MAPLE RIDGE
BRITISH COLUMBIA

FINAL REPORT

Blaney, North Alouette, and Fraser River Integrated Stormwater Management Plan

Our File 173.188
October 2021

Submitted by:

KERR WOOD LEIDAL
consulting engineers

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Executive Summary

This report presents an Integrated Stormwater Management Plan (ISMP) for the Blaney Creek, North Alouette River, and Fraser River watersheds in the City of Maple Ridge.

The Blaney Creek watershed is approximately 2,574 ha; it drains several smaller lakes and runs approximately 8.8 km from its headwaters before it joins the North Alouette River. The watershed is largely forested and includes important ecosystems such as the UBC Malcolm Knapp Research Forest, Blaney Bog Regional Park Reserve and much of the Codd Island Wetland Ecological Conservancy Area. The south portion of the watershed consists of large agricultural lots and development areas within the Urban Containment Boundary (UCB); impervious land makes up only 5% of the watershed.

The North Alouette River watershed is approximately 3,983 ha. The river has several tributaries along its upper 8 km and flows through a densely wooded canyon, before forming a meandering channel across the uplands plain, finally turning into 5 km of a slough-like stream that has been dredged and diked, prior to converging with the South Alouette River. The watershed is mostly forested, and includes portions of the Malcolm Knapp Research Forest and Golden Ears Park in the upper watershed. The North Alouette Regional Greenway and a portion of the Codd Island Wetland Ecological Conservancy Area are located in the lower watershed, which includes suburban residential areas and land that is part of the Agricultural Land Reserve (ALR). The North Alouette River is prone to flooding downstream from 232 Street.

The Fraser River watershed is the smallest of the three watersheds at 342 ha and is fully developed and entirely within the UCB; 57% of the land cover is impervious. There are approximately 4 small tributaries to the Fraser River within the catchment in addition to piped drainage. The watershed includes an area southwest of the Haney Bypass that is within Kanaka Creek Regional Park. To manage geotechnical risks on the Fraser River Escarpment, the City has an existing policy that sets out controls for water discharge for a portion of this watershed that borders the Fraser River.

The ISMP Objectives and Process

The purpose of this ISMP is to provide guidance and information on how to proceed with future land development and re-development while protecting and enhancing the overall health and natural resources of the study creeks and watersheds.

The ISMP process has been consistent with the Metro Vancouver Integrated Stormwater Management Plan Terms of Reference Template (2005), meeting at least the minimum level of effort clauses outlined in the template, and has included stakeholder consultation to inform, engage, and consult the public, external stakeholders, City staff, and Council.

Initial Stakeholder Consultation

Stakeholder consultation meetings were incorporated to present information and findings and to obtain input and feedback. Initial meetings were held with representatives from several City departments as well as members of the Alouette River Management Society, and members of the Alouette Valley Association. Watershed knowledge and input on key issues and potential solutions and alternatives were solicited, and both written and verbal feedback was received, documented and addressed to the extent possible given the limitations of the ISMP study process.

Public outreach for the ISMP was accomplished via an online survey open to all City residents and announced via several platforms.

Stakeholder Outreach on the Draft Report

Outreach at the draft report stage included the following groups:

Groups Invited to Comment

- Agricultural Land Commission (ALC)
- Alouette River Management Society (ARMS)
- Alouette Valley Association (AVA)
- BC Conservation Foundation (Wildsafe BC Program)
- City of Maple Ridge Environmental Advisory Committee
- City of Maple Ridge Staff from multiple departments
- City of Pitt Meadows
- Department of Fisheries and Oceans Canada (DFO)
- Katzie First Nation
- Kwantlen First Nation
- Metro Vancouver Regional Parks
- Ministry of Agriculture, Food and Fisheries
- Ministry of Forests, Lands, Natural Resource Operations and Rural Development
- Morningstar Homes
- UBC Malcolm Knapp Research Forest
- Wayne Stephen Bissky Architecture Urban Design Incorporated

All groups were provided with a link to the Draft Report and invited to have a meeting including a short overview presentation of the ISMP, an opportunity to ask questions and provide verbal or written comments. 13 stakeholder groups provided feedback. That feedback improved and enriched the Final version of the ISMP Report.

Background Review

A review of existing conditions and data included an initial summary of the watersheds' characteristics and a review of existing bylaws and criteria to manage stormwater and drainage, including municipal, provincial, and federal guidelines and regulations. Key drainage issues and environmental concerns were obtained from background documents and initial stakeholder input. These pertained to ongoing river flooding, erosion, undersized drainage infrastructure, impacts of recent and future development and the need for protection of fisheries and other environmental values. These issues were reviewed and considered during the work on the ISMP. Additional issues and concerns were raised during the stakeholder review of the Draft report and were considered and addressed as well, to the extent possible in this project, through recommendations for actions, additional work, and collaboration with others.

Field Drainage Inventory

The desktop review of existing data and documents was followed by a field drainage inventory of drainage features and infrastructure. The inventory was limited to areas of importance based on community observations and previously submitted reports outlining areas of concern including for example flooding, erosion, deposition and obstruction sites, as well as areas where field data could be collected to be used for modelling purposes.

Severe erosion was observed at three sites with potentially high risk hazard and related high consequences. However, the rate of erosion throughout the watershed seems normal and the consequences of the erosion sites appear to be minimal. Also, no anthropogenic obstructions were observed in the field.

KWL also undertook survey of culverts and manholes in the watersheds to fill in gaps in available data provided by the City. In particular, the survey targeted culverts and storm manholes where missing information would make modelling of these pieces of infrastructure difficult or the results unreliable.

Environmental Assessment

KWL completed a desktop review, field inventory, and assessment of environmental values in the study watersheds including aquatic species and habitats, riparian and watershed forest cover, terrestrial species and habitat, and water quality. The purposes of the assessments were to assess status and trends in watershed health; identify priority environmental issues to be addressed; and identify environmental enhancement opportunities. The Blaney Creek and North Alouette Watersheds contain diverse and regionally unique terrestrial and wetland habitats. For example, Blaney Bog and Codd Island Wetlands provide high quality habitat for many rare and endangered flora and fauna. North Alouette River and Blaney Creek watersheds provide excellent spawning habitat and extensive areas of rearing habitat for salmon and trout. Coho and chum salmon, coastal cutthroat trout, rainbow trout/steelhead, and well as other fish species have been recorded in these watersheds. The Fraser River catchment provides little spawning and rearing habitat and only coho salmon and threespine stickleback have been recorded in this catchment. Water quality in North Alouette tributaries is generally good, but Cattell Brook has had several water quality issues and the Fraser River tributary had poor water quality.

Based on the review of background information, field habitat assessment, and stakeholder engagement, several priority concerns and recommendations for protecting fish and aquatic habitat within the watersheds were identified.

Watershed Health Tracking

The health of a watershed is estimated based on the Watershed Health Tracking System (WHTS), outlined in the ISMP Template. The WHTS is a tool for assessing watershed health based on measuring three characteristics – the total impervious area (TIA, %), riparian forest integrity (RFI, %), and the diversity and abundance of creek bed taxa expressed as the Benthic Index of Biological Integrity (B-IBI, measured and predicted) – of any given watershed. The higher the RFI and the lower the TIA, the higher B-IBI scores should be, and the better the watershed health. Anderson Creek had a mean B-IBI score of 34.7 and 44 taxa of invertebrates. The North Alouette had a mean B-IBI score of 24.0 and 32 taxa. Biological conditions were ‘fair’ in Anderson Creek and ‘poor’ in the North Alouette River, based on the biological condition rankings found in the MAMF that correspond to these B-IBI scores. The B-IBI scores for both Anderson Creek and North Alouette River indicate relatively healthy watersheds. Higher than predicted B-IBI score for Anderson Creek may suggest that stormwater source controls used in the Silver Valley developments in this watershed have been effective at offsetting at least some of the impacts of that development. If future increases in impervious area are not mitigated, the watershed health would be expected to decrease. The measured score for North Alouette River is lower than predicted, indicating the watershed health is not as robust as would be expected given the large forested areas of the upper watershed.

Existing and Future Conditions Drainage Assessment

To assess the capacity of the drainage system, PCSWMM was used to simulate the watershed hydrology and upland hydraulics for pipes that are 400 mm in diameter and larger. The existing conditions model was calibrated and validated using flow monitoring data collected at five flow monitoring locations in the watersheds. As per the City’s Design Criteria Manual, design storms were used to assess pipe capacity and real storm events were used to assess the detention facility performance.

In the minor system, modelled flows exceeded the design criteria for the 10-year existing land use instantaneous peak flows in 7.9% of the total pipe length (corresponding to 27 out of 329 pipes). In the major system, flows exceeded the design criteria for the 100-year existing land use in 2.6% of the total pipe length (corresponding to 9 out of 38 pipes). Culverts were assessed for the 10-year conveyance capacity for driveway culverts, 100-year conveyance capacity for creek culverts and 200-year conveyance for culverts under arterial roads; 34% of the culverts (16) were identified as undersized under the existing conditions. Nine existing detention ponds were assessed. One of these has inadequate volume for existing conditions and five ponds will likely require adjustments to meet capacity criteria under future development and climate change conditions.

The future land use was developed by using OCP GIS data and any neighbourhood/community planning land uses. Land expected to develop/re-develop under the OCP and within the time horizon were considered and special attention was given to parcels designated as ‘Eco-Cluster’, where green spaces are set aside to a high degree. The future impervious areas of the Fraser River, North Alouette River and Blaney Creek watersheds were estimated at 62, 10, and 12%, respectively.

The major and minor conveyance system was evaluated for future land use conditions using the same criteria as for the existing conditions. The future conditions assessment without climate change resulted in 1 additional pipe exceeding the minor system design criteria 10-year peak flow and 1 additional pipe exceeding the design criteria for the major 100-year peak flow. Future conditions were also assessed taking climate change into account, by increasing the rainfall amounts by 10% and 20%, representing predicted climate change effects in years 2050 and 2080, respectively . The future conditions assessment under the effect of climate change in 2050 resulted in peak flows exceeding the minor system design criteria in 10.2% of the total pipe length, and the major system design criteria in 3.9% of the pipes (including existing deficiencies). For the 2080 scenario (+20% rainfall), minor system design criteria were exceeded in 12.2% of the total pipe length, and in 3.9% of the pipes in the major system. Under unmitigated future conditions with climate change there are 2 additional culverts that do not meet the assessment criteria in the 2050 scenario and 2 more that do not meet the assessment criteria under 2080 conditions. The increased rainfall also results in poorer performance of the detention ponds; under 2080 climate change conditions all of the 9 ponds have inadequate volumes.

Detention Facility Assessment

Detention facility simulations were completed to estimate the effectiveness of the flow control facilities and to understand which facilities may need to be upgraded under the existing, future land use, and future land use plus climate change scenarios. At four facilities, water levels would exceed their banks under 100-year design storm simulation. These facilities most likely do not require large modifications; a detailed study of safe overland flow routes due to flooding at a facility would be an option for those facilities. The Silver Valley Walkway facility may require modifications such as removing a flow control plate or reducing overflow levels to prevent flooding during smaller design storms. It is not clear that changes to the existing detention facilities are required, only that they may be warranted based on the high-level assessment in this ISMP.

Vision for the ISMP

Part of the ISMP process involves setting the overall goal for the health of the watershed as a vision statement. The Vision for the longer-term health of the Blaney, North Alouette and Fraser River watersheds was developed by considering existing goals and opportunities within City documents, incorporating the intent and purpose of the ISMP process, and input from City staff from multiple departments.

The ISMP incorporates the five priorities of the City’s Strategic Plan 2019-2022:

1. Community Safety
2. Intergovernmental Relations
3. Growth
4. Community Pride & Spirit
5. Natural Environment

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[1] Climate change predictions will vary over time as the global climate models underlying the rainfall predictions are updated and climate conditions continue to evolve. These values are benchmarks for the given planning horizons at the time of the study.

The following ISMP Vision Statement was developed.

> *In a City inspired by nature, we aspire to:*
>
> - *Preserve and improve the health of the watersheds - where we live, work, and play - while we allow for development as planned in our Official Community Plan.*
> - *Prepare for changes in climate and weather patterns and work to ensure the safety of our communities within our watersheds.*

Recommendations

In order to address the challenges and concerns for mitigating impacts of development and protecting and enhancing watershed health for the future, a suite of recommendations was developed. After extensive stakeholder consultation on the Draft Report, further recommendations and clarifications were added to address stakeholder concerns. The resulting recommendations form the 'plan' for the ISMP and are summarized as follows.

Capital Upgrade Program for Drainage Infrastructure

Potential infrastructure upgrades are proposed for undersized infrastructure in the minor or major drainage system under both existing and future conditions. The potential projects in this capital upgrade program provide planning-level budgets that cover preliminary and detailed designs and construction in current day costs. Potential upgrades to storm sewer infrastructure have been prioritized by considering whether a pipe is part of the major or minor system, the severity of surcharging at the inlet of a pipe, and the relative magnitude of upgrades required. Highest priority is given to recommended upgrades in the existing major drainage system where adequate conveyance or detention volume is not provided for the existing land use 100-year event or 200-year event for culverts under arterial and collector roads. It is recommended that infrastructure condition be assessed and infrastructure in poor condition be integrated into this priority. Priority 2 upgrades are minor system infrastructure where adequate conveyance is not provided for the 10-year event under existing land use. Priority 3 upgrades are minor or major system infrastructure that adequately convey flow under existing land use conditions but cannot convey flow under future land use with or without climate change. A Class 'C' Cost Estimate was completed for the pipes and culverts that were identified as having insufficient capacity for their required storm events. Storm sewer and culvert upgrade cost estimates are summarized as follows:

Priority 1 – Short Term Plan	
Fraser Watershed Storm Sewer (5 conduits)	$3,623,000
Blaney Watershed Storm Sewer (4 conduits)	$1,161,000
Fraser Watershed Culverts (1)	$1,412,000
Blaney Watershed Culverts (2)	$719,000
North Alouette Watershed Culverts (1)	$214,000
Priority 1 Total	**$7,129,000**
Priority 2 – Medium Term Plan	
Fraser Watershed Storm Sewer (27 conduits)	$7,915,000
Fraser Watershed Culverts (1)	$200,000
North Alouette Watershed Culverts (1)	$117,000
Priority 2 Total	**$8,232,000**

Priority 3 – Long Term Plan	
Fraser Watershed Storm Sewer (12 conduits)	$2,572,000
Blaney Watershed Storm Sewer (4 conduits)	$745,000
North Alouette Watershed Storm Sewer (4 conduits)	$996,000
Fraser Watershed Culvert (1)	$536,000
North Alouette Watershed Culvert (2)	$633,000
Priority 3 Total	**$5,482,000**
Watershed Summary	
Fraser Watershed Total Cost	$16,258,000
Blaney Watershed Total Cost	$2,625,000
North Alouette Watershed Total Cost	$1,960,000
Total Cost	**$20,843,000**

The City is recommended to consult with Wildsafe BC on priority locations for potential sizing of culverts to accommodate safe bear passage.

The modelling of the drainage system completed for this ISMP has limitations in the level of detail incorporated due to the watershed-scale size of the models as well as use of a single modeling scenario for Tier A/B attainment. The City is recommended to develop sub-watershed (200 – 300 ha) Master Drainage Plans (MDPs) to further examine the issues, emerging trends and upgrades needed in each catchment.

The City has identified that there is only limited information on overland flood paths for the 100-year event in existing urban areas. It is recommended that the City consider a future project to assess and review major overland flood paths using a risk assessment framework.

It is recommended that the City continue with implementing the flood protection plans as recommended in the North Alouette and South Alouette Rivers Additional Floodplain Analysis report completed by NHC in 2016.

For areas where there is no existing drainage servicing, it is recommended the City undertake drainage plans for these areas in accordance with the discussion in Section 12.4.

