

# Aquatic and Terrestrial Ecosystems Baseline Report for 84 Avenue in Bear Creek Park



**Prepared for:**

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Project No. 105763-01

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## EXECUTIVE SUMMARY

The City of Surrey (the City) is proposing to extend 84 Avenue from King George Boulevard to 140 Street (the Project) as part of a larger 84 Avenue extension initiative. Aplin & Martin Consultants Ltd. (Aplin Martin) was retained by the City to lead the Project and provide civil engineering services. Hemmera Envirochem Inc. (Hemmera) is providing environmental inputs for the Project on behalf of Aplin Martin.

Hemmera has reviewed and documented baseline conditions for the Project's environmental components including aquatic and terrestrial ecosystems in the Project study area.

The purpose of this Aquatic and Terrestrial Resources Baseline report is to document existing vegetation and wildlife habitat and fish and fish habitat present in the Project study area. Vegetation and wildlife species in BC are afforded legal protection and are managed under federal, provincial, and municipal legislation such as the federal *Fisheries Act*, *Species at Risk Act (SARA)*, *Migratory Birds Convention Act*, the provincial *Wildlife Act*, and various City Bylaws. Fish are protected by the federal *Fisheries Act* and streams (including wetlands) are protected by the provincial *Water Sustainability Act*.

A desktop review identified background information on native and invasive vegetation, protected vegetation and wildlife species, wildlife habitat, fish species, and watercourses that may occur within the Project study area. Field assessments were conducted within the Project study area between March 12 and May 20, 2021 with the following objectives:

- Assess and classify watercourses.
- Characterize fish and fish habitat values.
- Assess and characterize potential wetlands.
- Document occurrences of invasive vegetation and any unique wildlife habitat features incidentally observed.
- Assess wildlife habitat values associated with vegetated areas and watercourses based on biophysical attributes such as vegetation species composition, forest structure, aquatic features, and presence of veteran trees or coarse woody debris.
- Document any conspicuous stick nests afforded legal protection, specifically bald eagle (*Haliaeetus leucocephalus*) or great blue heron (*Ardea herodias*).
- Collect environmental DNA (eDNA) samples for detection of two at-risk species, northern red legged frog (*Rana aurora*), and Pacific water shrew (*Sorex bendirii*), from the watercourses of King Creek and Bear Creek.

Two fish-bearing watercourses cross through the Project study area: Bear Creek and King Creek (including a short tributary). Both watercourses support year-round salmonid presence and provide suitable habitat for one provincial fish species at risk (i.e., coastal cutthroat trout). Riparian habitat along Bear Creek was well established and predominantly consisted of native species. King Creek riparian habitat was characterized by maintained BC Hydro right-of-way and limited to low-lying shrubs and grasses and had increased invasive and non-native species encroachment.

Native vegetation and ecosystems in the Project study area were found to occur throughout Bear Creek Park, with a composition of forested, wetland, riparian, and shrubby/herbaceous areas. No at-risk plants with the potential to occur in the existing habitat present were observed during the field visit; however, identifying potential occurrences of these species was not the primary focus of the field assessments. Invasive vegetation was observed throughout much of the Project study area. Species identified as noxious under Schedule A of the Weed Control Regulation (and therefore require management) were only observed twice in the Project study area (knotweed and Canada thistle).

Habitat suitability for wildlife species was generally considered to be highly suitable for many species of terrestrial wildlife, offering breeding habitat for amphibians, nesting and foraging habitat for songbirds, raptors, and herons, and foraging and roosting habitat for bats. Bear Creek Park's location and designation as a Hub<sup>1</sup> in the City of Surrey's Green Infrastructure Network (GIN) was also considered highly important for terrestrial wildlife.

Habitat for at-risk species with the potential to occur in the Project study area was considered moderate to highly suitable for 12 species. Habitat for at-risk invertebrates may be present in the Project study area. High-value habitat was identified for at-risk amphibians, with the presence of northern red-legged frog confirmed in King Creek. Forested, riparian, wetland, and open habitat was found to offer moderate to high-value habitat for both at-risk birds and at-risk mammals.

No nests afforded legal protection (e.g., for some raptor or heron species) were observed during field assessments. Such nests can be constructed early each year, so the lack of observations in 2021 should not be interpreted as an indication of nesting habitat suitability nor does it preclude the potential for future nest construction.

This Executive Summary is not intended to be a stand-alone document, but a summary of findings as described in the following report. It is intended to be used in conjunction with the scope of services and limitations described therein.

This work was performed in accordance with a Work Order between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and Aplin & Martin Consultants Ltd. (Client), dated March 03, 2021 (Contract). This report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by Aplin & Martin Consultants Ltd.. In performing this work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the report was produced. The conclusions and recommendations contained in this report are based upon the applicable guidelines, regulations, and legislation existing at the time the report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

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<sup>1</sup> The GIN comprises 3 types of areas: Hubs, Corridors, and Sites. Hubs are defined as large, intact habitat areas > 10 hectares that provide habitat for a diversity of species. Hubs provides interior (core) habitat and refuge areas, can support species with larger home ranges, and provide refuge for species less tolerant of human disturbance.

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## LIST OF ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
Aplin Martin	Aplin & Martin Consultants Ltd.
BC	British Columbia
The City	City of Surrey
COSMOS	City of Surrey Mapping Online System
DFO	Fisheries and Oceans Canada
eDNA	environmental deoxyribonucleic acid
ESC	erosion and sediment control
FIDQ	Fisheries Inventory Data Queries
GIN	Green Infrastructure Network
Hemmera	Hemmera Envirochem Inc.
ISMP	Integrated Stormwater Management Plan
MBCA	<i>Migratory Birds Convention Act</i>
MFLNROD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
PVC	polyvinyl chloride
QEP	Qualified Environmental Professional
RAPR	Riparian Areas Protection Regulation
ROW	right-of-way
SARA	<i>Species at Risk Act</i>
SPEA	Streamside Protection and Enhancement Area
WSA	<i>Water Sustainability Act</i>

## LIST OF SYMBOLS AND UNITS OF MEASURE

Symbol / Unit of Measure	Definition
cm	centimetre
ha	hectare
km	kilometre
m	metre
mg	milligram
L	litre

## 1.0 INTRODUCTION

### 1.1 Project Background

The City of Surrey (the City) is proposing to extend 84 Avenue from King George Boulevard to 140 Street (the Project, **Figure 1**) as part of a larger 84 Avenue extension initiative. The purpose of the new road is to provide additional transportation capacity along east-west arterial roads through the central portion of the City, which is currently limited to two continuous arterial roads (i.e., 64 Avenue and 88 Avenue). The additional arterial road capacity is required to address traffic safety concerns, emergency response reliability, high traffic volumes on 88 Avenue, and traffic volume delays resulting from the limited connectivity between the Fleetwood and Newton neighbourhoods in the City of Surrey.

In 2000, 2007, and 2009, the City considered completing the missing segment of 84 Avenue between King George Boulevard and 140 Street. This was primarily in response to the traffic safety concerns, emergency response reliability, high traffic volumes on 88 Avenue, and delays caused by the lack of connectivity between Fleetwood and Newton. Since 2009, the City has grown by over 100,000 residents and severity of traffic collisions and congestion is becoming increasingly at the intersection of 88 Avenue and King George Boulevard, further necessitating the need for completing the remaining two segments of 84 Avenue. The intersection at 88 Avenue and King George Boulevard is the worst rated intersection in Surrey with respect to the number and severity of vehicle collisions that are occurring in that intersection. Completion of the 84 Avenue segment between King George Boulevard and 140 Street is expected to help improve traffic safety at the intersection of 88 Avenue and King George Boulevard by reducing traffic volumes and turning movements at 88 Avenue and King George Boulevard.

Completion of the Project will provide a significant multi-modal transportation corridor and connectivity for the communities of Newton and Fleetwood. The broader 84 Avenue corridor improvements will also integrate with existing higher order transit service with the R1 RapidBus along King George Boulevard, the upcoming R6 RapidBus on Scott Road, and the Surrey Langley Skytrain extension along Fraser Highway.

### 1.2 Project Description

The proposed Project will involve the construction of a road through a portion of the existing Bear Creek Park (**Figure 1**). Specific components of the Project will include:

- An arterial road alongside the existing 84 Avenue right-of-way (ROW) between King George Boulevard and 140 Street
- A multi-use pathway along the north side of the 84 Avenue extension
- A clear span crossing of Bear Creek and a box culvert crossing of King Creek
- A drainage ditch on south side of the new roadway
- An expansion of the existing parking lot located off 140 Street to include an additional 200 stalls.

Aplin & Martin Consultants Ltd. (Aplin Martin) was retained by the City to lead the Project and provide civil engineering services. Hemmera Envirochem Inc. (Hemmera) is providing the baseline environmental assessment for the Project on behalf of Aplin Martin. The baseline environmental assessment was conducted to identify aquatic and terrestrial resources present along the linear corridor, defined by the Project components, that will require planning consideration as part of future Project phases.



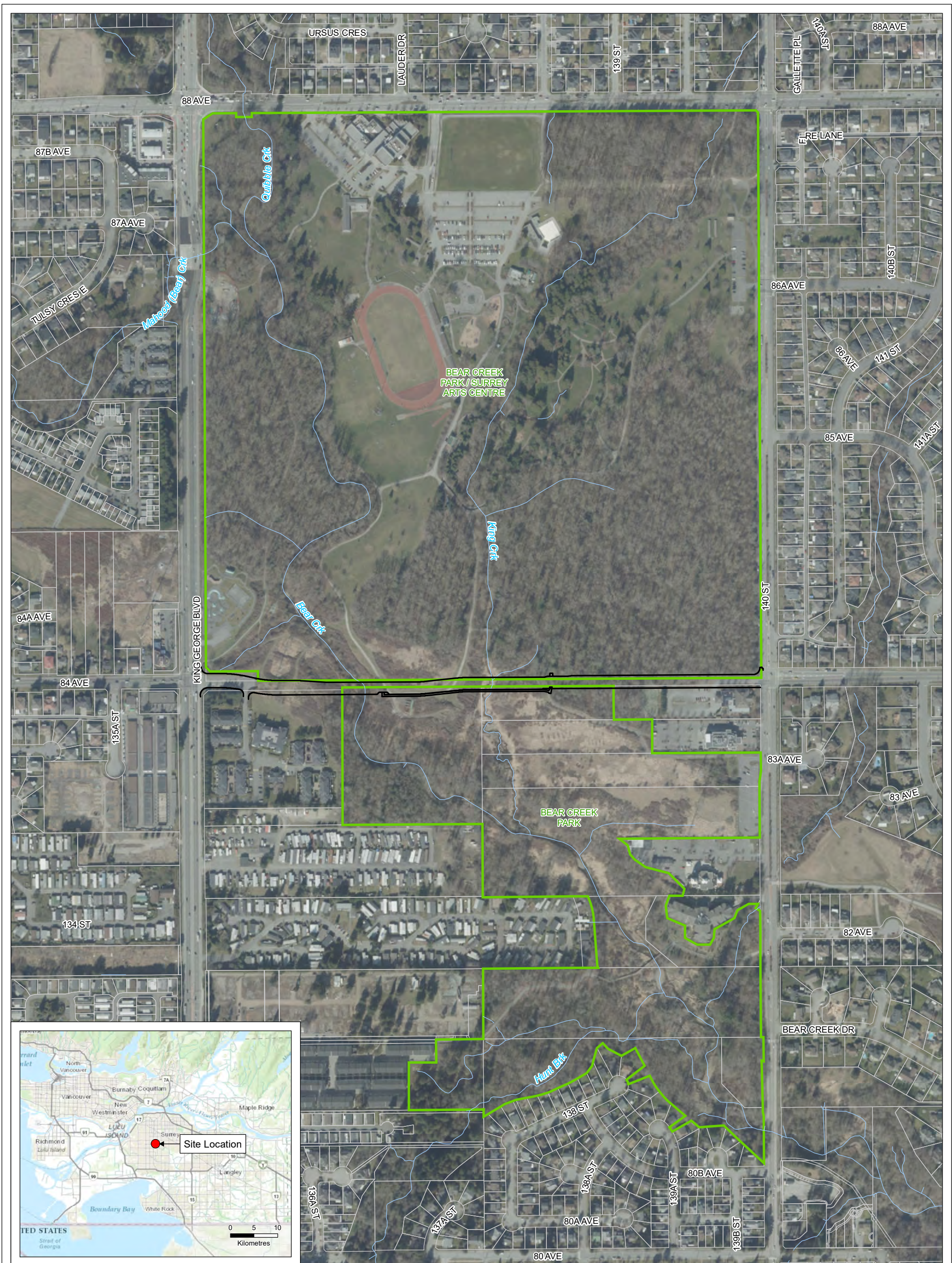
The Project is seeking to commence construction of the missing segment between King George Boulevard and 140 Street in the summer of 2021, completing the work by summer 2022. An extension of 84 Avenue between 124 Street and 128 Street will be completed in 2023 and will be assessed separately.

### 1.3 Scope of Work

An environmental baseline report characterizing existing aquatic and terrestrial ecosystem conditions within Bear Creek Park was requested by the City to understand the existing habitat values and the potential impacts of the Project on these environment resources and to inform Project permitting requirements. At the request of Aplin Martin, Hemmera has prepared an Aquatic and Terrestrial Ecosystems Baseline Report that considers the following ecological receptors (**Table 1**).

**Table 1 Ecological Receptors and Selection Rationale**

Ecological Receptor Category	Ecological Receptor	Rationale for Selection
Aquatic Environment	Fish and Fish Habitat	Identify fish species presence, fish habitat conditions, and fish habitat values associated with the Project that: <ul style="list-style-type: none"> <li>• Inform Project planning and design considerations.</li> <li>• Inform applicable regulatory requirements.</li> <li>• Inform future avoidance, mitigation, and offsetting requirements.</li> <li>• Determine applicable Project permitting and construction timing requirements.</li> </ul>
	Wetlands	Identify wetland conditions that support local site hydrology, important habitat features, and vegetation communities associated with the Project that: <ul style="list-style-type: none"> <li>• Inform Project planning and design considerations.</li> <li>• Inform applicable regulatory requirements.</li> <li>• Inform future avoidance, mitigation, and offsetting requirements.</li> <li>• Determine applicable Project permitting and construction timing implications.</li> </ul>
Terrestrial Environment	Vegetation	Identify existing vegetation conditions and values (i.e., important plant communities) and risks to vegetation (i.e., invasive plants species) associated with the Project that: <ul style="list-style-type: none"> <li>• Inform Project planning and design considerations.</li> <li>• Inform applicable regulatory requirements including those for weed control.</li> <li>• Inform future avoidance, mitigation, and offsetting requirements.</li> <li>• Determine applicable Project permitting and construction timing implications.</li> </ul>
	Wildlife and Wildlife Habitat	Identify existing wildlife communities and wildlife habitat values associated with the Project that: <ul style="list-style-type: none"> <li>• Inform Project planning and design considerations.</li> <li>• Inform applicable regulatory requirements.</li> <li>• Inform future avoidance, mitigation, and offsetting requirements.</li> <li>• Determine applicable Project permitting and construction timing implications.</li> </ul>
	Species at Risk	Identify species at risk with potential to occur or interact with the Project that: <ul style="list-style-type: none"> <li>• Inform Project planning and design considerations.</li> <li>• Inform applicable regulatory requirements.</li> <li>• Inform future avoidance, mitigation, and offsetting requirements.</li> <li>• Determine applicable Project permitting and construction timing implications.</li> </ul>

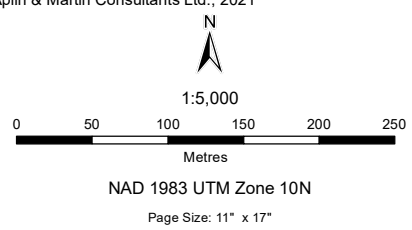


- Legend**
- Proposed Road Footprint
  - Watercourse
  - Bear Creek Park
  - Property Line

- Sources**
- Contains information licensed under the Open Government Licences - British Columbia, City of Surrey
  - Aerial Image: ESRI World Imagery
  - Inset Basemap: ESRI World Topographic Map
  - Road Alignment: 84th Avenue Extension King George Boulevard to 140 Street, Aplin & Martin Consultants Ltd., 2021

**Notes**

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.



84 Avenue Extension Between King George Boulevard to 140 Street

Proposed 84 Avenue Extension from King George Boulevard to 140 Street

105763-01 | Production Date: May 27, 2021 | Figure 1



Aplin & Martin Consultants Ltd.

Path: S:\Operations\Projects\105763-01\Drawings\210527.mxd

## 2.0 REGULATORY BACKGROUND

The following federal, provincial, and municipal environmental regulatory frameworks informed the selection of ecological receptors assessed in the baseline assessment. Each of these legislations provides regulatory requirements that guided assessments of potential impacts to the natural environment, particularly fish, vegetation, wildlife, and species at risk that may be present.

### 2.1 Federal

#### 2.1.1 Fisheries Act

The *Fisheries Act*, R.S.C., 1985, c. F-14 is the main federal law governing fisheries in Canada. The purpose of the Act (Section 2.1) is to provide a framework for the:

1. Proper management and control of fisheries.
2. Conservation and protection of fish and fish habitat, including by preventing pollution.

Fish habitat, as defined by the *Fisheries Act* under Subsection 2(1) is “water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas.”

The fish and fish habitat protection provisions apply to all fish and fish habitat throughout Canada. The Fish and Fish Habitat Protection and Pollution Prevention provisions of the Act include the following:

- A prohibition against causing the death of fish, by means other than fishing (Section 34.4)
- A prohibition against causing the harmful alteration, disruption, or destruction of fish habitat (Section 35)
- A framework of considerations to guide the Minister’s decision-making functions (Section 34.1)
- Ministerial powers to ensure the free passage of fish or the protection of fish or fish habitat with respect to existing obstructions (Section 34.3).

