4.5 At-risk Amphibian Assessment Highlights:

- The Project is located primarily within the existing, previously disturbed Highway 99 right-of-way, and suitable habitat within the Project alignment is limited.
- At-risk amphibians were not detected within the Project alignment during field studies undertaken in 2014 and 2015. The potential for at-risk amphibians to occur within the Project alignment is low.
- Applying mitigation, including least-risk timing windows, and adherence to standard practices for undertaking in-stream works and highway maintenance activities, will ensure that Project-related effects on at-risk amphibians are addressed.
- No Project-related residual or cumulative effects on at-risk amphibians are expected.

4.5 At-risk Amphibian Assessment

This section presents the results of the assessment of potential effects of the Project on at-risk amphibians, and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

4.5.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on at-risk amphibians in terms of Project setting and defines the spatial and temporal assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, accessibility constraints, or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore, administrative or technical boundaries do not exist for this VC and are not discussed further.

4.5.1.1 Assessment Context

Amphibians are an important component of aquatic and terrestrial ecosystems and the Lower Mainland region supports a diversity of amphibian species. Areas along the Project alignment, such as Burns Bog in Delta and the Richmond Nature Reserve in Richmond, provide habitat for amphibians. However, previous introduction of two invasive amphibian species and a variety of other stressors, including introduced pathogens and urban, industrial, and agricultural development, have likely contributed to the decline of native amphibian species in this area from historic levels (BC MOE 2014). No long-term trend monitoring is being conducted in the regional assessment area (RAA) and the variety of current projects and activities in the RAA that affect amphibians are not required to monitor and report on their effects. As such, the current ecological trend for amphibians in relation to the effects of other projects is not well understood.

This assessment is focused on the potential effects to at-risk amphibians, these being the ones with potential sensitivity to Project-related effects. In addition to having the potential to interact with and be affected by the Project, at-risk amphibians are of interest to the public, Aboriginal Groups, and/or the government agencies. There are also legally binding requirements that protect certain species and, in some cases, their habitat. Additional information supporting the selection of at-risk amphibians as a VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.5.1.2 Methodology

The assessment of at-risk amphibians follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach, the assessment of at-risk amphibians was designed to focus on two specific at-risk amphibian species that have the potential to occur within the Project alignment given the habitat available:

- Northern red-legged frog (*Rana aurora*; Special Concern under *SARA* Schedule 1, provincially Blue-listed).
- Western toad (*Anaxyrus boreas*; Special Concern under *SARA* Schedule 1, provincially Blue-listed).

Northern red-legged frog (red-legged frog) have been documented in Richmond, Delta, and Surrey (B.C. CDC 2015), including on the east, north, and west sides of Burns Bog (Delta 2003*a*). During studies conducted for the Project in 2014, red-legged frog DNA was not found within the Project alignment although it was detected in a roadside ditch approximately 200 m north of the Project, northeast of Highway 91 in Richmond. The species has been selected as representative of the at-risk amphibian VC.

Western toad use aquatic and terrestrial habitat, and return to the same breeding sites each year (Wind and Dupuis 2002). Although suitable habitat is available near the Project alignment (i.e., Burns Bog and Richmond Nature Reserve), western toad has not been documented within the Project alignment. Historic records exist from the Delta Nature Reserve, about 10 km from the Project alignment (Klassen et al. 1971), and from Tilbury Island, approximately four kilometres from the Project alignment (Hemmera 2006). Riparian habitat, in areas likely to be affected by the Project, is primarily grassy roadside verge and shrub-lined ditches abutting agricultural fields, and is of insufficient quality for western toad juvenile rearing. On this basis, western toad is considered unlikely to occur within the Project alignment (Dennis Knopp, pers. comm.) and is not considered further in this assessment.

The Project has the potential to interact with and affect red-legged frog through the loss or disturbance of its breeding or living habitat, or through direct mortality associated with Project construction. Interactions between Project activities and red-legged frog are discussed further in **Section 4.5.3.1**.

The presence of at-risk amphibians, change in area of available habitat, and change in water quality in aquatic habitat were used as indicators to assess trends of at-risk amphibians within the assessment area and evaluate potential Project-related effects. **Table 4.5-1** presents the indicators chosen for the assessment of Project-related effects on red-legged frog, and the rationale for their selection.

Table 4.5-1 Indicators for the At-risk Amphibians

Indicator	Rationale for Selection
Presence of at risk amphibians	Assesses Project-related construction and operations phases' potential mortality to at-risk amphibians.
Change in area of available at-risk amphibian habitat	Quantifies Project-related changes in at-risk amphibian habitat availability.
Change in water quality in at-risk amphibian habitat	Describes indirect Project-related changes to quality of at-risk amphibian breeding and living habitat.

4.5.1.3 Assessment Boundaries

The assessment boundaries for at-risk amphibians are defined below.

Spatial Boundaries

The local assessment area (LAA) and RAA for at-risk amphibians are defined in **Table 4.5-2** and shown on **Figure 4.5-1**. The boundaries of the assessment area take into account the scale and spatial extent of potential environmental effects deemed appropriate for red-legged frogs.

Table 4.5-2 Spatial Boundary Definitions for At-risk Amphibians

Spatial Boundary	Description of Assessment Area
Local Assessment Area (LAA)	Project alignment.
Regional Assessment Area (RAA)	Project alignment plus two km on either side.

The LAA includes the anticipated Project footprint, where direct effects may occur including the area in which the Project could interact with and potentially have an effect on at-risk amphibians. Consideration was also given to the behaviours and characteristics of at-risk amphibians in the area and their available habitat. The RAA was established to provide a regional context for the assessment of Project-related effects. While the spatial extent of seasonal movements of red-legged frog is not well known (COSEWIC 2004, Maxcy 2004), the maximum distance of their seasonal migration of two kilometres has been chosen as the RAA.

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on at-risk amphibians were established based on the potential for each phase of the Project to interact with and have an effect on at-risk amphibians. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect at-risk amphibians present within the Project alignment; therefore, the following temporal boundaries will be assessed:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of the Proposed Project**. Specific temporal considerations for the assessment of at-risk amphibians are discussed in the context of Project interactions and potential effects in **Section 4.5.3**.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on at-risk amphibians have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

No technical boundaries have been identified that could impose limitations on the assessment of potential Project-related effects on at-risk amphibians.

4.5.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of at-risk amphibians within the assessment areas. An overview of the regulatory context for management of at-risk amphibians as relevant to the Project is also provided.

4.5.2.1 Baseline Data Collection

In 2014, the Ministry initiated studies on at-risk amphibians to support Project planning and assessment (**Table 4.5-3**). Building on available information, these studies were designed to address known data gaps.