Bylaw and Policy Recommendations to Mitigate Impacts

The City should continue to use and implement the three-tiered approach to mitigation of flows from development and should continue to work with developers and consultants to apply the existing criteria, particularly emphasizing the benefits of multi-return period detention design.

Proper management of stormwater can lead to avoided costs for flooding, reduced needs for infrastructure upgrades, and increased property value. Healthy watersheds can also provide other benefits, so-called ecosystem services, that are necessary for community well-being but that are difficult to monetize, such as water filtration and storage, nutrient cycling, and recreation. By protecting natural areas from development and mitigating stormwater in developed areas using the three-tiered approach, valuable ecosystem services provided by healthy watersheds are also protected. The following enhancements to existing criteria and policies are recommended to support the protection and enhancement of watershed health:

1. Implement Tier A and Tier B criteria to mitigate the effects of development. This involves addressing and overcoming the barriers that cause Tier A and Tier B requirements to often fall short of performance targets.
2. Update the City's Stormwater Design Criteria Tier A wording and criteria to include elements for improving runoff water quality from vehicle-accessible surfaces.

3. Work with developers to close the gap between the intent of the Tier A and B criteria, and the design of stormwater management practices to achieve the criteria.
4. Add other means than infiltration and exfiltration for managing Tier A and B events in the Fraser River Escarpment Area. To meet the performance targets described for Tier C, storm sewers in this area may need to be designed to provide sufficient capacity to convey runoff from 10- and up to 100-year events.
5. Apply 2017 Metro Vancouver Baseline guidelines for stormwater management on single-family lots to encourage and support on-lot stormwater management while assisting the design community by providing robust stormwater management design options. These guidelines represent a minimum level of mitigation expected on single-family lots across the region.

It is increasingly recognized that natural systems provide a wide variety of services to society that have significant value. The City of Maple Ridge has a wealth of natural areas that provide benefits and services to the public. It is recommended that the City build up documentation of its many natural assets, linking the assets with the services they provide. An understanding and accounting for natural assets the City relies on can provide support for protection and maintenance of these natural assets similar to how traditional infrastructure is valued, inventoried, maintained and budgeted for.

In addition to the stormwater design criteria improvements recommended above, other recommended enhancements to existing programs and policies for the City's consideration include:

1. Continue to utilize the existing policies and bylaws already in place that support and protect watershed health.
2. Incorporate climate change in planning and sizing for stormwater infrastructure including sewers, culverts, and detention ponds.
3. Promote Green Infrastructure to mitigate impacts of development.
4. Develop a pilot program for water quality treatment of road runoff focusing on reducing existing stormwater pollution impacts on sensitive aquatic environments.
5. Allow for off-site stormwater management in cases where full on-site stormwater management compliance is not possible.
6. Enhance protection of sensitive ecosystems from development and other impacts.
7. Protect well capture zones and aquifers from contamination from stormwater infiltration facilities.
8. Seek options for implementing bio-engineering methods over rip-rap at interfaces between watercourses and drainage outfall channels.
9. Review and revise the City's approach on construction site erosion and sediment control (ESC) to require designers to have ESC-specific training, education and certification and to plan ESC measures based on a quantitative approach such as the Revised Universal Soil Loss Equation (RUSLE).
10. Promote regional development planning to better consider regional issues, values, and solutions, by instituting regional planning processes for areas where development is or is expected to be widespread.
11. Increase communication and awareness of the City's efforts and programs that support watershed health to improve public confidence in the City's efforts, and improve coordination between the City and stakeholder groups that have close ties to watershed health.

Proposed Environmental Protection and Enhancement Measures

Maintaining and enhancing the health and integrity of the Blaney, North Alouette, and Fraser watersheds will require an overarching strategy, political will, enforcement, participation of all levels of government, and collaboration with stakeholders and people active in the community. A strategy for maintaining and enhancing these watersheds prioritizes avoiding or minimizing impacts to existing natural ecosystems and natural assets.

Based on the assessments completed for this ISMP, there are 26 projects proposed to maintain and enhance watershed health (see Figures 16-1 through 16-3). Seven projects will promote and protect watershed health, and hence are the highest priority. These include protection of:

1. Rare and sensitive habitat types located in Blaney Bog and Anderson Creek from future development;
2. High quality fish habitat located in Blaney Creek and its tributaries, including Spring Creek and Donegani Creek;
3. High quality water within Balsam Creek from potential impacts of future development;
4. High quality fish habitat within the Upper North Alouette River from potential impacts of future development;
5. High quality water within Birch Creek from potential impacts of future development;
6. Rare old growth riparian habitat along Roslyn Creek;
7. High quality riparian habitat along North Alouette River and Connector A Creek.

Remaining recommended projects will improve stream or watershed health over and above the existing condition. These projects cover riparian enhancement, stream restoration, erosion repair, fish passage, research, stormwater management, and public engagement efforts.

Monitoring and Adaptive Management

To fulfill provincial requirements to monitor stormwater to assess and report on the effectiveness of ISMP implementation, Metro Vancouver and its member municipalities have developed a *Monitoring and Adaptive Management Framework for Stormwater* (MAMF). Through repeated sampling, watershed health trends and the effectiveness of specific watershed protection measures and management actions can be tracked over time. Using a monitoring and adaptive management approach for ISMP implementation allows for regular feedback on the efficacy of measures recommended in the ISMP and adaptive course-corrections over time.

KWL has proposed a monitoring program for the Blaney, North Alouette, and Fraser River ISMP, including chemical, physical and biological monitoring components that goes beyond the minimum requirements of the MAMF; it includes methods, sites, monitoring frequency, and recommended implementation approach. The primary focus for the first five years after completion of the ISMP will be to implement the proposed monitoring program, further investigate issues identified in 2016 monitoring and baseline analysis, and assess whether results indicate watershed health trends in the right direction or whether enhanced mitigation or management approaches are needed.

Additional water quality monitoring beyond the MAMF requirements includes agricultural runoff testing and in-pipe or end-of-pipe monitoring to better understand the pollutant loading that runoff is contributing to receiving streams.

Funding Options

The cost of recommended capital projects has been indicated. Recommended programs have not been costed at this time as they will incur internal costs that will require assessment of internal resources and needs as the programs are developed in detail. Various existing and potential funding sources could be considered for implementing the recommendations of this ISMP. Section 17.3 outlines options for consideration.

1. Introduction

The City of Maple Ridge (CMR) retained Kerr Wood Leidal Associates Ltd. (KWL) to develop an Integrated Stormwater Management Plan (ISMP) for the Blaney, North Alouette, and Fraser River watersheds. Figure 1-1 presents a map indicating the extents of the study area.

The ISMP study focuses on Blaney Creek, North Alouette River and their tributaries, as well as small tributaries draining to the Fraser River, and includes the trunk storm sewer pipes, bridges, culverts, and pump stations within these watersheds. Figure 1-2 and Figure 1-3 shows the existing stormwater drainage system.

1.1 Blaney Creek Watershed

The Blaney Creek watershed is approximately 2,574 ha. Its headwaters are on the south slope of Gwendoline Peak and drain Placid, Loon, Lost, and Blaney Lakes. Blaney Creek runs approximately 8.8 km from its headwaters to join the North Alouette River just west of Neaves Road. Its main tributaries, listed in order from upstream to downstream and beginning at the headwaters, are: Loon Creek, Anderson Creek, Spring Creek, Donegani Creek, and McKenzie Creek.

Approximately 80% (2,059 ha) of the watershed is within the City boundaries; of that, only 7% (141 ha) of the watershed is within the Urban Containment Boundary (UCB). The Blaney Creek watershed is largely forested. The Malcolm Knapp Research Forest managed by the University of British Columbia, is located in the mid-east portion of the catchment. The southernmost portion of the watershed consists of large agricultural lots on low-lying land. Recent urban developments in the area, such as Silver Valley, were designed and built using low impact development (LID) approaches in order to reduce the stormwater impacts of development to downstream infrastructure and ecosystems of the creek receiving waters.

Blaney Creek supports coho, chum, and pink salmon in addition to at least 3 other fish species. Adult salmon spawn mainly in the mid- and upper reaches of Blaney Creek. A waterfall 1 km upstream of the 224 Street Bridge limits the upstream passage of anadromous fish. The watershed also contains Blaney Bog Regional Park Reserve (115 ha) and a portion of Codd Wetland Ecological Conservancy Area[2] (101 ha). These areas represent the largest off-channel habitat for rearing salmon in the Alouette River watershed, and also provide critical habitat to many at-risk wildlife species and plant communities.

1.2 North Alouette River Watershed

The North Alouette River watershed is approximately 3,983 ha. Its headwaters drain the west aspect of Golden Ears and the east slopes of Gwendoline Peak. The North Alouette River originates at an elevation of 311 m near the outlet of Marion Lake. It has several tributaries along its upper 8 km and flows through a densely wooded canyon. The stream emerges from the canyon 10 km upstream of the confluence with the South Alouette River, forming a meandering channel across the uplands plain. The final 5 km are slough-like and have been dredged and diked. This section flows through agricultural lands in Pitt Meadows prior to converging with the South Alouette and discharging to the Pitt River.

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[2] Codd Wetland Ecological Conservancy Area is a Metro Vancouver Conservancy Area and there is no public access. The purchase and conservation management of the site are supported by the Province of British Columbia, Metro Vancouver, the City of Pitt Meadows, The Land Conservancy of British Columbia, and Ducks Unlimited. The Aquilini family contributed significantly to the purchase of Codd Wetland to protect it. http://www.metrovancouver.org/services/parks/learn/park-reserves/codd-wetland/Pages/default.aspx

Approximately 85% (3,390 ha) of the watershed is within the City boundaries; of that, only 7% (271 ha) of the watershed is within the UCB. Upstream of the UCB, the watershed is mostly forested. Downstream of the UCB, the land is part of the Agricultural Land Reserve (ALR).

The North Alouette River supports coho, chum and pink salmon and ten other fish species. Anadromous fish have access up to the impassable falls near the southern boundary of the Malcolm Knapp Research Forest. Most salmon spawn in the central and lower reaches of the North Alouette River. A portion of Codd Wetland Ecological Conservancy Area and Malcolm Knapp Research Forest is found in the North Alouette watershed. Photos 1-1 and 1-2 show two different reaches of the North Alouette River.

The North Alouette River is prone to flooding downstream from 232 St. This flooding has been studied and modelled separately from this ISMP (see North Alouette and South Alouette Rivers Additional Floodplain Analysis[3]), so the flooding concern is not a primary focus of this work.

Photo 1-1: North Alouette River at 232 Street

Photo 1-2: North Alouette River at 228 Street

1.3 Fraser River Watershed

At 342 ha, the Fraser River watershed is the smallest of the three watersheds under study. Draining south to the Fraser River, this catchment is fully developed and entirely within the UCB. The watershed is heavily urbanized but includes an area near the Fraser River (southeast of 227 Street) that is within Kanaka Creek Regional Park. There are approximately 4 small tributaries to the Fraser River within the catchment in addition to piped drainage. To manage geo-hazard risks on the Fraser River Escarpment, the City has an existing policy that sets out controls for water discharge for a portion of this watershed that borders the Fraser River.

Coho Salmon and Threespine Stickleback have been sampled in ditches within the Fraser River watershed.

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[3] https://www.mapleridge.ca/DocumentCenter/View/8145/North-and-South-Alouette-Rivers-Floodplain-Study?bidId=

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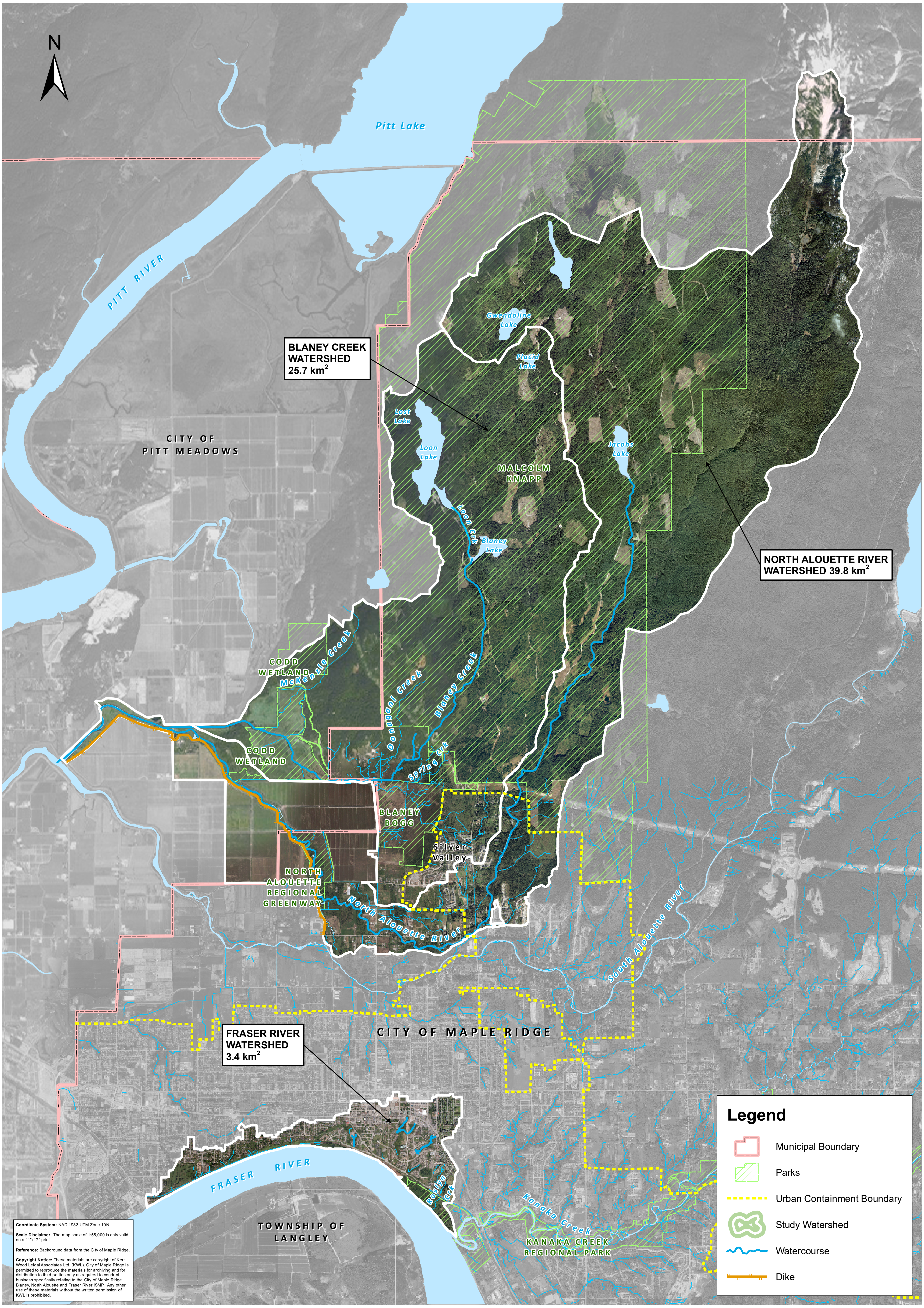
City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:55,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

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Legend

▭	Municipal Boundary
▨	Parks
┅	Urban Containment Boundary
◯	Study Watershed
∿	Watercourse
━	Dike

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Date October 2021

Scale 1:55,000

Study Area
2015 Airphoto (within Study Area)

Figure 1-1

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Blaney, North Alouette and Fraser River ISMP