#### 2.1.2 Migratory Birds Convention Act

The *Migratory Birds Convention Act*, 1994, SC 1994, c. 22 (MBCA) affords protection to various species of migratory birds. Section 5 of the MBCA prohibits the possession of a migratory bird or nest. The MBCA also prohibits the deposit of any substances, by a person or vessel, that is harmful to migratory birds in water or areas frequented by migratory birds.

#### 2.1.3 Species at Risk Act

The *Species at Risk Act*, SC 2002, c. 29 (SARA) was created to prevent wildlife species from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and to manage species of special concern to prevent them from becoming threatened or endangered. SARA prohibits killing, harming, harassing, capturing, or taking wildlife listed as extirpated, endangered, or threatened (unless under the authorization of a permit).

The relevant sections of SARA include:

- Section 33: No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada.
- Section 34 (1): With respect to individuals of a listed wildlife species that is not an aquatic species or a species of birds that are migratory birds protected by the MBCA Sections 32 and 33 do not apply in lands in a province that are not federal lands unless an order is made under subsection (2) to provide that they apply.

## 2.2 Provincial

### 2.2.1 Environmental Management Act

The *Environmental Management Act*, SBC 2003, c. 53 regulates industrial and municipal waste discharge, pollution, hazardous waste, and contaminated site remediation. The EMA provides the authority for introducing wastes into the environment, while protecting public health and the environment. The Act enables the use of permits, regulations, and codes of practice to authorize discharges to the environment and the enforcement options, such as administrative penalties, orders, and fines to encourage compliance.

### 2.2.2 Integrated Pest Management Act

The *Integrated Pest Management Act*, SBC 2003, c. 58, provides prohibitions and restrictions for pesticide use and sale. A person may not use a pesticide that causes or is likely to cause, or use, handle, release, transport, store, dispose of or sell a pesticide in a manner that causes or is likely to cause, and unreasonable adverse effect, use, handle, release, transport, store, dispose of, or sell a pesticide other than in accordance with this Act and the regulations, or use, handle, transport, store or dispose of a pesticide in a manner that does not accord with the manner specified on the label of the pesticide container or in the manufacturer's instructions that accompany the pesticide.

### 2.2.3 Water Sustainability Act

Any changes in and about a stream in the province of BC are subject to Section 11 of the *Water Sustainability Act*, SBC 2014, c. 15 (WSA). Changes include any modification to the nature of the stream, (e.g., land, vegetation, natural environment, flow), or any activity or construction within the stream channel that may result in an adverse effect, this includes construction, removal, or maintenance of culverts and bridges, stormwater outfalls, and construction of stormwater management systems. Construction of works in and about a stream require either the submittal of a Notification or an Application for a Change Approval online through FrontCounterBC<sup>2,3</sup>. Notifications are used for low-risk changes in and about a stream that have minimal impact on the environment or third parties, as specified in Part 3 of the Water Sustainability Regulation. Change Approvals are written authorizations for 'significant' works that permanently alter the direction, pattern, or flow of a stream, including watercourse realignment and bank erosion protection.

<sup>2</sup> Based on conversation with the City of Surrey's Environmental Manager and previous professional experience, Class C ditches are not considered streams, rather as ditches designed for the conveyance of stormwater and do not discharge to fish habitat. Therefore, permitting under the WSA is not considered to apply to Class C watercourses.

<sup>3</sup> Recent direction from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRD) is to submit all WSA application components of a Project under one submission package. Therefore, if both Approval and Notifications are required for a project, they must be submitted under one Approval application.

## 2.2.4 Weed Control Act

The *Weed Control Act*, RSBC 1996, c. 487, and the Weed Control Regulation aim to control the spread of designated noxious weeds on all provincial Crown and private land in BC. There is an obligation under the Act for the land occupier to control these weeds. The Act requires all land occupiers to avoid establishment and dispersal of noxious weeds as defined by the Act.

## 2.2.5 Wildlife Act

The *Wildlife Act*, RSBC. 1996, c. 488, protects most native vertebrates from direct harm, regulates hunting and trapping, and protects nesting birds and active nests that are occupied by a bird or its egg(s). The nests of some bird species are protected year-round under Section 34b of the *Wildlife Act*, regardless of whether or not they are occupied. These protected nests include the active or inactive nests of peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), and great blue heron (*Ardea herodias*).

## 2.3 Municipal

### 2.3.1 Surrey Soil Conservation and Protection Bylaw, 2007 No. 16389

This Bylaw states that soil removal or deposition in the City may be permitted and shall only occur after a permit has been issued by the General Manager of the City's Engineering Department. In addition, all soil removal or deposit activities or operations, shall conform to the terms and conditions of the applicable permit, as well as standards and requirements prescribed in Schedule A of this Bylaw, including, but not limited to the following restrictions:

- 10 – No soil removal or deposit shall be undertaken within 7.5 m of any highway, [ROW] or utility easement without first obtaining written consent from the City or the authority having jurisdiction over the [ROW] or easement. The General Manager may, at any time, require evidence of such consent.
- 11 – Unless prior written approval to do otherwise has been granted by the General Manager, organic soil shall:
  - a. not be removed, deposited or stockpiled when the organic soil is saturated or powdery dry.
  - b. be stockpiled at heights not greater than 4.0 m and bermed with slopes no steeper than 2:1 (horizontal:vertical).
  - c. be stockpiled so that vegetation cover is established on the stockpile as soon as possible but no later than 30 days after handling and be fertilized and irrigated as required to maintain the vegetation cover.
  - d. be stockpiled in such way that allows weed control at all times, which control can be by mechanical or chemical means.
  - e. be stockpiled in such way that prohibits travel upon by any vehicles or heavy machinery.
  - f. be stockpiled without any mixing of foreign matters, such as hog fuel, gravel or other organic matters.
  - g. for highly organic soils such as peat, be monitored during dry periods to correct accelerated decomposition and excessive heat build-up.
  - h. be stockpiled to allow runoff from the stockpile to be diverted into catchment ponds or silt traps prior to discharge into natural watercourses or ditches or alternatively, a 3 m wide buffer zone may be provided, if approved by the General Manager, along the perimeter of the downslope sides of the stockpile.

### **2.3.2 Surrey Erosion and Sediment Control Bylaw, 2006 No. 16138**

The Surrey Erosion and Sediment Control (ESC) Bylaw was established to ensure that adequate protection of the City's drainage system is taken during any construction. An ESC Permit issued from the City is required, per stipulations in the ESC Bylaw. The ESC Permit Application must contain an ESC Plan that must be designed, signed, and sealed by a Professional Engineer as well as reviewed and signed by the appointed City ESC Supervisor. No construction shall occur until the City has issued an ESC Permit.

Once the permit has been received, all construction activities must be undertaken so that no sediment or sediment-laden water is discharged greater than a total suspended solids concentration of 75 milligrams per liter (mg/L), or as otherwise specified in the approved ESC Plan. Additionally, a waterproof copy of any issued ESC Permit, which clearly states the name and phone number of the appointed City ESC Supervisor and the City Bylaw Office, must be posted in a visible location and for the duration of construction activities in the City.

### **2.3.3 Surrey Tree Protection Bylaw, 2006 No. 16100**

Part 7 of the Surrey Tree Protection Bylaw states that any person wishing to cut or remove a protected tree shall apply to the General Manager for a tree cutting permit to cut or remove the tree. A tree cutting permit application shall be in a form approved by the General Manager. The tree cutting permit may determine the number, size, species, and location of replacement trees and required security for their provision and maintenance.

### **2.3.4 Pesticide Use Control Bylaw, 2011 No. 17160**

This Bylaw regulates application of pesticides on public and private lands in the City of Surrey.

## 3.0 METHODS

### 3.1 Study Area

The existing 84 Avenue road right of way between 140 Avenue and King George Boulevard was used to create appropriate study areas. For purposes of the baseline assessment, a 500 metre (m) buffer around the Project footprint was used during the desktop review, and a 50 m buffer around the Project footprint was used to conduct field assessments (**Figure 2**).

### 3.2 Aquatic Environment

Data sources used to inform the aquatic environment existing conditions included data provided by the City, government databases, and citizen science-driven web resources. The following data sources were reviewed:

- Fisheries Inventory Data Queries (FIDQ) (Government of British Columbia 2021b)
- Habitat Wizard (Government of British Columbia 2021c)
- Fisheries and Oceans Canada (DFO) Aquatic Species at Risk Map (Government of Canada 2021)
- Lower Bear Creek Park Integrated Stormwater Management Plan (ISMP) (Parsons 2015)
- iMap BC (DataBC 2021)
- Species and Ecosystems Explorer (BC CDC 2021)
- City of Surrey Mapping Online System (COSMOS) (City of Surrey 2021).

#### 3.2.1 Fish and Fish Habitat

A fish and fish habitat field assessment was completed within the Project study area by two Hemmera Biologists on March 12, 2021. During the assessment, weather conditions were clear and sunny, and rain was not recorded 24 hours prior to the field visit. The entire Project alignment was surveyed between 140 Street and King George Boulevard along the 84 Avenue ROW to ground truth watercourses that cross or parallel the alignment.

All watercourses encountered were assessed 50 m upstream and downstream of the alignment or, if shorter, along their entire extent. An assessment using modified Resources Inventory Committee methods (Government of British Columbia 2001) was completed, and the following aquatic habitat data was collected and characterized: fish observations and habitat associations, substrate conditions, channel pattern, channel morphology, channel conditions, cover habitat, anthropogenic features, channel stability conditions, riparian habitat form and function, crown closure, and *in situ* water quality data. Measurements for bankfull width, bankfull depth, wetted width, and wetted depth were collected along eleven evenly spaced transects through the assessed area for each watercourse. Stream channel gradient was collected using a clinometer and averaged over the assessed watercourse reach.

Unique aquatic habitat features, and conditions were mapped with a handheld global positioning system and photo-documentation along the watercourse assessment area was collected.

*In situ* water quality data was collected at the Project alignment crossing, 50 m upstream, and 50 m downstream. Measured parameters included dissolved oxygen, conductivity, pH and temperature. All parameters were measured using a YSI® ProDSS which was calibrated as per the manufacturer's specifications prior to use.

### 3.2.2 Wetlands

A wetland assessment was completed to characterize wetland conditions in the Project study area. Two wetland specialists completed a wetland assessment between March 12 and May 20, 2021; the methodology used for the wetland assessment is included as **Appendix A**.

### 3.2.3 Watercourse Classification

Hemmera determined watercourse classifications for waterbodies in the Project study area based on a review of desktop data, site assessment results, and the City's watercourse definitions outlined in **Table 2**.

**Table 2 City Watercourse Classifications**

Class	Definition
Class A (Red)	Inhabited by fish year-round or potentially inhabited by fish year-round. Considered 'streams' as defined by the Provincial <i>Water Sustainability Act</i> and Riparian Areas Protection Regulation. Considered fish habitat as defined by the <i>Federal Fisheries Act</i> .
Class A(O) (Red-dashed)	Inhabited by fish primarily during the over-wintering period or potentially inhabited by fish during the over-wintering period with access enhancement. Considered a 'stream' as defined by the Provincial <i>Water Sustainability Act</i> and Riparian Areas Protection Regulation. Considered fish habitat as defined by the <i>Federal Fisheries Act</i> .
Class B (Yellow)	Provides food/nutrient value to downstream fish habitat. No fish potential present at any time of the year. Considered a 'stream' as defined by the Provincial <i>Water Sustainability Act</i> and Riparian Areas Protection Regulation. Considered fish habitat as defined by the <i>Federal Fisheries Act</i> .
Class C (Green)	A water feature that is not considered a 'stream' as defined by the Provincial <i>Water Sustainability Act</i> and Riparian Areas Protection Regulation. Not considered habitat as defined by the <i>Federal Fisheries Act</i> . No fish potential present at any time of the year.

### 3.3 Terrestrial Environment

Data sources used to inform the terrestrial environment existing conditions included data provided by the City, government databases, and citizen-science driven web resources. The following data sources were reviewed:

- BC Great Blue Heron Atlas (Great Blue Heron Management Team 2017)
- City of Surrey Biodiversity Conservation Strategy (Diamond Head 2014)
- City of Surrey Mapping Online System (COSMOS) (City of Surrey 2021)
- eBird (eBird 2021)
- iMap BC (DataBC 2021)
- Lower Bear Creek Park Integrated Stormwater Management Plan (ISMP) (Parsons 2015)
- BC Conservation Data Centre Species and Ecosystems Explorer (BC CDC 2021)
- Wildlife Tree Stewardship Program (WiTS 2021).



### 3.3.1 Vegetation

A field assessment to document general vegetation species composition, invasive vegetation distribution, and to refine the potential for at-risk plants and ecosystems to occur was conducted on May 7, 2021. Ecosystem classification followed the biogeoclimatic ecosystem classification system described in Field Guide for Site Identification and Interpretation for the Vancouver Forest Region (Green and Klinka 1994).

The provincial Invasive Alien Plant Program database (DataBC 2021) was reviewed to identify known occurrences of invasive vegetation within the study area. A screening exercise to assess potential for at-risk vegetation was also conducted (see **Section 3.3.3**).

### 3.3.2 Wildlife and Wildlife Habitat

Hemmera's desktop study of wildlife and wildlife habitat in the Project study area included a review of known available literature (Diamond Head 2014; Parsons 2015) and online databases (e.g., eBird). The online database review also included the wildlife tree stewardship atlases (WiTS 2021; Great Blue Heron Management Team 2017) for records of known bald eagle or great blue heron nest locations (which are provided by government, industry, conservation and naturalist groups, and the public). The City also conducts annual nest inventories for eagles, herons, and barn owls (*Tyto alba*); these locations are available on internal COSMOS.

Wildlife habitat suitability was considered for amphibians, birds, and mammals during field surveys conducted between March 12 and May 7, 2021. Vegetation species composition, forest structure, aquatic features, and high value features, such as veteran trees or coarse woody debris, were used to assess habitat suitability.

### 3.3.3 Species at Risk

To determine the potential presence of at-risk species that may occur within the Project study area, Hemmera conducted a desktop review of publicly available online databases (DataBC 2021; Cornell Lab of Ornithology 2021). Hemmera screened all BC Conservation Data Centre's (CDC's) records for federally SARA-listed or provincially Red- or Blue-listed wildlife located in either BC Ministry of Environment Region 2 (Lower Mainland) or the Coastal Western Hemlock biogeoclimatic zone (BC CDC 2021). The results of these searches were combined and duplicate results were excluded. Data on posted Critical Habitat for SARA listed species in and around the Project study area was obtained from iMapBC (DataBC 2021) and compared spatially to the Project study area.

Each of the species identified during screening was assigned an occurrence likelihood value of nil, low, moderate, or high based on their potential to occur within the Project study area (**Table 3**).

**Table 3 Interpretation of Ranking of Wildlife Potential to Occur in Project Study Area**

Value	Interpretation
High	Current understanding of the species' range in combination with known species habitat associations suggests that the species is expected to occur in the Project study area regularly and in densities that would be expected to occur in provincial benchmark* habitats.
Moderate	Current understanding of the species range in combination with known species habitat associations suggests that the species is expected to occur in the Project study area on a temporary or regular (i.e., predictable) seasonal basis and in densities that facilitate persistence of a functional population within the Project study area.
Low	Current understanding of the species' range in combination with known species habitat associations suggests that the species is unlikely to occur within the Project study area with regularity or in adequate density to facilitate a functional population. Several ecological life-requisite stages would be challenged based on existing habitat conditions in the Project study area and/or connectivity with larger, more contiguous occurrence of the species.
Nil	Current understanding of the species' range in combination with known species habitat associations suggests that the species is not expected to occur within the Project area. Species occurrence in the Project area would be considered accidental.

\* The provincial benchmark is the highest capability habitat for a particular species in the province, against which all other habitats for that species are rated.

Species profiles, recovery strategies, and management plans were reviewed to determine suitable habitat conditions for at-risk species (COSEWIC 2011; Poole et al. 2020; Government of Canada 2014, 2015, 2016a, 2016b, 2017, 2018, 2020).

During field surveys conducted on April 28, May 5, and May 7, 2021, Hemmera biologists assessed the habitat value of at-risk species (e.g., vegetation composition, presence of water features, forest structure) and recorded any observations of wildlife species at risk. Hemmera also conducted environmental DNA (eDNA) sampling for two at-risk species (i.e., northern red-legged frog (*Rana aurora*), and Pacific water shrew (*Sorex bendirii*)). eDNA sampling is a non-invasive sampling method to detect the presence of aquatic and semi-aquatic wildlife species (Hobbs et al. 2017). eDNA methods are predicated on the fact that species exogenously shed their genetic material into their environment as they complete their life processes, and this exogenous DNA may become suspended in aquatic ecosystems. The presence of genetic material from the target taxa in water collected on site can indicate a species' use of sampled habitats.

Collection of eDNA was conducted in habitat that was identified during the desktop review as being potentially suitable for northern red-legged frog and Pacific water shrew. eDNA surveys were conducted when conditions allowed (i.e., where flowing water was present) on April 28 and May 5, 2021. Two sites were sampled in each of Bear Creek and King Creek: one site approximately 50 m upstream of the Project alignment and one site approximately 50 m downstream. One-litre water samples were collected in triplicate from each site. Water samples were filtered, and preserved filters were analyzed by Bureau Veritas in Guelph, Ontario.

Additionally, a novel approach using baited polyvinyl chloride (PVC) tubes was deployed with the intent of detecting Pacific water shrew foraging. Two 10 centimetre (cm) long PVC tubes were connected via a coupler, leaving a small trough in the middle of the tube to form a "bait trap." Two diameter sizes of PVC tubing were used: 12.7 cm (½ inch) and 19.1 cm (¾ inch). Pulverized compost worms (*Eisenia andrei*) were

placed in the trough between the tube and coupler (**Photo 1 and 2, Appendix C**). The tubes were deployed for 1 week, upstream and downstream of the Project footprint on Bear Creek and King Creek. Three tubes were placed within 15 m of the water sampling locations (**Figure 2, Photos 3 and 4, Appendix C**). This technique is based on the assumption that if Pacific water shrew are present within the study area, they will forage on the bait and their DNA should be detectable. The application of this method has not previously been used to detect Pacific water shrew, but has been successful at detecting sharp-tailed snakes (*Contia tenuis*) following a similar methodology (Matthias et al. 2021). Cotton tipped applicators soaked in 70% isopropanol were used to swab the inside of the tubes, with preserved cotton swabs also analyzed by Bureau Veritas.