Table 4.5-3 Desktop and Field Studies Related to At-risk Amphibians

Study Name	Purpose of Study
Desktop literature review	• Determine which at-risk amphibians may be present in the LAA. • Identify key data gaps and areas of uncertainty within the LAA.
At-risk amphibian habitat assessment	• Assess at-risk amphibian habitat in aquatic features (e.g., streams, wetlands, sloughs, and ditches) within the LAA.
Environmental DNA (eDNA) sampling	• Determine at-risk amphibian presence in the LAA.

Desktop Literature Review

To determine the potential for presence of at-risk amphibians in the LAA and RAA, an ecosystem-based search of the B.C. Conservation Data Center's (CDC) online Species and Ecosystems Explorer database (B.C. CDC 2015) was conducted. The results included attributes for at-risk status (i.e., Red- or Blue-listing and inclusion on Schedule 1 of the SARA). The list was then refined by comparing each species' known geographic range and habitat requirements to the habitat available in the LAA. Information on the potential for presence of at-risk amphibians and their habitat in the Project alignment were compiled from the following sources:

- Species and Ecosystem Explorer (B.C. CDC 2015).
- Species at Risk Public Registry (Government of Canada 2013).
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Government of Canada 2014).
- iMapBC (DataBC 2014).
- Delta Watersheds: Fish and Amphibian Distributions Map (Delta 2003*a*).

- Delta Fish and Amphibians Study: 2000-2003 Sample Site Locations Map (Delta 2002).
- COSEWIC Assessment and Status Report on Western Toad (Wind and Dupuis 2002).
- Accounts and Measures for Identified Wildlife – Red-legged Frog (Maxcy 2004).
- South Fraser Perimeter Road Environmental Assessment Application (Hemmera 2006).

Habitat Assessment and Environmental DNA (eDNA) Sampling

The red-legged frog field studies used: (i) habitat assessments based on known occurrences, (ii) habitat information from the sources above, and (iii) environmental deoxyribonucleic acid (eDNA) analysis of red-legged frog DNA present within the Project alignment aquatic features. All aquatic features (e.g., streams, wetlands, sloughs, and roadside ditches) in the LAA were examined using aerial photographs to identify probable red-legged frog living and breeding habitat for the first stage of the at-risk aquatic amphibians assessment. Field-based assessments of habitat suitability were then conducted in the LAA and eDNA sampling was completed in aquatic features determined to be potentially suitable to support red-legged frog breeding based on:

- Presence of standing fresh water deeper than 0.5 m.
- Permanent or ephemeral status of water feature.
- Presence of emergent vegetation suitable for egg mass attachment.
- Connectivity to other water features having suitable habitat for red-legged frog.
- Proximity to known occurrences of red-legged frog (based on CDC 2015 and the other sources noted above).

Fourteen sites (a site is defined as a discrete lentic aquatic feature) in the LAA had suitable red-legged frog breeding or living habitat at the time of the field assessments, and most were sampled using eDNA methods (**Figure 4.5-1** and **Table 4.5-4**). Environmental DNA is any trace fragment of DNA that is released by an organism into the environment. This method requires collection of water samples from potentially inhabited habitat, with subsequent ex-situ polymerase chain reaction (PCR) analysis of the sample for the presence of red-legged frog and western toad DNA. Reliable detection of aquatic vertebrate species using eDNA, from a variety of freshwater systems, has been confirmed as an effective survey method for amphibians (Ficetola et al. 2008, Goldberg et al. 2011, Thomsen et al. 2012).

At each aquatic feature, one location, and at one site two locations, triplicate water samples were collected using eDNA-specific methods during the red-legged frog breeding season in May 2014 and May 2015. Samples were collected in clean polypropylene bottles and labelled using an indelible marker with the site name, collection time and date, and name of collector. The biologists did not enter the water during sampling in order to prevent contamination from boots and other gear. Biologists wore clean, sterile nitrile gloves to triple rinse the sample bottles with site water, and each bottle was filled with water from the surface of the feature. Immediately after sample collection, a water quality meter was used to collect water chemistry data to facilitate the calculation of detection probabilities. Using a GIS-capable tablet, biologists marked site UTM coordinates and collected water quality data. Water chemistry parameters collected in the field included:

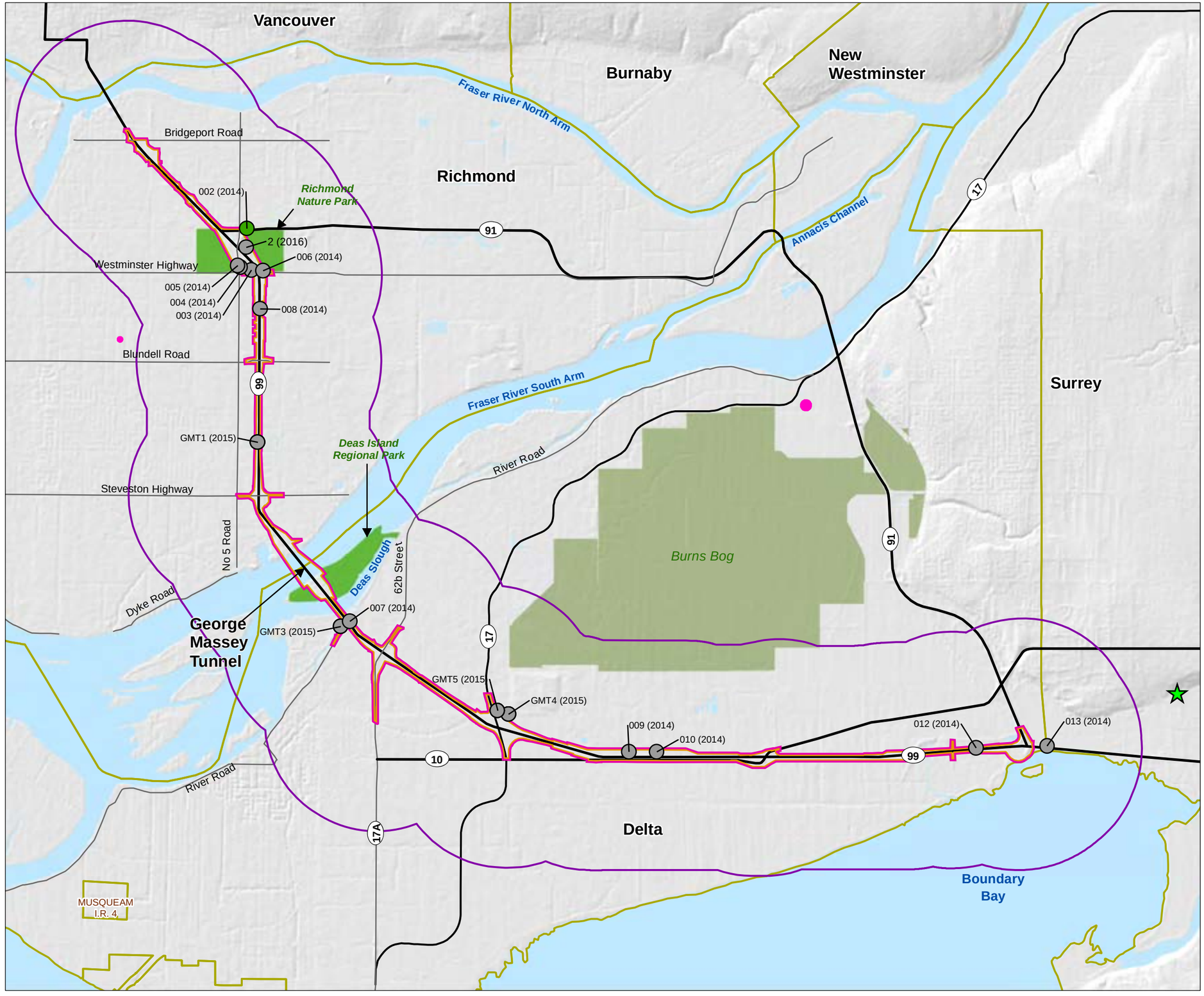
- water temperature (^{o}C)
- pH
- conductivity (mS/cm)
- dissolved oxygen (mg/L)