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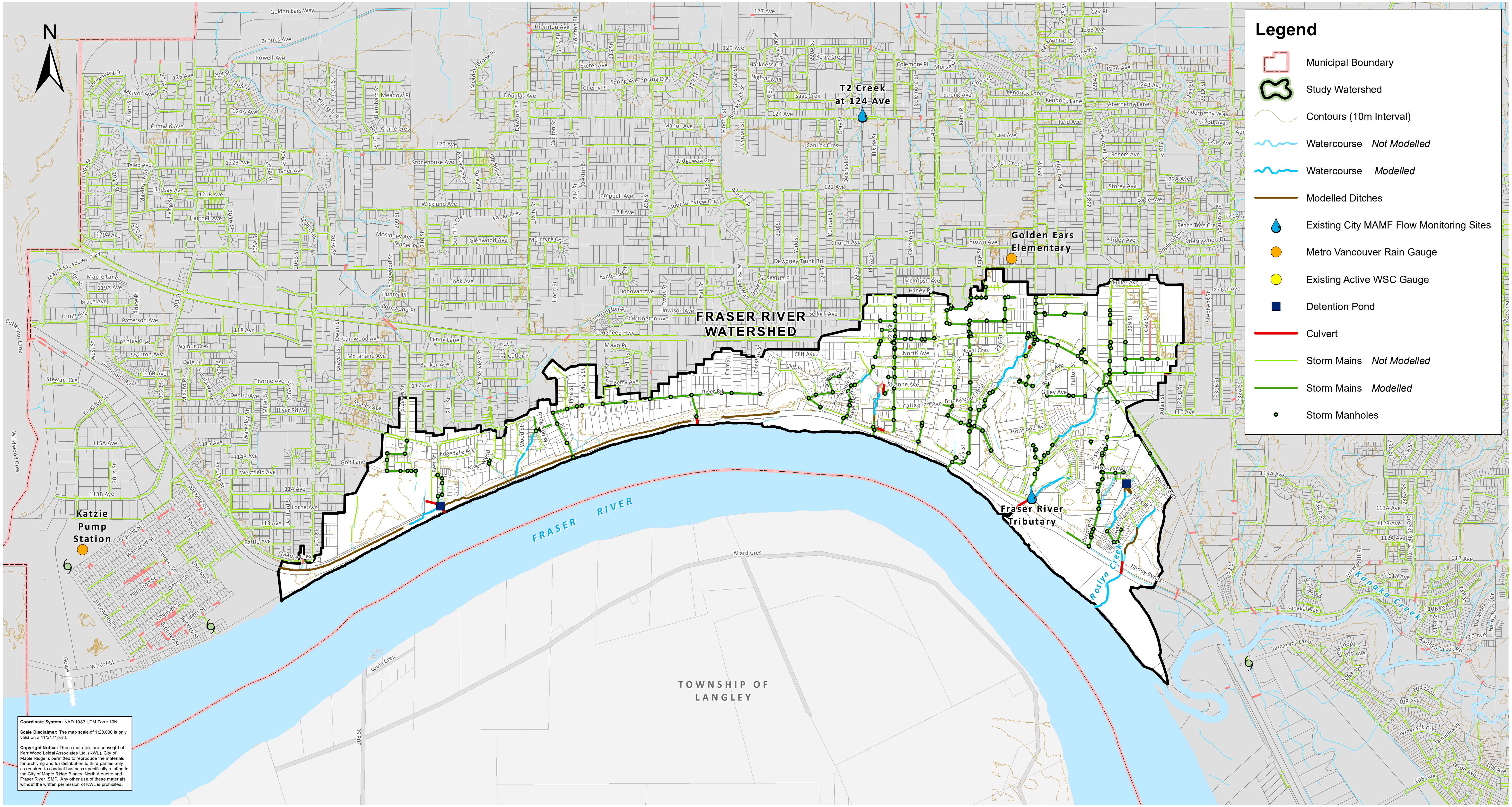

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:20,000 is only valid on a 11"x17" print.

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Scale	1:20,000

Drainage System Overview Fraser River Watershed

Figure 1-2

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\20200430\173188_Fig1-2B_DrainageOverview.mxd Date Saved: 2020-04-30 9:55:18 AM | Author: JLau

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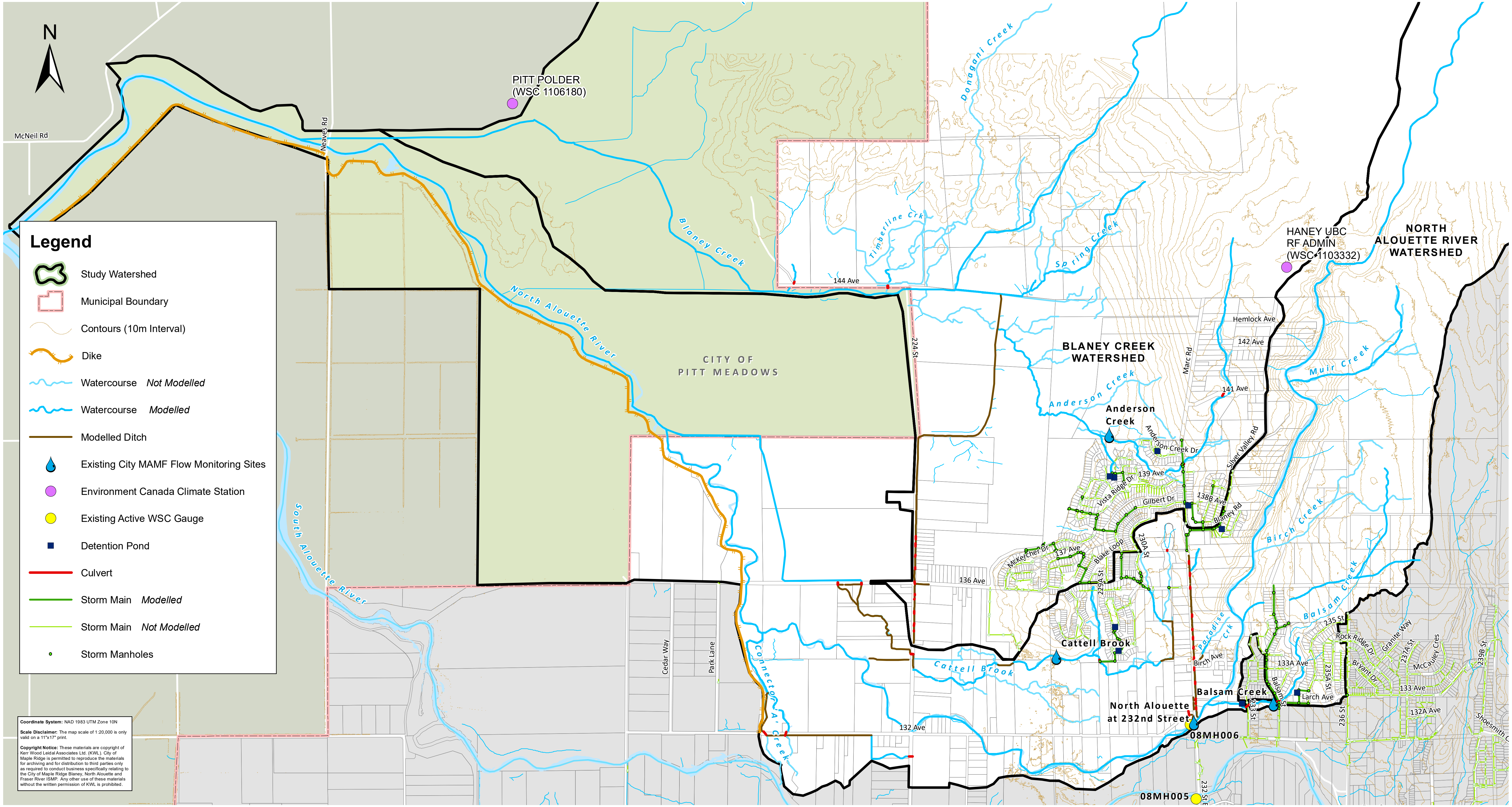

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:20,000 is only valid on a 11"x17" print.

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Scale	1:20,000

Drainage System Overview Blaney Creek/ North Alouette Rvier Watershed

Figure 1-3

2. ISMP Objectives and Scopes

2.1 Objectives

The purpose of this ISMP is to provide guidance and information on how to proceed with future land development and re-development while protecting and enhancing the overall health and natural resources of the study creeks and watersheds. The following objectives are proposed for the Blaney, North Alouette River and Fraser River ISMP:

- **ISMP based on the Template:** Develop an ISMP consistent with the *Metro Vancouver Integrated Stormwater Management Plan Terms of Reference Template (2005).* The ISMP will at least meet the minimum level of effort clauses outlined in the template.
- **Stakeholder Consultation:** Inform, engage, and consult the public, key external stakeholders, City staff, and Council.

2.2 Scope of ISMP

Major Phases of the ISMP are as follows:

- **Phase 1:** Review and Assessment of Existing Conditions and Data
- **Phase 2:** Watershed Vision Development
- **Phase 3:** Recommendations and Capital Programs
- **Phase 4:** Monitoring and Adaptive Management

3. Stakeholder Consultation

Stakeholder consultation for the ISMP reached out to a wide variety of audiences and included a public survey, engagement with a number of community groups, rightsholders and other government institutions/jurisdictions/agencies, feedback from the Maple Ridge Environmental Advisory committee, and numerous discussions with Maple Ridge staff from various departments.

3.1 Initial Stakeholder Consultation

Initial stakeholder consultation included meetings with City staff, the Alouette River Management Society and the Alouette Valley Association. The meetings assisted information gathering on fish habitat and water quality. It also identified stewardship priorities and top concerns regarding flooding, channel obstructions, and development. This information is documented in Appendix E.

3.2 Public Outreach

Public outreach for the ISMP was accomplished via an online survey. The survey was intended to be applicable for both of the City's ISMPs and the survey was open to all City residents, not just residents of the study area for this ISMP.

Notice of the survey was provided to the public via several platforms. The survey was posted on the City's website for one month, from July 19, 2019 to August 19, 2019. The survey was posted on the front page of City Spotlight section of the City's website. A link to the survey was provided on the City's Facebook page on August 1, 2019, reaching 1,760 people and receiving engagement with 53 people. Notice of the survey was published in the newspaper on August 2, and August 7, 2019. The City's public newsletter also featured notice of the survey in the July 31, 2019 edition and has a distribution mailing list that contains 181 subscribers.

INTEGRATED STORMWATER MANAGEMENT PLANS

ONLINE SURVEY

The City is developing plans for managing drainage and watershed health. The creation of these plans (called "**Integrated Stormwater Management Plans**") is a key action of the City of Maple Ridge Strategic Plan for 2019-2022 and supports the goals of the Official Community Plan.

The City of Maple Ridge is seeking your comments on the health of our local watersheds and drainage systems. Your feedback will help shape the City's Integrated Stormwater Management Plans.

To take the online survey and to learn more about the Integrated Stormwater Management Plans please visit ***www.mapleridge.ca/1008***

Thank you for your participation.

MAPLE RIDGE
BRITISH COLUMBIA

The questions posted in the online survey were:

Q1. Have you experienced flooding in your neighbourhood?
Q2. Are you aware of how natural features are important for drainage?
Q3. Your impression of watershed health (rural areas)
Q4. Your impression of watershed health (suburban areas)
Q5. Your impression of watershed health (urban areas)
Q6. How important is health of watersheds to you?
Q7. What level of investment drainage improvements would you support?

The survey received 26 individual responses. The survey responses are documented in Appendix E.

Most respondents indicated that they are concerned about watershed health and support investment in watershed health for the future. A majority of respondents are aware of flooding issues nearby or in their neighbourhood, which may indicate that those who are aware of flooding issues were more likely to respond than residents who are not aware of issues.

3.3 Environmental Advisory Committee Consultation

A Draft copy of the ISMP Report was submitted to the City's Environmental Advisory Committee (EAC) as part of their agenda package, and a presentation on the ISMP was provided at the December 9, 2020 EAC meeting. This was followed by discussion and feedback from EAC members.

3.4 Draft Report Outreach

In late 2020, a Draft copy of this ISMP was distributed to a number of external stakeholder groups and agencies for feedback, along with an offer for a presentation and virtual discussion. Many accepted the offer for consultation discussions, which took place from December 2020 through June 2021. Some groups provided written feedback on the Draft ISMP following in-person discussions. A small number of stakeholders that were invited to provided feedback did not respond to the invitation or indicated they did not have any feedback on the ISMP.

The following stakeholder groups did provide extensive feedback, contributing to the content and recommendations of this final document. These stakeholders are acknowledged and appreciated for their contribution to this report.

- Agricultural Land Commission
- Alouette River Management Society (ARMS)
- Alouette Valley Association (AVA)
- BC Conservation Foundation (Wildsafe BC Program)
- BC Ministry of Agriculture, Food and Fisheries (MoAFF)
- BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD)
- Department of Fisheries and Oceans Canada (DFO)
- Metro Vancouver Regional Parks
- Morningstar Homes
- University of British Columbia Malcolm Knapp Research Forest
- Wayne Stephen Bissky Architecture Urban Design Incorporated

4. Background Review

The available background reports and GIS layers were reviewed and are listed in Appendix A.

4.1 Drainage Overview

The following table below and Figure 1-2 and Figure 1-3 summarizes the key study area characteristics.

Table 4-1: Summary of Watershed Characteristics

Description	Blaney, North Alouette, and Fraser River Watershed
Drainage Area	• Blaney Creek: 2,574 ha. • North Alouette River: 3,983 ha. • Fraser River: 342 ha. • Blaney Creek originates in the mountains north of Maple Ridge, flows into the Blaney Bog area, and discharges into the North Alouette River. • The North Alouette River also originates in the mountains north of Maple Ridge and flows through the north agricultural area of Maple Ridge before discharging into the Alouette mainstem. • The Fraser River catchment is made up of approximately 4 minor creeks that discharge directly into the Fraser River.
Stream Length	• 8.8 km Blaney Creek – mainly a steep, mountainous, open channel. • 18.7 km North Alouette – steep mountainous headwaters with few tributaries. Lower gradient downstream with 3 bridge crossings, flows into the Pitt River flood plain. • 2.2 km Anderson Creek – Small steep tributary to Blaney Creek. • 0.7 km Balsam Creek – Small mountainous tributary to North Alouette River. • 2.6 km Fraser River tributaries (Cumulative) – Small urban streams draining down the Fraser River Escarpment.
Channel Slope	• Blaney Creek is very flat from Blaney Bog to its outlet (<0.01%), but has a channel slope of about 8% from its headwaters to Blaney Bog. • North Alouette has a slope of about 3.4% upstream of 232 Street and about 0.01% downstream of 232 Street. • Fraser River tributary creeks have slopes of approximately 5%.
Detention Facilities	• Blaney watershed: 2 above ground ponds and 2 bio-filtration facilities. • North Alouette watershed: 3 above ground ponds. • Fraser River watershed: 1 above ground pond and 1 bio-filtration facility.
Erosion	• Some documented active stream bank erosion and ravine slope instabilities.

Description	Blaney, North Alouette, and Fraser River Watershed
Topography	• Ground elevations range from 1698 m above the headwaters of the North Alouette River to 1 m where the North Alouette enters the South Alouette mainstem. • Blaney and the North Alouette mainly flow through mountainous ravines. • The lower reach of the North Alouette is very low gradient and flows through wide floodplain and farmland. • The small creeks flowing into the Fraser River from the urban centre of Maple Ridge are mostly low gradient streams with almost entirely urban catchments.
Soils	• Gravel & sand, silty clay, silt & clay, loam, till, peat, bedrock (see Figure 4-1).