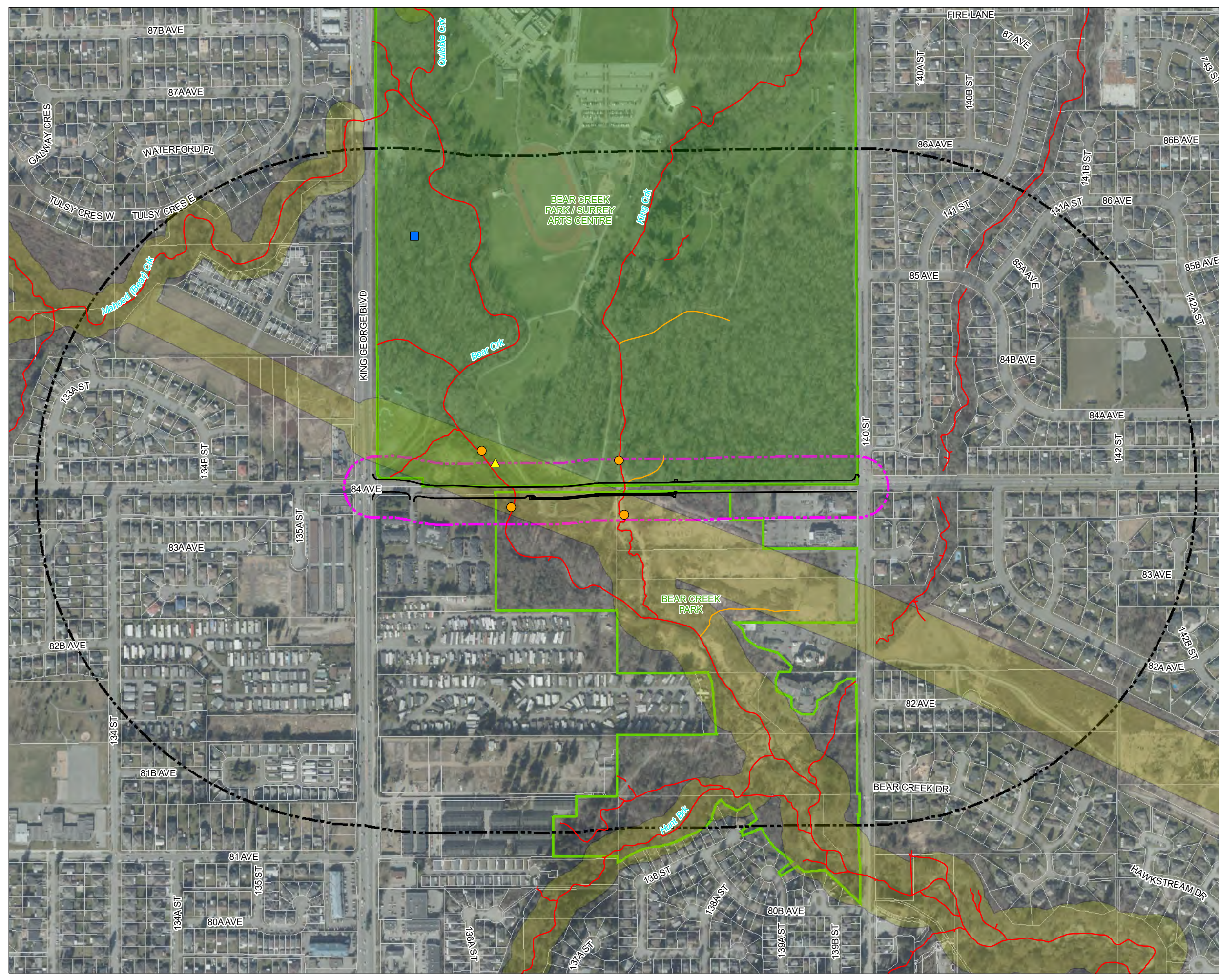
Due to the cryptic natures of Pacific water shrew and historic occurrence near the Project study area (see **Section 4.3.3**), specific biophysical attributes required by this species to meet life requisites were also recorded at all sites where eDNA samples were collected. These attributes include:

- A moist microenvironment that occurs in coniferous or deciduous forest, or dense marsh/wetland vegetation.
- An area of water (e.g., natural stream, wetland, or channelized watercourse, whether permanent, ephemeral, or intermittent) to support foraging.
- The presence of coarse woody debris to provide cover, as well as nesting and foraging substrate.

Habitat suitability at each site followed a Pacific water shrew habitat rating scheme previously developed by Hemmera (**Appendix B**) to evaluate critical biophysical attributes for the species, such as watercourse width and depth, connectivity, permanence of flow, riparian vegetation composition and structure, abundance of coarse woody debris, and shoreline access. A ranking of high, moderate, low, or nil suitability for each of four attributes was applied to each site (**Appendix B**).

84 Avenue Extension Between  
King George Boulevard to 140 Street

**Aquatic and Terrestrial Resources  
Baseline Characterization**



**Legend**

- COSMOS Bald Eagle Nest Location
- eDNA Sampling Location
- ▲ Knotweed Location
- Proposed Road Footprint
- Desktop Study Area
- Field Assessment Area
- Bear Creek Park
- Green Infrastructure Network Hub and Site
- Green Infrastructure Network Corridor
- Property Line

**Stream**

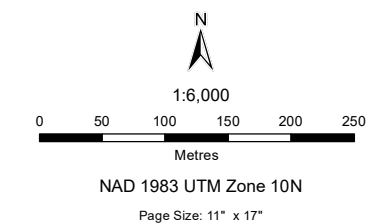
- Class A
- Class B

**Notes**

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

**Sources**

- Contains information licensed under the Open Government Licences - British Columbia, City of Surrey
- Aerial Image: ESRI World Imagery
- Road Alignment: 84th Avenue Extension King George Boulevard to 140 Street, Aplin & Martin Consultants Ltd., 2021



Path: S:\6\emissions\Project\105763\10\10\mxd\AF\Fig\_105763\_01\_AquaticResources\_210528.mxd

## 4.0 EXISTING CONDITIONS

### 4.1 Project Setting

The Project study area occurs within a vegetated park (i.e., Bear Creek Park) surrounded by residential and commercial development (**Figure 2**). Vegetation within the park comprises native trees, shrubs, and herbs in forested and riparian areas, and non-native shrubs and herbs occurring along edge habitats and field habitat (i.e., BC Hydro ROW).

The Project footprint is primarily aligned through or adjacent to the existing BC Hydro ROW, which is dominated by actively maintained low growing grasses and shrubs. The remainder of the Project footprint will pass through second-growth forest. The Project crosses 2 named watercourses, Bear Creek and King Creek, that flow through and converge within the park south of the Project study area.

The GIN comprises 3 types of areas: Hubs, Corridors, and Sites (Diamond Head 2014). Hubs are defined as large, intact habitat areas > 10 hectares (ha) that provide habitat for a diversity of species. Hubs provide interior (core) habitat and refuge areas, can support species with larger home ranges, and provide refuge for species less tolerant of human disturbance. Sites are small patches of habitat (< 10 ha) that provide habitat for fewer species than Hubs, and support species with smaller home ranges. Corridors are linear habitat areas that encourage the movement of species between fragmented Hubs and Sites, allowing species to access new habitat features required to meet their life needs.

Bear Creek Park acts as a Hub within the City's Green Infrastructure Network (GIN), while King Creek and Bear Creek act as GIN Corridors extending out from the park.

### 4.2 Aquatic Environment

#### 4.2.1 Fish and Fish Habitat Assessment

The fish and fish habitat assessment identified two watercourses that overlap the Project study area: Bear Creek and King Creek (including a short tributary) (**Figure 2**). A discussion of fish and fish habitat for each watercourse is provided in **Sections 4.2.1.1** and **4.2.1.2**. One aquatic at-risk species was identified as having the potential to occur within the Project study area – the provincially Blue-listed coastal cutthroat trout (*Oncorhynchus clarkii clarkii*). Critical habitat requirements for coastal cutthroat trout include cool waters, small gravels (< 85 millimetre) for spawning (NRCS 2007), and deep pools for rearing (Government of British Columbia 2021a). These habitats are present in Bear Creek and King Creek. Small gravels were present in adequate quantities for spawning, and deep pools, although limited, are available for over-wintering and summer rearing of cutthroat trout. No documented occurrences of federally-listed aquatic species at risk or their critical habitat is located in the Project study area (Government of Canada 2021).

##### 4.2.1.1 Bear Creek

Bear Creek (aka/alias Mahood Creek – watershed code: 900-005500-48100, **Photos 5 to 8, Appendix C**) is a 10.6 kilometre (km) long, 4<sup>th</sup> order tributary to the Serpentine River. Its headwaters are bound to the west of King George Boulevard to 128 Street. Bear Creek has several named tributaries including King Creek, Quibble Creek and Hunt Brook. Bear Creek flows in a southerly direction through

Bear Creek Park before its confluence with the Serpentine River in the 15200 block of 64 Avenue approximately 7 km southeast of the Project. COSMOS mapping classifies Bear Creek as a Class A<sup>4</sup> stream (City of Surrey 2021); this classification was field confirmed during the site assessment.

Bear Creek provides habitat for a variety of salmonid and coarse fish species; a review of the provincial FIDQ (Government of British Columbia 2021b) provides a list of species and their known occurrences in the system (**Table 4**).

**Table 4 Summary of Documented Fish Species in Bear Creek**

English Name	Latin Name	Status	BC List
Bullhead (general)	<i>Ameiurus</i> sp.	Exotic	-
Sculpin (general)	<i>Cottus</i> sp.	Native	-
Threespine stickleback	<i>Gasterosteus aculeatus</i>	Native	Yellow
Lamprey (general)	<i>Lampetra</i> sp.	Native	-
Western brook lamprey	<i>L. richardoni</i>	Native	Yellow
Pumpkinseed	<i>Lepomis gibbosus</i>	Exotic	-
Peamouth chub	<i>Mylocheilus carinus</i>	Native	Yellow
Coastal cutthroat trout	<i>O. clarki clarki</i>	Native	Blue
Pink salmon	<i>O. gorbuscha</i>	Native	No status
Chum salmon	<i>O. keta</i>	Native	No status
Coho salmon	<i>O. kisutch</i>	Native	No status
Rainbow trout	<i>O. mykiss</i>	Native	Yellow
Steelhead	<i>O. mykiss</i>	Native	Yellow
Sockeye salmon	<i>O. nerka</i>	Native	No status
Chinook salmon	<i>O. tshawytscha</i>	Native	No status
Redside shiner	<i>Richardsonius balteatus</i>	Native	Yellow
Sturgeon (general)	<i>Acipenser</i> sp.	Native	-

At the proposed road alignment, Bear Creek is confined within a shallow ravine with steep embankments to the east and west, and the riparian corridor is well established. Within the Project study area, Bear Creek has a sinuous channel pattern, riffle-pool channel morphology, and stream gradient of approximately 1%. Signs of American beaver (*Castor canadensis*) activity were prevalent throughout the Project study area and anthropogenic refuse (e.g., tires, plastic, discarded clothes) was commonplace. Crown closure ranged between 50 and 75% along the assessed reach and was strongly influenced by active management of regenerating trees by BC Hydro vegetation management crews.

<sup>4</sup> According to the City of Surrey's fish classification system:

**Class A:** Watercourse supports fish species year-round.

**Class B:** Watercourse is non-fish-bearing, but a source of food or nutrients for downstream fish habitat.

**Class C:** Watercourse is non-fish-bearing and does not provide food or nutrients to downstream fish habitat.

Upstream of the Project alignment, the average bankfull width was approximately 8.5 m, bankfull depth was 1.0 to 1.5 m, and substrates were comprised of boulder (2%), gravel/cobble (85%), and fines (13%) in the elongated pool/deeper pool areas. The upstream right (west) bank was periodically armoured with rip rap with one contiguous 10 m section present. An approximate 50 m<sup>2</sup> gravel bar was present approximately 15 m upstream of the road alignment and immediately downstream of a large, elongated pool (approximately 1 m depth). There was a small backwater area present on the left (east) bank, at the downstream end of the elongated pool, which likely activates during high flow periods. Upstream of the elongated pool, a small riffle sequence is present; there is a large tangle of willows (*Salix* sp.) (approximately 3 m wide by 5 m long) immediately adjacent to the riffle sequence along the left channel bank. Cover habitat along the channel was present in the form of moderate overhanging and undercut banks with trace amounts of large woody debris present. This cover provides habitat complexity and areas of refuge for fish species in the creek.

Fry of year, likely coho salmon (*Oncorhynchus kisutch*), were observed within/under the root mass of the willow tangle. The area upstream of the alignment represents viable rearing habitat with areas that may provide suitable spawning habitat for salmonid species present.

Riparian vegetation upstream of the alignment was well established and consisted of diverse native and invasive plant, shrub, and tree species. Dominant species include willow and red alder (*Alnus rubra*) with Himalayan blackberry (*Rubus armeniacus*) dominating the right bank and much of the understory; invasive knotweed<sup>5</sup> was observed upstream of the willow tangle on the left bank.

Downstream of the Project alignment, the average bankfull width was approximately 9 m, bankfull depth was 1.5 m, and substrates were comprised of boulders (5%), gravel/cobble (85%), and fines (10%). The frequency of larger, deeper pools increased downstream of the alignment. Anthropogenic alterations including rip rap banks and concrete were common and included a relic concrete structure along the left bank, old drainage infrastructure (e.g., old culverts), and a rock weir located approximately 15 m downstream of the road alignment. Based on these observations it was suspected there may have been a previous crossing of Bear Creek downstream of the Project alignment. Approximately 40 m to 50 m downstream of the alignment, vertical clay banks are present along the right bank and one area had significant iron ochre staining and discharge. Adjacent to the clay banks, a large gravel bar was present that contributes to a linear stretch of creek and likely provides a good source of spawning substrate for salmonid species such as chum salmon (*O. keta*). A variety of cover habitat was present including moderate undercut banks, large boulders, overhanging vegetation, deep pools, and large organic debris.

Fry of the year and resident costal cutthroat trout (*O. clarki clarki*) were observed in the deeper pools that were present downstream of the Project study area. Bear Creek provides good quality habitat for salmonid rearing and spawning within the Project study area.

Riparian vegetation downstream of the Project alignment was similar to the upstream composition; however, the area downstream of the alignment begins to flatten forming a low-lying bench along the left bank. This left bank bench was dominated by red alder, black cottonwood (*Populus trichocarpa*), and

<sup>5</sup> Four invasive knotweed species are known to occur in BC: Japanese knotweed (*Fallopia (Reynoutria) japonica* var. *japonica*), giant knotweed (*F. (R.) sachalinensis*), Bohemian knotweed (*F. (R.) x bohemica*), and Himalayan knotweed (*Polygonum (Koenigia) polystachya*). All 4 species are similar in appearance, biology, impacts, and distribution. Treatment methods do not differ between species, and all 4 are designated as noxious under Schedule A of the BC Weed Control Regulation.

an understory of willow, osoberry (*Oemleria cerasiformis*), salmonberry (*Rubus spectabilis*), English holly (*Ilex aquifolium*), Himalayan blackberry, ivy (*Hedera* sp.), sword fern (*Polystichum munitum*) and reed canarygrass (*Phalaris arundinacea*).

#### 4.2.1.2 King Creek

King Creek (watershed code: 900-005500-48100-61500, **Photos 9 to 13, Appendix C**) is a 1.43 km long, 2<sup>nd</sup> order tributary to Bear Creek. Its headwaters are located north of Fraser Highway in Green Timbers Urban Forest, 152 Street to the east, and the Mahood Creek drainage area to the west. King Creek flows in a southerly direction through Bear Creek Park to its confluence with Bear Creek in the 8300 block of 140 Street approximately 250 m south of the Project. King Creek is a Class A stream (City of Surrey 2021); this classification was field confirmed during the site assessment.

King Creek supports a variety of salmonid and coarse fish species; a review of the provincial FIDQ (Government of British Columbia 2021b) provides a list of species and their known occurrences in the system (**Table 5**).

**Table 5 Summary of Documented Fish Species in King Creek**

English Name	Latin Name	Status	BC List
Threespine stickleback	<i>Gasterosteus aculeatus</i>	Native	Yellow
Lamprey (general)	<i>Lampetra</i> sp.	Native	-
(Coastal) cutthroat trout	<i>Oncorhynchus. Clarki (clarki)</i>	Native	(Blue)
Coho salmon	<i>O. kisutch</i>	Native	No Status

At the proposed road alignment, King Creek has a well-defined channel within a shallow ravine with floodplain present on either side. Riparian vegetation was dominated by grasses (i.e., reed canarygrass) and Himalayan blackberry. King Creek has a sinuous channel pattern, riffle-run small pool channel morphology, and average channel gradient of 2% within the Project study area. Anthropogenic debris such as tires, plastic, and garbage were identified throughout the Project study area. Crown closure was 0% along the assessed reach.

The average bankfull width was approximately 2.5 m, bankfull depth ranged between 1.0 and 1.5 m, and substrates were comprised of fines (65%), gravel (25%), and boulder/cobble (10%). Cover habitat along the channel was present in the form of moderate undercut banks, deep pools, and large woody debris. An angular rip rap weir was present upstream of the road alignment. This weir had formed a large pool upstream and had functional large woody debris present. Immediately upstream of the Project alignment, a small tributary drainage discharged into King Creek along the left (east) bank. This tributary was wetted during the assessment with direct surface flow connection with King Creek and had no apparent obstacles to fish access. The tributary had minor flow and is expected to be ephemeral. This tributary was classified as a Class A(O) stream. Approximately 70 m upstream of the Project alignment King Creek is crossed by a pedestrian bridge; significant iron staining was observed on the southwest side of the west side of the bridge structure.



