermoregulation • Local level changes in abundance and distribution								
	• Bridge and grade separation structure construction • Paving • Installation of highway infrastructure • Installation of watercourse crossings and diversions • Removal of existing infrastructure	• Disruption of movement corridors (section to be twinned) • Restriction of gene flow (section to be twinned) • Habitat creation (section to be deactivated) • Decreased habitat fragmentation (section to be deactivated)								
	• Rehabilitation and restoration of disturbed areas • Revegetation of disturbed areas	• Temporary disturbance of moose • Habitat creation (highway section to be deactivated) • Decreased habitat fragmentation (highway section to be deactivated) • Establishment of non-native species • Changes in plant species communities								
	• Highway operation	• Sensory disturbance • Avoidance of Project Area and disruption of movement corridors • Vehicular collisions and potential mortality • Restriction of gene flow								
	• Highway maintenance	• Changes to movement patterns of moose • Attraction to salt ponds along roads; and • Vehicle collisions and potential mortality								
	• Use of heavy equipment (all activities)	• Sensory disturbance • Avoidance of Project Area								
SAR: Bats	• Vegetation clearing	• Loss of day and night roosting habitats • Loss of maternity colony habitat • Loss of foraging habitat	**Section 8.2 - General (as listed in Table 8.2 - All VECs)**	L	L	H	L/H	H	M	NS

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Increased habitat fragmentation / interruption of travel routes	**Section 8.2.3- Biological Environment General (as listed in Table 8.2 - Flora Species and Habitats)** **Section 8.2.3.2 - Wildlife (as listed in Table 8.2 - Wildlife: Mammals)** **Section 8.2.3.5 - SAR General (as listed in Table 8.2 - SAR: Flora)** **<u>Bats</u>** • Tree clearing around watercourse and waterbodies adjacent to the highway shall be minimized, to encourage bats to cross at higher heights to minimize vehicle collisions.							
	• Grubbing and soil management • Excavation • Fill placement and compaction • Ditch construction • Removal of existing infrastructure	• Loss of day and night roosting habitats • Loss of maternity colony habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes) • Collisions with vehicles								
	• Blasting	• Disturbance to hibernating bats								
	• Rehabilitation and restoration of disturbed areas • Revegetation of disturbed areas	• Temporary disturbance of bats • Habitat creation (highway section to be deactivated) • Decreased habitat fragmentation (highway section to be deactivated) • Establishment of non-native species • Changes in plant species communities								
	• Highway operation	• Disturbance to bats • Collisions with vehicles • Increased habitat fragmentation / interruption of travel routes)								
	• Use of heavy equipment (all activities)	• Contamination of watercourses/wetlands • Accidental exposure to toxic substances • Damage to vegetated habitats • Disturbance to bats • Collisions with vehicles								
SAR: Birds	• See Wildlife: Birds	See Wildlife: Birds	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Flora Species and Habitats)** **Section 8.2.3.2 - Wildlife (as listed in Table 8.2 - Wildlife: Birds)** **Section 8.2.3.5 - SAR General (as listed in Table 8.2 - SAR: Flora)**	L	L	H	L/H	H	M	NS
SAR: Turtles	• Vegetation clearing	• Loss of potential habitat • Loss of potential nesting habitat • Loss of overwintering habitat • Loss of food resources • Accidental mortality • Sensory disturbance	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.3 - Biological Environment General (as listed in Table 8.2 - Flora Species and Habitats)** **Section 8.2.3.2 - Wildlife (as listed in Table 8.2 - Wildlife: Mammals)**	L	L	H	L/H	H	M	NS

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Displacement / Avoidance of Project area	**Section 8.2.3.5 - SAR General (as listed in Table 8.2 - SAR: Flora)** **<u>SAR Turtles</u>** • Onsite monitoring for turtles to be conducted prior to Site Preparation and Construction activities in wood turtle Critical Habitat areas • Permanent and temporary road and water crossings to be planned in advance to help prevent turtle mortality and protect water quality • Known sensitive wood turtle habitat sites will be identified and avoided when building new roads and water crossings • The amount of road that parallels a watercourse will be minimized							
	• Grubbing and soil management • Wetland alteration • Fill placement and compaction • Excavation • Blasting • Ditch construction • Bridge and grade separation structure/placement • Installation of watercourse crossings and diversions • Removal of existing infrastructure	• Loss of potential habitat • Accidental mortality • Sensory disturbance • Displacement / Avoidance of Project area • Loss of foraging habitat • Accidental mortality • Disruption of seasonal movement patterns • Increased habitat fragmentation							
	• Rehabilitation and restoration of disturbed areas	• Temporary disturbance of SAR turtles • Habitat creation (highway section to be deactivated)							
	• Revegetation of disturbed areas	• Temporary disturbance of SAR turtles • Habitat creation (highway section to be deactivated) • Establishment of non-native species • Changes in plant species communities							
	• Highway operation	• Direct mortality • Displacement / Avoidance of Project Area							
	• Vegetation management	• Accidental mortality							
	• Infrastructure maintenance	• Reduced water quality • Loss of overwintering habitat • Reduced survivorship							
	• Use of heavy equipment (all activities)	• Collisions with vehicles/Mortality • Disturbance of SAR turtles /behavioural effects							
Land Use	• Vegetation clearing	• Loss of Mi'kmaq land and resource use sites • Loss of Plant species of significance / harvesting areas	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.4.1 - Land Use** • Land acquisition and compensation will be in accordance with the Nova Scotia *Expropriation Act* and follow NSTIR's land acquisition procedures • The provision of alternate access or access roads will be considered when permanent legal accesses are impacted by the project. All existing accesses will be reviewed within the project limits. Service roads are an alternative to be considered to provide access to properties impacted by control of access designation or other access restrictions. The decision to construct a service road shall consider the feasibility and cost	M	M	H/M	H/ M	L/M/H	M	NS/ S/ PS
	• Grubbing and soil management	• Activities may not be compatible with surrounding or adjacent land or resource use activities as defined by planning measures of the *Municipal Government Act* • Loss of access to areas surrounding the project • Disruption or degradation of lands which affects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures. • Loss of Mi'kmaq land and resource use sites							

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
		• Loss of plant species of significance/ harvesting areas	effectiveness of all other alternatives, including: land purchase, transfer of land ownership, and acquisition of access rights • Construction activities will not interfere unnecessarily with public convenience of access to an any public or private roads, footpaths, highways or other transportation routes • Accommodation of access will be provided to forestry or agricultural operators, when reasonable and safe to do so • Traffic control and Detour Plans with required personnel • 'Temporary Traffic Accommodation On-Site Road Safety Audit' • Notification of detours and closures will be posted • All existing accesses (vehicular or pedestrian) will be maintained on all roadways and properties affected by the construction activities until alternative access is provided • Activities associated with the project schedule will be communicated with local communities and stakeholders • Coordinate operations on crossroads, service roads, or other private roads with the appropriate authorities during construction. The Proponent will obtain any necessary permits from government agencies such as NSTIR and/or Local Authority • Existing ATV and snowmobile trails will be accommodated when safe and feasible to do so • Land and resources currently used by Mi'kmaq for traditional purposes should be avoided where possible • New MEKS study will be executed							
	• Removal of existing infrastructure • Excavation • Blasting • Fill placement and compaction • Ditch construction • Bridge and grade separation structure construction • Rehabilitation / site restoration of affected areas • Revegetation	• Activities may not be compatible with surrounding or adjacent land or resource use activities as defined by planning measures of the *Municipal Government Act* • Loss of access to areas surrounding the project • Disruption or degradation of lands which affects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures • Disruption to human activities • Loss of Mi'kmaq land and resource use sites • Loss of Plant species of significance /harvesting areas							
	• Highway operation • Highway maintenance • Infrastructure maintenance • Vegetation management	• Disruption or degradation of lands which affects land so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures • Loss of access to areas surrounding the project • Loss of Mi'kmaq land and resource use sites • Loss of Plant species of significance /harvesting areas							
Human Health & Safety	• Removal of existing infrastructure • Excavation • Blasting • Rehabilitation / site restoration of disturbed areas • Revegetation of disturbed areas	• Disruption to human activities • Change in access to an area • Effect to Human Health and Safety • Disruption to human activities • Change in access to an area • Effect to Human Health and Safety	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.4.2 - Human Health and Safety** • Best management practices • Nova Scotia *Occupational Health and Safety Act* and regulations • *Nova Scotia Temporary Workplace Traffic Control Manual* • *TAC Manual of Uniform Traffic Control Devices for Canada* • All excavations will be filled prior to any hour of darkness and on non-working days • Any excavations within four metres of lanes carrying traffic will be backfilled and compacted prior to closing down operations each day • No materials or equipment will be stored within 10 m of the traveled portion of existing Highway 104, 7 m of Trunk 4, and 4 m of the traveled portion of all other roadways, except in the medians where the minimum clearance required is 2.5 m	-	-	-	-	-	-	NS
	• Highway operation • Highway maintenance • Infrastructure maintenance	• Disruption to human activities • Effects to Human Health and Safety								

Valued Environmental Components	Project Component	Description of Potential Environmental Effects	Recommended Mitigation Measures or Best Management Practices (BMPs)	After Mitigation Measures or BMPs						
				Magnitude	Geographic Extent	Duration	Frequency of Occurrence	Reversibility of Effects (Permanence)	Ecological Context	Significance of Residual Effect*
			• Highway roads condition information (such as the NSTIR 511 Road Conditions Call Line) will be updated as required							
Heritage & Archaeological Resources	• Vegetation clearing	• Disturbance or removal of Heritage and Archaeological Resources	**Section 8.2 - Project General (as listed in Table 8.2 - All VECs)** **Section 8.2.5.1 - Heritage and Archaeological Resources** • *Archaeology Contingency Plan* • If resources are encountered, any ground-disturbing activity must stop and the Coordinator of Special Places (902-424-6475) contacted immediately regarding suitable mitigation • A formal shovel testing program in areas identified as having possible or probable historic structures and elevated potential for historic or First Nations archaeological resources • Areas where historic structures are confirmed will have site-specific mitigation measures applied prior to construction, determined in consultation with NSTIR and NSCCH • If riverbanks in the Sutherland's River area not assessed are to be impacted, a follow-up survey should be conducted • The three sites which are considered to have elevated potential for archaeological resources (but which could not be assessed during the 2018 survey) be re-visited by a professional archaeologist after removal of the tree growth but prior to full grubbing, if possible • The French River Cemetery and a small buffer of approximately 5 m around the edges of the cleared field should be avoided by construction activity • Staging areas and siting of temporary ancillary elements will avoid archaeological resources, whenever possible • If Project Area changes prior to or during highway construction, an archaeologist should assess new potential impact areas	L	L	L	L	H	L	NS
	• Grubbing and soil management	• Disturbance or removal of Heritage and Archaeological Resources								
	• Excavation • Blasting • Fill placement and compaction • Ditch construction • Bridge and grade separation structure construction • Highway infrastructure placement • Installation of watercourse crossings and diversions • Wetland alterations • Removal of existing infrastructure	• Disturbance or removal of Heritage and Archaeological Resources								
	• Infrastructure maintenance • Vegetation management	• Disturbance or removal of Heritage and Archaeological Resources								

S: Significant adverse environmental effect
PS: Potentially significant adverse environmental effect
NS: Not significant adverse environmental effect
NA: Not required or not applicable
L: Low
M: Medium
H: High
Significance Criteria Definitions are included in Chapter 8

8.1 Potential Environmental Effects and Project-Related Interactions

Potential interactions between Project Components / Project Activities and VECs are identified in Table 8.3 to provide an indication of which activities under each project phase (Site Preparation, Construction, Operation and Maintenance) interact to create an effect within the boundaries.

The VECs were also evaluated to determine if there are interactions between the existing environment and characteristics (i.e., physical, biophysical, land use, and cultural conditions) and Project Components / Project Activities. The following table identifies the interaction and the rationale for selection of the VECs (Table 8.3).

Table 8.3 Interactions between VECs and Project Components

PROJECT PHASES / COMPONENTS	VALUED ENVIRONMENTAL COMPONENTS													
	Atmospheric Environment			Physical Environment			Biological Environment					Socio-Economic		Cultural
	Air Quality	Noise	Climate Change / Greenhouse Gases	Geology and Soil Quality	Surface Water Quality / Quantity	Groundwater Quality / Quantity	Flora	Wildlife / Wildlife Habitat	Wetlands	Fish and Fish Habitat	Species at Risk	Land Use	Human Health / Safety	Historical / Archaeological site
Site Preparations:														
Vegetation Clearing	X	X	X	X	X	X	X	X	X	X	X	X		X
Grubbing and Soil Management	X	X	X	X	X	X	X	X	X	X	X	X		X
Waste Recovery / Disposal														
Erosion and Sediment Control Measures									X					
Construction:														
Excavation	X	X		X	X	X	X	X	X	X	X	X	X	X
Blasting	X	X		X	X	X	X	X	X	X	X	X	X	X
Fill Placement and Compaction	X	X		X	X	X	X	X	X	X	X	X		X
Ditch Construction	X	X		X	X		X	X		X	X	X		X
Bridge and Grade Separation Structure Construction	X	X			X	X		X	X	X	X	X		X
Removal of Existing Infrastructure	X	X		X	X		X	X	X	X	X	X	X	X
Paving	X	X	X	X	X	X		X			X			
Highway Infrastructure		X						X			X			X
Installation of Watercourse Crossings and Diversions		X		X	X	X		X	X	X	X			X
Wetland Alterations		X	X	X	X	X	X	X	X		X			X
Rehabilitation / Site Restoration	X	X		X	X	X	X	X	X		X	X		
Revegetation	X	X		X	X	X	X	X	X		X	X		
Erosion and Sediment Control Measures												X		
Waste Recovery / Disposal												X		
Operation and Maintenance														
Highway Operation	X	X	X				X	X			X	X	X	
Highway Maintenance	X	X	X	X	X	X	X	X	X	X	X	X	X	
Infrastructure Maintenance		X	X	X	X		X	X	X	X	X	X	X	X
Vegetation Management		X		X	X		X	X	X		X	X		X

Legend: [Blank] = No Effect
[X] = Potential Significant Adverse Effect

8.1.1 Atmospheric Environment

The atmospheric environment was identified as requiring further assessment because of potential effects to the identified VECs of Air Quality, Noise, Climate Change and Greenhouse Gases.

Air quality includes the chemical and physical properties of the air surrounding the Project. Air is a potential pathway for the transport and eventual deposition of possible air contaminants to the natural environment, such as aquatic, terrestrial, and human environments. Effects to air quality may occur as a result of dust and particulate emissions from Project activities; therefore, 'Air Quality' was carried forward as a VEC and is described further is section 8.1.1.1.

Noise is commonly defined as unwanted sound or 'noise pollution' that can be disruptive to normal daily activities, thereby reducing the quality of the surrounding environment. Sound intensity, frequency, and duration all influence noise levels. The generation of noise during Project activities has the potential to affects humans and wildlife; as a result, 'Noise' was carried forward as a VEC and is described further is Section 8.1.1.2.

As indicated in the document 'Incorporating *Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners'* (Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003), the effects of a project on climate change and greenhouse gases are important to consider when conducting an environmental assessment. Therefore, 'Climate Change and Greenhouse Gases' was carried forward as a VEC and is described further in Section 8.1.1.3.

8.1.1.1 Air Quality

Ambient air quality within the Project area is currently considered good, as recent data from the National Air Pollution Surveillance (NAPS) Program (ECCC, 2013b) indicate that CO, NO_2, O_3, and SO_2 concentrations detected at monitoring stations within proximity of the Project area do not exceed the provincial maximum permissible ground level concentrations outlined in the *Air Quality Regulations* (Table 8.4). Additionally, $PM_{2.5}$ and O_3 did not exceed federal thresholds established under the *Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone* (ECCC, 2013a; Table 8.4). Further details on ambient air quality in Nova Scotia and within proximity to the Project area are discussed in Section 5.1.2.

Table 8.4 Annual air contaminant emissions (2016) within proximity to the Project area compared against federal and provincial regulatory thresholds

Air Contaminant	Averaging Period	Average Monthly Contaminant Concentration[1] (2016)	Average Monthly Contaminant Concentration Conversion (µg /m³)[2]	Regulatory Threshold (µg /m³)	
			(2016)	Federal[3]	Provincial[4]
Particulate Matter less than 2.5 microns ($PM_{2.5}$)	24-hour	5 µg/m3[5]	5.0	28 (2015) 27 (2020)	--
	Annual	--	--	10 (2015) 8.8 (2020)	--
Sulphur Dioxide (SO_2)	1-hour	0.6 ppb[6]	1.9	--	900
	24-hour	0.6 ppb[6]	1.9	--	300
	Annual	--		--	60
Nitrogen Dioxide (NO_2)	1-hour	1 ppb[5]	2.3	--	400
	Annual	--	--	--	100
Carbon Monoxide (CO)	1-hour	0.2 ppm[7]	274.5	--	34,600
	8-hour	0.2 ppm[7]	274.5	--	12,700
Ozone (O_3)	1-hour	23 ppb[5]	54.1	--	160
	8-hour	23 ppb[5]	54.1	135 (2015) 133 (2020)	--

[1] Source: ECCC 2013b.
[2] Concentrations converted to µg /m³ using conversion formula [0.049*concentration (ppb)*molecular weight]
(Source: Boguski 2006)
[3] Based on *Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone* (ECCC 2013a)
[4] As outlined in the *Ambient Air Quality Regulations* pursuant to Section 25 and 112 of the *Environment Act*
[5] Average monthly air contaminant concentration obtained from Pictou air quality monitoring station
[6] Average monthly air contaminant concentration obtained from Port Hawkesbury air monitoring station
[7] Average monthly air contaminant concentration obtained from Halifax air quality monitoring station

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. The temporal boundaries for the assessment of the potential effects of the Project activities on Air Quality includes the lifetime of the Project and beyond. Potential changes to air quality during the Site Preparation and Construction phases are anticipated to range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to be indefinite. Spatial boundaries are limited to the immediate Project area and within approximately 300 m of the Project Area. This boundary was consistent with that used in previous environmental assessments conducted on highway twinning projects in Nova Scotia. The area within 300 m of the Project Area would encompass both the Local Assessment Area and the Regional Assessment Area.

Significance Determination

For air quality, a residual environmental effect was deemed significant if, after implementing appropriate mitigation measures, the maximum permissible ground level concentrations for Project-related emissions of interest (e.g., CO, NO_2, O_3, SO_2, $PM_{2.5}$) exceed criteria set in the *Air Quality Regulations* or the CAAQS (see Table 4.4).

Potential Environmental Effects and Project-Related Interactions

There is potential for the proposed Project to adversely impact air quality due to generation of emissions from combustible fuels and dust generated through use of heavy machinery or vehicular traffic. Dust and combustible fuel emissions are anticipated to be short-lived, dissipating within 300 m of the Project area as a result of ambient winds. As such, potential impacts to air quality are anticipated to be temporary.

Potential impacts to air quality associated with the proposed Project are summarized in Table 8.5. These impacts can occur during both the initial Site Preparation and Construction phase activities and subsequent Operation and Maintenance phase activities. Project activities during each of these phases and their potential effects on air quality are discussed in the following subsections. Note that while it is technically not a Project activity, the use of heavy equipment throughout all Project phases can also potentially impact air quality and so is also discussed in Table 8.5.

Table 8.5 Summary of Potential Effects of Highway 104 Twinning Project on Air Quality

Project Component /Activities/ Physical Works	Alteration	Potential Effect on Air Quality*
Site Preparation and Construction Phases		
• Vegetation clearing	• Soil exposure due to clearing result in increased emissions of particulate matter (dust)	• Reduced air quality
• Grubbing and soil management • Construction activities - Excavation - Blasting - Fill placement and compaction - Ditch construction - Installation of highway infrastructure - Removal of existing infrastructure (deactivated Highway 104 section, culverts)	• Soil exposure due to ground disturbance may result in increased emissions of particulate matter (dust)	• Reduced air quality • Emission exceedances above *Air Quality Regulations* • Emission exceedances above CAAQS

Project Component /Activities/ Physical Works	Alteration	Potential Effect on Air Quality*
• Paving	• The use of a mobile asphalt plant and associated paving equipment may result in the following emissions: - Total suspended particulate matter (TSP) - Polycyclic aromatic hydrocarbons (PAHs) - Volatile organic compounds (VOCs) - Combustion gases	
• Rehabilitation / Site restoration	• Soil exposure due to ground disturbance may result in increased emissions of particulate matter (dust)	• Reduced air quality
• Revegetation (planting, and hydroseeding)	• Revegetation will result in soil stabilization and a reduction in dust generation	• Improved air quality relative to site clearing and construction activities
Operation and Maintenance Phase		
• Highway operation	• Vehicle traffic will result in emissions of: - Combustion gases - Noise	• Reduced air quality
All Phases- Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• The use of heavy equipment may result in emissions of: - Noise - Total suspended particulate matter (TSP) - Combustion gases, such as carbon monoxide (CO), sulphur dioxide (SO2), and nitrogen oxides (NOx) • Paving equipment may also result in emissions of - Polycyclic aromatic hydrocarbons (PAHs) - Volatile organic compounds (VOCs)	• Reduced air quality • Emission exceedances above *Air Quality Regulations* • Emission exceedances above CAAQS

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

Activities occurring during the Site Preparation and Construction phases which have the potential to have an impact on Air Quality are discussed in the following subsections.

Vegetation Clearing

Initial Site Preparation, in the form of vegetation clearing, will entail the removal of all forested areas within the Project Area. Impacts to air quality associated with vegetation clearing are anticipated to be minimal as grubbing will not occur as part of vegetation clearing and any areas of soil exposed by heavy equipment traffic will be stabilized using mulch, hydroseed, or similar, and will not be left exposed for any extended period.

Grubbing and Soil Management

The grubbing and soil management portion of the Site Preparation phase will entail the removal and stockpiling of topsoil (including humus and other organic material), leading to exposure of underlying mineral soils and the potential for emissions of particulate matter (i.e., dust generation). Impacts to air quality associated with grubbing and soil management activities are anticipated to be minimal as exposed soils will be quickly stabilized using mulch, hydroseed, or similar, and are not typically intended to be exposed for any extended period.

It is anticipated that particulate matter emissions will be highest during the Construction phase, as the use of heavy equipment on unpaved surfaces (e.g., access roads, laydown areas, and portions of unpaved road) will be required for several Project activities. Such activities include the removal of existing infrastructure, excavation, blasting, fill placement, grading, and ditch construction.

Construction Activities

It is anticipated that particulate matter emissions will be highest during the Construction phase, as the use of heavy equipment on unpaved surfaces (e.g., access roads, laydown areas, and portions of unpaved road) will be required for several Project activities. Such activities include the removal of existing infrastructure, excavation, blasting, fill placement, grading, installation of highway infrastructure, and ditch construction. The Construction phase may also include the removal of the section of the existing highway 104 to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and any required soil stabilization activities) between Browns Mountain Road and Pushie Road. Potential impacts to air quality are similar to those for other Construction phase activities, i.e., emissions of particulate matter.

Dust emissions during Construction phase activities are anticipated to be short-lived, dissipating within 300 m of the generation site as a result of ambient winds; however, mitigation measures will be implemented to minimize potential impacts to air quality. Note that combustion gases emitted by heavy equipment are treated separately from physical impacts of heavy equipment discussed here and are addressed later in this section.

Paving

In addition to the usual combustion emissions from heavy equipment (discussed later in this section), the mobile paving plant will also produce emissions of volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The majority of paving activities will occur during the Construction phase, with minor paving activities occurring as needed during the Operation and Maintenance phase. Emissions are anticipated to be short-lived, dissipating within 300 m of the generation site as a result of ambient winds, however mitigation measures will be implemented to minimize potential impacts to air quality.

Rehabilitation, Restoration, and Revegetation of Disturbed Areas

Rehabilitation, restoration, and revegetation of areas disturbed by Project Activities may be required. Rehabilitation and restoration activities such as contouring and grading may result in increased dust emissions, however this effect will be short-lived and dissipate within 300 m of the generation site. The final step in restoration, revegetation, will result in the stabilization of areas of exposed soils and lead to a decrease in dust generation and an overall increase in local air quality.

Operation and Maintenance Phase – Activities

Activities occurring during the Operation and Maintenance phase which have the potential to have an impact on Air Quality are discussed in the following subsections.

Highway Operation (Traffic)

The Operation and Maintenance phase of the proposed Project may impact air quality primarily from gas emissions associated with vehicular traffic. (Note that emissions from heavy equipment are discussed separately, in the following section).

The project is not expected to cause a regional increase in GHG and air emissions as it is not expected to result in increased traffic on Highway 104. Furthermore, there could be a net reduction in GHG emissions due to an operations impact on GHG, emissions are negligible contributions to overall atmospheric quality.

Due to a more efficient and safer traffic flow, the highway may contribute positively to reduction in long idling associated with delay events due to collisions, in acceleration/deceleration events and idling events due to congestion associated with peak season ADT levels. The Project also increases the resiliency of the transportation network, allowing for potential traffic flow management in the event of lane closures on the Project or on other ancillary routes again thereby reducing congestion and idling events.

Dust generation, and subsequent particulate matter emissions, may occur during the Operation and Maintenance phase, but is expected to be lower than emissions during Site Preparation and Construction phase, since the road surface will be paved.

All Phases – Operation and Maintenance of Heavy Equipment

The heavy equipment used for the Site Preparation, Construction, and Operations and Maintenance phase activities (e.g., earth movers, excavators, dump trucks, graders, paving equipment, snow plows, and salt trucks) are typically diesel powered. The use of such equipment results in the release of combustion gases, such as carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen oxides (NO_x), as well as particulate matter (dust). In addition to these emissions, the use of mobile paving equipment may result in emissions of volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs).

Combustible gas emissions are anticipated to be short-lived, dissipating within 300 m of the generation site as a result of ambient winds, however mitigation measures will be implemented to minimize potential impacts to air quality.

Such equipment will also create noise emissions, which are discussed in Section 8.1.1.2.

8.1.1.2 Noise

Noise pollution can disrupt normal daily activities, thereby reducing the quality of the surrounding environment. The intensity or 'sound pressure level' of noise is measured in logarithmic units called decibels (dB). The A-weighted decibel (dBA) is used to evaluate community noise (e.g., noise from traffic or construction equipment) and its effects on humans, since dBA compensates for the varying ability for humans to detect very high and low pitched sounds.

The formerly named Nova Scotia Department of Environment and Labour developed *Guidelines for Environmental Noise Measurement and Assessment* in Nova Scotia (NSDEL, 1990). Within these guidelines, noise criteria for different periods of the day were established as follows:

- $L_{eq} \leq$ 65 dBA between 7:00 am and 7:00 pm (day);
- $L_{eq} \leq$ 60 dBA between 7:00 pm and 11:00 pm (evening); and
- $L_{eq} \leq$ 55 dBA between 11:00 pm and 7:00 am (night).

Within the Municipality of the County of Antigonish, the following noise criteria have been established under the regional 'Noise By-Law':

- $L_{eq} \leq$ 90 dBA between 7:00 am and 7:00 pm (day);
- $L_{eq} \leq$ 90 dBA between 7:00 pm and 10:00 pm (evening); and
- $L_{eq} \leq$ 70 dBA between 10:00 pm and 7:00 am (night).

Several limitations regarding noise criteria outlined in the *Guidelines for Environmental Noise Measurement and Assessment* in Nova Scotia (NSDEL, 1990) and the Municipality of the County of Antigonish 'Noise By-Law' are important to note:

- Transportation, as a noise source, was excluded from the guidelines;
- Municipal by-law does not apply to noise caused by the Province of Nova Scotia and their contractors and employees between the hours of 7:00 am and 10:00 pm while acting within reasonable execution of their duties; and
- No noise by-laws exist for the Municipality of Pictou County.

Despite these limitations, the *Guidelines for Environmental Noise Measurement and Assessment* in Nova Scotia (NSDEL, 1990) and the Municipality of the County of Antigonish 'Noise By-Law' have been adopted for this assessment in lieu of alternate regulatory limits within the Province of Nova Scotia.

The provincial *Pit and Quarry Guidelines* (NSEL, 1999) state criteria similar to the *Guidelines for Environmental Noise Measurement and Assessment*:

- $L_{eq} \leq$ 65 dBA between 7:00 am and 7:00 pm (day);
- $L_{eq} \leq$ 60 dBA between 7:00 pm and 10:00 pm (evening); and
- $L_{eq} \leq$ 55 dBA between 10:00 pm and 7:00 am (night).

These criteria will also apply to any borrow pits or quarries utilized as part of the construction of the Project.

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. The temporal boundaries for the assessment of the potential effects of the Project activities on Noise includes the lifetime of the Project and beyond. Potential changes to noise quality are anticipated to occur during periods of Site Preparation, Construction, and Operation and Maintenance. The duration of Site Preparation and Construction phases are anticipated to range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to be indefinite. Spatial boundaries are limited to the immediate Project area and within approximately 300 m of the Project area, which would encompass both the Local Assessment Area and the Regional Assessment Area.

Significance Determination

For noise, a residual environmental effect, following the implementation of mitigation measures, was determined as significant if the maximum Project-related emissions of noise meet one of the following criteria:

- Sound levels (dBA) exceed criteria established under the provincial guideline and municipal by-law;
- A change of 5 dBA where an exceedance of the *Guidelines for Environmental Noise Measurement and Assessment* and by-law already exists; or
- An increase in 10 dBA where the guideline and by-law are not in exceedance.

Potential Environmental Effects and Project-Related Interactions

There is potential for the proposed Project to adversely impact sound quality as a result of noise emissions associated with the use of heavy machinery. Potential impacts to ambient noise are summarized in Table 8.6. These impacts can occur during both Site Preparation and Construction phase activities and subsequent Operation and Maintenance phases. Project activities during each of these phases and their potential effects on noise are discussed in the following subsections.

Potential impacts to noise levels associated with the proposed Project are summarized in Table 8.6. These impacts can occur during both the initial Site Preparation and Construction phase activities and subsequent Operation and Maintenance phase activities. Project activities during each of these phases and their potential effects on noise levels are discussed in the following subsections. Note that while it is technically not a Project activity, the use of heavy equipment throughout all Project phases can also potentially impact noise levels and so is also discussed in Table 8.6.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to noise are discussed in Section 8.2.

Table 8.6 Summary of Potential Effects of Highway 104 Twinning Project on Noise Environment

Project Component / Activities / Physical Works	Alteration	Potential Effects on Noise Environment*
Site Preparation and Construction Phases		
• Vegetation clearing	• Noise emissions • Removal of forests	• Decrease in 'dampening' effect on existing highway noise, leading to an increase in noise levels above background levels
• Site Preparation and Construction activities, including: - Grubbing and soil management - Removal of infrastructure - Excavation - Blasting - Fill placement and compaction - Ditch construction - Bridge and grade separation structure construction - Installation of highway infrastructure - Installation of watercourse crossings and diversions - Wetland alteration - Paving - Rehabilitation / Site restoration - Revegetation	• Noise emissions	• Sound levels (dBA) exceeding provincial guidelines and municipal by-laws

Project Component / Activities / Physical Works	Alteration	Potential Effects on Noise Environment*
Operation and Maintenance Phase		
• Highway operation (Vehicular traffic)	• Noise emissions	• Sound levels (dBA) exceeding provincial guidelines and municipal by-laws
• Highway maintenance - Snow removal - Road salt application	• Noise emissions	• Increase in sound levels above background levels
• Infrastructure maintenance and Vegetation Control - Vegetation mowing/cutting - Paint-striping - Ditch maintenance - Re-paving, as required	• Noise emissions	• Increase in sound levels above background levels
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Noise emissions	• Increase in noise levels above background levels • Sound levels (dBA) exceeding provincial guidelines and municipal by-laws

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases – Activities

Activities occurring during the Site Preparation and Construction phases which have the potential to have an impact on Noise levels are discussed in the following subsections.

Vegetation Clearing

Initial site preparation, in the form of vegetation clearing, will entail the removal of all forested areas within the Project Area. The removal of forests could lead to a decrease in the 'dampening' effect of vegetation and a slight increase in baseline noise levels in parts of the Project Area.

Site Preparation and Construction

Some noise will be generated by equipment utilized for clearing and hauling away vegetation. Changes in background noise levels are anticipated to be temporary in nature, and spatially localized (within 300 m of the noise source) during the Site Clearing and Construction phases of the Project.

The Site Preparation and Construction phase activities will lead to a slight increase in background noise levels. Changes in background noise levels are anticipated to be temporary in nature, and spatially localized (within 300 m of the noise source) during the Site Clearing and Construction phases of the Project. Note that noise generated by heavy equipment is discussed separately, later in this section.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility that NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and any required soil stabilization activities) between Browns Mountain Road and Pushie Road. Potential impacts are similar to those discussed during other Construction phase activities, i.e., noise emissions and an increase in background noise levels. Noise emissions are anticipated to be temporary, and spatially localized (dissipating within 300 m of the generation site) during the deactivation of the existing alignment through Marshy Hope. No significant effects are predicted.

Operation and Maintenance Phase - Activities

Activities occurring during the Operation and Maintenance phase which have the potential to have an impact on Noise are discussed in the following subsections.

Highway Operation

Noise emissions during the Operation and Maintenance phase of the Project will occur as a result of vehicular traffic. During operation, traffic volume is not anticipated to increase relative to current volume. Subsequently, noise emissions associated with vehicular traffic during operation are not expected to differ significantly relative to baseline noise levels (Table 5.7) for the twinning portions of the Project; however, through the new four-lane alignment south of the existing highway of the project, noise levels (Leq) will likely increase from baseline due to the currently rural and forested nature of that area.

All Phases – Operation and Maintenance of Heavy Equipment

Site Preparation and Construction activities, such as grubbing & soil management, excavation, fill placement and compaction will require the use of heavy equipment (e.g., earth movers, excavators, dump trucks, and graders). Noise emissions resulting from the use of heavy equipment during these Project activities may result in changes to background noise levels. Changes in background noise levels are anticipated to be temporary in nature, and spatially localized (within 300 m of the noise source), during the Site Clearing and Construction phases of the Project.

The use of machinery for maintenance activities, such as snow removal, road salt application, vegetation control, and infrastructure maintenance, will result in noise emissions and changes to background noise levels during the Operations and Maintenance phase of the proposed Project. Such activities will occur throughout the lifespan of the Operation and Maintenance phase but are anticipated to be localized (to within 300 m), relatively short in duration, and occur primarily during daytime hours.

8.1.1.3 Climate Change and Greenhouse Gases

As discussed in Section 5.1.3, the Government of Canada has indicated its intent to address climate change by reducing national GHG emissions to 30% below 2005 levels by the year 2030; Nova Scotia aims to reduce GHG emissions by 10% by the year 2020. According to 2005-2016 data published in the *National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada – Executive*

Summary 2018, Nova Scotia has already achieved both of these goals (Table 5.3). Between 2005 and 2016, construction GHG emissions were consistently low (1 Mt CO_2 eq), contributing <1% to total GHG emissions recorded for the Energy IPCC Sector; GHG emissions from road transport increased between 2005 and 2016 from 129 to 143 Mt CO_2 eq (Table 5.4).

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. The temporal boundaries for the assessment of the potential effects of the Project activities on Climate Change and Greenhouse Gases includes the lifetime of the Project and beyond. GHG emissions are expected to occur during periods of Site Preparation, Construction, and Operation and Maintenance. The duration of the Site Preparation and Construction phases are anticipated to range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to occur indefinitely.

Spatial boundaries are limited to the immediate Project area and within approximately 300 m of the Project area, which would encompass both the Local Assessment Area and the Regional Assessment Area.

Significance Determination

Provincial guidance documents for assessing climate change outlined in Section 4.2.2.1 do not provide protocol for determining significance for Climate Change and GHG emissions. The guidance document *Incorporating Climate Change Considerations in Environmental Assessment: General Guidance for Practitioners* (Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment, 2003) states that "unlike most project related environmental effects, the contribution of an individual project to climate change cannot be measured" (p.4). Since impacts of an individual project to climate change and GHG emissions is not accurately measurable, significance determination for GHG emissions was not possible. Instead, the Guidelines indicate that focus should be directed to GHG emissions levels (i.e., low, medium, or high levels) associated with the Project. Subsequently, emitter levels (i.e., low, medium, or high) were used as a proxy for 'Climate Change and Greenhouse Gases' in the current assessment to determine whether a GHG Management Plan will be required. Information on emitter levels was obtained from the *National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada – Executive Summary 2018* (ECCC, 2018).

Potential Environmental Effects and Project-Related Interactions

There is potential for the proposed Project to result in GHG emissions due to the use of vehicles, equipment and heavy machinery. Potential impacts to GHG emitter levels are summarized in Table 8.7. These impacts can occur during both the initial construction activities and the subsequent Operation and Maintenance phases. Project activities during each of these phases and their potential effects on GHG emitter levels are discussed in the following subsections.

Table 8.7 Summary of Potential Effects of Highway 104 Twinning Project on GHG Emission Levels

Project Component / Activities / Physical Works	Alteration	Potential Effect GHG Emission Levels*
Site Preparation and Construction Phases		
• Vegetation clearing	• Loss of carbon sequestration and carbon storage capacity in the Project landscape	• Minimal changes to the GHG net balance in the local area
• Site Preparation and Construction activities - Grubbing and soil management - Wetland alteration	• Loss of carbon sequestration and carbon storage capacity in the Project landscape	• Minimal changes to the GHG net balance in the local are
• Paving	• The use of a mobile asphalt plant and associated paving equipment may result in emissions of: - Total suspended particulate matter (TSP) - Polycyclic aromatic hydrocarbons (PAHs) - Volatile organic compounds (VOCs) • Combustion gasses	• Minimal changes to the GHG net balance in the local area
Operation and Maintenance Phase		
• Highway operation (traffic)	• Changes to GHG emitter levels	• Increase in provincial and national GHG emissions
• Infrastructure maintenance (Re-paving, as required)	• Changes to GHG emitter levels	• Increase in provincial and national GHG emissions
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Changes to GHG emitter levels	• Increase in provincial and national GHG emissions

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases – Activities

Activities occurring during the Site Preparation and Construction Phases which have the potential to have an impact on Climate Change and Greenhouse Gas Emissions are discussed in the following subsections.

Vegetation Clearing

Removal of forests will result in removal of carbon sequestration and carbon storage capacity in the Project landscape. This may lead to minimal changes to the GHG net balance in the local area, among which boundaries include the Project Area, LAA, and RAA.

Site Preparation and Construction

Grubbing and soil management and other ground-disturbance activities during the Site Preparation and Construction phase will also result in removal of carbon sequestration and carbon storage capacity in the Project landscape. This may lead to minimal changes to the GHG net balance in the local area, among which boundaries include the Project Area, LAA, and RAA.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and any required soil stabilization activities) between Browns Mountain Road and Pushie Road. Potential impacts are similar to other Construction phase activities, though at a much smaller scale. No significant effects are predicted. The eventual establishment of forest habitat along this corridor could also lead to a positive impact on the GHG net balance in the local area.

Operation and Maintenance Phase – Activities

Activities occurring during the Operation and Maintenance phase which have the potential to have an impact on Climate Change and Greenhouse Gas Emissions are discussed in the following subsections.

Highway Operation

The Operation and Maintenance phase of the Project is not anticipated to result in increased traffic flow but instead improve the efficiency of transportation along Highway 104 by reducing congestion and travel time. Subsequently, no increases to GHG emissions or impacts to global climate change are anticipated to result from vehicular traffic during this phase. Use of equipment with diesel combustion engines for maintenance operations (e.g., snow removal and vegetation control) is anticipated to result in low levels of GHG emissions. Combustible gas emissions are anticipated to be short-lived, dissipating within 300 m of the Project area as a result of ambient winds.

All Phases – Operation and Maintenance of Heavy Equipment

During Site Preparation and Construction, the operation of heavy equipment (e.g. front-end loaders, excavators, and bulldozers) with internal combustion engines (typically diesel fuelled) for Project activities (e.g., clearing and grubbing, excavation, blasting, grading, and paving) will result in the release of GHG emissions. As indicated in Table 5.1, national GHG emissions associated with construction activities were consistently low between 2005 and 2016, accounting for only 0.001% of total GHG emissions within the Energy Sector. As indicated in Section 5.1.4, the IPCC Sector that applies to this Project is ‘Energy’, which includes combustion energy sources associated with construction. Some GHG emissions will also occur during Operation and Maintenance phase activities; however, the magnitude will be considerably smaller than during the Site Preparation and Construction phases.

8.1.2 Physical Environment

The physical environment was identified as requiring further assessment because of potential effects to the identified VECs of Geology and Soil Quality, Surface Water Quality, and Hydrogeology and Groundwater Quality.

Geology and Soil Quality includes the existing topsoil, subsoil, and bedrock layers that comprise the ground surrounding the Project. Soils play important roles in local ecosystems. Effects to soil quality may result as a result of Project activities therefore, 'Geology and Soil Quality' was carried forward as VEC and is described further in Section 8.1.2.1.

Surface Water includes the existing aboveground water in the area surrounding the Project. Surface water is a potential pathway for the transport and eventual deposition of sediments and contaminants to other aspects of the natural environment, such as aquatic, wetland, terrestrial, and human environments. Effects to water quality may occur result from ground disturbance required for this Project therefore, 'Surface Water Quality' was carried forward as VEC and is described further in Section 8.1.2.2.

Hydrogeology and Groundwater Quality refers to the interaction between subsurface rock and water, and the quality of this water. Groundwater is also a potential pathway for the transport and eventual deposition of sediments and contaminants to other aspects of the natural environment, such as aquatic, wetland, terrestrial, and human environments. Effects to water quality may occur as a result of the ground disturbance required for this Project therefore, 'Hydrogeology and Groundwater Quality' was carried forward as VEC and is described further in Section 8.1.2.3.

8.1.2.1 Geology and Soil Quality

The geological setting is described in Section 5.2.1. The potential for changes to geology, soils, and geochemistry and quality is discussed below.

Boundaries

The spatial boundary for potential geological effects is delineated by the area within 300 metres of the proposed corridor.

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. Potential impacts to geology are expected to occur during periods of Site Preparation, Construction and Operation and Maintenance. The duration of Site Preparation and Construction phases is anticipated to range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to occur indefinitely.

Significance Determination

A residual environmental effect on geology and soil quality was determined to be significant if, after following the implementation of mitigation measures, the following criteria was met for effects to Geology and Soils:

- Soil chemical concentrations exceed the CSR criteria for the site land use as a result of project activities.

Potential Environmental Effects and Project-Related Interactions

Activities such as ground disturbance, blasting, road salting, and highway maintenance may result in effects on geology and soils. Potential impacts to geology and soil quality are summarized in Table 8.8. These impacts can occur during both the initial Site Preparation and Construction activities, and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on geology and soil quality are discussed in the following subsections.

Table 8.8 Summary of Potential Effects of Highway 104 Twinning Project on Geology and Soil Quality

Project Component / Activities / Physical Works	Alteration	Potential Effect On Geology and Soil Quality*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of forests • Ground disturbance	• Changes in sediment deposition patterns • Decreased soil quality
• Site Preparation and Construction activities, such as - Grubbing and soil management - Wetland alteration and removal - Removal of existing infrastructure - Fill placement and compaction including grading - Ditch construction	• Ground disturbance • Breaking and removal of bedrock • Removal of topsoil Altered surface hydrology • Potential contamination of soils or exposure of acid bedrock • Erosion of bare soil • Removal of asphalt (deactivated highway section)	• Changes in sediment deposition patterns • Decreased soil quality • Decreased asphalt leachate into soils (deactivated highway section)
• Excavation • Blasting	• Ground disturbance • Breaking and removal of bedrock • Altered surface hydrology • Potential contamination of soils or exposure of acid bedrock	• Alteration of bedrock layers • Changes in sediment deposition patterns • Soil erosion and sedimentation issues • Decreased soil quality
• Installation of watercourse crossings and diversions • Bridge and grade separation structure construction (i.e., concrete placement)	• Riverbank and/or substrate disturbance • Potential contamination of soils or exposure of acid bedrock	• Decreased soil quality

Project Component / Activities / Physical Works	Alteration	Potential Effect On Geology and Soil Quality*
• Paving	• Creation of a long strip of impervious surface material	• Effects to local soil characteristics via redirection of surface water runoff
• Rehabilitation / site restoration of affected areas	• Ground disturbance	• Temporary increase in erosion and sedimentation levels
• Revegetation (i.e., planting, and hydroseeding)	• Stabilization of bare soil	• Permanent decrease in erosion and sedimentation levels
Operation and Maintenance Phase		
• Highway maintenance: • Winter road salting	• Addition of salt to roadside terrestrial habitats	• Increased salinity of roadside soils • Decreased soil quality
• Highway maintenance: - Waste management - Snow removal - Sanding	• Accumulation of sand along roadsides and medians	• Altered soil characteristics on roadsides
• Infrastructure maintenance (minor): - Pavement - Shoulder - Watercourse crossings - culverts	• Ground disturbance • Erosion of bare soil	• Changes in sediment deposition patterns
• Vegetation management: - Vegetation removal - Mowing - Planting	• Minor ground disturbance • Addition of herbicides to roadside soils	• Decreased soil quality
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Accidental leaks and spills*	• Soil contamination

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phase – Activities

Vegetation Clearing

Removal of forests has minimal potential to impact geology and soils within the Project Area. Some small-scale disturbance of surface soils may occur but will be very localize spatially and will only occur once. The majority of the effects to geology and soils will occur during the Site Preparation and Construction phases, discussed below.

Site Preparation and Construction Activities

Some site preparation activities have the potential to cause impacts to geology and soil quality, as outlined in Table 8.8. Site clearing and highway construction activities have the greatest potential for impacts to geology and soils. Site clearing will involve clearing and grubbing of vegetation and removal of existing infrastructure, while roadbed preparation may require removal or alteration of wetlands, topsoil removal, blasting of bedrock (discussed below), grading, contouring, and ditch construction. All of these activities will cause changes to existing topography and can result in changes to bedrock and soils. All activities requiring ground disturbance will result in areas of bare soils, which are more prone to erosion. This increased erosion can then result in changes in sediment deposition patterns, leading to effects on soil characteristics. (Note that potential surface water impacts are discussed separately in Section 8.1.2.2).

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section may entail the removal of the existing asphalt and potentially culverts (and any required soil stabilization activities) between Browns Mountain Road and Pushie Road. The removal of asphalt and highway infrastructure, as well as any required soil stabilization activities along this section, will lead to ground disturbance and could cause local impacts to soil quality. These potential ground disturbance impacts will be of relatively small spatial extent and temporal duration, and as well as reversible. The magnitude of these impacts can be greatly reduced by the use of proper sediment and erosion control measures and surface water management.

Removal of the impervious asphalt layer and the potential re-contouring of some sections of the existing roadbed to a more natural state could positively impact soils by allowing natural ecological processes to occur and return the roadbed soils to a more natural state conducive to vegetation growth. This impact will be a one-time positive temporary effect which will be permanent. Revegetation of this section will also permit natural soil stabilization and ecological processes to occur.

Ground disturbance activities also have the potential to contaminate soils or to expose acidic bedrock. However, no acid-bearing bedrock is expected to occur within the Project Area, and any potential contamination impacts can be avoided or minimized with proper mitigation measures.

Excavation and Blasting

Excavation and blasting activities will be required for roadbed preparation. These activities will cause breaking and removal of bedrock and subsoil layers, which can lead to altered surface hydrology and then affect local erosion and sedimentation patterns. This can lead to localized changes in physical soil characteristics, such as particle size and deposition rate. However, with proper best management practices and mitigation, no decrease in soil quality will occur, as these activities will not result in deposition of any contaminants into soils within the Project Area. This impact is therefore not considered a significant effect.