4.2 Existing Bylaws and Criteria

Criteria to manage stormwater and drainage within the City were collated from the following major sources and are summarized in Table 4-2:

- Maple Ridge Watercourse Protection Bylaw No. 6410 – 2006
- City of Maple Ridge Design Criteria Manual, 2015
- Maple Ridge Official Community Plan Bylaw No. 7060-2014
- The Streamside Protection Regulation, 2001
- City of Maple Ridge Policy Statement No. 6.23
- City of Maple Ridge Strategic Plan 2019-2022

Table 4-2: Summary of Existing Stormwater Criteria

Application	Criteria/Methodology
Conveyance	
Minor Drainage System	Convey up to the 1:10-year event[1]
Major Drainage System	Accommodate runoff from the 1:100 year event[1]
Stormwater Management Plan	
Tier A (Infiltration)	Capture small events - 50% Mean Annual Rainfall (MAR*)[1]
Tier B (Detention)	Control runoff from larger events - 50% of MAR to MAR[1]
Tier C (Discharge)	Provide adequate level of flood protection - Exceed MAR[1]
Rate Control	
Standard Rate Control	The runoff from a 1:10 year minor storm shall be detained and released at the 1:2 year forested rate. The runoff from a 1:100 year major storm event shall be detained to a 1:10 year pre-development rate for upland areas.[1] For sensitive system where the downstream area is considered to be prone to flooding, the 1:100-year storm event shall be detained to the 1:2-year pre-development rate.
Additional Rate Control (for sensitive systems)	Limit the post-development peak rate of runoff from the development site for the 1:2 year design storm to the natural peak runoff flow from the site in a forested pre-development condition for the 1:2 year design storm[1]

Application	Criteria/Methodology
Environmental Protection	
Volume Reduction Source Controls	Infiltration facilities shall be designed for a design storm of 25 mm in 24 hours; post development infiltration from the entire parcel is no less than the infiltration that would have occurred prior to construction of any building or impermeable surface on the parcel.
Water Quality Treatment	For Construction and Development Works: TSS level must not be greater than 25 mg/L during dry weather and less than 75 mg/L during the wet season; turbidity levels must not be greater than 20 NTU, and the pH of water discharged from the site should fall between 6 and 9.0.[2]
Infiltration Restrictions	
Drainage Design in the Fraser River Escarpment[5]	Stormwater drainage ditches or buried storm services shall be provided where existing roads, residential and commercial run-off causes ponding of water. Buried storm services shall be provided for all new roads or upgraded facilities. All storm drainage facilities shall be designed in accordance with the current stormwater management criteria. No groundwater discharge of new construction residential commercial, road or parking areas shall be allowed. All such drainage shall be carried to storm water ditches or sewers. All storm ditches shall be constructed to avoid ponding of water and drain to the north & west by gravity. No discharge shall be allowed into river bank ravines. No storm water discharge shall be permitted over the river bank slopes or ravines unless transferred to river level in continuous storm sewers or pipes. If approval cannot be obtained to discharge stormwater by pipe into the Fraser River then the discharge must be directed to a storm drainage system – ditch or storm sewer – on the road right-of-way. Where there is no storm water collection system within the road right-of-way fronting the property then consideration must be given to the extension of the existing storm drainage system. Landscape ponding is not permitted. Within 300 m of the crest, all storm runoff and discharge from roof areas, driveways, parking, hard-surfaced landscaping or road is removed from site in adequate facilities and is not allowed to discharge into the ground water system.[6] Design and construction of all perimeter drains or other drainage facilities for buildings or structures shall be required to drain into adequate sumps and shall be discharged from the site in adequate facilities. Design and construction of buildings, structures and services will be such that no ground water seepage, surface runoff, or other water shall be allowed to discharge towards or onto the adjacent slopes or ravines.

1. City of Maple Ridge Design Criteria Manual, 2015
2. Maple Ridge Watercourse Protection Bylaw No. 6410 – 2006
3. Maple Ridge Official Community Plan Bylaw No. 7060-2014
4. CMR Policy Statement No. 6.23 Control of Surficial and Groundwater Discharge in the Area bounded by 207 St, 124 Ave, 224 St and the Crest of the Fraser River Escarpment.
5. CMR Policy Statement No. 6.24 Subdivision of, or building on, Land with 300 m of the Crest of the Fraser River Escarpment

DFO Stormwater Guidelines

The DFO 2001 *Draft Urban Stormwater Management Guidelines for the Protection of Fish and Fish Habitat* (DFO Guidelines) represent the highest level of environmental protection criteria available in BC. These guidelines are widely applicable in areas with fish-bearing streams for mitigation of development in the Lower Mainland of B.C. The DFO Guidelines are shown below for reference and discussion as part of the framework of criteria available for these watersheds.

Environmental Protection	**Volume Reduction** Source Controls	On-site rainfall capture (runoff volume reduction) for 6-month 24-hour storm (72% of the 2-year 24-hour storm).
	Water Quality Treatment	Remove 80% of Total Suspended Solid based on 50 µm particle size from 6-month 24-hour storm (72% of the 2-year 24-hour storm).
	Rate Control Detention / Diversion	Control post-development flows in creeks to pre-development levels for 6-month, 2-year and 5-year 24-hour event.

Agriculture and Rural Development Subsidiary Agreement (ARDSA)

The ARDSA drainage criteria are applicable to areas that occur within the ALR. These criteria provide the design targets for drainage of agricultural lands and supersede or replace other municipal criteria for these areas.

Flood & Erosion Protection	Agricultural Lowland Flooding – ARDSA	• Limit flooding to 5 days during a 10-year 5-day winter storm. • Limit flooding to 2 days during a 10-year 2-day growing season storm. • Provide 1.2 m of freeboard during baseflows between storm events.

Provincial Streamside Protection Regulation

The City's watercourse protection bylaw is based on the older provincial Streamside Protection Regulation (SPR) enacted in 2001 under the *Fish Protection Act* (1997). Its purpose is to protect streamside protection and enhancement areas from residential, commercial, and industrial development so that the areas can provide natural features, functions and conditions that support fish life processes. Although many municipalities have adopted the newer provincial Riparian Areas Regulation (RAR) methods for designating stream setbacks, the City has elected to continue using the SPR approach. Based on the SPR setbacks (Table 4-3) watercourse protection areas have been mapped throughout the City and have been endorsed by the City, Fisheries and Oceans Canada, and BC Ministry of Forests, Lands, and Natural Resource Operations. A Watercourse Protection Development Permit (WPDP) is required for all development and building permits within 50 metres of the top of bank from watercourses and wetlands.

Table 4-3: Widths of Streamside Protection and Enhancement Areas

Existing or Potential Streamside Vegetation Conditions	Streamside Protection and Enhancement Area		
	Fish Bearing	Not Fish Bearing	
		Permanent	Non-Permanent
≥ 50 m or ≥ 30-50 m	At least 30 m		At least 15 m
≥ 15 & ≤ 30 m	Greater of: • Existing width or • Potential width or • 15 m	15 m	
< 15 m		At least 5 m & up to 15 m	
• All width measured from the top of the bank. • Streamside Protection Regulation, Section 6(1), BC Regulation under *Fish Protection Act*, 1997. • The Streamside Protection Regulation and Opportunities for Citizen Advocacy, West Coast Environmental Law. • https://www.mapleridge.ca/344/Checklists-Guidelines-Regulations • As per City policy, native vegetation and trees within setback areas are to be retained • Agricultural setbacks from streams can be different (less) than above. However, this would only apply to instances where there are appropriate and compatible farming practices – the lesser setbacks would not be applicable where buildings or non-farm uses are proposed			

Other Regional Stormwater Guidance

Other regional initiatives and guidance contribute approaches and options to the development of stormwater management for an ISMP, including:

- 2016 Climate Projections for Metro Vancouver
- 2015 Metro Vancouver Options for a Region-Wide Baseline for Onsite Rainwater Management
- 2014 Metro Vancouver Monitoring and Adaptive Management Framework for Stormwater;
- 2012 Metro Vancouver Stormwater Source Control Guidelines Update;
- 2012 Metro Vancouver ISMP Lessons Learned;
- 2010 Beyond the Guidebook 2010;
- 2010 Metro Vancouver Integrated Liquid Waste and Resource Management Plan;
- 2007 Beyond the Guidebook – Context for Rainwater Management and Green Infrastructure in BC;
- 2005 GVRD Stormwater Source Control Guidelines;
- 2005 GVRD ISMP Template Update;
- 2002 GVRD Template for Integrated Stormwater Management Planning;
- 2002 GVRD Effectiveness of Stormwater Source Control
- 2002 Stormwater Planning: A Guidebook for BC; and
- 2001 GVRD Liquid Waste Management Plan.

4.3 Soils and Aquifers

Soils mapping based on the provincial soils database is shown in Figure 4-1. While much of the developable area within the study area watersheds is understood to have low-infiltration soils such as glacial till, silt and clay, there are also some areas of gravel and sand, and some peat in the lowland areas. The majority of the upland area of the Blaney Creek and North Alouette watersheds are noted to be underlain by granitic rock.

The province maintains maps of aquifers and groundwater wells in the area and the information is accessible online[4]. The study area region covers multiple identified aquifers, with most noted to have low well density and moderate to high (in an area coinciding with the gravel and sand soils) vulnerability.

4.4 Stakeholder Issues and Concerns (Initial Feedback)

Key items that have been obtained from background documents and early stage input from the Alouette River Management Society and Alouette Valley Association are described below. These issues were reviewed and considered during the work of the ISMP, however, not all issues raised can be verified as significant concerns and some issues are outside the scope of consideration for the ISMP. Some concerns have already been addressed by the City.

North Alouette River Flooding

- The North Alouette River is an unregulated river with relatively high rates of sediment transport and a dynamic river channel. The river floods about once in five years (or less) due to heavy rainfall, backflow from the Fraser River, sediment deposition in the river channel, or channel blockage (e.g., log jams), and regularly causes damage to properties within the floodplain (ARMS, 2016).
- Log jams and gravel bars in the North Alouette River tend to accumulate regularly. Log jams are caused by fallen trees that have washed from banks and traveled downstream. They can cause flooding problems and increase risk to private bridges. Figure 4-2 shows properties reported flooding during the March 2007 event along the North Alouette River. The flooding was likely caused by a log/debris jam and subsequent breach on the North Alouette River. Photo logs are also available (AVA, 2016). (*note - the City does not monitor for log jams on watercourses. The City's current policy is to evaluate and react to concerns reported by residents on a case by case basis. If residents have concerns about fallen trees in the river, they are advised contact the City's Operations Centre at OperationsCentre@mapleridge.ca*)
- Lowland flooding in the Alouette basin is a long-standing challenge. Parts of the lowlands are subjected to some degree of inundation during most years in December or January.
- Infilling of lowland areas (i.e., raising level of the entire lot) has altered the active floodplain and is believed to contribute to flooding (ARMS, 2016). Filling of land in the North Alouette floodplain has affected neighbouring properties (AVA, 2016). [5]

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[4] https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells-aquifers/understanding-aquifers

[5] The City approved in 2018 a bylaw controlling soil deposition: https://www.mapleridge.ca/DocumentCenter/View/573/Soil-Deposit-Regulation

Stream Bank Erosion and Sedimentation

Photo 4-1: Possible Undersized Ditch Along 232 Street near North Alouette River[6]

- Active stream bank erosion has been identified along the North Alouette in the *North Alouette and South Alouette Rivers Additional Floodplain Analysis* report completed by NHC in 2016 but some of the erosion locations have already been addressed by the City.
- Potential erosion sites along other major watercourses have not been identified at this time.
- Gravel accumulation in the North Alouette River may be due to erosion of banks in the upstream reach near the Balsam Creek confluence (by Greg Moore Trail) (ARMS 2016).
- Minor watercourses (including the connector and roadside ditches) have been noted as filling in with silt. Sediment accumulation reduces channel conveyance capacity, can allow aquatic vegetation to establish further affecting drainage, and can impact the availability of fish habitat (AVA, 2016).

Undersized Culverts and Ditches

- Culverts and ditches are thought to be undersized to handle high water at some locations (AVA, 2016).

Impacts of Future Development

- The Alouette River Management Society (ARMS) is concerned about the flooding and erosion impacts of existing upstream development. Members believe that developers need to build, monitor, and maintain stormwater mitigation measures.
- Residents also believe that changes to downstream conditions in Pitt Meadows (filling land, dikes, filling in ditches, channels) may affect the creeks and conditions upstream in the City of Maple Ridge.

Policy Planning

Residents have voiced concerns that planning should not occur in isolation from other agencies and cities, which may have different priorities and regulations. For example, the City of Pitt Meadows and the Agricultural Land Commission (ALC) have allowed the construction of a cranberry dike which has affected drainage in the Maple Ridge section of the valley.

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[6] The ditch has been reconstructed since the photo was taken.

Environmental Issues

Stakeholder consultation and the desktop and field inventories identified 16 priority environmental concerns, which are summarized in Section 6.5.

A list of documents reviewed is listed in Appendix A.

Three environmental concerns previously identified during stakeholder engagement and field review are no longer considered a priority based on updated information received from the City of Maple Ridge.[7]

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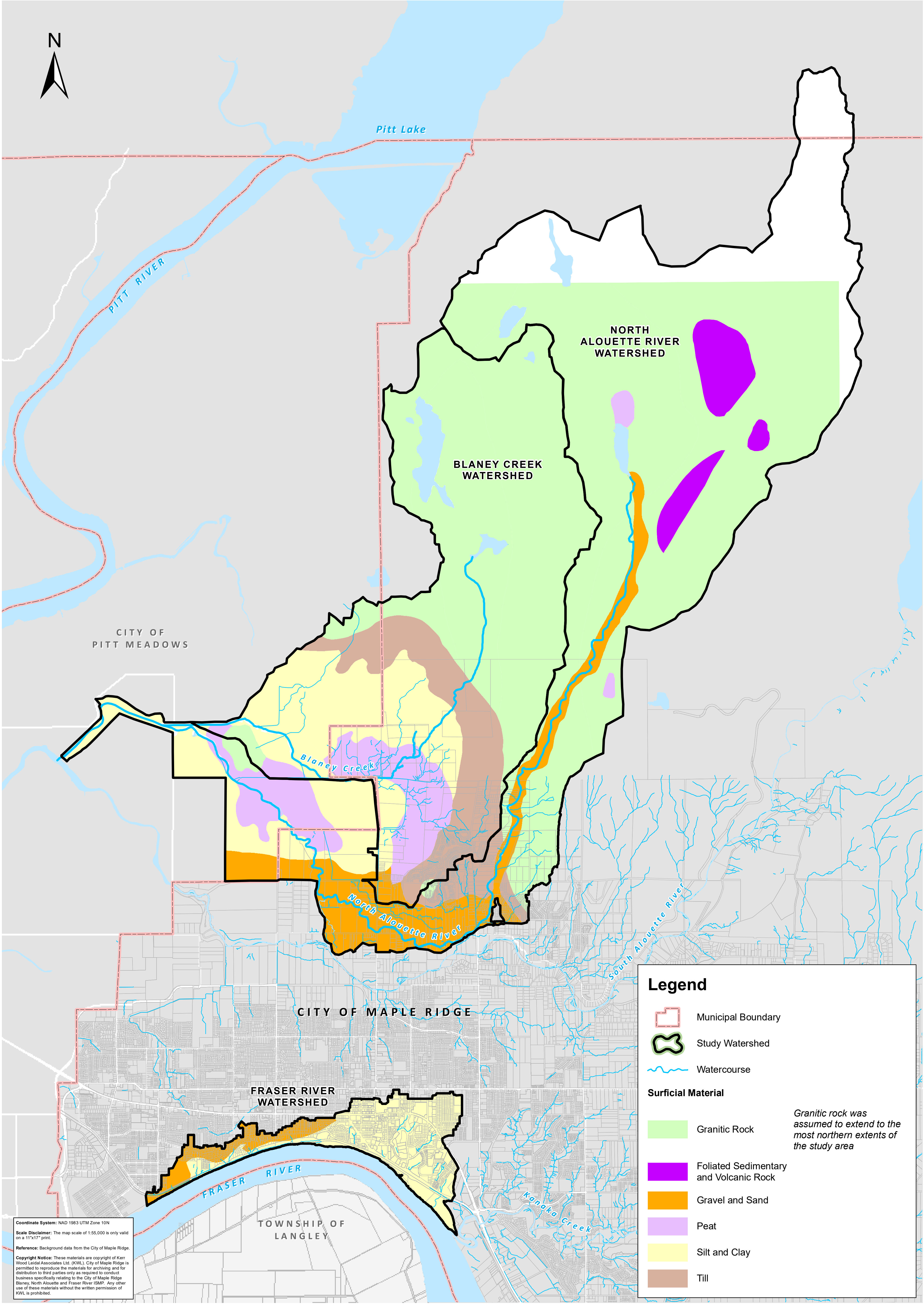
[7] Environmental concerns no longer considered a priority include the following:

- Previously piped and buried sections of Cattell Brook have since been daylighted and diverted around the subdivision in Sept 2019;
- The ability to use fill of unknown quality has been addressed through the implementation of the Maple Ridge Soil Deposit Regulation Bylaw on May 8, 2018. The bylaw addresses the issue of soil quality for fill and requires tracking of soil from its source to placement. Although sources for fill material is now being tracked soil placed prior to the implementation of this bylaw still has the potential to be of environmental concern. Therefore, during site re-development, any suspected fill materials should be tested as per BC's Environmental Management Act (2003) and remediated if above the provincial guidelines; and
- The removal of gravel occurred in the North Alouette River under the 224 Street and 132 Avenue Bridges in 2011 and 2013, respectively. It was completed under the two bridges to reduce the risk and occurrence of flooding within the immediate area based on Northwest Hydraulic Consultants (NHC) recommendation. Approvals were received from both Fisheries and Oceans Canada (DFO) and the Ministry of Forests, Lands, and Natural Resources Operations and Rural Operations (MFLNRORD). Best management practices were in place and all works were monitored by an environmental professional.