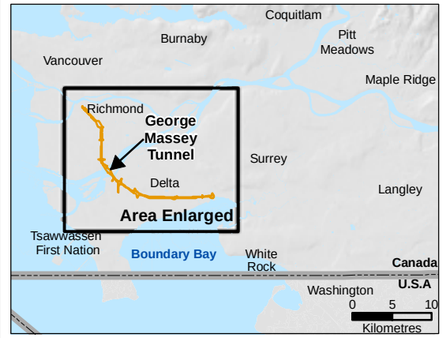
The biologists placed the sample bottles in an insulated cooler with ice packs during fieldwork to prevent DNA degradation prior to off-site filtration and preservation.

Detailed information on the habitat characteristics of the sites is provided in **Appendix A**.

Table 4.5-4 Sample Sites within the LAA with Potentially Suitable Habitat for Red-Legged Frog

Site #	Description
Sites in LAA	
GMT1 (2015)	Roadside ditch immediately west of Highway 99 near Mylora Sidaway golf course.
2 (2016)	Ditch beside a disused road west of the Highway 99 to Highway 91 east-bound off-ramp in Richmond. A 300 m-long continuous ditch with mixed conifer hardwood forest on one margin. Permanently wet with emergent wetland vegetation present.
003 (2014)	Roadside ditch with cattails on the west side of Highway 99, just north of Westminster Highway.
GMT3 (2015)	Cattail wetland adjacent to Green Slough.
004 (2014)	Roadside ditch with cattails on the east side of No. 5 Road, just north of Westminster Highway.
GMT4 (2015)	Roadside ditch with cattails west of 72nd Street near the Vancouver Landfill entrance.
005 (2014)	Roadside ditch with cattails on the west side of No. 5 Road, just north of Westminster Highway.
GMT5 (2015)	Cattail wetland on the north side of Burns Drive east of the South Fraser Perimeter Road near the Vancouver Landfill.
006 (2014)	Roadside ditch with cattails on the east side of Highway 99, just north of Westminster Highway, adjacent to the Richmond Nature Reserve.
007 (2014)	Cattail wetland adjacent to Green Slough.
008 (2014)	Roadside ditch south of Westminster Highway, east of Highway 99.
009 (2014)	Roadside ditch in the flooded cottonwood/red alder – salmonberry forest on the north side of Highway 99 near Highway 17.
010 (2014)	A second sample from the roadside ditch in the flooded cottonwood/red alder – salmonberry forest on the north side of Highway 99 near Highway 17.
012 (2014)	Roadside ditch, on the north side of Highway 99, east of the Highway 91 interchange near Boundary Bay.
Sites immediately adjacent to the LAA (and sampled)	
002 (2014)	Roadside ditch with cattails on the west side of Highway 99, just north of Highway 91 in Richmond.
013 (2014)	Ditch south of Colebrook Road.





Legend

- Red-legged frog sighting
- Red-Legged Frog eDNA Sample Location (eDNA present)
- Red-Legged Frog eDNA Sample Location (No eDNA present)
- CDC records of red-legged frog observations [1]
- At-Risk Amphibians Local Assessment Area
- At-Risk Amphibians Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

[1]Variation in polygon size represents differences in mapping accuracy associated with source data for each B.C. CDC element occurrence record

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

N

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Kilometres

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

AT-RISK AMPHIBIANS OVERVIEW

Figure 4.5-1	15/05/2016

B.C. on the Move

Path: O:\217-299\285\077\03\mxd\WildlifeEA\Fig4-5-1_285_077_03_EA_ARiskAmphibians_160114_FINAL.mxd

4.5.2.2 Regulatory Context

Regulation and management of at-risk amphibians in B.C. occur primarily through the following federal and provincial legislation.

Federal

At the federal level, legal protection for at-risk amphibian species is provided under the *Species at Risk Act* (SARA), S.C. 2002, c. 29, which enables management of species at risk to prevent extinction or extirpation from Canada. Under the SARA Section 32(1), it is an offence to kill, harm, harass, capture, or take an individual of a wildlife (including amphibian) species that is listed as Extirpated, Endangered, or Threatened under Schedule 1. The species' residence and critical habitat are also afforded legal protection under Sections 33, 56 and 58(1) of the SARA.

Provincial

The B.C. *Wildlife Act,* R.S.B.C. 1996, c. 488 is the primary provincial legislation protecting wildlife but excluding plants, plant communities, and insects. The Province of B.C., through the B.C. CDC, also assigns species and ecological communities at risk in B.C. to one of three lists (Red, Blue, Yellow) based on provincial Conservation Status Rank. Further explanation regarding the assignment of Conservation Status Rank by the CDC to species and ecosystems at risk is provided in **Section 4.7 Vegetation**.

4.5.2.3 Existing Conditions

Red-legged Frog Habitat

Red-legged frogs require different habitats for breeding and living. They breed in a wide variety of wetlands, including both temporary and permanent ditches, ponds, lakes, and slow-moving streams with emergent vegetation (Maxcy 2004). Living habitat is generally in smaller water bodies in or adjacent to damp forests.