During the assessment, coastal cutthroat trout, salmon fry and threespine stickleback (*Gasterosteus aculeatus*) were observed within the pool habitat upstream of the weir. Fish habitat values in King Creek (within the Project study area) were characterized as providing marginal spawning habitat (predominantly localized to areas downstream of the pedestrian bridge crossing) and moderate rearing habitat values. Fry of year, likely coho salmon, were observed in the deeper pools that were present downstream of the Project study area.

Riparian vegetation on the west side of King Creek consisted of Himalayan blackberry and reed canarygrass. On the east side, riparian vegetation consisted of reed canarygrass and policeman's helmet (*Impatiens glandulifera*), with limited presence of native vegetation under the BC Hydro ROW (i.e., beaked hazelnut (*Corylus cornuta*), hardhack (*Spiraea douglasii*), Pacific ninebark (*Physocarpus capitatus*), osoberry and salmonberry).

#### 4.2.1.3 Water Quality Data

Water quality results are presented in **Table 6**. All measured water quality parameters were within acceptable range to support salmonid fish species habitat (Government of British Columbia 2019).

**Table 6 In-situ Water Quality Results**

Watercourse	Site ID	Location	Water Temperature (°C)	pH	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
Bear Creek	B-1	Upstream	7.6	6.53	345.1	13.09	1.69
	B-2	Alignment	7.6	6.54	367.1	12.72	1.74
	B-3	Downstream	7.6	6.41	344.4	12.74	1.87
King Creek	K-1	Upstream	7.0	6.26	198.0	12.49	1.90
	K-2	Alignment	7.0	6.36	198.1	12.36	1.81
	K-3	Downstream	7.1	6.63	196.7	12.24	2.14
King Creek Tributary	T1	-	6.4	6.53	88.2	12.78	12.41

#### 4.2.2 Watercourse Classification

The City's watercourse classification for each watercourse assessed in the Project study area is provided in **Table 7**.

**Table 7 City Watercourse Classification and Streamside Protection Area Setbacks**

Watercourse	Watercourse Type	Classification
Bear Creek	Stream	A
King Creek	Stream	A
King Creek Tributary	Stream	A(O)

### 4.2.3 Wetland Assessment

An assessment of potential wetlands along the proposed Project route through Bear Creek Park was conducted between March 12 and May 20, 2021. The findings of the wetland assessment are included in **Appendix A**.

## 4.3 Terrestrial Environment

### 4.3.1 Vegetation

The terrestrial environment is composed of forested, riparian, and shrubby/herbaceous areas. The eastern portion of the Project occurs in a naturalized area of second- (or possibly third-) growth mixed forest which extends to the north beyond the Project into Bear Creek Park (**Photos 14 and 15, Appendix C**). The western portion of the Project alignment occurs in open grassy fields with shrubby patches (and riparian zones where it crosses the 2 creeks), which are periodically managed through cutting as part of BC Hydro ROW maintenance (**Photo 16, Appendix C**). Though review of the Invasive Alien Plant Program database showed no documented occurrences of invasive vegetation in the Project study area, field assessments confirmed the presence of several invasive plant species, listed in **Table 8**.

**Table 8 Invasive Plant Species Observed in Project Area**

English Name	Latin Name	Provincial Invasive Species Priority List <sup>6</sup>	Regulated Under
Policeman's helmet	<i>Impatiens glandulifera</i>	Regional containment/Control	-
Reed canarygrass	<i>Phalaris arundinacea</i>	-	Community Charter <sup>7</sup>
Himalayan blackberry	<i>Rubus armeniacus</i>	Regional containment/Control	-
Common tansy	<i>Tanacetum vulgare</i>	Regional containment/Control	-
Scotch broom	<i>Cytisus scoparius</i>	Regional containment/Control	-

The Lower Bear Creek ISMP found no listed at-risk vegetation species during field surveys, but due to survey timing (late fall), many herbaceous species were not identified (Parsons 2015). Parsons indicated that the site may provide habitat for at least 3 provincially listed species including the blue-listed pointed broom sedge (*Carex scoparia*) and Vancouver Island beggarticks (*Bidens amplissima*), as well as the red-listed streambank lupine (*Lupinus rivularis*). These species may occur along the floodplain and banks of Bear and/or King creeks.

Hemmera's species at risk screening exercise (described in **Section 3.3.3**) identified 2 additional species at risk that could be present within Bear Creek Park: pink water speedwell (*Veronica catenata*) and Roell's brotherella (*Brotherella roellii*). All at-risk vegetation species were considered to have a low likelihood of occurrence based on suboptimal habitat conditions and known distribution range in BC.

<sup>6</sup> Provincial Invasive Species Priority List [https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/publications/provincial\\_priority\\_is\\_list.pdf](https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/publications/provincial_priority_is_list.pdf)

<sup>7</sup> [https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/144\\_2004](https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/144_2004)

Ecological communities are also listed in the screening exercise. The forested area described during the vegetation assessment is classified as the Coastal Western Hemlock very dry maritime high bench floodplain (CWHxm1 08 – Sitka spruce – salmonberry) which is provincially blue-listed.

During the field assessments, a diversity of native plant species were observed. Within the forested area, the dominant trees consisted of black cottonwood and red alder (*Alnus rubra*) with some western redcedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*). The dense shrub understory was composed primarily of osoberry (*Oemleria cerasiformis*), vine maple (*Acer circinatum*) and salmonberry, with some red elderberry (*Sambucus racemosa*). The thick blanket of herbaceous ground covers was dominated by false lily-of-the-valley (*Maianthemum dilatatum*) and Pacific bleeding heart (*Dicentra formosa*) interspersed with tall fringecup (*Tellima grandiflora*), piggyback plant (*Tolmiea menziesii*), spiny wood fern (*Dryopteris expansa*), sword fern, trailing blackberry (*Rubus ursinus*) and western trillium (*Trillium ovatum*).

Along the southern edge of the forested area was a dense fringe of native and invasive shrubs, including Himalayan blackberry (*Rubus armeniacus*) and willows (*Salix* sp.).

Riparian habitat along King Creek was dominated by dense reed canarygrass and some patches of jewelweed, otherwise known as policeman's helmet (*Impatiens glandulifera*). Native species included vine maple and horsetail (*Equisetum arvense*).

In the open habitats within the ROW are patches of native hardhack, red-osier dogwood (*Cornus sericea*), and willows with large hedgerows of invasive Himalayan blackberry. The majority of the ROW is dominated by invasive reed canarygrass and Scotch broom (*Cytisus scoparius*). A single occurrence of suspected Canada thistle (*Cirsium arvense*) was also documented.

#### 4.3.2 Wildlife and Wildlife Habitat

The Project study area contains a diversity of wildlife habitat types from open grass and shrub areas under the BC Hydro ROW to mature mixed wood forests, wet upland forest, shrub swamp, and riparian zones adjacent to Bear and King creeks. The presence of creek habitats ensures a constant water source, which is an important habitat value for many wildlife species. For example, low-lying wet areas and riparian habitats may support breeding amphibians and foraging mammals. In addition, Bear Creek Park attracts a large variety of bird species during the breeding season, including songbirds, raptors, and waterbirds, and provides year-round habitat for many resident avian species (eBird 2021).

Bear Creek Park is a GIN Hub and Corridor (**Figure 2**), providing large (> 10 ha), core habitat areas as well as connectivity between other high suitability habitat areas, including Green Timbers Urban Forest to the north (Diamond Head 2014). Within Bear Creek Park, the riparian zones of Bear and King creeks have been documented as wildlife Corridors having high use, as well as the BC Hydro ROW (Parsons 2015).

Suitable nesting habitat occurs for many bird species in the Project study area. Habitat for songbirds protected under the MBCA is considered highly suitable throughout Bear Creek Park, with over 120 species documented in the park (eBird 2021). A pair of mallards (*Anas platyrhynchos*) were observed on Bear Creek north of the road alignment during 2 field visits, and a red-tailed hawk (*Buteo jamaicensis*) was observed perching on the furthest east 500 kV BC Hydro tower on 3 separate field visits, but no nests were observed.

Great blue herons were observed along King Creek on multiple field visits, but no known great blue heron nests were identified during the desktop review of protected nests or during field assessments. No other nests afforded year-round protection (e.g., bald eagle) were documented during desktop review and no bird nests were observed during the 2021 field assessments.

Small- and medium-sized mammals were also observed during the 2021 field assessments (e.g., mice, squirrels) within the Project study area. Evidence of American beaver was observed near Bear Creek (i.e., recent tree gnawing). No bat species were observed but, based on the habitat in Bear Creek Park (e.g., mature trees, open flyways, sources of water), bats are anticipated to be roosting and foraging in and around the Project study area. A dead gartersnake (*Thamnophis* sp.) and a dead coast mole (*Scapanus orarius*) were also observed incidentally, and coyote (*Canis latrans*) scat was observed under the BC Hydro ROW.

#### 4.3.3 Species at Risk

The desktop wildlife screening identified all terrestrial species at risk or species afforded legal protection that could occur in the Project study area. The desktop screening exercise for species at risk resulted in 47 terrestrial invertebrate and vertebrate species with a low, moderate, or high likelihood of occurring in the Project study area. Eleven of these species were considered as having a moderate or high likelihood of occurring (**Table 9**). Rationale for why potential occurrence for each species is provided in **Table 9**. The complete list including species with a low likelihood of occurring is presented in **Appendix D**.

No posted Critical Habitat for SARA listed species occurs in the Project study area. One species at risk occurrence from Bear Creek (aka Mahood Creek); Pacific water shrew was last documented using this watercourse in 2004; however, the exact location of the observation is unknown (DataBC 2021). No other historic occurrences of species at risk were found within 1 km of the Project study area (northern red-legged frog was the nearest species at risk identified (from desktop assessment), approximately 2 km away in Lay Creek in Green Timbers Urban Forest).

**Table 9 Species at Risk Likely to Occur in the Project Study Area**

English Name	Latin Name	BC List	SARA Status	Local Habitat Needs	Likelihood of Occurrence	Rationale
<b>Invertebrates</b>						
Oregon forestsnail	<i>Allogona townsendiana</i>	Red	Endangered	Forest with leaf litter	L/M	Documented occurrences in South Surrey but no confirmed occurrences within 10 km of Project study area; although, habitat may be suitable.
Western thorn	<i>Carychium occidentale</i>	Blue	-	Forest with leaf litter	L/M	No confirmed occurrences in the Project study area but has been documented in Tynehead Regional Park (within 5 km); although habitat may be suitable.
<b>Amphibians</b>						
Northern red-legged frog	<i>Rana aurora</i>	Blue	Special Concern	Forest, open habitat, open water, riparian habitat, watercourses, wetland	H	Documented presence in King Creek, habitat is suitable.
Western toad	<i>Anaxyrus boreas</i>	Yellow	Special Concern	Forest, open water, open habitat, riparian habitat, watercourses, wetland	M	Uncommon in Metro Vancouver, but known to sporadically occur; habitat is suitable.
<b>Birds</b>						
Bald eagle	<i>Haliaeetus leucocephalus</i>	No Status	-	Forest, riparian habitat, open habitat, open water, wetland	H	Species not endangered but nests are protected year-round, and documented occurring in and around Project study area.
Barn swallow	<i>Hirundo rustica</i>	Blue	Threatened	Forest, open water, open habitat, riparian habitat, urban, watercourses, wetland	M	Documented occurrences from Bear Creek Park. Foraging habitat present, but nesting habitat absent in Project study area.
Great blue heron, <i>fannini</i> subspecies	<i>Ardea herodias fannini</i>	Blue	Special Concern	Forest, open habitat, open water, riparian habitat, urban, wetland	H	Documented occurring in and around Project study area.
Peregrine falcon	<i>Falco peregrinus</i>	No Status	Special Concern	Open habitat, open water, riparian habitat, urban, watercourse, wetland	M	Documented occurrences from Project study area, not highly suitable habitat, but may forage in Bear Creek Park and may nest on transmission towers.

English Name	Latin Name	BC List	SARA Status	Local Habitat Needs	Likelihood of Occurrence	Rationale
<b>Mammals</b>						
Little brown myotis	<i>Myotis lucifugus</i>	Yellow	Endangered	Forest, open habitat, riparian habitat, urban	H	Assumed presence within Project study area as habitat is suitable and species is ubiquitous.
Pacific water shrew	<i>Sorex bendirii</i>	Red	Endangered	Forest, riparian habitat, watercourses, wetland	M	Documented occurrences in Bear (Mahood) Creek, location in relation to Project study area is unknown. Could potentially be present in Bear Creek or King Creek as habitat is potentially suitable in each watercourse.
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	Blue	-	Forest, riparian habitat, urban	M	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area. Foraging habitat present.

No documented occurrences of at-risk invertebrates were identified; however, suitable habitat for terrestrial gastropods such as Oregon forestsnail and western thorn may occur in associations of bigleaf maple (*Acer macrophyllum*), black cottonwood, Douglas-fir, and stinging nettle (*Urtica dioica*).

The highest-suitability habitat for at-risk amphibians were in the 2 creeks, with King Creek offering higher suitability for breeding due to the occurrence of aquatic vegetation. The eDNA sampling results for northern red-legged frog resulted in a positive detection in King Creek, but no detection in Bear Creek.

Four at-risk or legally protected bird species were considered as having a moderate to high potential to occur in the Project study area. Foraging habitat for barn swallow (e.g., open habitat, watercourses) was considered suitable, but nesting habitat for this species (e.g., buildings, bridges) was not documented in the Project study area. Habitat for at-risk or protected raptors (i.e., bald eagle and peregrine falcon) was considered suitable for both foraging (e.g., open habitat with high perching locations) and nesting (e.g., large trees, 500 kV transmission towers) life requisites. Foraging habitat for great blue heron was also considered highly suitable (e.g., two creeks), with numerous observations made during field assessments; as great blue herons tend to nest in colonies, nesting habitat was considered moderately suitable in the Project study area due to the relatively low abundance of large trees capable of supporting multiple nesting individuals. One bald eagle nest was determined to occur within Bear Creek Park, approximately 400 m north of the proposed road alignment (**Figure 2**) (City of Surrey pers. comm. 2021). No nests afforded legal protection were identified within the Project study area.

Two at-risk bat species were considered likely to occur in the Project study area, with little brown myotis assumed to be present (**Table 9**). Foraging and roosting habitat are abundant in the Project study area, but hibernation habitat (i.e., veteran trees > 50 cm diameter at breast height with sign of decay or cavities) was not observed.

Pacific water shrew was the only other at-risk mammal considered to potentially occur in the Project study area. The highest rated Pacific water shrew habitat was at King Creek, north of the road alignment (**Figure 2**) where the habitat was assessed as moderate suitability (**Appendix B**). This site had relatively low levels of invasive vegetation (e.g., reed canarygrass and Himalayan blackberry) and relatively higher levels of coarse woody debris than the other sites. The other three sites were assessed as low to moderate suitability for Pacific water shrew due to steep channel banks, heavy invasive species cover, and sparse coarse woody debris presence. eDNA for Pacific water shrew was not detected in water samples taken either creek; eDNA was also not detected using the baited tube technique, despite evidence of foraging (i.e., no bait remaining in PVC tubes) (**Appendix E**).

## 5.0 SUMMARY AND CONCLUSIONS

Hemmera conducted a desktop review in March and April 2021 and subsequent field assessments between March 12 and May 7, 2021 in the Project study area to document baseline conditions that will inform potential project interactions with aquatic and terrestrial resources.

The Project study area overlaps two fish-bearing watercourses: Bear Creek and King Creek (including a short tributary stream) and has the potential to support habitat for the Blue-listed coastal cutthroat trout. Fish habitat in Bear Creek provides viable rearing and potential spawning habitat for salmonids; King Creek provides moderate rearing and marginal spawning habitat for salmonids. Riparian vegetation along Bear Creek was well-established and vegetation composition was predominantly of native species. King Creek riparian vegetation was characterized by modified BC Hydro ROW conditions whereby, vegetation was limited to low-lying shrubs and grasses and included the encroachment of dense thickets of non-native and invasive plants (i.e., reed canarygrass and Himalayan blackberry). Instream and riparian fish habitat will require protection and restoration to the extent practicable. Where protection and restoration are not possible, compensation will be necessary.

The Project study area is a mosaic of natural habitats including regenerating forest and riparian corridors, interspersed with disturbed, open habitats along the BC Hydro ROW, all of which contain a mix of native and non-native vegetation. Five at-risk plant species were considered to have a low potential to occur in the Project study area due to restricted distribution ranges and suboptimal habitat conditions. No at-risk plants with the potential to occur were observed in 2021 during the vegetation surveys. One blue-listed ecological community, the CWHxm 08 high bench floodplain, was observed during the vegetation field assessment. As a best practice, a rare plant survey should be conducted in advance of Project construction.

The wetland assessment identified wet areas through the east side of the Project study area (east of Bear Creek); however, habitat characterized as wetland was limited to two polygons of shrub swamp that possessed the vegetative and soil indicators of this type of wetland habitat.

Invasive vegetation was observed throughout much of the Project study area, with the most commonly observed species being Himalayan blackberry and reed canarygrass as well as some Scotch broom, common tansy and jewelweed. A small amount of Canada thistle, identified as noxious under Schedule A of the Weed Control Regulation, was observed in the Project study area, and would require additional management considerations during Project construction.

An arborist survey to identify protected trees was not conducted as part of baseline data collection therefore an assessment by a certified arborist should also be conducted to help inform potential Project interactions.