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:55,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date October 2021
Scale 1:55,000

Soils Map

Figure 4-1

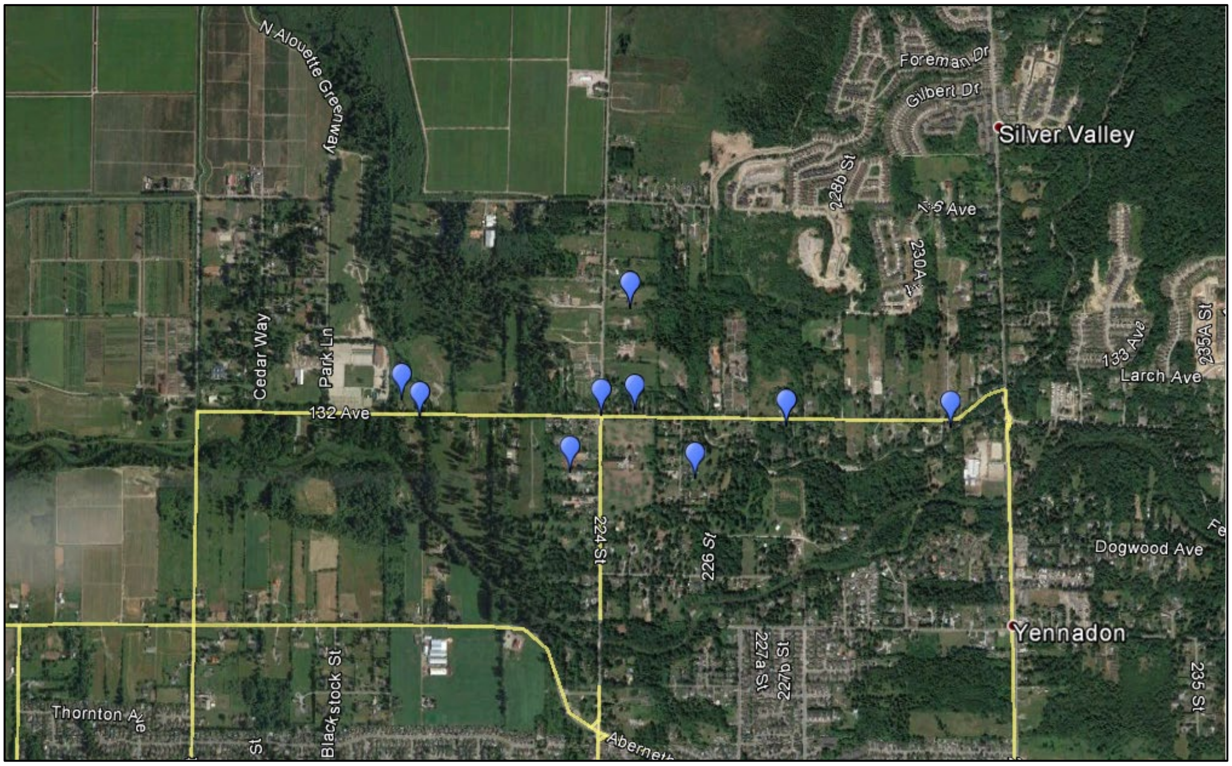


Figure 4-2: Locations Where Flooding Was Reported During the March 2007 Event

5. Field Drainage Inventory

Field inventory of drainage features and infrastructure for the Blaney, North Alouette and Fraser River watersheds were largely completed between October 1 and December 1, 2016. The inventory was limited to areas of importance based on community observations and previously submitted reports outlining areas of concern including flooding, erosion, blockages, etc. These areas were reviewed in the field along with areas where field data could be collected to be used for modelling purposes. Small creeks that discharge into the Fraser River along Haney By-pass and along River Road were reviewed in the field. Anderson and Balsam Creek were traversed, as well as ditches along Cattell Brook and ditches along 232 St. from North Alouette to 137 Ave. At the time of the field work, the North Alouette River between 136 Ave. and 232 St. was visited but not inventoried due high water levels and unsafe flows for work in close proximity to the creek.

Locations of interest were identified and recorded with the GIS collector application on an iPad. Field inventory work included gathering or updating basic information on culverts, erosion sites, deposition sites, and stream obstructions.

Additional data that required more precise measurements such as culvert and manholes inverts were collected by the KWL survey team. Data collected in the field was then used to update the City’s GIS data set for use in the modelling and other work in this study. Culverts and manholes surveyed are detailed in Appendix B.

5.1 Erosion

Sites of significant erosion were identified, reviewed in the field, and assigned a relative severity level of low, moderate or high, based on a visual assessment that took into account the following parameters:

- total height and length of eroded bank;
- apparent rate of erosion; and
- apparent capacity of bank material to resist further erosion.

Note that this visual assessment was conducted by KWL field staff and represents their best judgement in the field, but this is not equivalent to the assessment of a geotechnical engineer.

In addition to rating the severity of these sites, a simple qualitative risk framework was used to assess relative risk associated with erosion. Erosion sites were visually assessed to assign a hazard and consequence level:

- Low, moderate, or high hazard based on the measured height of visible scour
- Low, moderate, or high consequence based on the proximity of manmade features (sheds, fences, buildings, retaining structures, etc.) to the eroding bank
- This was based on a visual assessment that took into account the perceived level of risk to human life, property damage or destruction and wildlife habitat.

Table 5-1 summarizes the erosion ratings and locations (see Figure 6-6 for locations).

Table 5-1: Summary of Observed Severe Erosion Sites

Location	Measured Approx.		Observed		
	Length (m)	Height (m)	Location (Left, Right)	Hazard (Low, Med, High)	Consequence (Low, Med, High)
near Brickwood Close	10	2.0	Right Bank	High	High
River Rd. near River Bend	7	2.0	Right Bank	High	High
Blaney Ck. @ 144	40	2.5	Right Bank	High	High
Severity ratings based on erosion area: Low = less than 10 m^2, Moderate = 10 to 50 m^2, High = greater than 50 m^2 Consequence Ratings: High = roads or buildings at risk, Moderate = private property at risk, Low = all others Refer to Figure 6-6 for location of the erosion sites.					

Of the three locations identified, the one near Brickwood Close and near River Road at River Ben pose a concern to private property as shown in Photo 5-1 and Photo 5-2 respectively. The Blaney Creek erosion site occurs directly under the 144 Ave outfall which is at risk and is shown in Photo 5-3.

Photo 5-1: Bank Erosion near Brickwood Close Facing North West

Photo 5-2: Bank Erosion @ River Rd. near River Bend Facing Southwest

Photo 5-3: Bank Erosion on Blaney Creek near 144 Ave.

As creek gradients decline, floods become the dominant process for channel formation. The general form of the channel at any point is dictated by discharge and sediment load, as well as the integrated effect of factors such as climate, vegetation, soils, geology and basin physiography. Channels adjust to increases in discharge, such as those associated with watershed development, but accurate predictions of change are challenging for a number of reasons (Booth and Henshaw 2001), and because of this identifying these changes in the field can also be difficult. Based on the field reconnaissance, the rate of erosion throughout the watershed seems normal and the consequences of the erosion sites appear to be minimal.

5.2 Sediment Deposition and Obstructions

There was only one natural obstruction observed in the field in the form of a beaver dam located at the end of 136 Ave. in Cattell Brook; no anthropogenic obstructions were recorded.

The limited field work for this study did not identify any areas of deposition that appeared likely to cause any consequences in the near future. Deposition within the 232 St. ditch was observed and recorded. However, since the field inventory, improvements works of the 232 St. corridor have taken place and the sediment deposition issue has been resolved.

5.3 Culvert Survey

KWL undertook survey of a number of culverts and manholes in the Blaney, North Alouette River, and Fraser River watersheds as part of the ISMP process to fill in gaps in available data provided by the City. In particular, the survey targeted culverts and storm manholes where missing information would make modelling of these pieces of infrastructure difficult or the results unreliable.

Not all missing information was able to be filled in by the survey allowance that was budgeted for the ISMP work. Some culvert and manhole survey was not possible due to inaccessible locations, including ravine or fenced areas, railroad right-of-way, or locations in busy roads such as Lougheed Highway. Culvert information was especially limited along 232 St. north of 132 Ave, and along 224 St. north of 129 Ave. to 144 Ave.

Surveys were carried out between November 21 and November 25, 2016 around Maple Ridge, allowing measurement of invert elevations, opening sizes, lengths, material types, and general arrangement of the crossings. A total of 17 individual culverts were surveyed at these 13 locations as 4 crossings had multiple culverts in parallel. KWL surveyed culverts to fill gaps in the available data on the drainage system for the ISMP study areas.

Results from the culvert survey are found in Appendix B. The surveyed information was incorporated into the system data used to model the drainage infrastructure for the study area watersheds.

6. Environmental Assessment

KWL completed a desktop review, field inventory, and assessment of environmental values in the study watersheds including aquatic species and habitats, riparian and watershed forest cover, terrestrial species and habitat, and water quality. The purposes of the assessments were to:

- assess status and trends in watershed health;
- identify priority environmental issues to be addressed; and
- identify environmental enhancement opportunities.

The results of inventory and assessment are included below. Appendix C (Aquatic Species and Habitat Inventory) and D (Water Quality and Benthic Invertebrate Monitoring) include complete methodology and detailed results for the inventory and assessment.

6.1 Aquatic Species and Habitat Inventory

Presence of Fish Species

Figure 6-1 shows document fish presence in the study watercourses. Fish presence may include Coho salmon, chum salmon (Photo 6-1), coastal cutthroat trout, rainbow trout/steelhead, and two other fish species have been recorded in Blaney Creek.

Fraser River

Only two species of fish have been recorded in the Fraser River catchment: coho salmon and threespine stickleback. Fish species found in the Fraser River may be present in these small tributaries if they are accessible from the main stem.

Blaney Creek

The DFO maintains a central database (Salmon Escapement Database - NuSEDS) that tracks numbers of escapements (salmon returning to natal watercourses to spawn). Historical escapements of adult salmon are provided by DFO for Blaney Creek are as follows (data not available after 2017):

Photo 6-1: Chum salmon (*Oncorhynchus keta)* spawner

Table 6-1: NuSEDS Salmon Escapement Data for Blaney Creek

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1997	1998	1999	2000
Chum	350	1650	1560	4770	350	530	642			700		6412	113
Coho	200	100	250	185	220	54	15	26	56	0	353	71	34
Grand Total	**550**	**1750**	**1810**	**4955**	**570**	**584**	**657**	**26**	**56**	**700**	**353**	**6483**	**147**
	2001	**2002**	**2004**	**2005**	**2008**	**2009**	**2010**	**2011**	**2012**	**2014**	**2015**	**2016**	**2017**
Chum	5266	675	5603		5387	4753	237	1562	2294	1738	1768	4607	1157
Coho	36	150		211	23	8	265	106					
Grand Total	**5302**	**825**	**5603**	**211**	**5410**	**4761**	**502**	**1668**	**2294**	**1738**	**1768**	**4607**	**1157**

The introduced common carp has been recorded in Blaney Creek (Shead et al. 1999) and can have negative effects on native fish and amphibian species and aquatic plants.

North Alouette River

In the North Alouette River, coho and chum salmon, coastal cutthroat trout, rainbow trout/steelhead, and nine other fish species have been recorded.

The North Alouette is stocked with chum fry from the Fraser Regional Corrections Centre – Alouette River Management Society Hatchery (Allco Hatchery). There are records of stocking with rainbow Trout as recently as 1984, steelhead in 1986, and cutthroat trout in 1987 (MOE 2016).

The North Alouette River is not as productive as the South Alouette because waterfalls restrict upstream access (DFO 1999).

ARMS has been conducting salmon spawner surveys with volunteers since 2007 on a section of the North Alouette River near the bridge at 132nd Avenue and 232nd Street. The data does not indicate the entire number of spawners for a given season, but provides a snapshot for the times monitored. Maple Ridge compiled data provided by ARMS and determined fish counts on a per hour basis. For the North Alouette, ARMS data from 2007 to 2019 shows that between 5 and 112 spawners were recorded per hour. The fish counted were almost all chum salmon.

Historical escapements in North Alouette River area as provided by DFO are as follows (data not available after 2015):

Table 6-2: NuSEDS Salmon Escapement Data for North Alouette River

	1987	1988	1989	1990	1991	1992	1993	1994
Chum	1650	850	1850	4600	1700	935	750	
Coho	200		100	200	120	20	5	40
Grand Total	**1850**	**850**	**1950**	**4800**	**1820**	**955**	**755**	**40**
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2015**
Chum	22	152	55	11	173	101	92	18
Coho								
Grand Total	**22**	**152**	**55**	**11**	**173**	**101**	**92**	**18**

The escapement counts are extremely variable. However, it is understood that salmon stocks are generally declining and this does appear to be the case for the North Alouette. Fisheries and Oceans Canada have stated that Pacific salmon are “experiencing drastic population declines due to a combination of climate, habitat and harvesting pressures.”[8] DFO summarizes some of the current the pressures on salmon populations in their interactive e-book titled *State of the Canadian Pacific salmon: Responses to changing climate and habitats*.

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[8] https://www.canada.ca/en/fisheries-oceans/news/2021/06/canada-launches-transformative-effort-to-save-pacific-salmon.html

Field Habitat Assessment

A field inventory of Blaney Creek, the North Alouette River, and Fraser River tributaries was carried out in September and October of 2016 (September 29, October 12, 25-26). In the Blaney and North Alouette watersheds, the inventory included areas below the Malcolm Knapp Research Forest. The inventory included stream surveys at 38 sites (12 in Blaney, 20 in North Alouette, and 6 in the Fraser River watersheds; see Figure 6-1). The survey sites were concentrated in the middle area of the Blaney and North Alouette watersheds, falling mainly in the developed areas in the City (Figure 6-2).