The terrestrial ecosystem mapping (TEM; **Section 4.7 Vegetation**) identified three wetland community types in the LAA, which were evaluated during field studies in 2014 for habitat suitability of red-legged frog. Two of these wetland communities were evaluated during field studies in 2014 to determine their habitat suitability for red-legged frog. These habitats were:

- The cattail marsh adjacent to Green Slough (0.7 ha, TEM polygon 428 [see Section 4.7 Appendix A for TEM mapping figures]).
- The flooded forest on the north side of Highway 99 near the Vancouver Landfill (7.1 ha, TEM polygon 157 [see Section 4.7 Appendix A])).

The remaining identified wetland community, the Lyngbye's sedge salt marsh wetland situated on Deas Island, was not considered to be suitable habitat for at-risk amphibians because of the prevailing saline environment and was therefore not sampled.

Other cattail marsh wetlands were not field-sampled because they either did not appear to support suitable red-legged frog breeding habitat during the sampling period (i.e., TEM polygon 380, a recently constructed highway water detention pond [see **Section 4.7 Appendix A**]), or were on the south side of Highway 99, where the potential for red-legged frog to occur is very low (i.e., TEM polygon 155 [see **Section 4.7 Appendix A**]).The remainder of the aquatic features (i.e., ditches) in the LAA have low potential to support red-legged frog breeding because of poor water quality. Amphibians are sensitive to oxygen availability in aquatic habitats (Govers et al. 2010), and breeding success is partly dependant on levels of dissolved oxygen (Sacerdote and King 2009). Water quality data collected within roadside ditches, as part of the fish and fish habitat baseline study and during the eDNA baseline study, indicate that the majority of the roadside ditches within the Project alignment have levels of dissolved oxygen that fall below the B.C. ambient water quality criteria for dissolved oxygen (B.C. MOE 1997), in both spring and summer sampling periods. As such, the levels of dissolved oxygen in the majority of LAA watercourses are likely prohibitive to at-risk amphibian breeding. Furthermore, habitat in these roadside ditches is unlikely to support at-risk amphibian breeding due to lack of slow flowing, shallow water with emergent vegetation for egg-laying (Storm 1960, Licht 1969, Briggs 1987, Richter and Azous 1995). These ditches also support invasive amphibian species (green frog [*Lithobates clamitans*] and bullfrog [*L. catesbeianus*]), which prey upon native amphibian eggs and out-compete native tadpoles (Kiesecker and Blaustein 1997, COSEWIC 2012).

Pathogens, including Chytridiomycosis (caused by *Batrachochytrium dendrobatidis* (Bd)) and illness caused by rana viruses (family *Iridoviridae*) are infectious amphibian diseases that have been confirmed to cause mortality in amphibians (COSEWIC 2012). Direct evidence of disease-induced amphibian declines has been linked to Chytridiomycosis globally and in B.C. (SPES 2012). Widespread presence of these pathogens is suspected in the LAA and RAA due to the ubiquitous presence of highly mobile non-native amphibians that carry these pathogens (green frog and American bullfrog).

Based on water quality, the roadside ditches in the LAA are unlikely to support at-risk amphibian breeding habitat. They may provide living habitat for red-legged frog, as supported by observations outside the LAA of an adult red-legged frog in a roadside ditch near King George Highway and detection of eDNA from red-legged frog in a roadside ditch in Richmond. This ditch habitat, however, is also considered low quality living habitat.

Red-legged Frog Presence

When applied with strict protocols and validated methods, eDNA provides a highly effective and accepted method to identify presence of target taxa, including red-legged frog, western toad, chytrid and Bd with a high degree of efficacy (Hobbs 2015, Herder et al 2014). Accepted methods were applied during sample collection, to ensure rigour and reliability from the eDNA assessment (Hobbs et al 2015).

From the result of the eDNA sampling, no red-legged frog[1] presence was confirmed in the LAA (**Table 4.5-5**); specifically, there was no evidence of recent (approximately 7 to 25 days) presence of red-legged frog within the LAA (Strickler et al. 2015) at the time of sampling (Strickler et al. 2015). Since samples were collected during the breeding season in 2014 and 2015, when DNA concentration is expected to be the highest and the likelihood of positive detection is increased (Goldberg et al. 2011), the negative results provide evidence that red-legged frog is not likely to be using wetlands and ditches within the LAA for breeding. These areas could, however, be used as living habitat. Red-legged frog was detected at Site # 002 (2014) (**Figure 4.5-1**), immediately adjacent to the LAA.

Table 4.5-5 Red-legged Frog Observations in the LAA and RAA

Site ID	Habitat Type	Red-legged frog detected (Yes/No)	Habitat Present	
			Breeding	Living
Sites in LAA				
GMT1 (2015)	Ditch	No	No	Unlikely
003 (2014)	Ditch	No	No	Unlikely
GMT3 (2015)	Marsh	No	No	Unlikely
004 (2014)	Ditch	No	No	Unlikely
GMT4 (2015)	Ditch	No	No	Unlikely
005 (2014)	Ditch	No	No	Unlikely
GMT5 (2015)	Ditch	No	No	Unlikely
006 (2014)	Ditch	No	No	Unlikely
007 (2014)	Marsh	No	No	Possible
008 (2014)	Ditch	No	No	Unlikely
009 (2014)	Marsh	No	No	Possible

[1] Although the focus of this assessment is red-legged frog, the eDNA study also evaluated the presence of western toad. No western toad presence was identified during this study

Site ID	Habitat Type	Red-legged frog detected (Yes/No)	Habitat Present	
			Breeding	Living
010 (2014)	Marsh	No	No	Possible
012 (2014)	Ditch	No	No	Unlikely
2-2015 (2016)	Ditch	Not sampled	Possible	Possible
Sites immediately adjacent to the LAA				
002 (2014)	Ditch	Yes	Unlikely	Confirmed
013 (2014)	Ditch	No	No	Unlikely

4.5.2.4 Quality and Reliability

The quality and reliability of the data collected and analysed for this analysis is high because it used standard government-approved (e.g., RISC) methods for habitat assessments and peer-reviewed methods for other studies (e.g., eDNA). These methods have been developed for the specific purpose of identifying or establishing trends in amphibians, and in the case of eDNA, are particularly effective for uncommonly occurring at-risk species.

4.5.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with at-risk amphibians, and potential effects of such interactions on red-legged frog. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.5.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 4.5.5**. A discussion of potential cumulative effects on at-risk amphibians is presented in **Section 4.5.6**.