Habitat suitability for wildlife species along the Project corridor was generally considered to be highly suitable for many species of terrestrial wildlife (e.g., amphibian breeding, songbird, raptor, and heron nesting and foraging, bat roosting). Many bird species afforded protection under MBCA are known to occur in the Bear Creek Park; no bird nests were observed in the Project study area during any field assessment, but new nests may be constructed into June and July, and additional surveys would be required prior to Project construction. The habitat connectivity that Bear Creek Park offers as a GIN Hub was also considered highly suitable for terrestrial wildlife.



Habitat values for at-risk species with the potential to occur in the Project study area were generally limited; however, at-risk species from many taxonomic groups (i.e., gastropods, amphibians, birds, and mammals) were considered as having a moderate to high potential to occur. Hemmera determined that habitat for at-risk invertebrates may occur in the Project study area and suitable mitigation should be developed during future stages of the Project. High-value habitat was identified for amphibians, with the presence of northern red-legged frog confirmed in King Creek. Forested, riparian, wetland, and open habitat was found to offer moderate to high-value habitat for both at-risk birds and at-risk mammals.

The eDNA results appear to confirm the habitat classification made during the field assessment. Habitat for northern red-legged frog was considered moderate to high value in King Creek, and low value Bear Creek. Habitat for Pacific water shrew was considered to be low to moderate at Bear Creek and King Creek south of the Project alignment, and moderate at King Creek north of the Project alignment. Lower ratings were given due to heavy invasive species cover, steep banks, and low coarse woody debris abundance. A lack of eDNA detection at either creek, however, cannot definitively conclude Pacific water shrew absence from the Project study area.

No bird nests afforded legal protection (i.e., for bald eagles and great blue herons) were observed during the field assessment, but as these nests can be constructed early each year, the lack of observed nests should not be interpreted as an indication of nesting habitat suitability in the Project study area. Additional surveys for conspicuous stick nests may be required once final Project design is known. The known bald eagle nest 400 m north of the Project study area would not interact with the Project as it is located beyond the most conservative disturbance setback distance (i.e., 300 m) (Government of British Columbia 2013).

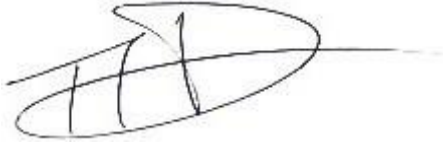
The baseline information presented in this report will be used to inform and evaluate potential effects of the Project on aquatic and terrestrial resources, including changes to habitat quantity and quality, alterations to regional connectivity, disturbance, and direct mortality.

## 6.0 CLOSURE

We sincerely appreciate the opportunity to have assisted you with this project and if there are any questions, please do not hesitate to contact the undersigned by phone at 604.669.0424.

Report prepared by:

**Hemmera Envirochem Inc.**



Kyle Routledge, B.Sc., R.P.Bio.

Wildlife Biologist / Terrestrial Ecologist

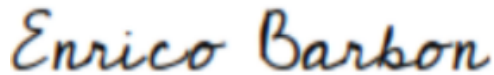
Report reviewed by:

**Hemmera Envirochem Inc.**



Trevor Welton, R.P.Bio.

Project Director



Enrico Barbon, MA, R.B.Tech, ASCT

Director, Municipal and Climate Change Services

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# **APPENDIX A**

## **84 Avenue Extension Project (Bear Creek Park) – Wetland Habitat Assessment**



**Hemmera Envirochem Inc.**

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May 28, 2021  
File No. 105763-01

Aplin and Martin Consultants  
201 – 12448 82 Avenue  
Surrey, BC V3W 3E9

**Attention: Jeremy Hanson, P.Eng., Project Manager**

Dear Jeremy,

**Re: 84 Avenue Extension Project (Bear Creek Park) - Wetland Habitat Assessment**

## **1.0 INTRODUCTION**

The City of Surrey (the City) is proposing to connect 84 Avenue from 140 Street to King George Boulevard (the Project). The Project will cross a BC Hydro powerline right-of-way (ROW) and will bisect the southern portion of Bear Creek Park (**Figure 1**). The City retained Hemmera Envirochem Inc. (Hemmera) to provide environmental assessment services for the Project, specifically for terrestrial and aquatic resources. The initial site assessment identified wet areas that could be characterized as wetlands, so additional efforts was applied to determine if any wetlands occur within the Project boundaries, and to classify and delineate the extent of any identified wetland habitats.

This memorandum summarizes the methods and findings related to describing the existing conditions of wetlands within the Project boundaries. This memorandum is provided separately from Hemmera's Aquatic and Terrestrial Ecosystems Baseline Report, to allow Hemmera's wetland specialist subconsultant, Ecologic Consultants, to participate and sign off on the data they collected and subsequent habitat classifications. The information provided herein has been compiled following guidance provided in the *Water Sustainability Act (WSA)* application guidance document for the British Columbia (BC) South Coast Region (BC MFLNRORD 2019).

Wetland identification and delineation will be used to identify areas for avoidance or redesign (where practicable), quantify Project effects and to identify suitable mitigation.

This Work was performed in accordance with Work Order between Hemmera Envirochem Inc. (Hemmera), a wholly owned subsidiary of Ausenco Engineering Canada Inc. (Ausenco), and Aplin and Martin Consultants (Client), dated March 10, 2021 (Contract). This Report has been prepared by Hemmera, based on fieldwork conducted by Hemmera, for sole benefit and use by Aplin and Martin Consultants.

In performing this Work, Hemmera has relied in good faith on information provided by others and has assumed that the information provided by those individuals is both complete and accurate. This Work was performed to current industry standard practice for similar environmental work, within the relevant jurisdiction and same locale. The findings presented herein should be considered within the context of the scope of work and project terms of reference; further, the findings are time sensitive and are considered valid only at the time the Report was produced. The conclusions and recommendations contained in this Report are based upon the applicable guidelines, regulations, and legislation existing at the time the Report was produced; any changes in the regulatory regime may alter the conclusions and/or recommendations.

## 1.1 Ecological Context

Wetlands can be defined as lands that are saturated with water long enough to promote formation of soils dominated by anaerobic processes. Such soils support biological activity that is adapted to a wet environment such as the growth of hydrophytic vegetation (i.e., moisture-loving plants) (Cherry 2011; Government of Canada 1991).

Though wetlands can have areas of open water, fully aquatic systems (e.g., streams, lakes, ponds) are not considered wetlands. Rather, wetlands are the in-between areas where open water transitions to terrestrial uplands and soils remain inundated sufficiently long to support anaerobic processes. Shallow, open water ecosystems are often included in the definition of wetlands and are distinguished from fully aquatic open water systems by the presence of macrophytes (i.e., large aquatic plants). The lack of macrophytes is indicative of an ecological shift from soil-based ecosystems to aquatic. As transitional areas, wetlands can possess characteristics of both terrestrial and aquatic ecosystems, often resulting in biologically diverse and productive habitats. Water in wetlands can be standing or flowing and wetland soils can be either mineral or organic. These features are the underpinning of wetland classification in Canada (Warner and Rubec 1997) and in BC (MacKenzie and Moran 2004).

Wetlands are ecologically important communities as they perform unique ecological functions (Michaud 2001), including:

- Water recharge to aquifers and waterbodies
- Protection from erosion
- Flood reduction/control
- Habitat for wildlife and plants
- Water filtration/quality improvement
- Food and nutrient source.

In BC, freshwater wetlands can be classified into 5 broad categories (MacKenzie and Moran 2004):

1. Bog – Organic peat (sphagnum) soil (> 40 centimetre (cm) depth), low pH (< 5.5).
2. Fen – Organic non-peat (brown mosses) soil (> 40 cm depth), high pH (> 5.0).
3. Marsh – Mineral soils or well-humified organics, dominated by sedges/rushes.
4. Swamp – Mineral soils, temporary but significant water flow, dominated by trees or shrubs.
5. Shallow water – Permanent water, aquatic and/or emergent vegetation.



## 1.2 Regulatory Context

In BC, the WSA defines a stream as, “*any natural watercourse, natural body of water, or a natural source of water supply including, a lake, pond, river, creek, spring, ravine, gulch, **wetland**, or glacier, whether usually containing water or not*” (Government of BC 2014). As such, Section 11 of the WSA (protection for streams) would apply to any changes or alterations to wetlands proposed as part of Project activities. WSA Change Approval applications are administered by the Ministry of Forest, Lands, Natural Resource Operations and Rural Development (FLNRORD). This report provides the information required to support a Section 11 Approval application under the WSA for wetland habitat impacted by construction of the Project.

84 Avenue Extension Between  
King George Boulevard to 140 Street

Wetlands Field Assessment



Legend

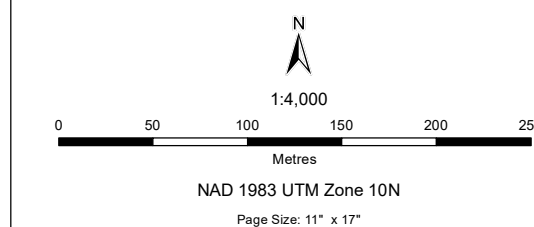
- Field Plot
- Proposed 84 Avenue Connection Alignment
- Watercourse
- Shrub Swamp
- Bear Creek Park
- Property Line

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licences - British Columbia, City of Surrey
- Aerial Image: City of Surrey Orthophoto, 2020
- Road Alignment: 84th Avenue Extension King George Boulevard to 140 Street, Aplin & Martin Consultants Ltd., 2021
- Inset Basemap: ESRI World Topographic Map



105763-01    Production Date: May 27, 2021    Figure 1



Aplin & Martin  
Consultants Ltd.

## 2.0 METHODS

### 2.1 Desktop

A desktop review was conducted to inform the wetland assessment through historical and current imagery, topography, and known ecosystem information. The following spatial files were reviewed:

- Aerial photos - recent (March 2020) and historical (1949) (City of Surrey 2021)
- Lidar – 2018 (City of Surrey 2021)
- Project boundaries (i.e., proposed 84 Avenue road alignment)
- Biogeoclimatic ecosystem classification (Data BC 2021).

Additional resources reviewed included the Wetlands of BC (MacKenzie and Moran 2004) for general wetland classification and the Lower Bear Creek Integrated Storm Management Plan (Parsons 2015) to understand regional water flow and water management objectives.

### 2.2 Field

Biologists made 4 site visits to assess the area within the Project boundaries for wetlands: a reconnaissance assessment on March 12, 2021 and 2 field assessments on April 1 and April 8, with a follow-up assessment on May 20, 2021. Wetlands were differentiated from upland areas using the following field indicators:

- Landscape position/topography
- Vegetation/species complex
- Soil wetland indicators (i.e., organic layer, mottling, gleying)
- Level of disturbance.

Biologists documented the extent of the identified wetlands in the field using a handheld global positioning system (GPS) unit to approximate wetland extents; these extents were further refined using ArcGIS software.

Wetlands were classified according to the main categories of the BC Wetland Classification System (MacKenzie and Moran 2004) and/or the biogeoclimatic ecosystem classification system for forested ecosystems as described in the Field Guide to Site Identification and Interpretation for the Vancouver Forest Region (Green and Klinka 1994) where applicable.

For areas that have been subjected to anthropogenic disturbance, the provincial classification system does not apply as well as in undisturbed natural areas; however, the concepts of what constitutes a wetland are still relevant. Therefore, in areas of frequent disturbance (e.g., ROW), wetlands were differentiated from uplands using the field indicators described above, but standard wetland classifications were not assigned.

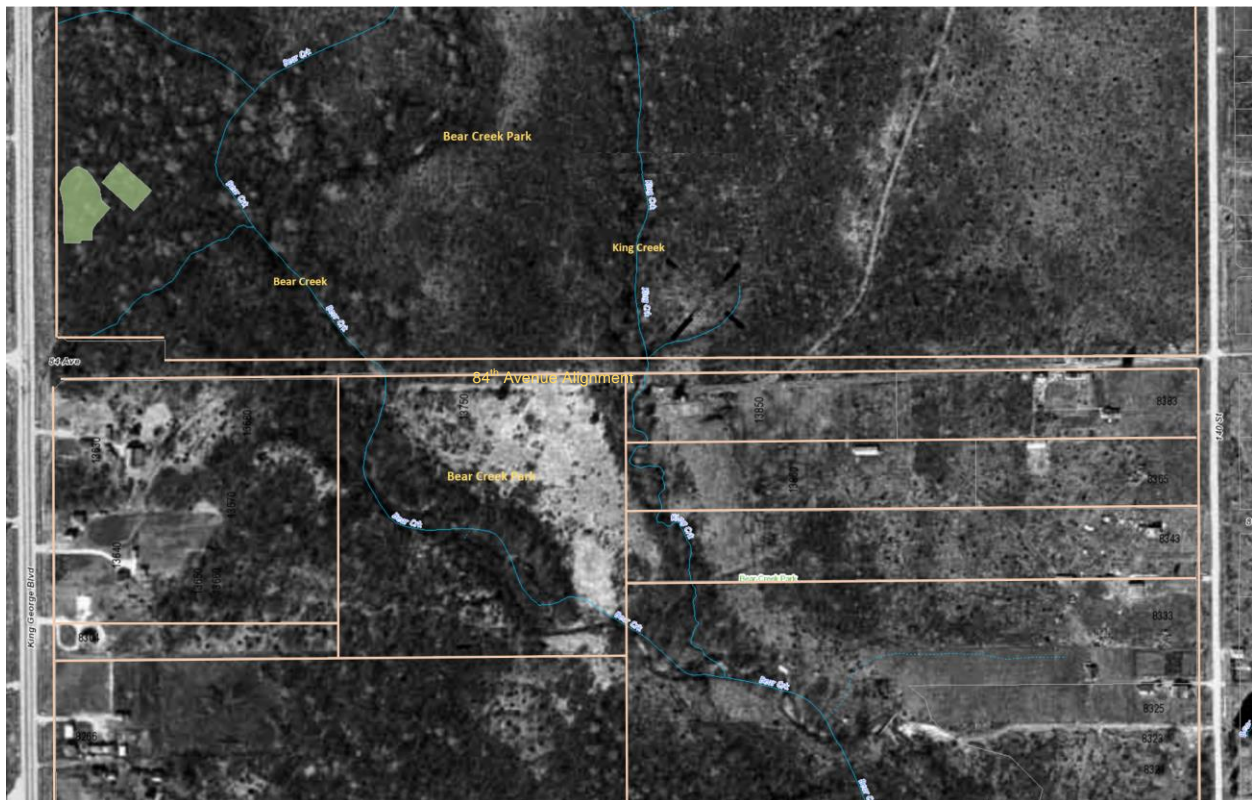
### 3.0 RESULTS

The Project occurs within the Bear Creek watershed and includes the King Creek and Bear Creek catchments. With the exception of a steep grade at the west end of the site between King George Boulevard and Bear Creek, the overall landscape is relatively flat but slopes gently towards either King or Bear Creek.

#### 3.1 Desktop

The Project is located within the Coastal Western Hemlock Very Dry Maritime Subzone (CWHxm). This biogeoclimatic zone is found along the south side of the Fraser River at elevations spanning from sea level to approximately 700 metres (m) above sea level. The CWHxm is characterized by warm dry summers and moist mild winters with relatively low snowfall (Green and Klinka 1994). Mature zonal sites (i.e., sites that best reflect the regional climate and are least influenced by local topography and or soils) within the CWHxm are typified by stands of Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*), while moist, rich forested sites, as present in Bear Creek Park, are typified by western hemlock, western redcedar (*Thuja plicata*) and red alder (*Alnus rubra*) with salmonberry (*Rubus spectabilis*) and sword fern (*Polystichum munitum*) in the understory.

Review of an aerial photo dated 1949 shows that the southern area of Bear Creek Park was cleared prior to 1949 (**Figure 2**). The area north of the Project appears to have been logged and left to regenerate naturally. South of the Project, the land was cleared and parceled as farmland. The image in **Figure 2** pre-dates the construction of the BC Hydro powerline ROW.



**Figure 2 Aerial Photo of Study Area circa 1949 (City of Surrey COSMOS)**

Today, the southern area of Bear Creek Park is subject to 2 distinct management regimes:

1. Open grassy fields with shrubby patches, which are periodically cleared as part of ROW maintenance for the BC Hydro high voltage transmission powerlines.
2. Naturalized area of second- (or possibly third-) growth mixed forest to the north of the BC Hydro ROW. The forest is topographically heterogenous, composed of a mosaic of depressions and hummocks, gradually decreasing in elevation, with soil moisture increasing as water is impounded against the main footpath **Figure 3**).

The soils of the Bear Creek watershed are primarily underlain by low-permeability clays and silts (Parsons 2015), causing infiltrated rainwater to ultimately flow through the top 0.5 to 1.5 m of soil as it is transported from uplands to bodies of water such as streams and creeks. This type of water flow path is called “interflow” and accounts for much of the conveyance of water within the southern part of Bear Creek Park. Interflow water is often rich in nutrients.

### 3.2 Field Surveys

Biologists surveyed 18 field plots at locations within and outside of areas characterized high soil moisture and standing water (**Figure 3, Table 1**).

The 3 main ecological communities identified in southern Bear Creek Park within the Project boundaries were: i) shrub swamp, ii) upland forest, and iii) disturbed grass “meadows.” The shrub swamp is described in more detail below. Also included in the discussion are areas of the upland forest that were identified in initial site assessments as potentially having wetland characteristics. These were re-assessed in mid-May once high surface water conditions had receded and found to not be wetlands.

**Shrub swamp:** Swamp wetlands are characterized by having mineral soils, temporary shallow flooding, and significant water flow while dominant vegetation can consist of trees and/or shrubs (MacKenzie and Moran 2004). At the east end of the Project, where the west culvert crosses under the trail, the vegetation and soils show indications of prolonged saturation and hence these areas were classified as shrub swamp (**Figure 3, Table 1**). The main driver of the shrub swamp is its location relative to the culvert outlet, as water is channelized for a short distance (approximately 20 m) before terminating and infiltrating into the soils and flowing subsurface downgradient towards King Creek. Here, soils are sufficiently moist to support hydrophytes such as willow, red-osier dogwood (*Cornus sericea*), and hardhack (*Spiraea douglassii*) as well as reed canarygrass (*Phalaris arundinaceae*), which is a highly competitive grass species that grows well in disturbed sites and is adapted to a wide amplitude of soil moisture levels.