At each site, the survey team measured physical characteristics, assessed aquatic habitat, and took photographs. The results of the field habitat assessment were used to assess spawning and rearing habitat within the watersheds, as well as identify priority concerns for fish and aquatic habitat.

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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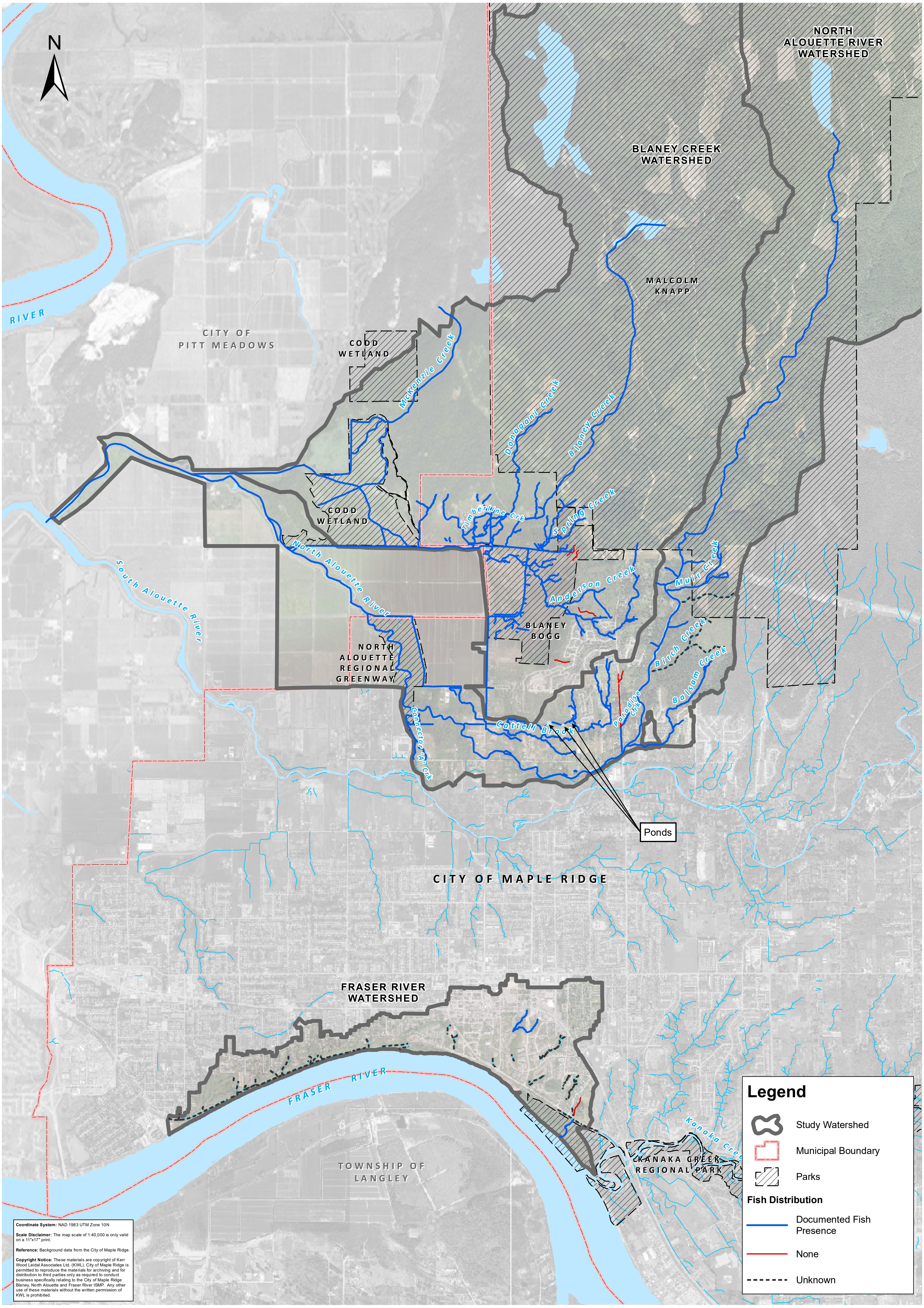

Legend

⬭	Study Watershed
▭	Municipal Boundary
▨	Parks

Fish Distribution

━	Documented Fish Presence
━	None
╌	Unknown

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:40,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No.	173-188
Date	October 2021
Scale	1:40,000

Fish Presence

Figure 6-1

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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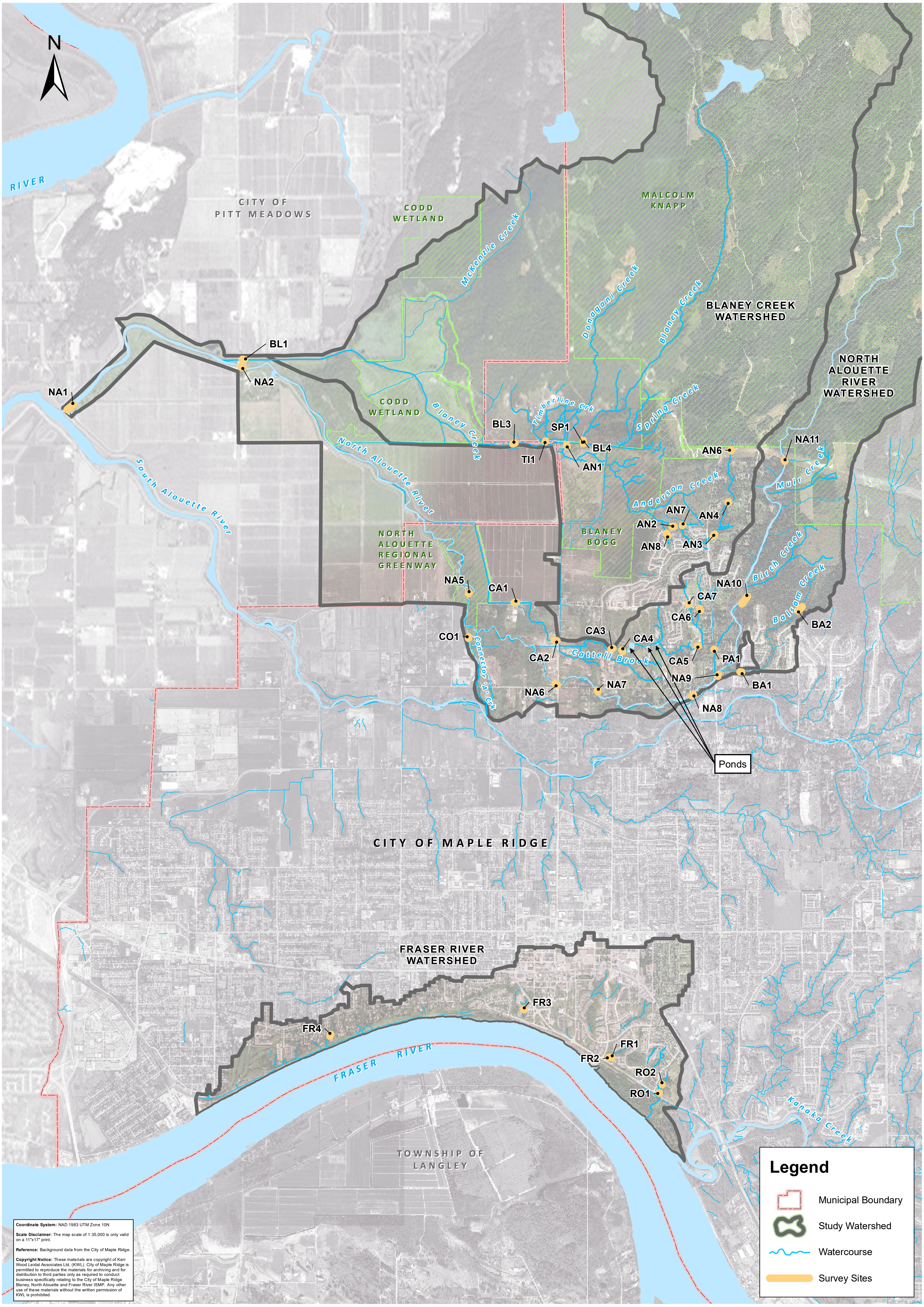

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date March 2021
Scale 1:35,000

Stream Survey Sites at Representative Locations

Figure 6-2

Fish Habitat Quality

A variety of sources were used to determine the quality and distribution of spawning and rearing habitats. These included the KWL aquatic habitat inventory, stream mapping and orthophotos, biophysical inventories of Blaney Bog and Codd Island Wetlands, DFO reports, and other reports and information.

Spawning Habitat

The most abundant spawning gravels in the watersheds are found in the middle and upper reaches of the North Alouette River (Photo 6-2), in Blaney Creek upstream of Blaney Bog, in Anderson Creek upstream of Blaney Bog, and in Balsam Creek (Figure 6-3). These watersheds provide excellent spawning habitat for salmon and trout. The creeks in the Fraser River catchment provide little spawning habitat.

Photo 6-2: High quality spawning habitat in the North Alouette River (site NA10)

Most salmon spawn in the central and lower reaches of the North Alouette River (DFO 1999). Coho and chum spawn mainly in the mid and upper reaches of Blaney Creek (DFO 1999). Coho migrates upstream in the last half of September and spawn from October to mid-December in Blaney Creek and until the end of December in the North Alouette River. Chum salmon arrive in the first half of October and spawn from October to November. ARMS conducts spawning surveys in the North Alouette.

From October 6 to December 29, 2013, volunteers counted 133 chum, 9 pink, 14 coho, and 6 unidentified live spawners and 37 unidentified dead spawners in the North Alouette River. Coho spawns in Cattell Brook but are limited by reaches with abundant fines. In Balsam Creek, coho spawners are found as far upstream as Balsam Street. Chum spawners are not usually found in Balsam Creek due to its small size, and do not pass the Balsam Street culvert (R. Davies pers. comm., 2016). Unidentified trout (either rainbow or coastal cutthroat) were observed spawning in Balsam Creek upstream of the Balsam Street culvert during the field inventory.

Rearing Habitat

The North Alouette and Blaney watersheds provide extensive areas of rearing habitat for juvenile salmon and trout (Figure 6-3). The Fraser River catchment provides little rearing habitat due to extensive loss of creeks, loss of riparian habitat, lack of woody debris and pools, and fragmentation. The most important areas for rearing salmonids are:

- North Alouette River, middle and upper reaches;
- Blaney Creek, middle and upper reaches;
- Anderson Creek, throughout;
- Blaney Bog, including sections of Blaney, Spring (Photo 6-3), and Anderson Creeks;
- Codd Wetlands, including sections of the North Alouette River and Blaney Creek;
- Cattell Brook, lower reaches; and
- Paradise Creek, lowest reach.

Coho juveniles feed and find shelter throughout the upper reaches of the North Alouette and Blaney watersheds. The middle and upper reaches of the North Alouette provide extensive cover, channel complexity, large woody debris, and pools (DFO 1999). A DFO study found that the reach of the North Alouette from 232 Street upstream for 2.2 km contained 63.8% of fish biomass of the river, at only 13% of the total area of the river. Likewise, the 800 m reach of Blaney Creek upstream of 224th Street (5.3% of total area) was the only length of the creek that supported juvenile salmonids. This was likely due to the greater cover and lower disturbance in these reaches compared to lower reaches, and the presence of upstream barriers (Griffith & Russel, 1980). Coastal cutthroat trout are present throughout Anderson Creek, and juvenile coho use the lower sections up to the gully west of 232th Street and have been abundant at sampling sites. Juvenile salmonids overwinter in the lower sections of Cattell Brook. In periods of high water in the North Alouette River, juveniles use the lower reach of Paradise Creek as refuge (Davies 1996).

Photo 6-3: High quality rearing habitat in Spring Creek, within Blaney Bog (site SP1)

The watershed also contains Blaney Bog Regional Park Reserve (115 ha) and a portion of Codd Wetland Ecological Conservancy Area (101 ha). Together, Codd Island Wetlands and Blaney Bog form the largest area of off-channel salmonid rearing habitat within the Alouette watershed and provide some of the most important off channel wetland habitat for rearing salmon in the lower Fraser River (Gebauer 2001). Juvenile coho, coastal cutthroat trout, and rainbow trout all use the wetland channels, and Chinook smolts are likely to use them for refuge and feeding. Characteristics of the areas that make particularly good rearing habitat are low gradient channels, flooding, inflow of well-oxygenated water from Blaney, Spring, and Anderson Creeks with high water quality, macroinvertebrates, and cover from overhanging vegetation and undercut banks.

Barriers to Fish Passage

Based on background information and the field survey, five definite barriers to fish passage were identified, four potential, one flow-dependent, and one partial barrier to some species only (Figure 6-4, Table 6-3). There is also one culvert that a stakeholder identified as a potential barrier after the KWL field inventory (Alouette Valley Association pers. comm. 2016). It is unknown whether this culvert on Cattell Brook is a barrier. Restoration efforts should only focus on anthropogenic barriers such as culverts where fish passage historically occurred.

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City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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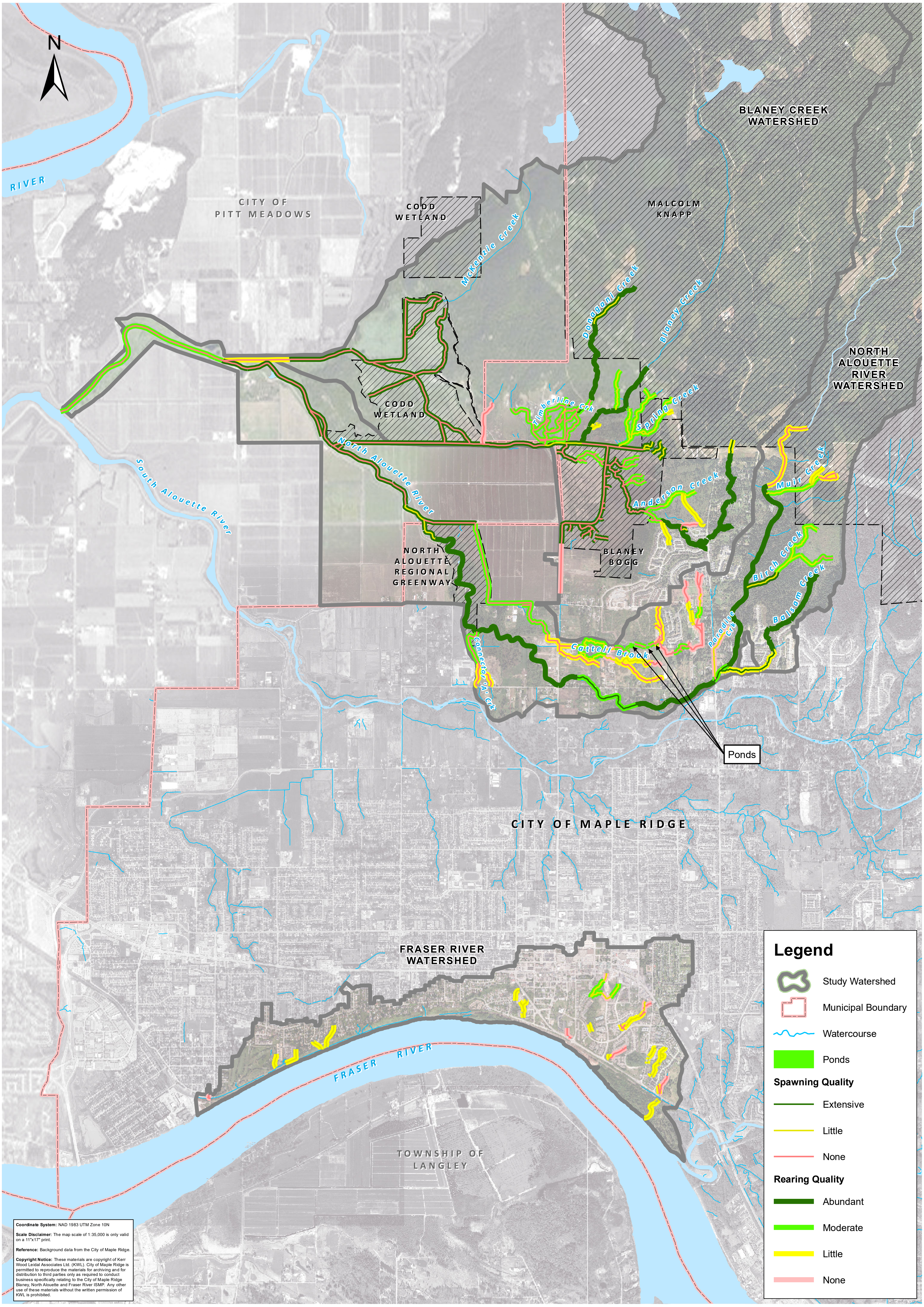