4.5.3.1 Project Interactions

An overview of potential interactions between Project activities and at-risk amphibians during the construction and operation of Project components is provided in **Appendix B**. A preliminary evaluation of the potential effects of Project interactions on at-risk amphibians, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Potential effects on at-risk amphibians resulting from Project construction and operation (i.e., maintenance) activities may include direct mortality, disturbance or permanent loss of breeding/living habitat, and introduction of alien invasive species (AIS; e.g. green frog, pathogens). Project-related activities could occur year round, including during the at-risk amphibian breeding season which is a sensitive life period, generally extending from February to October (Calef 1973).

During pre-Application consultation, Aboriginal Groups expressed concern that atmospheric noise from construction activities and traffic could adversely affect wildlife and interfere with frog calls. Changes to noise, light, and visual stimuli resulting in effects on at-risk amphibians are unlikely to occur as a result of the Project and are therefore not considered further in this assessment. As at-risk amphibian breeding habitat was not identified within the LAA, disturbance to breeding activity (calling) as a result of construction is not expected.

Direct highway mortality has been acknowledged as an effect on red-legged frogs (COSEWIC 2004); however, the existing width of, and traffic volumes on, Highway 99 present a formidable barrier to red-legged frog migrations and will continue to do so after the widened highway becomes operational. Direct highway mortality is therefore not considered further.

As previously discussed, no likely at-risk amphibian breeding habitat was identified within the LAA; therefore, consideration of interactions and Project-related effects to at-risk amphibians is limited to the effects related to living habitat.

Fragmentation of at-risk amphibian habitat, and habitat avoidance as a result of sensory disturbance, was not considered a potential interaction given that Highway 99 activities that lead to such potential effects will be the same in the future as they are under existing conditions. The future alignment of Highway 99 with the Project will not change from the existing Highway 99 alignment, resulting in no fragmentation effects as a result of the Project.

Construction: Potential effects on at-risk amphibians as a result of Project-related site preparation and construction activities are as follows:

- Mortality from vegetation grubbing and clearing, and instream construction activities.
- Change in area of available living habitat from disturbance and infilling of upland ditches, as well as instream construction activities in and around roadside ditches.
- Indirect change to living habitat from changes in ambient water quality (e.g., dissolved oxygen) due to an increase in sediment input resulting from road construction activities (e.g., vegetation clearing, temporary drainage de-watering and relocation).
- Indirect change to living habitat from introduction to AIS, including pathogens, green frog, and bull frog, during construction (e.g., transfer of pathogens on equipment or machinery and introduction through relocation of AIS during salvage).

Operation: Potential effects on at-risk amphibians during Project operation may result from routine maintenance activities of the highway and upland ditches. These activities have the potential to cause changes in amphibian living habitat due to vegetation and debris removal, induced turbidity, or temporary disruption of natural channel flows.

Given that the Project is within an existing transportation corridor, and land cover in the LAA is of a disturbed nature (see **Section 4.7 Vegetation**), at-risk amphibian living habitat within these areas is influenced by a combination of direct physical activities and indirect factors such as road runoff. The Ministry has standard operating practices (e.g., B.C. MOTI 2003, B.C. MOTI 2010) to minimize the effects of highway operations and maintenance on adjacent land uses. In addition, aquatic features that do not currently support pathogens, and are therefore sensitive to pathogen transfer effects will be identified during pre-construction eDNA assessment. With these practices in place, Project-related disturbance to at-risk amphibian living habitat during operations and maintenance is anticipated to be negligible. Therefore, the effect is not considered further in this assessment.

4.5.3.2 Potential Effects

Mortality of At-risk Amphibians

Construction Phase

Site preparation activities, including vegetation clearing and grubbing, have the potential to result in direct mortality of at-risk amphibians that may be present in riparian and upland habitats within the Project alignment through crushing by heavy machinery. Because no at-risk amphibians were found within the Project alignment, interactions with vehicles are likely to have a very low probability of occurrence.

Operation Phase

The Project is not anticipated to increase the potential risk of mortality of at-risk amphibians during the operations phase. Existing conditions suggest that there is a low likelihood of at-risk amphibians using living habitat within the Project alignment and the existing risk of mortality is likely to be high given current traffic volume conditions along Highway 99. Traffic volumes in the LAA will increase; however, no measureable change from the existing risk of amphibian mortality is projected. As such, direct amphibian mortality as a result of highway operation will not be considered further in this assessment.

Potential Loss of At-risk Amphibian Living Habitat

Construction Phase

Temporary loss of at-risk amphibian living habitat may occur during instream works including clearing and grubbing of riparian vegetation, temporary de-watering of upland ditches, and installation of temporary drainage structures.

It is anticipated that there will be some overlap between Project components, specifically the support piers for the new bridge and the cattail marsh adjacent to Green Slough (TEM polygon 428 [see **Section 4.7 Appendix A**]), resulting in a potential loss of at-risk amphibian living habitat in this area.

The flooded forest wetland (TEM polygon 157 [see **Section 4.7 Appendix A**]) does not overlap with Project components and, therefore, this site will not be impacted by the Project.

Change in Water Quality in At-risk Amphibian Living Habitat

Construction Phase

Clearing and grubbing of riparian vegetation along ditches, ditch relocation for Highway 99 widening, and interchange upgrades have the potential to result in increased sedimentation and degrade ambient water quality. In addition, inadvertent transfer of AIS and pathogens may occur.

Dissolved oxygen in roadside ditches in the LAA (Sites 003 (2014), 006 (2014), and 008 (2014); **Figure 4.5-1**) and in the flooded forest (sites 9 and 10; **Figure 4.5-1**) are outside the standard *Water Quality Guidelines for the Protection of Aquatic Life* specified by the Canadian Council of Ministers of the Environment (CCME 2014), and are not of a sufficient level to support aquatic life (see **Section 4.2 Sediment and Water Quality**). However, dissolved oxygen levels in the cattail marsh adjacent to Green Slough (TEM polygon 428) meet the *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014), and therefore could support living habitat for red-legged frog. Although red-legged frog were not detected during baseline eDNA studies despite repeated sampling (2014 and 2015), mitigation measures to prevent or reduce adverse effects to at-risk amphibians associated with degraded ambient water quality in the cattail marsh are described in **Section 4.5.4**.

Accidental spills of toxic/hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete), as well as potential failure of sediment containment measures, could result in changes to ambient water quality during Project construction activities. Potential changes to ambient water quality resulting from accidents or malfunctions during Project construction are assessed in **Section 8.0 Accidents and Malfunctions**.

Operation Phase

Highway maintenance activities, including ditch cleaning and riparian vegetation maintenance, may induce turbidity within upland ditches and degrade ambient water quality.