At the middle section of the Project (between King Creek and Bear Creek) lies another wet area that is dominated by facultatively hydrophytic shrubs and grasses (**Figure 3, Table 1**). This area had water-saturated soils and standing water at between 10 cm and 20 cm depth. Dominant species found at this site included hardhack, reed canarygrass and willows. The landscape position of the area is a shallow basin contained to the south by a gravel trail and to the north by wet forest. The shrubs in this area are periodically cleared as part of the BC Hydro ROW maintenance, creating an anthropogenically disturbed area that maintains wetland features and functions such as flood reduction, water recharge and filtration.

**Upland forest:** The second- (or possibly third-) growth forested area north of the BC Hydro powerline ROW is a gradation of upland forest sloping gently downward towards King Creek, eventually becoming lowland subhygric forest as it gets closer to the paved path separating the forest from the Hydro ROW. The paved path serves as a barrier to surface (and potentially subsurface water flow) resulting in water pooling to the north of the path. The heterogeneous landscape of this forest is a mosaic of hummocks that provide micro habitats for trees to grow, and depressions in between, where water pools seasonally. As high surface runoff conditions prevailed during the winter months and early spring in 2021, surface water was seen to be flowing and pooling in areas of the forest west of field plots BC01 – BC05 (**Figure 3**).

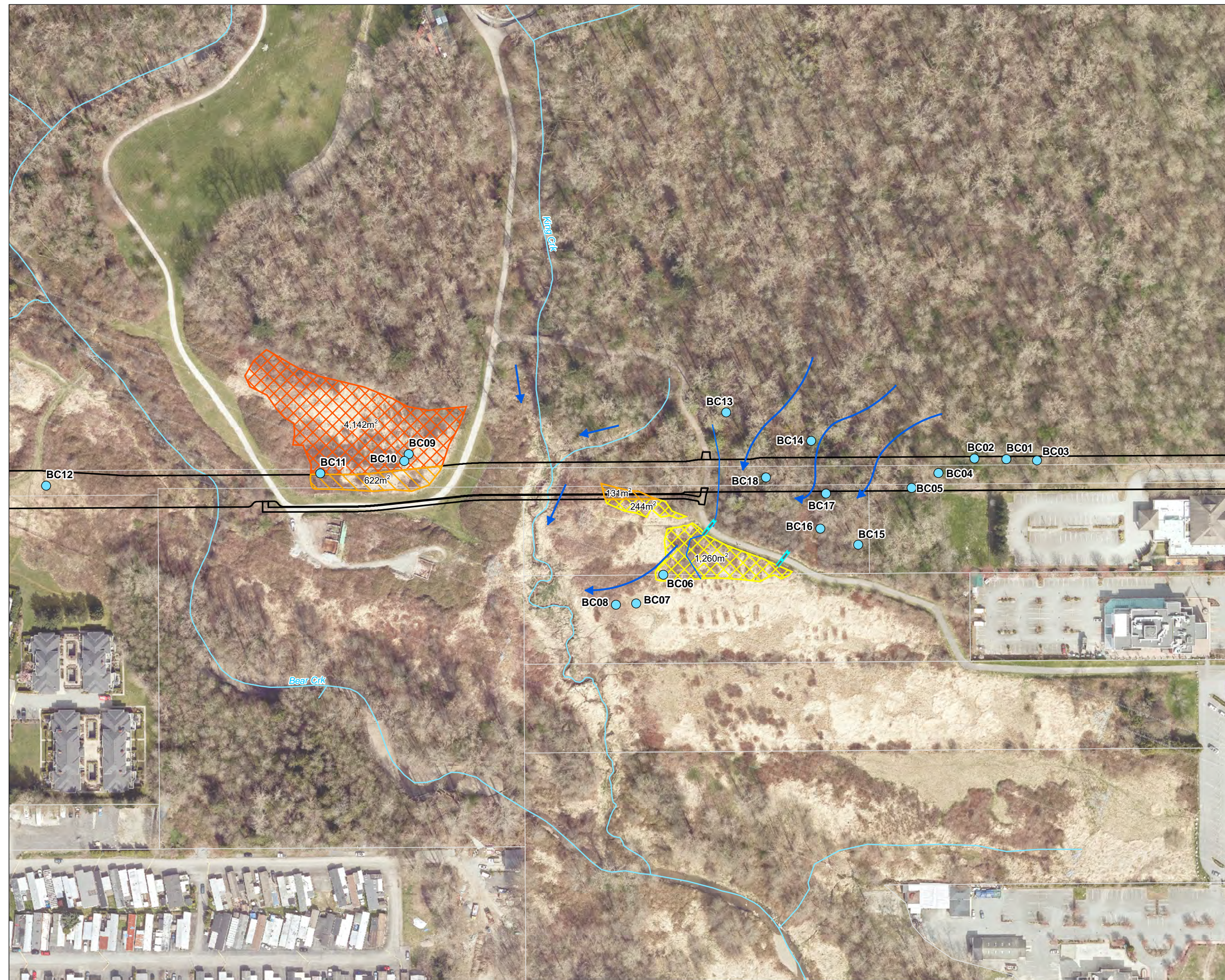
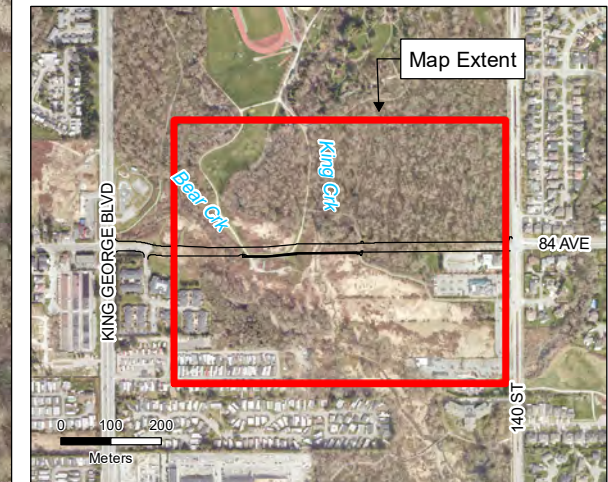
Field plots (BC01, BC 02, BC03, BC04, and BC05) were established on April 1, 2021 at what were deemed to be within and at the edge of a swamp wetland. At each field plot a small soil pit was dug (30 cm depth) to look for indications of water saturation. At all forested plots, the soils were mineral with very shallow veneer of organic materials. Very limited soil mottling was observed at field plots BC02, BC04, and BC05 despite subsurface water being reached at depths shallower than 30 cm while no indication of water saturation was observed in field plots BC01 and BC03. Dominant vegetation species at these sites consisted of black cottonwood (*Populus balsamifera*), western redcedar, red alder, vine maple (*Acer glabrum*), osoberry (*Oemleria cerasiformis*), and salmonberry.

West of field plots BC01 – BC05, overland and subsurface water was observed to be draining through the forest, ultimately being channeled towards 2 culverts directing water under the paved path (one culvert at the southwest corner of the forest and the second approximately 50 m to the east) into the managed BC Hydro ROW. This abundance of water led to additional follow-up surveys to confirm if soils in this part of the forest were water-saturated for a sufficient length of time to result in anoxic, hydric soil conditions. It can be challenging to definitively classify wetlands during spring flood conditions. Saturated conditions may exist, but it is the persistence of these conditions into the growing season is the critical factor.

A follow-up field survey was conducted on May 20, 2021 in the previously flooded forest area following the emergence of deciduous vegetation. Field plots BC13 – BC18 (**Figure 3**) were established to characterize this part of the forest. During the investigation, no hydrophytes (such as skunk cabbage) were present, and the vegetation present was strongly indicative of rich, fresh to mesic forest, and can be classified according the biogeoclimatic ecosystem classification system as CWHxm 08, Sitka spruce – salmonberry site series (Green and Klinka 1994).

**Grass “meadows”:** The majority of the area under the powerlines consists of an open expanse of grasses and small shrubs, dominated by reed canarygrass and some hedgerows of Himalayan blackberry, both of which are invasive plant species. This open landscape is intentionally maintained in an early successional state to reduce the risk of damage to the overhead electrical infrastructure.

**Wetlands Intersected by Road Alignment**



**Legend**

- Field Plot
- Culvert
- Proposed 84 Avenue Connection Alignment
- Direction of Water Flow
- New Drainage
- Watercourse
- Property Line

**Wetland**

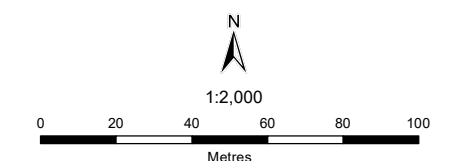
- Shrub Swamp Overlapping with Road Alignment
- Shrub Swamp Not Overlapping with Road Alignment
- Shrub Swamp Down-Gradient of Road Alignment

**Notes**

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

**Sources**

- Contains information licensed under the Open Government Licences - British Columbia, City of Surrey
- Road Alignment: 84th Avenue Extension King George Boulevard to 140 Street, Aplin & Martin Consultants Ltd., 2021
- Aerial Image: City of Surrey Orthophoto, 2020
- Inset Basemap: City of Surrey Orthophoto, 2020



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**Table 1 Site Descriptions at Each Field Plot**

Site	BC01	BC02	BC03	BC04	BC05	BC06	BC07	BC08	BC09	BC10	BC11	BC12
<b>Landscape position</b>	Upslope hummock	Downslope depression	Upslope depression	Downslope depression	Downslope depression	Level	Level	Level	Slight depression	Depression	Depression	Upland, gentle slope
<b>Soil</b>	Silt-loam No gleying or mottling	Silt-loam Slight gleying & red mottling	Silt-loam No gleying or mottling	Silt-loam Abundant mottling	Silt-loam Some gleying	Silt loam Gleying	Clay loam Gleying	Clay loam Some gleying	Well-formed humic layer Gleying	Well-formed humic layer Gleying	Well-formed humic layer Gleying	Sandy loam Mottling
<b>Water depth</b>	N/A	N/A	N/A	N/A	30 cm	25 cm	N/A	N/A	20 cm	10c m	N/A	N/A
<b>Soil disturbance level</b>	Undisturbed	Undisturbed	Undisturbed	Undisturbed	Undisturbed	Undisturbed	Disturbed Soil	Disturbed Soil	Undisturbed	Undisturbed	Undisturbed	Disturbed Soil
<b>Wetland Y/N</b>	N	N	N	N	N	Y	N	N	Y	Y	Y	N
<b>Ecological community</b>	Upland forest	Upland forest	Upland forest	Upland forest	Upland forest	Shrub swamp	Grass "meadow"	Grass "meadow"	Shrub swamp	Shrub swamp	Shrub swamp	Grass "meadow"
<b>Ecological* classification</b>	CWHxm08	CWHxm08	CWHxm08	CWHxm08	CWHxm08	N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Note:** Where ecological classification is deemed "N/A" these are disturbed sites that are not classifiable within either the Biogeoclimatic Ecosystem Classification System nor the Wetland Classification System of British Columbia.



## 4.0 WETLAND CHARACTERIZATION

The volume and direction of water flow constitutes one of the main drivers of wetland formation. Where a wetland will be bisected by an impermeable feature such as a road, not only will the wetland intersected by the road footprint be lost directly to clearing, but the wetlands downslope of the road may also be functionally impaired or lost as a result of altered hydrology while wetlands upslope of the structure may be inundated for longer period due to drainage impediments which could influence soils and vegetation composition. An effects assessment to wetlands (and other key environmental resources) will be conducted as part of Project planning activities.

## 5.0 RECOMMENDATIONS

Natural areas provide ecosystem services such as habitat for wildlife, air and water purification, and aesthetics for human well-being. In the case of wetlands, the ecological services also include filtration, attenuation, and recharge of water. In BC, where proposed projects result in the alteration or loss of ecosystem services, mitigations are required to reduce the impacts of these ecosystem alterations. Mitigations are adjudicated according to the Mitigation Hierarchy (BC MOE 2014) which prioritizes:

1. Avoidance
2. Minimization
3. Restoration on site
4. Offsetting (on- or off-site).

For the King George Boulevard to 140 Street extension of 84 Avenue, we recommended that the proposed Project footprint be designed to **avoid** natural areas as much as practicable. The proposed footprint is confined to the 84 Avenue road alignment ROW that was established many years ago and will connect 84 Avenue on the east and west sides. The road alignment is bordered by park land and BC Hydro ROW resulting in limited opportunity for avoidance or minimization.

The Project has taken steps to **minimize** the road footprint by relocating a proposed multi-use pathway and removing a U-turn location that would have required a median. Additional recommendations to minimize Project effects to wetlands include:

1. Conducting a plant salvage of native forest plants such as trillium (*Trillium ovatum*) and bleeding heart (*Dicentra formosa*), which can be conserved and used in restoration plantings elsewhere within Bear Creek Park.
2. Stockpiling soils and coarse woody debris from the native forest areas to be used in construction of new, enhanced natural areas.

Where avoidance of and minimization of effects to wetlands is not possible, **on-site restoration** is recommended. Opportunities for on-site restoration include:

- Removal of invasive vegetation within the King Creek riparian corridor
- Addition of native shrubs within the King Creek corridor to promote biodiversity
- Plant native shrubs along edges of wetlands to reduce edge effects from road construction.

In addition to on-site restoration, we recommend creation of wetlands of equivalent size and ecological value to **offset** Project effects to existing wetlands. Ideally, these new wetlands would be near enough to the Project to serve the purpose of utilizing road run-off water and directing it to the area due south of the Project boundary, but still within the King Creek catchment. These constructed wetlands should be designed not only to attenuate flow of water from the roadway, but also to filter water and allow it to infiltrate into the soils to ultimately percolate laterally into King Creek.

## 6.0 CLOSURE


We have appreciated the opportunity of working with you on this Project and trust that this report is satisfactory to your requirements. Please feel free to contact the undersigned regarding any questions or further information that you may require.

Report prepared by:  
**Hemmera Envirochem Inc.**



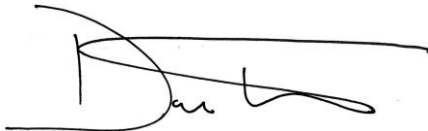
Jacqueline Shaben, M.Sc., R.P.Bio.  
Senior Vegetation Ecologist

Report reviewed by:  
**Hemmera Envirochem Inc.**



Trevor Welton, R.P.Bio.  
Project Director

Report reviewed by:



Dan McAllister, M.Sc., P.Ag.  
Director and Soil Scientist

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# **ATTACHMENT A**

## **Site Photos**



**Photo 1** Field plot BC01, looking south.



**Photo 2** Field plot BC04 looking north.



**Photo 3** Field Plot BC05 looking west.



**Photo 4** Field Plot BC06 looking north – note red osier dogwood and willows



**Photo 5** Field Plot BC06 Soil pit – note water depth and organics in soils.



**Photo 6** Field Plot BC07 non-wetland site



**Photo 7** Field Plot BC08 looking south-east non-wetland site



**Photo 8** Field Plot BC09 looking north-east wetland west of King Creek





**Photo 9** BC09 Soil core – note gleying



**Photo 10** BC11 Looking north – note willow clearing for BC Hydro right-of-way maintenance



**Photo 11** Field Plot BC12 looking north – located west of Bear Creek. April 01, 2021

# **APPENDIX B**

## **Pacific Water Shrew Habitat Suitability Assessment**

**Habitat suitability rating scheme for Pacific water shrew.**

% of Provincial Best	Intermediate Knowledge – 4 Class		Indicators or Key Biophysical Attributes
	Rating	Code	
100 to 76%	HIGH	H	<p><b>WATER</b> = Bankfull width of 5 to 10 m, bankfull depth of &lt;2 m, and gradient of &lt;45°. Good connectivity. Permanent presence of water.</p> <p><b>RIPARIAN</b> = Riparian area around and including a permanent stream or creek (&lt;10 m wide) or wetland with a mature coniferous forest (Structural Stage 5 to 7 as per Land Management Handbook #25; British Columbia 2010) of Western Redcedar and/or Western Hemlock, or a mature deciduous or mixed forest (Structural Stages 4 to 7). Dense riparian cover, vegetation overhanging water, and leaf litter also abundant. Indicators such as rich soils, moist habitat, and riparian plant species are present (i.e., rich to very rich and moist to wet on edatopic grids in Land Management Handbook #28; Green and Klinka 1994).</p> <p><b>CWD</b> = Downed woody debris in all decay classes (British Columbia 2010) is abundant and in diameters similar to vegetation.</p> <p><b>ACCESS</b> = Gentle to moderate slopes (&lt;35° from horizontal) between WATER and RIPARIAN</p>
75 to 26%	MODERATE	M	<p><b>WATER</b> = Can include a natural or modified channel, 1 to 10 m wide, bankfull depth of &lt;2 m and gradient of &lt;45°. Limited to good connectivity. Permanent or ephemeral presence of water.</p> <p><b>RIPARIAN</b> = As for High above, but younger Structural Stages, primarily broadleaf, and/or 50% or greater vegetation cover. Some indicators such as rich soils, moist habitat, riparian plant species present.</p> <p><b>CWD</b> = Downed woody debris present but not abundant and with limited decay classes and diameter distributions.</p> <p><b>ACCESS</b> = Gentle to moderate slopes (35 to 50° from horizontal between WATER and RIPARIAN</p>
25 to 1%	LOW	L	<p><b>WATER</b> = A ditch, channelized watercourse, or a natural watercourse with a width of 1 to 20 m, a bankfull depth of &gt;2 m, and/or a gradient of &gt;45°. No to limited connectivity. Ephemeral presence of water.</p> <p><b>RIPARIAN</b> = Limited shrub understorey cover/density (i.e., &lt;50%). Limited canopy cover / young forest (i.e., &lt;50%). Invasive species dominance. Very few indicators such as rich soils, moist habitat, or riparian plant species present (previously or currently disturbed). Maximum Structural Stage of 5.</p> <p><b>CWD</b> = Downed woody debris sparse or absent. One to two decay classes and very limited diameter distributions.</p> <p><b>ACCESS</b> = Steep to moderate slopes (50 to 70° from horizontal) between WATER and RIPARIAN</p>
0%	NIL	N	<p><b>WATER</b> = No water and/or &gt;100 m from a waterbody or heavily managed (e.g., mowing, cultivated, or grazed) habitat &gt;75% of watercourse length. Culverted, or isolated reach with culverts &gt;30 m in length, or a bankfull width of &gt;20 m or banks &gt;65 degree gradient. No connectivity. Ephemeral or no presence of water.</p> <p><b>RIPARIAN</b> = No riparian cover for &gt;75% of watercourse, exposed soil or bryophytes are dominant vegetation. Structural Stages 1 to 2.</p> <p><b>CWD</b> = Downed woody debris absent.</p> <p><b>ACCESS</b> = Steep slopes (70 to 90° from horizontal) between WATER and RIPARIAN</p>

**Study Area:** Bear Creek Park

**Site Name:** King Creek

**UTM:** 10 //

**Date:** April 28, 2021

**Observers:** KR

**Site ID:** North

**Descriptions**

**Water:** Bankful width 2-5 m, water depth < 2 m, gradient < 45 degrees, good connectivity, permanent flow.

**Rank: M**

**Riparian:** More native vegetation on east side of creek, mixed forest transitions to herbaceous layer near edge of creek. Horsetail and skunk cabbage present. West side has higher invasive abundance (Himalayan blackberry), but also has native species, including willow. Evidence of heavy knotweed distribution along east side of creek.