Coordinate System: NAD 1983 UTM Zone 10N

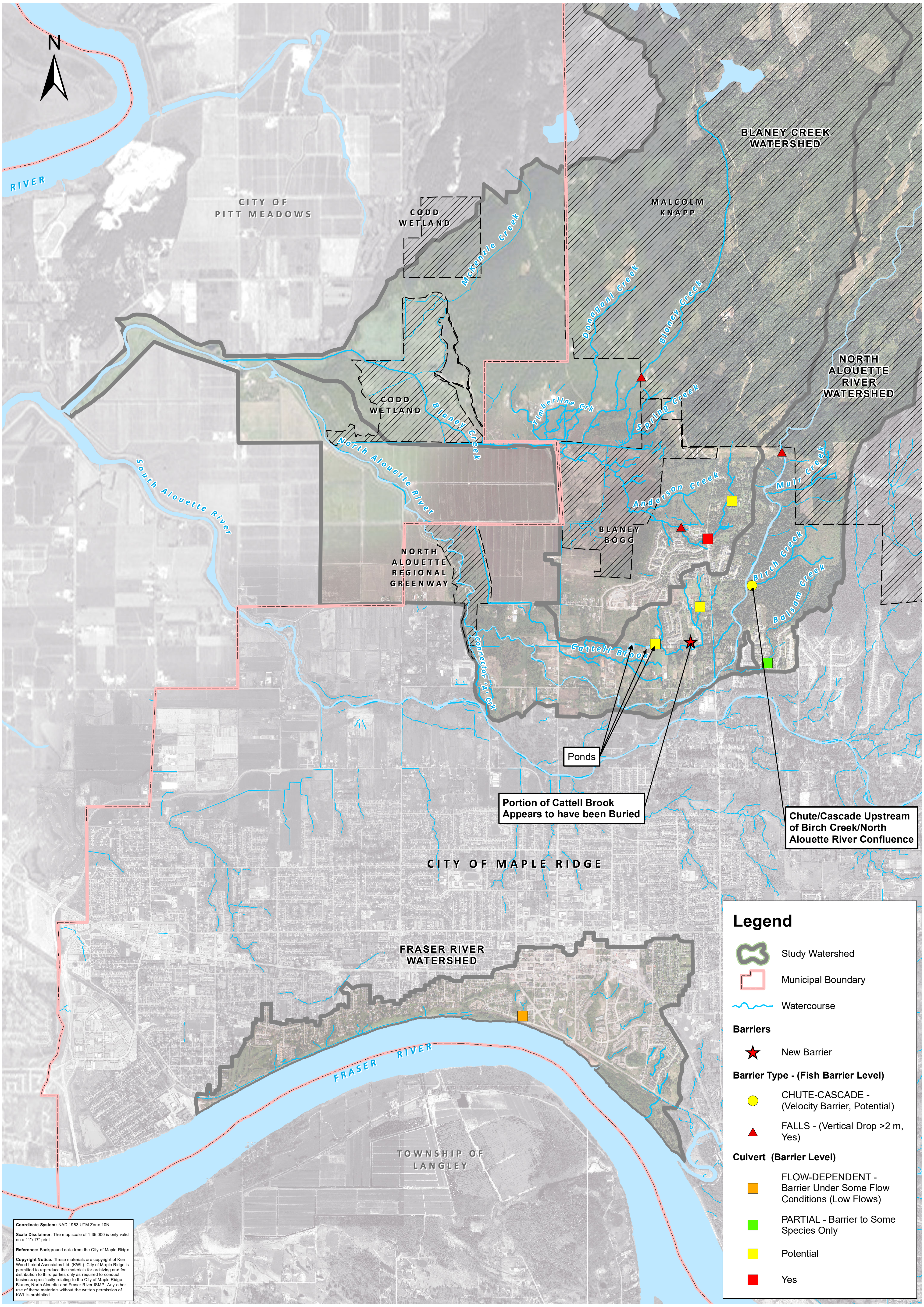
Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date March 2021
Scale 1:35,000

Salmonid Spawning and Rearing Habitat

Figure 6-3



Ponds

Portion of Cattell Brook Appears to have been Buried

Chute/Cascade Upstream of Birch Creek/North Alouette River Confluence

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date March 2021
Scale 1:35,000

Barriers to Fish Passage

Figure 6-4

Table 6-3: Barriers to Fish Migration

Stream	Type	Barrier level	Description
North Alouette River			
North Alouette River	Falls	Yes	Impassable falls, upstream limit for spawning salmon; estimated from Griffith and Russell (1980)
Cattell Brook (Under 136 Avenue)	Culvert	Potential	Masse (2012) identified this culvert as a low priority; KWL field investigation showed that the culvert is a potential barrier but not high priority.
Cattell Brook	Buried Sections	Yes	Sections of Cattell Brook were historically buried, although several sections were recently daylighted or were approved to be daylighted prior to completion of the ISMP[9]
Birch Creek	Chute-cascade	Potential	Cascade down steep bank to North Alouette, fish passage into Birch Creek unlikely (Davies 1996)
Balsam Creek (Under Balsam Street)	Culvert	Partial (some species only)	Masse (2012) identified this culvert as a high priority and recommended streambed simulation; KWL field investigation showed that inlet grate and cobbles may be a potential barrier; Identified that chum spawners don't go above this culvert (Davies pers. comm. 2016); Further investigation recommended.
Balsam Creek (Under 233 Street)	Culvert	Potential (some species only)	Culvert identified by residents as a potential fish barrier. Adult spawners observed coming up to culvert but not passed it. Potential barrier is the invert.
Blaney Creek			
Blaney Creek	Falls	Yes	Impassable falls, upstream limit for spawning salmon (DFO 1999, MOE 2016).
Anderson Creek (Under 232 Street)	Culvert	Yes	Inlet grate plugged with sediment and debris, creating a 0.70 m drop; outlet not visible; old wooden culvert; resident said gravel trucks were parked on road for several weeks straight and could be source of sediment; unidentified fish (possibly juvenile trout) present at outlet pool.
Anderson Creek (Under 141 Avenue)	Culvert	Potential	A 0.2 m drop into a 0.20 m plunge pool at relatively higher water levels; steep long culvert with no baffles.
Anderson Creek	Falls	Yes	Bedrock falls, upstream limit for spawning salmon.
Fraser River Tributaries			
Tributary to Fraser River (Under 223rd Street)	Culvert	Flow-dependent	Debris and leaf jams behind culvert grate at invert. Clearing of these jams will need to occur periodically throughout the year.

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[9] Buried sections of Cattell Brook that have been approved to be restored and/or daylighted are located north of 132 Ave. and west of 232 St. south of the Hampstead, Nelson's Peak and Robinson developments, as well as areas near 136 Ave. and 232 St. Buried sections remain where the brook skirts agricultural land to the north of 136 Ave. and west of 224 St. and before its outlet into the Blaney Creek channel.

6.2 Riparian Corridor Assessment

Watershed forest cover was mapped using high-resolution orthophotos provided by the City (2011 and 2015) and ESRI orthophoto base mapping for areas not covered by the City orthophotos (Figure 6-5). Riparian forest cover was calculated by including all forest cover within 30 m of the centreline of each stream.

Watershed forest cover and Riparian Forest Integrity (RFI) varied from low in the Fraser tributaries watershed to high in the North Alouette River watershed (Figure 6-5, Table 6-4). The North Alouette River watershed had the highest watershed forest cover (82.1%) and RFI (61.6%) of the three watersheds. Blaney Creek watershed also had a high watershed forest cover (73.3%), but a lower RFI (45.6%). Both of these watersheds have large tracts of forest in their upper watersheds, within the Malcolm Knapp Research Forest, but much of the riparian forest in their lower reaches has been lost. The Fraser River watershed has lost most of its forest cover due to urbanization and has a very low RFI of 12.0%.

Table 6-4: Watershed Forest Cover and Riparian Forest Integrity

Catchment	Total Area (ha)	Watershed Forest Cover		Riparian Forest		
		(ha)	(%)	Buffer Area (ha)	Forested Area (ha)	Integrity (RFI) (%)
North Alouette River	4072	3344	82%	231	142	62%
Blaney Creek	2558	1876	73%	203	92	46%
Fraser River	3602	83	23%	203	24	12%

Where forest cover is has been lost, it may be due to a variety of causes, including agricultural practices, historical development, or other land clearing activities. It is not possible to attribute the gaps in RFI to specific causes at this time.

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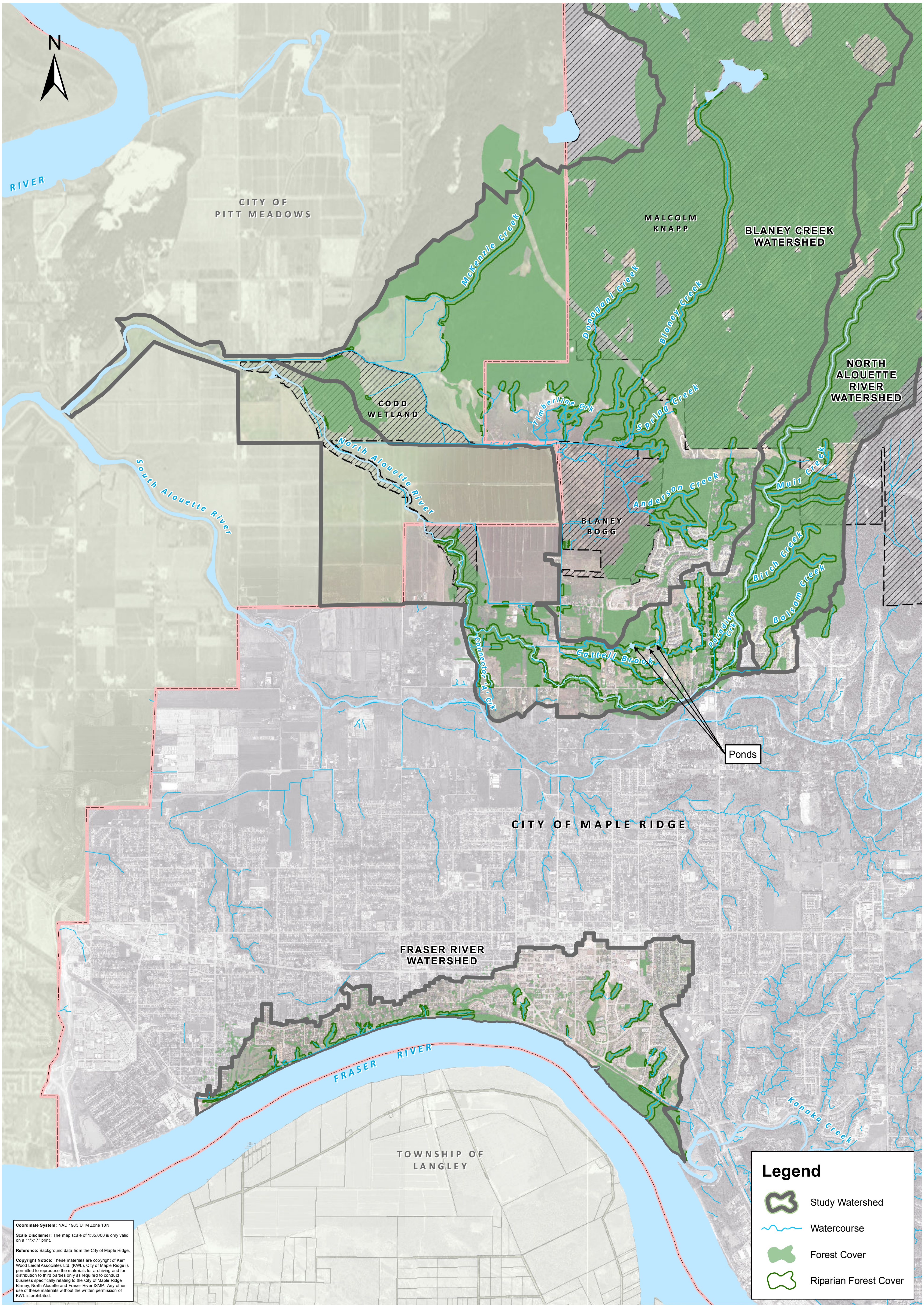


Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Legend

	Study Watershed
	Watercourse
🟩	Forest Cover
	Riparian Forest Cover

Project No. 173-188
Date April 2017
Scale 1:35,000

Riparian Forest Integrity and Watershed Forest Cover

Figure 6-8

6.3 Terrestrial Species and Habitat Assessment

The Blaney and North Alouette Watersheds contain diverse and regionally unique terrestrial and wetland habitats. Up to 24 species at risk rely on these habitats. The widespread conversion of wetlands to agricultural and residential areas has reduced the available habitat for many of these species. Protecting the habitat that remains is critical for conserving these populations.