Widening of Highway 99 and interchange upgrades are expected to result in an increase of impervious surface area and consequently the rate of stormwater runoff entering the upland ditches will increase. Mitigation measures to prevent or reduce adverse effects associated with stormwater runoff are described in **Section 4.5.4**. It is noted that highway drainage is a small component of the water in the ditches in Richmond where most of the water drains areas outside the highway right-of-way.

4.5.4 Mitigation Measures

Mitigation for the Project has been and will continue to be informed by standard industry practices and best management practices (BMP) including specific amphibian BMP recently developed by the B.C. provincial government, consideration of mitigation measures, and the results of follow up programs undertaken for past Ministry developments; input from regulators, public, and Aboriginal Groups; and evaluation of technical and economic feasibility. Standard industry practices and BMPs proposed to avoid or reduce adverse effects on at-risk amphibians were based on the following key documents:

- *2012 Standard Specifications for Highway Construction* (B.C. MOTI 2012).
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).
- *Standards and Best Practices for Instream Works* (B.C. MWLAP 2004).
- *Develop with Care 2014: Guideline for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia* (B.C. MOE 2014).
- DRAFT *Best Management Practices for Amphibian and Reptile Salvages in British Columbia* (Wind et al. 2013).
- *Riparian Restoration Guidelines* (B.C. MOE 2008).
- *Tree Replacement Criteria* (B.C. MELP 1996).
- *National Guide to Erosion and Sediment Control on Roadway Projects* (TAC 2005).

A hierarchical approach based on the four types of mitigation as outlined below, was used in identifying strategies to avoid or minimize potential Project-related effects:

- Avoidance: Measures to avoid potential effects on the VC have been/will be incorporated into Project considerations such as site and route selection, project scheduling, project design, and construction and operation procedures and practices.
- Minimization: Where potential effects on the VC cannot be avoided through project considerations, standard mitigation measures, BMPs, and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels.

- Restoration or Habitat Enhancement: Where potential Project-related effects cannot be avoided or minimized through standard mitigation measures, best practices, or implementation of EMPs, affected components will be restored on site to pre-Project conditions.
- Compensation/offset: Where on-site restoration is not feasible, appropriate means to counteract, or make up for potential Project-related effects on the VC will be identified.

Proposed mitigation measures to avoid or minimize adverse Project-related effects on at-risk amphibians are summarized in **Table 4.5-6**.

4.5.4.1 Avoidance

The Project has been designed to be located largely within the existing Highway 99 Right-of-Way (ROW), in areas that have been previously disturbed and contain minimal natural vegetation, thereby avoiding potential overlap with at-risk amphibians. As such potential encroachment on at-risk amphibian living habitat, as well as potential temporary loss of at-risk amphibian habitat resulting from instream works, ground disturbance, clearing, and grubbing of riparian vegetation during Project construction will be minimized and restricted to within this ROW.

As described in **Section 4.4 Fish and Fish Habitat**, upland ditches will be designed to maintain ambient water quality and pre-development flow regimes to avoid or minimize potential Project-related changes to ambient water quality as a result of highway stormwater runoff during Project operation.

4.5.4.2 Minimization

Project Design

Engineering considerations indicate that an overlap between the proposed bridge support piers and the cattail marsh adjacent to Green Slough (TEM polygon 428) cannot be avoided; however, through Project design, this unavoidable overlap will be minimized and will not affect the functionality of the ecosystem. This will minimize the extent of potential at-risk amphibian living habitat.

Effects of Project construction on the recently-established cattail marsh in the Highway 17 interchange (TEM polygon 380) will be minimized during design to reduce the ground disturbance.

Best Management Practices and Environmental Management

Environmental protection measures that will be implemented during Project construction and operation to prevent or minimize potential effects on at-risk amphibians will be outlined in a Construction Environmental Management Plan (CEMP), and subsequently in an Operational Environmental Management Plan (OEMP), as described in **Section 12.0 Management Plans.** The CEMP will include a Fish and Fish Habitat Management Plan, Erosion and Sediment Control Plan, and Terrestrial Vegetation and Wildlife Management Plan. These component plans will describe standard best practices and Project-specific mitigation measures and will effectively prevent or minimize potential adverse effects on at-risk amphibians that might otherwise result from the Project during construction. Key elements of these plans are discussed below.

Mitigation Measure #1: Fish and Fish Habitat Management Plan

Mitigation proposed to avoid or minimize potential Project-related adverse effects on fish and fish habitat will also benefit at-risk amphibians. Relevant provisions from the Fish and Fish Habitat Management Plan (e.g., mitigation for upland ditches) will be implemented and are anticipated to mitigate effects to at-risk amphibian habitat related to changes in ambient water quality.

As described in **Section 4.4 Fish and Fish Habitat Assessment**, Project construction and operation activities that involve instream works will be conducted in accordance with provincial standards and best practices, including the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012) and the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010), respectively. Also with consideration of low likelihood of at-risk amphibians to be present in upland ditches within the Project alignment, the potential for at-risk amphibian mortality during Project-related instream works is greatly reduced.

Upon completion of instream works associated with Project construction activities, channel flows will be re-established, and riparian vegetation will be restored through hydro-seeding and re-planting to pre-disturbance conditions or better. Therefore, riparian habitat quality in ditches relative to existing conditions will be maintained or improved.

Mitigation Measure #2: Erosion and Sediment Control

Erosion and sediment control measures to be included in the Erosion and Sediment Control Plan are presented in **Section 4.4 Fish and Fish Habitat**. They generally include installing and maintaining erosion and sediment control measures at potentially affected watercourses prior to the onset of Project construction and operation, operating machinery and equipment in-the-dry from the top-of-bank of watercourses, and restoring cleared areas promptly after use.

Mitigation Measure #3: Terrestrial Vegetation and Wildlife Management

A Terrestrial Vegetation and Wildlife Management Plan will be developed as part of the CEMP to avoid or mitigate potential effects to vegetation and wildlife (including at-risk amphibians) during Project construction. The plan will describe procedures for amphibian salvage and translocation, as well as mitigation approaches to minimize ground disturbance.

Project-related instream works will be conducted within prescribed regional least-risk fisheries timing windows (i.e., July 15 to September 30; Delta 2003*b*, B.C. MOE 2006) or with alternative mitigation approaches (e.g., work in-the-dry, combined with amphibian salvages) to avoid effects to water quality during sensitive amphibian breeding life stages. All maintenance activities will adhere to the provisions of the B.C. *Water Act* (where applicable) and be undertaken in accordance with provincial standards and best practices, including the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

Amphibian Salvage and Translocation

As part of pre-construction activities, amphibian salvage and translocation will be conducted to avoid or minimize potential Project-related mortality to native amphibians from instream works during Project construction. Salvage and translocation will comply with the B.C. *Wildlife Act* and pertinent permits, and will be undertaken in accordance with the DRAFT *Best Management Practices for Amphibian and Reptile Salvages in BC* (Wind et al. 2013). Salvage areas and suitable translocation habitat will be identified, and sites where salvage is conducted and amphibians are transported, will be pre-tested for pathogens to avoid the transport and introduction of AIS (i.e. green frog) to new aquatic features.