Installation of Watercourse Crossings

The construction and installation of watercourse crossings (bridges and culverts) and their associated support structures will require disturbance of soils and possibly bedrock adjacent to watercourses, and possibly work within the larger watercourses. Damage to riparian zones and streambanks can cause increased erosion, leading to exposure of previously buried geology and soils. The magnitude of this erosion can be minimized with proper surface water control mitigation measures.

Removal or diversion of watercourses during the Construction phase can affect soil quality within the Project Area, by altering local sediment deposition patterns. However, this impact is temporary, infrequent, and of short duration. The magnitude can be minimized with proper surface water control mitigation measures

Paving

Paving of the twinned highway will result in the creation of a long strip of impervious material, which will affect local soil characteristics via redirection of precipitation inputs. This impact will be permanent, but the magnitude can be minimized with proper mitigation measures.

Operation and Maintenance Phase – Activities

The following aspects of post-construction highway Operation and Maintenance activities have been identified to possibly affect geology and soil quality, as identified in Table 8.8.

Highway Maintenance

Operation and Maintenance Activities, as outlined in Table 8.8, also have the potential to impact soil quality. This is mainly via salting of roads, which is conducted as part of winter road maintenance activities. Road salting can lead to increased salinity of roadside soils within the Project Area, especially after spring snow melt occurs. This can impact soil fertility, with potential impacts on local vegetation communities. While these impacts are likely to be seasonally frequent, with salting and sanding occurring as required for road safety, their magnitudes can be minimized with proper mitigation measures. Snow removal and sanding activities could also cause effects on soil quality by creating accumulations of sand-containing snow along the roadsides. This sand will be released quickly into surface waters and deposited on roadsides after spring snowmelt occurs. However, the sand used for traction control generally has too large of a grain size to be carried far by surface waters, except under very high flow conditions. Accumulations of sand can cause changes to local soil structure, with potential impacts on local vegetation communities. This impact is expected to be limited to the roadside and median but will be frequent and permanent. However, this impact will not cause contamination of soils, and so is not considered a significant impact. Proper mitigation measures will minimize any potential impacts of sand spreading on soil quality.

Infrastructure Maintenance

Periodic required maintenance of highway infrastructure could cause ground disturbance, with resulting impacts to geology and soils. Maintenance activities could include repair or replacement of paving, culverts, bridges, overpasses, and roadsides. Possible impacts will be similar to those

outlined for the Construction phase, however, impacts due to infrastructure maintenance activities will be of much lower magnitude than the Construction phase activities, will be infrequent, and will be very limited spatially and temporally. Proper mitigation measures will minimize or eliminate any potential impacts of such activities on geology and soil quality.

Vegetation Management

Maintenance of vegetation along the roadsides and median could potentially cause impacts to soil quality if herbicides are used for vegetation control. This possible impact should occur infrequently and be very limited spatially. Proper mitigation measures can minimize or eliminate any potential impacts of herbicide use on soil quality.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment throughout the Project lifecycle has some potential to affect soil quality within the Project area and downstream. This is mainly via accidental spills and leaks, which are discussed in Chapter 7, Accidents and Malfunctions. Ground disturbance by heavy equipment is discussed separately under both the Construction and Operations and Maintenance phases.

8.1.2.2 Surface Water Quality

As a result of the Project, portions of the Project Area will be re-contoured, and converted to impervious surfaces, such as asphalt. This has the potential to increase the rate of runoff as well as risks to release of sediment and soils from acts of construction or erosion. Surface water quality and quantity was selected as VEC for this assessment due to these risks.

A summary of the environmental setting, including physical qualities of surface water in the Project Area, is described in Section 5.2.

Boundaries

Areas of potential effects due to the Project could include watercourses and wetlands within the Project Area, and areas downstream of the Project Area. The spatial boundaries used for the assessment include the whole Project Area as well as sections of watercourses and wetlands occurring 20 m outside of the Project Area. In many cases, the effects are likely to be observed slightly downstream of the Project Area.

The temporal boundaries for the assessment of the potential effects of the Project activities on Surface Water Quality includes the lifetime of the Project and beyond. The temporal boundaries for potential effects to surface water quality from the twinning of Highway 104 include the construction and operation phases. The magnitude of potential effects will vary within the Project Area both temporally and spatially, depending on the types and timing of Project activities in relation to seasonal surface water abundance and drainage patterns.

Significance Determination

As part of the implementation of the Project, the Project will be designed to reduce effects from potential erosion and release of substances such as silt or soil. For example, slopes will be designed and built to appropriate standards, and drainage of the area should be maintained or improved as to reduce the risk of releases. As such, designing to approved standards and implementation of sediment and control measures will be the threshold for the determination of significance of effects to surface water.

A repeated or sustained exceedance of the CCME Freshwater Aquatic Life (FWAL) criteria for Total Suspended Solids (TSS) is considered a significant adverse effect on surface water quality. There are separate criteria for clear flow and high flow conditions.

Under clear flow conditions, the maximum allowable increase over background levels in 25 mg/L for a short-term (24 hour) exposure. For longer exposures (24 hours to 30 days), the limit is 5 mg/L over the background level.

Under high flow conditions, the maximum increase when background levels are between 25 and 250 mg/L is 25 mg/L. When background levels are higher than 250 mg/L, the levels should not increase by more than 10% of the background level.

Should contaminants be accidentally released into surface water, the Nova Scotia *Contaminated Sites Regulations – Tier 1 Environmental Quality Standards for the Protection of Freshwater Aquatic Life in Surface Water* (NSE, 2014: Section 1, Table 3) will apply. An exceedance of any of these criteria would be considered a significant adverse effect on surface water quality.

Potential Environmental Effects and Project-Related Interactions

Activities such as the disturbance of land, soil and geology, and highway maintenance may result in the release of debris, soil and sediment. Any such releases have the potential to adversely affect surface water quality of down-gradient watercourses and wetlands via site drainage. Potential impacts to surface water quality are summarized in Table 8.9. These impacts can occur during both the initial construction activities and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on Surface Water Quality are discussed in the following subsections.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Surface Water Quality are discussed in Section 8.2.

Table 8.9 Summary of Potential Effects of Highway 104 Twinning Project on Surface Water Quality

Project Component / Activities / Physical Works	Alteration	Potential Effect On Surface Water Quality*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of forests • Minor ground disturbance	• Increased run-off into watercourses and wetlands • Alteration of surface water flow patterns • Increased sediment load to watercourses
• Construction activities, such as: - Grubbing and soil management - Wetland alteration - Removal of existing infrastructure - Excavation - Blasting - Fill placement and compaction (including grading) - Ditch construction	• Ground disturbance • Removal of topsoil • Altered surface hydrology • Disturbance of contaminated soils or acid bedrock	• Alteration of surface water flow patterns • Increased sediment load to watercourses • Loss of aquatic habitat • Modified flow volumes • Modified stream velocity • Changes in sediment bed loads • Flooding • Decreased water quality
• Bridge and grade separation structure construction (i.e., concrete placement) • Installation of watercourse crossings and diversions	• Riverbank and/or substrate disturbance • Disturbance of contaminated soils or acid bedrock • Rerouting of watercourses • Interruption of flow	• Decreased water quality via increased sediment load or contaminants • Habitat degradation
• Paving	• Creation of impervious surfaces	• Alteration of local surface water hydrology
• Rehabilitation / site restoration of affected areas	• Ground disturbance • Erosion of bare soil	• Increased sediment load into watercourses
• Revegetation (i.e., planting, and hydroseeding)	• Minimal ground disturbance • Erosion of bare soil	• Stabilization of bare soils • Decreased sediment flow into watercourses
Operation and Maintenance Phase		
• Highway maintenance: - Winter Road Salting	• Addition of salt to roadside aquatic habitats	• Increased salinity of roadside watercourses (water and sediments) • Decreased water quality

Project Component / Activities / Physical Works	Alteration	Potential Effect On Surface Water Quality*
• Highway maintenance: - Snow removal - Sanding	• Accumulation of snow and sand along roadsides and medians due to plowing	• Decreased water quality after spring snowmelt
• Infrastructure maintenance (minor): - Pavement - Shoulder - Watercourse crossings - Culverts	• Ground disturbance • Erosion of bare soil	• Increased sediment load into watercourses
• Vegetation management: - Vegetation removal - Mowing - Planting	• Ground disturbance and erosion • Leaching of nutrients from cut vegetation	• Decreased water quality • Localized nutrient inputs
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Accidental leaks and spills*	• Surface water contamination

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases – Activities

Vegetation Clearing

The removal of forested areas has some potential to impact surface water quality. Once forests are removed, rainfall infiltration into these areas will decrease, resulting in increased runoff into nearby watercourses and wetlands. Some minor ground disturbance activities may also occur due to the use of heavy equipment for logging, leading to changes to existing microtopography and natural drainage patterns. Activities resulting in minor ground disturbance will also result in areas of bare soils, which are more prone to erosion. This increased erosion can then result in increased sedimentation in receiving watercourses and wetlands via sediment-laden runoff. (Note that potential aquatic habitat impacts are discussed in detail in Section 8.1.6 (Fish and Fish Habitat), while potential wetland impacts are discussed in Section 8.1.5 (Wetlands). Such impacts can be mitigated with proper erosion and sediment control techniques.

Site Preparation and Construction Activities

Many Site Preparation and Construction phase activities have the potential to cause impacts to surface water, as outlined in Table 8.9. Site clearing and roadbed construction activities have the greatest potential for impacts to surface water quality. Site clearing will involve clearing and grubbing of vegetation, removal of any existing infrastructure in some locations, while roadbed preparation may require removal or alteration of wetlands, topsoil removal, blasting, grading, contouring, and ditch construction. All of these activities will cause changes to existing topography and natural drainage patterns, which will impact flow to existing watercourses and wetlands. All

activities requiring ground disturbance will result in areas of bare soils, which are more prone to erosion. This increased erosion can then result in increased sedimentation in receiving watercourses and wetlands via sediment-laden runoff. (Note that potential aquatic habitat impacts are discussed in detail in Section 8.1.6 (Fish and Fish Habitat), while potential wetland impacts are discussed in Section 8.1.5 (Wetlands).

Ground disturbance activities also have the potential to disturb contaminated soils (if present), which could impact surface water quality. These activities may also increase exposure of soluble calcareous bedrock (e.g., gypsum and limestone) to the elements, which may exacerbate the erodibility of bedrock; this may result in increased runoff of base-rich waters to receiving aquatic features such as watercourses and wetlands. These potential impacts can be avoided or minimized with proper mitigation measures.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and culverts (and any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. The removal of asphalt and highway infrastructure along this section will lead to ground disturbance and could cause impacts to surface water quality. Re-contouring of the existing roadbed to a more natural state and the removal of culverts could impact downstream water quality via sediment input. This impact will be a one-time temporary and reversible effect which will be of relatively small spatial extent and temporal duration. The magnitude of this impact can be greatly reduced by the use of proper sediment and erosion control measures and surface water management, similar to those utilized during the Construction phase.

Bridge and Grade Separation Structure Construction

The construction and installation of watercourse crossings (bridges and culverts) and their associated support structures will require ground disturbance adjacent to watercourses, and possibly work within the larger watercourses. Damage to riparian zones and streambanks can cause increased erosion, leading to sediment-laden runoff entering the watercourse. Work directly within watercourses will result in disturbance of the substrate, leading to increased sediment loading in the watercourse. This decrease in water quality is temporary, infrequent, and of limited duration. The magnitude can be minimized with proper surface water control mitigation measures, and by using work-in-the-dry construction methodologies for installation of key watercourse crossings (whether bridge or culvert).

Watercourse Diversions and Watercourse Removals

Removal or diversion of watercourses during the Construction phase can affect surface water quality within the Project Area, by increasing sediment load in the watercourse. This could lead to habitat impacts within the Project Area and downstream. However, this impact is temporary, infrequent, and of short duration. The magnitude can be minimized with proper surface water control mitigation measures.

Paving

Paving of the twinned highway will result in the creation of a long strip of impervious material, which will affect local surface hydrology patterns via redirection of precipitation inputs. This impact will be permanent, but the magnitude can be minimized with proper mitigation measures.

Rehabilitation, Restoration and/or Revegetation of Disturbed Areas

Twinning of Highway 104 and deactivation of unused sections of Highway 104 may also require rehabilitation and revegetation activities to properly contour and stabilize areas of bare soil. This may require small localized areas of ground disturbance, in the form of contouring or infilling, and could affect surface water quality. Proper mitigation measures will minimize this effect.

The revegetation of bare soil areas will result in increased infiltration of surface water, and entrapment of suspended sediments, leading to decreased flow and decreased sedimentation rates into nearby watercourses, leading to an increase in local surface water quality.

Operation and Maintenance Phase – Activities

Operation and Maintenance activities have the potential to result in impacts to Surface Water Quality. These activities and potential impacts are described in the following subsections.

Highway Maintenance

Post-Construction Operation and Maintenance Activities, outlined in Table 8.9, also have the potential to impact surface water quality. This is mainly via winter road salting of roads, which is conducted as part of winter road maintenance activities. Road salting can lead to increased salinity of surface waters within the Project Area, especially after spring snow melt. This can impact habitats in watercourses and wetlands downstream of the Highway. While this impact is likely to be seasonally frequent, occurring as required for road safety, its magnitude can be minimized with proper mitigation measures.

Snow removal and sanding activities could cause effects on surface water quality by creating accumulations of sand-containing snow along the roadsides. This sand will be released quickly into surface waters after spring snowmelt occurs. However, the sand used for traction control generally has too large of a grain size to be carried far by surface waters, except under very high flow conditions. This impact is expected to be limited to the roadside and median, to be of short duration, and to occur only seasonally. Proper mitigation measures will minimize or eliminate any potential impacts of sand spreading on surface water quality.

Infrastructure Maintenance

Periodic required maintenance of highway infrastructure could cause ground disturbance, with resulting impacts to surface water quality. Maintenance activities could include repair or replacement of culverts, bridges, overpasses, and roadsides. Possible impacts will be much of much lower magnitude than during the Construction phase, will be infrequent, and will be very limited spatially and temporally. Proper mitigation measures will minimize or eliminate any potential impacts of such activities on surface water quality.

Vegetation Management

Maintenance of vegetation along the roadsides and median could potentially cause impacts to surface water quality. Ground disturbance is not expected to be a major issue, as mowing machines would generally be driving on vegetated ground, and wet soils (prone to rutting) would generally be avoided.

Planting of vegetation (though expected to be limited in application), could create temporary small areas of bare soil which could lead to sedimentation issues if soil is not stabilized. However, this potential impact is expected to be infrequent, very limited spatially and temporally, and can be mitigated with proper soil and erosion control mitigation measures.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment has some potential to affect surface water quality and quantity within the Project Area and downstream. This is mainly via accidental spills and leaks, which are discussed in Chapter 7, Accidents and Malfunctions. Ground disturbance by heavy equipment is discussed separately under Site Clearing and Construction Activities.

The impacts of the use of heavy equipment throughout the Operations and Maintenance phase are similar to those during the Site Preparation and Construction phase, but are of much smaller magnitude and spatial extent, as well as shorter duration. Similar mitigation measures will minimize any potential impacts to surface water quality.

8.1.2.3 Hydrogeology and Groundwater Quality

The hydrogeological setting is described in Section 5.2.3. The potential for changes to groundwater quantity and quality are discussed below. Groundwater quantity and quality affect the function of water wells and Groundwater Dependent Ecosystems (GDEs).

Boundaries

The spatial boundary for potential groundwater effects is delineated by the area within 300 metres of the proposed Project Area, shown in Figure 5.3, Figure 5.4 and Figure 5.5.

The temporal boundaries for the assessment of the potential effects of the Project activities on Hydrogeology and Groundwater Quality includes the lifetime of the Project and beyond. Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. Potential impacts to groundwater are expected to occur during periods of Site Preparation, Construction, and Operation and Maintenance. The duration of Site Preparation and Construction phases is anticipated to range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to be indefinite.

Significance Determination

Significant changes to the groundwater regime are those that impair the function of a drinking water well or a Groundwater Dependent Ecosystem (GDE). A residual environmental effect was

determined significant if the following conditions were met following the implementation of mitigation and off-setting:

- The yield of a well is reduced such that the quantity available is no longer adequate for the intended use;
- A well that provided potable water meeting the *Health Canada Guidelines for Canadian Drinking Water Quality* (GCDWQ) can no longer do so; and
- The quantity or quality of groundwater discharged to a stream or wetland is altered such that the pre-existing biota are adversely affected.

Potential Environmental Effects and Project-Related Interactions

Activities such as the disturbance of earth and bedrock may result in the release of debris, soil and sediment. Such releases may have the potential to adversely affect groundwater quality. Potential impacts to groundwater quality are summarized in Table 8.10. These impacts can occur during both initial construction activities and subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on ground water quality are discussed in the following subsections.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Hydrogeology and Groundwater Quality are discussed in Section 8.2.

Table 8.10 Summary of Potential Effects on Hydrogeology and Groundwater Quality

Project Component / Activities / Physical Works	Alteration	Potential Effect on Hydrogeology and Groundwater Quality*
Site Preparation and Construction Phases		
• Vegetation clearing	• Increased run-off to watercourses	• Decreased infiltration to groundwater table • Changes to ambient water temperature of receiving surface water • Increased nutrients / biological oxygen demand in surface water
• Construction Activities, such as - Grubbing and soil management - Excavation - Bridge and Grade Separation Structure Construction - Fill placement and compaction for the highways and access roads	• Increased run-off and reduced groundwater recharge • Ground disturbance • Elimination / interruption of groundwater flow paths	• Reduced quantity of water flowing to well or GDE • Lowered water table • Stream flow not sustained / periodic drying, due to removal of groundwater discharge areas • Redirection of groundwater discharge to new areas

Project Component / Activities / Physical Works	Alteration	Potential Effect on Hydrogeology and Groundwater Quality*
- Removal of existing infrastructure		• Changes to ambient water temperature of receiving surface water, due to removal of groundwater discharge areas • Increased nutrients / biological oxygen demand in surface water, due to removal of groundwater recharge areas; • Changes to redox conditions (increases in concentrations of metals such as iron and manganese; release of gases, odours) in groundwater and in surface water due to groundwater discharge
• Installation of watercourse crossings and diversions • Wetland alterations	• Removal of groundwater recharge or discharge areas	
• Blasting	• Elimination / interruption of groundwater flow paths	• Reduced quantity of water flowing to wells
	• Sub-sonic vibrations	• Increased flow of silt through fractures • Increased turbidity in water wells
	• Release of ammonium	• Increased loading of ammonium to groundwater and eventually aquatic habitats (due to groundwater discharge), resulting in fish toxicity • Ammonium and/or nitrate in well water
	• Oxidation of sulphide-bearing rock	• Acid generation, toxicity to biota in streams and wetlands (due to groundwater discharge)
• Paving	• Increased run-off and reduced groundwater recharge • Leaching of petroleum hydrocarbons from asphalt	• Reduced quantity of water flowing to well or GDE • Lowered water table • Stream flow not sustained / periodic drying

Project Component / Activities / Physical Works	Alteration	Potential Effect on Hydrogeology and Groundwater Quality*
		• Redirection of groundwater discharge to new areas • Groundwater contaminant concentrations exceed GCDWQ or CCME *Guidelines for Protection of Aquatic Life*
• Rehabilitation / site restoration of disturbed areas	• Ground disturbance • Erosion of bare soil	• Increased sediment load into watercourses • Enhanced infiltration of surface water into groundwater
• Revegetation (i.e., planting, and hydroseeding) of disturbed areas	• Stabilization of bare soils	• Decreased sediment load into watercourses • Enhanced infiltration of surface water into groundwater
Operation and Maintenance Phase		
• Highway maintenance (winter road salting)	• Salt inputs • Runoff and absorption of water into groundwater	• Salinity increase in groundwater
All Phases - Operation and Maintenance of Heavy Equipment		
Operation, fueling, and maintenance of heavy equipment during all Project activities	• Fuel leaks and spills*	• Groundwater contaminant concentrations exceed GCDWQ or CCME *Guidelines for Protection of Aquatic Life*

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

Groundwater interacts with features at the ground surface, features in the shallow sub-surface, and deeper geologic material. Disturbance of these environments has the potential to affect groundwater flow patterns and quality. Impacts of Project activities with potential to cause impacts to Groundwater Quality and Quantity are discussed in the following subsections

Vegetation Clearing

The removal of forested areas within the Project area will lead to decreased infiltration of surface water in the local area, and increased runoff to watercourses and wetlands. This could lead to localized decreases in infiltration into the groundwater table. It could also lead to warming and nutrient enrichment of surface water runoff flowing into groundwater recharge areas, leading to a slight increase in groundwater temperature and nutrient levels. This impact is not predicted to be significant.

Site Preparation and Construction Activities

Site Preparation and Construction phase activities such as grading, diversion of surface watercourses and drainage paths, wetland alterations, excavation and stockpiling of overburden, and blasting of rock have the potential to reduce the quantity and/or quality of groundwater supporting wells and GDEs. In particular, changes at the ground surface may alter groundwater recharge areas, and excavation of material from below the water table may eliminate or divert groundwater flow paths. Table 8.10 provides a summary of construction and operations phase activities and their potential effects on groundwater.

The road bedding material may furthermore intercept streams and wetlands that previously flowed across or parallel to the corridor. This can have the effect of raising the water table on the up-gradient side of the road, increasing the amount of ponded water in places. Areas down gradient of the corridor may experience a lowered water table, and wetlands or streams may become periodically or permanently dry. Alteration of the flow regime could result in increased dissolution of the gypsum/anhydrite rock in the Antigonish Basin (eastern part of corridor). This could promote alteration of fracture networks, and karst formation.

Ground disturbance activities also have the potential to increase exposure of soluble calcareous bedrock (e.g., gypsum and limestone) to the elements, which may exacerbate the erodibility of these; this may result in increased runoff of base-rich waters to receiving aquatic features such as watercourses and wetlands. These potential impacts can be avoided or minimized with proper mitigation measures.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and culverts (and any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. Effects would be similar to those outlined for other Construction phase activities, though at a smaller scale. With proper mitigation, effects are not predicted to be significant.

Effects during construction may be minimized through use of Best Management Practices, and some negative effects may be reversible, if groundwater recharge and discharge areas are restored as a final stage in road construction. The primary tool for monitoring potential changes to groundwater is a Pre-Construction Water Well Survey. NSTIR maintains a policy and guidelines for Pre-Construction Well Surveys. Surveys are intended to establish baseline conditions in each well within 300 metres of the centreline of the new road or highway (as per NSTIR policy). If, during or post-construction, there is a demonstrated, measurable change to the quantity or quality of water supplied by a well as a result of Project activities, an alternative supply may be offered in the form of well maintenance, improvement, or replacement. Additional mitigation measures for potential groundwater impacts during the Construction phase are discussed in Section 8.2.

Paving

Paving of the new twinned section of Highway 104 will result in the creation of a long strip of ground which is impervious to water. This can lead to increased surface water run-off and reduced groundwater recharge in the local area, which could then result in a slightly lowered water table and reduced quantity of water flowing to wells or GDE. Some groundwater discharge may also be redirected to new areas.

The presence of the paved strip can also result in leaching of petroleum hydrocarbons from the asphalt layer, resulting in groundwater contaminant concentrations exceeding GCDWQ or CCME Guidelines for Protection of Aquatic Life.

Rehabilitation/Restoration and/or Revegetation of Disturbed Areas

Twinning of Highway 104 and deactivation of a section of Highway 104 may also require rehabilitation and revegetation activities to properly contour and stabilize areas of bare soil. This may require small localized areas of ground disturbance, in the form of contouring or infilling, and could affect groundwater quality. Proper mitigation measures will minimize this effect.

The revegetation of bare soil areas will result in increased infiltration of surface water, leading to increased infiltration into groundwater reserves.

Operation and Maintenance Phase - Activities

The permanent alteration of the highway corridor to include an increased area of paved, impermeable surface may reduce the potential for groundwater recharge. Potential effects of reduced recharge include the following:

- A lowered water table resulting in reduced flow to wells and GDEs;
- Drier conditions in streams and wetlands; and
- Lower water levels in nearby wells, particularly dug wells.

Highway Maintenance - Road Salting

Winter maintenance will require salting and/or brining of the roadway to control ice and snow. The run-off of salt adjacent to highways and roads has a demonstrated effect of increased sodium and chloride concentrations in adjacent aquifers. Water wells connected to zones of salt infiltration may show measurable changes in potable water quality. Proposed mitigation measures are included in Section 8.2.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment has some potential to affect groundwater within the Project Area and downstream. This is mainly via accidental spills and leaks, which are discussed in Chapter 7, Accidents and Malfunctions. Ground disturbance by heavy equipment is discussed separately under Site Clearing and Construction Activities.

The impacts of the use of heavy equipment throughout the Operations and Maintenance phase are similar to those during the Site Preparation and Construction phase, but are of much smaller

magnitude and spatial extent, as well as shorter duration. Similar mitigation measures will minimize any potential impacts to groundwater quality.

8.1.3 Biological Environment - Flora

As described in Chapter 5, habitats within the Project Area are relatively diverse and support a wide range of vascular plant and lichen species (referred to collectively here as 'flora'), including Species of Conservation Concern (SOCC) in terrestrial, wetland, and aquatic habitats. The potential for Project-related impacts to flora species (including SOCC) and their habitats are discussed below in relation to the main Project phases.

The potential for Project-related impacts to flora Species at Risk (SAR) is discussed in Section 8.1.7.

8.1.3.1 Boundaries

The spatial boundary for potential effects to vascular plant and lichen species and their habitats includes terrestrial, wetland, and freshwater environments within the whole Project Area, and within approximately 200 m of the Project Area, as alterations (including indirect effects) due to Project activities are not expected to extend any further. The area within 200 m of the Project Area would encompass both the LAA and the RAA. A buffer zone of 200 m was chosen based on the expertise and experience of the assessment team.

Temporal boundaries refer to the duration of environmental effects associated with Project components and activities. Potential impacts to flora species and communities will occur during the site preparation, construction, and operations phases and beyond. The Operation and Maintenance phase of the Project is anticipated to occur indefinitely. Impacts to flora resulting from the Project are expected to be greatest during the Construction phase, when most of the habitat removal will occur, however, minor impacts may also occur throughout the operations phase (e.g., vegetation management) and beyond.

8.1.3.2 Significance Determination

For vascular plants and lichens, including SOCC, a residual environmental effect will be determined significant if the following conditions are met following the implementation of mitigation and off-setting:

- Interactions are determined to have had a permanent effect to any species' distribution or abundance within the Province.

8.1.3.3 Potential Effects of the Project on Flora Species and Communities

Vascular plants and lichens occur in all terrestrial, wetland, and freshwater environments within the Project Area and so have potential to interact with Project activities occurring in all these habitat types.

Potential impacts to flora species and communities, including SOCC, associated with the proposed Project are summarized in Table 8.11. These impacts will occur primarily during the initial Site Clearing and Construction phase activities, though additional lesser impacts may occur during the

subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on flora species and communities are discussed in the following subsections.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Flora are discussed in Section 8.2.

Table 8.11 Summary of Potential Effects of Highway 104 Twinning Project on Flora

Project Component / Activities / Physical Works	Alteration	Potential Effect on Vascular Plants and Lichens*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of forests and vegetation	• Loss of specimens, including some SOCC • Loss and alteration of habitat for some species • Creation of habitat opportunities for other species (e.g., ground lichens – specifically *Stereocaulon condensatum*) • Increased habitat fragmentation.
• Site Preparation and Construction activities, such as: - Grubbing and soil management - Wetland alteration - Excavation - Blasting - Fill placement and compaction (including grading) - Ditch construction - Removal of existing infrastructure	• Removal of topsoil and seedbank • Removal/alteration of wetland areas • Ground disturbance • Altered surface hydrology/redirection of small watercourses • Exposure of underlying soils (deactivated highway section)	• Loss of specimens, including some SOCC • Unintentional introduction of non-native or invasive plant species via machinery • Loss and alteration of habitat for some species • Creation of habitat opportunities for other species (e.g., ground lichens – specifically *Stereocaulon condensatum*) • Increased habitat fragmentation • Minor habitat creation (deactivated highway section) • Decreased habitat fragmentation (deactivated highway section)
• Rehabilitation and restoration of disturbed areas • Revegetation (planting, and hydroseeding)	• Ground disturbance • Reestablishment of vascular plant communities	• Habitat creation • Intentional introduction of non-native plant species via hydroseed mixes • Unintentional introduction of non-native or invasive plant species via machinery

Project Component / Activities / Physical Works	Alteration	Potential Effect on Vascular Plants and Lichens*
		• Changes in community composition within maintained Right-of-Way • Changes in community composition beyond maintained Right-of-Way
Operation and Maintenance Phase		
• Highway operation (Traffic)	• Vehicle transport of seeds or propagules of non-native or invasive species	• Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way
• Vegetation management • Infrastructure maintenance - Ditch maintenance	• Removal/ mowing of roadside vegetation • Ground disturbance	• Loss of flora specimens • Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way • Loss and alteration of habitat for some species
• Highway maintenance - Winter road salting	• Addition of sodium chloride to roadside terrestrial, wetland, and aquatic habitats	• Damage to flora specimens • Habitat alteration • Changes in community composition within maintained Right-of-Way
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Noise emissions • Vehicle exhaust emissions • Ground disturbance	• Loss and alteration of habitat • Loss of flora specimens, including some SOCC • Air quality impacts on sensitive lichens

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases – Activities

The primary effects of roadway construction on flora species are direct species loss and various forms of habitat loss or degradation. Road construction generally requires clearing of vegetated areas, which can lead to direct loss of vascular plant specimens and habitats. Site preparation (i.e., clearing, grubbing and soil management) will involve the removal of all plant material (trees, shrubs, herbaceous plants, mosses, lichens) within the Project footprint, leading to loss of vascular plant specimens and communities in the immediate footprint of the Project Area. Much of the topsoil will also be removed during this phase, and stockpiled for later use in rehabilitation and revegetation

during the Construction phase. Table 8.12 provides a summary of the maximum areas of the main habitat types that could be removed by the Project, based on the P-ELC.

Table 8.12 Summary of Areas of Main Habitat Types Present within the Project Area

Major Category	% of Total	Hectares
Coniferous	21%	78.6
Deciduous	28%	106.8
Gravel-Soil / Asphalt /Cutover	2%	6.6
Herbaceous / Gravel-Soil	10%	37.7
Herbaceous	6%	24.1
Mixed wood	33%	127.5
Total	100%	381.2

From an ecological perspective, however; the area affected by the construction of a roadway is much greater than the immediate footprint of the road itself (Deblinger and Richard, 1998). Creation of a roadway affects many habitat factors such as sunlight levels, soil moisture levels, drainage patterns, soil chemistry, and soil structure, all of which can lead to changes in flora species composition along and near roadways. Roadways tend to have ample sunlight and moisture from road drainage, leading to the development of a different species community than originally present. This is especially true when forests are cleared for road construction.

Vegetation Clearing

The main impact of the Construction phase on flora species and habitats will be habitat loss and/or alteration due to vegetation clearing activities. It is estimated that a maximum of 221 ha of upland forest habitat could be removed or altered by the Project. Removal of habitat is likely to have the largest impact on flora populations in the general area of the Project, particularly along the new four-lane alignment south of the existing highway where no highway corridor currently exists.

Many vascular plant and lichen species will lose habitat due to loss of forest areas from the Project Area. Many lichen species are epiphytic, and so are most abundant in forested areas. Lichen diversity is also known to be higher in mature and old growth forests, with many species only occurring in these habitats (Lesica et al., 1991; McMullin et al., 2008). Clearing or harvesting of forested areas is known to have a detrimental influence on lichen biodiversity (Esseen and Renhorn, 1998).

Loss of forested habitat could result in loss of habitat and specimens of at least one vascular plant SOCC, the lesser pyrola (*Pyrola minor*), and for several epiphytic forest lichen SOCC, including blue felt lichen (*Degelia plumbea*), shaggy fringed lichen (*Anaptychia palmulata*), crumpled bat's wing lichen (*Collema leptaleum*), shelter shingle lichen (*Vahliella leucophaea*), an unnamed *Leptogium* (*Leptogium acadiense*), appressed jellyskin lichen (*Leptogium subtile*), birdsnest jellyskin lichen (*Leptogium tennuissimum*), pompom-tipped shadow lichen (*Phaeophyscia pusilloides*), and beaded jellyskin lichen (*Leptogium teretiusculum*).

This loss or alteration of forest habitat will occur throughout the vegetated habitats affected by the Project. This habitat loss or alteration will be a one-time effect, but the results will be permanent. In consideration of the conservation statuses of the species encountered, and with the application of appropriate mitigation, this Project should not have a permanent effect on the overall distribution or abundance (both within the region, and within the province) of any of the identified flora species or SOCC (SAR addressed separately in Section 8.1.7). As such, the overall effects of the Project on flora is not predicted to be significant. Relevant mitigation measures are provided in Section 8.2.3.

Generally speaking, vascular plant and lichen species are vulnerable to the same general types of threats from development; primarily, habitat loss and/or various forms of habitat degradation. One notable exception; however, is that lichens are generally more sensitive to atmospheric pollution and changes in humidity levels. Lichens require moisture in order to photosynthesize, but as they do not have true roots or a vascular system to take up and distribute water, they absorb moisture directly from the atmosphere. However, they are unable to regulate their water uptake and loss rates (Green and Lange, 1994), and so are affected by even small changes in humidity levels. Such changes can influence the abundance and diversity of local lichen communities (Canters et al., 1991; Renhorn et al., 1997). Clearing of forested areas affects not only the area cleared, but also an adjacent zone of varying width which is subsequently affected by changes in humidity, sunlight levels, and wind speeds and patterns. Creation of the new roadside will, however, create habitat for soil- and rock-dwelling lichens, many species of which are already abundant alongside the existing highway (including the SOCC granular soil foam lichen).

Site Preparation and Construction

Additional impacts to flora species and habitats will occur during the required site preparation activities (listed in Table 8.11). This loss or alteration of species and habitats may result from grubbing and soil management, excavation, fill placement, grading, ditch construction, wetland alteration, and watercourse diversion activities. These activities will impact flora and flora habitat via the clearing or alteration of non-forested vegetated areas, including wetlands, which support these species. It is estimated that a maximum of 221 ha of upland forest habitat and 32 ha of wetland habitat could be removed or altered by the Project. Removal of habitat is likely to have the largest impact on flora populations in the general area of the Project, particularly along the new four-lane alignment south of the existing highway where no highway corridor currently exists.

Impacts to wetlands and riparian zones could cause impact to specimens and habitat of several vascular plant SOCC, such as black ash (*Fraxinus nigra*), halberd-leaved tearthumb (*Polygonum arifolium*), meadow horsetail (*Equisetum pratense*), blue vervain (*Verbena hastata*), and hop sedge (*Carex lupulina*), as well as lichen SOCC including blue felt lichen, appressed jellyskin lichen, beaded jellyskin lichen, and birdsnest jellyskin lichen; impacts to small watercourses could impact the aquatic brookside stippleback lichen (*Dermatocarpon luridum*). Impacts on existing gravel roadsides could result in loss of specimens of granular soil foam lichen (*Stereocaulon condensatum*). It should be noted, however, that granular soil foam lichen appears to opportunistically colonize sterile mineral soils rather readily in the LAA; thus, the Project construction may afford opportunities for this species to proliferate, if suitable conditions prevail post-construction.

Alteration and removal of wetlands can lead to changes in local humidity regimes, which, as discussed previously, can lead to negative impacts on lichen species and communities. Wetland alteration and removal can also affect the distribution and composition of forested areas, which in the long-term could affect lichen communities on a small scale. However, as most of the common lichen species are widespread throughout the LAA, and suitable habitat is abundant, the impacts of localized humidity changes are unlikely to be significant. Negative effects of changes to humidity regimes in lichen habitat is not expected to be a concern for the Project.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and any required soil stabilization activities) between Browns Mountain Road and Pushie Road. The potential impacts to flora species and communities are primarily positive, as the removal of the asphalt layer will create habitat and permit colonization by plant and ground-dwelling lichen species. Slight adverse impacts could occur during the actual asphalt removal process as a result of the movement of heavy equipment and/or any required minimal site clearing activities, however these effects are expected to be minimal. The physical removal of the existing asphalt layer will result in some ground disturbance, but it will be limited spatially and will be of short duration. Ultimately this activity will have a positive impact on local terrestrial vascular plant and lichen species populations and habitats by increasing the amount of habitat available for colonization. As the vegetation community in this area matures, habitat complexity will increase and the developing forest will also begin to provide habitat for epiphytic lichen species.

Rehabilitation, Restoration, and Revegetation of Disturbed Areas

Twinning of Highway 104 and deactivation of unused sections of current Highway 104 may also require rehabilitation and revegetation activities to properly contour and stabilize areas of bare soil. This has potential for unintentional introductions of invasive plant species via seed transport on machinery, which could lead to negative impacts on existing flora populations. Proper cleaning of heavy equipment prior to arrival in the Project Area will minimize this potential impact. Furthermore, NS Highway Seed Mix will be used, unless otherwise approved and certified free of invasive species and noxious weeds to similarly mitigate against the ingress of these species.

Operation and Maintenance Phase - Activities

The Operation and Maintenance phase of the new twinned highway also has potential to impact vascular plant and lichen species and communities within the Project Area, though to a lesser degree than the Construction phase. Project activities occurring during the Operations and Maintenance phases that may lead to impacts on flora species and habitats are also summarized in Table 8.11. They are discussed in more detail in the following subsections.

Highway Operation

Once the twinned highway is constructed, resulting traffic is expected to have little to no adverse effect on flora species and habitats, with the possible exception of unintentional introduction of invasive plant species. Seeds and plant fragments (propagules) of such species may be unintentionally transported by vehicles. Invasive species are known to become established along roadways (Tyser and Worley, 1992). The spread of one notorious invasive species, purple loosestrife (*Lythrum salicaria*), has been shown to be aided in short-distance dispersal by roadside ditches and culverts (Wilcox, 1989).

Highway Maintenance - Winter Road Salting

The application of salt as part of winter road maintenance has the potential to affect roadside plant and lichen species and communities. Once applied to roadways as part of winter maintenance activities, salt then enters the environment via splash and spray from vehicles, transportation by wind, snow melt into the soil and as runoff to surface waters. This can lead to elevated salinity levels in roadside terrestrial wetland, and aquatic habitats, particularly in spring after snowmelt. This can adversely affect sensitive plant and lichen species growing along the roadside. Salt primarily causes dehydration which leads to foliage damage, but also causes osmotic stress that harms root growth in vascular plants (Jones et al., 1986). Increased salt levels are well-known to affect sensitive plant species and can cause changes in community composition (EC, 2001). The main effects are chloride ion toxicity and dehydration, with the magnitude of effect varying across species. At high concentrations, salt can also physically affect soil structure via development of salt crusts. Salt can also affect soil chemistry with resulting effects on soil fertility (EC, 2001). Less is known about the impacts of salt on lichen species, however, it is known that the sensitivity of lichens to salt varies considerably (Nash and Lange, 1988).

This impact of winter road salting is not predicted to be significant, as the impact is not expected to affect the distribution or abundance of any flora species. Mitigation measures to minimize the effects of salt on local flora are outlined in Section 8.2.3.

Winter snow clearing activities are also expected to occur frequently throughout the winter and early spring months but are not predicted to have an impact of flora species or communities.

Vegetation Management and Infrastructure Maintenance

As roadside vegetation communities grow and develop along the new twinned Highway 104, periodic maintenance will be required to minimize the establishment of tall woody plants to maintain original road design features and safety. Post-construction mowing, often conducted as part of roadside maintenance, slows the establishment of woody plants, further affecting community composition and succession patterns. Infrastructure such as culverts, overpasses, and ramps may also need periodic maintenance. The road surface itself will eventually need repaving. Potential impacts to flora species and their habitat from these activities are similar to those outlined for Site Preparation and Construction phase activities, but at a lesser scale. There could be some removal of flora specimens during such activities, as well as a small amount of habitat alteration, but

it is expected to be minimal and to occur only infrequently. Therefore, the effects of these activities are not considered significant.

Such vegetation control could potentially affect SOCC occurring along the roadside. One lichen SOCC, *Stereocaulon condensatum* (ranked by ACCDC as S3), is abundant along sections of the existing highway (particularly near Broadway), where it grows in open gravelly areas dominated by ground-dwelling lichen species. Such habitat is unlikely to require mowing. Specimens of *S. condensatum* in this habitat could be driven over by mowing equipment accessing other areas to be mowed, and likely have been in the past; it is considered unlikely that this type of activity will kill specimens of *S. condensatum* or greatly affect the abundance of the species in this area.

All Phases – Operation and Maintenance of Heavy Equipment

Some lichen species, particularly cyanolichens, are very sensitive to air quality impacts. As they do not have true roots, lichens rely on air and rain-borne nutrients. They do not have a protective cuticle layer to protect them, not do they have stomata to regulate the uptake of gaseous compounds (Richardson, 1992; Häffner et al., 2001). As cyanobacteria are very sensitive to pollutants, cyanolichens are therefore also susceptible to air pollution, especially sulfur or nitrogen-based pollutants, including vehicle exhaust. Lichen diversity has long been noted to decrease near industrial areas, and many species have been extirpated around developed areas. Use of heavy equipment will create emissions that could potentially impact some cyanolichen species. However, these emissions will be very limited both spatially and temporally and will not exceed any air quality guidelines. Effects of vehicle emissions on lichens are not expected to be a concern for this project. This is corroborated by field observations of several cyanolichen species within very close proximity of the current highway corridor. *Lobaria pulmonaria*, *L. scrobiculata*, *L. quercizans*, *Collema subflaccidum*, *Parmeliella triptophylla*, and *Leptogium cyanescens* were frequently observed cyanolichen species adjacent to the existing highway.

Seeds and plant fragments (propagules) of invasive plant species may be unintentionally transported by heavy equipment from areas they have colonized to new potential habitat. Fortunately, this potential impact can be mitigated with standard equipment cleaning procedures.

8.1.4 Biological Environment - Wildlife and Wildlife Habitat

The occurrence of wildlife species and their habitats within the Project Area and LAA is described in Section 5.2.2.

As summarized by Trombulak and Frissel (2000), roads are considered to have seven main types of impacts on wildlife populations and habitats. These are:

- Mortality from road construction;
- Mortality from collisions with vehicles;
- Modification of animal behaviour;
- Alteration of the physical environment;
- Alteration of the chemical environment;
- Spread of exotic species; and

- Increased alteration and use of habitats by humans.

The potential for impacts to wildlife and wildlife habitat is discussed in the following subsections for each major species group (mammals, birds, reptiles and amphibians). Note that Species at Risk within all groups are discussed in detail in Section 8.1.7.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Wildlife and Wildlife Habitat are discussed in Section 8.2.

8.1.4.1 Mammal Species and Habitat

Construction and operation of highways and related infrastructure has the potential to have several types of impacts on mammal species and their habitats. Road construction is well known to result in habitat loss and alteration for mammals (Trombulak and Frissell, 2000). As mammal species vary considerably in terms of size, habitat requirements, behaviour, and life histories, the effects of highways will differ for individual species and for different habitat types. The main categories of impacts include:

- Habitat loss;
- Habitat alteration/fragmentation/degradation;
- Direct mortality;
- Changes in behaviour; and
- Disruption of gene flow.

Mammal species may utilize terrestrial, aquatic and/or wetland habitats, and therefore removal of any of these habitat types will impact one or more mammal species.

Note that potential impacts to mammal SAR are discussed in Section 8.1.7.

Boundaries

The spatial boundary for potential effects to mammal species and their habitats includes the whole Project Area at a minimum. Aquatic habitats such as watercourses and wetlands that flow or extend through the Project Area, may also be affected outside of the main Project Area.

In terms of temporal boundaries, impacts to mammal species and their habitats resulting from the Project are possible throughout the lifetime of the Project and beyond.

Significance Determination

A significant environmental effect on mammal species and their habitats would result if a substantive change in the numbers and habits of any species could be attributed to the development and operation of the Project. Any activity that contravenes the *Wildlife Act* would also be considered significant.

A residual effect that does not meet this criterion will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

Potential impacts of the Project on mammals, are discussed by Project phase in the following subsections. The potential impacts on mammal species and their habitats are summarized in Table 8.13. These impacts can occur during both the initial construction activities and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on mammal species and habitats are discussed in the following subsections.

Table 8.13 Summary of Potential Effects of the Project on Mammals and Mammal Habitat

Project Component / Activities / Physical Works	Alteration	Potential Effect on Mammals and Mammal Habitat*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of vegetation, including forests • Removal or alteration of wetlands	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes) • Displacement of mammals • Direct mortality
• Site Preparation and Construction, including - Grubbing and soil management - Wetland alteration (i.e. removal and infilling - Excavation - Fill placement and compaction - Paving - Ditch construction - Removal of existing infrastructure (i.e., asphalt, culverts and overpasses)	• Removal of topsoil • Removal or alteration of wetlands • Ground disturbance • Removal of asphalt layer in deactivated section	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes along twinned section • Displacement of mammals • Direct mortality • Habitat creation (deactivated section) • Decreased habitat fragmentation / interruption of travel routes along deactivated section
• Blasting	• Noise emissions • Vibration	• Disturbance of mammals
• Rehabilitation and Restoration of disturbed areas • Revegetation of disturbed areas	• Seeding of exposed soil • Reestablishment of vegetation communities	• Establishment of non-native species, leading to effects on mammal habitat • Changes in plant species communities, leading to effects on mammal habitat
Operations and Maintenance Phase		
• Highway operation	• Vehicle traffic • Noise emissions • Light emissions	• Direct mortality via vehicle collisions • Disturbance of mammals • Habitat fragmentation

Project Component / Activities / Physical Works	Alteration	Potential Effect on Mammals and Mammal Habitat*
• Highway maintenance - Road salting	• Increased salinity of roadside ditches, wetlands and watercourses	• Damage to vegetated habitats • Attraction of mammals to salt pools
• Vegetation management	• Removal/ mowing of roadside vegetation	• Loss of foraging habitat • Mortality of mammals
• Infrastructure maintenance	• Ground disturbance	• Mortality of mammals
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment for all Project activities	• Vehicle traffic • Noise emissions • Light emissions	• Collisions with vehicles/ Direct mortality • Disturbance of mammals/behavioural effects

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

Various mammal species are likely to use the majority of habitats within the Project Area. These species were summarized in Section 5.4.2. The majority of these species have potential to interact with Project activities occurring in forested, non-forested, wetland, riparian, and disturbed habitats. The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to mammals via several Project activities. Project components occurring during the Construction phase that may lead to impacts on mammal species and habitats are listed in Table 8.13, and discussed below.

Vegetation Clearing

The main impact of the Project on mammals will likely be habitat loss and/or alteration due to required vegetation removal. This may be particularly true along the new four-lane alignment south of the existing highway where no highway corridor currently exists. It is estimated that a maximum 221 ha of forest habitat may be removed by the Project, pending final Project design. Many mammal species will lose foraging habitat due to loss of forested areas from the Project Area. Overwintering habitat may also be lost for some mammals. This loss or alteration of habitat will occur throughout the forested habitats affected by the Project. This habitat loss or alteration will be a one-time effect, but the results will be permanent. However, this effect can be mitigated (See Section 8.2 for Mitigation Measures), and the residual effects are predicted to be insignificant.