**Rank: M**

**CWD:** CWD present but limited in diameter distribution.

**Rank: M**

**Access:** Gentle to moderate slopes (35-50 degrees)

**Rank: M**

**Overall Field Rank: M**

**Photos:** Y

**Comments:** Highest quality SOBE habitat of all 4 locations.

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**Study Area:** Bear Creek Park

**Site Name:** King Creek

**UTM:** 10 //

**Date:** April 28, 2021

**Observers:** KR

**Site ID:** South

**Descriptions**

**Water:** Bankful width 2-4 m, water depth < 2 m, gradient < 45 degrees, good connectivity, permanent flow.

**Rank: M**

**Riparian:** Majority of site is reed canarygrass, with some Pacific ninebark, willow, and Indian plum (Osoberry). Hard hack increases away from water on east side of creek while Himalayan blackberry increases away from water on west side of creek.

**Rank: L/M**

**CWD:** Very sparse CWD, nothing greater than 8 cm diameter.

**Rank: L**

**Access:** Incised channel, few access points (east side has better access than west; all baited tubes placed on east side).

**Rank: L (west)**

**M (east)**

**Overall Field Rank: L/M**

**Photos:** Y

**Comments:** Habitat at north King Creek site higher quality.

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**Study Area:** Bear Creek Park

**Site Name:** Bear Creek

**UTM:** 10 //

**Date:** April 28, 2021

**Observers:** KR

**Site ID:** North

**Descriptions**

**Water:** Bankful width 5-10 m, water depth < 2 m, gradient < 45 degrees, good connectivity, permanent flow.

**Rank:** H

**Riparian:** Sparse vegetation cover along edge of water, red alder, salmonberry, reed canarygrass, sporadic Himalayan blackberry. Vegetation cover increase away from water (cobble creek banks). **Rank:** L/M

**CWD:** Very little CWD present.

**Rank:** L

**Access:** Gentle to moderate slopes.

**Rank:** H

**Overall Field Rank:** L/M

**Photos:** Y

**Comments:**

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**Study Area:** Bear Creek Park

**Site Name:** Bear Creek

**UTM:** 10 //

**Date:** April 28, 2021

**Observers:** KR

**Site ID:** South

**Descriptions**

**Water:** Bankful width 5-10 m, water depth < 2 m, gradient < 45 degrees, good connectivity, permanent flow.

**Rank:** H

**Riparian:** Riparian vegetation on east side starts at top of bank, which is approximately 3 m high on very steep slope (>70 degrees). West side has riparian veg extending down into water. Most veg is native (large component of red alder), but Himalayan blackberry also present. Many rocks and cobbles present along shoreline.

**Rank:** L/M

**CWD:** Very little CWD on east side (L), more abundant on west side (M).

**Rank:** L

**Access:** Little vegetation exists on east side before ban, then very steep. Access is better on west side.

**Rank:** L

**Overall Field Rank:** L/M

**Photos:** Y

**Comments:**

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# **APPENDIX C**

## **Photos**



**Photo 1** Baited PVC tube trap for terrestrial eDNA sampling.



**Photo 2** Bait being added to PVC tube trap for eDNA sampling. Photo taken April 28, 2021.



**Photo 3** Deployed baited PVC tube trap terrestrial eDNA sampling. Photo taken April 28, 2021.



**Photo 4** Deployed baited PVC tube trap terrestrial eDNA sampling. Photo taken April 28, 2021.



**Photo 5** Westward view of Bear Creek. Photo taken March 12, 2021.



**Photo 6** Southward view of Bear Creek, taken April 28, 2021.



**Photo 7** Eastward view of Bear Creek ravine. Photo taken March 12, 2021.



**Photo 8** Northward view of Bear Creek, taken April 28, 2021.



**Photo 9** View of King Creek, facing north from the BC Hydro ROW. Photo taken March 12, 2021.



**Photo 10** View of the King Creek floodplain north of the road alignment facing south. Photo taken May 7, 2021.



**Photo 11** Shrubby riparian vegetation transitioning to invasive vegetation along King Creek floodplain, facing south immediately north of road alignment. Photo taken April 28, 2021.



**Photo 12** View of King Creek floodplain at the road alignment, facing south. Photo taken May 7, 2021.



**Photo 13** View of King Creek floodplain with associated invasive vegetation and steep banks, south of road alignment, facing north. Photo taken April 28, 2021.



**Photo 14** Typical view of the forested area within the study area north of the road alignment. Photo taken May 7, 2021.





**Photo 15** View of the forest/ shrub wetland interface south of the road alignment. Photo taken May 7, 2021.



**Photo 16** Typical view of the vegetation located underneath the BC Hydro ROW. Photo taken May 7, 2021.

# **APPENDIX D**

## **Species At Risk Screening Results**

Appendix D Species at Risk Table

English Name	Latin Name	BC List	COSEWIC	SARA Status	Local Habitat Needs	Likelihood of Occurrence	Rationale
<b>Gastropods</b>							
Broadwhorl tightcoil	<i>Pristiloma johnsoni</i>	Blue	-	-	Forest with leaf litter	L	No confirmed occurrences in the Project study area, but habitat may be suitable.
Oregon forestsnail	<i>Allogona townsendiana</i>	Red	Endangered	Endangered	Forest with leaf litter	L/M	Documented occurrences from south Surrey but no confirmed occurrences in Project study area, habitat may be suitable,
Pygmy fossaria	<i>Galba parva</i>	Blue	-	-	Open water, wetland	L	Habitat not likely suitable, but not enough information to exclude.
Western thorn	<i>Carychium occidentale</i>	Blue	-	-	Forest with leaf litter	L/M	No confirmed occurrences in the Project study area but has been documented in Tynehead Regional Park (2020 COS pers. comm.), but habitat may be suitable.
<b>Insects</b>							
Autumn meadow hawk	<i>Sympetrum vicinum</i>	Blue	-	-	Forest, open water, riparian habitat, watercourses	L	Documented occurrences from Coquitlam and Delta, but no confirmed occurrences in Project study area.
Black petaltail	<i>Tanypteryx hageni</i>	Blue	-	-	Open water, watercourses, wetland	L	Habitat not likely suitable, but not enough information to exclude.
Black saddlebags	<i>Tramea lacerata</i>	Red	-	-	Riparian habitat, open water, wetland	L	Habitat not likely suitable, but not enough information to exclude.
Blue dasher	<i>Pachydiplax longipennis</i>	Blue	-	-	Open water, riparian habitat, watercourses, wetland	L	Habitat not likely suitable, but not enough information to exclude.
Clodius parnassian	<i>Parnassius clodius</i>	Blue	-	-	Forest, riparian habitat	L	Habitat not likely suitable, but not enough information to exclude.
Gypsy cuckoo bumble bee	<i>Bombus bohemicus</i>	Red	-	1-E	Forest, open habitat, urban	L	Suitable habitat present on site, but likely outside distribution range.
Sinuuous snaketail	<i>Ophiogomphus occidentis</i>	Blue	-	-	Open water, watercourses	L	Documented occurrences from Vancouver and Fraser Valley, but no confirmed occurrences in Project study area.
Western bumble bee	<i>Bombus occidentalis</i>	Blue	Threatened	-	Forest, open habitat	L	Potential suitable habitat.
Western pine elfin, <i>sheltonensis</i> subspe	<i>Callophrys eryphon sheltonensis</i>	Blue	-	-	Forest, wetland	L	Habitat not ideal (often found in mature pine stands), but known occurrences from Lower Mainland
Yellow-banded bumble bee	<i>Bombus terricola</i>	Blue	-	1-SC	Forest, farmland, open habitat, urban areas	L	Suitable habitat present on site, but likely outside distribution range.
<b>Amphibians</b>							
Northern red-legged frog	<i>Rana aurora</i>	Blue	Special Concer	Special Concern	Forest, open habitat, open water, riparian habitat, watercourses, wetland	H	Documented presence in King Creek, habitat is suitable.
Oregon spotted frog	<i>Rana pretiosa</i>	Red	Endangered	Endangered	Open water, riparian habitat, watercourses, wetland	L	Suitable habitat present on site, but likely outside distribution range.
Western toad	<i>Anaxyrus boreas</i>	Yellow	Special Concer	Special Concern	Forest, open water, open habitat, riparian habitat, watercourses, wetland	M	Uncommon in Metro Vancouver, but known to sporadically occur, habitat is suitable.
<b>Reptiles</b>							
Northern rubber boa	<i>Charina bottae</i>	Yellow	Special Concer	Special Concern	Forest, open habitat, riparian habitat, watercourses	L	Unlikely to occur but habitat may be suitable.
<b>Birds</b>							
Bald eagle	<i>Haliaeetus leucocephalus</i>	No Status	-	-	Forest, riparian habitat, open habitat, open water, wetland	H	Species not endangered but nests are protected year-round, and documented occurrences in and around Project study area.
Band-tailed pigeon	<i>Patagioenas fasciata</i>	Blue	Special Concer	Special Concern	Forest, open habitat, open water, riparian habitat, urban	L	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area
Barn owl	<i>Tyto alba</i>	Red	Threatened	Threatened	Forest, Open habitat, riparian habitat, urban, watercourse, wetland	L	Documented occurrences from south of Fraser River, but no confirmed occurrences in Project study area, habitat not highly suitable.
Barn swallow	<i>Hirundo rustica</i>	Blue	Threatened	Threatened	Forest, open water, open habitat, riparian habitat, urban, watercourses	M	Documented occurrences from Bear Creek Park. Foraging habitat present but nesting habitat absent.
Black swift	<i>Cypseloides niger</i>	Blue	Endangered	Endangered	Open water, watercourses, wetland	L	Documented occurrences from Bear Creek Park, but likely on migration. No suitable nesting habitat in Project study area and species not anticipated to occur outside of migratory period.
California gull	<i>Larus californicus</i>	Blue	-	-	Open habitat, open water, urban, watercourses, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Common nighthawk	<i>Chordeiles minor</i>	Yellow	Special Concer	Threatened	Forest, open habitat, open water, urban, watercourses, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Double-crested cormorant	<i>Phalacrocorax auritus</i>	Blue	-	-	Forest, open water, urban, watercourses, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Evening grosbeak	<i>Coccothraustes vespertinus</i>	Yellow	Special Concer	Special Concern	Forest, riparian habitat, urban	L	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area
Great blue heron, <i>fannini</i> subspecies	<i>Ardea herodias fannini</i>	Blue	Special Concer	Special Concern	Forest, open habitat, open water, riparian habitat, urban, wetland	H	Documented occurrences in and around Project study area.
Green heron	<i>Butorides virescens</i>	Blue	-	-	Open water, riparian habitat, urban, watercourses, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Gyr Falcon	<i>Falco rusticolus</i>	Blue	Not at Risk	-	Open habitat, open water, wetland, watercourses	L	Documented occurrences from Metro Vancouver, but no confirmed occurrences in Project study area, habitat not highly suitable.
Lark sparrow	<i>Chondestes grammacus</i>	Blue	-	-	Open habitat	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Olive-sided flycatcher	<i>Contopus cooperi</i>	Blue	Special Concer	Threatened	Forest, open water, riparian habitat, wetland	L	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area
Peregrine falcon	<i>Falco peregrinus</i>	No Status	Special Concer	Special Concern	Open habitat, open water, riparian habitat, urban, watercourse, wetland	M	Documented occurrences from Project study area, not highly suitable habitat, but may forage in Bear Creek Park.
Purple martin	<i>Progne subis</i>	Blue	-	-	Forest, open habitat, riparian habitat, urban, watercourses, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Rough-legged hawk	<i>Buteo lagopus</i>	Blue	Not at Risk	-	Open habitat, Riparian habitat, urban, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Rusty blackbird	<i>Euphagus carolinus</i>	Blue	Special Concer	Special Concern	Forest, open water, urban, wetland	L	Documented occurrences from Metro Vancouver, but no confirmed occurrences in Project study area, habitat not highly suitable.
Short-eared owl	<i>Asio flammeus</i>	Blue	Special Concer	Special Concern	Open habitat, urban, open water, riparian habitat, wetland	L	Documented occurrences in Surrey, but no confirmed occurrences in Project study area, habitat not highly suitable.
Western screech-owl	<i>Megascops kennicottii</i>	No Status	Threatened	Threatened	Forest, open habitat, riparian habitat, urban	L	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area

Appendix D Species at Risk Table

English Name	Latin Name	BC List	COSEWIC	SARA Status	Local Habitat Needs	Likelihood of Occurrence	Rationale
<b>Mammals</b>							
Little brown myotis	<i>Myotis lucifugus</i>	Yellow	Endangered	Endangered	Forest, open habitat, riparian habitat, urban	H	Assumed presence within Project study area as habitat is suitable and species is ubiquitous.
Long-tailed weasel, <i>altifrontalis</i> subspec	<i>Mustela frenata altifrontalis</i>	Red	-	-	Forest, open habitat, riparian habitat, urban, watercourse, wetland	L	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area
Olympic shrew	<i>Sorex rohweri</i>	Red	-	-	Forest, riparian habitat, watercourse	L	No documented occurrences in Project study area.
Pacific water shrew	<i>Sorex bendirii</i>	Red	Endangered	Endangered	Forest, riparian habitat, watercourses, wetland	M	Documented occurrences in Mahood Creek, upstream of Project study area, could potentially be present in Bear Creek.
Snowshoe hare, <i>washingtonii</i> subspecie	<i>Lepus americanus washingtonii</i>	Red	-	-	Forest, open habitat, riparian habitat	L	No documented occurrences in Project study area.
Southern red-backed vole, <i>occidentalis</i>	<i>Myodes gapperi occidentalis</i>	Red	-	-	Forest, riparian habitat, wetland	L	No documented occurrences in Project study area.
Townsend's big-eared bat	<i>Corynorhinus townsendii</i>	Blue	-	-	Forest, riparian habitat, urban	M	Documented occurrences from Green Timbers Urban Forest, but no confirmed occurrences in Project study area
Townsend's mole	<i>Scapanus townsendii</i>	Red	Endangered	Endangered	Forest, open habitat, riparian habitat	L	Habitat not suitable on site.
Trowbridge's shrew	<i>Sorex trowbridgii</i>	Blue	-	-	Forest, riparian habitat	L	Suitable habitat present on site, but likely outside distribution range.

## **APPENDIX E**

### **Pacific Water Shrew and Northern Red-Legged Frog eDNA Analysis Report**



**Attention: Kyle Routledge**  
 Hemmera Envirochem Inc  
 4730 Kingsway - Floor 18  
 Burnaby, BC  
 Canada, V5H 0C6

**Client Project #: 105763-01**  
**Site Location: Bear Creek Park, Surrey, BC**  
**C.O.C. #: 20210510**  
**Quote #: eDNA20210427**  
**PO#: N/A**

**Report Date: 2021/05/17**  
**Report #: HE20210517**  
**Version: 1**

**ENVIRONMENTAL DNA - CERTIFICATE OF ANALYSIS**

**BV JOB #: E20210510**

**Received: 2021/05/10, 11:00 AM**

Sample Type: Cellulose Nitrate (CN) filter, preserved in silica  
 # Samples Received: 13  
 Sample Type: Cotton Swab, preserved in silica  
 # Samples Received: 13

<b>Analyses (eDNA Isolation - Species)</b>	<b>Test Requested</b>	<b>Test Performed</b>	<b>Date eDNA Extracted</b>	<b>Date Analyzed IntegritE-DNA™</b>	<b>Date Analyzed Target Species</b>	<b>Laboratory Method</b>	<b>Analytical Method (qPCR Primer/Probe set)</b>
eDNA Isolation and IntegritE-DNA™	26	26	2021/05/10 2021/05/11	2021/05/11 2021/05/12 2021/05/13	N/A	GUE SOP-00056	ePlant5
Pacific Water Shrew ( <i>Sorex bendirii</i> )	26	25	N/A	N/A	2021/05/11 2021/05/12 2021/05/17	GUE SOP-00056	eSOBE4
Northern Red-legged Frog ( <i>Rana aurora</i> )	7	7	N/A	N/A	2021/05/12	GUE SOP-00056	eRAAU1

**Remarks:**

**Bureau Veritas Laboratories (Animal DNA Department, DNA Services) is accredited to ISO17025:2017 for eDNA testing.**

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by industry professionals using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas Laboratories in writing). All data has met quality control and method performance criteria unless otherwise noted.