Mitigation to Minimize Ground Disturbance

Project footprint disturbance will be minimized by flagging construction boundaries in the field and marking clearing perimeters to minimize the potential for accidental encroachment on forested areas and wetlands that may be suitable living habitat for at-risk amphibians.

Disturbance to the cattail marsh adjacent to Green Slough, which has potential to support at-risk amphibian living habitat, will be minimized by:

- Limiting heavy machinery access points from River Road South to prevent substrate compaction.
- Placing site infrastructure as close as possible to the existing road verges during detailed design to minimize the need for clearing in the wetland.
- Storing machinery and construction materials outside of the wetland.

4.5.4.3 Habitat enhancement

As discussed under mitigation of Project-related effects on vegetation, the following measures are proposed to improve the functionality of the highly disturbed cattail marsh adjacent to Green Slough (TEM polygon 428), which overlaps with the Project:

- Removal of invasive species and garbage from the marsh and revegetation using native species as appropriate to improve habitat quality in the area surrounding the new bridge support piers.
- Installation of an appropriate stormwater management system for the upgraded highway and the new bridge to avoid potential introduction of contaminants into the ecosystem through road runoff.

The above measures are expected to improve the quality and viability of the ecosystem within TEM polygon 428, and counteract potential effects of the loss of amphibian habitat due to the proposed installation of new bridge piers.

4.5.4.4 Habitat Offsetting

Mitigation Measure #4: Offsetting of Effects to Cattail Marsh near River Road South

As described in **Section 4.7 Vegetation**, unavoidable Project footprint effects on the cattail marsh near Green Slough (River Road South) will be offset through the creation of a cattail marsh within a biofiltration pond near the existing south portal of the Tunnel. This habitat will be subject to monitoring during and after construction to ensure that it is functioning as intended. The establishment of the cattail marsh, which has the potential to provide suitable living habitat for at-risk amphibians, is expected to offset the partial loss of marsh area within TEM polygon 428.

Table 4.5-6 Summary of Mitigation Measures to Address Potential Adverse Project Effects on At-risk Amphibians

Potential Effect	Mitigation Measure
Construction Phase	
Direct mortality of at-risk amphibians from instream works	• *Mitigation measure #3*: Salvage and translocate at-risk amphibians to nearby suitable habitat.
Loss of at-risk amphibian living habitat	• Project siting and design • *Mitigation measure #1*: ▫ Undertake instream works in accordance with standards and best practices, including the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012). ▫ Restore riparian vegetation to pre-disturbance conditions or better. • *Mitigation measure #3*: Minimize ground disturbance to avoid sensitive habitats, including the cattail marsh adjacent to Green Slough. • *Mitigation measure #4*: Habitat offsetting of the cattail marsh near Green Slough with creation of new approach near south portal.
Changes to water quality in at-risk amphibian living habitat	• *Mitigation measure #1*: Undertake instream works in accordance with standards and best practices, including *Standard Specifications for Highway Construction* (B.C. MOTI 2012). • *Mitigation measure #2*: Install and maintain functional erosion and sediment controls. • *Mitigation measure #3:* prior to construction, test for presence of pathogens at aquatic features with potential exposure to machinery or equipment.
Operation Phase	
Loss of at-risk amphibian living habitat	• *Mitigation measure #1*: Undertake instream works in accordance with the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).
Changes to water quality in at-risk amphibian living habitat	• Project siting and design: Design ditches to maintain ambient water quality and pre-development flow regimes. • *Mitigation measure #1*: Undertake instream works in accordance with standards and best practices, including the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

4.5.5 Residual Effects and their Significance

4.5.5.1 Characterization of Residual Effects

Residual effects are those adverse effects that remain following implementation of mitigation measures. All potential Project-related effects on at-risk amphibians are expected to be addressed through mitigation measures, resulting in no residual effects. Implementation of mitigation measures described in **Section 4.5.4** is anticipated to address potential effects related to physical injury or mortality, change in habitat availability and quality, or introduction of AIS of at-risk amphibians. Avoidance mitigation is expected to be immediately effective in protecting at-risk amphibians from habitat loss and direct mortality. Minimization mitigation is expected to be immediately effective or effective immediately following the proposed restoration and enhancement of disturbed areas. These are standard mitigation measures that the Ministry has used on other project within the lower mainland with proven success.

4.5.5.2 Confidence and Risk

The confidence with this characterization of residual effects and its predictions is high.
A number of factors were considered in reaching this conclusion including:

(i) The quality and reliability of the data that supported the assessment. Standard sampling methods, reliable methods published in government or peer-reviewed documents were used.

(ii) The availability of data for the area surrounding the LAA (including in the RAA) is reasonable, in large part from MoTI studies on the nearby South Fraser Perimeter Road and the Environmental Assessment Office-sponsored amphibian work in Burns Bog (Fraker et al. 1999).

(iii) The experience in identifying and managing effects on at-risk amphibians from the nearby MoTI South Fraser Perimeter Road gives high confidence in the likelihood of effects and the means by which they should be managed.

(iv) The use of standard BMPs or MoTI-prescribed policies for avoiding or minimizing Project-related effects on at-risk amphibians, including pre-construction assessment of pathogens, minimizing construction-related disturbance to aquatic features in the Project area, avoiding construction-related disturbance to identified Environmentally Sensitive Areas (ESA) and invasive species (and pathogen) management to minimize transfer between sites.

No further risk assessment is considered necessary as the mitigation measures proposed address effects and uncertainty.

4.5.6 Cumulative Effects and their Significance

As discussed in **Section 4.5.5**, the Project is not likely to have any residual effect on at-risk amphibians. Therefore, a cumulative effects assessment was not necessary.

4.5.7 Follow-up Strategy

The potential for at-risk amphibians to occur within the Project alignment is low. During construction, implementation of the CEMP is expected to effectively prevent or minimize potential adverse effects on at-risk amphibians that might otherwise result from the Project during construction.

As described above, the creation of a cattail marsh within a biofiltration pond near the existing south portal of the Tunnel proposed to offset effects on the existing cattail marsh near Green Slough has the potential to provide suitable habitat for at-risk amphibians. As part of the vegetation follow-up program, this habitat will be subject to monitoring during and after construction to ensure that it is functioning as intended.