Site Preparation and Construction Activities

Additional loss and/or alteration of mammal habitat will occur during the Site Preparation and Construction phases. This loss or alteration of terrestrial and wetland habitat may result from grubbing and soil management, excavation, fill placement, grading, ditch construction, wetland alteration and removal, and watercourse diversion activities. In addition to the forested habitat lost during the vegetation clearing activities, an estimated 32 ha (pending final Project design) of wetland may be lost during the Site Preparation and Construction phases. These activities will

impact mammals and their habitat via the clearing or alteration of forested areas and wetlands which support many of these species.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and any required soil stabilization activities) between Browns Mountain Road and Pushie Road. However, the recolonization of this corridor by vegetation communities will eventually create habitat for a variety of mammal species and decrease local habitat fragmentation.

In addition to habitat loss, some mammals may be killed directly during road construction activities (Trombulak and Frissell, 2000) such as excavation, blasting, or infilling, as well as by vehicle encounters (roadkill) (Mazerolle, 2004). However, this impact is expected to affect only very small numbers of individuals, and the overall impact will not be significant.

Blasting

Noise and vibration of blasting activities required for this project may startle or temporarily disturb some mammal species or cause them to move away from areas undergoing blasting activities. However, this impact is of short-term, infrequent, and reversible. It is not expected to result in a residual effect on mammals. No mitigation for blasting activities is required for potential impacts to mammals.

A discussion of potential impacts of blasting on hibernating bats is provided in Section 8.1.7.1, Species at Risk.

Rehabilitation, Restoration, and Revegetation of Disturbed Areas

The twinning of Highway 104 (and possible removal of asphalt layer along the deactivated section) may also require revegetation activities to properly stabilize areas of bare soil. This has the potential for unintentional introductions of exotic or invasive plant species, primarily through seed transport on machinery. Establishment of such species could lead to habitat alterations that could negatively affect mammal species. Proper mitigation measures, primarily through machine cleaning, can minimize the potential for negative effects.

Operations and Maintenance Phase - Activities

The Operation and Maintenance phase activities of the new twinned highway also has potential to cause impacts to mammal species via several Project activities. Project activities occurring during the Operations and Maintenance phases that may lead to impacts on mammal species and habitats were also summarized in Table 8.13. They are discussed in more detail below.

Highway Operation

Once roadways are constructed, the most obvious and direct threat to mammals is direct mortality caused by vehicles. Vehicle-deer collisions are probably the most well-known example, due to both

their frequency of occurrence in areas with high deer populations and the potential for loss of human life and/or property damage. Collisions with small mammals tends to be underreported due to the lack of property damage or personal injury, however, these collisions occur frequently on most highways.

The highest rates of road mortality for mammals often occur where roads are located between foraging, breeding, or overwintering habitats, forcing mammals to cross the road to access these habitats (Ashley and Robinson 1996; Smith and Dodd, 2003; Langen et al., 2009). Roadkill is often more of an issue, for deer in particular, in areas where lanes are separated by a solid barrier or where roadsides consist of steep banks, essentially corralling animals on the road when traffic is present (Bellis and Graves, 1971; Romin and Bissonette, 1996). Some mammal species, such as coyotes, may then be attracted to roadkill as a food source, increasing their risk of vehicle collisions.

Traffic-related mortality during the operations phase of this Project is not considered a significant risk to mammals. While considerable numbers of mammals may be killed on roads each year, such impacts are rarely sufficient to impact population levels of terrestrial vertebrates (Forman and Alexander, 1998).

Vegetation Control and Infrastructure Maintenance

As roadside vegetation communities grow and develop, periodic maintenance may be required to minimize the establishment of tall woody plants. Infrastructure such as culverts, overpasses, and ramps may also need periodic maintenance. The road surface itself will eventually need repaving. Potential impacts to mammals and their habitat from these activities are similar to those outlined for Site Preparation and Construction phase activities, but at a lesser scale. There could be some accidental mortality of mammals during such activities, as well as a small amount of habitat alteration, but it is expected to be minimal and to occur only infrequently. Therefore, the potential effect is not considered significant.

Highway Maintenance - Road Salting

Road salt application to roadways in winter has the potential to temporarily raise salinity levels in pooled water in roadside ponds, ditches, wetlands and watercourses, particularly in spring after snowmelt. Some mammal species such as deer and moose have learned to visit such pools in spring to obtain salt.

The use of road salt during winter road maintenance activities for this Project is not predicted to cause a significant effect to mammals, assuming that applicable mitigation measures are adhered to.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment on the site during the Construction phase has potential to cause impacts to mammal species, namely though increased risk of mortality during construction activities (accidental burial of adults or juveniles, vehicle collisions). This risk will vary both temporally and spatially, depending on the timing of the activity in relation to mammal seasonal behaviour patterns and the specific locations within the Project Area in which the activity is

occurring. This is a one-time impact that will be permanent but can be mitigated somewhat (See Mitigation in Section 8.2.3.2). However, due to the relatively small number of individuals of non-SAR species likely affected, this is not considered a significant impact.

The use of heavy equipment will also be required sporadically during the Operations phase of this Project, as part of infrastructure and ditch maintenance and winter snow plowing activities. The operation, fueling, and maintenance of heavy equipment has the potential to impact mammals via collisions, noise and light disturbance, and accidental exposure to hazardous substances. These required maintenance activities are expected to be quite limited in terms of spatial and temporal duration.

8.1.4.2 Birds and Bird Habitat

As indicated in Section 5.1.1, birds were selected as a VEC due to the potential for interactions between Project activities and birds and their associated habitats. The construction and operation of highways and related infrastructure has the potential to have several types of impacts on bird species and their habitats. An overview of these potential impacts, as well as a discussion of their temporal and spatial boundaries and significance determination, is provided in the following subsections.

Boundaries

The spatial boundary for potential effects to bird species and their habitats includes the whole Project Area and LAA.

The temporal boundaries for the assessment of the potential effects of the Project activities on birds includes the lifetime of the Project and beyond. Within this overall timeline, there are sensitive periods (occurring annually) related to seasonal bird breeding and migration behaviours. The Site Preparation and Construction phases will occur over three to seven years and the Operation and Maintenance phase timeline is indefinite, with no plans of decommissioning.

Significance Determination

Any Project activities resulting in non-permitted contravention of the *Migratory Birds Convention Act* (MBCA), *Species at Risk Act* (SARA), *Nova Scotia Endangered Species Act* (NSESA), or the Nova Scotia *Wildlife Act,* or which substantially changes the population or distribution of an unlisted bird species, will be deemed to have a significant impact. Residual effects which do not meet this criteria will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

Potential environmental effects on birds and their habitat may occur during all Project phases. The main potential adverse effects include the following:

- Habitat loss (permanent and temporary);
- Habitat alteration and disruption (permanent or temporary);
- Nest destruction, disturbance, or abandonment;
- Sensory disturbance (e.g., noise, light); and
- Accidental mortality.

Project activities associated with the Site Preparation and Construction, and Operation and Maintenance, are summarized in Table 8.14 and discussed in the following subsections.

Table 8.14 Summary of Potential Effects of Highway 104 Twinning Project on Birds and Bird Habitat

Project Component / Activities / Physical Works	Alteration	Potential Effect on Birds and Bird Habitat*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of vegetation, including forests • Removal or alteration of wetlands • Noise emissions	• Permanent and temporary loss of bird habitat • Permanent and temporary alteration and disruption of bird habitat • Habitat fragmentation • Nest (including eggs, nestling) destruction, disturbance, or abandonment • Disturbance of birds; and • Accidental mortality
• Site Preparation and Construction activities including - Grubbing and soil management - Wetland alteration - Excavation - Fill placement and compaction (including grading) - Blasting - Ditch construction - Removal of existing infrastructure (i.e., culverts and overpasses) - Bridge and Grade Separation Structure construction - Paving - Installation of highway infrastructure (i.e. lighting)	• Removal of topsoil • Removal or alteration of wetlands • Ground disturbance • Noise emissions • Light emissions	• Permanent and temporary loss of bird habitat • Permanent and temporary alteration and disruption of bird habitat • Habitat fragmentation • Nest (including eggs, nestling) destruction, disturbance, or abandonment • Disturbance of birds; and • Temporary displacement of birds • Accidental mortality

Project Component / Activities / Physical Works	Alteration	Potential Effect on Birds and Bird Habitat*
- Installation of watercourse crossings and diversions		
• Rehabilitation and restoration of disturbed areas • Revegetation of disturbed areas	• Ground disturbance • Seeding of exposed soil	• Establishment of non-native species • Changes in plant species communities
Operations and Maintenance Phase		
• Highway operation • Infrastructure maintenance: - Pavement - Shoulders - Watercourse crossings - Barrier maintenance - Marking and painting - Signage and lighting • Vegetation management: - Vegetation removal - Mowing - Planting	• Vehicle traffic • Noise emissions • Light emissions • Removal of vegetation	• Permanent and temporary loss of bird habitat • Habitat fragmentation • Nest (including eggs, nestling) destruction, disturbance, or abandonment • Temporary displacement of birds • Accidental mortality • Disturbance of birds/behavioural effects
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Vehicle traffic • Increased noise emissions • Increased light emissions	• Direct mortality • Disturbance of birds/behavioural effects

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

The level of impact on birds during the Site Preparation and Construction phases of the Project is dependent on the timing of the associated activities. The level of impact associated with timing of this work is further discussed in the Mitigation Measures section below.

Vegetation Clearing

Bird habitat will be temporarily and permanently lost and/or altered during the Site Preparation and Construction phases of the Project, mainly due to vegetation clearing activities. Habitat loss and alteration will primarily occur within the Project Area boundaries and in any additional areas of impact that may occur outside of the Project Area (e.g., laydown areas). Habitat loss and alteration caused by clearing can also lead to habitat fragmentation and the intrusion of edge effects, both of which have been shown to negatively impact breeding birds (Ortega and Capen, 1999).

A large number of migratory bird species breed in the vicinity of both the Project Area and the LAA between mid-April and late August (ECCC, 2017). If clearing activities occur within the breeding

season, eggs, nests, and birds in the Project Area and within the vicinity of the Project Area will be negatively impacted both directly and indirectly. Many species of birds are known to occur within the Project Area and many of these species could be displaced due to loss and/or alteration of habitat.

Some habitat fragmentation and disturbance of birds already occurs along the existing Highway 104 corridor. The widening of the current highway corridor is unlikely to impact the existing bird community; however, in the new four-lane alignment south of the existing highway, habitat fragmentation and disturbance will be increased somewhat due to the creation of an entirely new highway corridor through a largely forested area.

The effects to birds from clearing activities will vary both temporally and spatially, depending on the timing of the activity in relation to bird seasonal behaviour patterns and the specific locations within the Project Area in which the activity is occurring. The clearing of the Project Area is a one-time impact that will be permanent but can be mitigated somewhat (See Mitigation in Section 8.2). However, due to the relatively small number of individuals of non-SAR species likely affected, and the absence of a substantial effect to any bird species' population or distribution, this is not considered a significant impact.

Site Preparation and Construction

Bird habitat will be temporarily and permanently lost and/or altered during the Site Preparation and Construction phases of the Project, mainly due to vegetation clearing activities.

Bird habitat will be also be temporarily and permanently lost and/or altered during the Site Preparation and Construction phases of the Project, due grubbing and soil management activities. Impacts would be similar to those discussed above under Vegetation Clearing. Additional potential impacts to birds predicted during the Site Preparation and Construction phases (after vegetation clearing) are related to disturbance impacts from the operation of heavy machinery, which is discussed in detail later in this section.

The Construction phase may also include the removal of the section of existing highway to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and completion of any required soil stabilization activities) between Browns Mountain Road and Pushie Road. Ultimately, the reestablishment of native vegetation communities in some areas, and the reduction of traffic along this section should have a positive impact on local bird populations, by increasing the amount of available habitat and increasing habitat connectivity and reducing sensory and behavioural disturbance.

Some bird species, such as Barn Swallows and Cliff Swallows, are known to utilize human-made structures for breeding. It is possible that if the removal of existing infrastructure (such as bridges)

occurs during the breeding season it may result in nest destruction, disturbance, and abandonment, if these structures are being utilized for breeding purposes.

Rehabilitation, Restoration, and Revegetation of Disturbed Areas

The twinning of Highway 104 and deactivation of the section between Browns Mountain Road and Pushie Road may also require revegetation activities. This has the potential for unintentional introductions of invasive plant species. Establishment of such species could lead to habitat alterations that could negatively affect bird species and habitat. Ultimately, the reestablishment of native vegetation communities along this section should have a positive impact on local bird populations, by increasing the amount of available habitat and increasing habitat connectivity.

Operations and Maintenance Phase - Activities

The Operation and Maintenance of the new twinned highway also has potential to cause impacts to bird species via several Project activities. Project activities occurring during the Operations and Maintenance phase that may lead to impacts on bird species and habitats were also summarized in Table 8.14. They are discussed in more detail below.

Highway Operation

During the operations phase of the proposed Project, sensory disturbance caused by traffic noise and lights could impact bird species located within the vicinity of the highway. Traffic noise may result in birds avoiding the area in proximity to the highway (Schaub et al., 2008). However, birds occupying habitat within proximity to the highway may be disturbed by traffic noise and result in changes in behaviour. These changes may increase distraction, making them more vulnerable to predation. Alternatively, this may cause an increase in anti-predator vigilance, which could indirectly affect bird reproductive rate by reducing foraging time (Quinn et al., 2006). Lights produced from roadways may negatively impact birds and reduce habitat quality. Lighting structures are known to attract migrating bird species and this attraction may increase probabilities of collisions with structures and vehicles (van de Laar, 2007).

The Operation and Maintenance phase of the proposed project may result in direct and indirect mortality of migratory and resident bird species found within the area of work activities. Direct mortality may result from collisions with vehicles and associated infrastructure. Passeriformes make up 40% of all bird vehicle-collision causalities in North America. In Canada, when adjusted for scavenging, the number of road-killed birds per 100 km during the nesting season is over 3,400 individuals (Bishop and Brogan, 2013). Researchers in Eastern Ontario also recorded substantial bird mortalities due to vehicle collisions (212 individuals) along a 37 km stretch of road in one field season (Eberhardt, 2009). The frequency of collisions can also increase near watercourses, in open areas, and with increasing traffic, road corridor width, and road elevation (summarized in Kociolek et al., 2011).

Vegetation Management and Infrastructure Maintenance

As roadside vegetation communities grow and develop, periodic maintenance may be required to minimize the establishment of tall woody plants. Vegetation clearing activities could result in habitat

loss for species within these areas. Vegetation clearing may also affect forage, cover, and habitat connectivity for bird species. If vegetation control activities occur within the nesting period, nests, eggs, and/or birds within and in the vicinity of the impacted area will be negatively impacted. Indirect mortality also may occur if work activities result in nest abandonment or increased predation.

Infrastructure such as bridges, culverts, overpasses, and ramps may also need periodic maintenance. These activities may disturb birds within the vicinity of the work area. If this maintenance were to occur during the nesting period, birds and their eggs and/or nest occurring on or near such structures could also be impacted.

Potential impacts to birds and their habitat from vegetation control and highway maintenance activities are similar to those outlined for Construction phase activities, but at a lesser scale. There could be some accidental mortality of birds during such activities, as well as a small amount of habitat alteration, but it is expected to be minimal and to occur only infrequently. Therefore, the overall effect of these activities is not considered to be significant.

Sensory effects due to equipment noise and light emissions are discussed below under Operation and Maintenance of Heavy Equipment.

Highway Maintenance – Winter Road Salting

Highway maintenance activities such as the application of road salt in winter may attract birds to roadways, making them subject to collisions with vehicles. In addition, the ingestion of sufficient amounts of salt can also lead to death (Mineau and Brownlee, 2005).

Sensory effects and accidental mortality on birds due to equipment noise and lighting are similar to those discussed below under Operation and Maintenance of Heavy Equipment.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment on the site during the Site Preparation and Construction phases also has potential to cause impacts to bird species, namely through increased noise emissions and collisions with machinery. Noise pollution created during Site Preparation and Construction may impact the reproductive success of nesting birds within and in proximity to the Project Area. Noise associated with work activities may negatively impact egg production and incubation, can also lead to behavioural changes in breeding birds resulting in abandonment of nests, eggs, and nestlings. Noise can also interfere with the ability of parents to hear begging calls from nestlings (Warren et al., 2006). Work during the Site Preparation and Construction phases may also disturb birds through visual stimuli (e.g., machinery and personnel) and noise within the Project Area and in vicinity of the work. As reviewed and outlined by Ortega (2012), noise pollution affects birds in a variety of ways including (but not limited to): physical damage to ears; stress responses; fright-flight responses; avoidance response; changes in other behavioural responses such as foraging; changes in reproductive success (previously discussed);

changes in vocal communication; interference with the ability to hear predators; and potential changes in populations.

The use of heavy equipment will also be required sporadically during the Operations phase of this Project, as part of infrastructure and ditch maintenance and winter snow plowing activities. Potential effects are similar to those outlined for the Construction phase and for Highway Operation. Required maintenance activities are expected to be quite limited in terms of spatial and temporal duration, and to occur infrequently.

Direct mortality of birds could also result from collisions with vehicles and machinery. As previously discussed, if work activities (e.g., clearing and grubbing), occurs during the nesting period, direct mortality to nesting birds, eggs, and nestlings may occur. Indirect mortality may occur if work activities result in nest abandonment and increased predation.

8.1.4.3 Reptile and Amphibian Species and Habitats

The construction and operation of highways and related infrastructure has the potential to have several types of impacts on reptile and amphibian species and their habitats. Road construction is well known to result in habitat loss and alteration for reptiles and amphibians (Trombulak and Frissell, 2000). As reptile and amphibian species vary considerably in terms of habitat requirements, behaviour, and life history, the effects of highways will differ across species. The main categories of impacts include:

- Habitat loss and alteration (including fragmentation and degradation);
- Direct mortality;
- Changes in behaviour/migration routes; and
- Disruption of gene flow.

As reptiles and amphibians utilize terrestrial, aquatic and wetland habitats, removal of any of these habitat types will impact one or more species of reptiles and amphibians. While reptiles and amphibians are mobile species, they tend to be generally less mobile than mammals and birds, which are faster-moving with larger home ranges. This reliance on smaller areas of habitat is thought to increase their vulnerability to habitat alteration (Sinsch, 1990).

Boundaries

The spatial boundary for potential effects to reptile and amphibian species and their habitats includes the whole Project Area at a minimum. Aquatic habitats such as watercourses and wetlands which flow or extend through the Project Area, may also be affected downstream of the main Project Area.

In terms of temporal boundaries, impacts to reptile and amphibian species and their habitats resulting from the Project are possible throughout the lifetime of the project and beyond.

Significance Determination

A significant environmental effect on non-SAR reptile and amphibian species and their habitats would result if a substantive change in the numbers and habits of any species could be attributed to

the development and operation of the Project. (Note that SAR reptiles are discussed in Section 8.1.7).

An impact that resulted in contravening the *Wildlife Act* by disturbing the eggs or nest of a turtle would also be considered significant.

A residual effect that does not meet this criterion will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

Potential impacts of the Project on reptiles and amphibians, as well as the temporal and spatial boundaries and significance of any potential impacts, are discussed in the following subsections. The potential impacts on reptile and amphibian species and their habitats are summarized in Table 8.15. These impacts can occur during both the initial construction activities and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on reptile and amphibian species and habitats are discussed in the following subsections.

Table 8.15 Summary of Potential Effects of the Project on Reptile and Amphibian Species and Habitats

Project Component / Activities / Physical Works	Alteration	Potential Effect on Reptile and Amphibian Species and Habitat*
Site Clearing and Construction Phases		
• Vegetation clearing	• Removal of vegetation, including forests	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation • Displacement of reptiles and amphibians • Mortality of reptiles and amphibians
• Site Preparation and Construction, including - Grubbing and soil management - Fill placement and compaction - Excavation - Wetland alteration - Ditch construction - Removal of Infrastructure (culverts, section of existing highway to be deactivated)	• Removal of topsoil • Removal or alteration of wetlands and vernal pools • Ground disturbance • Noise emissions	• Loss of breeding habitat • Loss of foraging habitat • Increased habitat fragmentation • Temporary and permanent displacement of reptiles and amphibians • Accidental mortality of reptiles and amphibians • Decreased habitat fragmentation (section of existing highway to be deactivated)

Project Component / Activities / Physical Works	Alteration	Potential Effect on Reptile and Amphibian Species and Habitat*
		• Habitat creation (section of existing highway to be deactivated)
• Rehabilitation and Restoration of disturbed areas • Revegetation of disturbed areas	• Ground disturbance • Seeding of exposed soil	• Establishment of non-native species • Changes in plant species communities, affecting reptiles and amphibians • Habitat creation (section of existing highway to be deactivated)
Operations and Maintenance Phase		
• Highway operation	• Vehicle traffic • Noise emissions Light emissions	• Direct mortality (roadkill) • Avoidance of area • Disturbance of wildlife
• Highway maintenance - Winter road salting - Snow removal	• Increased salinity of sediments and water in roadside ditches	• Contamination of watercourses/wetlands • Impacts of salt on larval amphibians
• Vegetation management	• Removal/ mowing of roadside vegetation • Ground disturbance	• Loss of foraging habitat • Displacement of reptiles and amphibians • Mortality of reptiles and amphibians
• Infrastructure maintenance - Paint striping - Ditch maintenance - Re-paving, as required - Signage and lighting repair	• Ground disturbance	• Loss of foraging and breeding habitat (roadside pools) • Displacement of reptiles and amphibians • Mortality of reptiles and amphibians
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Vehicle traffic • Increased noise emissions • Increased light emissions	• Collisions with vehicles/Mortality of reptiles and amphibians • Disturbance of reptiles and amphibians /behavioural effects

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

Reptiles and amphibians are likely to use the majority of habitats within the Project Area. Small wetlands and vernal pools within the Project Area support breeding wood frogs, yellow-spotted salamanders, and spring peepers, while larger, more permanent water bodies may support green frogs and bullfrogs. Ponds and rivers support painted turtles, snapping turtles, and wood turtles.

Wooded areas support salamanders, spring peepers, wood frogs, pickerel frogs, green snakes, garter snake, and ring-necked snakes. Wood turtles, a SAR species discussed in detail in Section 8.1.7, may also utilize these habitats, as well as agricultural fields. Therefore, all of these species have potential to interact with Project activities occurring in forested, non-forested, wetland, riparian, and disturbed habitats. The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to reptiles and amphibians via several Project activities. Project components occurring during the Construction phase that may lead to impacts on reptile and amphibian species and habitats are listed in Table 8.15, and discussed below.

Vegetation Clearing

One of the main impacts of the Project on both reptile and amphibians will be via the initial vegetation clearing activity. An estimated 221 ha of forest could potentially be removed. Many reptile and amphibian species, such as northern spring peeper, spotted salamander, red-backed salamander, wood frog, pickerel frog, maritime garter snake, ring-necked snake, and smooth green snake will lose foraging habitat due to loss of forested areas from the Project Area. Wood frogs, which hibernate under leaf litter in wooded areas, will lose overwintering habitat. Snake species may also lose overwintering habitat.

Site Preparation and Construction Activities

Additional impacts to both reptile and amphibians will be occur during the Site Preparation and Construction phase activities, which will result in habitat loss and/or alteration for these species. This will occur primarily though impacts to wetlands and watercourses within the Project Area. An estimated 32 ha of wetland could be removed or altered by the proposed Project. This loss or alteration may result from grubbing and soil management, excavation, fill placement, grading, ditch construction, wetland alteration, and watercourse diversion activities. These activities will impact amphibians and reptiles via the grubbing, infilling, or alteration of forested areas and wetlands which support many of these species, particularly along the new four-lane alignment south of the existing highway where no highway corridor currently exists.

Wetland and watercourse removal or alteration may result in loss of foraging, breeding and overwintering habitat for amphibians, and foraging and overwintering habitat for turtles. Snakes will also lose foraging habitats in and around wetlands. Removal of vernal pools will cause loss of breeding habitat for yellow-spotted salamanders, northern spring peepers, and wood frogs. An estimated maximum of 32 ha of wetland will be removed or altered by the Project, pending final Project design.

In addition to the direct and obvious potential effects of habitat loss caused by tree-clearing, wetland removal and infilling activities, less obvious changes at the local environment can make habitats less suitable for reptiles and amphibians. Road creation causes changes in microhabitats in the area surrounding the road, often resulting in less vegetation cover and leaf litter, leading to drier conditions that are less hospitable to amphibians, particularly salamanders (Marsh and Beckman, 2004). It has also been suggested that these reduced moisture levels could be further compounded by pollutants and sediment in roadway runoff (Semlitsh et al., 2007). Impervious roads also lead to

increases in surface water runoff into nearby wetlands, which can decrease the amount of suitable breeding, foraging and rearing habitat for amphibians (Richter, 1997). In addition, increased fluctuations in water levels and flow velocities in wetlands can cause decreases in amphibian richness (Richter and Azous, 1995). Increased sediment loading in streams has been shown to cause declines in salamander densities (Orser and Shure, 1972).

Creation of roads, with their often grassy maintained right-of-way, can lead to increased prey density by creating habitat for small mammals, causing predatory species such as snakes to spend more time hunting in such locations. In addition, some species of snake may be attracted to roads that serves as basking sites (Klauber, 1939; Brattstrom, 1965; Sullivan, 1981a), especially during cooler spring and fall weather when thermoregulation is more of an issue. Both of these behaviours can lead to increased collision risk for snakes. Roads also provide easier hunting opportunities for predators such as raptors as they increase the visibility of prey as they cross a road (Vandermast, 1999), increasing predation risk for snakes.

Roads generally do not provide much in the way of suitable habitat for reptiles or amphibians, and can result in fragmentation of suitable habitat into smaller, separate areas of habitat (Bennett, 1991). This habitat fragmentation creates long-lasting edge effects which can affect species within these habitats (Forman and Alexander, 1998). Studies have also shown that barrier effects created by roadways can result in reductions in genetic diversity and gene flow in the local area due to the increase in inbreeding, as well as decreased ability to recolonize (Rodriguez et al., 1996).

In addition to habitat loss and alteration, slow moving-organisms such as amphibians and reptiles may be killed directly during road construction activities (Trombulak and Frissell, 2000) such as excavation, blasting, or infilling, as well as by vehicle encounters (roadkill) (Mazerolle, 2004).

Some loss of individuals and loss or alteration of habitat will occur throughout the forested and wetland habitats affected by the Project. This habitat loss or alteration will be a one-time effect, but the results will be permanent. However, this effect can be mitigated (See Section 8.2 for Mitigation Measures), and the residual effects are predicted to be insignificant.

The Construction phase may also include the removal of the section of existing highway to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and culverts (and completion of any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. Ultimately, the reestablishment of native vegetation communities in some areas, and the reduction of traffic along this section should have a positive impact on local reptile and amphibian populations, by increasing the amount of available habitat and increasing habitat connectivity.

Blasting

Noise and vibration of any blasting activities required for the Project may startle some reptiles and amphibians or cause them to move away from areas undergoing blasting activities. However, this

impact is of very short-term, will occur infrequently, and is reversible. It is not expected to result in a residual effect on reptiles and amphibian. No mitigation for blasting activities is required for potential impacts to reptiles and amphibians.

Rehabilitation, Restoration, and Revegetation of Disturbed Areas

The twinning of Highway 104 and the removal of the deactivated section will require revegetation activities. This has the potential for unintentional introductions of invasive plant species. Establishment of such species could lead to habitat alterations that could negatively affect reptile and amphibian species. This can be avoided with proper mitigation.

Ultimately, the reestablishment of native vegetation communities along some areas of the existing section of highway to be deactivated will have a positive impact on local reptile and amphibian populations, by increasing the amount of available habitat and decreasing habitat fragmentation in the local area.

Operation and Maintenance Phase - Activities

Project activities occurring during the Operations and Maintenance phases that may lead to impacts on reptile and amphibian species and habitats are summarized in Table 8.15, and are discussed in more detail below.

Highway Operation (Traffic)

Once the highway is built, the most obvious and direct threat to reptiles and amphibians is direct mortality caused by vehicles. Amphibians and reptiles tend to be relatively small, slow moving species which are easily hit while crossing roads. In addition, many amphibian and some snake species have a protective behaviour of becoming immobile when they sense the presence of a predator. This unfortunately does not work in their favour on highways, as many species will freeze when they sense headlights and/or vibrations (Mazerolle at al., 2005), a behaviour which can greatly reduce the chances of them crossing a road successfully. The highest rates of road mortality for amphibians occur where roads are located between essential habitats such as for foraging, breeding, or overwintering habitats, forcing individuals to cross the road (Ashley and Robinson, 1996; Smith and Dodd, 2003; Langen et al., 2009). Wetlands within 100 m of roadways have been identified as ‘hot spots’ for amphibian and reptile roadkill, especially at causeways where wetlands abut both sides of the road (Langen et al., 2009).

Timing also plays a role in mortality rates. Much of this roadkill occurs during the amphibian spawning and turtle nesting season (spring to early summer). Many species, such as salamanders, migrate in large numbers from forested areas to wetland pools to breed (Semslitch, 2002), and some amphibian species may make multiple trips to breeding ponds throughout a single breeding season (Lamoureux et al., 2002). Turtles are most at risk of road collisions in late spring and early summer when they often cross roads as they look for sandy soils to lay their eggs in (i.e., Fowle, 1996), a habitat type that is unfortunately often found along roadsides. This has been an issue for common snapping turtles in Ontario (Haxton, 2000) and in Nova Scotia. A second pulse of mortality has been noted in some species during the periods when newly-metamorphosed frogs and toads are

dispersing from their natal ponds, and when turtle hatchlings are emerging from their nest and heading to the nearest water body of water (Smith and Dodd, 2003).

Reed et al. (2004) concluded that road mortality of reptile and amphibians is substantial, and probably the greatest source of anthropogenic mortality. Roadkill has been identified as a serious conservation problem for reptiles in some parts of Canada (Haxton, 2000; Desroches and Picard, 2005, 2007). It is especially a concern for turtles, with their very long maturation period and low reproductive rate (Brooks et al., 1991). In some areas of North America, sex ratios of turtle populations are now skewed towards males due to the disproportionate loss of breeding females due to roadkill since the development of the road networks in the last century (Gibbs and Steen, 2005).

It has also been suggested that roadways could interfere with within-species pheromone communication in snakes via masking of species-specific scents by contaminants such as oil residue or asphalt (Klauber, 1931; Shine et al., 2004).

The operation of the twinned highway has potential to cause impacts to reptiles and amphibians, namely though increased traffic resulting in wildlife-vehicle collisions. Areas of highway between wetlands and foraging habitat pose an increased risk of collisions for turtles and amphibians. Sandy or gravelly roadsides might also attract nesting turtles from nearby water bodies. Some snake species may also bask on asphalt to thermoregulate, especially in spring and fall when nights are cool.

NSDNR has reports of two snapping turtles being hit on highways in Pictou Antigonish Counties (NSDNR BIR, 2018). No amphibians or small reptiles such as snakes are listed in the database, likely because such collisions are usually barely noticeable to drivers and do not get reported to NSDNR.

Traffic-related mortality during the operations phase of this Project is not considered a significant risk to reptiles and amphibians. While considerable numbers of amphibians may be killed on roads each year, such roadkill has minimal effects on population sizes of terrestrial vertebrates (Forman and Alexander, 1998). There are also no species of amphibians considered to be Species at Risk in the Project Area. Reptile SAR (two turtle species – wood turtle and snapping turtle) are discussed in Section 8.1.7.

Highway Maintenance - Winter Road Salting

Road salting has the potential to cause impacts to amphibian species, many of which will breed in small roadside pools. Winter road maintenance activities have been shown to have impacts on amphibians. Russell et al. (2006) found a significant negative relationship between runoff from road salt applied to Nova Scotia highways and amphibian species richness in roadside ponds, with effects extending some 50 m into adjacent forestland. A study by Denoël et al. (2010) on the effects of salt on frog tadpoles found that high salt concentrations reduced the speed and movement of tadpoles, which could potentially have long-term impacts on tadpole survival and frog population dynamics.

It is possible that road salting along the new twinned highway could impact local amphibian populations. However, minimization of salt application and adherence to the NSTIR *Salt Management Plan* should help minimize these impacts. The use of road salt during winter road maintenance activities for this Project is not considered to result in a significant effect to reptiles and amphibians, assuming that applicable mitigation measures are adhered to. Residual effects are not expected to be significant.

Vegetation Management and Infrastructure Maintenance

As roadside vegetation communities grow and develop, periodic maintenance may be required to minimize the establishment of tall woody plants. Infrastructure such as culverts, overpasses, and ramps may also need periodic maintenance. The road surface itself will eventually need repaving. Potential impacts to reptiles and amphibians and their habitat from these activities are similar to those outlined for Site Preparation and Construction phase activities, but at a lesser scale. There could be some accidental mortality of reptiles and amphibians during such activities, as well as a small amount of habitat alteration, but it is expected to be minimal and to occur only infrequently. Therefore, the resulting effects of these activities is not considered significant.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment on the site during the Site Preparation and Construction phases has potential to cause impacts to reptile and amphibian species, namely though increased risk of mortality during construction activities (accidental burial of adults or eggs/larvae, vehicle collisions). This risk will vary both temporally and spatially, depending on the timing of the activity in relation to amphibian and reptile seasonal behaviour patterns and the specific locations within the Project Area in which the activity is occurring. This is a one-time impact that will be permanent but can be mitigated somewhat (See Mitigation Measures in Section 8.2). However, due of the very small localized areas in which this impact may occur, and the relatively small number of individuals likely affected, this is not considered a significant impact.

During the Operation and Maintenance phase, the operation, fueling, and maintenance of heavy equipment has the potential to impact wildlife via collisions, noise and light disturbance, accidental exposure to hazardous substances, and introduction of invasive species. Aside from transport trucks, heavy equipment is only expected to be used on the Project site during the operations phase during required maintenance activities, which are expected to be quite limited in terms of spatial and temporal duration. There could be some accidental mortality of reptiles and amphibians during such activities (vegetation clearing, ditch clearing, culvert replacement), but it is expected to involve very low numbers of individuals and to occur only infrequently. Therefore, any resulting effects of these activities are not considered significant to reptiles and amphibians.

While winter snow clearing activities are expected to occur frequently throughout the winter and early spring months, all amphibian and reptile species in NS will be hibernating at that time and should not be directly affected. The resulting effects of these activities are not considered significant to reptiles and amphibians.

8.1.5 Biological Environment - Wetlands

Wetlands were selected as a VEC due to their potential to interact with the Project, the critical functions and benefits they provide surrounding ecosystems (see Table 5.23), their subsequent value at the local and landscape level, and by virtue of their regulated status in Nova Scotia under the *Environment Act*. Wetlands provide habitat for a diversity of flora and fauna (including SAR and SOCC), and functional groupings thereof, thereby conserving regional biodiversity. Freshwater marshes and wetlands with open shallow water provide important habitat for wildlife that is highly dependent on aquatic environments for survival, such as freshwater fish (e.g., stickleback, dace), waterfowl (e.g., ducks, geese), migratory birds (e.g., Common Yellowthroat, Swamp Sparrow), amphibians (e.g., American bullfrogs, pickerel frogs), and mammals (e.g., muskrats, beavers).

Wetlands perform a suite of additional ecosystem services, including, but not limited to water surface storage, stream flow support, sediment retention and stabilization, water purification (e.g., nitrate removal), and climate change mitigations (e.g., carbon sequestration). Wetlands also provide recreational, aesthetic and socio-economic value to humans.

Wetlands which are known to support SAR are known as Wetlands of Special Significance (WSS) in Nova Scotia, and are afforded additional protection under the *Environment Act*.

To preserve wetland functions and benefits, two objectives were established through the *Nova Scotia Wetland Conservation Policy* (NSE, 2011), namely:

- Achieving no loss to Wetlands of Special Significance; and
- Achieving no net loss in area and function for other wetlands.

As stated in the Policy, NSE will not approve alterations to WSS or those which pose a substantial risk to WSS unless alterations:

- "are required to maintain, restore, or enhance a WSS"; or
- "provide necessary public function, based on an Environmental Assessment (if required) with public review or other approvals (e.g. Wetland Alteration Approval) as appropriate".

There is potential for the proposed Project to adversely affect wetlands during the lifecycle of the Project, resulting in the following effects to wetlands:

- Loss of wetland habitat (area); and
- Loss of, or changes to wetland functions within affected wetlands.

Potential impacts to Wetlands are summarized in Table 8.16. These impacts can occur during the Site Preparation, Construction, and Operations and Maintenance phases of the Project. Activities associated with each phase, and their potential effects on Wetlands, are discussed in the following subsections.

Boundaries

Spatial boundaries considered in this assessment include the Project Area and Local Assessment Area.

Temporal boundaries refer to the duration of environmental effects associated with Project components and activities. Site preparation and construction activities could be initiated in the winter of 2019 (e.g., clearing) and are anticipated to take approximately three to seven years, depending on the final delivery method for the Project. Highway operations are expected to occur indefinitely with no plans for decommissioning. Since Wetlands may be affected by Project activities, temporal boundaries encompass the lifespan of the Project.

Significance Determination

Pursuant to the *Activities Designation Regulations* under Section 66 of the Nova Scotia *Environment Act*, for any wetland whose area is more than 100 m^2 in size, an approval from NSE is required for alteration of such wetlands. As previously discussed, NSE has established the goal of no loss to WSS and no net loss in area and function for other wetlands, as described in the *Nova Scotia Wetland Conservation Policy* (NSE, 2011). Therefore, a residual effect to wetlands was determined significant if, following the implementation of mitigation and offsetting, the following conditions were met:

- Unauthorized permanent net loss of wetland area and function; or
- Loss of a wetland identified as a WSS.

An effect that does not meet the significance determinations conditions will not be considered significant.

Potential Environmental Effects of Highway Construction Activities on Wetlands

Potential impacts of the Project on wetlands are discussed by Project phase in the following subsections. The potential impacts on wetlands are summarized in Table 8.16. These impacts can occur during both the initial construction activities and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on wetlands are discussed in the following subsections.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Wetlands are discussed in Section 8.2.

Table 8.16 Summary of Potential Effects of Highway 104 Twinning Project on Wetlands

Project Component / Activities / Physical Works	Alteration	Potential Effect on Wetlands*
Site Preparation and Construction Phases		
• Vegetation clearing	• Tree clearing in forested wetlands	• Changes to wetland functions (ecological/habitat functions and hydrologic functions) • Changes to plant community composition/reduction in wetland plant diversity
• Site preparation activities, including	• Removal of wetland overburden	• Loss of wetland area

Project Component / Activities / Physical Works	Alteration	Potential Effect on Wetlands*
- Grubbing and soil management - Excavation - Blasting - Wetland alteration - Grading - Removal of existing infrastructure (culvert, section of existing highway to be deactivated)	• Increase in erosion and sedimentation • Increase in run-off into adjacent wetlands • Removal and replacement of wetland soils and organics with fill • Noise emissions • Dust emissions • Ground disturbance • Sedimentation and erosion • Noise pollution • Dust emissions Increased run-off into adjacent wetlands	• Changes to wetland functions (ecological/habitat functions and hydrologic functions) • Changes to plant community composition/reduction in wetland plant diversity • Introduction and establishment of non-native plant species. Decline in native wetland plant diversity • Changes water quality and fish habitat quality • Loss of wildlife that inhabit or rely on wetlands for resources • Reduction in overall biodiversity
• Bridge and grade separation structure placement • Installation of watercourse crossings and diversions	• Erosion and sedimentation	• Changes to functions of wetlands associated with watercourses • Decreased surface water quality in wetlands and downstream • Reduced fish habitat downstream of wetlands
• Rehabilitation / restoration of disturbed areas	• Ground disturbance	• Increased sedimentation into wetlands
• Revegetation (i.e., planting and hydroseeding)	• Nutrient loading to adjacent wetlands • Introduction of invasive species	• Changes to biological processes (e.g., nutrient uptake by plants, decomposition rates) • Changes to wetland plant communities and diversity
Operation and Maintenance Phase		
• Infrastructure maintenance: - Culverts (e.g., replacement) - Bridges (e.g., repairs) - Shoulder - Pavement	• Ground disturbance • Sedimentation and erosion	• Changes to functions of wetlands associated with watercourses • Sediment loading in adjacent watercourses • Decreased surface water quality in wetlands and downstream • Reduced fish habitat downstream of wetlands
• Vegetation management: - Hydroseeding	• Removal of roadside vegetation	• Reduction in wetland plant abundance

Project Component / Activities / Physical Works	Alteration	Potential Effect on Wetlands*
- Mowing - Application of herbicides - Planting	• Addition of herbicides to adjacent wetlands via run-off • Seeding of disturbed areas	• Reduction in surface water quality in wetlands • Reduction in fish habitat quality • Changes to plant community composition/reduction in wetland plant diversity • Introduction and establishment of non-native plant species. Decline in native wetland plant diversity
• Highway maintenance: - Snow plowing - Winter road salting	• Introduction of salt into adjacent wetlands via run-off	• Changes to salinity in wetland surface water and soils • Changes to vegetation communities
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Ground disturbance • Accidental spills or leaks* • Noise emissions • Light emissions	Contamination of wetland water or soils

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Species at risk were identified within 14 wetlands in the LAA, while SAR critical habitat was identified in a single wetland in the LAA. Eleven wetlands supporting Species at Risk, referred to as Wetlands of Special Significance (WSS) intersect the Project Area. SAR that comprise these WSS include, but are not limited to, Canada Warbler, wood turtle, and black ash. In the Maritimes, the Canada Warbler commonly uses wetlands for important life history functions such as breeding and nesting. Canada Warblers were recorded within 2 wetlands during the breeding bird program. Wood turtles are often associated with floodplains but may utilize a variety of wetland habitats. Two (2) floodplain swamps are located within wood turtle critical habitat. Black ash is typically found in areas with poorly drained soils that are often seasonally flooded, and is most commonly found growing on peat and muck soils. Black ash was identified in 4 wetlands that intersected the Project Area. The direct removal of wetland habitat during Site Preparation and Construction may subsequently eliminate important habitat for flora and fauna, including SAR.

Site Preparation and Construction Phases - Activities

Many wetlands occur within the LAA and the Project Area. The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to wetlands and their associated hydrological and ecological functions via several Project activities. Project components occurring during the Construction phase that may lead to impacts on wetlands are listed in Table 8.16, and discussed below.

Vegetation Clearing

Removal of forest habitat will occur during the Vegetation clearing phase. Some treed wetlands could be affected by this activity, however the majority of wetland impacts will occur during the Site Preparation and Construction activities, discussed in the following section.

Site Preparation and Construction Activities

Site preparation activities (i.e., grubbing, infilling, contouring) will result in alteration to or loss of wetland habitat through the removal of vegetation and overburden. Construction activities which may result in loss of wetland habitat include excavation, blasting, and wetland alteration, i.e., removal of wetland soils and overburden, and infilling in preparation for the roadbed. Wetland plant diversity may be reduced through the direct removal of wetland habitat during both clearing and grubbing activities. These activities may also affect wetland ecological (habitat) and hydrologic functions. Additional Construction activities which may impact wetland functions include the placement of bridge and grade separation structures, installation of watercourse crossings, watercourse diversion (if required), and hydroseeding.

A total of 32 ha of wetland habitat is encompassed by the Project Area and much of this area could be removed as a result of the proposed Project (see Table 5.22). Approximately 6 ha of this total area comprises 11 WSS that overlap with the Project Area. Direct loss of wetland habitat will occur via the removal of vegetation and overburden during Site Preparation activities (i.e., clearing and grubbing). Construction activities that may result in the direct loss of wetland habitat include excavation, blasting, and infilling.

Site preparation activities may also cause sedimentation and erosion which could cause loss of wetland habitat. Vegetation acts as a buffer between wetlands and sediment laden run-off by slowing the flow of water and enabling the sediment to settle out before reaching wetlands. Removal of vegetation adjacent to wetlands through clearing and grubbing may result in an increase in sediment loading associated with erosion of upland soils. Construction activities that result in ground disturbance in adjacent upland habitat (e.g., excavation, blasting, ditch construction, fill placement, grading) may also result in sedimentation and erosion. The construction and installation of watercourse crossings (i.e., bridges and culverts), as well as watercourse diversions, where required, may lead to sediment loading in wetlands associated with watercourses.

Loss or alteration to wetland habitat, including WSS, will require authorization from NSE. To achieve no net loss to wetland habitat, habitat compensation will be required to replace lost wetland area and functions. Following the implementation of permitting requirements, offsetting, and mitigation measures, impacts to wetlands are not anticipated to be significant.

Sedimentation and erosion may also result in changes to ecological (habitat) functions that are important for supporting fish and fish habitat. The accumulation of sediments in wetlands may decrease wetland volume, the duration that wetlands retain water, and subsequent loss of open water areas (Dowling, 2010). Wetlands perform various functions which maintain the quality of receiving waters and suitable habitat for fish, aquatic invertebrates, and species which rely on these

organisms for food resources. One such function is water cooling, i.e., maintenance or reduction in temperature of downstream waters. Wetlands also perform sediment retention and stabilization by intercepting and filtering sediments, thereby reducing turbidity of downstream waters. Temporary increases in sedimentation can affect fish habitat suitability, resulting in immediate relocation and, in extreme cases, fish mortality (Wilber and Clarke, 2001). Additionally, wetlands support fish and fish habitat by maintaining stream flow during dry periods. Potential impacts to ecological functions that support fish and fish habitat are anticipated to be temporary in nature and spatially limited to within 300 m downstream of the wetland. Following the implementation of erosion and sediment control measures, potential environmental effects to wetland functions which support fish and fish habitat are not anticipated to be significant.

Wetland plant diversity may be reduced through the direct removal of wetland habitat during grubbing activities. The removal of vegetation during Site Preparation and replacement with an impervious surface (i.e., pavement) during Construction, may lead to an increase in site run-off and a decline in plant diversity, or introduction of exotic or invasive species. Run-off results in increased nutrients and altered pH in soils, conditions which invasive species are more adaptive to than native plant species (Bocking, 2015). Non-native and invasive species may also be transferred to wetlands directly through the operation of heavy machinery, or indirectly through dust emissions from heavy machinery. The generation of airborne particulates may facilitate the introduction and dispersal of non-native and invasive species into adjacent wetland habitats. Non-native and invasive species can outcompete native plants for resources (e.g., light, resources), resulting in changes in vegetation community composition, with subsequent impacts on local ecosystems.

The hydrologic regime of a wetland influences its vegetation composition, classification, and development; the construction of roads that bisect and subsequently infill or reduce wetland areas can alter the hydrologic regime on a local and landscape level (Bocking, 2015); specifically, the ability of a wetland to effectively perform hydrologic (e.g., surface water retention and flood control) and water quality maintenance (e.g., filtering and absorbing sediments, metals, nutrients, chemicals and hydrocarbons) functions. One of the most common effects of highway construction on wetlands is the alteration of drainage patterns (Shuldiner et al., 1979). The replacement of wetland habitat with an impervious surface and the construction of drainage features (e.g., roadside swales) may alter wetland water supply and drainage. Should blasting occur during construction, fractures to underlying bedrock may also promote wetland drainage.

Another important hydrologic function that wetlands perform is surface water storage. Wetlands mitigate flooding by intercepting and either storing surface runoff or delaying the movement of surface waters through the wetland. Once intercepted, wetlands remove excess nitrogen, phosphorus, dissolved carbon, inorganic nutrients, and suspended sediments from run-off. This process results in improved water quality, including drinking water, of downstream waters. Removal and replacement of wetland habitat and adjacent vegetation with impervious surfaces may result in increased run-off, decreased storage capacity of the receiving wetland, potential flooding of areas downgradient to surface water flow, and reduced water quality of surface water, including drinking water.