Bureau Veritas Laboratories' liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas Laboratories has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas Laboratories unless otherwise agreed in writing. Bureau Veritas Laboratories is not responsible for the accuracy or any data impacts that result from the information provided by the customer or their agent.

Results relate to supplied samples tested. This Certificate should not be reproduced except in full, without the written approval of the laboratory.

**eDNA tests are used to confirm presence of eDNA in samples for the targeted species / species groups.**

**Collected eDNA samples will contain eDNA at various stages of degradation, being subject to environmental forces that breakdown DNA, including microbial activity, ultraviolet radiation, heat, hydrolysis, and enzymatic activity. eDNA is first evaluated for eDNA quality and presence of qPCR assay inhibitors using the IntegritE-DNA™ assay before testing for target species or genera to confirm that the eDNA is of sufficient quality for testing and to identify and address qPCR inhibition (if present) to avoid false negatives.**

**SAMPLE RETENTION:** Samples and DNA extracts generated from the samples will be retained by Bureau Veritas Laboratories for a period of 90 days after which time they will be discarded unless prearrangement has been made by client with Bureau Veritas Laboratories for longer storage.



**Attention: Kyle Routledge**  
 Hemmera Envirochem Inc  
 4730 Kingsway - Floor 18  
 Burnaby, BC  
 Canada, V5H 0C6

**Client Project #: 105763-01**  
**Site Location: Bear Creek Park, Surrey, BC**  
**C.O.C. #: 20210510**  
**Quote #: eDNA20210427**  
**PO#: N/A**

**Report Date: 2021/05/17**  
**Report #: HE20210517**  
**Version: 1**

**ENVIRONMENTAL DNA - CERTIFICATE OF ANALYSIS**

**BV JOB #: E20210510**

**Received: 2021/05/10, 11:00 AM**

**Methodology for Sample Analysis**

Samples received to the laboratory are entered into the Laboratory Information Management System (LIMS) upon receipt. Samples were inspected and assessed for amount of silica beads, silica bead saturation level, coin envelope condition and number of coin envelopes in each bag. Samples were frozen at -20°C until processing in the laboratory. Sample analysis is completed within 10 or 15 business days (as indicated by the client on the COC) following receipt of samples by the testing laboratory.

eDNA isolation is completed using the DNeasy Blood & Tissue Kit™ (QIAGEN). A negative control is included as a blank filter sample with each batch of eDNA isolation to monitor for potential laboratory contamination during the eDNA isolation process.

Following eDNA isolation (150µL) from a quarter of filter, the IntegritE-DNA™ assay<sup>1</sup> is used to avoid the potential of a false negative (Type II error) during target species or genera testing. The IntegritE-DNA™ assay evaluates the integrity of eDNA for suitability for qPCR and for presence of qPCR inhibitors which may reduce the effectiveness of the qPCR assay for target species or genera. This assay evaluates the quality of eDNA to assess whether it is amplifiable using a qPCR assay that targets the chloroplast genome derived from plants/algae that are ubiquitously found in fresh water systems. Four technical replicates per eDNA sample, four technical replicates of negative control (Ultrapure water), and two technical replicates of positive control are used for the IntegritE-DNA™ assay. The cut-off Ct (qPCR cycle threshold) value for the IntegritE-DNA™ assay is 27. If the IntegritE-DNA™ assay produces a positive detection frequency of ≥ 2 of the 4 technical replicates, this indicates that the eDNA for the target taxa is likely to be of sufficient quality to be detected (if present) with the target assay. If the IntegritE-DNA™ assay produces a positive detection frequency < 2 of the 4 technical replicates (eDNA is degraded or qPCR inhibitors are present), then sample cleanup is completed using the OneStep PCR Inhibitor Removal Kit™ (ZYMO Research) to remove potential qPCR assay inhibitors from the isolated eDNA. Subsequent to inhibitor removal, the IntegritE-DNA™ assay is repeated to re-assess whether the eDNA is of sufficient quality for qPCR. If a sample fails at the IntegritE-DNA™ assay for the second time the client will be informed that the quality of the sample is insufficient for the qPCR assay. eDNA indicator (IntegritE-DNA™) in the sample suggests that degradation has taken place and therefore the target species assay may be ineffective. Once a sample passes the IntegritE-DNA™ assay, then the target species or genera assay is performed. Eight technical replicates per eDNA sample, eight technical replicates of the negative control (Ultrapure water), and two technical replicates of positive control (total DNA or synthetic DNA) are used for the target species or genera assay to assess the detection or non-detection of DNA of the target species or genera. The cut-off Ct value for target species assay is 50.

<sup>1</sup>Hobbs J, Round JM, Allison MJ, Helbing CC (2019) Expansion of the known distribution of the coastal tailed frog, *Ascaphus truei*, in British Columbia, Canada, using robust eDNA detection methods. PLOS ONE 14(3): e0213849.

---

**BECKY HENDERSON**  
 Senior Customer Service Representative, Bureau Veritas Laboratories, DNA Services  
 Email: becky-a.henderson@bureauveritas.com  
 Phone #: (519) 836 2400 Ext. 7067714

Please direct all questions regarding this Certificate of Analysis to your Customer Service Representative above.

=====

For Service Group specific validation please refer to the Validation Signature Page.

**Total Cover Pages: 2**



BUREAU VERITAS

BV JOB #: E20210510
Report Date: 2021/05/17
Report #: HE20210517

Client Name: Hemmera Envirochem Inc
Client Project #: 105763-01
Site Location: Bear Creek Park, Surrey, BC
Sampler Initials: K.R.

RESULTS - Pacific Water Shrew (Sorex bendirii)

Table with 14 columns: Client Sample ID, BV Case ID, Sampling Date, Preservation Type, COC Number, IntegritE-DNA Positive detection (Ct≤27), QC Batch, Cleanup required, IntegritE-DNA Positive detection (Ct≤27) after cleanup, QC Batch, Analytical Method (qPCR Primer/Probe set), Target Species eDNA Positive detection (Ct≤50), QC Batch. Includes 33 data rows and 5 footnotes.

RESULTS - Northern Red-legged Frog (Rana aurora)

Table with 14 columns: Client Sample ID, BV Case ID, Sampling Date, Preservation Type, COC Number, IntegritE-DNA Positive detection (Ct≤27), QC Batch, Cleanup required, IntegritE-DNA Positive detection (Ct≤27) after cleanup, QC Batch, Analytical Method (qPCR Primer/Probe set), Target Species eDNA Positive detection (Ct≤50), QC Batch. Includes 8 data rows and 3 footnotes.





BUREAU VERITAS

BV JOB #: E20210510
Report Date: 2021/05/17
Report #: HE20210517

Client Name: Hemmera Envirochem Inc
Client Project #: 105763-01
Site Location: Bear Creek Park, Surrey, BC
Sampler Initials: K.R.

GENERAL COMMENTS

eDNA is extracted (150 µL) from a quarter of filter, and 2 µL is used as a template for each technical replicates.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

Table with 10 columns: QC Batch, Parameter, Date, eDNA Isolation Negative Control (Detection at, Pass/Fail), qPCR Positive Controls (Detection at, Pass/Fail), qPCR Negative Controls (Detection at, Pass/Fail). Rows include QC batches 210511Q1 through 210512Q4.

1 eDNA Isolation Negative Control: Blank filters were included for each batch of eDNA extraction to monitor for laboratory contamination during eDNA isolation. eDNA Isolation Negative Control is assessed using IntegritE-DNA™ only. QC results show no eDNA was isolated from the negative control, therefore there was no indication of sample contamination during handling. Acceptance criteria: 0 of 4 technical replicates

2 qPCR Positive Controls: Two technical replicates of isolated eDNA from freshwater sample were used as positive controls for IntegritE-DNA™. Two technical replicates of total DNA or synthetic DNA from the target species were used as positive controls for eDNA assays. Results show that 100% of the technical replicates amplified the positive control eDNA as expected, therefore an observation of negative result in eDNA samples is not related to the qPCR performance. Acceptance criteria: 2 of 2 technical replicates

3 qPCR Negative Controls (Ultrapure water): Four technical replicates for IntegritE-DNA™ and eight technical replicates for target species or genera were used to monitor for laboratory contamination. Results show that 0% of the technical replicates in the negative controls had amplified eDNA, indicating no contamination was detected. Acceptance criteria: 0 of 4 technical replicates for IntegritE-DNA™, and 0 of 8 technical replicates for other assays.

LABORATORY RESULTS VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Handwritten signature: Ali Mirabzadeh

Reporter: ALI MIRABZADEH, M.Sc.
Scientific Specialist, Bureau Veritas Laboratories, DNA Services

Handwritten signature: H. Allen

Reviewer: HEATHER ALLEN, M.Sc.
Supervisor, Bureau Veritas Laboratories, DNA Services



BV JOB #: E20210510  
 Report Date: 2021/05/17  
 Report #: HE20210517

Client Name: Hemmera Envirochem Inc  
 Client Project #: 105763-01  
 Site Location: Bear Creek Park, Surrey, BC  
 Sampler Initials: K.R.

### Pacific Water Shrew (*Sorex bendirii*) eDNA Assay Validation Information

#### eDNA assay Validation

All eDNA assays are validated through a rigorous multi-step evaluation protocol that includes tests of DNA target specificity and amplification sensitivity. All eDNA tests available at Bureau Veritas Laboratories have been validated for performance using interlaboratory verification.

#### General eDNA Assay Information

Target Species Pacific Water Shrew (*Sorex bendirii*)  
 Species Abbreviation SOBE  
 eDNA qPCR Primer/Probe set eSOBE4  
 eDNA qPCR Format TaqMan

#### eDNA Assay Specificity Tests

A. qPCR Activity: Multi-species analysis of eDNA assay efficiency

Multiple qPCR reactions (n=25) performed per target DNA. Detection within the standardized eDNA qPCR assay = Yes

SOBE	SOCI	SOMO	SONA	SOPA	SORO	SOTR	SOVA	ODHE	HOSA	NTC
Yes	No	Yes (50%)*	No	Yes*	No	No	No	No	No	No

\*Substantially weaker detection ability than SOBE. Unlikely to provide signal in the field.

B. Confirmation of species-specificity in eDNA assay :

#### eDNA Assay Sensitivity Test

DNA (µg/L)	Detection Frequency (n=25)	Binomial Standard error (n=8)
5	100%	0%
1	100%	10%
0.2	76%	15%
0.04	28%	16%
0.008	0%	0%
0	0%	0%

#### Abbreviations

SOBE Pacific Water Shrew (*Sorex bendirii*)  
 SOCI Cinereus/Masked Shrew (*Sorex cinereus*)  
 SOMO Dusky/Montane Shrew (*Sorex monticolus*)  
 SONA Cardilleran Water Shrew (*Sorex navigator*)  
 SOPA American Water Shrew (*Sorex palustris palustris*)  
 SORO Olympic Shrew (*Sorex rohweri*)  
 SOTR Trowbridge's Shrew (*Sorex trowbridgii*)  
 SOVA Vagrant Shrew (*Sorex vagrans*)  
 ODHE Mule Deer (*Odocoileus hemionus*)  
 HOSA Human (*Homo sapiens*)  
 NTC qPCR no template control  
 qPCR quantitative real-time polymerase chain reaction  
 eDNA environmental DNA

#### References

- Hobbs, J, Adams, IT, Round, JM, Goldberg, CS, Allison, MJ, Bergman, LC, Mirabzadeh, A, Allen, H, Helbing, CC (2020) Revising the range of Rocky Mountain tailed frog, *Ascaphus montanus*, in British Columbia, Canada, using environmental DNA methods. Environmental DNA. 2020; 00: 1– 12. <https://doi.org/10.1002/edn3.82>
- Hobbs, J, Round, JM, Allison, MJ, Helbing, CC (2019) Expansion of the known distribution of the coastal tailed frog, *Ascaphus truei*, in British Columbia, Canada, using robust eDNA detection methods. PLOS ONE 14(3): e0213849.
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- Veldhoen N, Hobbs J, Ikononou G, Hii M, Lesperance M, Helbing, CC (2016) Implementation of novel design features for qPCR-based eDNA assessment. PLOS ONE 11(11): e0164907. <https://doi.org/10.1371/journal.pone.0164907>



BV JOB #: E20210510  
 Report Date: 2021/05/17  
 Report #: HE20210517

Client Name: Hemmera Envirochem Inc  
 Client Project #: 105763-01  
 Site Location: Bear Creek Park, Surrey, BC  
 Sampler Initials: K.R.

### Northern Red-legged Frog (*Rana aurora*) eDNA Assay Validation Information

#### eDNA assay Validation

All eDNA assays are validated through a rigorous multi-step evaluation protocol that includes tests of DNA target specificity and amplification sensitivity. All eDNA tests available at Bureau Veritas Laboratories have been validated for performance using interlaboratory verification.

#### General eDNA Assay Information

Target Species Northern Red-legged Frog (*Rana aurora*)  
 Species Abbreviation RAAU  
 eDNA qPCR Primer/Probe set eRAAU1  
 eDNA qPCR Format TaqMan

#### eDNA Assay Specificity Tests

A. qPCR Activity: Multi-species analysis of eDNA assay efficiency

Multiple qPCR reactions (n=25) performed per target DNA. Detection within the standardized eDNA qPCR assay = Yes

ASMO	ANBO-VI	LICA	PSRE	RAAU	RAPR	RACA	RALU	TAGR	HOSA	NTC
No	No	No	No	Yes	No	No	No	No	No	No

B. Confirmation of species-specificity in eDNA assay :

#### eDNA Assay Sensitivity Test

DNA (µg/L)	Detection Frequency (n=25)	Binomial Standard error (n=8)
5	100%	0%
1	88%	11%
0.2	40%	17%
0.04	20%	14%
0.008	28%	16%
0	0%	0%

#### Abbreviations

ASMO	Rocky Mountain Tailed Frog ( <i>Ascaphus montanus</i> )	
ANBO-VI	Western Toad ( <i>Anaxyrus (Bufo) boreas</i> )	Sourced from Vancouver Island (VI)
LICA	Bullfrog ( <i>Lithobates (Rana) catesbeiana</i> )	
PSRE	Pacific Chorus Frog ( <i>Pseudacris (Hyla) regilla</i> )	
RAAU	Northern Red-legged Frog ( <i>Rana aurora</i> )	
RAPR	Oregon Spotted Frog ( <i>Rana pretiosa</i> )	
RACA	Cascades Frog ( <i>Rana cascadae</i> )	
RALU	Columbia Spotted Frog ( <i>Rana luteiventris</i> )	
TAGR	Rough-skinned Newt ( <i>Taricha granulosa</i> )	
HOSA	Human ( <i>Homo sapiens</i> )	
NTC	qPCR no template control	
qPCR	quantitative real-time polymerase chain reaction	
eDNA	environmental DNA	

#### References

- Hobbs, J, Adams, IT, Round, JM, Goldberg, CS, Allison, MJ, Bergman, LC, Mirabzadeh, A, Allen, H, Helbing, CC (2020) Revising the range of Rocky Mountain tailed frog, *Ascaphus montanus*, in British Columbia, Canada, using environmental DNA methods. *Environmental DNA*. 2020; 00: 1– 12. <https://doi.org/10.1002/edn3.82>
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- Klymus, KE, Merkes, CM, Allison, MJ, Goldberg, CS, Helbing, CC, Hunter, ME, Jackson, CA, Lance, RF, Mangan, AM, Monroe, EM, Piaggio, AJ, Stokdyk, JP, Wilson, CC, Richter, CA (2019) Reporting the limits of detection and quantification for
- Veldhoen N, Hobbs J, Ikonomou G, Hii M, Lesperance M, Helbing, CC (2016) Implementation of novel design features for qPCR-based eDNA assessment. *PLOS ONE* 11(11): e0164907. <https://doi.org/10.1371/journal.pone.0164907>



BUREAU VERITAS

BV JOB #: E20210510
Report Date: 2021/05/17
Report #: HE20210517

Client Name: Hemmera Envirochem Inc
Client Project #: 105763-01
Site Location: Bear Creek Park, Surrey, BC
Sampler Initials: K.R.

Bureau Veritas
GUE FCD-00441/12
CHAIN OF CUSTODY RECORD



From Canada, send to:
Bureau Veritas, DNA Services
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240 Portage Rd
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ENVIRONMENTAL DNA (eDNA) CHAIN OF CUSTODY RECORD

Page 1 of 2

«An incomplete or incorrect form may lead to delays in testing»

COCA 20210510

Form with sections: 1 Invoice Information (Required), 2 Report Information (If differs from invoice), 3 Project Information (where applicable), 4 Turnaround Time (TAT) (Required), 5 IMPORTANT INFORMATION, 6 CLIENT SPECIAL INSTRUCTIONS, and a table for eDNA ANALYSIS with columns for Number, Sample identification, Date Sampled, Date Filtered and Preserved, Filter Material, Filter Size, Filter Pore Size, Preservation Method, Assays Requested, and Comments.

1 See instruction guide for the available eDNA assays at Bureau Veritas.

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BUREAU VERITAS

BV JOB #: E20210510
Report Date: 2021/05/17
Report #: HE20210517

Client Name: Hemmera Envirochem Inc
Client Project #: 105763-01
Site Location: Bear Creek Park, Surrey, BC
Sampler Initials: K.R.

From Canada, send to:
Bureau Veritas, DNA Services
335 Laird Rd #2
Guelph, ON N1G 4P7
eDNA@bureauveritas.com

From USA, send to:
Bureau Veritas
240 Portage Rd
Po Box 670, PMB 19
Lewiston NY 149092-1604

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