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APPENDIX A

At-risk Amphibian Habitat Assessment Data

Table 1 At-risk Amphibian Habitat Data from eDNA Sample Sites within the LAA

Sample Site	Habitat Characteristics					Water Quality Data				eDNA Results
	Presence of standing fresh water	Permanent fresh water	Presence of emergent vegetation	Connectivity to other water features with suitable habitat	Within 1 km of CDC red-legged frog record	Temperature (C)	pH	Conductivity (µS/cm)	Dissolved oxygen (mg/L)	Red-legged frog DNA presence
002 (2014)	Yes	Yes	Yes	No	No	11.7	7.27	876.0	1.61	Yes
003 (2014)	Yes	Yes	No	Yes	No	13.9	8.06	266.5	2.86	No
004 (2014)	Yes	Yes	No	Yes	No	12.1	7.85	254.9	3.36	No
005 (2014)	Yes	Yes	Yes	Yes	No	12.7	7.51	272.1	1.58	No
006 (2014)	Yes	Yes	Yes	Yes	No	11.4	6.50	145.9	1.20	No
007 (2014)	Yes	Yes	Yes	Yes	No	11.9	6.56	567.0	6.54	No
008 (2014)	Yes	Yes	Yes	Yes	Yes	11.9	7.19	322.3	1.01	No
009 (2014)	No	Yes	Yes	Yes	No	14.9	6.69	234.6	1.49	No
010 (2014)	Yes	Yes	Yes	Yes	No	15.7	7.00	126.8	0.43	No
012 (2014)	Yes	Yes	No	No	No	14.6	6.95	345.5	2.33	No
013 (2014)	Yes	Yes	Yes	Yes	No	16.5	8.62	409.5	1.66	No
GMT1 (2015)	Yes	Yes	No	No	No	21.5	5.89	273.1	2.65	No
GMT3 (2015)	Yes	Yes	Yes	Yes	No	19.0	6.76	285.1	3.31	No
GMT4 (2015)	Yes	Yes	Yes	Yes	No	23.2	7.29	382.4	7.53	No
GMT5 (2015)	Yes	Yes	Yes	Yes	No	23.5	6.99	197.3	3.74	No
2 (2016)	Yes	Yes	Yes	Yes	Yes	13.7	5.52	112.1	5.2	Pending

APPENDIX B

Overview of Potential Project Interactions with At-risk Amphibians

Table 1 Overview of Potential Project Interactions with At-risk Amphibians.

Project Phase/Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Pre-Construction / Site Preparation			
Pre-construction / site preparation	No Interaction	• Surveying. • Conducting additional site investigations (i.e., a geotechnical drilling program). • Relocating utilities. • Preloading for embankment and highway construction. • Acquiring property for the Project.	**Nature of interaction:** No interactions are anticipated. **Rationale:** Activities are not proposed near identified at-risk amphibian living habitat and do not represent a risk to amphibian mortality.
	No Effect	• N/A	N/A
	Potential Effect	• Clearing and grubbing of vegetation, mainly in the existing Hwy 99 ROW. • Restoration of Green Slough to its historic alignment. • Installing temporary drainage structures and diversions. • Installing temporary roads, laydown areas, and site offices.	**Potential Project-related effects include:** • Loss (temporary or permanent) of potential at-risk amphibian living habitat from Project-related works in and around upland ditches. • Changes in ambient water quality from induced turbidity during works in and around upland ditches. • Potential direct mortality of at-risk amphibians during instream works.

Project Phase/Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Construction Phase			
New bridge construction, including approaches and ramp connections	No Interaction	• Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls	**Nature of interaction:** No interactions are anticipated. **Rationale:** Activities are not proposed within or near at-risk amphibian living habitat and do not represent a risk to amphibian mortality.
	No Effect	• N/A	N/A
	Potential Effect	• Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation.	**Potential Project-related effects include:** • Loss (permanent) of at-risk amphibian living habitat from ground improvements and installation of piers for the new bridge south approach. • Changes in ambient water quality from induced turbidity during works on the edge of Deas Slough and Green Slough.

Project Phase/Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Highway 99 improvements, including interchange upgrades	No Interaction	• N/A	N/A
	No Effect	• N/A	N/A
	Potential Effect	• Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A. • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street. • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving.	**Potential Project-related effects include:** • Direct mortality of at-risk amphibians from Project-related works in and around upland ditches associates with interchange upgrades, compaction of soil. • Changes in ambient water quality from induced turbidity during works in and around upland ditches.
Tunnel decommissioning	No Interaction	• Removing electrical/mechanical/utilities equipment from the Tunnel. • Removing of four Tunnel segments and associated scour protection. • Backfilling of onshore portions of Tunnel approaches. • Transporting Tunnel elements for offsite disposal and operating support vessels for that activity.	**Nature of interaction:** No interactions are anticipated. **Rationale:** Activities are not proposed within or near at-risk amphibian living habitat, and are not anticipated to result in at-risk amphibian mortality, or cause changes to at-risk amphibian living habitat quality or quantity.
	No Effect	• N/A	N/A
	Potential Effect	• N/A	N/A

Project Phase/Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
Decommissioning of Deas Slough Bridge	No Interaction	• Removal of Deas Slough Bridge including substructures.	**Nature of interaction:** No interactions are anticipated. **Rationale:** Activities are not proposed within or near at-risk amphibian living habitat, and are not anticipated to result in at-risk amphibian mortality, or cause changes to at-risk amphibian living habitat quality or quantity.
	No Effect	• N/A	N/A
	Potential Effect	• N/A	N/A
Operation Phase			
Highway 99 and interchanges	No Interaction	• N/A	N/A
	No Effect	• N/A	N/A
	Potential Effect	• Operating reconfigured Highway 99 and interchanges. • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.).	**Potential Project-related effects include:** • Changes in ambient water quality from induced turbidity during maintenance works in and around upland ditches, and from stormwater runoff during highway operation. • Accidental spills of deleterious substances into upland ditches is assessed in **Section 8.0 Accidents and Malfunctions.**

Project Phase/Component	Interaction Ranking	Project Works and Activities that Interact with the VC	Nature of Potential Interaction
New bridge	No Interaction	• Operating the new bridge. • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.)	**Nature of interaction:** No interactions are anticipated. **Rationale:** Activities are not proposed within or near at-risk amphibian living habitat, and are not anticipated to result in at-risk amphibian mortality, or cause changes to at-risk amphibian living habitat quality or quantity.
	No Effect	• N/A	N/A
	Potential Effect	• N/A	N/A

"N/A" indicates that no Project works and/or activities are applicable to the category