The Construction phase may also include the removal of the section of existing highway to be deactivated upon commissioning of the new highway, although there remains the possibility that NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and completion of any required soil stabilization activities) between Browns Mountain Road and Pushie Road. These activities are not anticipated to result in any loss of wetland area. Activities which result in ground disturbance may have similar impacts to wetland functions as those associated with other Construction phase activities. Potential impacts associated with these activities will be short in duration and will be limited to the section of highway no longer in use. The magnitude of impacts to any wetlands adjacent to or down-gradient from these activities can be greatly reduced by the use of standard mitigation measures. Following the implementation of mitigation measures, potential impacts of removing existing infrastructure on wetland functioning are not anticipated to be significant.

Without the implementing of standard mitigation measures, potential impacts to wetland hydrology would be long-term and irreversible. Following the implementation of mitigation measures, these impacts are not anticipated to be significant. Cumulative hydrologic functions are anticipated to be maintained through compensation of wetland area and function.

Rehabilitation, Restoration, and Revegetation of Disturbed Areas

Hydroseeding involves the application of a slurry of seeds and mulch to minimize erosion and hasten revegetation of areas of exposed soil. When applied to areas which drain into wetlands, hydroseeding has the potential to impact wetlands as a result of nutrient loading. This may alter plant communities and their biological processes (e.g., nutrient uptake and decomposition rates). Approved hydroseeding mixes may also contain non-native plant species which could also alter the composition of wetland plant communities. Introduction of non-native and invasive species may also occur during Project activities that result in sedimentation and erosion. Sedimentation can affect vegetation by suffocating native species, allowing invasive species to take over by forming large monotypic stands (Dowling, 2010). Potential impacts to wetland plant communities associated with Construction activities are anticipated to be relatively short-term (i.e., the duration of the Construction phase). However, if invasive species are introduced into wetland habitats, potential impacts to native plant communities could be long-term and spatial limits may extend beyond wetland boundaries. However, following the implementation of mitigation measures, impacts to wetland vegetation are not anticipated to be significant.

Operations and Maintenance Phase - Activities

Loss of wetland habitat is not anticipated to occur during the Operations phase of the Project. However, Operation and Maintenance activities may result in changes to wetland ecological and hydrologic functions. These activities and potential impacts are described in the following subsections.

Highway Maintenance - Winter Road Salting

Winter maintenance of highways by the Proponent will entail plowing and de-icing (i.e., salting) road surfaces. Spring melt and rainfall events can lead to salt-laden run-off into adjacent wetlands.

Increased salinity in wetland soils and surface water could result in changes to the composition and survivorship of native plant communities, fish, aquatic invertebrates, birds, and mammals which utilize aquatic resources for survival. These impacts are short in duration (seasonal) and reversible. Following the implementation of mitigation measures, impacts of road salt run-off on wetland communities are not anticipated to be significant.

Vegetation Control and Highway Maintenance

Vegetation management will entail manual or mechanical (i.e., mowing) removal of vegetation from the highway shoulder. Potential exists for the spread of non-native species into adjacent wetlands as a result. The use of herbicides may be required should manual or mechanical methods of removal prove unsuccessful. Run-off containing herbicides could potentially affect the composition, survival and diversity of wetland flora and fauna. Although vegetation management will be ongoing throughout the lifespan of the Project, it will generally be short in duration (seasonal). Following the implementation of standard mitigation measures, potential affects to wetland flora and fauna are not anticipated to be significant.

Maintenance of highway infrastructure, such as culvert and bridge replacements or repairs, may lead to ground disturbance and erosion, leading to sediment loading in adjacent wetlands. Potential impacts to wetlands and the species they support were previously noted in the discussion of potential impacts associated with construction activities. Potential impacts associated with maintenance activities are anticipated to be smaller in magnitude as these activities will be localized to a small area, short in duration, and temporary. Following the implementation of mitigation measures, the potential effects to wetlands and ecological (habitat) functions as a result of highway maintenance activities are not anticipated to be significant.

All Phases – Operation and Maintenance of Heavy Equipment

As it relates to wetlands, the effects of noise emissions by heavy machinery and blasting during all are primarily in terms of disturbance to wildlife (including Species at Risk) that may be utilizing the wetland habitat. These effects are discussed in Sections 8.1.4 (Wildlife) and 8.1.7 (Species at Risk).

8.1.6 Biological Environment - Fish and Fish Habitat

Fish and fish habitat are protected federally under the *Fisheries Act* and provincially under Section 66 of the *Environment Act*: *Activities Designation Regulations*. As stated in Chapter 5, Section 5.6, fish and fish habitat was selected as a VEC due to their presence in the Project area. Direct interaction with fish and fish habitat is anticipated during the Site Preparation, Construction, and Operation and Maintenance phases of the Project.

Although 170 watercourses were identified within the LAA, only 127 of these watercourses are located within the Project Area. One hundred (100) of the 127 watercourses have the potential for fish at some point during the year, which leaves twenty-seven (27) watercourses with no potential habitat for fish (Table 8.17). Forty-five (45) of the identified watercourses within the Project Area were confirmed to contain fish either during the 2018 fish sampling program or assumed presence. Further details are provided in the Aquatics Technical Report (CBCL, 2018) in Appendix E.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Fish and Fish Habitat are discussed in Section 8.2.

Table 8.17 Watercourse Summary by Fish Habitat Potential within the LAA and Project Area

Fish and Fish Habitat Status	Local Assessment Area	Project Area
Total Watercourses	170	127
Confirmed fish-bearing	52	45
Potential for Fish*	76	55
No fish habitat	42	27

** These are in addition to the Confirmed Fish-bearing Watercourses.*

Watercourse alteration activities are anticipated for all 127 watercourses identified in the Project Area. These activities will include:

- Potential culvert or bridge crossings;
- Potential watercourse diversions or re-alignments;
- Potential watercourse removals;
- Potential watercourse connections (i.e. a watercourse was identified on either side of the highway with no culvert connecting them. These areas may want to be considered for culvert crossings; and
- Unaffected watercourses.

The following VEC analysis for Fish and Fish Habitat is based on desktop analysis and field studies conducted in 2016 and 2018 (see Section 5.6).

Boundaries

Spatial boundaries are limited to the fish and fish habitat approximately 100 m upstream and 300 m downstream of identified watercourse crossing locations within the Project Area. In some cases, the spatial boundaries within the watercourses may extend past the Project Area.

Temporal boundaries are those associated with instream activities and activities that could result in impacts to fish and fish habitat during the Site Preparation, Construction, and Operation and Maintenance phases of the Project.

In addition, fish and fish habitat are also bounded temporally by specific CRA and SAR spawning and migration seasons, as defined by DFO. The temporal boundary restriction for instream activities to protect spawning activities and eggs is currently set provincially and federally to occur from October 1 to May 31 of each year. This leaves a timing window to conduct instream works from June 1 to September 30. Requests to extend this temporal boundary can be granted with permission and approval from NSE and DFO. Further details regarding specific spawning periods for fish potentially present in the Project area are provided in the Aquatics Technical Report (CBCL, 2018) in Appendix E.

Significance Determination

A residual effect for fish and fish habitat was considered to be significant under the following circumstances:

- Impacts to fish and fish habitat that occur as a result of Project activities without federal and provincial approval and/or without required implemented approval conditions (e.g., offsetting plan);
- Project-related activities that even after the implementation of mitigation measures result in large scale fish mortality that decrease CRA fish productivity and cannot be remedied with a suitable offsetting plan; and
- Project-related activities that result in permanent habitat alteration or destruction of suitable CRA or SAR fish habitat that cannot be offset with an appropriate offsetting plan and/or where no suitable alternative habitat can be identified or accessed within the LAA.

Potential Environmental Effects and Project-Related Interactions

Potential environmental effects may occur to fish and fish habitat during the Site Preparation, Construction, and Operation and Maintenance phases of the Project. The following potential environmental effects are anticipated:

- Increased sediment loading in watercourses;
- Permanent fish habitat alteration;
- Temporary noise disruption;
- Temporary fish habitat alteration; and
- Increased salinity of aquatic environments.

Accidental mortality may occur as a result of some of the impacts. Project activities associated with Site Preparation and Construction, and Operation and Maintenance phases are summarized in Table 8.18 and discussed in the following subsections.

Table 8.18 Summary of Potential Effects of Highway 104 Twinning Project on Fish and Fish Habitat

Project Component / Activities / Physical Works	Alteration	Potential Effect On Fish and Fish Habitat*
Site Preparation and Construction Phases		
• Vegetation clearing	• Increased sediment loading in watercourses	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and/or displacement • Loss of fish
• Site Preparation and Construction activities, including - Grubbing and soil management - Excavation	• Increased sediment loading in watercourses • Permanent fish habitat alteration • Temporary noise disruption • Temporary fish habitat alteration	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and/or displacement • Loss of fish

Project Component / Activities / Physical Works	Alteration	Potential Effect On Fish and Fish Habitat*
- Fill placement and compaction - Ditch construction - Removal of existing infrastructure (culverts, bridges, and section of highway to be deactivated)		
• Installation of Watercourse Crossings, Watercourse Diversions and Watercourse Removals including: - Installation of new culverts - Installation of bridges with abutments and piers below the high water mark - Replacements, modifications or extensions to existing culverts or bridges that result in an increase in the existing footprint.	• Increased sediment loading in watercourses • Permanent fish habitat alteration • Temporary noise disruption • Temporary fish habitat alteration	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and/or displacement • Loss of fish
• Blasting	• Noise emissions	• Temporary loss of habitat • Temporary fish disruption and/or displacement
Operations and Maintenance Phase		
• Highway maintenance - Winter road salting	• Increased salinity of aquatic environments	• Change in water quality and invertebrate biodiversity due to salt in freshwater streams may limit fish species presence and abundance • Impacts to fish species' presence and abundance • Impacts on invertebrate biodiversity and abundance in freshwater streams
• Infrastructure maintenance at watercourse crossings; including; - Replacements, modifications or	• Increased sediment loading in watercourses • Permanent fish habitat alteration • Temporary noise disruption	• Permanent loss of habitat • Temporary loss of habitat • Temporary fish disruption and displacement • Loss of fish

Project Component / Activities / Physical Works	Alteration	Potential Effect On Fish and Fish Habitat*
extensions to existing culverts or bridges that result in a permanent increase in the existing footprint. This includes the inlet and plunge pools.	• Temporary fish habitat alteration	
All Phases - Operation and Maintenance of Heavy Equipment		
Operation, fueling, and maintenance of heavy equipment during all Project activities	• Accidental spills or leaks* • Noise emissions	• Temporary loss of habitat • Temporary fish disruption and displacement • Temporary fish habitat alteration

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases – Activities

Considerable Fish Habitat occurs within the LAA and the Project Area. The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to Fish and Fish Habitat. Project components occurring during the Construction phase that may lead to impacts on Fish and Fish Habitat are listed in Table 8.18, and discussed below.

Vegetation Clearing

The clearing of forest habitat within the Project Area is not predicted to have any significant impacts on fish or fish habitat. The initial phase of vegetation clearing is unlikely to occur in wetlands or within a 30 m buffer of watercourses, eliminating the potential for sedimentation issues in watercourses. These areas will be cleared later, during the later grubbing and construction activities, and the potential effects are discussed below.

Site Preparation and Construction Activities

Activities for the Site Preparation and Construction phases have the potential to cause runoff into adjacent watercourses resulting in a temporary increase in instream sedimentation above background levels. These activities may include grubbing and soil management, excavation, fill placement and compaction, ditch construction, removal of existing infrastructure, and installation of watercourse crossings and diversions. Temporary increases in sedimentation can disrupt fish activities by altering fish social hierarchies, changing feeding and swimming behaviour, causing immediate relocation and in extreme cases, mortality (Wilber and Clarke, 2001). According to the CCME Water Quality Guidelines for the Protection of Aquatic Life, the maximum allowable levels of turbidity above background levels is 8 NTU for short durations (e.g., ≤ 24 hours) and 2 NTU for longer durations (e.g., 30 days) (CCME, 1999). Increases in instream sediment may also result in covering of natural substrates with sediment, which would temporarily change the function of the habitat. If temporary sedimentation occurs into adjacent watercourses, it is anticipated that the

local fish residents would likely temporarily relocate to suitable alternative habitat upstream or downstream of the impact and then return to their preferred habitat when the sediment settles.

The Construction phase may also involve the removal of the Highway 104 section to be deactivated, including removal of the asphalt layer and potentially some culverts. This ground disturbance could cause increased sediment loading in watercourses, noise emissions, and temporary fish habitat alteration while instream structures are being removed. Potential impacts will be similar to those mentioned above for the other Site Preparation and Construction phase activities.

Installation of Watercourse Crossings, Watercourse Diversions and Watercourse Removals

Permanent Alteration: Fish habitat, including habitat for CRA and SAR species, will be permanently altered during watercourse crossings, watercourse diversions, and watercourse removals. The installation of watercourse crossing includes the following activities:

- Installation of new culverts at watercourse crossings;
- Installation of bridges with abutments and piers below the high water mark; and
- Replacements, modifications or extensions to existing culverts or bridges that result in a permanent increase in the existing footprint. This includes the inlet and plunge pools.

The exact total area of fish habitat to be removed at each proposed watercourse alteration location is presently unknown and is pending final Project design.

The majority of the permanent watercourses identified in the Project area provide overall habitat functions ranging between 'moderate' and 'good' for salmonids. Many of these watercourses provide adequate percentages of suitable substrate for spawning (i.e., small and large gravel), moderate to abundant quantities of instream cover, deep pools, good flow, and optimal water quality results. Loss of these habitats may result in local changes in habitat use as it is anticipated that fish species using these habitats for important life history events (spawning, rearing, overwintering) will be obligated to find suitable alternative habitat either upstream or downstream of the impact. In some situations, where suitable alternative habitat is not found in the same watercourse, fish may use suitable habitats in connecting tributaries.

In many cases, suitable alternative habitat for salmonid species is available following a small scale permanent instream alteration; however, improperly installed culverts can reduce or eliminate fish passage, ultimately impacting local fish populations. The proper installation of permanent structures such as culverts and bridges is imperative to allow fish access to their critical life history habitats upstream and downstream of these structures. For example, salmonid species identified in the Project area such as Atlantic salmon, brown trout and brook trout need access to suitable spawning habitat, and when this habitat cannot be accessed due to improperly installed instream structures, these species may suffer. Span bridges and open bottom culverts with a natural stream bottom (i.e., bed and banks) are most preferable for fish passage (DFO, 2015). The second preference for fish passage is an embedded culvert with rebuilt fish habitat within the culvert. The least preferred option for fish passage is a round bottom culvert which is properly designed according to slope. This may include the installation of carefully placed baffles to encourage fish to use the structure.

Permanent alterations to fish habitat may result in small scale fish accidental mortality. Although mitigation measures will be in place to reduce mortality (see Section 8.2 below), small scale fish mortality may occur.

Temporary Alterations: Fish habitat, including habitat for CRA and SAR species, will also be temporarily altered during watercourse crossings, watercourse diversions and watercourse removal. Examples of temporary habitat alteration include:

- Fish habitat that is altered during instream construction activities and then restored or reinstated post-construction (e.g., dewatered area for a culvert or bridge installation);
- Project-related sedimentation that results in the complete covering of natural substrates; and
- Temporary instream structures such as cofferdams and aqua-dams that are placed on top of fish habitat. Temporary cofferdams are anticipated to be installed during the culvert and bridge installations.

During the instream construction phase, fish will have limited use of the area and will need to relocate and temporarily use alternate suitable habitat upstream or downstream of the watercourse crossing site. Fish may use habitat in the same watercourse or in connecting tributaries. During dewatering, fish salvages will occur where fish are physically removed and placed either upstream or downstream of the impacted area. Dewatering activities could result in mortality of some fish. Large fish are easy to see, collect and remove via backpack electro-fishing and netting; however, smaller fish species (e.g., stickleback), salmonid young of the year or eels can be harder to see and easier to get stuck, especially if there is moderate to abundant instream vegetation, boulders and woody debris present. In addition, accidental spills and leaks of diesel, gasoline or oil from heavy equipment used during construction activities can also enter watercourses, resulting in fish mortality. Although mitigation measures will be in place to reduce mortality (see Section 8.2 below), small scale fish mortality may occur. Once instream activities are complete and habitat is restored to its original pre-construction condition, the local fish population is anticipated to return to the area and continue using the habitat.

Increased Sediment Loading in Watercourses: Increased sediment loading in watercourses may occur during construction of watercourse crossings, watercourse diversions and watercourse removals. An increase in sediment may occur during permanent and temporary alterations to fish habitat if proper sediment erosion control is not in place. Temporary fish disruption and displacement may occur when sediment levels are noticeably above background levels.

Watercourse alteration activities are anticipated for watercourses with no fish habitat (i.e., ephemeral watercourses). Although, no permanent alterations are anticipated to fish habitat at these locations, increased sediment loading into fish habitat may occur further downstream from the construction activities. These potential impacts are discussed in detail earlier in this section.

Blasting

Temporary Noise Disruption: Temporary noise disruption to fish and fish habitat, including CRA and SAR species, may occur during blasting activities. (Note that the use of heavy equipment is discussed separately later in this section). In order to predict impacts of noise on fish, one must know whether the sound produced is within the hearing frequency of the fish and loud enough to be detectable above threshold levels (i.e., the lowest sound level that a fish can detect at each frequency). For example, Hawkins and Johnstone (1978) suggest that salmon, with their narrow hearing range and reduced sensitivity to high frequency noise, are unlikely to detect sounds originating in the air. Adverse effects of noise on fish may include behavioral changes including avoidance (Slotte et al., 2004; Nedwell and Mason, 2012) and startle responses (Wardle et al., 2001; McCauley et al., 2003), auditory tissue damage and temporary hearing loss (Hastings et al., 1996; McCauley et al., 2003; Popper et al., 2005; Wysocki and Ladich, 2005), temporary threshold shift (Popper et al., 2005; Popper et al., 2009), and physical injury resulting in mortality (Yelverton et al., 1975; Ruggerone et al., 2008). While the studies examining impacts to noise on fish are lacking, it is apparent that most behavioral reactions (e.g., startle responses and avoidance) are temporary and although damage to hearing is possible at high decibels, it appears to be temporary in most cases. Temporary noise disruptions may cause fish to relocate temporarily to alternative suitable habitat upstream or downstream of the impact and then return to their preferred habitat Project activities generating noise cease.

Increased Sediment Loading in Watercourses: Increased sediment loading in watercourses may occur during excavation, blasting and use of heavy equipment. Temporary fish disruption and displacement may occur when sediment levels are noticeably above background levels. These potential impacts are discussed in detail earlier in this section.

Operation and Maintenance Phase – Activities

Operation and Maintenance activities have the potential to result in changes to watercourses which could impact fish and fish habitats. These activities and potential impacts are described in the following subsections.

Highway Maintenance

Highway maintenance activities such as sanding and salting could result in salt run-off into adjacent fish and fish habitat. The introduction of sodium chloride (NaCl) to freshwater watercourses may have negative impacts to water quality and subsequently the local populations of aquatic invertebrates and fish. For example, environmentally relevant concentrations of NaCl and calcium chloride ($CaCl_2$) have been found to significantly reduce rainbow trout larva growth. Although this impact was sublethal, a reduction in growth may impact salmonid population dynamics (Hintz and Relyea, 2017). In addition, an increase in salinity reduced the population density of the freshwater crustacean *Daphnia dentifera* (Searle et al., 2015) and has shown to cause mortality in amphipods (Rapp Learn, 2017). Subsequently, the presence of salinity in the freshwater environment can cause a decrease in aquatic invertebrate biodiversity (Rapp Learn, 2017). Furthermore, with a decrease in aquatic invertebrates, fish will likely choose to forage elsewhere, potentially decreasing the overall diversity and abundance of fish in affected watercourses. Although the application of salt during

weather events cannot be avoided due to human health and safety, a number of mitigation measures can be and are currently being implemented within NSTIR to reduce the negative impacts on the aquatic environment (see Mitigation Measures in Section 8.2).

Infrastructure Maintenance: Watercourse Crossings

Permanent Alterations: Infrastructure maintenance of watercourse crossings was identified as an activity that may result in permanent fish habitat removal during the Operation and Maintenance phase of the Project. Permanent fish habitat removal may occur during the following identified infrastructure maintenance activities:

- Highway repairs that result in a permanent increase in footprint below the high water mark;
- Replacement or repairs to existing culverts that result in a permanent increase to the existing footprints; and
- Replacement or repairs to bridges resulting in a permanent increase to the existing footprints below the high water mark.

Potential impacts will be similar to those discussed earlier in the Site Preparation and Construction phases section.

Highway repairs adjacent to watercourses and replacements or repairs to existing culverts or bridges may also potentially interact with fish and fish habitat through direct sediment releases and soil erosion from the Project site. Temporary increases in turbidity and total suspended solids above background levels may disrupt fish activities and potentially cause accidental mortality. Potential impacts will be similar to those mentioned in the Site Preparation and Construction phases section above.

Temporary Alterations: Temporary alterations to fish and fish habitat are also anticipated during repairs, replacements or maintenance to existing infrastructure. Examples of temporary habitat alteration include:

- Fish habitat that is altered during instream activities and then restored or reinstated post-maintenance (e.g., dewatered area for a culvert or bridge repair or replacement);
- Project-related sedimentation that results in the complete covering of natural substrates; and
- Temporary instream structures such as cofferdams and aqua-dams that are placed on top of fish habitat. Temporary cofferdams are anticipated to be installed during the culvert and bridge repairs or replacements.

Potential impacts will be similar to those mentioned for the Site Preparation and Construction phases section.

All Phases – Operation and Maintenance of Heavy Equipment

Temporary Noise Disruption: Temporary noise disruption to fish and fish habitat, including CRA and SAR species, may occur via the use of heavy equipment during all Project phases, but especially the Site Preparation and Construction phases. Noise impacts to fish are also anticipated while heavy

equipment is being used during watercourse maintenance, replacements and repairs. Potential impacts will be similar to those mentioned in the Site Preparation and Construction phase section. Potential impact to fish from noise are discussed in detail under the Blasting subheading earlier in this section. While the studies examining impacts to noise on fish are lacking, it is apparent that most behavioral reactions (e.g., startle responses and avoidance) are temporary and although damage to hearing is possible at high decibels, it appears to be temporary in most cases. Temporary noise disruptions may cause fish to relocate temporarily to alternative suitable habitat upstream or downstream of the impact and then return to their preferred habitat Project activities generating noise cease.

8.1.7 Biological Environment - Species at Risk

Species at Risk are protected federally under the *Species at Risk Act* and provincially under the *Nova Scotia Endangered Species Act.* As stated in Chapter 5, Section 5.7, Species at Risk were selected as a VEC due to their presence in the Project area. Interactions with Species at Risk are possible during the Site Preparation, Construction, and Operation and Maintenance phases of the Project.

8.1.7.1 Species at Risk-Flora

Three species of flora SAR are known to occur within the LAA; these are black ash, blue felt lichen, and pygmy pocket moss. Potential effects of the Highway 104 twinning project on these flora SAR are discussed in the following subsections.

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. Site preparation and construction activities could be initiated in the winter of 2019 (e.g., clearing) and are anticipated to take approximately three to seven years, depending on the final delivery method for the Project. Highway operations are expected to occur indefinitely with no plans for decommissioning. Since habitat for flora SAR will be removed by Project activities associated with both construction and operation, temporal boundaries encompass the lifespan of the Project and beyond.

Spatial boundaries considered in this assessment include the Project Area and LAA.

Significance Determination

A significant adverse residual effect to flora SAR is defined as one that:

- Results in a non-permitted contravention under Sections 32-36 of SARA, or Section 13 of the NSESA*;* or
- Threatens the long-term sustainability of these species. Threats to long-term sustainability may include changes to distribution, abundance, or critical habitat.

Any Project component or activity resulting in non-permitted contravention of the above prohibitions under the NSESA or SARA, or which threatens the long-term sustainability of flora SAR within the Project Area and LAA, will be deemed to have a significant impact on flora SAR. Threats to long-term sustainability may include changes to distribution, abundance, or critical habitat. A residual effect which does not meet this criterion will not be considered significant.

Potential Environmental Effects of Highway Construction Activities on Flora SAR

Black ash occurs primarily in forested wetlands and so has some potential to interact with Project activities affecting wetland habitats. Blue felt lichen is known to occur at one location within the Project Area, and a second location just outside it. Pygmy pocket moss has been detected on bare soils at five locations within the LAA.

The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to flora SAR and habitat via several Project activities. These potential impacts are similar (though reduced in number) to those outlined for non-SAR Flora, and are listed in Table 8.19.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Species at Risk are discussed in Section 8.2.

Table 8.19 Summary of Potential Effects of Highway 104 Twinning Project on Flora Species at Risk

Project Component / Activities / Physical Works	Alteration	Potential Effect on Flora Species at Risk*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of vegetation	• Loss of black ash specimens. • Loss and alteration of habitat for some species Increased habitat fragmentation • Unintentional introduction of non-native or invasive plant species via machinery
• Site Preparation and Construction activities, such as: - Grubbing and soil management - Wetland alteration - Excavation - Blasting - Fill placement and compaction (including grading) - Ditch construction - Removal of existing infrastructure	• Removal of topsoil and seedbank • Removal of wetland areas • Ground disturbance • Altered surface hydrology/redirection of small watercourses. • Exposure of underlying soils creation (highway section to be deactivated)	• Loss and alteration of habitat for some species • Increased habitat fragmentation • Unintentional introduction of non-native or invasive plant species via machinery • Habitat creation (highway section to be deactivated) • Decreased habitat fragmentation (highway section to be deactivated)
• Rehabilitation and Restoration of disturbed areas	• Ground disturbance	• Habitat creation

Project Component / Activities / Physical Works	Alteration	Potential Effect on Flora Species at Risk*
• Revegetation of disturbed areas (planting, and hydroseeding)	• Reestablishment of vascular plant communities • Seeding of disturbed areas	• Intentional introduction of non-native plant species via hydroseed mixes • Unintentional introduction of non-native or invasive plant species via machinery • Changes in community composition within and beyond maintained Right-of-Way
Operation and Maintenance Phase		
• Highway operation (Traffic)	• Vehicles transport of seeds of non-native or invasive species	• Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way
• Vegetation management and Infrastructure maintenance/repair - Ditch maintenance - Infrastructure maintenance - Snow plowing	• Removal/ mowing of roadside vegetation • Ground disturbance	• Unintentional introduction of non-native or invasive plant species • Changes in community composition within and beyond maintained Right-of-Way • Loss and alteration of habitat for some species
• Highway maintenance - Winter road salting	• Addition of sodium chloride to roadside terrestrial, wetlands, and aquatic habitats	• Salinity impacts on black ash specimens • Habitat alteration • Changes in community composition within maintained Right-of-Way
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Accidental spills or leaks* • Vehicle exhaust emissions • Ground disturbance • Noise emissions	• Loss and alteration of habitat • Air quality impacts on sensitive lichens

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

The general impacts of activities conducted during the Site Preparation and Construction Phases on Flora SAR are very similar to those identified for non-SAR flora, and are outlined in Table 8.19. Impacts specific to flora SAR are discussed in the following subsections.

Vegetation Clearing

Clearing activities will impact flora SAR and their habitat, via the removal of vegetation and vegetation communities which could result in loss of black ash and blue felt lichen specimens and habitat. The removal of forested wetlands in particular may result in the loss of black ash specimens. A total of 12 black ash specimens are known to occur within the footprint and could potentially be removed by the Project. Nearly all of these occur within wetlands in gypsum-dominated bedrock areas in the eastern portion of the Project Area. A total of 24 additional wetlands within the Project Area fall within these gypsum or limestone areas and are possibly suitable habitat for black ash.

Clearing of vegetation will cause the main impacts to blue felt lichen and its habitat, via the clearing of forested areas in which this epiphytic lichen species occurs. The clearing of forests can have ecological impacts much larger than the physically-cleared area. Removal of trees changes light levels reaching the forest floor and generally causes decreases in average humidity levels, which can affect lichen species, including blue felt lichen.

Site Preparation and Construction Activities

Site preparation and construction activities such as grubbing and soil management, infilling, contouring, and grading may also lead to changes in surface water flow patterns which could negatively affect black ash specimens and their habitat by increasing or decreasing water volumes reaching the forested wetlands in which they occur. This could then cause negative impacts to black ash by either flooding them or causing them stress via dehydration. This could also be compounded by salt runoff (discussed in the next section).

Operation and Maintenance Phase – Activities

The Operation and Maintenance of the new twinned highway also has potential to cause impacts to flora SAR specimens and habitat via Project activities. Project activities occurring during the Operations and Maintenance phases that may lead to impacts on black ash and its habitat were also summarized in Table 8.19. Impacts specific to flora SAR are discussed in the following subsections.

Highway Maintenance - Winter Road Salting

The application of salt as part of winter road maintenance has the potential to affect black ash specimens and their habitat. Once applied to roadways as part of winter maintenance activities, salt then enters the environment via splash and spray from vehicles, transportation by wind, snow melt into the soil and as runoff to surface waters. This can lead to elevated salinity levels in roadside terrestrial wetland, and aquatic habitats, particularly in spring after snowmelt. This can adversely affect sensitive plant and lichen species growing along the roadside. Salt primarily causes dehydration which leads to foliage damage but also causes osmotic stress that harms root growth in vascular plants. Increased salt levels are well-known to affect sensitive plant species and can cause changes in community composition (EC, 2001). The main effects are chloride ion toxicity and dehydration, with the magnitude of effect varying across species. At high concentrations, salt can also physically affect soil structure via development of salt crusts. Salt can also affect soil chemistry with resulting effects on soil fertility. The related green ash (*F. pennsylvanica*) is known to be very sensitive to salt, with leaf damage known to occur at 3.5 psu (Pezeshki and Chambers, 1986). High

salt concentrations can cause rapid mortality of green ash seedlings. The closely-related black ash likely has similar salinity tolerance and could therefore be affected by road salt.

Less is known about the impacts of salt on lichen and moss species, however, it is known that the sensitivity of lichens to salt varies considerably across species (Nash and Lange, 1988). However, road salting is not expected to impact blue felt lichen, which occurs on tree trunks in forested areas. The known locations are at a minimum 70 m from the proposed twinned highway section and are not expected to be exposed to road salt.

The impact of road salting on flora SAR is not predicted to be significant. Mitigation measures to minimize the effects of salt on local flora, which are also applicable to flora SAR, are outlined in Section 8.2.3.

All Phases – Operation and Maintenance of Heavy Equipment

Potential impacts of the use of heavy equipment on vascular plants and lichens throughout the Project lifecycle were discussed in detail in Section 8.1.3 (Flora). Potential impact to flora SAR species are very similar, and are not expected to be a concern for this project.

8.1.7.2 Species at Risk – Mainland Moose

The mainland moose has been listed as 'Endangered' under the *Nova Scotia Endangered Species Act* since 2003 (NSESA, 1998). Mainland moose have large home ranges (30-55 km^2), thereby requiring large areas and a variety of habitats essential to their survival. Such habitats include open or disturbed areas containing high forage availability (i.e., early successional deciduous vegetation) in spring and fall. Areas of dense cover and aquatic sites, such as riverine areas and wetlands, are important for thermo-regulation in summer. Habitat with dense cover (e.g., coniferous forest) is also utilized in winter for shelter (Parker, 2003; Snaith and Beazley, 2004; NSDNR, 2007). A core moose population occurs in the Pictou-Antigonish highlands. Pellet groups have been identified on the Cape George peninsula near Eigg Mountain. ACCDC has records of two sightings of moose within 5 km of the Project Area, both within the Auld Mountain highlands. PGI surveys were conducted in 2016 and 2018 to determine the presence of moose within the Project Area. While no pellet groups were observed during these surveys, one pellet group was observed incidentally in August 2018 during the wetland field program; this pellet group was located within the right-of-way for the proposed highway alignment through the new four-lane alignment south of the existing highway. During the PGI surveys conducted in 2016, moose tracks were observed within 2 km of the Project area.

Due to the presence of preferred habitat in the Project Area and the potential for moose to utilize habitat within the LAA, moose have been selected as a VEC since Project activities may interact with moose and moose habitat.

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. Site preparation and construction activities could be initiated in the

winter of 2019 (e.g., clearing) and are anticipated to take approximately three to seven years, depending on the final delivery method for the Project. Highway operations are expected to occur indefinitely with no plans for decommissioning. Since moose may be affected by Project activities associated with both construction and operation, temporal boundaries encompass the lifespan of the Project.

Spatial boundaries considered in this assessment include the Project Area and Local Assessment Area. Due to the 2 reports of moose sightings within 5 km of the Project area and moose evidence (scat and tracks) observed in the proposed new four-lane alignment south of the existing highway during the 2016 and 2018 field programs, the Local Assessment Area for moose and the purpose of this assessment encompasses a 5 km radius outside the Project Area.

Significance Determination

Species listed under the Nova Scotia *Endangered Species Act*, and the habitat which supports these species is provincially protected; under the Act, it is an offence to:

- Kill, injure, or disturb a species at risk;
- Destroy, disturb, or interfere with its residence (e.g., nest, den, hibernaculum); and
- Destroy, disturb, or interfere with its core habitat. Core habitat is defined as habitat essential for the long-term survival and recovery of the species.

Any Project component or activity resulting in non-permitted contravention of the above prohibitions under the NSESA, or which threatens the long-term sustainability of moose within the Project Area and LAA, will be deemed to have a significant impact on moose. Threats to long-term sustainability may include changes to distribution, abundance, or critical habitat. A residual effect which does not meet this criteria will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

There is potential for the proposed Project to adversely impact moose during Site Preparation, Construction, and Operations and Maintenance as a result of the following:

- Habitat loss, alteration, or fragmentation;
- Sensory disturbance; and
- Vehicular traffic.

These factors may result in effects to moose, such as changes to behaviours which support life history functions, disruption of movement corridors, restriction of gene flow, displacement, local level changes in abundance and distribution, seasonal attraction to roads, and mortality.

Project activities associated with Site Preparation, Construction, and Operation and Maintenance, as well as the alteration to the environment and potential impacts to moose are summarized in Table 8.20 and discussed in the following subsections.

Table 8.20 Summary of Potential Effects of Highway 104 Twinning Project on Mainland Moose

Project Component / Activities / Physical Works	Alteration	Potential Effect on Mainland Moose*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of forested areas	• Loss of foraging habitat • Loss of forested cover for shelter • Local level changes in abundance and distribution
• Site preparation activities, such as: - Grubbing and soil management - Excavation - Blasting - Fill placement and compaction - Ditch construction - Wetland alterations - Rehabilitation of affected areas	• Removal of wetlands • Noise emissions	• Loss of habitat suitable for thermoregulation • Local level changes in abundance and distribution • Sensory disturbance
• Construction activities - Bridge and grade separation structure construction - Paving - Installation of highway infrastructure - Installation of watercourse crossings and diversions - Removal of existing infrastructure (asphalt layer and culverts)	• Habitat alteration and fragmentation (section to be twinned) • Removal of asphalt layer (section to be deactivated)	• Disruption of movement corridors (section to be twinned) • Restriction of gene flow (section to be twinned) • Habitat creation (section to be deactivated) • Decreased habitat fragmentation (section to be deactivated)
• Rehabilitation and restoration of disturbed areas • Revegetation of disturbed areas	• Ground disturbance • Noise emissions • Seeding of exposed soil	• Temporary disturbance of moose • Habitat creation (highway section to be deactivated) • Decreased habitat fragmentation (highway section to be deactivated) • Establishment of non-native species • Changes in plant species communities

Project Component / Activities / Physical Works	Alteration	Potential Effect on Mainland Moose*
Operation and Maintenance Phase		
• Highway operation (traffic)	• Increased habitat fragmentation • Noise emissions • Visual disturbance	• Sensory disturbance • Avoidance of Project Area and disruption of movement corridors • Vehicular collisions and potential mortality • Restriction of gene flow
• Highway maintenance - Winter road salting	• Increased salinity of roadside pools	• Changes to movement patterns of moose • Attraction to salt ponds along roads; and • Vehicle collisions and potential mortality
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during all Project activities	• Noise emissions • Visual disturbance • Olfactory disturbance	• Sensory disturbance • Avoidance of Project Area

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

The possible occurrence of mainland moose within the LAA is discussed in Chapter 5. Moose may occur in terrestrial or wetland habitats within the Project Area. Therefore, all Project activities occurring in forested and wetland habitats have potential to interact with mainland moose. The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to mainland moose via several Project activities. Project components occurring during the Construction phase that may lead to impacts on mainland moose and habitats are listed in Table 8.20, and discussed below.

Vegetation Clearing

The removal of forest habitat within the Project Area is likely to be the main impact to mainland moose within the LAA. Habitat types utilized by moose (e.g., coniferous, deciduous and mixed wood forests, open or disturbed areas containing early successional deciduous vegetation, and wetlands) are present within the Project Area and LAA. Site preparation activities (e.g., clearing and grubbing) and construction activities (e.g., excavation, blasting, filling, and grading) will result in the direct loss of habitat within the Project Area. Such habitat may provide foraging opportunities and shelter for moose or support other seasonally important activities, such as thermoregulation. Loss of habitat which supports life sustaining activities may result in local level changes in abundance and distribution of moose. These potential impacts are anticipated to be minimal for the following reasons. Firstly, PGI surveys conducted in 2016 and 2018 did not find any pellet groups, suggesting that an established population of moose does not exist within or immediately adjacent to the Project Area. The extent of the Project Area between Sutherlands River and Antigonish, with the

exception of the new section between Barneys River Station and James River, encompasses the existing Highway 104. Studies have indicated that moose tend to avoid using habitat near roads (Beazley et al., 2004; Wattles, 2015), and radio-telemetry data on moose have found that individuals tend to avoid proximities within 500 m of roads (Laurian et al., 2008a). The results of these studies suggest that moose populations do not typically utilize habitat directly adjacent to existing highways. Secondly, habitat types within the Project Area or LAA are not unique or rare in the province. Give the mobility of moose and their large home ranges, removal of habitat in the Project Area would likely result in moose utilizing similar habitat nearby the Project Area or LAA as opposed to local level changes in abundance or distribution.

During the 2016 PGI surveys, two observations of moose tracks were recorded in the proposed new four-lane alignment south of the existing highway. During the 2018 wetland program, an incidental observation of moose scat was also recorded in this general area. These observations suggest that while an established population of moose does not likely exist in the Project Area, moose may use this area as a corridor to more suitable habitats. Subsequently, fragmentation may impact moose, particularly in the proposed new four-lane alignment south of the existing highway, as installation of highway infrastructure may disrupt movement patterns and restrict movement to critical habitat and subsequent gene flow between populations. A study by Laurian et al. (2008b), demonstrated that moose with home ranges near highways avoided crossing roads. Almost one half of tracked moose never crossed a paved highway, while the remainder crossed infrequently. In Nova Scotia, the construction of Highway 101 between Halifax and Windsor has resulted in habitat fragmentation, restriction of movement and subsequent isolation of the small southwestern/ Tobeatic population of moose from other populations (Beazley et al., 2004).

Impacts associated with fragmentation during the Construction phase of the proposed Project are anticipated to last the duration of this Project phase, i.e., at least 3-7 years. Following implementation of mitigation measures, impacts to moose as a result of habitat fragmentation are not anticipated to be significant.

Site Preparation and Construction Activities

In addition to the effects of forest removal discussed above, activities affecting wetlands within the Project Area may also affect moose, by removing habitat potentially used for foraging and thermoregulation. The assessment of effects related to the removal of potential wetland habitat is similar overall to the effects of vegetation removal discussed in the previous section.

Rehabilitation, Restoration, and Revegetation

Areas disturbed by Project activities, and the area along the section of Highway 104 to be removed may require rehabilitation, restoration, and/or revegetation activities. Such activates may cause localized noise, dust, and gaseous emissions, which will be short-term in nature and insignificant. Revegetation activities also have the potential for unintentional introductions of invasive plant species. Establishment of such species could lead to habitat alterations that could negatively affect mainland moose. However, proper mitigation will minimize this risk, and no significant impacts to mainland moose are expected. Ultimately, the revegetation of the section of the existing highway to

be deactivated will result in additional habitat for mainland moose, and decrease habitat fragmentation in the local area.

Visual and olfactory impacts associated with Site Preparation and Construction activities are anticipated to occur within the immediate vicinity of work areas. Ambient noise levels associated with Site Preparation and Construction are expected to be spatially localized to within 300 m of the noise source. Sensory related disturbances associated with Site Preparation and Construction are expected to be temporary in nature (lasting 3-7 years) and occur for short durations within daytime hours. The results of the 2016 and 2018 PGI surveys suggest that moose do not regularly utilize habitat within 300 m of the proposed alignment and, subsequently, sensory disturbance to moose is not expected to be significant.

Operation and Maintenance Phase - Activities

The Operation and Maintenance of the new twinned highway also has potential to cause impacts to mainland moose via several Project activities. Project activities occurring during the Operations and Maintenance phases that may lead to impacts on mainland moose were also summarized in Table 8.23. They are discussed in more detail below.

Highway Operation (Traffic)

During the operations phase of the proposed Project, there is potential for vehicular collisions to result in direct mortality of moose. This potential may be higher in the currently undeveloped four-lane alignment south of the existing highway where high volumes of vehicular traffic do not currently exist. Maintenance activities associated with operations, such as road salting (discussed below), may indirectly lead to moose mortality.

A review of wildlife encounter data between 2003 and 2018 provided to CBCL Limited by NSDNR indicated that there are currently no reports of vehicular collisions with moose along the existing Highway 104 between Sutherlands River and Antigonish. Vehicular traffic is not anticipated to increase in volume relative to current conditions as a result of the highway twinning. With the implementation of mitigation measures, the risk of mainland moose mortality as a result of vehicular collisions or winter maintenance activities during operations is not anticipated to be significant.

The new highway may also cause disruption of movement patterns and restrict movement to critical habitat as a result of highway traffic. These impacts may occur indefinitely, as decommissioning of the proposed highway is not anticipated at this time. However, these impacts are not anticipated to be significant should appropriate mitigation measures be implemented.

Highway Maintenance - Winter Road Salting

The use of road salt during winter months has been identified as an attractant for wildlife, particularly ungulates such as moose, and a major factor contributing to vehicular collisions (Environment Canada and Health Canada, 2001). Fraser and Thomas (1982) indicated that most moose sightings and half of all moose-vehicle collisions in Ontario occur at, or near, salt pools. In

Quebec, moose have also shown attraction to salt ponds along roads; a study by Grenier (1973) determined that 2.3 times as many moose were killed where salt ponds existed along a highway than where there were no salt ponds. These studies suggest that although moose tend to avoid road areas at the coarse scale, they may seek seasonal short-term benefits (e.g., sodium intake) at a finer scale (Laurian et al., 2012). Following adherence to the NSTIR *Salt Management Plan* and application of mitigation measures to minimize impacts to moose (see Section 8.3.1), residual effects to moose as a result of road salting are not anticipated to be significant.

All Phases – Operation and Maintenance of Heavy Equipment

Site preparation and construction activities, including, but not limited to clearing and grubbing, blasting (if required), earth moving, road bed preparation, and infrastructure construction will require the use of heavy equipment (e.g., earth movers, excavators, dump trucks, and graders) which can result in sensory disturbance. Noise impacts (i.e., changes to ambient noise levels and vibration) may result from blasting or equipment operations, olfactory impacts may be associated with the use of lubricants and fuels on site, and visual impacts may occur due to the presence of workers and heavy machinery in the Project Area. Several studies have shown sensory disturbance associated with road construction, maintenance and operation activities can result in wildlife displacement or avoidance of disturbance areas (Forman et al., 1997; Jalkotzy et al., 1997).

The use of machinery for maintenance activities, such as snow removal, road salt application, vegetation control, and infrastructure maintenance, will result in noise emissions and changes to sound quality during the Operations and Maintenance phase of the proposed Project. Such activities will occur throughout the lifespan of the Operation and Maintenance phase, but are anticipated to be localized (to within 300 m), relatively short in duration, and occur primarily during daytime hours. Noise emissions during the operation phase of the Project will also occur as a result of vehicular traffic. During operation, traffic volume is not anticipated to increase relative to current volume. Subsequently, noise emissions associated with vehicular traffic during operation are not expected to differ significantly relative to baseline noise levels and sensory disturbance to moose is not anticipated to be significant.

8.1.7.3 Species at Risk - Bats

The little brown Myotis and the Northern long-eared Myotis have been listed as ‘Endangered’ under the NSESA since 2013, and the SARA since 2014. They are both resident bat species in Nova Scotia, which may migrate short distances to overwinter communally in hibernacula, usually caves or abandoned mine workings (Moseley, 2007). These sites are ecologically important, not only for overwintering, but also because they serve as swarming sites where bats congregate and mate in the autumn. CBCL ecologists conducted a bat study at a gypsum outcrop in nearby Brierly Brook in the spring of 2018, on the advice of provincial regulators who felt the area had some potential to support a bat hibernaculum (existing or recently-used bat hibernacula are considered to be Critical Habitat under SARA). The program consisted of a desktop review of available relevant information on bats and karst in the area, followed by a field survey for suitable caves and sinkholes which could act as hibernacula. The field survey also provided input into suitable locations for acoustic monitoring, which was conducted in 2018. While the study could not prove definitively that a

hibernaculum is present in Brierly Brook, both species of Myotis were determined to be present at low levels in the Brierly Brook area. Due to the presence of suitable habitat in the Project Area and the potential for bats to utilize habitat within the LAA, little brown Myotis and Northern long-eared Myotis have been selected as a VEC since Project activities may interact with bats and bat habitat.

Boundaries

The spatial boundary for potential effects to bats and bat habitat includes the whole LAA at a minimum. Behaviour such as commuting between foraging and roosting areas, as well as hibernacula, can result in increased bat 'traffic' along certain routes within the region. However, these routes are poorly understood and therefore cannot be mapped or measured, though they likely occur along watercourses, wetlands, forested areas, and linear features. For the purposes of this report, the spatial boundary for bats is considered to be within 5 km of the Project Area.

In terms of temporal boundaries, impacts to bats resulting from the Project are possible throughout the lifetime of the project and beyond.

Significance Determination

A significant adverse residual effect to bat Species at Risk is defined as one that:

- Results in a non-permitted contravention under Sections 32-36 of SARA, Section 13 of the NSESA, or Section 51 of the Nova Scotia *Wildlife Act;* or
- Threatens the long-term sustainability of these species. Threats to long-term sustainability may include changes to distribution, abundance, or critical habitat.

To date, only hibernacula have been identified as critical habitat for the bat species occurring in Nova Scotia (EC, 2015).

A residual effect which does not meet this criterion will not be considered significant.

Potential Effects on Bats

Bats live long lives, reproduce slowly, and utilize large areas of the landscape, three features which suggest that they are particularly vulnerable to road development (Altringham, 2008). Bat activity and diversity has been shown to decline with increasing human development (Jung and Kalko, 2011). Roads are known to impact bats in three main ways (Berthinussen and Altringham, 2011). These are: 1) direct mortality via collisions with vehicles; 2) loss and damage to foraging and roosting habitat, and 3) severance of flight routes used for nightly commuting and seasonal migration. These are discussed in the following subsections.

Potential effects of this Project on bats and their habitats are summarized in Table 8.21. These impacts can occur during both the initial construction activities and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on bats are discussed in the following subsections.

Table 8.21 Summary of Potential Effects on Bats and Bat Habitat

Project Component / Activities / Physical Works	Alteration	Potential Effect on Bats and Bat Habitat*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of forested areas	• Loss of day and night roosting habitats • Loss of maternity colony habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes)
• Site preparation and construction activities, such as: - Grubbing and soil management - Excavation - Fill placement and compaction - Ditch construction - Removal of existing infrastructure	• Removal/alteration of wetlands	• Loss of day and night roosting habitats • Loss of maternity colony habitat • Loss of foraging habitat • Increased habitat fragmentation / interruption of travel routes) • Collisions with vehicles
• Blasting	• Sub-sonic vibrations • Physical disturbance	• Disturbance to hibernating bats
• Rehabilitation and restoration of disturbed areas • Revegetation of disturbed areas	• Ground disturbance • Noise emissions • Seeding of exposed soil	• Temporary disturbance of bats • Habitat creation (highway section to be deactivated) • Decreased habitat fragmentation (highway section to be deactivated) • Establishment of non-native species • Changes in plant species communities
Operation and Maintenance Phase		
• Highway operation (Traffic)	• Noise missions • Light emissions	• Disturbance to bats • Collisions with vehicles • Increased habitat fragmentation / interruption of travel routes)
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy	• Increased traffic • Increased noise and light emissions	• Contamination of watercourses/wetlands

Project Component / Activities / Physical Works	Alteration	Potential Effect on Bats and Bat Habitat*
equipment during all Project phases and activities		• Accidental exposure to toxic substances • Damage to vegetated habitats • Disturbance to bats • Collisions with vehicles

*Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

Bats utilize large areas of the landscape and so have potential to interact with Project activities occurring in forest and wetland habitats. Table 8.21 provides a summary of construction and operations phase activities and their potential effects on bat species at risk and their habitats, as well as a summary of activities during both the construction and operations phases.

The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range for possible impacts to bats via several Project activities. Project activities occurring during the Construction phase that may lead to impacts on bat species and habitats are listed in Table 8.21.

Vegetation Clearing

The clearing activities required for the Construction phase will impact bats and their habitat, via the clearing of forested areas which bats rely upon for foraging and roosting. Removal of forested habitat is likely to have the largest potential impact on bat populations in the general area of the Project, particularly along the proposed new four-lane alignment section where no highway corridor currently exists. Both of the endangered bat species, but especially the Northern long-eared Myotis bat (a forest-interior species) forage within forested areas (Fenton and Bell, 1979). Thus, both species will lose foraging habitat due to loss of forested areas from the Project site.

During the summer months, both bat species roost in trees in forested areas. Males and non-reproductive females roost singly, while reproductive females may gather in larger maternity colonies to rear young. Therefore, the loss of forested area on the Project area may result in some loss of roosting habitat and possibly maternity colony habitat for both species. Both species may also roost or form maternity colonies in man-made structures, however no suitable man-made structures are proposed to be removed by the Project.

Both species may also roost or form maternity colonies in man-made structures such as old buildings, fortunately, no buildings are slated to be removed by the project. Removal of Project infrastructure such as overpasses, or culverts, might also result in the loss of summer roosting habitat for bats, however, it quite unlikely that bats are roosting under any of the overpasses or culverts that will be removed or replaced as part of this project.

Site Preparation and Construction Activities

Site Preparation and Construction phase activities such as grubbing and soil management, fill placement, grading, watercourse diversions and wetland alterations will result in the loss and/or alteration of wetland habitats. Many of the insects that bats feed on have aquatic larval phases, and reproduce in wetlands or watercourses, resulting in higher insect density around such features. Removal of wetlands may therefore affect bats via loss of foraging habitat, especially the little brown Myotis which tends to forage over wetlands (Fenton and Bell, 1979).

The Construction phase may also include the removal of the section of existing highway to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and culverts (and completion of any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. Ultimately, the reestablishment of native vegetation communities along this section should have a positive impact on local bat populations, by increasing the amount of available habitat and decreasing habitat fragmentation.

Blasting

It has been speculated in the past that blasting could cause sub-sonic vibrations and/or physical disturbance of roosting bats, particularly during hibernation. However, this is unlikely to be a concern with this project, as no bat hibernacula have been confirmed to occur within 5 km of the Project Area. The potential presence of bat hibernacula in the vicinity of the Project is discussed in Section 5.7.1. Should a hibernaculum in fact be present at Brierly Brook, it is not expected to be affected by blasting within the main Project Area, which is over 1 km away. Blasting has historically occurred in the much closer Nova Construction Gypsum quarry within the Brierly Brook deposit, and presumably continues to occur at Nova Construction's aggregate quarry just north of the outcrop. Blasting for highway construction will be temporary, infrequent and of short duration, and is not expected to cause impacts to bats.

Rehabilitation, Restoration, and Revegetation

Areas disturbed by Project activities, and the area along the section of Highway 104 to be removed may require rehabilitation, restoration, and/or revegetation activities. Such activities may cause localized noise, dust, and gaseous emissions, which will be short-term in nature and insignificant. Revegetation activities also have the potential for unintentional introductions of invasive plant species. Establishment of such species could lead to habitat alterations that could negatively affect bats. However, proper mitigation will minimize this risk, and no significant impacts to bats are expected. Ultimately, the revegetation of the section of the existing highway to be deactivated will result in additional foraging and roosting habitat for bats, and decrease habitat fragmentation in the local area.

Visual and olfactory impacts associated with Site Preparation and Construction activities are anticipated to occur within the immediate vicinity of work areas. Ambient noise levels associated with Site Preparation and Construction are expected to be spatially localized to within 300 m of the

noise source. Sensory related disturbances associated with Site Preparation and Construction are expected to be temporary in nature (lasting 3-7 years) and occur for short durations within daytime hours. Sensory disturbances to bats are therefore not expected to be significant.

Operation and Maintenance Phase - Activities

The Operation and Maintenance of the new twinned highway also has potential to cause impacts to bats via several Project activities. Project activities occurring during the Operations and Maintenance phases that may lead to impacts on bat species and habitats were also summarized in Table 8.21.

Highway Operation

The operation of the twinned highway (traffic) has some potential to cause impacts to bats via two main pathways. These are: 1) direct collisions with vehicles; and 2) disturbance from highway traffic noise and light emissions. Several recent studies have shown that bats of many species are killed by collision with vehicles (Medinas et al., 2013; Lesinski, 2007; Gaisler et al., 2009; Russell et al., 2009; Lesinski, Sikora & Olszewski, 2010). Russell et al. (2009) reported a significant impact on a summer roost/maternity colony of *M. lucifugus* from road kills. In addition, it is thought that vehicle mortality of bats is probably severely underreported due to the difficulty in finding carcasses of small nocturnal creatures before they are removed by scavengers (Slater, 2002).

The behaviour of a species, as well as the age and/or experience of individual bats, can also affect the collision rate for bats. Lesinki (2009) and Fensome and Mathews (2016) found that road causalities were higher for low-flying gleaning bat species (species which capture prey from surfaces, rather than from the air) than for higher-flying species. Lesinki (2007) also found that juveniles were killed more often than adults, with most deaths occurring in August and the first half of September during the annual dispersal period of young bats.

The habitats on either side of the road also affects bat crossing activities. Gaisler et al. (2009) documented bat mortality along roadways, and reported that significantly greater mortality occurred in a road section situated between two artificial lakes. Bats often fly along regular routes or ‘flyways’, and Lesinki (2009) noted the highest incidence of road casualties in places where roads crossed bat flyways, especially at junctions with forest edges and tree alleys. Russel et al. (2009) found that bats crossing a highway used tree canopy along highway crossings as cover, and when canopy cover was low (< 6m), the bats cross lower and closer to traffic and are more likely to be struck by vehicles. Several *Myotis* species, including *M. lucifugus* and *M. septentrionalis*, are known to use linear corridors such as gravel and paved roads, probably for commuting (Zimmerman & Glanz, 2000).

The risk of bat-vehicle collisions may be greater in the new four-lane alignment south of the existing highway, where the only existing roadways were narrow and infrequently used. However, as the majority of traffic will likely occur during the day when bats are not active, the risk of vehicle mortality to bats is lessened. Overall, the low numbers of bats occurring in the general area makes the risk of bat-vehicle collisions quite low.

The increased noise and light emissions of the new highway may also disrupt bat commuting corridors and increase habitat fragmentation. There is some evidence that increased noise and light can have negative impacts on bat foraging (Murphy et al., 2009). Bats have been shown to avoid traffic-like noise (Schaub et al., 2008), and increased noise levels have been shown to cause reduced foraging efficiency in bat species which hunt by gleaning prey off the ground (detecting the faint rustling noises of ground-dwelling prey) (Siemers and Schaub, 2010). This is thought to be due to interference with echolocation via the masking effect of anthropogenic noise on the faint noises created by prey insects. Recent studies have shown that gleaning species tend to forage less frequently near highways (Bennet and Zurcher, 2013; Bennett et al., 2013). Increased noise and light levels can therefore deter bats from an area, leading to the loss of potential foraging and roosting habitats. Berthinussen and Altringham (2012) found that total bat activity, the number of species and the activity of an abundant bat species were all positively correlated with distance from the road. Wray et al. (2005) reported several negative effects of highway development on an endangered bat species, including fragmentation of habitat through the addition of streetlights and loss of tree cover and the severing of commuting and foraging routes for a population of endangered greater horseshoe bats (*Rhinolophus ferrumequinum*) in Wales.

Slow-flying bat species, such as *Myotis* spp. tend to avoid illuminated areas, such as under streetlights (Rydell, 1992). Recent studies have shown that roadways appear to function as barriers and filters to bat assemblages by restricting movement (Abbott et al., 2012; Bennett and Zurcher, 2012) and changing space use (Bennett et al., 2013). Kerth and Melber (2009) suggested that highways have stronger barrier effects on bat species that forage close to surfaces (such as Northern long-eared Myotis) than on bats that forage in open space. They also found that the Myotis species they studied never crossed the highway when traveling between roosts. Recent studies (Bennet and Zurcher 2013; Bennett et al. 2013) have shown that gleaning species (such as Northern long-eared Myotis) will often balk at crossing over roads, even along established travel routes.

Traffic volumes are not expected to increase on the new twinned section. While information on bat foraging activity and travel routes within the LAA is extremely limited, it is possible that the existing Highway 104 corridor is already acting as a barrier to bats, and if so, the wider twinned corridor will continue to do so, possibly to a somewhat greater extent. While this may slightly increase local habitat fragmentation for bats (particularly the Northern long-eared Myotis, a forest-interior species), this barrier effect may also help minimize the effects of vehicle collisions on bats. Habitat fragmentation effects will also occur along the new four-lane alignment south of the existing highway, which is currently forested to varying degrees.

All Phases – Operation and Maintenance of Heavy Equipment

The operation, fueling, and maintenance of heavy equipment on the site during the Construction phase has potential to cause impacts to bats, namely though increased traffic resulting in increased noise and light emissions. Traffic noise has been shown to affect foraging behaviour of bats (Murphy et al., 2009; Schaub et al., 2008; Siemers and Schaub, 2010), while slow-flying bat species, such as *Myotis* spp. tend to avoid illuminated areas, such as under streetlights (Rydell, 1992). Bats are predicted to avoid areas where construction activities are occurring, which could decrease their

foraging and roosting habitat and interrupt commuting routes. However, the fact that much of the highway construction activities are expected to occur during the day should lessen any disturbance effects on nocturnal bat activity. Daytime roosting activities in the near vicinity of construction activities could be impacted slightly, but as bats are generally not reliant on a single summer roost location, this impact should be minimal.

Mortality due to collisions with vehicles is also possible during the Construction phase, however, as the majority of construction activities will presumably occur during the daylight hours when bats are not active, collisions of bats with heavy equipment are not expected to be a concern. Collisions are more likely to occur during the operations phase, when vehicle traffic will occur at a much higher volume and velocity. Potential traffic mortality of bats is therefore discussed in more detail under the Section on Potential Impacts of the Operations and Maintenance phase section.

Aside from transport trucks, heavy equipment is only expected to be used on the Project site during the Operation and Maintenance phase during required maintenance activities, which is expected to be quite limited in terms of spatial and temporal duration. Again, such activities are expected to occur primarily during daylight hours, when bats are not active, so collision of bats with heavy equipment is not expected to be a concern.

Heavy equipment could also be used during winter for snow clearing and road salting activities; however, bats will be hibernating at this time and so will not interact with plowing or salting equipment.

8.1.7.4 Species at Risk – Birds

As indicated in Section 5.7.2, species at risk were selected as a VEC due to potential Project activities impacting these species at risk and their associated habitats. This section focuses on five species of birds known to occur in the Project Area that are protected under the NSESA, SARA, or both; these are:

- Canada Warbler;
- Eastern Wood-Pewee;
- Olive-sided Flycatcher;
- Evening Grosbeak; and
- Barn Swallow.

Additional information on these species is provided in Section 5.7.2.

Boundaries

The temporal and spatial boundaries for bird Species at Risk are consistent with those identified for birds in Section 8.1.4.2. However, because many of these species are migratory, temporal considerations must consider sensitive periods such as the breeding bird period (mid-April to late-August) and migration.

Significance Determination

A significant adverse residual effect to bird Species at Risk is defined as one that:

- Results in a non-permitted contravention under Sections 32-36 of SARA, Section 13 of the NSESA, or Section 51 of the Nova Scotia *Wildlife Act,* or the *Migratory Birds Convention Act;* or
- Threatens the long-term sustainability of these species. Threats to long-term sustainability may include changes to distribution, abundance, or critical habitat.

A residual effect which does not meet this criterion will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

Potential environmental effects on bird Species at Risk may occur during all phases of the Project which includes Construction, and Operation and Maintenance phases. The potential adverse effects include the following:

- Habitat loss (permanent and temporary);
- Habitat alteration;
- Nest destruction, disturbance, or abandonment;
- Sensory disturbance (e.g. noise, light); and
- Mortality.

Project activities associated with the Site Preparation and Construction phases are similar to those summarized in Table 8.14. All the potential effects on birds and their associated habitats described in Section 8.1.4.2 (Birds and Bird Habitat) for various Project phases are also applicable to the bird Species at Risk outlined in this section, and so are not reiterated here.

Based on available literature, potential habitat for five bird Species at Risk was classified into broad categories using the P-ELC. Potential habitat for each Species at Risk was identified and quantified as a means to assess the potential effects to bird Species at Risk and their associated habitats. The identified potential habitat within the Project Area for each species that may be cleared during the Site Preparation and Construction phases is discussed below. Potential impacts of the proposed Project on birds and bird habitat, including the Species at Risk discussed herein, are outlined in Section 8.1.4.2.

Canada Warbler

Canada Warbler was observed within the Project Area during field surveys and the proposed Project activities may impact Canada Warbler and their habitat. As outlined in Chapter 5, Canada Warbler breeds in moist forests with a dense, deciduous shrub layer, complex understory, with available perch trees. Based on described habitat features, potential Canada Warbler breeding habitat was identified within the Project Area using the P-ELC. Potential Canada Warbler habitat was classified as areas having wet coniferous/deciduous cover, of varying heights. Using the P-ELC, approximately 31 hectares of potential habitat occurs within the Project Area, which may be removed during the Site Preparation and Construction phases of the proposed Project. However, while this habitat may serve as potential habitat for Canada Warbler, based the low number of Canada Warblers observed

within the Project Area at the time breeding bird surveys were conducted, the potential impact to this species is not considered significant if clearing is conducted outside of the nesting period. Additionally, the amount of similar habitat identified within the LAA is approximately 97 hectares, which suggests alternative habitat for Canada Warbler occurs in proximity to the Project Area.

Olive-sided Flycatcher

The Olive-sided Flycatcher was incidentally observed at one location within the Project Area. In Nova Scotia, this flycatcher can be found in spruce-dominated forests with edge habitat, often produced by natural clearings such as wetlands, rivers, and lakes. The Olive-sided Flycatcher and potential breeding habitat may be affected during the proposed Project activities. Based on available literature, potential Olive-sided Flycatcher breeding habitat as classified using the P-ELC by extracting primarily 'coniferous areas, with varying levels of moisture and height structure'. Using the P-ELC, approximately 79 hectares of potential Olive-sided Flycatcher habitat was identified within the Project Area, which may be removed during the Site Preparation and Construction phases of the proposed Project. However, approximately 243 hectares of similar habitat are predicted the P-ELC to be present within the LAA. While the areas identified within the Project Area may serve as potential habitat, much of this habitat was found to be unoccupied by Olive-sided Flycatcher at the time that breeding bird surveys were conducted; therefore, if clearing activities occur outside the nesting period, the potential impact to the Olive-sided Flycatcher is not anticipated to be significant.

Eastern Wood-Pewee

The Eastern Wood-Pewee was observed within the LAA. The proposed Project activities may impact Eastern Wood-Pewee and their associated habitats during each Project phase as outlined in Section 8.1.4.2. Eastern Wood-Pewee prefers older, predominately deciduous forests and shows preference for riparian forests. Based on an analysis of breeding bird atlas point count data, pewees are strongly associated with mature poplar and hardwood forests in the Maritimes. Using the P-ELC, potential Eastern Wood-Pewee habitat was identified as 'older, moist to wet, mixed-wood and deciduous areas' and a total of approximately 26 hectares of these areas were identified within the Project Area. This potential habitat may be cleared during the Site Preparation and Construction phases of the proposed Project. Much of the identified habitat was unoccupied by Eastern Wood-Pewees at the time of surveys which suggests Eastern Wood-Pewees were not breeding in the identified potential habitat in the Project Area. In addition, similar potential habitat areas were identified within the LAA (approximately 78 hectares), which suggests alternative habitat for Eastern Wood-Pewee occurs in proximity to the Project Area. Because of low Eastern Wood-Pewee occupancy within the Project Area if clearing activities occur outside the nesting period, the impact of the proposed Project activities on the Eastern Wood-Pewee is not anticipated to be significant.

Evening Grosbeak

The Evening Grosbeak was observed within the proposed Project Area. While this species can be found within the Project Area and LAA year round, only breeding habitat was identified, as winter habitat selection is poorly studied and less defined. As indicated in Chapter 5, the Evening Grosbeak generally breeds in old coniferous and mixed wood forest stands where insects are

abundant. As summarized by COSEWIC (2016), the nesting habitat of the Evening Grosbeak generally consists of large mature and old mixed wood forest stands that contain a high proportion of fir, white spruce or trembling aspen, with a diversified structure and a relatively open canopy (Stewart et al., 2015; COSEWIC, 2016;). Potential Evening Grosbeak habitat was classified as 'older mixed-wood and coniferous areas of varying wetness' using the P-ELC. These areas were identified and quantified with approximately 92 hectares occurring within the Project Area and approximately 298 hectares within the LAA, which suggests considerable alternative habitat for Evening Grosbeak occurs in proximity to the Project Area. Assuming all clearing activities will occur outside of the nesting period, the impact of the proposed Project activities on Evening Grosbeak are not anticipated to be significant.

Barn Swallow

Potential habitat for Barn Swallow was not defined using the P-ELC as breeding habitat is closely associated with human-made structures (e.g., barns) and the P-ELC does not identify and quantify these features. A Barn Swallow was observed foraging within an agricultural field and was suspected to be breeding in a barn located outside of the Project Area. This barn will not be removed as part of the proposed project activities, and the impact of the proposed Project activities on Barn Swallow are not expected to be significant.

8.1.7.5 Species at Risk – Turtles

Wood turtles are listed as 'Threatened' under both Schedule 1 of the federal *Species at Risk Act* (SARA, 2002) and Section 12 of the Nova Scotia *Endangered Species Act* (NSESA, 1998). Snapping turtles are listed as 'Special Concern' under Schedule 1 of the federal *Species at Risk Act* (SARA, 2002) and 'Vulnerable' under Section 12 of the Nova Scotia *Endangered Species Act* (NSESA, 1998). Both wood and snapping turtles have been reported to occur within 5 km of the Project Area. Suitable habitat for both species exists in the LAA, and wood turtle critical habitat occurs within the Project Area. These reports are based on data obtained from the ACCDC database (ACCDC 2015, 2018), data on wildlife encounters between 2003-2018 obtained from NSDNR, information obtained from the NSDNR Significant Habitat database, consultation with the Wildlife Division at NSDNR, and habitat assessment and visual encounter surveys (VES) conducted by CBCL Limited in 2016 and 2017. Rare turtles were not observed during the VES, however potential nesting and overwintering habitat for wood turtles were observed within the Project Area (CBCL, 2018e).

Due to reported observations of wood turtles and snapping turtles (turtle SAR) within 5 km of the Project Area, the presence of suitable habitat and wood turtle critical habitat within the Project Area, and the potential for Project activities to interact with these species or habitat which supports them, turtle SAR have been selected as a VEC for this assessment.

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. Site preparation and construction activities could be initiated in the winter of 2019 (e.g., clearing) and are anticipated to take approximately three to seven years, depending on the final delivery method for the Project. Highway operations are expected to occur

indefinitely with no plans for decommissioning. Since turtles may be affected by Project activities associated with both construction and operation, temporal boundaries encompass the lifespan of the Project.

Spatial boundaries considered in this assessment include the Project Area (right-of-way footprint) and LAA. The LAA encompasses all areas surveyed for wood turtles during the 2016 and 2017 visual encounter surveys (CBCL, 2017). Each survey covered approximately 1,000 linear meters of the subject watercourse, plus a variable width survey zone (defined largely by floodplain morphology), measured laterally on either side the watercourse (average range 30-75 m). The LAA for rare turtles and the purpose of this assessment is upwards of 1 km from the right-of-way in some areas.

Significance Determination

A significant adverse residual effect to wood turtles or snapping turtles is defined as one that:

- results in a non-permitted contravention under Sections 32-36 of SARA, Section 13 of the NSESA, or Section 51 of the Nova Scotia *Wildlife Act;* or
- Threatens the long-term sustainability of these species. Threats to long-term sustainability may include changes to distribution, abundance, or critical habitat.

A residual effect which does not meet this criterion will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

There is potential for the proposed Project to adversely impact wood turtles and snapping turtles during Site Preparation, Construction, and Operation, as a result of the following:

- Habitat loss, alteration, or fragmentation;
- Accidental mortality; and
- Noise pollution

Project activities associated with Site Preparation, Construction, and Operation and Maintenance phases, as well as their associated alteration to the environment and potential effects to wood turtles and snapping turtles are summarized in Table 8.22, and discussed in the following subsections.

Table 8.22 Summary of Potential Effects of Highway 104 Twinning Project on Turtle SAR

Project Component / Activities / Physical Works Activity	Alteration	Potential Effect on Turtle SAR*
Site Clearing and Construction Phases		
• Vegetation clearing	• Removal of habitat (e.g., upland forest and wetland) and associated vegetation	• Loss of potential habitat • Loss of potential nesting habitat • Loss of overwintering habitat • Loss of food resources • Accidental mortality • Sensory disturbance

Project Component / Activities / Physical Works Activity	Alteration	Potential Effect on Turtle SAR*
		• Displacement / Avoidance of Project Area
• Site Preparation and Construction activities - Grubbing and soil management - Wetland alteration - Excavation - Fill placement and compaction - Blasting - Ditch construction - Bridge and grade separation structure placement - Installation of watercourse crossings and diversions - Removal of existing infrastructure	• Removal/ alteration of wetlands • Erosion and sedimentation into watercourses • Alteration to watercourse banks • Noise emissions • Light emissions	• Loss of potential habitat • Accidental mortality • Sensory disturbance • Displacement / Avoidance of Project Area • Loss of foraging habitat • Accidental mortality • Disruption of seasonal movement patterns • Increased habitat fragmentation
• Rehabilitation and restoration of disturbed areas	• Ground disturbance • Noise emissions	• Temporary disturbance of SAR turtles • Habitat creation (highway section to be deactivated)
• Revegetation of disturbed areas	• Ground disturbance • Noise emissions • Seeding of exposed soil	• Temporary disturbance of SAR turtles • Habitat creation (highway section to be deactivated) • Establishment of non-native species • Changes in plant species communities
Operation and Maintenance Phase		
• Highway operation (Traffic)	• Vehicle collisions • Noise emissions	• Direct mortality • Displacement / Avoidance of Project Area
• Vegetation management	• Removal/ mowing of roadside vegetation • Collisions with equipment	• Accidental mortality
• Infrastructure maintenance (e.g., culvert and bridge repairs)	• Erosion and sedimentation into watercourse	• Reduced water quality • Loss of overwintering habitat • Reduced survivorship

Project Component / Activities / Physical Works Activity	Alteration	Potential Effect on Turtle SAR*
All Phases - Operation and Maintenance of Heavy Equipment		
• Operation, fueling, and maintenance of heavy equipment during Construction and Operation & Maintenance phase activities (as identified within this Table)	• Vehicle traffic • Increased noise emissions • Increased light emissions	• Collisions with vehicles/mortality • Disturbance of SAR turtles /behavioural effects

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

The two turtle SAR possibly present may use a portion of the habitats within the Project Area. Wood turtles utilize an array of habitats throughout the year, but preferred habitat includes freshwater streams or rivers with year round current and sand or gravel bottoms, as well as floodplain areas (Government of Canada, 2016a). Being more terrestrial than other aquatic turtles (e.g., snapping turtles), wood turtles have been found to occupy terrestrial habitats in up to 40% of annual observations (Wisconsin DNR, 2017). Although they prefer riparian areas with either forested or diverse, patchy cover, they may also utilize alternate habitats such as wetlands, agricultural fields and pastures (Wisconsin DNR, 2017; Government of Canada, 2018). Snapping turtles also inhabit an array of environments, but prefer slow-moving waterbodies with soft mud bottoms and dense aquatic vegetation characteristic of ponds, marshes, swamps, and slow-moving streams (Government of Canada, 2016b). As ectotherms, these species are highly dependent on climactic conditions. Due to their need to thermoregulate during the active season, and their relatively low mobility, habitat which provides opportunities for activities such as thermoregulation and foraging, and which is adjacent to a watercourse or waterbody, is critical for survival.

Both of these species therefore have some potential to interact with Project activities occurring in forested, wetland, riparian, and agricultural habitats. The permanent alteration of the Project Area to construct a twinned highway corridor has the potential to cause a range of possible impacts to turtle SAR via several Project activities. Project components occurring during the Construction phase that may lead to impacts on turtle SAR are listed in Table 8.22 and discussed below.

Vegetation Clearing

One of the main threats to both wood turtles and snapping turtles is the loss of habitat (Government of Canada 2016a, b). Suitable habitat for wood turtles and snapping turtles exists within the Project Area. Wood turtle 'Critical Habitat' is also known to exist within the Project Area. Impacts of forest removal on turtle SAR are similar to those outlined in Section 8.1.4.3 for Reptiles and Amphibians, particularly the terrestrial species. The removal of riparian and terrestrial habitat through site clearing activities may result in the direct loss of potential habitat and opportunities for foraging, nesting and other seasonally important activities for wood turtles, such as thermoregulation. Loss of habitat which supports life sustaining activities may result in local level changes in abundance and distribution of wood turtles. These effects would be long-term and

irreversible if not properly mitigated. However, following the implementation of mitigation measures during Site Preparation and Construction, impacts to wood turtles as a result of terrestrial habitat loss are not anticipated to be significant.

Site Preparation and Construction Activities

During the Site Preparation and Construction phase, any activity which results in the removal of riparian or wetland habitat through grubbing and construction activities (e.g., excavation, blasting, wetland alteration, filling, and grading) may also result in the direct loss of potential habitat and opportunities for foraging, nesting and other seasonally important activities for SAR turtles,
In addition, any alteration to or disturbance of aquatic or riparian habitat which has been identified as containing preferred or critical habitat, may affect wood turtles and snapping turtles. Alteration of overwintering habitat may occur as a result of erosion and sedimentation associated with construction activities conducted in or near watercourses. Such activities include culvert installation and watercourse diversion, where applicable. Any activity that results in ground disturbance near a watercourse (e.g., excavation, blasting, infilling, grading) can also result in erosion and sedimentation into the watercourse. Sediment loading may affect the suitability of overwintering habitat by reducing depth, increasing water turbidity and reducing dissolved oxygen levels. Changes in water quality conditions may affect not only habitat suitability but also survivorship. A correlation has been also found between the siltation of deep pools and the decline of several turtle species (Bodie, 2001), and wood turtles have been shown to require a stable and high concentration of dissolved oxygen for survival (Government of Canada, 2016a).

Potential impacts to overwintering habitat and survivorship may also occur if watercourse crossings are not properly installed. Improper installation of watercourse crossings can result in alteration of watercourse morphology by changing flow patterns upstream and downstream (i.e., increasing distance between pool-riffle sequences), increasing velocity and turbulence, increasing downstream erosion, generating channel braiding, and creating debris blockages (Becker, 2001; Suvendu, 2013). Sediment loading may occur as a result, potentially reducing water depth (and overwintering habitat suitability) and, subsequently, increasing water temperatures and decreasing dissolved oxygen levels. Potential impacts to wood turtles and snapping turtles are anticipated to last the duration of the Construction phase and to be temporary and reversible. Following the implementation of suitable mitigation measures, potential impacts to wood turtles and snapping turtles are not anticipated to be significant.

Prior to initiation of Site Preparation and Construction activities, sediment control fencing will be erected around work areas to prevent sedimentation and erosion. Depending on the location and extent of the fencing, turtles may be inhibited from accessing potential overwintering, nesting or foraging habitat. This fragmentation of habitat could adversely affect wood turtles and snapping turtles. Potential impacts may be greater when completing Site Preparation and Construction activities in or adjacent to critical habitat identified along West Barneys River. Potential impacts associated with fragmentation of work sites is anticipated to last the duration of the Construction phase, or until work in a particular area is complete and fencing is removed. Following

implementation of mitigation measures, potential impacts to wood turtles and snapping turtles are not anticipated to be significant.

Blasting

Site preparation and construction activities may include blasting, which could result in sensory disturbance to turtles. Noise impacts (i.e., changes to ambient noise levels and vibration) may result from blasting (if required). Much of the literature dealing with noise effects on turtles is focused on sea turtles, and potential impacts of noise on wood turtles and snapping turtles is not well documented. However, ambient noise levels associated with Site Preparation and Construction activities are expected to be spatially localized to within 300 m of the noise source. Noise emissions associated with Site Preparation and Construction activities are anticipated to be temporary (lasting 3-7 years) and occur for short durations within daytime hours. Blasting, if it occurs, will be infrequent. Following the implementation of best management practices for blasting, potential impacts to turtles resulting from blasting noise and vibration are not anticipated to be significant

Rehabilitation, Restoration, and Revegetation

Areas disturbed by Project activities, and the area along the section of Highway 104 to be removed may require rehabilitation, restoration, and/or revegetation activities. Such activities may cause localized noise, dust, and gaseous emissions, which will be short-term in nature and insignificant. Revegetation activities also have the potential for unintentional introductions of invasive plant species. Establishment of such species could lead to habitat alterations that could negatively affect turtles. However, proper mitigation will minimize this risk, and no significant impacts to turtle SAR are expected. Ultimately, the revegetation of portions of the highway section to be deactivated could result in additional habitat for wood turtles, and decrease local habitat fragmentation.

Operation and Maintenance Phase - Activities

The Operation and Maintenance of the new twinned highway also has potential to cause impacts to turtle SAR via several Project activities. Project activities occurring during the Operations and Maintenance phases that may lead to impacts on turtle SAR were also summarized in Table 8.22. They are discussed in more detail below.

Highway Operation

The operation of the new highway will have two main effects on turtles, these are: 1) direct mortality; and 2) habitat fragmentation. One of the leading causes of wood turtle and snapping turtle mortality is vehicular collisions on roads. Wood turtles and snapping turtles are particularly susceptible to vehicular collisions as they undergo seasonal movements to nesting and overwintering sites, demonstrate nest site fidelity, and have been found to use gravel shoulders as nesting sites. For snapping turtles, collisions are reportedly common in areas where roads bisect a wetland or are located adjacent to a wetland (COSEWIC, 2008). Due to their long life history characteristics (i.e., slow recruitment, late maturation, and long lifespan), survivorship of adults and older recruiting juveniles is critical for sustaining populations of wood turtles and snapping turtles. A review of wildlife-vehicle collisions reported between 2003 and 2018 provided by NSDNR indicated that only one turtle (snapping) collision was reported along the section to be twinned over a 15-year

period. However, this data only reflects cases that have been reported to NSDNR and may be an underrepresentation of mortality rates associated with vehicular collisions in the Project area. Impacts associated with vehicular collisions are permanent and irreversible, but are predicted to be very infrequent. Following the implementation of mitigation measures, roadkill impacts to wood turtles and snapping turtles are not anticipated to be significant.

Replacement of habitat with road infrastructure results in a fragmented landscape. Once in operation, the twinned highway may separate turtles from potential resources and nesting sites, thereby resulting in changes to foraging and breeding behaviour and local level changes in distribution. Roads have been well known to result in barrier effects to wildlife. Populations can become isolated as a result of an inability to cross physical barriers, an unwillingness to cross due to perceived danger, or selection against genotypes that use roads due to vehicular collisions. The end result is the same, i.e., restriction of gene flow resulting in isolated subpopulations, reduced genetic variation, and increased vulnerability to disease. Impacts associated with habitat fragmentation would be permanent and irreversible. However, they can be mitigated through optimal selection and design of watercourse crossing structures (e.g., bridges, culverts) that facilitate safe passage of wildlife along the bed of the watercourse. Following the implementation of mitigation measures, habitat fragmentation impacts to wood turtles and snapping turtles are not anticipated to be significant.

Noise emissions from vehicular traffic will also occur for the duration of the Project. As indicated in the construction discussion, potential impacts of noise on wood turtles and snapping turtles are unknown. Given that wood turtles are known to utilize road shoulders for nesting and to cross roads on seasonal migrations to nesting sites, noise emissions from vehicular traffic does not appear to be a major deterrent. Following the implementation of noise reduction mitigation measures, potential impacts to turtles from noise pollution are not anticipated to be significant.

Vegetation Management and Infrastructure Maintenance/Repair

Highway maintenance activities may also result in accidental mortality of wood turtles or snapping turtles. Such activities include vegetation control, culvert and bridge repairs and replacements, and grading of highway shoulders. During the mechanical removal of roadside vegetation (i.e., mowing), there is potential for interaction with wood turtles. Culvert and bridge repairs and replacement will entail the use of heavy machinery which may lead to collisions with turtles at watercourse crossings. As previously discussed, alterations to watercourse structures may also result in reduced habitat suitability and survivorship. Since both wood and snapping turtles are known to create nests in anthropogenic gravel sites (e.g., road shoulders), grading of highway shoulders may result in destruction or disturbance of nests or eggs, as well as accidental mortality of adults. Maintenance activities may also include repairs to or replacement of bridges and culverts, which can result in sediment loading and changes to watercourse characteristics that are essential for survival (e.g., water depth, water temperature, and dissolved oxygen). As previously discussed under Construction impacts, sediment loading and changes to critical water quality parameters may result in reduced overwintering potential and survivorship. Highway maintenance activities will occur throughout the lifespan of the Project, but are relatively infrequent and short in duration, and any impact to water

quality would be temporary. Following the implementation of mitigation measures, potential impacts of maintenance activities on wood turtles and snapping turtles is not anticipated to be significant.

All Phases – Operation and Maintenance of Heavy Equipment

Site preparation (e.g., vegetation clearing, grubbing and soil management) and construction activities, including (but not limited to) excavation, excavation, infill placement, grading, ditch construction, removal of existing infrastructure, and installation of highway infrastructure will require the use of heavy equipment (e.g., earth movers, excavators, dump trucks, and graders). There is potential for the use of heavy equipment during Site Preparation and Construction to result in noise disturbance, direct injury or mortality of adults during the active season (April to October) or the accidental destruction of buried eggs or nests. The use of heavy machinery within the Project Area will be temporary, ceasing upon completion of construction. However, potential impacts to turtles would be permanent and irreversible. Following the implementation of mitigation measures, potential impacts to adult turtles, and their eggs or nests due to operation of heavy equipment are not anticipated to be significant.

The use of heavy equipment for maintenance activities may also result in noise pollution during the Operation and Maintenance phase of the Project. Impacts associated with these activities (e.g., road salting, vegetation management, culvert and bridge replacements or repairs) would be short-term in duration and occur infrequently.

8.1.7.6 Other SAR Species

As discussed in Section 5.7.8, monarch butterflies, a federally and provincially listed SAR, may occur occasionally within the Project Area, particularly during migration. While some vegetation which adult monarch butterflies may forage up on will be removed by the Project, this is not significant, as it is a very minor component of the suitable foraging habitat available for this species within Nova Scotia. As no larval food plants for this species (milkweeds) have been documented to occur within the Project Area, no impacts to reproduction of this species are predicted. Impacts of this Project on Monarch butterflies will therefore be insignificant. No mitigation measures are required.

8.1.8 Socio-Economic Environment

The socio-economic environment, specifically land use, was selected as a VEC because of the potential for interactions with current and anticipated land uses and the Project. Some factors considered include the current and anticipated use of the lands for residential, industrial, resource, recreational purposes, and land uses and resources used by Aboriginal persons for traditional purposes. Potential interactions include the removal of lands from certain land usage for the purpose of the Project, or the restriction of access to lands by virtue of the Project's presence.

Some of these factors are protected or influenced by legislation such as the *Provincial Parks Act* and the *Municipal Government Act.*

As the potential environmental effects on the Socio-Economic Environment are identified within this section, consideration will also be made for the possibility of other land-uses (i.e., other undertakings) to act in combination with the proposed environmental effects of the Project.

8.1.8.1 Land Use

Lands surrounding the Project Area have seen a range of different land uses through the past and present, and will continue to do so into the future. These uses include the following, which are highlighted in Section 5.8.2:

- Existing and Planned Features, such as other undertakings;
- Land Uses (i.e., residential areas, industrial uses, recreational areas and parks);
- Resources Uses (agricultural, mining and forestry use); and
- Traditional land uses and resources used by Aboriginal persons for traditional purposes.

It is important to understand these land features, and how they may interact with the Project and the Project Area.

Boundaries

The proposed Project passes through a number of communities along the Project alignment between New Glasgow to Antigonish, including Sutherlands River, Egerton, Telford, French River, Broadway, Kenzieville, Barneys River Station, Rossfield, Marshy Hope, Indian Lake, Beaver Mountain, James River, Beaver Meadow, Addington Forks and Brierly Brook.

Spatial boundaries for this assessment include areas where this is a potential for Project activities to interact with land use, both current and anticipated uses. The specific area include in this assessment include the immediate Project Area (Project Area – defined here as the Project right-of-way), the LAA, and the RAA which includes the LAA and adjacent communities (e.g., Sutherlands River, Egerton, Telford, French River, Broadway, Kenzieville, Barneys River Station, Rossfield, Marshy Hope, Indian Lake, Beaver Mountain, James River, Beaver Meadow, Addington Forks and Brierly Brook (Figure 5.16).

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. The temporal boundaries associated with the Site Preparation and Construction phases of the Project may range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to occur indefinitely.

Significance Determination

In addition to the legislation pursuant to the *Municipal Government Act and Provincial Parks Act*, two other guidelines provide context to the potential effects to the Mi'kmaq. These guidelines include *the Proponent's Guide: The Role of Proponents in Crown Consultation with the Mi'kmaq of Nova Scotia* (NSOAA, 2011); and the *Mi'kmaq Ecological Knowledge Study Protocol* (Assembly of Nova Scotia Mi'kmaq Chiefs, 2014). These guidelines form the basis for identifying the loss of the

availability or access to land and resources that are currently used by the Mi'kmaq for traditional purposes.

As identified earlier in this section, a residual environmental effect, following the implementation of mitigation and off-setting, was determined significant if the following conditions were met:

- Non-permitted contravention of any of the prohibitions outlined in the *Provincial Parks Act*;
- Project activities were not compatible with the land or resource use activities as designated in municipal plans pursuant to the *Municipal Government Act*; and
- A loss of the availability or access to land and resources that are currently used by the Mi'kmaq for traditional purposes and which is long-term or cannot be accommodated.

Potential Environmental Effects and Project-Related Interactions

Potential impacts to Land Use are summarized in Table 8.23. These impacts can occur during the Site Preparation and through initial Construction phase activities, and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on Land Use are discussed in the following subsections.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Land Use are discussed in Section 8.2.

Table 8.23 Summary of Potential Effects of Highway 104 Twinning Project on Land Use

Project Component / Activities / Physical Works	Alteration	Potential Effects On Land Use *
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of vegetation • Change in traditional use of Mi'kmaq land and resource use sites • Minor ground disturbance	• Loss of Mi'kmaq land and resource use sites • Loss of Plant species of significance or harvesting areas
• Site Preparation (grubbing and soil management)	• Removal of topsoil and seedbank • Ground disturbance • Altered surface hydrology/redirection of small watercourses	• Disruption or degradation of lands which affects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures • Loss of Mi'kmaq land and resource use sites • Loss of Plant species of significance or harvesting areas

Project Component / Activities / Physical Works	Alteration	Potential Effects On Land Use *
• Construction activities: - Removal of existing infrastructure - Excavation - Blasting - Fill placement and compaction - Ditch construction - Bridge and grade separation structure construction (i.e., concrete placement) - Rehabilitation / site restoration of affected areas - Revegetation (i.e., planting, and hydroseeding) -	• Change in Land use • Change in traditional use of Mi'kmaq land and resource use sites • Removal of wetland areas • Ground disturbance • Altered surface hydrology/redirection of small watercourses	• Activities may not be compatible with surrounding or adjacent land or resource use activities as defined by planning measures of the Municipal Government Act • Loss of access to areas surrounding the project • Disruption or degradation of lands which affects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures • Loss of Mi'kmaq land and resource use sites • Loss of plant species of significance or harvesting areas
Operation and Maintenance Phase		
• Highway operation (presence of the highways and traffic) • Highway maintenance: - Waste management - Snow removal - Winter road salting • Infrastructure maintenance (minor): - Shoulder - Watercourse crossing • Vegetation management: - Vegetation removal - Mowing - Planting	• Change in land use • Change in traditional use of Mi'kmaq land and resource use sites	• Disruption or degradation of lands which effects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures • Loss of access to areas surrounding the project • Loss of Mi'kmaq land and resource use sites • Loss of plant species of significance or harvesting areas

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

The Project Components / Activities / Physical Works could potentially interact with land use by disrupting existing uses. The assessment of Project-related environmental effects included the following potential environmental effects:

- Activities may not be compatible with surrounding or adjacent land or resource use activities as defined by planning measures of the *Municipal Government Act*;

- Disruption or degradation of lands which effects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures;
- Loss of access to areas surrounding the project;
- Loss of Mi'kmaq land and resource use sites; and
- Loss of Mi'kmaq plant species of significance or harvesting areas.

Site Preparation and Construction Phases - Activities

The following aspects of Site Clearing and Construction phase activities have been identified to affect Land Use as identified in Table 8.23.

Vegetation Clearing

The following aspects of vegetation clearing (i.e. removal of vegetation, change in traditional use of Mi'kmaq land and resource use sites, and minor ground disturbance) have been identified to affect Land Use as identified in Table 8.23.

Effects related to Resource Use: Vegetation clearing will result in the disruption of lands so that the present activities or resource use on those lands cannot continue at existing levels, even with the implementation of mitigation measures, specifically agricultural and forestry. This include the loss agriculture land, and of merchantable forest resources, as a result of the clearing of the ROW. There is an estimated 12 ha of Agricultural lands, 333 ha of forested lands that will be affected within the Project Area. Effects to these properties include the loss of portions of these lands as a result of vegetation clearing.

Effects related to Traditional Use: Site clearing activities have potential to affect Mi'kmaq land and resource uses. Effects to Mi'kmaq land and resource uses may include:

- Loss of access to Mi'kmaq fishing, hunting, and gathering opportunities;
- Loss of harvesting area, or change in the availability of resources used for traditional purposes; and
- Loss of plant species of significance to Mi'kmaq.

The extent of the locations of the Current Mi'kmaq land and resource use activities is not fully known as the previous MEKS was completed in 2004 and did not include the new alignment south of the existing highway. Within the *Mi'kmaq Ecological Knowledge Study Protocol,* it states that if a previous MEKS, for the same study area, is more than five years old that a new MEKS is required. Traditional activities and usage which will require additional information include:

- Kill/hunting: for example, species such as fox, beaver, muskrat, coyote, otter, porcupine, duck, goose, rabbit, partridge, raccoon, deer, salmon, trout, eel, striped bass, gaspereau, smelt, mackerel, and perch, or traplines;
- Burial/birth: for example, burial sites;
- Ceremonial: for example, sacred sites or ceremony sites;
- Gathering food/medicinal: for example, food plants, berries, wild fruit, eggs, medicinal plants, sweet grass, fire wood, speciality wood, feathers, stone, and clay; and

- Occupation/habitation: for example, canoe routes, overnight sites, or group campsites.

Loss of gathering areas used by Indigenous people, may be potentially significant, even if plant species of significance identified within the study exist with the RAA. The permanent removal or loss of some specimens within the study areas is not expected to create a significant effect to Mi'kmaq land and resource uses; however, these areas should be determined then evaluated for significance.

A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on Lands used by the Mi'kmaq for traditional purposes.

Site Preparation - Grubbing and Soil Management

The following aspects of grubbing and soil management (i.e. removal of topsoil and seedbank, alteration or surface hydrology and ground disturbance) have been identified to affect Land Use as identified in Table 8.23. Effects related to the physical environment such as geology and soil quality and surface water quality are addressed in Sections 8.1.2.1 and 8.1.2.2, respectively.

Effects related to Traditional Use*:* The extent of the locations of the current Mi'kmaq land and resource use activities is not fully known. It is anticipated that plant species of significance to Mi'kmaq and Gathering locations may be located within the Project Area and RAA. Grubbing and soil management activities will include ground disturbance which may result in the removal of topsoil and seedbank, and altered surface hydrology/redirection of small watercourses. Regarding similar effects for other components; surface water quality are further addressed in Section 8.1.2.2, fish and fish habitat in Section 8.1.6 and Flora in Section 8.1.3. Grubbing and soil management activities also have potential to affect Mi'kmaq archaeological resources (further assessed in Section 8.1.9).

Construction Activities

It is anticipated that Construction phase will affect land uses through the change in Land use; change in traditional use of Mi'kmaq land and resource use sites; removal of wetland areas; ground disturbance; and alteration surface hydrology/redirection of small watercourses. Such activities include the removal of existing infrastructure; excavation; blasting; fill placement and compaction; ditch construction; bridge and grade separation structure construction; rehabilitation / site restoration of affected areas; revegetation (i.e., planting, and hydroseeding); erosion and sediment control measures; and waste recovery and disposal.

Effects related to Existing and Pending Infrastructure**:** There are currently no projects in the general area of the Project registered with the NSE environmental approval process or the Canadian Environmental Assessment Registry (Nova Scotia Environment, 2018; and Canadian Environmental Assessment Agency, 2018). Recent industrial development in the areas was assessed by reviewing the NS EA website (of provincial Environmental Assessments (EA)). This revealed that four projects have undergone the EA process within the vicinity of the Project since 2012 and include the Brierly Brook aggregate quarry, James River quarry, Aulds' Mountain Wind Farm, and Glen Dhu South Wind Farm (Nova Scotia Environment, 2018).

Project Activities are not to occur on the existing and pending Infrastructure lands, with exception of some of the lands identified for the Glen Dhu South Wind Farm. Effects to these areas may include:

- Project Activities that may not be compatible with surrounding or adjacent land or resource use activities;
- Loss of access to areas surrounding the Project; or
- Disruption/degradation of lands which affects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures (such as noise, dust, and air emissions).

Effects, such as traffic disruptions, may also occur as a result of construction activities which occur over the 3-7 year period; however, overall road improvement to the area may create an overall positive effect.

Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), road closures and detours, will be implemented to separate these activities from contact with the public. Traffic control procedures will be implemented as required, including temporary detours and closures. Notification detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use.

NSTIR has consulted with the operators of the existing Glen Dhu Wind farm, Shear Wind Inc. regarding the twinning of Highway 104. Shear Wind Inc. has confirmed that no activities are currently planned for the proposed Glen Dhu South Wind Farm, and that no power purchase agreements or additional permits are in place. Therefore, there are no anticipated development conflicts with the Glen Dhu South Wind Farm. In the future, should a wind farm development be initiated in the local area, such a project would be developed with the proposed highway Project in consideration.

The Construction phase may also include the removal of the section of existing highway to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and completion of any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. The effects of this activity could include the change in access to these areas as a result of the Project. This will affect the existing land use and the traditional use of the land. These effects will be localized to the Project Area and though are expected to be permanent in duration, other access will be provided or maintained to these areas by the new 104 Highway or developed or maintained access roads. Mitigation measures, such as signage, separation infrastructure (i.e., barricades), and road closures, will be implemented to notify the public of these changes. In addition, there are no non-permitted contravention of the *Provincial Parks Act* anticipated, and the Project activities are compatible with the land or resource use activities as designated by the *Municipal Government Act.* There are no

issues related to current Mi'kmaq traditional use anticipated with the deactivation of this section of highway.

Effects related to Resource Use: Construction activities of the Project will result in the disruption of lands so that the present activities or resource use on those lands cannot continue at existing levels, even with the implementation of mitigation measures. There is an estimated 12 ha of Agricultural lands, 333 ha of forested lands and 286 ha of mineral exploration licences that will be affected within the Project Area.

Effects to these properties include the loss of portions of these lands or loss of access to these lands as a result of highway construction. Some adjacent properties may have a temporary restriction of access for safety purposes during Site Preparation and Construction.

Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), and detours, will be implemented to separate these activities from contact with the public.

Effects related to Zoning: As a result of Site Preparation and Construction activities, potential effects that have been identified include:

- Project Activities may not be compatible with surrounding or adjacent land or resource use activities, as defined by planning measures of the *Municipal Government Act*;
- The Project causes a loss of access to areas surrounding the Project Area; and
- The Project causes disruption or degradation of lands to the extent that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures.

The Project intersects both Pictou and Antigonish Counties. In Pictou County, the Project Area falls within a 'General Development' zone, in which all uses are permitted. In Antigonish, the Project Area occurs within two municipal zones; these are 'Rural Development' and 'Rural General'. Both of these zones have the same permitted uses, including agriculture, dwellings, community centres, fishing and fishing-related activities, forestry and forestry-related activities, and tourism and recreation.

Prior to Project development, property acquisition will be required to obtain additional RoW to allow for the execution of the Project. Engagement with property owners is ongoing and property acquisition will be contingent on the final selected alignment. If any future acquisition requirements are identified, this will be determined later in the Project during the DBFOM phase. Residential dwellings within the RAA may experience disruption or degradation, which could include traffic disruptions as a result of construction activities.

The new highway alignment will divert from the original highway west of James River (Exit 31) around Marshy Hope and Barneys River Station. Services, such as private business and fire/rescue services, in this area may be affected by the change in traffic flow along the original highway. Trunk 4 through this area will be maintained throughout the construction of the Project and through the post-construction operations. Effects, such as traffic disruptions, may also occur as a result of

construction activities which occur over the 3-7 year period. Mitigation measures, such as marking and signage and detours, will be implemented. Traffic control procedures will be implemented as required, including temporary detours and closures. Notification of detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use.

Effects related to Recreational Use and Protected and Designated Areas: The Project Area incorporates, or is in close proximity to, a number of areas used for recreation. These are listed in Chapter 5.

Effects to these areas may include:

- Project Activities that may not be compatible with surrounding or adjacent land or resource use activities;
- Loss of access to areas surrounding the Project; or
- Disruption/degradation of lands which effects lands so that activities on the present land or resource use cannot continue at existing levels with the implementation of mitigation measures (such as noise, dust, and air emissions).

Construction activities may restrict the access to these areas or change to existing land uses for safety reasons, which will result in temporary or permanent loss to some access points and recreational uses such as hunting. Snowmobile and ATV use has been identified as specifically effected, as the proposed Project will include controlled access to the highway. The need for ATV and snowmobile access has been identified, and crossing structures have been integrated into the conceptual design of the Project to allow for safe passage these vehicles. Access to recreational places and Protected and Designated Areas will be maintained as much as possible. The Project will improve access to the Riverside Speedway and Beaver Mountain Provincial Park with the upgrades to Exit 30 located at James River. However, other effects such as temporary traffic disruptions may also occur as a result of construction activities. Traffic control procedures will be implemented as required, including temporary detours and closures. Notification detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use. Activities associated with the project schedule will be communicated with the local communities and local stakeholders.

Effects related to Traditional Use: Site clearing and construction activities have potential to affect Mi'kmaq land and resource uses. Effects to Mi'kmaq land and resource uses may include:

- Effects to Mi'kmaq archaeological resources (further assessed in Section 8.1.9);
- Loss of access to Mi'kmaq fishing, hunting, and gathering opportunities;
- Loss of harvesting area, or change in the availability of resources used for traditional purposes; and
- Loss of plant species of significance to Mi'kmaq.

The extent of the locations of the Current Mi'kmaq land and resource use activities is not fully known. It is anticipated that plant species of significance to Mi'kmaq and Gathering locations may be located within the Project Area and RAA. If sites are identified, temporary and/or permanent loss of access to these sites may potentially pose a threat to Mi'kmaq use within these areas, and therefore may be significant.

Loss of gathering areas used by Indigenous people, may be potentially significant, even if plant species of significance identified within the study exist with the RAA. The permanent removal or loss of some specimens within the study areas is not expected to create a significant effect to Mi'kmaq land and resource uses; however, these areas should be determined then evaluated for significance.

A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on Lands used by the Mi'kmaq for traditional purposes.

Operation and Maintenance Phase - Activities

The following aspects of the Operation and Maintenance phase activities have been identified to affect Land Use as identified in Table 8.23.

Effects associated with Noise or Air Quality, which may affect Land Use are addressed in Section 8.1.1.

Highway Operation

Following the acquisition of land and operation of the highway, the traffic improvement will result in transport of goods and people more safely and efficiently. This is anticipated to create an indirect positive effect to land users in the LAA and RAA. All Project-related operations, plans, policies, protocols and guidelines will be conducted in accordance with relevant legislation, regulations, guidelines and accepted industry practice.

***Effects related to Existing and Pending Infrastructure and Zoning*:** Project Activities are not to occur on the existing and pending Infrastructure lands, with exception of the lands identified for Glen Dhu South Wind Farm. There are no anticipated development for the Glen Dhu South Wind Farm; therefore, there should be no conflict between the projects.

Effects related to Recreational Use and Protected and Designated Areas: Access to recreational places and Protected and Designated Areas will be maintained as much as possible. The Project will improve access to the Riverside Speedway and Beaver Mountain Provincial Park with the upgrades to Exit 30 located at James River. The need for ATV and snowmobile access has been identified, and crossing structures have been integrated into the conceptual design of the project to allow for safe passage of these vehicles.

***Effects related to Traditional Use*:** The operations and controlled accesses of the highway and have potential to affect Mi'kmaq land and resource uses. Effects to Mi'kmaq land and resource uses may include:

- Loss of access to Mi'kmaq fishing, hunting, and gathering opportunities.

As mentioned in the Site Preparation and Construction section, the extent of the locations of the Current Mi'kmaq land and resource use activities is not fully known. If sites are identified with the Project Area or RAA, depending on the land and resource use activities, temporary and/or permanent loss of access to these sites may not pose a threat to Mi'kmaq use within these areas, and therefore may not be significant.

A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on Lands used by the Mi'kmaq for traditional purposes.

Highway Maintenance, Infrastructure Maintenance, and Vegetation Management

It is anticipated that Operations and Maintenance phase, will affect land uses through the change in Land use; and change in traditional use of Mi'kmaq land and resource use sites. Such activities include the following which may result in disruption or degradation of lands which effects lands; loss of access to areas surrounding the Project, and loss of Mi'kmaq land and resource use sites or plant species of significance or harvesting areas:

- Highway maintenance:
  - Waste management;
  - Snow removal; and
  - Winter road salting.
- Infrastructure maintenance (minor):
  - Shoulder; and
  - Watercourse crossings.
- Vegetation management:
  - Vegetation removal;
  - Mowing; and
  - Planting.

***Effects related to Existing and Pending Infrastructure, and Resource Uses*:** Land use along the proposed Project includes forestry, agriculture, industrial and residential properties. Highway and infrastructure maintenance may affect land use within the Project Area, such as the increased use of salting practices and amounts applied to the roadway. Salting practices are currently occurring along Highway 104. The Project will result in the increase in the amount of salt used because of the additional lanes and the subsequent increase of salt required to cover these areas. NSTIR's *Salt Management Plan* will be used as a mitigation measure for this effect. Following the *Salt Management Plan*, effects to neighboring lands, such as agriculture use, are not anticipated.

The movement of recreational use access locations is not anticipated as a result of operation of the Project. Operations and Maintenance activities may restrict the access to these areas for safety reasons during the completion of maintenance activities, resulting in temporary loss to access points.

Other effects such as traffic disruptions may also occur as a result of maintenance activities, however, they are anticipated to be infrequent and short in duration. Traffic control procedures will

be implemented as required, including temporary detours and closures. Notification detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use.

***Effects related to Traditional Use*:** Maintenance activities have potential to affect Mi'kmaq land and resource uses. Effects to Mi'kmaq land and resource uses may include:

- Loss of access to Mi'kmaq fishing, hunting, and gathering opportunities.

As mentioned in the Site Preparation and Construction section, the extent of the locations of the Current Mi'kmaq land and resource use activities is not fully known. If sites are identified with the Project Area or RAA, depending on the land and resource use activities, temporary and/or permanent loss of access to these sites may not pose a threat to Mi'kmaq use within these areas, and therefore may not be significant.

A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on Lands used by the Mi'kmaq for traditional purposes.

8.1.8.2 Human Health and Safety

The Project will be completed following the applicable federal and provincial legislation and guidelines regarding the health and safety of the Public. NSTIR and the Proponent will complete the work in compliance with these acts such as the Nova Scotia *Occupational Health and Safety Act*. This assessment is limited to the potential effects of Human Health and Safety to the public as a result of the Project. The assessment of effects pertaining to land-use are further outlined in Section 8.1.8.1. The effects of vehicle collisions and vehicle – wildlife collisions are assessed in Chapter 7 Accidents and Malfunctions (Section 7.4: Vehicle Collisions; and Section 7.5: Vehicle – Wildlife Collisions).

Boundaries

Spatial boundaries for this assessment include areas where this is a potential for Project activities to interact with public use. The specific area for this assessment includes the immediate Project Area (Project Area), defined as the Project ROW.

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. The temporal boundaries associated with the Site Preparation and Construction phases of the Project may range between 3 to 7 years, depending on the finalized Project schedule. The Operation and Maintenance phase of the Project is anticipated to occur indefinitely.

Significance Determination

A residual environmental effect, following the implementation of mitigation and off-setting, was determined significant if the following conditions were met:

- Project activities could not be completed following Nova Scotia *Occupational Health and Safety Act* and its regulations or guidelines.

The effects of vehicle collisions and vehicle – wildlife collisions are assessed in Chapter 7 Accidents and malfunctions, Section 7.4 Vehicle Collisions and Section 7.5 Vehicle – Wildlife Collisions.

Potential Environmental Effects and Project-Related Interactions

Potential effects to Human Health and Safety are summarized in Table 8.24. These effects can occur throughout the Project but are focused primarily during Construction and the subsequent Operation and Maintenance phase. Project activities during each of these phases and their potential effects on Human Health and Safety to the public are discussed in the following subsections. The assessment of effects pertaining to land-use are further outlined in Section 8.1.8.1. The effects of vehicle collisions and vehicle – wildlife collisions are assessed in Chapter 7 Accidents and Malfunctions (Section 7.4: Vehicle Collisions; and Section 7.5: Vehicle – Wildlife Collisions).

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Human and Health and Safety are discussed in Section 8.2.

Table 8.24 Summary of Potential Effects of Highway 104 Twinning Project on Human Health and Safety

Project Component / Activities / Physical Works	Impact	Potential Effect On Human Health and Safety*
Site Preparation and Construction Phases		
• Removal of existing infrastructure • Excavation • Blasting • Rehabilitation / site restoration of affected areas • Revegetation (i.e., planting, and hydroseeding)	• Removal of infrastructure • Change in use of the Area to the Public • Ground disturbance	• Disruption to human activities • Change in access to an area • Effect to Human Health and Safety
Operation and Maintenance		
• Highway operation • Highway maintenance: - Waste management - Snow removal - Sanding - Salting • Infrastructure maintenance (minor): - Pavement - Shoulder - Watercourse crossings - Barrier maintenance - Marking and painting - Signage, lighting	• Change in Traffic Flows	• Disruption to human activities • Effects to Human Health and Safety

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

All project activities will be completed in compliance with the Nova Scotia *Occupational Health and Safety Act* and its regulations or guidelines. Maintaining human health and safety is of fundamental importance. Effects to human health and safety can range from injury to fatalities; therefore, the identification of these effects and application of safety measures are important.

Site Preparation and Construction Phases - Activities

The following aspects of the Site Preparation and Construction phases may possibly impact Human Health and Safety, as identified in Table 8.24.

Site Preparation Activities

Disruption to human activities and change of access to areas may occur as are result of Site Preparation and Construction activities. These are likely to be implemented early in the Site Preparation phases and carried through the life span of the Project. These activities are restricted to within the Project Area or ROW and many of these changes will be permanent following the start of construction, with the exception of the temporary storage of materials and equipment.

Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), road closures and detours and storage practices, will be implemented to separate these activities from contact with the public. Traffic control procedures will be implemented as required, including temporary detours and closures. Notification detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use. Materials or equipment will not be stored within 10 m of the traveled portion the existing Highway (104), and 4 m of the traveled portion of all other roadways.

Construction activities, such as blasting and excavations, pose a potential effect or hazard to human health and safety. These activities are to occur only within the Project Area or ROW. Access to the construction sites will be restricted and only individuals with the appropriate training (i.e., site-specific training) and authorizations will be required for access to these locations. Best management practices, such as signage and barriers will be used as necessary within these work areas.

The Construction phase may also include the removal of the section of existing highway to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and culverts (and completion of any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. This could involve removal of infrastructure (e.g., culverts), rehabilitation / site restoration of affected areas; and revegetation (i.e., planting, and hydroseeding). These activities may result in the following potential effects to Human Health and Safety:

- Disruption to human activities;
- Change in access to an area; and
- Effects to Human Health and Safety.

The deactivation activities will occur over a short period of time, however, their results will be permanent. Implementation of these activities, such as excavation of culverts and construction involved with the rehabilitation / site restoration, pose a potential effect or hazard to human health and safety.

These activities are restricted to within the currently operational ROW for this segment of Highway 104. Access to the construction sites will be restricted and only individuals with the appropriate training (i.e., site-specific training) and authorizations will be permitted access to these locations. Best management practices, such as signage and barriers will be used as necessary within these work areas. Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), and road closures, will be implemented to separate these activities from contact with the public. The rehabilitation / site restoration will be placed following best management practices for slope stability.

The duration of activities such as excavations and blasting are expected to occur within the Site Preparation and Construction phases; however, are not anticipated to be required during the whole duration of those phases. The occurrence of blasting (if required) is likely to be restricted to locations of culvert crossing, interchanges, bridges and fencing for excavations, and areas of new road construction within the proposed four-lane alignment south of the existing highway. Access by the public will be restricted in areas of blasting or excavation activities. The commencement of traffic and usage of this area will only occur following the completion of construction activities.

Construction practices will be completed following industry standards and will be completed in isolation from the public. If activities such as blasting are required, these operations will be completed in compliance with the *General Blasting Regulations* pursuant to the Nova Scotia *Occupational Health and Safety Act*. As such, all personnel completing these activities will be required to have a valid blasting licence and pre-clearance surveys (i.e., pre-blast surveys) will be require prior to completing a blast.

All excavations will be filled prior to any hour of darkness and on non-working days, except where a barrier designed to restrain errant vehicles is located between the traffic and the excavation. Any excavations within four metres of lanes carrying traffic will be backfilled up to profile grade and compacted prior to closing down operations each day.

Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), blasting plans, and road detours or closures, will be implemented to separate these activities from contact with the public. All necessary measures to safely and expeditiously accommodate traffic using the Provincial Highway within the Project Area will be implemented using all roads open to the public. All project activities will be completed in compliance with the Nova Scotia *Occupational Health and Safety Act* and its regulations or guidelines. Following the implementation of mitigation measures, the effects to Human Health and Safety are not expected to be significant.

The assessment of effects as a result of land-use is further outlined in Section 8.1.8.1.

Operation and Maintenance Phase - Activities

The following aspects of the Operation and Maintenance phase may possibly impact Human Health and Safety, as identified in Table 8.24.

Highway Operation

With the construction of a highway project, there is a potential of injury or mortality as a result of vehicle collisions and vehicle – wildlife collisions. Human populations within the identified communities in the RAA and Nova Scotia are not expected to significantly increase; as a result, the traffic volume is not predicted to increase significantly (CBCL, 2017). Redevelopment of the highway is to provide additional safety measures; such as twinned lanes, increased sight lines, or wildlife passage (i.e., divided medians and cleared ditches). Highway twinning feasibility studies for this Project reported that approximately 30-35% of collisions could be reduced from twinning based on elimination of intersection-related, angle, and head-on collisions and some reduction in single vehicle, rear-end, and sideswipe collisions (CBCL, 2016, 2017). This will provide additional engineered safety measures and is expected to result in the increased visibility, provide a conduit for travel and or deterrent for wildlife to cross the highway, which in turn, will likely produce a reduced rate of collision, reduced potential for head on collisions, and continue the transport of people and goods. Human health and safety was identified as one of the fundamental needs for the project and include accidents and malfunctions, such as vehicle collisions and vehicle – wildlife collisions.

The effects of vehicle collisions and vehicle – wildlife collisions are assessed in Chapter 7 Accidents and malfunctions (Section 7.4: Vehicle Collisions; and Section 7.5: Vehicle – Wildlife Collisions).

Highway Maintenance

The change in traffic flows as a result of maintenance activities may result in the disruption to human activities and effects to Human Health and Safety. These effects are short in duration (i.e., painting of traffic markings, snow removal and salting, and repaving) but may be frequent and are required for the overall help and safety of the public. These activities are restricted to within the Project Area or ROW and many will be permanently reoccurring activities, with the exception of the temporary storage of materials and equipment.

Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), road closures and detours and storage practices, will be implemented to separate these activities from contact with the public. Highway roads condition information will be updated periodically and as required for the publics use, such as NSTIR 511 Road Conditions Call Line. Traffic control procedures will be implemented as required, including temporary detours and closures. Notification detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use. Materials or equipment will not be stored within 10 m of the pavement edge of the existing Highway (104), 7 m of Trunk 4, and 4 m of the traveled portion of all other roadways.

8.1.9 Cultural Resources

In terms of Cultural Resources, 'Heritage and Archaeological Resources' were selected as a VEC because of the potential for interactions with these resources and the Project.

8.1.9.1 Heritage and Archaeological Resources

Heritage and archaeological resources are physical remnants, found either atop or below the ground surface, which are associated with, and provide information on past human use and interaction with the physical environment. These remnants may include both built and depositional resources ranging from the period of earliest human occupation to the relatively recent past. Heritage resources typically encompass historic sites, such as cemeteries, heritage buildings and sites, monuments, and areas of significance to Aboriginal (i.e., Mi'kmaq) communities or other groups.

An Archaeological Resource Impact Assessment (ARIA) was completed by Davis MacIntyre & Associates in 2018 to identify whether heritage and archaeological resources potentially exist in the LAA. The ARIA consisted of a historic background study and field reconnaissance surveys. Based on historic settlement reports, Precontact or heritage and archaeological resources may be present in the area between Sutherland's River and Antigonish.

As part of the historic background study, the Maritime Archaeological Resource Inventory was consulted to determine if known archaeological resources existed within or near the LAA.

Results indicated that 15 archaeological sites are registered within a 5-kilometer radius of the LAA, however none appear to intersect the LAA. Field reconnaissance surveys resulted in identification of areas and features of archaeological potential or significance within the LAA. These include 30 suspected or confirmed historic structures representing archaeological sites or parts of sites (e.g., houses, barns, and outbuildings). In total, 72 areas of elevated potential for First Nations archaeological resources. The latter consists of:

- 4 areas of elevated potential for historic resources;
- 8 areas of low to moderate archaeological potential;
- 56 areas of moderate potential; and
- 4 areas of high potential for First Nations archaeological resources.

Due to their presence (confirmed or potential) within the LAA and Project Area, 'Heritage and Archaeological Resources' were chosen as a VEC due to the potential for the proposed Project to interact with these resources.

Boundaries

Temporal boundaries refer to the duration of environmental effects associated with Project Components and Activities. Project activities which may lead to adverse effects to Heritage and Archaeological Resources are primarily those which result in ground disturbance, the majority of which are to occur during Site Preparation and Construction. These activities may be initiated as early as the winter of 2019 (e.g., clearing) and are anticipated to take approximately three to seven years, depending on the final delivery method for the Project. Although the likelihood is small, there

is potential for Project activities during the Operations and Maintenance phase to interact with Heritage and Archaeological Resources. Temporal boundaries are therefore anticipated to last the lifecycle of the Project.

While field reconnaissance surveys in 2018 extended beyond the Project Area to include the LAA, only land owned by NSTIR (i.e., the Project Area) will be subject to ground disturbance throughout the lifespan of the Project. For the purpose of this assessment, spatial boundaries will be limited to the Project Area.

Significance Determination

A significant environmental effect on Heritage and Archaeological Resources or sites is one that, following the implementation of mitigation, results in disturbance or destruction to an archaeological, historical, or paleontological resource or site that:

- is protected under the *Special Places Protection Act;* or
- has been identified to be of major importance to affected Aboriginal groups, communities, or provincial heritage regulators, due to factors such as rarity, condition, spiritual importance, or research importance.

A residual effect that does not meet these conditions will not be considered significant.

Potential Environmental Effects and Project-Related Interactions

Potential environmental effects to Heritage and Archaeological Resources include the following:

- Alteration or disturbance of Heritage and Archaeological Resources; and
- Removal of Heritage and Archaeological Resources.

Effects to Heritage and Archaeological Resources may occur as a result of ground disturbance, i.e., ground-breaking or land-altering activities. Ground disturbance is most likely to occur during the Site Preparation and Construction phases of the proposed Project. Given the lack of land-altering activities associated with the Operations and Maintenance phase, interactions between Project activities and Heritage and Archaeological Resources are considered negligible during these phases of the Project.

Potential impacts to Heritage and Archaeological Resources are summarized in Table 8.25. Project activities associated with each phase and their potential effects on Heritage and Archaeological Resources are discussed in the following subsections.

The application of suitable mitigation measures, such as environmental protection measures, best management practices, industry standards, and habitat compensation / off-setting projects, will facilitate the reduction or elimination of potential environmental effects. Proposed mitigation measures specific to Heritage and Archaeological Resources are discussed in Section 8.2.

Table 8.25 Summary of Potential Effects of Highway 104 Twinning Project on Heritage and Archaeological Resources

Project Component / Activities / Physical Works	Alteration	Potential Effect on Heritage and Archaeological Resources*
Site Preparation and Construction Phases		
• Vegetation clearing	• Removal of forests and vegetation • Ground disturbance by vehicles	• Disturbance to or removal of Heritage and Archaeological Resources
• Site Preparation activities: - Grubbing and soil management	• Ground disturbance during the removal of ground cover (e.g. roots, stumps)	• Disturbance to or removal of Heritage and Archaeological Resources
• Construction activities: - Excavation - Blasting - Fill placement - Grading - Ditch construction - Bridge and grade separation structure construction - Highway infrastructure placement - Installation of watercourse crossings and diversions - Wetland alterations - Removal of existing infrastructure (if required)	• Ground disturbance during removal or alteration of surface and subsurface materials	• Disturbance to or removal of Heritage and Archaeological Resources
Operation and Maintenance Phase		
• Infrastructure maintenance • Vegetation management	• Ground disturbance during maintenance activities which require ground breaking (e.g., bridge or culvert repairs) • Ground disturbance should vegetation management result in ground-breaking or land alteration (e.g., tree and stump removal)	• Disturbance or removal of Heritage and Archaeological Resources

* Potential impacts of Accidents and Malfunctions throughout all phases are discussed in Chapter 7.

Site Preparation and Construction Phases - Activities

The occurrence of Heritage and Archaeological Resources within the LAA is discussed in Chapter 5. Project components occurring during the Site Preparation and Construction phases that may lead to impacts on Heritage and Archaeological Resources are listed in Table 8.25, and discussed below.

Vegetation Clearing

The removal of trees from the Project Area has some potential for interaction with Heritage and Archaeological resources, though the potential is much less than during the later Site Preparation and Construction phase, discussed in detail below. And effects to this VEC as a result of vegetation clearing are predicted to be negligible.

Site Preparation and Construction

Site Preparation activities, such as clearing, grubbing and soil management, have the potential to result in ground disturbance through the removal of organic materials (i.e., trees, stumps, roots, shrubs, and topsoil) and potential interactions with Heritage and Archaeological Resources. The majority of potential effects on Heritage and Archaeological Resources will occur during the Construction phase of the Project, as activities which result in ground-breaking or land alteration are predominantly conducted during this phase. Such activities include excavation, whereby large amounts of soil and rock are removed from the ROW, either manually or via blasting, as well as fill placement, grading, ditch construction, wetland alteration, bridge and grade separation structure construction, installation of highway infrastructure, and removal of existing infrastructure, where required. Most archaeological sites are located in the upper portions of soil stratigraphy, i.e., in soil layers deposited since the retreat of glaciers approximately 11,000 years ago. Activities which result in disturbance to or the removal of surface and subsurface soils may, subsequently, result in damage to or the removal of heritage and archaeological resources from the Project Area.

The Construction phase may also include the removal of the section of existing highway to be deactivated by the creation of the new four-lane alignment, although there remains the possibility than NSTIR may keep portions of it in operation as access roads. Removal of this section would entail the removal of the existing asphalt and potentially culverts (and completion of any required soil stabilization activities) between from Browns Mountain Road to Pushie Road. This activity may result in ground disturbance, but it is not anticipated that interaction with Heritage and Archaeological Resources will occur. Since these activities will entail the removal of material from an already disturbed area, and will not require excavation of new ground, effects to Heritage and Archaeological Resources are anticipated to be negligible.

Installation of Watercourse Crossings and Watercourse Diversions

Construction activities near water (e.g., watercourse diversion and installation of watercourse crossings) may also interact with Heritage and Archaeological Resources. As discussed in the ARIA report (Davis MacIntyre & Associates, 2018), Woodland/Ceramic sites were concentrated along coasts, shorelines, and navigable watercourses, owing in part to the fact that watercourses were the main transportation routes during the Precontact period. Although most watercourses in the LAA

are small and not navigable, some areas of elevated potential for First Nations use were noted along watercourses in the LAA (Figure 5.20).

Operations and Maintenance Phase - Activities

Activities resulting in ground disturbance are limited during the Operations and Maintenance phase of the Project. There is potential for ground disturbance to occur during maintenance activities associated with infrastructure (e.g., bridge and culvert) repairs or vegetation management, such as tree clearing parallel to the alignment, should this be required for future safety purposes. Due to the lack of ground-breaking activities associated with Highway Operations and Maintenance, effects to Heritage and Archaeological Resources during this phase of the Project are anticipated to be negligible.

8.2 Mitigation Measures

The following Project-specific mitigation measures and best management procedures have been identified to minimize environmental effects as identified in Section 8.1. The Proponent will follow construction best management practices and specified permit conditions during construction.

The following mitigation measures have been identified for the entire Project. Further description of the environmental management procedures are identified in Chatper 9:

- Project activities will be conducted in compliance with federal, provincial legislation and municipal by-laws and regulations, such as the provincial *Environmental Act*, *Endangered Species Act, Wildlife Act*, *Environmental Goals and Sustainable Prosperity Act, Provincial Parks Act*, *Special Places Protection Act, Occupational Health and Safety Act*, and the federal *Fisheries Act*, *Migratory Birds Convention Act*, *Species at Risk Act* and their regulations;
- The NSTIR's *Generic EPP for the Construction of 100 Series Highways* will be implemented and followed by the Proponent (NSTIR, 2007). This EPP will be updated periodically;
- An *Emergency Response Plan* should be implemented, in coordination with local HAZMAT authority / fire department (as per NSTIR's *Spill Contingency Plan*);
- A site-specific *Spill Response Plan* should be implemented, and should include locations of spill response equipment, reporting procedures, and handling / disposal of materials. All spills will be cleaned up as soon as reasonably possible following the site-specific *Spill Response Plan*;
- A site-specific EPP will be developed and followed by the Proponent and may include other required Environmental Control Plans (ECP). This document will include training and mitigation measures that will reduce impacts to terrestrial, aquatic and human health such as accidental spills/leaks and release of fuel and mechanical fluids, hazardous materials and deleterious substances. At minimum, the EPP will include the following:
    - Emergency Response Plan;
    - Emergency Spill Response Plan, including locations of spill response equipment;
    - Erosion and Sediment Control Plan;
    - Water quality monitoring program;

    - Site dewatering plans;
    - Handling and storage of fuel, gasoline and associated products;
    - Waste management strategy; and
    - Operation and maintenance of machinery.
- All equipment and vehicles will be regularly checked and maintenance will be conducted as required to maintain all equipment and vehicles in optimal working order and minimize noise and combustion gas emissions;
- NSTIR's *Spill Contingency Plan* shall be adhered to;
- Ensure the use of Best Management Practices for all construction and maintenance activities;
- The Proponent will be required to have a spill containment kit onsite and personnel who are familiar with the use of the kit. Spill kits will contain appropriate and sufficient materials to handle surface water spills and land spills; and
- Spills of hazardous materials must be contained as quickly as possible and reported to the appropriate regulatory authorities (i.e., DFO and NSE).

Additional project specific mitigation measures are provided in the following subsections for each environment:

- Atmospheric Environment;
- Physical Environment;
- Biological Environment;
- Socio-economic Environment; and
- Heritage and Archaeological Resources.

8.2.1 Atmospheric Environment

Mitigation measures will be implemented by the Proponent throughout the Project lifecycle to reduce the potential environmental effects to the Atmospheric Environment as identified in section 8.1.1. The mitigation measures that have been selected are listed below by the most relevant VEC(s).

8.2.1.1 Air Quality, Climate Change and Greenhouse Gases

Mitigation measures that have been selected which are specifically applicable to Air Quality, Climate Change and Greenhouse Gases include:

- All vehicles and machinery will be regularly checked and maintained to ensure that air contaminant emissions are kept to a minimum;
- Loads on vehicles will be covered and secured as required when travelling on public highways;
- Dust suppression techniques will be applied to mitigate the release of dust from Project activities. Dust abatement techniques will be utilized if necessary;
- Should the Project require blasting during construction, all blasting regulations will be followed. Notice of blasting will be provided to local land users, when necessary;

- If material is tracked from the construction site onto roadways used by the public. As soon as reasonably possible the proponent shall remove all material from the affected roadway to reduce the potential for dust or sediment release;
- Natural vegetation shall be preserved wherever where possible; cleared areas shall be re-seeded and re-vegetated to reduce erosion and dust generation and to re-establish modes of carbon sequestration;
- Cleared areas will be reseeded and revegetated promptly to reduce dust generation.

8.2.1.2 Noise

Mitigation measures that have been selected which are specifically applicable to Noise include:

- Vehicles and machinery will be regularly checked and all required maintenance conducted to ensure noise emissions are minimized;
- Equipment and vehicles will be equipped with noise controls, such as muffling devices;
- Should the Project require blasting during construction, notice of blasting will be provided to local land users, when necessary; and
- Noise monitoring will be conducted if complaints arise. The program should follow *Guidelines for Environmental Noise Measurement and Assessment* in Nova Scotia (NSDEL, 1990). If the threshold is exceeded, additional noise mitigation measures will be investigated.

8.2.2 Physical Environment

Mitigation measures will be implemented by the Proponent throughout the Project lifecycle to reduce the potential environmental effects to the Physical Environment as identified in Section 8.1.1.1. These measures will mitigate impacts to Geology and Soil Quality, Surface Water Quality, and Hydrogeology and Groundwater. Mitigation measures that have been selected which are applicable to all of these VECs include:

- All fuels, gases, and potentially harmful substances will be contained within approved and appropriate containers. All transportation and storage of materials must be in compliance with the *Transportation of Dangerous Goods Act* and regulations;
- Bulk storage of fuel products on site will be avoided;
- All equipment and vehicles will be inspected for spills or leaks; any detected spills or leaks will be addressed immediately. Inspections will be documented throughout the Project site Preparation and Construction phases;
- Vegetation disturbance, soil disturbance, and sedimentation shall be reduced through the utilization of existing cleared and disturbed land whenever possible;
- Hazardous materials will be stored (not in bulk) at least 30 m from any watercourses;
- Fuel or service vehicles and machinery shall be fuelled and serviced at least 30 m from any watercourses, and on a hardened, impermeable, and level surface; and
- Secondary containment shall be used whenever possible for equipment such as pumps and generators.

Additional mitigation measures specific to individual Physical Environment VECs are listed below, according to VEC.

8.2.2.1 Geology and Soil Quality

Mitigation measures that have been selected which are specifically applicable to Geology and Soil Quality include:

- All soils and surface water impacted via spills and releases will be handled in accordance with applicable environmental regulations and legislation;
- NSTIR's *Salt Management Plan* (SMP) will be followed, in accordance with Environment Canada's *Code of Practice for the Environmental Management of Road Salt*. The plan includes best management practices to provide safe, and cost effective roadway management systems while reducing the use and potential impacts from salt;
- All new material used for the proposed of construction will be clean and devoid of contamination;
- All material shall be handled and stored in a manner applicable to relevant regulatory requirements. Protocols for the handling and storage of topsoil are to be included in operational procedures;
- Areas of potential contamination should be identified before ground disturbance, and site-specific mitigative actions enacted (such as infill or removal);
- Herbicide use shall not be the first choice for vegetation removal, and will be used only if manual or mechanical vegetation control measures are insufficient to control vegetation; and
- Following the completion of abrasive blasting, all debris material shall be removed and disposed of. All waste materials shall be dispose of in an environmentally acceptable manner, and in compliance with all local and provincial laws and regulations.

8.2.2.2 Surface Water Quality and Groundwater Quality

Mitigation measures that have been selected which are specifically applicable to Surface Water Quality include:

- Development of a Project-specific *Surface Water Management Plan that meets the objectives of* NSTIR's standard *Environmental Protection Plan* (EPP);
- An engineered *Sediment and Erosion Control Plan* (SECP) that demonstrates due diligence and accepted best practices and stamped by a professional Engineer licensed to practice in Nova Scotia will be implemented by the Proponent. The SECP may include details on the following topics:
    - The use of sediment and erosion control measures such as silt fence or curtains;
    - Methods for containment of contact water during construction;
    - Methods for placement, spreading, and stabilization of reclaimed materials (grubbings) that prevent erosion and controls sedimentation; and
    - Removal of non-organic sediment and erosion control measures following construction, as necessary (grubbings, mulch, and hay may be left in place).
- All culverts will be designed following applicable legislation, guidelines and standards to maintain ephemeral stream flows and small wetlands;
- All well decommissioning activities will follow the requirements of the *Well Construction Regulations*;
- Meet the objectives of NSE Wetland and Watercourse Alteration specifications;

- Fueling and storage of gasoline and associated products (e.g., oils, greases, diesel, hydraulic and transmission fluids), will occur in a designated refueling /storage area at least 30 m from any waterbody or wetland;
- All maintenance of equipment will occur at minimum of 30 m from any waterbody or wetland;
- When possible, timing and staging for construction activities will be completed outside of extreme weather such as storms to reduce the potential of run-off;
- Any excess construction materials (asphalt, concrete, or other wastes) shall be disposed of in an approved location. Temporary storage areas for such waste, if necessary, shall be stored at least 30 m from waterbodies and 60 m from wells;
- Best management practices should be implemented to reduce erosion and promote groundwater recharge. Specifically, these include:
    - Employment of erosion control curtains and preservation of stumps and natural vegetation;
    - Management of exposed soil;
    - Storm water control and run-off reduction;
    - Design criteria that preserves ephemeral streams and small wetlands, where possible; and
    - Implementation of infiltration galleries in appropriate areas.
- A project-specific surface water quality monitoring program will be developed and conducted throughout this Project. This will include collection of background Total Suspended Solids (TSS) values in potentially affected areas prior to initiation of construction activities, after clearing and prior to grubbing. TSS samples shall also be taken at the same time of year in similar site conditions, as TSS values can vary on a seasonal and daily basis;
- Appropriate approvals will be obtained for activities that have the potential to negatively impact watercourses;
- Construction zones will have buffer zones and erosion control structures in place;
- Regular maintenance of drainage infrastructure should be conducted to ensure normal water flow. This shall occur under low flow conditions;
- Vehicles shall not ford watercourses; and
- Sedimentation and erosion control structures will stay in place until vegetation is established. Areas should be assessed in late spring or early summer of the year following construction. If banks and soils are fully established with successful vegetation re-growth, then the sediment erosion control measures may be removed. If erosion and sedimentation is still an issue, sediment erosion control will need to stay in place and then additional measures must be implemented to stabilize soils.

8.2.3 Biological Environment

Mitigation measures will be implemented by the Proponent to reduce the potential environmental effects to the Biological Environment as identified in Section 8.1.3, 8.1.4, and 8.1.5 throughout the Project lifecycle. The mitigation measures that have been selected include:

- Effects during construction will be minimized via the development and implementation of NSTIR's *Generic EPP* and use of best management practices;
- Best management practices should be implemented to achieve compliance with the Nova Scotia *Endangered Species Act* (NSESA), and the federal *Species at Risk Act* (SARA) and their associated regulations;
- Cleared or grubbed areas will managed to reduce potential of sedimentation and erosion; and
- NS Highway Seed Mix will be used, unless otherwise approved and certified free of all prohibited noxious weed varieties identified in the provincial *Agricultural Weed Control Act* 1989 and regulations, and federal *Plant Protection Act* 1990, and *Seeds Act* 1985 and related regulations and policies.

8.2.3.1 Flora

Mitigation measures will be implemented to reduce the potential environmental effects to vascular plant and lichen species and communities as identified in Section 8.1.3 throughout the main Project phases. The mitigation measures that have been selected include, but are not limited to, the following:

- Natural vegetation, top-soil and useable grubbings will be preserved, retained and reused to the greatest extent possible, to facilitate re-establishment of native vegetation via their contained seedbanks;
- Site clearing activities will be kept to a minimum;
- Herbicides, if used, shall only be used according to NSTIR's *Integrated Roadside Vegetation Maintenance Program*, including application of buffers; 30 m to watercourses and 60 m to sensitive areas, such as wetlands;
- Cleared areas will be re-seeded and re-vegetated as soon as feasible;
- NSTIR's *Integrated Roadside Vegetation Management Manual* will be adhered to;
- All Wetland and Watercourse Alteration permit approval conditions shall be adhered to;
- To avoid unintentional introduction or spread of invasive or exotic plant vascular species (such as Japanese knotweed and purple loosestrife), all equipment used on site must be cleaned thoroughly prior to arriving at the Project Area;
- NS Highway Seed Mix will be used in revegetation activities unless otherwise approved; and
- Winter road salting will comply with NSTIR's *Salt Management Plan*, developed in accordance with Environment Canada's *Code of Practice for the Environmental Management of Road Salt*.

In addition, mitigation measures designed to minimize impacts to other VECs, particularly air quality, soil quality, surface water quality, wildlife, wetlands, and fish and fish habitat will also aid in minimizing impacts to flora. These mitigation measures are listed in their respective sections elsewhere in Section 8.2.

8.2.3.2 Wildlife and Wildlife Habitat

Mitigation measures will be implemented by the Proponent throughout the Project lifecycle to reduce the potential environmental effects to wildlife species and habitats that were identified in

Section 8.1.4. The mitigation measures selected to minimize impacts to mammals, birds, reptiles, and/or amphibians throughout the Project lifecycle include (but are not limited to):

- A Wildlife Management Plan will be implemented to minimize direct and indirect adverse impacts to wildlife;
- Two wildlife crossings, in conjunction with ATV crossings and fencing, will be incorporated in the highway design in order to maintain habitat connectivity;
- Creation or restoration of compensatory wetlands to mitigate loss or alteration of wetland habitat;
- NSDNR will be notified of any deer collisions during the Construction phase;
- Excess noise shall be reduced when possible, by ensuring that equipment and vehicles are adequately muffled and in good working order;
- Site lighting shall be minimized, in order to minimize light disturbance to wildlife (particularly birds);
- Existing access roads and cleared areas shall be utilized to reduce unnecessary disturbance;
- A *Spill Response Plan* shall be developed and adhered to, along with any associated measures (e.g., ensure equipment is checked daily for leaks, and keeping emergency spill-kits on site);
- All federal and provincial legislation, permits, approvals and guidelines relevant to wildlife shall be complied with;
- All potentially destructive or disruptive activities shall be avoided during sensitive wildlife periods (such as the mid-April to end of August bird breeding window) or within sensitive areas in order to reduce the risk of negative impacts to breeding and migratory birds and their nests;
- Consultation with appropriate protocols or regulatory authorities must occur if clearing activities and activities that are known to be disruptive to birds are planned within the breeding window;
- Prior to maintenance work, bridges should be inspected for nesting birds. If present, maintenance work should be completed after nesting is complete;
- If further investigation for any wildlife is required, surveys should be completed by a qualified biologist; and
- Habitat fragmentation and direct mortality of reptiles and amphibians can be mitigated through proper design of stream crossing structures (i.e., bridges, arches, or open-bottom culverts). As identified in NSDNR mapping, bridge and culvert spans will accommodate terrestrial habitat, allowing reptiles and amphibians to cross road corridors without being exposed to traffic or predators.

In addition, mitigation measures designed to minimize impacts to other VECs, particularly air quality, soil quality, surface water quality, flora, wetlands, and fish and fish habitat will also aid in minimizing impacts to wildlife. These mitigation measures are listed in their respective sections elsewhere in Section 8.2.

8.2.3.3 Fish and Fish Habitat

Mitigation measures will be implemented to reduce the potential environmental effects to fish and fish habitat VEC as identified in Section 8.1.6 throughout the Project life cycle. All applicable provincial and federal policies, regulations and Acts relevant to fish will be followed such as the provincial *Environment Act – Activities Designation Regulations*, federal *Fisheries Act* [Sections 34 and 35], *Fisheries Protection Policy Statement: Section 8.2 Serious Harm to Fish* [Section 35] and *Provisions for Flow and Fish Passage* [Sections 20 and 21], and the federal *Species at Risk Act*.

All required provincial water approval applications and reports will be submitted to the province for review, as well applications for a DFO *Request for Review* and subsequent DFO applications for *Fisheries Act* authorization, if required. The mitigation measures that have been selected include:

- Any 'serious harm' to fish and fish habitat, as defined in the *Fisheries Act*, shall be compensated for when required by DFO.
- The instream works timing window restrictions will be followed (e.g., allowable window is between June 1 and September 30, restricted window is October 1 to May 31). If work is required outside of this window, a request for an extension will need to be approved by both NSE and DFO.
- Culverts and bridges will be designed to allow for fish passage for all watercourses crossings identified as having the potential for fish within the Project area (see Appendix E). A total of 100 watercourses within the Project Area have the potential for fish at some point during the year in the Project area.
- All watercourse crossings for culverts will meet the objectives of the *Guidelines for the Design of Fish Passage for Culverts in Nova Scotia* (DFO, 2015).
- If sedimentation and erosion is an issue, potential impacts to fish and fish habitat further downstream of the site should be assessed.
- Mitigation measures for culvert and bridge replacements, modifications or extensions will follow the mitigation measures listed above for construction activities.
- *Fish Salvages and Dewatering Activities During Construction*: Prior to complete dewatering of the area within the temporary dams, fish salvages will be conducted for all watercourses identified as having potential for fish within the Project area (see Appendix E). The fish salvages can be conducted with an electrofisher and dip nets until no more fish are captured or seen. All captured fish will be relocated upstream or downstream of the construction area in suitable fish habitat. In addition:
    - Water from dewatered areas shall be pumped a minimum of 30 m from the watercourse to a location where sediment laden water will not enter the watercourse or wetlands;
    - To maintain the flow of water, clean water will be pumped and diverted from an upstream location around the dewatered construction site to a suitable downstream location which will not cause an increase in instream sedimentation (e.g., over a splash pad or boulders/bedrock);
    - All pumps used for water intakes and for dewatering must have an intake screen size of 2.54 mm or less to prevent fish intake or impingement per *DFO Freshwater Intake End-of Pipe Fish Screen Guideline* or *Guideline Summary* (DFO, 1995); and

- Once the area is dewatered, a check for missed fish will be conducted under or behind aquatic vegetation, boulders and woody debris.

- If blasting is to occur in or near a watercourse, approval from DFO will be required, and operations will be conducted in accordance with the *Guidelines for Use of Explosives in or Near Canadian Fisheries Waters* (Wright and Hopky, 1998).
- *Winter Road Salting:* The following mitigation measures are specific to reducing the amount of highway salt run-off into watercourses:
  - Roads should be salted as per NSTIR's Salt Management Plan.

It is recognized that mitigation measures designed to protect Surface Water Quality and Groundwater Quality will also aid in minimizing impacts to Fish and Fish Habitat. Mitigation measures applicable to Surface Water Quality and Groundwater Quality are listed in Section 8.2.2.

8.2.3.4 Wetlands

Additional mitigation measures should be employed during the Site Preparation and Construction, and Operations phases to reduce potential impacts to wetlands and their associated functions. The mitigation measures that have been selected include, but are not limited to, the following:

- All wetland removals or alterations will be mitigated via wetland compensation activities, determined in consultation with NSE;
- Where possible, clearing operations will be conducted during winter months on frozen ground to protect the underlying vegetative mat and to reduce erosion and sedimentation of wetlands;
- Manual clearing will be conducted where ground conditions are not suitable for heavy equipment access;
- Sediment fencing will be erected around construction areas prior to commencement of Site Preparation and Construction;
- To minimize erosion and prevent sedimentation of wetlands to be preserved, a 5 m buffer will be maintained adjacent to wetlands wherever practical;
- Erosion control measures (i.e., erosion control blankets, hydraulic mulches, turf reinforced mats and rip-rap) will be used to line ditches, swales, drainage channels, and steep banks to avoid erosion and siltation of down-gradient wetlands. These control measures will be installed prior to significant ground disturbance;
- Material will be stockpiled in such a way as to prevent erosion and sedimentation to any adjacent wetlands;
- Surface runoff and runoff from stockpiled material will be managed using standard sediment and erosion control practices;
- The area used for temporary ancillary project elements will avoid wetlands;
- Cleared areas within and immediately adjacent to wetlands should be re-seeded or otherwise re-vegetated in order to reduce erosion;
- Whenever possible, work should be stopped during periods of inclement weather (e.g., high winds, high rainfall); and

- Where possible, quarried, crushed material will be used for road building in and near wetlands with portions to be preserved, to minimize the risk of introducing or spreading non-native or invasive plant species.

8.2.3.5 Species at Risk

General mitigation measure for flora, wildlife, and fish species and habitats (listed elsewhere in this section) will also aid in mitigating impacts to SAR flora and wildlife species and their habitats. Mitigation measures specific to all SAR which have been selected for this Project include:

- If any obvious SAR (such as mainland moose, wood turtle, or black ash) are identified on site during any phase of construction, NSDNR should be notified;
- Best management practices must be implemented to achieve compliance with the *Endangered Species Act* and its regulations;
- Wildlife crossing structures shall be constructed to reduce potential effects to habitat connectivity and movement corridors;
- Whenever possible, the spans of bridges or culverts to be installed should be wider than the watercourse, creating corridors for wildlife passage;
- Watercourse crossing structures (e.g., culverts, bridges shall utilize optimal design and proper installation to reduce habitat fragmentation); and
- Bridges should be designed and built so that abutments are not in the watercourse but rather on firm shorelines with adequate setbacks from the water.

Additional mitigation measures specific to each SAR group are provided in the following subsections.

Flora SAR: Black Ash, Blue Felt Lichen, and Pygmy Pocket Moss

Mitigation measures will be implemented throughout the Project lifecycle to reduce the potential environmental effects to flora SAR as identified in Section 8.1.7.1. The mitigation measures that have been selected include, but are not limited to the following:

- The use of herbicides shall be avoided near SAR and SOCC - hand cutting, mowing or spot spraying near these species is preferred if vegetation removal is required for any reason;
- Seed should be collected from black ash specimens too large to move, and raised to a suitable size for replanting into nearby suitable habitat, possibly in a collaborative effort with First Nations groups, some seeds should be collected following the National Tree Seed Centre protocol and sent to the Centre if quantities permit;
- Small black ash specimens within the footprint should be transplanted to nearby areas of suitable habitat, possibly in a collaborative effort with First Nations groups;
- Should black ash be replanted in nearby suitable habitat, a monitoring plan will be developed and implemented to assess the success of the transplantation;
- A vegetated buffer surrounding SAR species observations should be maintained wherever possible. The minimum buffer distances should be determined in consultation with NSDNR; and
- Post-construction monitoring of SAR observations should be conducted to evaluate the efficacy of the vegetated buffer.

Mammal SAR: Mainland Moose

Mitigation measures will be implemented throughout the Project lifecycle to reduce the potential environmental effects to the mainland moose as identified in Section 8.1.7.2. The mitigation measures that have been selected include, but are not limited to the following:

- Fencing shall be erected in conjunction with wildlife crossing structures to facilitate the passage of moose across the highway;
- Buffer zones will be established and maintained between natural areas and the new alignment;
- Passive warning signs and reduced speed limits shall be utilized in areas where moose may be present, such as the four-lane alignment south of the existing highway; and
- A brush free zone shall be maintained adjacent to the highway to increase visuals of moose and reduce risk of collision.

Mammal SAR: Little brown Myotis and Northern long-eared Myotis

Mitigation measures will be implemented to reduce the potential environmental effects to endangered bats as identified in Section 8.1.7.3 throughout the Project lifecycle. The mitigation measures that have been selected include, but are not limited to the following:

- Tree clearing around watercourse and waterbodies adjacent to the highway shall be minimized, to encourage bats to cross at higher heights to minimize vehicle collisions.

SAR Birds

There are no extra mitigation measures required that are specific to bird SAR.

SAR Reptiles: Wood and Snapping Turtles

Throughout the Project lifecycle, mitigation measures will be implemented to reduce the potential environmental effects to wood turtles and snapping turtles that were identified in Section 8.1.7.5. The mitigation measures that have been selected include, but are not limited to, the following:

- Onsite monitoring for turtles should be conducted immediately prior to and during Site Preparation and Construction activities in sensitive turtle areas;
- Permanent and temporary road and water crossings shall be planned in advance to help prevent turtle mortality and protect water quality;
- Known sensitive wood turtle habitat sites (e.g. potential nesting areas) shall be identified and avoided when building new roads and water crossings; and
- The amount of road that parallels a watercourse will be minimized;

Other SAR Species

No mitigation measures are required for any other SAR species which may occasionally be present within the LAA, such as the Monarch butterfly.

8.2.4 Socio-Economic Environment

Mitigation measures will be implemented by the Proponent to reduce the potential environmental effects to the Socio-economic Environment as identified in Section 8.1.8 throughout the Project life

cycle. The mitigation measures that have been selected are listed according to relevant VEC in the following subsections.

8.2.4.1 Land Use

Mitigation measures will be implemented to reduce the potential environmental effects to Land Use throughout the Project life cycle. These mitigation measures include:

- Land acquisition and compensation will be in accordance with the Nova Scotia *Expropriation Act* and follow NSTIR's land acquisition procedures;
- The provision of alternate access or access roads will be considered when permanent legal accesses are impacted by the project. All existing accesses will be reviewed within the project limits. Service roads are an alternative to be considered to provide access to properties impacted by control of access designation or other access restrictions. The decision to construct a service road shall consider the feasibility and cost effectiveness of all other alternatives, including: land purchase, transfer of land ownership, and acquisition of access rights;
- Construction activities shall be carried out so as not to interfere unnecessarily with the convenience of the public, in terms of accessing and using any public or private roads, footpaths, highways or other transportation routes, whether under the control of NSTIR, or any other authority;
- Accommodation of access will be provided to forestry or agricultural operators, when reasonable and safe to do so;
- Traffic control procedures will be implemented following TIR typical approval process, as required, including temporary detours and closures. Detour Plans will include geometry, traffic accommodation, signing, and the results of a 'Temporary Traffic Accommodation On-Site Road Safety Audit'. Notification of detours and closures will be posted prior to implementation and any required modifications will be completed as needed. Flag persons, detour signage, barriers, markings, lighting, safety devices, and other appurtenances will be maintained for the duration that the detour or closure is in use;
- All existing accesses (vehicular or pedestrian) will be maintained on all roadways and properties affected by the construction activities until alternative access is provided;
- Activities associated with the project schedule will be communicated with the local communities and local stakeholders;
- The Proponent will coordinate operations on crossroads, service roads, or other private roads with the appropriate authorities during construction. The Proponent will obtain any necessary permits from government agencies such as NSTIR and/or Local Authority;
- Existing ATV and snowmobile trails will be accommodated when safe and feasible to do so;
- Land and resources that are currently used by the Mi'kmaq for traditional purposes should be avoided; and
- A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on Lands used by the Mi'kmaq for traditional purposes.

8.2.4.2 Human Health and Safety

Mitigation measures will be implemented to reduce the potential environmental effects to Human Health and Safety throughout the Project life cycle. These mitigation measures include:

- Best management practices should be implemented to achieve compliance with the Nova Scotia *Occupational Health and Safety Act* and its regulations;
- During construction, all necessary measures will be implemented to safely and expeditiously accommodate traffic within and adjacent to the Project Area. The procedures and protocols outlined in the *Nova Scotia Temporary Workplace Traffic Control Manual* and the *TAC Manual of Uniform Traffic Control Devices for Canada* will be followed during the Project;
- All excavations will be filled prior to any hour of darkness and on non-working days, except where a barrier designed to restrain errant vehicles is located between the traffic and the excavation. Any excavations within four metres of lanes carrying traffic will be backfilled up to profile grade and compacted prior to closing down operations each day;
- No materials or equipment will be stored within 10 m of the pavement edge of the existing Highway 104, 7 m of Trunk 4, and 4 m of the traveled portion of all other roadways, except in the medians where the minimum clearance required is 2.5 m; and
- To ensure the public has access to current and accurate information, highway roads condition information (such as the NSTIR 511 Road Conditions Call Line) will be updated periodically and as required.

8.2.5 Cultural

Mitigation measures will be implemented to reduce the potential environmental effects to the Cultural Environment as identified in Section 8.1.9 throughout the Project life cycle. The mitigation measures that have been selected are listed according to VEC in the following subsection.

8.2.5.1 Heritage and Archaeological Resources

Mitigation measures will be implemented to reduce the potential environmental effects to the cultural environment, specifically Heritage and Archaeological Resources throughout the Project life cycle. These mitigation measures include:

- An *Archaeology Contingency Plan* will be prepared, which will include protocols for the discovery of unanticipated Heritage and Archaeological Resources (‘chance find procedure’), stop work requirements and the notification requirements for NSCCH;
- In the unlikely event that archaeological resources are encountered during Site Preparation, Construction, or Operation and Maintenance, any ground-disturbing activity must be halted immediately and the Coordinator of Special Places (902-424-6475) must be contacted immediately regarding a suitable method of mitigation;
- A formal shovel testing program shall be completed in any areas where possible or probable historic structures and areas of elevated potential for historic or First Nations archaeological resources have been identified within the area of impact, in order to confirm the presence or absence of heritage and archaeological resources on site;
- Areas of elevated potential or where the presence of historic structures are confirmed will require the implementation of site-specific mitigation measures prior to commencement of construction. These measures will vary depending on the extent and significance of the site

but may include monitoring, further testing, or complete excavation. Site-specific mitigation measures will be determined in consultation with NSTIR and NSCCH;

- A small portion of Sutherland's River could not be assessed due to the steep and dangerous nature of accessing the river from the highway on the north side. If the riverbanks are to be impacted in this area, a follow-up reconnaissance should be conducted via an alternate access system to more effectively assess this portion of the landscape;
- It is recommended that three sites which appear, based upon historic mapping, to represent elevated potential for archaeological resources and which could not be assessed during the field reconnaissance surveys due to vegetation cover (i.e., dense growth, blow-down, or clear-cutting detritus), should be re-visited by a professional archaeologist after removal of the tree growth but prior to full grubbing, if possible;
- The full extent of the French River Cemetery and a small buffer of approximately 5 m around the edges of the cleared field should be avoided by construction activity of any sort. If this is not possible, CCH must be consulted in depth, and a professional archaeological firm contracted to determine a suitable method of mitigation;
- Staging areas and siting of Temporary Ancillary Project Elements (e.g., temporary access roads, petroleum storage areas, mobile asphalt plants) will avoid archaeological resources, whenever possible; and
- In the event that changes are made to the Project Area prior to or during highway construction, an archaeologist should be contracted to assess any additional impact areas not assessed under the current research permit.

8.3 Residual Environmental Effects and Significance Determination

Following assessment of the effects on the identified VECs, mitigation measures are applied to reduce the magnitude of each effect. For each interaction where a mitigation measure is applied, the effectiveness of each mitigation measure will be assessed in order to identify any remaining residual effects. Residual effects are effects to VECs that are anticipated to remain following the implementation of mitigation measures. The residual effects are then characterized to determine the extent and nature of the effect. To determine significance, the residual effect will be assessed in consideration of magnitude, geographical extent, duration, frequency, reversibility, and ecological and social context, as described in Section 4.2. Significance determination will be conducted for each individual VEC, and VEC-specific follow-up and monitoring measures will be applied to assess the effectiveness of the proposed mitigation measures. VEC-specific follow-up and monitoring measures are identified in Section 8.4.

Following the implementation of mitigation measures, the following residual effects were identified.

8.3.1 Atmospheric Environment

A number of potential residual effects to the Atmospheric Environment were identified for specific Atmospheric VECs. With proper mitigation, none of these residual effects are predicted to be significant for any Atmospheric VECs (Air Quality, Noise, and Climate Change & Greenhouse Gases), although follow up and monitoring measures should be applied to determine the effectiveness of the mitigation measures for impacts to Noise. These measures are further described in Section 8.2.1.

The following subsections outline the assessment of significance for identified residual effects for each Atmospheric VEC.

8.3.1.1 Air Quality

The Project is still in the preliminary design phase and the amount of equipment and material to be used is still to be determined, pending the outcome of the DBFOM process and the design solution of the selected Proponent. Based on our understanding of the Project, the effects assessment for air quality identified the following potential effects:

- Change in air quality;
- Emission exceedances above *Air Quality Regulations;* and
- Emission exceedances above CAAQS.

Considering the implementation of the identified mitigation measures for air quality, the residual effects assessment for air quality is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **moderate**, as a result of the Project emissions exceeding baseline conditions during Site Preparation, Construction, and Operation and Maintenance phases; however, these exceedances are likely to be less than regulatory criteria or published guideline values. This is applicable for all the identified effects during Site Preparation and Construction. The magnitude will fall to **low** during Operations and Maintenance, as the Project is not expected to result in increased traffic on Highway 104, but rather facilitate a more safe and efficient traffic flow;
- Geographic Extent: The geographic extent is anticipated to be categorized as **moderate**, as effects are limited to within approximately 300 m of the Project area (*effect extends outside of the Project Area to the LAA and RAA*). This is applicable for all the identified effects during Site Preparation, Construction, and Operations and Maintenance phases;
- Duration: The duration of effects for Operations and Maintenance is categorized as long-term **(high)**, for the life of the Project and beyond. Temporary changes in emissions will be **moderate,** from the start of Site Preparation activities until the completion of Construction;
- Frequency: The frequency of effects is categorized as **high**, as use will be continuous throughout the Project lifecycle; however, this frequency is anticipated to be similar to baseline conditions as the Project is not expected to result in increased traffic on Highway 104;
- Permanence: The permanence of effects during Site Preparation and Construction are categorized as **moderate***;* though effects will be continuous during Site Preparation and Construction, these effects as these are rapidly dissipated, and will cease upon the

completion of these phases. During Operations and Maintenance, air quality levels are anticipated to return to normal air quality levels, as traffic is expected to be similar to the existing conditions and is not expected to result in increased traffic; and

- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **moderate** as the majority of the Project takes place along an existing alignment, and adjacent to the existing traffic, the remaining portion of the highway will divert from the existing alignment through a new alignment corridor.

Mitigation measures for potential effects to air quality are outlined in Section 8.2.1, and include adherence with NSTIR's *Generic EPP*, dust suppression techniques, maintaining equipment in good working and reduction of idling equipment throughout the Site Preparation, Construction, and Operation and Maintenance phases. Upon adherence to the NSTIR's *Generic EPP* and implementation of mitigation measures as outlined in Section 8.2.1, the maximum permissible ground level concentrations for Project-related emissions of interest are not anticipated to exceed provincial or federal thresholds. Therefore, residual effects to air quality are expected to be *Not Significant*, per the significance determination.

8.3.1.2 Noise

The effects assessment for noise identified the following potential effects:

- Sound levels (dBA) exceeding provincial guideline and municipal by-law.

Considering the implementation of the identified mitigation measures for noise, the residual effects assessment is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **high** as noise levels may exceed baseline conditions (in the realigned Barneys River Station to James River section) and periodically exceed published guideline values (entire route) during Site Preparation and Construction phases. However, the areas where the alignment is adjacent to the existing highway it is are not expected to have an increase of 5 dBA in those locations where an exceedance of the *Guidelines for Environmental Noise Measurement and Assessment* and by-law already exists. This is applicable during Site Preparation, Construction, and Operations and Maintenance phases;
- Geographic Extent: The geographic extent is anticipated to be categorized as **moderate**, as effects are limited to within approximately 300 m of the Project area (*effect extends outside of the Project Area to the LAA and RAA*). This is applicable for all the identified effects and during Site Preparation, Construction, and Operations and Maintenance phases;
- Duration: The duration of effect for the Operations phase is categorized as **high (long-term)**, for the life of the Project and beyond. Temporary changes in noise are categorized as **moderate** in duration**,** from the start of Site Preparation activities until the completion of the Construction phase;
- Frequency: The frequency of use will be continuous throughout the Project lifecycle, and as a result is categorized as **high**; however, this is similar to the existing conditions and the Project is not expected to result in increased traffic on Highway 104;

- Permanence: The permanence effects during Site Preparation and Construction phases are short lived and will be completed over the **moderate** term in alignment with the completion of Construction activities. During the Operations and Maintenance phase, the noise levels within the realigned Barneys River Station to James River section of the highway are anticipated to increase, and for all remaining portions noise levels are expected to be similar to the existing conditions. Therefore, for the Operations and Maintenance phase, the permanence is categorized as being **high**; and
- Ecological, Land Use and Cultural Context (of effect): In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **moderate,** as the majority of the Project takes place along the existing Highway 104 alignment, adjacent to the existing traffic; the remaining portion (the realigned Barneys River Station to James River section) of the highway will divert from the existing alignment through a new alignment corridor.

Mitigation measures for potential effects to noise are outlined in Section 8.2.1, and include adherence with NSTIR's *Generic EPP*, maintaining equipment in good working and implementation of noise controls (such as muffling devices), and notification of works throughout the Site Preparation, and Construction phases. Upon adherence to the NSTIR's *Generic EPP*, implementation of mitigation measures and noise monitoring as outlined in Section 8.2.1, noise level emissions associated with Project activities is not to exceed the significance criteria (i.e., 5 DBA over the provincial or municipal by-law) at sensitive receptors within the twinning sections. Traffic is not expected to increase in the area of the sensitive receptors during operations, resulting in noise remaining at similar levels. No sensitive receptors, such as residential homes, are anticipated within the LAA along the new alignment between Barneys River Station to James River. Therefore, the increase of noise which will result from Site Preparation, Construction, and Operation and Maintenance phases is not anticipated to affect public health. However, activities within the new realignment between Barneys River Station to James River portion of the highway within the Site Preparation, Construction, Operation and Maintenance may exceed the significance criteria. The follow-up measures are recommended to assess if the significance criteria are exceeded. A complaint-based noise monitoring program during construction may be required to assess if the mitigation measures to address the residual effects are sufficient.

8.3.1.3 Climate Change and Greenhouse Gases

The effects assessment for Climate Change and GHG emissions identified the following potential effects:

- Increase in provincial and national GHG emissions.

Considering the implementation of the identified mitigation measures for climate change and GHG emissions the residual effects assessment is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **low** as a result of the Project emissions; these are not anticipated to exceed the Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment's status as 'Low magnitude' (less than 10,000 tonnes CO_2e per year). This is applicable during Site Preparation, Construction, and Operations and Maintenance phases;

- Geographic Extent: The geographic extent is anticipated to be categorized as **moderate**, as effects are approximately within 300 m of the Project area (*effect extends outside of the Project Area to the RAA*). This is applicable for all the identified effects and during Site Preparation, Construction, and Operations and Maintenance phases;
- Duration: The duration of effect for operations is categorized as **high** (long-term), for the life of the Project and beyond. Temporary changes in emissions will be **moderate,** from the start of Site Preparation activities until the completion of Construction;
- Frequency: The frequency of use will be continuous throughout the Project lifecycle, and as a result is categorized as **high**; however, this is similar to the existing conditions and the Project is not expected to result in increased traffic on Highway 104;
- Permanence: The effects during Site Preparation and Construction phases are short lived and will be completed over the **moderate** term following the completion of Construction activities. During the Operations and Maintenance phase, the GHG emissions are anticipated to return to normal levels, as traffic is expected to be similar to the existing conditions is not expected to result in increased traffic; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **moderate,** as the majority of the Project takes place along the existing alignment, adjacent to the existing traffic; the remaining portion of the highway (Barneys River Station to James River section) will divert from the existing alignment through a new alignment corridor.

Mitigation measures for potential effects to Climate Change and GHG emissions are outlined in Section 8.2.1, and include adherence with NSTIR's *Generic EPP*, preserving natural vegetation wherever where possible, re-establishing cleared areas with vegetation to re-establish modes of carbon sequestration and maintaining equipment in good working and reduction of idling equipment throughout the Site Preparation, Construction, and Operation and Maintenance phases.

Upon adherence to the NSTIR's *Generic EPP* and implementation of mitigation measures as outlined in Section 8.2.1, changes to GHG emissions associated with Project activities are not anticipated to result in greater than 10,000 tonnes CO_2e per year (low magnitude); therefore residual effects are *Not Significant*.

8.3.2 Physical Environment

Potential residual effects to the Physical Environment were identified for the specific Physical VECs. With proper mitigation, none of the residual effects are predicted to be significant, following the implementation of mitigation measures for Geology and Soil Quality, Surface Water Quality, and Hydrogeology and Groundwater. However, a Surface Water Quality monitoring program is required during the Site Preparation and Construction phases to ensure the adequacy of the mitigation measures. This program is further described in Section 8.4.2.

The following subsections outline the assessment of significance for identified residual effects for each Physical Environment VEC.

8.3.2.1 Geology and Soil Quality

The effects assessment for Geology and Soil Quality identified the following potential impacts:

- Alteration of bedrock layers;
- Alteration of soil characteristics on roadsides;
- Changes in sediment deposition patterns;
- Decreased asphalt leachate into soils (for deactivated portions);
- Decreased soil quality;
- Erosion and sedimentation issues; and
- Increased salinity of roadside soils.

Considering the implementation of the identified mitigation measures for Geology and Soil Quality outlined in Section 8.2, the residual effects assessment for Geology and Soil Quality is as follows:

- Magnitude: The magnitude of impact is anticipated to be **low,** as mitigation measures will minimize any potential impacts;
- Geographic Extent: The geographic extent is anticipated to be **low**, as the effect is limited to the Project Area;
- Duration: The duration of effect for alterations to Geology and Soil Quality is **long-term (high)**, for the life of the Project and beyond;
- Frequency: The frequency of conditions causing effects to Geology and Soil Quality are anticipated to be **low** (infrequent), and will occur primarily during the Site Preparation and Construction phases. The frequency of salt application will likely be regular **(high),** occurring every winter weather event that meets certain criteria (e.g. road temperature, moisture and air temperature) for the life of the Project;
- Permanence: The permanence of the alterations is categorized as **high**, as these effects will be permanent; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already highly disturbed. For the new realignment between Barneys River Station and James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to Geology and Soil Quality are outlined in Section 8.2, and include a requirement for an *Erosion and Sediment Control Plan* to be conducted throughout the Site Preparation and Construction phases. NSTIR's *Salt Management Plan* must also be adhered to throughout the Operation and Maintenance phase. Following the implementation of these plans and other mitigation measures outlined in Section 8.2, the Project is not anticipated to have a significant residual environmental effect on Geology and Soil Quality; in other words, the anticipated impacts are *Not Significant*.

8.3.2.2 Surface Water Quality

The effects assessment for Surface Water Quality identified the following potential impacts:

- Alteration of local surface water hydrology;
- Changes in sediment bed loads;

- Decreased water quality;
- Erosion issues;
- Flooding;
- Habitat degradation;
- Increased salinity of roadside watercourses;
- Increased sediment load into watercourses;
- Localized nutrient inputs;
- Loss of aquatic habitat;
- Modified flow volumes; and
- Modified stream velocity.

Considering the implementation of the identified mitigation measures for Surface Water Quality outlined in Section 8.2, the residual effects assessment for Surface Water Quality is as follows:

- Magnitude: The magnitude of impact is anticipated to be **low** as mitigation measures will minimize any potential impacts;
- Geographic Extent: The geographic extent is anticipated to be **moderate**, as the effect is mostly limited to the Project Area, but could occur downstream in the LAA;
- Duration: The duration of effect for alterations to Surface Water Quality is short-term **(low)** as potential effects on suspended sediment levels is evident only during the Site Preparation and Construction phases of the Project or its effects extend for a portion of the Project Activities). However, the duration for salinity increases due to road salting may be of **moderate** duration;
- Frequency: The frequency of conditions causing effects to Surface Water Quality following application of mitigation Measures are anticipated to be **low** (infrequent), and will occur primarily during the Site Preparation and Construction phases. The frequency of salt application will likely be regular **(high),** occurring every winter weather event that meets certain criteria (e.g., road temperature, moisture and air temperature) for the life of the Project;
- Permanence: The permanence of the alterations to Surface Water Quality will be **low**, as these effects will be of short duration and Surface Water Quality will recover to baseline conditions following application of mitigation measures; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already moderately disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to Surface Water Quality are outlined in Section 8.2, and include requirements for an *Erosion and Sediment Control Plan* and a water quality monitoring program to be conducted throughout the Site Preparation and Construction phases. NSTIR's *Salt Management Plan* must also be adhered to throughout the Operation and Maintenance phase. Following the implementation of these plans and other mitigation measures outlined in Section 8.2,

the Project is not anticipated to have a significant residual environmental effect on Surface Water Quality; in other words, the anticipated impacts are *Not Significant*.

8.3.2.3 Hydrogeology and Groundwater Quality

The effects assessment for Hydrogeology and Groundwater Quality identified the following potential impacts:

- Acid generation, toxicity to biota in streams and wetlands;
- Ammonium and/or nitrate in well water;
- Changes to ambient water temperature of receiving surface water;
- Changes to redox conditions (increases in concentrations of metals such as iron and manganese; release of gases, odours);
- Flooding during heavy rainfall;
- Groundwater contaminant concentrations exceed GCDWQ or CCME *Guidelines for Protection of Aquatic Life*;
- Increased flow of silt through fractures, resulting from blasting activities;
- Increased loading of ammonium to aquatic habitats, resulting in fish toxicity;
- Increased nutrients / biological oxygen demand in surface water;
- Increased sediment load into watercourses;
- Increased turbidity in water wells;
- Lowered water table;
- Redirection of groundwater discharge to new areas;
- Reduced quantity of water flowing to wells or GDE; and
- Stream flow not sustained / periodic drying.

Considering the implementation of the identified mitigation measures for Hydrogeology and Groundwater Quality outlined in Section 8.2, the residual effects assessment for Hydrogeology and Groundwater Quality is as follows:

- Magnitude: The magnitude of impact is anticipated to be **low** as mitigation measures will minimize any potential impacts;
- Geographic Extent: The geographic extent is anticipated to be **low**, as the effect is limited to the Project Area;
- Duration: The duration of effect for alterations to Hydrogeology and Groundwater Quality is short term **(low)** as the effect is evident only during the Site Preparations and Construction phases of the Project or its effects extend for a portion of the Project Activities);
- Frequency: The frequency of conditions causing effects to Hydrogeology and Groundwater Quality following application of mitigation Measures are anticipated to be **low** (infrequent), and will occur primarily during the Site Preparation and Construction phases. The frequency of salt application will likely be regular **(high),** occurring every winter weather event that meets certain criteria (e.g. road temperature, moisture and air temperature) for the life of the Project;
- Permanence: The permanence of the alterations to Hydrogeology and Groundwater Quality will be **low**, as these effects will be of short duration and Hydrogeology and Groundwater Quality will recover to baseline conditions following application of mitigation measures; and

- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already moderately disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to Hydrogeology and Groundwater Quality are outlined in Section 8.2, and include requirements for an *Erosion and Sediment Control Plan* and a water quality monitoring program to be conducted throughout the Site Preparation and Construction phases. NSTIR's *Salt Management Plan* must also be adhered to throughout the Operation and Maintenance phase. Following the implementation of these plans and other mitigation measures outlined in Section 8.2, the Project is not anticipated to have a significant residual environmental effect on Hydrogeology and Groundwater Quality; in other words, the anticipated impacts are *Not Significant*.

8.3.3 Biological Environment

Potential residual effects to the Biological Environment were identified for the Biological VECs. None of these were determined to be significant, following the implementation of mitigation measures. However; follow up and monitoring measures should be applied to determine the effectiveness of the mitigation measures for impacts to Fish and Fish Habitat, SAR Flora (Black Ash), SAR Wildlife (mainland moose and wood turtle), and Wetlands. These measures are further described in Section 8.3.3. No additional residual effects have been identified for non-SAR Flora and Wildlife following the implementation of mitigations measures.

The following subsections outline the assessment of significance for the identified residual effects for each Biological Environment VEC.

8.3.3.1 Flora

The effects assessment for Flora identified the following potential impacts to vascular plant and lichen species:

- Air quality impacts on sensitive lichens;
- Changes in community composition within and beyond maintained Right-of-Way;
- Changes in plant species communities;
- Creation of habitat opportunities for other species;
- Decreased habitat fragmentation (inactive section of existing Highway 104);
- Habitat alteration/loss;
- Habitat creation (inactive section of existing Highway 104);
- Increased habitat fragmentation;
- Intentional introduction of non-native plant species via hydroseed mixes;
- Loss and alteration of habitat;
- Loss of flora specimens, including some SOCC; and
- Unintentional introduction of non-native or invasive plant species.

Upon adherence to an EPP and implementation of mitigation measures, residual impacts to Flora are not expected to be significant. The rationale for this determination is as follows:

- Magnitude: The magnitude of impact is anticipated to be **Low** as much of the corridor is already cleared and considerable suitable alternative habitat is present within the LAA;
- Geographic Extent: The geographic extent is anticipated to be **Low**, with direct impacts to non-SAR flora species occurring within a small buffer zone around the Project Area;
- Duration: The duration of effects is **high**, as alteration will be permanent (throughout the life of the Project);
- Frequency: The frequency of conditions causing disruptions to flora and flora habitat will be **low** (infrequent), as the majority of habitat removal will occur at once, during the Construction phase. Small-scale temporary alterations and disruptions to flora and flora habitat may also occur infrequently as highway maintenance activities are required.
- Permanence: Habitat loss for flora will have **high** permanence, as effects will be permanent for the life of the Project; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already highly disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to Flora are outlined in Section 8.2. Following the implementation of these plans and other mitigation measures outlined in Section 8.2, the Project is not anticipated to have a significant residual environmental effect on Flora; in other words, the anticipated impacts are *Not Significant*.

8.3.3.2 Wildlife and Wildlife Habitat

The effects assessment for Wildlife identified the following potential impacts to (non-SAR) mammal, bird, reptile and amphibian species and their habitats:

- Accidental mortality;
- Attraction of mammals to salt pools;
- Changes in plant species communities leading to changes in wildlife habitat;
- Contamination of watercourses/wetlands;
- Damage to vegetated habitats;
- Direct mortality (roadkill);
- Disturbance of wildlife/behavioral effects/avoidance of area;
- Establishment of non-native species;
- Habitat fragmentation;
- Impacts of salt on larval amphibians;
- Increased habitat fragmentation / interruption of travel routes;
- Loss of breeding habitat; and
- Loss of foraging habitat.

Considering the implementation of identified mitigation measures for wildlife and wildlife habitat, the residual effects assessment for wildlife and wildlife habitat is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **low** as much of the corridor is already cleared and considerable suitable alternative habitat is present within the LAA;
- Geographic Extent: The geographic extent is anticipated to be categorized as **low**, with impacts to non-SAR species occurring within the Project Area and a limited distance adjacent to it;
- Duration: The duration of effects is categorized as **high** (long-term), as alterations to habitats will last for the life of the Project. Temporary alterations and disruptions of **low** (short-term) duration may occur during periodic highway maintenance activities.
- Frequency: The frequency of conditions causing wildlife habitat loss is categorized as **low**, as habitat loss will only occur once, during the Site Preparation phase. The frequency of conditions causing disturbance to wildlife is anticipated to be **high** during the Operation and Maintenance phase, as traffic and its associated noise and light emissions and risk of vehicle collisions will occur continually;
- Permanence: Habitat alterations and accidental mortality will be of **high** permanence until the highway is no longer in use, which is assumed to be indefinite period of time. Effects due to temporary alterations and disruptions due to maintenance activities will be of **low** permanence and will only be in place until the activities are completed; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already highly disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Following the implementation of mitigation measures, the Project is not anticipated to have a significant residual environmental effect on wildlife; in other words, the anticipated impacts are *Not Significant*.

8.3.3.3 Wetlands

The effects assessment for Wetlands identified the following potential impacts to Wetlands:

- Changes to biological processes (e.g., nutrient uptake by plants, decomposition rates);
- Changes to plant community composition/reduction in wetland plant diversity;
- Changes to salinity in wetland surface water and soils;
- Changes to wetland functions (ecological/habitat functions and hydrologic functions);
- Decreased surface water quality in wetlands and downstream;
- Introduction and establishment of non-native plant species;
- Introduction of non-native plants to wetlands;
- Loss of important habitat for wetland flora, fauna, and SAR;
- Loss of wetland area;
- Reduction in overall biodiversity; and
- Sediment loading in adjacent watercourses.

Considering the implementation of identified mitigation measures for Wetlands, the residual effects assessment for Wetlands is as follows:

- Magnitude: The magnitude of impact is anticipated to be **low** as much of the corridor is already cleared and considerable wetland habitat is present within the LAA;
- Geographic Extent: The geographic extent is anticipated to be **low**, with impacts to Wetlands occurring within the Project Area and a small buffer zone around it;
- Duration: The duration of effects is categorized as **high,** as wetland removals and alterations will be permanent (will last for the life of the Project and beyond), although creation of compensatory wetlands will mitigate this effect;
- Frequency: The frequency of conditions causing wetland loss and alteration is categorized as **low**, as this will only occur once, during the Site Preparation phase;
- Permanence: The permanence of wetland loss and alteration is categorized as **high**, as these will be permanent for the life of the Project and beyond; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already highly disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to Wetlands are outlined in Section 8.2. Where avoidance, destruction or disturbance to wetlands is unavoidable, the Proponent will be required to develop and submit a suitable wetland compensation proposal to offset losses to provincially regulated wetlands and wetland functions. This plan will be developed in coordination with and approved by NSE. To reduce potential impacts to wetlands and wetland functions, all NSE Wetland Alteration specifications shall be adhered to. Following wetland compensation, adherence to an EPP, and implementation of mitigation measures during Site Preparation and Construction, and Operations and Maintenance phases, Project activities are not anticipated to contravene the goals established in the *Nova Scotia Wetland Conservation Policy*, nor are residual effects to wetlands or wetland functions expected to be significant.

8.3.3.4 Fish and Fish Habitat

The effects assessment for Fish and Fish habitat identified the following potential impacts:

- Permanent loss of habitat;
- Temporary loss of habitat;
- Temporary fish displacement;
- Loss of fish;
- Changes in water quality;
- Impacts to fish species' presence and abundance; and
- Impacts on invertebrate biodiversity and abundance in freshwater streams.

Considering the implementation of the identified mitigation measures for fish and fish habitat, the residual effects assessment for fish and fish habitat is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **low** as suitable alternative habitat is anticipated to be used for permanent alterations as long as instream structures are installed properly;
- Geographic Extent: The geographic extent is anticipated to be categorized as **low** (*effect is limited to the Project Area*) as long as instream structures are installed properly;
- Duration: The duration of effect for permanent alterations is categorized as **high (**long-term), for the life of the Project and beyond. Temporary alterations and disruptions will be categorized as moderate in duration (medium-term), from the start of site preparation activities until the post construction monitoring inspections prove that the watercourses are restored to original conditions and that re-vegetation is established. The duration of salinity in the watercourses from highway salt application is anticipated to occur for the life of the Project with the highest concentrations occurring in the winter and following spring run-off events, decreases in salinity may occur in the summer and fall months;
- Frequency: The anticipated frequency of conditions causing temporary disruptions to fish and fish habitat is categorized as **low** (infrequent). Temporary alteration to fish and fish habitat will occur for each instream structure in fish habitat. The frequency of salt application will likely be of **high** frequency**,** occurring every winter weather event that meets certain criteria (e.g., road temperature, moisture and air temperature) for the life of the Project;
- Permanence: The permanence of the alterations and accidental mortality is categorized as **high**, as these effects will be permanent. Temporary alterations and disruptions will have **low** permanence, as they will only be in place until instream construction activities are complete; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already moderately disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to fish and fish habitat are outlined in Section 8.2, and include a requirement for a water quality monitoring plan to be conducted throughout the Site Preparation and Construction phases. NSTIR's *Salt Management Plan* must also be adhered to throughout the Operation and Maintenance phase. Following the implementation of these plans and other mitigation measures outlined in Section 8.2, the Project is not anticipated to have a significant residual environmental effect on fish and fish habitat; in other words, the anticipated impacts are *Not Significant*.

8.3.3.5 Species at Risk (Wildlife)

The effects assessment for Species at Risk (Wildlife) identified the following potential impacts:

SAR Mammals (Mainland Moose):

- Attraction to salt ponds along roads;
- Avoidance of Project Area;
- Changes in plant species communities;

- Direct mortality (roadkill);
- Disruption of movement corridors;
- Local level changes in abundance and distribution;
- Loss of foraging habitat;
- Loss of habitat suitable for thermoregulation;
- Restriction of gene flow;
- Sensory disturbance; and
- Vehicle collisions and potential mortality.

SAR Mammals (Little brown Myotis and Northern long-eared Myotis):

- Accidental exposure to toxic substances;
- Collisions with vehicles;
- Contamination of watercourses/wetlands;
- Damage to vegetated habitats;
- Disturbance of bats;
- Disturbance to bats in hibernacula;
- Increased habitat fragmentation / interruption of travel routes);
- Loss of day and night roosting habitats;
- Loss of foraging habitat; and
- Loss of maternity colony habitat.

SAR Birds (Canada Warbler, Eastern Wood Pewee, Olive-sided Flycatcher, Barn Swallow, and Evening Grosbeak):

- Accidental mortality during construction;
- Changes in plant species communities leading to changes in bird habitat;
- Direct mortality (roadkill);
- Disturbance of birds and /or nests;
- Establishment of non-native species;
- Habitat fragmentation;
- Nest (including eggs, nestling) destruction, disturbance, or abandonment;
- Permanent and temporary loss and alteration and disruption of bird habitat; and
- Temporary displacement of birds.

SAR Turtles (Wood turtle and Snapping turtle):

- Direct mortality;
- Displacement / Avoidance of Project Area;
- Disruption of seasonal movement patterns;
- Habitat fragmentation;
- Loss of food resources;
- Loss of foraging opportunities;
- Loss of overwintering habitat in watercourses;
- Loss of potential nesting habitat;
- Reduced survivorship;

- Reduced water quality; and
- Sensory disturbance.

Considering the implementation of identified mitigation measures for SAR Wildlife, the residual effects assessment is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **low,** as much of the corridor is already cleared and considerable suitable alternative habitat for all SAR wildlife species identified is present elsewhere within the LAA or RAA. In addition, little (if any) evidence has been observed of these species within the Project Area;
- Geographic Extent: The geographic extent is anticipated to be categorized as **low**, with impacts to SAR wildlife species generally occurring only within small specific habitats within the Project Area;
- Duration: The duration of effect for SAR wildlife habitat alterations is categorized as **high**, i.e., effects may occur throughout the life of the Project. However, no 'Critical Habitat' for any SAR is predicted to be negatively impacted;
- Frequency: The frequency of conditions causing disruptions to SAR wildlife species habitats is anticipated to be categorized as **low** (infrequent) for most SAR, as most of the habitat loss will occur once, during the Site Preparation and Construction phases. The frequency for potential for disturbance to SAR wildlife due to traffic and the associated noise emissions, light emissions, and risk of vehicle collisions will be **high**;
- Permanence: The permanence of habitat alterations will be categorized as **high**, lasting the lifespan of the Project. The risk of accidental mortality due to vehicle collisions will also be permanent. Temporary alterations and disruptions due to maintenance activities will not be permanent and will only be in place until the activities are completed; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already moderately disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to SAR are outlined in Section 8.2, and include a requirement for wildlife crossing structures to be installed to minimize habitat fragmentation for deer, mainland moose, and wood turtles in order to eliminate any residual effects. This habitat fragmentation will be mitigated by the installation and maintenance of suitable wildlife crossing structures in areas with higher potential for occurrence of these species. The crossing designs will be approved by NSDNR, and follow up monitoring may be required to assess wildlife use of the passages. A monitoring plan for wood turtles should also be implemented during the Site Preparation and Construction phases. These follow-up plans are discussed in more detail in Section 8.4.

Upon adherence to these plans, a site-specific EPP and implementation of the mitigation measures listed in Section 8.2 during Site Preparation, Construction, and Operations and Maintenance phases, Project activities are not anticipated to contravene Sections 32-36 of SARA, Section 13 of the NSESA,

or Section 51 of the Nova Scotia *Wildlife Act.* Additionally, upon adherence to an EPP and implementation of mitigation measures, Project activities are not anticipated to threaten the long-term sustainability of any SAR Wildlife species within the Project Area or LAA. The Project is not anticipated to have a significant residual environmental effect on most SAR; in other words, the anticipated impacts are *Not Significant*.

8.3.3.6 Species at Risk (Flora)

The effects assessment for Species at Risk Flora identified the following potential impacts to flora SAR:

- Air quality impacts on sensitive lichens;
- Changes in community composition within and beyond maintained Right-of-Way;
- Changes in plant species communities;
- Creation of habitat opportunities for other species;
- Decreased habitat fragmentation (inactive section of existing Highway 104);
- Habitat alteration/loss;
- Habitat creation (inactive section of existing Highway 104);
- Increased habitat fragmentation;
- Intentional introduction of non-native plant species via hydroseed mixes;
- Loss and alteration of habitat;
- Salinity impacts on black ash specimens;
- Loss of flora specimens, including some SOCC; and
- Unintentional introduction of non-native or invasive plant species.

Considering the implementation of identified mitigation measures for Species at Risk Flora, the residual effects assessment is as follows:

- Magnitude: The magnitude of impact is anticipated to be **low** for blue felt lichen and pygmy pocket moss; there is considerable suitable alternative habitat for these SAR Flora species present elsewhere within the LAA. No blue felt lichen will be removed, and the Project may result in the creation of habitat for pygmy pocket moss. The impact will be **moderate** for black ash, as up to 12 specimens of black ash (about 1% of known Nova Scotia population) could require removal or relocation (if feasible);
- Geographic Extent: The geographic extent is anticipated to be categorized as **low**, with impacts to SAR Flora species generally occurring only within small specific habitats within the Project Area;
- Duration: The duration of effect for SAR Flora habitat alterations is categorized as **high**, i.e., as effects will last for life of the Project. However, no 'Critical Habitat' for any SAR is predicted to be negatively impacted. Removal of individual black ash specimens would be considered permanent;
- Frequency: The frequency of conditions causing disruptions to SAR wildlife species habitats is categorized as **low** (infrequent) for most SAR Flora, as the habitat loss will occur once, during the Site Preparation and Construction phases. The frequency for potential air quality impacts to blue felt lichen is categorized as **moderate** due to traffic emissions, however, levels are unlikely to be high enough to harm the specimens. Impacts to black ash from road

salting could be categorized as **low** (infrequent), as exposure to salty water should only occur during the relatively short spring snow melt period;

- Permanence: Habitat alterations will be of categorized as **high** permanence, lasting until the proposed highway is no longer in service; a period of time which is considered indefinite at present. The removal of black ash specimens will also be permanent. The permanence of temporary alterations and disruptions due to maintenance activities is categorized as **low**, as these effects will only be in place until the activities are completed; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low** for much of the Project, as the majority of the corridor runs through an area that is already highly disturbed. For the new realignment between Barneys River Station to James River, the effect will be **moderate**, as this section of the Project area is moderately pristine.

Mitigation measures for potential impacts to SAR Flora are outlined in Section 8.2, and include a requirement for collection of any Black ash seeds present on specimens to be removed, as well as transplantation of specimens of a size considered feasible. Any resulting seedlings and trees should then be planted on nearby suitable habitat, perhaps in collaboration with local First Nations. As a species listed under the NSESA, removal of black ash specimens will require permission and input from NSDNR. A monitoring plan for black ash should also be developed to determine the success of the plantings.

Upon adherence to this plan, a site-specific EPP and implementation of the mitigation measures listed in Section 8.2 during site preparation, construction, and operations, Project activities are not anticipated to contravene Sections 32-36 of SARA, Section 13 of the NSESA, or Section 51 of the *Nova Scotia Wildlife Act.* Additionally, upon adherence to an EPP and implementation of mitigation measures, Project activities are not anticipated to threaten the long-term sustainability of any SAR Flora species within the Project Area or LAA. The Project is not anticipated to have a significant residual environmental effect on any SAR Flora species; in other words, the anticipated impacts on SAR Flora species are *Not Significant.*

8.3.4 Socio-Economic Environment

Potential residual effects to the Socio-Economic Environment were identified for specific Socio-Economic Environment VECs. These are described for each VEC in the following subsections. There is a potential for a significant residual impact for loss of the availability or access to land and resources that are currently used by the Mi'kmaq for traditional purposes; these residual impacts may potentially be long-term or may not be able to be accommodated, following the implementation of mitigations measures. Follow up and monitoring measures should be applied to determine the effectiveness of the mitigation measures; these measures are further described in Section 8.4.4. No additional residual effects have been identified for the Land Use or Human Health and Safety VECs following the implementation of mitigations measures.

8.3.4.1 Land Use

There is a potential for a significant residual impact for loss of the availability or access to land and resources that are currently used by the Mi'kmaq for traditional purposes and which is long-term or cannot be accommodated, following the implementation of mitigations measures. The effects assessment identified the following potential effects:

- Activities may not be compatible with surrounding or adjacent land or resource use activities as defined by planning measures of the *Municipal Government Act;*
- Loss of access to areas surrounding the Project;
- Disruption or degradation of lands, such that resource use cannot continue at existing levels, even with the implementation of mitigation measures;
- Loss of Mi'kmaq land and resource use sites; and
- Loss of plant species of significance or harvesting areas.

Residual effects as a result of loss of access to areas surrounding the Project in not expected following the implementation of mitigation measures; therefore, the potential effects are not identified as significant. Considering the implementation of the identified mitigation measures for Land Use, the residual effects assessment for land use is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **moderate.** In Antigonish, the Project Area occurs within two municipal zones; these are 'Rural Development' and 'Rural General'. Both of these zones have the same permitted uses, including agriculture, dwellings, community centres, fishing and fishing related activities, forestry and forestry related activities, and tourism and recreation;
- Geographic Extent: The geographic extent is anticipated to be categorized as **moderate**, as effects are contained to the Project Area. This is applicable for all the identified effects and during Site Preparation, Construction, and Operations and Maintenance. Project Activities will not be completed within a Provincial Park; therefore, all activities will be completed in compliance with the *Provincial Parks Act.* As a result, no residual effects were identified;
- Duration: The duration of effect for operations is categorized as **high** (long-term), for the life of the Project and beyond. Temporary changes resulting from loss of access, and the disruption or degradation of lands is categorized as **moderate,** spanning a period of time from the start of Site Preparation activities until the completion of Construction;
- Frequency: The frequency of disturbance is categorized as **high**, as this may occur regularly during the Construction phase, but will decrease to **moderate** frequency throughout the Operations and Maintenance phase for effects which result in the loss of access, disruption or degradation of lands and land-use compatibility. Effects to Loss of Mi'kmaq land and resource use sites, and loss of plant species of significance or harvesting areas will occur once at the removal; however, the removal of such will remain in effect permanently as described under permanence;
- Permanence: The permanence of effects during Site Preparation and Construction phases are **low** (short-term) and will be completed over the **moderate** term following the completion of Construction activities; this is applicable for effects to land compatibility, loss of access, and disruption or degradation of lands. Effects to Loss of Mi'kmaq land and

resource use sites, and loss of Plant species of significance or harvesting areas will be **high** and extend through the Project lifecycle and beyond; and

- Ecological, Land Use and Cultural Context (of effect): In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **moderate** as the majority of the Project takes place along the existing alignment, adjacent to the existing traffic; the remaining realignment between Barneys River Station to James River of the highway will divert from the existing alignment through a new corridor. Site Preparation and Construction activities throughout the LAA have potential to create direct and indirect effects to Mi'kmaq land and resource uses. Effects to Mi'kmaq land and resource uses may include: effects to Mi'kmaq archaeological resources; loss of access to Mi'kmaq fishing, hunting, and gathering opportunities; loss of harvesting area, or change in the availability of resources used for traditional purposes; and loss of plant species of significance to Mi'kmaq.

Mitigation measures for potential effects to Land Use are outlined in Section 8.2.4, and include the following high-level mitigations throughout the Site Preparation, Construction, and Operation and Maintenance phases. They include:

- Adherence with NSTIR's *Generic EPP*;
- Land acquisition and compensation will be in accordance with the Nova Scotia *Expropriation Act* and follow NSTIR's land acquisition procedures;
- Access to lands will be maintained, when possible;
- Traffic on existing roadways and intersections is to continue to operate at the existing standards and level of service throughout the Construction activities, as possible and Traffic control procedures will be implemented as required;
- Activities associated with the Project schedule will be communicated with the local communities and local stakeholders;
- Land and resources that are currently used by the Mi'kmaq for traditional purposes should be avoided, if possible; and
- Communication and engagement with the Mi'kmaq should be implemented prior to and during Construction activities.

Upon adherence to the NSTIR's *Generic EPP* and implementation of mitigation measures as outlined in Section 8.2.4, residual effects of pertaining to compatibility with surrounding or adjacent land, by planning measures of the *Municipal Government Act*, loss of access to areas surrounding the Project, and disruption or degradation of lands were determined to be *Not Significant* following the significance determination.

The loss of Mi'kmaq land and resource use sites and loss of Plant species of significance or harvesting areas was determined to be *Significant* or *Potentially Significant* because of the following:

- The extent of the locations of the Current Mi'kmaq land and resource use activities is not fully known. If sites are identified with the PA, LAA, or RAA, depending on the land and resource use activities, temporary and/or permanent loss of access to these sites may or

may not pose a threat to Mi'kmaq use within the areas, and therefore may be *Significant*; and

- Loss of plant gathering areas used by Indigenous people, may be *Potentially Significant*, even if plant species of significance identified within the study exist with the RAA. The permanent removal or loss of some specimens within the study areas is not expected to create a significant effect to Mi'kmaq land and resource uses; however, these areas should be first be determined, and then evaluated for significance.

A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on lands and resources used by the Mi'kmaq for traditional purposes.

Further description of Monitoring and follow-up requirements are available in Section 8.4.4.

8.3.4.2 Human Health and Safety

Ultimately, the Project will result in positive improvements to Human Health and Safety in the LAA and RAA. The Project will result in overall safety improvements and reduction of collisions, which include geometric road design, improved interchanges and grade separation structures, twinning and widening the highway, introduction of the divided median, and wildlife passage, collectively allowing for safer and more efficient movement of people and goods. Some potential effects to Human Health and Safety can occur throughout the Project but are focused primarily during the Site Preparation and Construction phases, and the subsequent Operation and Maintenance phase of the Project. The effects assessment identified the following potential effects:

- Disruption to human activities;
- Change in access to an area; and
- Effects to Human Health and Safety.

Effects to Air Quality which may interact with Human Heath are described in Section 8.1.1.1, the mitigation measures for potential effects are outlined in Section 8.2.1. Mitigation measures, such as marking and signage, separation infrastructure (i.e., barricades), blasting plans, and road detours or closures, will be implemented to separate these activities from contact with the public. All necessary measures to safely and expeditiously accommodate traffic using the Provincial Highway within the Project Area will be implemented using all roads open to the public. All Project activities will be completed in compliance with the Nova Scotia *Occupational Health and Safety Act* and its regulations or guidelines. In addition to these mitigation measures, the Project will adhere with NSTIR's *Generic EPP* throughout the Site Preparation, Construction, and Operation and Maintenance phases.

No additional residual effects have been identified for Human Health and Safety VEC following the implementation of mitigations measures. The effects of vehicle collisions and vehicle – wildlife collisions are assessed in Chapter 7 Accidents and malfunctions, Section 7.4 Vehicle Collisions and Section 7.5 Vehicle – Wildlife Collisions.

All Project Activities will be completed following Nova Scotia *Occupational Health and Safety Act* and its regulations or guidelines; therefore prior to and following the implementation of mitigation measures, the effects to Human Health and Safety are expected to be *Not Significant*.

8.3.5 Cultural Environment

Potential residual effects to the Cultural Environmental were identified for the single Cultural Environment VEC. All were determined not to be significant, following the implementation of mitigations measures; these are described for Heritage and Archaeological Resources in the following subsection.

8.3.5.1 Heritage and Archaeological Resources

The effects assessment for Heritage and Archaeological Resources identified the following potential impacts:

- Disturbance or removal of Heritage and Archaeological Resources.

Considering the implementation of the identified mitigation measures for Heritage and Archaeological Resources, the residual effects assessment for Heritage and Archaeological Resources is as follows:

- Magnitude: The magnitude of impact is anticipated to be categorized as **low** as Heritage and Archaeological Resources are not predicted to be encountered, and if they are, effects to such resources can be mitigated;
- Geographic Extent: The geographic extent is anticipated to be categorized as **low,** as potential effects are limited to the Project Area;
- Duration: The duration of effect for permanent alterations is categorized as **low** (short-term), as the potential for interaction with Heritage and Archaeological Resources is limited to the Site Preparation and Construction phases;
- Frequency: The frequency of conditions causing impacts to Heritage and Archaeological Resources are anticipated to be categorized as **low** (infrequent), occurring only during the Site Preparation and Construction phases;
- Permanence: The permanence of any alterations to Heritage and Archaeological Resources is categorized as **high**, as these effects will be permanent for the life of the Project and beyond; and
- Ecological, Land Use and Cultural Context: In the context of Ecological, Land Use and Cultural considerations, the effect is categorized as **low**, as the Project Area has already been surveyed for heritage and archaeological features.

Mitigation measures for potential impacts to Heritage and Archaeological Resources are outlined in Section 8.2, and include requirements to complete a formal shovel testing program; follow-up reconnaissance programs, as required; and implementation of additional site-specific mitigation measures following consultation with NSCCH. These are discussed in more detail in Section 8.4.5. Following the implementation of these plans and other mitigation measures outlined in Section 8.2, the Project is not anticipated to have a significant residual environmental effect on Heritage and Archaeological Resources; in other words, the anticipated impacts are *Not Significant*.

8.4 Monitoring and Follow-up

Following assessment of the effects, and the implementation of mitigation measures, the effectiveness of each mitigation measure applied was assessed in order to identify any residual effects. Residual effects are effects to VECs that are anticipated to remain following the implementation of mitigation measures. VEC-specific follow-up and monitoring measures will be applied to assess the effectiveness of the proposed mitigation measures. Required monitoring and follow-up programs for various VECs identified for the Project within each of the four main environments (Atmospheric, Physical, Biological, and Cultural) are outlined in the following subsections.

8.4.1 Atmospheric Environment

Follow-up and monitoring measures have been identified for Noise. No monitoring or follow-up programs were identified for any other Atmospheric Environment VECs. The following monitoring and follow-up programs identified for Noise include:

- Noise monitoring during construction, as required.

Noise Monitoring

A complaint-based noise monitoring program should be conducted during Project Activities. The sampling should follow *Guidelines for Environmental Noise Measurement and Assessment in Nova Scotia* (NSDEL, 1990). If the threshold is exceeded, additional noise mitigation measures will be investigated.

8.4.2 Physical Environment

The following monitoring and follow-up programs have been identified for the Physical environment:

- Surface Water Quality monitoring program during construction.

Surface Water Quality Monitoring Program during Construction

A water quality monitoring program will be executed during construction. The purpose of the program is to assess the efficacy of the application of environmental protection measures, and to maintain compliance with permit requirements for activities such as working in and adjacent to watercourses. The program will document the effectiveness of the program and identify and document the implementation of remedial actions, if necessary. The water quality monitoring program will include the following elements and will be used with other monitoring and inspection measures as identified in either NSTIR's *Generic EPP* or the Proponent's project-specific EPP:

- Monitoring of TSS or NTU: this will occur periodically during construction, such as during in-water works and during and following precipitation events resulting in the visible flow of water overland; and
- Erosion and Sedimentation Control (ESC) measures shall also be inspected and maintained regularly.

No monitoring or follow-up programs were identified for the following Physical Environment VECs:

- Hydrogeology and Groundwater; and
- Geology and Soils.

8.4.3 Biological Environment

The following monitoring and follow-up programs may be required for the Biological Environment, specifically Wetlands, Fish and Fish Habitat, and Species at Risk:

- Wetland compensation plan, and post-construction wetland monitoring of impacted wetlands;
- Implementation of a monitoring program to assess use of wildlife passages by wildlife SAR;
- Implementation of a monitoring plan for wood turtles in NSDNR significant habitat areas during Site Preparation and Construction;
- A black ash monitoring and management plan, designed to gather and germinate seed from existing black ash specimens slated for removal and assess survival of transplanted black ash specimens;
- Construction monitoring of fish habitat; and
- Post-construction monitoring of fish habitat.

Wetland Compensation Plan and Wetland Monitoring

The *Nova Scotia Wetland Conservation Policy* establishes specific goals and objectives with the intent to prevent net loss of wetlands. It is anticipated that the development of the project will result in the loss of wetland habitat, which will result in the requirement of an authorization from NSE. Preparation of a suitable wetland monitoring plan for impacted wetlands is a typical application requirement for attaining these approvals.

The Proponent will be required to develop and submit a suitable wetland compensation proposal, including monitoring plan, to offset losses to provincially regulated wetlands and wetland functions. This proposal will be developed in coordination with, and approved by NSE. It is estimated that post-construction monitoring of the wetland compensation site(s) will be required to ensure the efficacy of the compensation plan, and that provincial 'no net loss' policies are met.

Wildlife Passage Monitoring Program

This program will be completed in areas where wildlife passage structures have been installed, in order to confirm the use of such structures by wildlife. The monitoring program shall be developed with input from NSDNR.

Black Ash Management and Monitoring Plan

Prior to removal, the black ash specimens occurring within the Project Area should be assessed during the growing season for the presence of seeds. Should any seeds be present, they will be monitored by a qualified botanist until they are mature, at which time they will be gathered and sent to a suitable facility (perhaps the Strathlorne Forest Nursery or similar) for germination and rearing. Should any seedlings be obtained, they should be allowed to grow for a few years until they are large enough to transplant back into suitable habitat. They should then be monitored yearly to

assess the success of the program. As this species has considerable cultural significance, selection of suitable habitat and the actual planting could be done in collaboration with First Nations.

In addition, if it is feasible, any black ash specimens within the Project Area which are small enough to transplant should be salvaged prior to clearing and grubbing activities. These trees could then be transplanted into suitable nearby habitat, ideally a tall shrub/deciduous treed wetland overlying calcareous bedrock. This should be done by a qualified botanist/horticulturist at the optimal time of year to maximize success, and the trees should be monitored at least annually for a minimum of two years to assess the success of the program. Seedlings grown from collected seed and transplanted to the wild should also be monitored. As this species has considerable cultural significance, selection of suitable habitat and the monitoring program should ideally be done in collaboration with First Nations.

Onsite Monitoring for Wood Turtles during Site Preparation and Construction

A monitoring plan for wood turtles is recommended for areas of the Project Area identified by NSDNR as being 'Critical Habitat' for this species. Areas within 100 m of riparian zones should be monitored immediately before site clearing activities by a qualified biologist, to minimize potential harm to wood turtle specimens. Prior to pre-construction and construction activities, biologists should also survey for evidence/signs that would suggest wood turtles have nested, as eggs may be buried within the Project Area. Should any wood turtles be encountered, NSDNR should be notified and a SARA permit would be required to relocate the turtle(s). This plan should be developed in consultation with NSDNR. Project personnel shall be trained and familiarized with the identification of wood turtles and instructed on steps to take if a wood turtle is identified within or in close proximity to the work site.

Construction Monitoring of Fish Habitat

During the Construction phase, turbidity monitoring will be conducted to detect excess sedimentation during all active instream construction activities. Such Monitoring will be the responsibility of the Proponent. The turbidity monitoring will include visual inspection for fluid leaks as well as turbidity sampling. A minimum of three sampling stations should be established along each intermittent, small permeant or large permanent watercourse; these will include one upstream of construction activities (i.e., control site), one immediately downstream of the culvert or bridge crossing and one downstream of the crossing. Prior to instream construction activities, turbidity samples will be taken at each sample station prior to any instream work to establish a baseline for future comparison. According to the CCME *Water Quality Guidelines for the Protection of Aquatic Life* (CCME, 1999), for short-term exposure the maximum increase allowed is 8 NTU from background levels for any 24-h period. For long-term exposure the maximum increase allowed is 2 NTUs from background for inputs lasting between 24 hours and 30 days. If exceedances occur and the cause is determined to be a result of Project related activities, all activities must cease immediately until appropriate mitigation measures for the situation are implemented and successful. All exceedances must be reported to the appropriate provincial and federal authorities within 24 hours of the event (i.e., DFO and NSE).

Post Construction Monitoring of Fish Habitat

Once construction is completed, the Proponent will be responsible for returning the watercourse channels, beds and banks to preconstruction conditions or better. All revegetation around watercourses will be conducted following DFO protocols. Sediment erosion control structures will stay in place until vegetation is established. Areas should be assessed in late spring or early summer of the year following construction. If banks and soils are fully established with successful vegetation re-growth, then the sediment erosion control measures may be removed. If erosion and sedimentation is still an issue, sediment erosion control will need to stay in place and then additional measures must be implemented to stabilize soils. If sediment erosion is an issue, potential impacts to fish and fish habitat further downstream of the site should be assessed.

8.4.4 Socio-Economic Environment

The following monitoring and follow-up programs have been identified for the Socio-economic environment:

- Updated Mi'kmaq Ecological Knowledge Study (MEKS) for the Project.

Mi'kmaq Knowledge Study (MEKS)

A new MEKS study is on-going and will be completed by early summer 2019 to determine if the proposed project will have an effect on Lands used by the Mi'kmaq for traditional purposes.
An MEKS has been completed previously (2004) which encompasses a large portion of the Project Area; however, the *Mi'kmaq Ecological Knowledge Study Protocol (*Assembly of Nova Scotia Mi'kmaq Chiefs, 2014*)*, it states that if a previous MEKS, for the same study area, is more than five years old that a new MEKS is required. Traditional activities and usage which will require additional information include:

- Kill/hunting: for example, species such as fox, beaver, muskrat, coyote, otter, porcupine, duck, goose, rabbit, partridge, raccoon, deer, salmon, trout, eel, striped bass, gaspereau, smelt, mackerel, and perch, or traplines;
- Burial/birth: for example burial sites;
- Ceremonial: for example sacred sites or ceremony sites;
- Gathering food/medicinal: for example food plants, berries, wild fruit, eggs, medicinal plants, sweet grass, fire wood, speciality wood, feathers, stone, and clay; and
- Occupation/habitation: for example canoe routes, overnight sites, or group campsites.

8.4.5 Cultural Environment

The following monitoring and follow-up programs have been identified for the Cultural Environment, specifically Heritage and Archaeological Resources:

- Completion of a formal shovel testing program;
- Follow-up reconnaissance programs, as required; and
- Implementation of additional site-specific mitigation measures following consultation with NSCCH.

Completion of a Formal Shovel Testing Program

This program will be completed in any areas where possible or probable historic structures and areas of elevated potential for historic or First Nations archaeological resources have been identified within the area of impact, in order to confirm the presence or absence of heritage and archaeological resources on site. Shovel tests shall be conducted accordance with provincial standards; shovel tests should be 0.40 m by 0.40 m and will be spaced at 10 m intervals in areas larger than 30 m x 30 m in areas determined to be of moderate archaeological potential, and at 5 m intervals in areas of high archaeological potential or in moderate or low-moderate potential areas smaller than 30 m x 30 m.

Follow-up Reconnaissance Programs

A Follow-up Reconnaissance Program is recommended because a small portion of Sutherland's River could not be assessed due to the steep and dangerous nature of accessing the river from the highway on the north side. If the riverbanks are to be impacted in this area, a follow-up reconnaissance should be conducted via an alternate access system to more effectively assess this portion of the landscape.

In addition, it is recommended that three sites which appear, based upon historic mapping, to represent elevated potential for archaeological resources and which could not be assessed during the field reconnaissance surveys due to vegetation cover (i.e., dense growth, blow-down, or clear-cutting detritus), should be re-visited by a professional archaeologist after removal of the tree growth but prior to full grubbing, if possible.

Further follow-up reconnaissance programs will be required, in the event that changes are made to the Project Area prior to or during highway construction; an archaeologist should be contracted to assess any additional impact areas not assessed under the current research permit.

Implementation of Additional Site-specific Mitigation Measures

Additional site-specific mitigation measures may be required, for works in areas of elevated potential or where the presence of historic structures are confirmed prior to commencement of construction. These measures will vary depending on the extent and significance of the site but may include monitoring, further testing, or complete excavation. Site-specific mitigation measures will be determined in consultation with NSTIR and NSCCH.

CHAPTER 9

Monitoring and Environmental Management

This Chapter provides a brief overview of the proposed Project and summarizes the environmental management requirements, including monitoring and follow-up programs, which either mitigates effects to Project VECs, or monitors any remaining residual effects to Project VECs following application of mitigation.

9.1 Overview

NSTIR has proposed the twinning of the 38 km section of Highway 104 from Sutherlands River to West of Antigonish. This would complete twinning from the New Brunswick border to east of Antigonish, a distance of 200 km. The Project will be procured via a DBFOM contract which will engage a Proponent to carry out all of the above activities. NSTIR has thus only conducted preliminary design to the point to have a general understanding of all of the project components.

The Project, as currently defined, will include the following key components:

- Twinning of existing lanes (approx. 28 km);
- Construction of a new four-lane highway section (approx. 10 km), diverting from the existing alignment at west of Barneys River Station and reconnecting west of James River;
- Approximately 25 structure additions or modifications, including interchanges and large watercourse crossings; this will also incorporate infrastructure to permit wildlife passage in key areas.

All project works will be completed in accordance with applicable legislations, industry standards, and applicable best management practices including NSTIR's *Generic EPP*, and any site-specific plans, and regulatory approvals, authorizations and permits.

This Class 1 registration document was completed following in *A Proponent's Guide to Environmental Assessment* (NSE, 2017) and in accordance with *Environmental Assessment Regulations* and *Environment Act*. As part of this Environmental Assessment, the assessment of effects was completed throughout Site Preparation, Construction, and Operations and Maintenance phases of the Project, for selected VECs. VECs selected for this Project included:

- Atmospheric Environment
    - Air Quality;
    - Noise; and
    - Climate Change and Greenhouse Gases.
- Physical Environment
    - Geology and Soil Quality;
    - Surface Water Quality; and
    - Hydrogeology and Groundwater Quality.
- Biological Environment
    - Flora;
    - Wildlife and Wildlife Habitat;
    - Wetlands;
    - Fish and Fish Habitat; and
    - Species at Risk.
- Socio-Economic Environment
    - Land Use; and
    - Human Health and Safety.
- Cultural Environment
    - Historical and Archaeological Resources.

Potential effects of the Project on the identified VECs were assessed for activities occurring during the Site Preparation, Construction, and Operations and Maintenance Phases of the Project, as well as the removal of select sections of existing Highway 104, which will be removed from service once the Project is operational. VEC-specific spatial and temporal boundaries were determined for the geographical areas and time periods for which the VECS may interact or are likely to be influenced by the Project. Each identified environmental effect, either direct or indirect, was evaluated within these spatial and temporal boundaries. VEC-specific boundaries were selected, as they may vary among VECs. A broad range of suitable mitigation measures were developed to address the effects of the Project on the identified VECs. The application of these mitigation measures was taken into account when determining the significance of any residual environmental effects. A summary of the assessment is presented in Table 9.1.

Table 9.1 Summary of Potential Effects, Mitigation, and Follow-up Measures for the Highway 104 Twinning Project

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
Air Quality	• Change in air quality; • Emission exceedances above *Air Quality Regulations;* and • Emission exceedances above CAAQS.	Section 8.2.1	None	None
Noise	• Sound levels (dBA) exceeding provincial guideline and municipal by-law.	Section 8.2.1	Sound levels (dBA) exceeding provincial guideline and municipal by-law in new four-lane alignment section	Complaint-based noise monitoring (Section 8.4.1 and 9.2.2.1)
Climate Change and Greenhouse Gases	• Increase in provincial and national GHG emissions.	Section 8.2.1	None	None
Geology and Soil Quality	• Alteration of bedrock layers; • Alteration of soil characteristics on roadsides; • Changes in sediment deposition patterns; • Decreased asphalt leachate into soils (for deactivated portions of current highway); • Decreased soil quality; • Erosion and sedimentation issues; and • Increased salinity of roadside soils.	Section 8.2.2	None	None

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
Surface Water Quality	• Alteration of local surface water hydrology; • Changes in sediment bed loads; • Decreased water quality; • Erosion issues; • Flooding; • Habitat degradation; • Increased salinity of roadside watercourses; • Increased sediment load into watercourses; • Localized nutrient inputs; • Loss of aquatic habitat; • Modified flow volumes; and • Modified stream velocity.	Section 8.2.2	None	Surface water quality monitoring program (Section 8.4.2 and 9.2.2.2)
Hydrogeology and Groundwater Quality	• Acid generation, toxicity to biota in streams and wetlands; • Ammonium and/or nitrate in well water; • Changes to ambient water temperature of receiving surface water; • Changes to redox conditions (increases in concentrations of metals such as iron and manganese; release of gases, odours); • Flooding during heavy rainfall;	Section 8.2.2	None	None

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Groundwater contaminant concentrations exceed GCDWQ or CCME *Guidelines for Protection of Aquatic Life*; • Increased flow of silt through fractures, resulting from blasting activities; • Increased loading of ammonium to aquatic habitats, resulting in fish toxicity; • Increased nutrients / biological oxygen demand in surface water; • Increased sediment load into watercourses; • Increased turbidity in water wells; • Lowered water table; • Redirection of groundwater discharge to new areas; • Reduced quantity of water flowing to wells or GDE; and • Stream flow not sustained / periodic drying.			
Flora	• Loss of specimens, including some SOCC; • Unintentional introduction of non-native or invasive plant species via machinery; • Loss and alteration of habitat for some species;	Section 8.2.3.1	None	None

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Creation of habitat opportunities for other species (e.g., ground lichens); • Increased habitat fragmentation; • Air quality impacts on sensitive lichens; • Habitat creation (section of route to be removed from service); • Intentional introduction of non-native plant species via hydroseed mixes; • Unintentional introduction of non-native or invasive plant species via machinery; • Changes in community composition within maintained Right-of-Way; and • Changes in community composition beyond maintained ROW.			
Wildlife	• Accidental mortality; • Attraction of mammals to salt pools; • Changes in plant species communities leading to changes in wildlife habitat; • Contamination of watercourses/wetlands; • Damage to vegetated habitats;	Section 8.2.3.2	None	Wildlife passage (Section 8.4.3 and Section 9.2.2.4)

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Disturbance of wildlife/ behavioural effects; • Establishment of non-native species; • Impacts of salt on larval amphibians; • Increased habitat fragmentation / interruption of travel routes; • Loss of breeding habitat; • Loss of foraging habitat; • Nest (including eggs, nestling) destruction, disturbance, or abandonment; • Permanent and temporary alteration and disruption of habitat; • Permanent and temporary loss of habitat; and • Temporary displacement of wildlife.			
Wetlands	• Changes to biological processes (e.g., nutrient uptake by plants, decomposition rates); • Changes to functions of wetlands associated with watercourses; • Changes to plant community composition/reduction in wetland plant diversity; • Changes to wetland plant communities and diversity;	Section 8.2.3.3	None	Wetland compensation plan and wetland monitoring (Sections 8.4.3 and 9.2.2.3)

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Changes to water quality and fish habitat quality; • Decreased surface water quality in wetlands and downstream; • Introduction and establishment of non-native plant species; • Decline in native wetland plant diversity; • Loss of wetland area; • Loss of wildlife that inhabit or rely on wetlands for resources; • Reduced fish habitat downstream of wetlands; • Reduction in fish habitat quality; • Reduction in overall biodiversity; • Reduction in wetland plant abundance; • Sediment loading in adjacent watercourses; • Introduction and establishment of non-native plant species; • Changes to salinity in wetland surface water and soils; and • Changes to vegetation communities.			
Fish and Fish Habitat	• Permanent loss of habitat; • Temporary loss of habitat; • Temporary fish disruption and/or displacement; • Loss of fish;	Section 8.2.3.4	None	Offsetting for fish and fish habitat (Sections 8.4.3 and 9.2.2.8)

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Change in water quality; • Impacts to fish species' presence and abundance; and • Impacts on invertebrate biodiversity and abundance in freshwater streams.			Construction monitoring of fish habitat (Sections 8.4.3 and 9.2.2.8) Post-construction monitoring of fish habitat (Sections 8.4.3 and 9.2.2.8)
Species at Risk	• Accidental exposure to toxic substances; • Accidental mortality (moose, bats, birds, turtles) • Air quality impacts on sensitive lichens; • Changes in community composition (flora); • Collisions with vehicles (moose, bats, birds, turtles) • Damage to vegetated habitats; • Decreased habitat fragmentation (section of route to be removed from service) for moose; • Displacement / avoidance of Project area by all wildlife SAR; • Disturbance to hibernating bats; • Habitat alteration/loss for all wildlife SAR; • Habitat creation (section of route to be removed from service) for moose, bats and turtles;	Section 8.2.3.5	None	Wildlife passage monitoring program (Sections 8.4.3 and 9.2.2.5) Black ash monitoring and management plan (Sections 8.4.3 and 9.2.2.5) Onsite monitoring for wood turtles during Site Preparation and Construction phases (Sections 8.4.3 and 9.2.2.6)

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Habitat fragmentation for all wildlife SAR; • Disruption of seasonal travel routes for moose; • Loss of day and night roosting habitats for bats; • Loss of foraging habitat for bats; • Loss of maternity colony habitat for bats; • Loss of overwintering habitat for turtles; • Loss of potential nesting habitat for turtle and bird SAR; • Reduced survivorship for bird SAR; • Reduced water quality for turtle SAR; • Salinity impacts on black ash specimens; • Sensory disturbance for all fauna SAR; and • Unintentional establishment of non-native species.			
Land Use	• Activities may not be compatible with surrounding or adjacent land or resource use activities as defined by planning measures of the *Municipal Government Act*; • Disruption or degradation of land resulting in decrease of land or resource uses below current levels;	Section 8.2.4.1	Loss of Mi'kmaq land and resource use sites; and Loss of plant species of significance or harvesting areas.	MEKS (Sections 8.4.4 and 9.2.2.10)

VEC	Potential Effects	Mitigation Measures Location	Significant Residual Effect	Follow-up Measures
	• Loss of access to areas surrounding the Project; • Loss of Mi'kmaq land and resource use sites; and • Loss of plant species of significance or harvesting areas.			
Human Health and Safety	• Disruption to human activities; • Change in access to an area; and • Effects to Human Health and Safety.	Section 8.2.4.2	None	None
Heritage and Archaeological Resources	• Disturbance to or removal of Heritage and Archaeological Resources	Section 8.2.5.	None	Completion of a formal shovel testing program (Sections 8.4.5 and 9.2.2.12) Follow-up reconnaissance programs (Sections 8.4.5 and 9.2.2.13) Implementation of additional site-specific mitigation measures (Sections 8.4.5 and 9.2.2.14)

9.2 Environmental Management and Commitments

The implementation of environmental management and monitoring programs is fundamental to NSTIR's approach to the construction and operation of highways within the Province. This section outlines the environmental management practices and follow-up monitoring programs required to document environmental conditions, validate effect predictions, and assess the effectiveness of the implemented mitigation measures. These programs will enable NSTIR to determine whether there is a need to modify and improve the selected mitigation measures.

Environmental management is intended to ensure that all aspects of the Project Construction and Operation and Maintenance phases are conducted in a safe manner with minimal environmental effects. Mitigation measures were identified during the Environmental Assessment process, and were used to address potential effects (Section 8.2). These mitigations measures will be implemented as part of the 'Environmental Management and Commitments' for the Project. A full description of the required mitigation measures is included in Section 8.2.

Both internal and external environmental management practices are required to monitor and document the effectiveness of the identified mitigation measures to confirm the appropriate environmental standards or guidelines are met. External environmental monitoring is conducted by regulatory authorities, while the Proponent will undertake its own internal Environmental Compliance Monitoring (ECM). As part of ECM, the Proponent shall coordinate with stakeholders, monitor activities with potential to effect environmental features, communicate with regulatory authorities, and advise workers on-site regarding environmental monitoring and mitigation measures during all Project phases. The Proponent may also be required to conduct an Environmental Effects Monitoring (EEM) program, which will aid in ensuring assessment predictions were correct and that mitigation measures are sufficient.

9.2.1 Environmental Protection Plans

All Project activities must be conducted in compliance with federal and provincial legislation and municipal bylaws and regulations, such as the provincial *Environmental Act, Endangered Species Act, Wildlife Act, Environmental Goals and Sustainable Prosperity Act, Provincial Parks Act, Special Places Protection Act, Occupational Health and Safety Act*, and the federal *Fisheries Act, Migratory Birds Convention Act, Species at Risk Act* and their associated regulations.

A considerable portion of NSTIR's and the Proponent's ECM responsibilities will be managed via Environmental Protection Plans (EPP), which shall be observed throughout the lifetime of the Project. Two main EPPs will be utilized as part of this Project, and are described in the following subsections.

9.2.1.1 NSTIR's Generic EPP for the Construction of 100 Series Highways

As part of their ongoing commitment to the safe and environmentally-conscious development and operation of highways in Nova Scotia, NSTIR's *Generic EPP*. The Proponent selected by NSTIR must ensure they are complaint with this document. The *Generic EPP* provides outlines, requirements,

and best management practices for the following components of highway construction projects, including:

- Roles and responsibilities;
- General protection measures;
- Monitoring and inspection requirements;
- Contingency plans;
- Emergency spill response plan (including locations of on-site spill response equipment);
- Special provisions;
- Erosion and sediment controls;
- Clearing protocols;
- Spill contingency; and
- Environmental inspection and reporting forms.

The full *Generic EPP for the Construction of 100 Series Highways* document is available online at http://www.gov.ns.ca/tran/enviroservices/epp100series/generic%20epp_july%202007.pdf. In order to ensure the Proponents compliance with this document, NSTIR's Project Engineer as well as other Environmental Services staff will periodically inspect construction sites and environmental control measures on-site.

NSTIR'S *Salt Management Plan* and *Integrated Roadside Vegetation Management Plan* will also be applicable to this Project, and the Proponent and any subcontractors must ensure they are in compliance with these plans during all Project phases.

9.2.1.2 Site-Specific Environmental Protection Plan

In addition to the *Generic EPP* discussed in the previous subsection, a *Site-Specific EPP* will be developed and followed by the Proponent. All personnel working on the Project must ensure they are compliant with this *Site-Specific EPP* (as well as the *Generic EPP*). The EPP will include training and mitigation measures to reduce effects to terrestrial, aquatic, and human health caused by accidental spills or leaks of fuels, mechanical fluids, hazardous materials, or any other deleterious substances. It is anticipated that the Proponent will use the following breakdown of components in their *Site-Specific EPP*, but will build upon it as required. At minimum, the EPP will include the following components:

- An outline of key Project personnel;
- Roles and responsibilities of Project personnel;
- A detailed *Emergency Response Plan*;
- A detailed *Emergency Spill Response Plan* (including locations of onsite spill response equipment);
- A detailed and site-specific *Erosion and Sediment Control Plan*;
- Site-specific dewatering plans;
- Guidelines on handling and storage of fuel, gasoline and associated products;
- Waste management strategy;
- Guidelines on the safe environmentally conscious operation and maintenance of required machinery;

- Any commitments outlined in the EA;
- Any terms and conditions of approval identified by NSE;
- Guidance on required protective measures for environmentally sensitive features; such as:
    - Identification and avoidance of Species at Risk and Critical Habitat;
    - Avoidance of heritage and archaeological resources;
    - Contingency and emergency response plans;
- Environmental inspection requirements for Project phases and activities;
- Environmental training and orientation requirements for workers; and
- Monitoring requirements and follow-up programs.

This document may also include other *Environmental Control Plans* (ECPs) as required should site conditions change or unexpected events (such as floods, accidents, accidental spills, or discovery of sites of historic significance) occur. These documents will provide contingency plans and outline applicable emergency response measure to be undertaken should unplanned events occur. Further guidance on these events is also provided in the *Generic EPP* and in NSTIR's *Health, Safety, and Environment Program*.

It will be the responsibility of the Proponent to ensure that appropriate and suitable environmental control measures are properly installed, maintained and monitored during the Operation and Maintenance phase of this Project. The Proponent must also ensure they are compliant with all relevant requirements in the Terms and Conditions of any governmental approvals or authorizations obtained for the Project.

The Proponent may also be required to conduct an *Environmental Effects Monitoring* (EEM) program, which involves monitoring environmental variables over time with the objective of detecting changes due to anthropogenic activities. EEM will improve the general understanding of cause and effect relationships between site activities and environmental variables, allow early detection of environmental changes, and aid in ensuring that assessment predictions were correct and that mitigation measures are sufficient. Recommendations for EEM should be part of the Proponent's ECP and should be updated as required to accommodate changing site conditions.

9.2.2 Monitoring and Follow-up Requirements

As a result of the effects assessment in Chapter 8, after the implementation of mitigation measures (Section 8.2), the following monitoring and follow-up requirements have been identified to monitor that the mitigations measures are effective or to follow-up that the effects are not significant:

- Execution of a complaint-based noise monitoring program during Site Preparation and Construction phases;
- Execution of a surface water quality monitoring program during Construction;
- Preparation of a wetland compensation plan, and execution of post-construction wetland monitoring of impacted wetlands;
- Implementation of a wildlife passage monitoring program during Operations and Maintenance phase;
- Implementation of a black ash monitoring and management plan, including:

    - Execution of a black ash seed collection program;
    - Execution of a black ash transplant program and monitoring plan;
- Onsite monitoring for wood turtles during Site Preparation and Construction phases;
- Preparation of offsetting plan for losses to fish and fish habitat;
- Monitoring of fish habitat during Site Preparation and Construction phases;
- Post-construction monitoring of fish habitat;
- Execution of an updated Mi'kmaq Ecological Knowledge Study (MEKS);
- Implementation of a land acquisition program;
- Completion of an archaeological shovel testing program;
- Execution of follow-up reconnaissance programs for heritage and archaeological resources; and
- Implementation of additional site-specific mitigation measures for heritage and archaeological resources.

Brief overviews of requirements for these monitoring and follow-up plans are provided in the following subsections.

9.2.2.1 Noise Monitoring

Noise monitoring should be conducted during activity periods of the Site Preparation and Construction phases. Implementation of this program will be complaint-based. The sampling should follow the *Guidelines for Environmental Noise Measurement and Assessment* in Nova Scotia (NSDEL, 1990). If the threshold is exceeded, additional noise mitigation measures (e.g., constructing noise walls or berms) will be investigated.

9.2.2.2 Surface Water Quality Monitoring Program during Construction

A water quality monitoring program will be executed during construction. The purpose of the program is to assess the application environmental protection measures and comply with permit requirements for activities such as working in and adjacent to watercourses. The program will document the effectiveness of the program and identify and document the implementation of remedial actions, if necessary. The water quality monitoring program will include the monitoring of TSS or NTU periodically during construction, such as during in-water works and during and following precipitation events resulting in the visible flow of water overland. Additionally, erosion and sedimentation (ESC) measures shall also be inspected and maintained regularly. Other monitoring and inspection measures may be implemented as warranted, and these will be identified in the EPP.

9.2.2.3 Wetland Compensation and Monitoring Plan

The *Nova Scotia Wetland Conservation Policy* establishes specific goals and objectives with the intent to prevent net loss of wetlands. It is anticipated that the development of the project will result in the loss of wetland habitat, which will result in the requirement of an authorization from NSE. Preparation of a suitable wetland monitoring plan for impacted wetlands is a typical application requirement for attaining these approvals.

NSTIR will be required to develop and submit a suitable wetland compensation proposal, including monitoring plan, to offset losses to provincially regulated wetlands and wetland functions. This proposal will be developed in coordination with, and approved by NSE. It is estimated that post-construction monitoring of the wetland compensation site(s) will be required for a period of five years (typical) to ensure the efficacy of the compensation plan, and that provincial 'no net loss' policies are met.

NSE will likely require follow-up monitoring of wetlands impacted by the Project, and NSTIR would engage an experienced consultant to meet approval requirements. Follow-up monitoring is anticipated to be required at any altered wetlands within and adjacent to the PA, for an estimated period of five years, unless otherwise stated in the 'Site-specific Terms and Conditions' of the wetland approval.

9.2.2.4 Wildlife Passage Monitoring Program during Operation and Maintenance Phase

This program will be completed in areas where wildlife passage structures have been installed, in order to confirm the use of such structures by wildlife; primarily the SAR mainland moose and wood turtle, and secondarily by other non-SAR wildlife species, such as white-tailed deer. This monitoring program shall be developed with input from NSDNR.

9.2.2.5 Black Ash Management and Monitoring Plan

Prior to removal, the black ash specimens occurring within the Project Area should be assessed during the growing season for the presence of seeds. Should any seeds be present, they will be monitored by a qualified botanist until they are mature, at which time they will be gathered and sent to a suitable facility (perhaps the Strathlorne Forest Nursery or similar) for germination and rearing. Should any seedlings be obtained, they should be allowed to grow for a few years until they are large enough to transplant back unto suitable habitat. They should then be monitored yearly to assess the success of the program. As this species has considerable cultural significance, selection of suitable habitat and the actual planting could be done in collaboration with First Nations.

Should it be feasible, any black ash specimens within the Project Area which are small enough to transplant should be salvaged prior to vegetation clearing activities. These trees could then be transplanted into suitable nearby habitat, ideally a tall shrub/deciduous treed wetland overlying calcareous bedrock. This should be done by a qualified botanist/horticulturist at the optimal time of year to maximize success, and the trees should be monitored at least annually for a minimum of two years to assess the success of the program. Seedlings grown from collected seed and transplanted to the wild should also be monitored. As this species has considerable cultural significance, selection of suitable habitat and the monitoring program should ideally be done in collaboration with First Nations.

9.2.2.6 Onsite Monitoring for Wood Turtles during Site Preparation and Construction

A monitoring plan for wood turtles is recommended for areas of the Project Area identified by NSDNR as being significant habitat for this species. Areas within 100 m of riparian zones should be monitored immediately before site clearing activities by a qualified biologist, to minimize potential harm to wood turtle specimens. Prior to pre-construction and construction activities, biologists should also survey for evidence/signs that would suggest wood turtles have nested as eggs may be buried within the Project Area. Should any wood turtles be encountered, NSDNR should be notified and a SARA permit would be required to relocate the turtle(s). This plan should be developed in consultation with NSDNR. Project personnel shall be trained and familiarized with the identification of wood turtles and instructed on steps to take if a wood turtle is identified within or in close proximity to the work site.

9.2.2.7 Offsetting for Fish and Fish Habitat

An Authorization pursuant to be *Fisheries Act* will be required if the Project results in a serious harm to Commercial, Recreational or Aboriginal (CRA) fishery species. Offsetting plans will be required as part of *Fisheries Act* Authorization requirement to compensate for the loss of habitat. The final selection of watercourse crossing structures or removal of existing infrastructure is not known at this time. It is anticipated that an authorization pursuant to the *Fisheries Act* will be required for the Project. Additional information on proposed compensations programs is included in Chapter 8.

9.2.2.8 Monitoring of Fish Habitat during Site Preparation and Construction Phases

During the Site Preparation and Construction phases, turbidity monitoring will be conducted to detect excess sedimentation during all active instream construction activities. Such monitoring will be the responsibility of the Proponent. The turbidity monitoring will include visual inspection for fluid leaks as well as turbidity sampling. A minimum of three sampling stations will be established along each intermittent or permanent watercourse; these will include one upstream of construction activities (i.e., control site), one immediately downstream of the culvert or bridge crossing and one downstream of the crossing. Prior to instream construction activities, turbidity samples will be taken at each sample station prior to any instream work to establish a baseline for means of comparison. According to the *CCME Water Quality Guidelines for the Protection of Aquatic Life* (CCME, 1999), for short-term exposure the maximum increase allowed is 8 NTU from background levels for any 24-h period. For long-term exposure the maximum increase allowed is 2 NTUs from background for inputs lasting between 24 hours and 30 days. If exceedances occur and the cause is determined to be a result of Project-related activities, all activities must cease immediately until appropriate mitigation measures for the situation are implemented and successful. All exceedances must be reported to the appropriate provincial and federal authorities within 24 hours of the event (i.e., DFO and NSE).

9.2.2.9 Post-Construction Monitoring of Fish Habitat

Once construction is completed, the Proponent will be responsible for returning the watercourse channels, beds and banks to preconstruction conditions or better. All revegetation around

watercourses will be conducted following DFO protocols. Sediment erosion control structures will stay in place until vegetation is established. Areas should be assessed in late spring or early summer of the year following construction. If banks and soils are fully established with successful vegetation re-growth, then the sediment erosion control measures may be removed. If erosion and sedimentation is still an issue, sediment erosion control will need to stay in place and then additional measures must be implemented to stabilize soils. If sediment erosion is an issue, potential effects to fish and fish habitat further downstream of the site should be assessed.

9.2.2.10 Mi'kmaq Ecological Knowledge Study (MEKS)

A follow-up MEKS study is recommended to determine if the proposed Project will have any effects on lands used by the Mi'kmaq for traditional purposes that are either long-term or cannot be accommodated. Within the *Mi'kmaq Ecological Knowledge Study Protocol* (Assembly of Nova Scotia Mi'kmaq Chiefs, 2014), it states that if a previous MEKS, for the same study area, is more than five years old that a new MEKS is required. Traditional activities and usage which will require additional information include:

- Kill/hunting: for example species such as fox, beaver, muskrat, coyote, otter, porcupine, duck, goose, rabbit, partridge, raccoon, deer, salmon, trout, eel, striped bass, gaspereau, smelt, mackerel, and perch, or traplines;
- Burial/birth: for example burial sites;
- Ceremonial: for example sacred sites or ceremony sites;
- Gathering food/medicinal: for example food plants, berries, wild fruit, eggs, medicinal plants, sweet grass, fire wood, speciality wood, feathers, stone, and clay; and
- Occupation/habitation: for example canoe routes, overnight sites, or group campsites.

NSTIR has commissioned Membertou Geomatics to prepare this MEKS, which is anticipated to be a condition of approval of the Environmental Assessment, required prior to Site Preparation and Construction activities. Field surveys are scheduled for May and June of 2019, with the report to be completed in summer 2018.

9.2.2.11 Land Acquisition Program

Land acquisition and compensation will be in accordance with the Nova Scotia *Expropriation Act* and follow NSTIR's land acquisition procedures. Preliminary engagement with property owners is ongoing and property acquisition will be contingent on the final selected alignment. Each property owner that is impacted will be contacted to meet with a land representative from the Province to discuss the land requirements and an independent property appraisals will be completed for each property per the *Expropriation Act* to determine the market value of the lands required for the Project and any damages for injurious affection to remaining lands.

9.2.2.12 Archaeological - Completion of a Formal Shovel Testing Program

This program will be completed in any areas where possible or probable historic structures and areas of elevated potential for historic or First Nations archaeological resources have been identified within the Project Area, in order to confirm the presence or absence of heritage and archaeological resources on site. Shovel tests shall be conducted accordance with provincial standards; shovel tests

should be 0.40 m by 0.40 m and will be spaced at 10 m intervals in areas larger than 30 m x 30 m in areas determined to be of moderate archaeological potential, and at 5 m intervals in areas of high archaeological potential or in moderate or low-moderate potential areas smaller than 30 m x 30 m.

9.2.2.13 Archaeological - Follow-up Reconnaissance Programs for Heritage and Archeological Resources

A follow-up reconnaissance program for heritage and archeological resources is recommended for a small portion of Sutherland's River which could not be assessed due to the steep and dangerous nature of accessing the river from the highway on the north side. If the riverbanks are to be effected in this area, a follow-up reconnaissance should be conducted via an alternate access route to more effectively assess this portion of the landscape.

In addition, historic mapping indicates there are three sites which appear to represent areas of elevated potential for archaeological resources. These sites could not be assessed during the 2018 field reconnaissance surveys due to vegetation cover (i.e., dense growth, blow-down, or clear-cutting detritus). These areas are; 1) the area west of Lamont Road and south of the existing highway, extending approximately 250 m west from Lamont Road; 2) a section approximately 350 m long along the south side of the existing highway around 'Stone Wall 12', east of Browning Book; and 3) a section approximately 350 m long along the south side of the existing highway around 'Stone Wall13', also east of Browning Book. These three sites should be re-visited by a professional archaeologist after removal of the vegetation and prior to grubbing, if possible.

In the event that changes are made to the Project Area prior to or during highway construction, an archaeologist should be contracted to assess any additional areas not assessed under the current research permit.

9.2.2.14 Archaeological - Implementation of Additional Site-Specific Mitigation Measures for Heritage and Archaeological Resources

Additional site-specific mitigation measures may be required, for works in areas of elevated potential for archaeological resources or where the presence of historic structures are confirmed prior to commencement of construction activities. These measures will vary depending on the extent and significance of the site, but could include monitoring, further testing, or complete excavation. Site-specific mitigation measures will be determined in consultation with NSTIR and NSCCH.

9.3 Summary of Residual Effects and Significance

Potential residual adverse effects were evaluated for all identified VECs. Following the implementation of the proposed environmental management, mitigation and monitoring integrated through design, most VECs have no predicted significant adverse residual environmental effects. Only two VECs may have possible negative residual effects, i.e., the direct and indirect effects of noise, and the restricted access to land and loss of plant species of significance or harvesting areas

for Mi'kmaq people. These effects are applicable during the Construction, Maintenance and Operations phases of the Project.

Complaint-based noise monitoring during these phases will be required to assess if the mitigation measures to address the residual effects are adequate. The Proponent will develop and implement a suitable noise monitoring program to address this potential residual effect. Should noise levels exceed the criteria, the Proponent will be required to investigate additional noise mitigation measures.

Follow-up measures are recommended to assess if the significance criteria for access to land for Mi'kmaq people is exceeded during the Site Preparation and Construction phases. NSTIR has commissioned a Mi'kmaq Ecological Knowledge Study (MEKS) to determine if the proposed Project will have any residual effects on access to lands used by Mi'kmaq for traditional purposes. This study is currently underway and the results should be available in summer of 2019.

The remaining project effects are of limited spatial and temporal duration, and with implementation of proper mitigation will not be significant. Other follow-up program were identified to assess the effectiveness of the proposed mitigation measures, such as water quality monitoring, wetland monitoring, black ash transplantation monitoring, wood turtle monitoring, and other post-construction monitoring programs. Additional compensation programs, such as wetland compensation and fish habitat offsetting programs, will also likely be required in compliance with Nova Scotia's *Wetlands Conservation Policy* and the federal *Fisheries Act*. The compensation programs will provide compensation to achieve no net loss of wetlands or fish habitat.

The proposed Project is expected to improve both the level of safety performance and service within this corridor, by providing a conduit for the safe passage of people and goods; this is to be achieved through delivery of the Project in a manner that is designed to reduce environmental, social, and economic effects impacts. The Project will continue to provide service to the local communities for years to come, while enhancing safety performance.

The sections of Highway 104 within the Project Area have been identified by the public and stakeholders as needing improvement, due to concerns over collisions and fatalities. The proposed Project will improve the current safety conditions, and may result in an approximately 30-35% reduction of intersection-related, angle, and head-on collisions, and some reduction in single vehicle, rear-end, and sideswipe collisions (CBCL 2016, 2017). The Project will result in an overall net benefit to communities and safety performance, while minimizing the effects to the atmospheric, physical, biological, socio –economic, and cultural environment.

CHAPTER 10 References

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APPENDIX A

NSTIR Collision Data

APPENDIX B

Consultations

APPENDIX C

Effects Assessment Criteria Rankings

APPENDIX D

Noise Assessment – Technical Report

APPENDIX E

Aquatic Environment – Technical Report

APPENDIX F

Vegetation Assessment – Technical Report

APPENDIX G

Breeding Bird Survey – Technical Report

APPENDIX H

Ungulates Pellet Group Inventory (PGI) – Technical Report

APPENDIX I

Wetland Assessment – Technical Report