Terrestrial Habitat

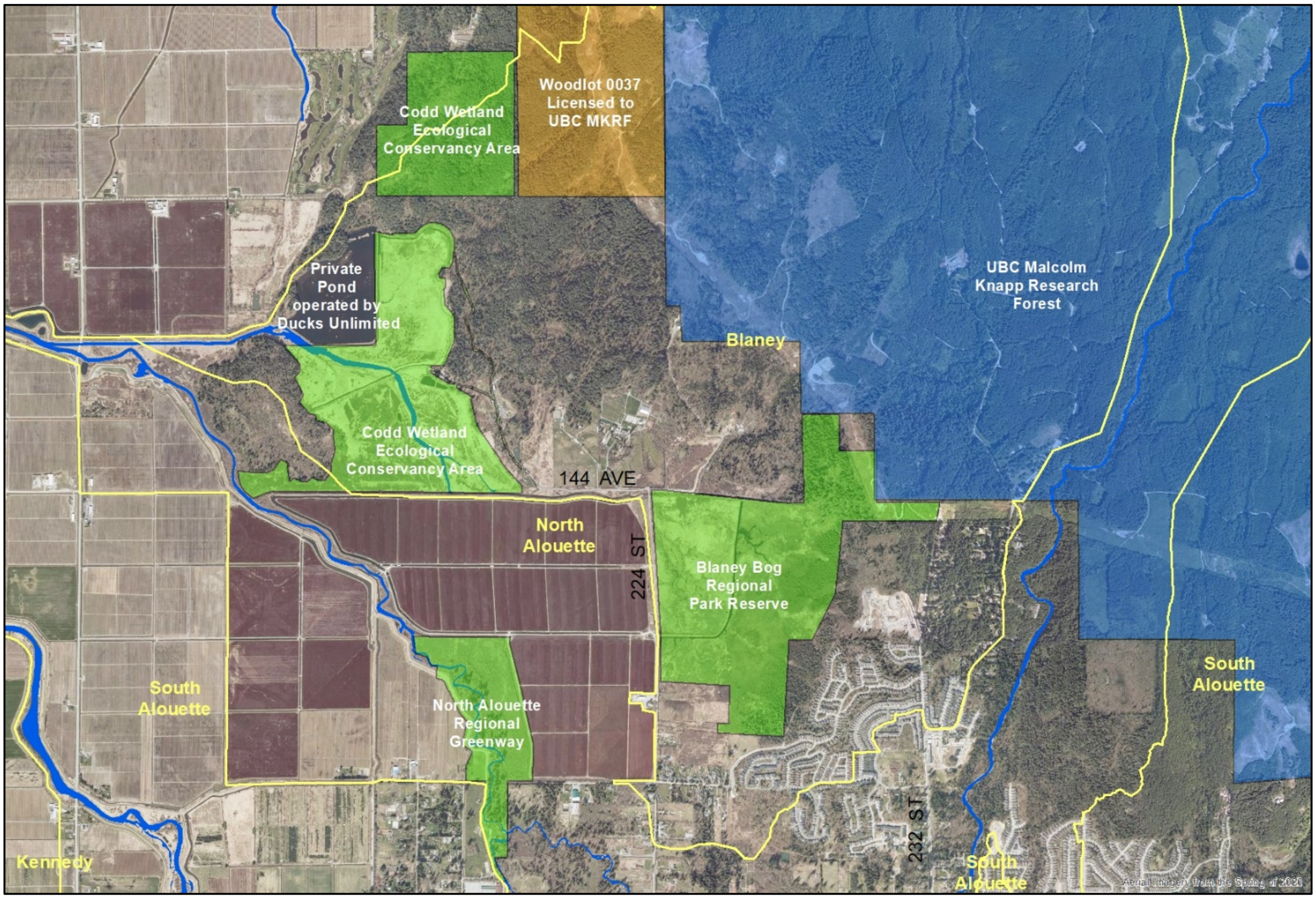
Blaney Bog

Blaney Bog is a unique bog-fen wetland complex located in the Blaney Creek watershed and administered as a Regional Park Reserve area by Metro Vancouver Regional Parks. The 147 ha bog (114 ha protected as park) is located at the south-western foot of an upland area comprised of the foothills of Golden Ears and its associated ridge, including the UBC Malcom Knapp Research Forest and the Silver Valley neighbourhood. The complex is made up of mound bog-stream fen in the south and east and stream fen area in the northwest. Blaney Bog is the only documented mound bog-stream fen complex in the Fraser Lowlands and is a site of high biodiversity (Downarowicz 2003). It provides high quality habitat for many rare and endangered species, including Great Blue Heron, Green Heron, American Bittern, Peregrine Falcon, Northern Red-legged Frog, and Pacific Water Shrew. Sandhill Cranes forage and roost in the bog, and suitable nesting habitat is present (Summers 2001). Bog laurel, Labrador tea, cloudberry, bog cranberry, bog blueberry, cotton-grass, round-leaved sundew, woolgrass, and 16 species of mosses grow in the unique acidic soil conditions of the bog (Summers 2001, Gebauer 2002).

Codd Island Wetlands

Codd Island Wetlands (101 ha) is one of the last undiked wetlands in Pitt Meadows. The wetlands are administered by Metro Vancouver Parks as an Ecological Conservancy Area. Most of the area is classified as fen habitat, dominated by reed canary grass wetland. The following species also grow in areas of low and tall shrubland: sweet gale, hardhack, red-osier dogwood, Pacific crabapple, black hawthorn, salmonberry, red elderberry, black twinberry, thimbleberry, Pacific willow, scouler willow, Sitka willow, black cottonwood, and red alder (Gebauer 2001). These habitats provide nesting and perching habitats for songbirds. Smaller areas of forest include Douglas-fir, Western redcedar, Western hemlock, grand fir, red alder, paper birch, bigleaf maple, and Western flowering dogwood. Raptors roost and nest in these trees. Many of the rare and endangered wildlife species present in Blaney Bog also use Codd Island Wetlands and breed there. Sandhill Cranes nest and forage within in the Codd Island Wetlands (Summers 2001). The wetlands provide critical off-channel habitat for juvenile salmonids (Gebauer 2001).

Codd Wetland Ecological Conservancy Area **(Source: CMR)**



Metro Vancouver Park Locations

North Alouette Regional Greenway

The North Alouette Regional Greenway includes a section of the North Alouette River and its riparian forest. Many large Sitka spruce are present in this area, and the plant community is rare and regionally significant (Henderson & Ryder 2006). Red-tailed Hawks have nested in the area.

Other areas of high-quality wildlife habitat in the study watersheds include a large pond operated by Ducks Unlimited Canada, the UBC Malcolm Knapp Research Forest (5157 ha, approximately 70% within the study area watersheds), Woodlot W0037 Licensed to UBC and riparian forests along the North Alouette River, Balsam Creek, and lower Cattell Brook.

Wildlife

Species at Risk

There are 24 species at risk that are present or potentially present in the study area.

The North Alouette River, Blaney Creek, and their tributary systems provide important foraging habitat for Great Blue Herons. Historically, there have been ten Great Blue Heron colonies in the Alouette watershed, with four in the Blaney and North Alouette watersheds (Mitchell 2012). In 2012, only the Alouette River Colony was active, which had been in decline. The colony did not produce any fledged young in 2010-2012 (Mitchell 2012). A new heron nesting site in the UBC Malcolm Knapp Research Forest was identified in 2013 within the North Alouette Watershed (Mitchell 2013).

The Georgia Depression population of Sandhill Cranes was removed from the provincial Red List (Endangered) in 2006, although it is limited in size and habitat, and continues to lose habitat (Harding 2010).

Northern Red-legged Frogs were recorded breeding at Blaney Bog in 2012. Pacific Tailed frog were recorded in the headwaters of the North Alouette River (Mitchell 2013). In 2013, many adult Western Toads were observed migrating on a road in the UBC Malcolm Knapp Research Forest, indicating that breeding occurred nearby.

Other Wildlife

In addition to 24 species at risk, there are 101 species of birds, 20 species of mammals, four species of amphibians, and one species of reptile recorded in the study watersheds.

Mosquitos

The City provides funding for Metro Vancouver to monitor and manage mosquitos through their service provider, Morrow BioScience Limited. Mosquitos are controlled utilizing spraying of Bti (as active ingredient in microbial larvicide product *Aquabac*) and other methods. Mosquitos are monitored and controlled in accordance with a Mosquito Pest Management Plan approved by the Ministry of Environment. Metro Vancouver provides information about management processes and activities on their website[10]. The Government of Canada reports that “Bti only becomes toxic in the stomachs of mosquito and black fly larvae. Because of this, it does not affect other insects, honeybees, fish, birds or mammals. The United States Environmental Protection Agency categorizes the risks posed by Bt strains to non-target organisms as minimal to non-existent. The insecticidal toxin biodegrades quickly in the environment through exposure to sunlight and microorganisms.”[11]

Invasive Plant Species

Invasive plant species are present in the study area, mainly in developed areas. Mapping of invasive plants was limited to Japanese knotweed encountered during field survey work and was not comprehensive. KWL found five sites with Japanese knotweed that were not in the Maple Ridge database: one beside Blaney Creek, two beside North Alouette, and two beside an unnamed tributary to the Fraser River (Figure 6-6). This species can damage roads, sidewalks, and other infrastructure. Himalayan blackberry was common in riparian areas throughout the developed portion of the study area. Both species can have detrimental

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[10] http://www.metrovancouver.org/services/parks/ParksPublications/2020MVRDYear-EndMosquitoControlReport.pdf; http://www.metrovancouver.org/services/parks/learn/natural-resource-management/wildlife-management/Pages/default.aspx

[11] https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/fact-sheets-other-resources/bacillus-thuringiensis-subspecies-israelensis.html

effects on native vegetation. Stakeholders have reported knotweed in the North Alouette Greenway, along the North Alouette and near the Codd Wetland Ecological Conservancy Area.

The City of Maple Ridge has been actively managing Japanese knotweed as well as Giant hogweed, which was not encountered during the field survey (City of Maple Ridge, 2020). To help control the spread of these species, the City has undertaken the following initiatives (City of Maple Ridge, 2014):

- Participating with other municipalities in the development of a regional invasive species strategy for Metro Vancouver. This strategy is led by the Invasive Species Council of Metro Vancouver (ISCMV);
- Training staff to be able to identify these invasive species and how to safely remove them;
- Working with local stakeholder groups to share knowledge regarding invasive species locations; and
- Providing educational material on its website regarding identification, management, and control of noxious weeds with a focus on Japanese knotweed and Giant hogweed.

6.4 Water Quality and Benthic Invertebrate Data Analysis and Monitoring

Results of the analysis of existing water quality and benthic invertebrate monitoring and MAMF monitoring are summarized below. Full details and methodology can be found in Appendix D.

Environment and Climate Change Canada has collected water quality data from the North Alouette River upstream of the 132 Ave. bridge every two weeks from March 2, 2004 to May 10, 2016 (Environment & Climate Change Canada 2016). An analysis of the 13 MAMF water quality parameters recorded in these data showed that water quality in the river is generally high, with consistently low conductivity, turbidity, nutrients, pathogens, and dissolved metals. Three minor divergences from this pattern are:

- Dissolved oxygen values frequently below 11 mg/L (median of 10 mg/L in 2010, median of 11 mg/L in 2005-2006, 2008-2009), but never falling below 6.5 mg/L over 12 years;
- Consistently acidic waters (yearly medians range from 6.40 to 6.81); and
- Several winters where water temperatures fell to 0°C or slightly above freezing.

KWL conducted water quality monitoring of twelve parameters in the wet and dry seasons of 2016 at five sites (Figure 6-7):

- Anderson Creek (BL-1),
- North Alouette River (NA-1),
- Balsam Creek (NA-2),
- Cattell Brook (NA-3), and
- a tributary to the Fraser River (FR-1).

Methods followed Metro Vancouver’s Monitoring and Adaptive Management Framework (Metro Vancouver 2014).

Based on this monitoring:

- Balsam Creek had excellent water quality, with all water quality parameters falling in the MAMF Good category (Figure 6-8, Figure 6-9, and Figure 6-10).
- Anderson Creek generally had good water quality. Conductivity and dissolved oxygen (dry season) were in the Satisfactory or Needs Attention categories in Anderson Creek.

- North Alouette River generally had good water quality. Temperature (wet season) and dissolved oxygen (dry season) were in the Satisfactory or Needs Attention categories for the North Alouette River.
- Cattell Brook had several water quality issues, with dissolved oxygen, turbidity, conductivity, and *E. coli* (wet season) all in Satisfactory or Needs Attention categories.
- The Fraser River tributary had poor water quality, with turbidity, conductivity, *E. coli*, fecal coliforms, iron, copper, zinc (wet/dry seasons), and dissolved oxygen (dry season) all falling in Satisfactory or Needs Attention categories.

Benthic invertebrate sampling was conducted in Anderson Creek (BL-1) and the North Alouette River (NA-1). Benthic sampling was only completed in these two watersheds as the Fraser River catchment did not have suitable sampling conditions (i.e., higher gradient streams with riffle habitat). The sites were selected based on the area in the catchment were the greatest development change (as quantified by the predicted change in impervious surfaces) is expected to occur within the watershed. Anderson Creek had a mean B-IBI score of 34.7 and 44 taxa of invertebrates. The North Alouette had a mean B-IBI score of 24.0 and 32 taxa. Biological conditions were fair in Anderson Creek and poor in the North Alouette River, based on the biological condition rankings found in the MAMF that correspond to these B-IBI scores (Metro Vancouver 2014).

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Blaney, North Alouette and Fraser River ISMP

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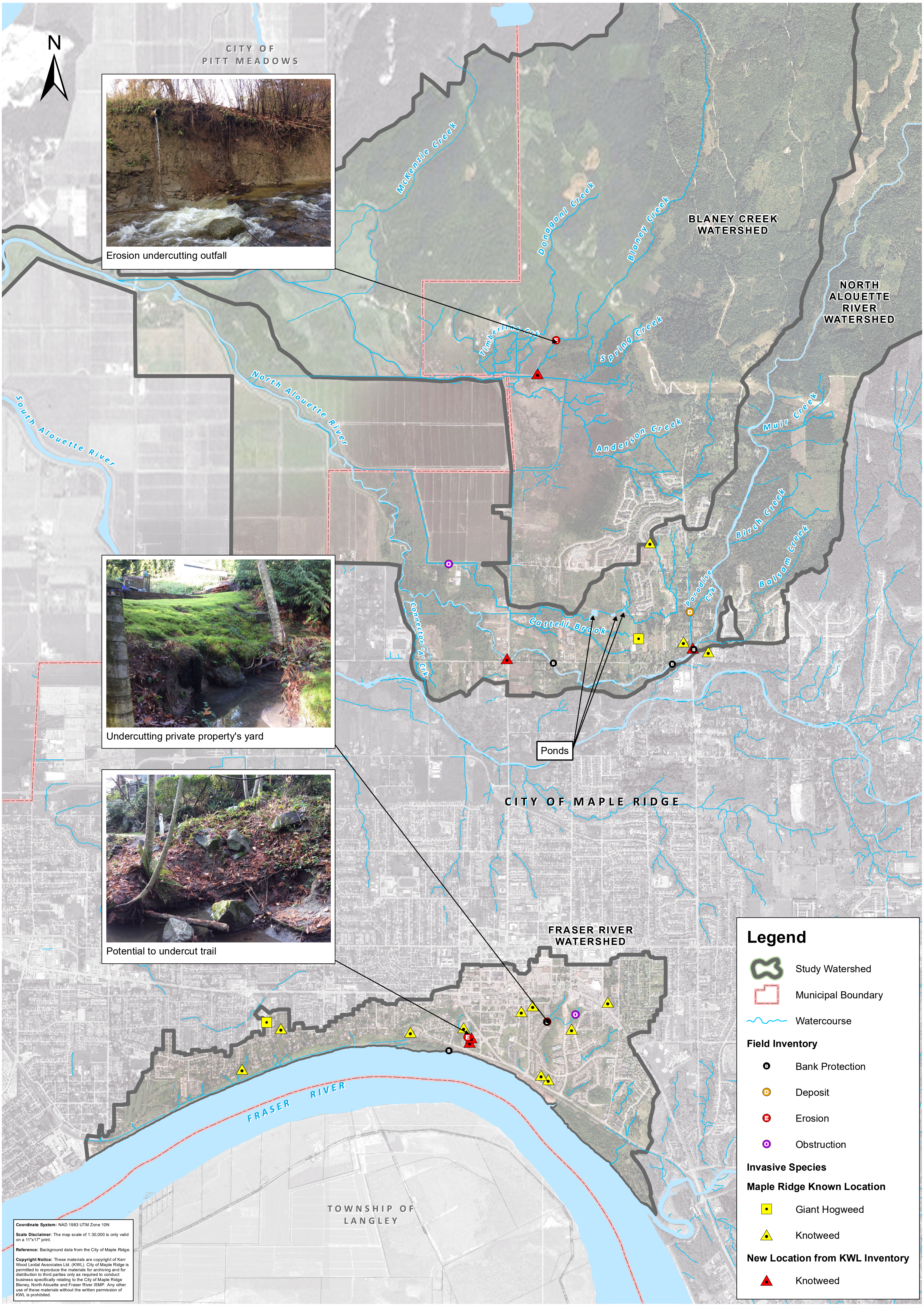


Erosion undercutting outfall

Undercutting private property's yard

Potential to undercut trail

Legend

- Study Watershed
- Municipal Boundary
- Watercourse

Field Inventory

- ● Bank Protection
- ● Deposit
- ● Erosion
- ● Obstruction

Invasive Species

Maple Ridge Known Location

- ■ Giant Hogweed
- ▲ Knotweed

New Location from KWL Inventory

- ▲ Knotweed

Coordinate System: NAD 1983 UTM Zone 10N

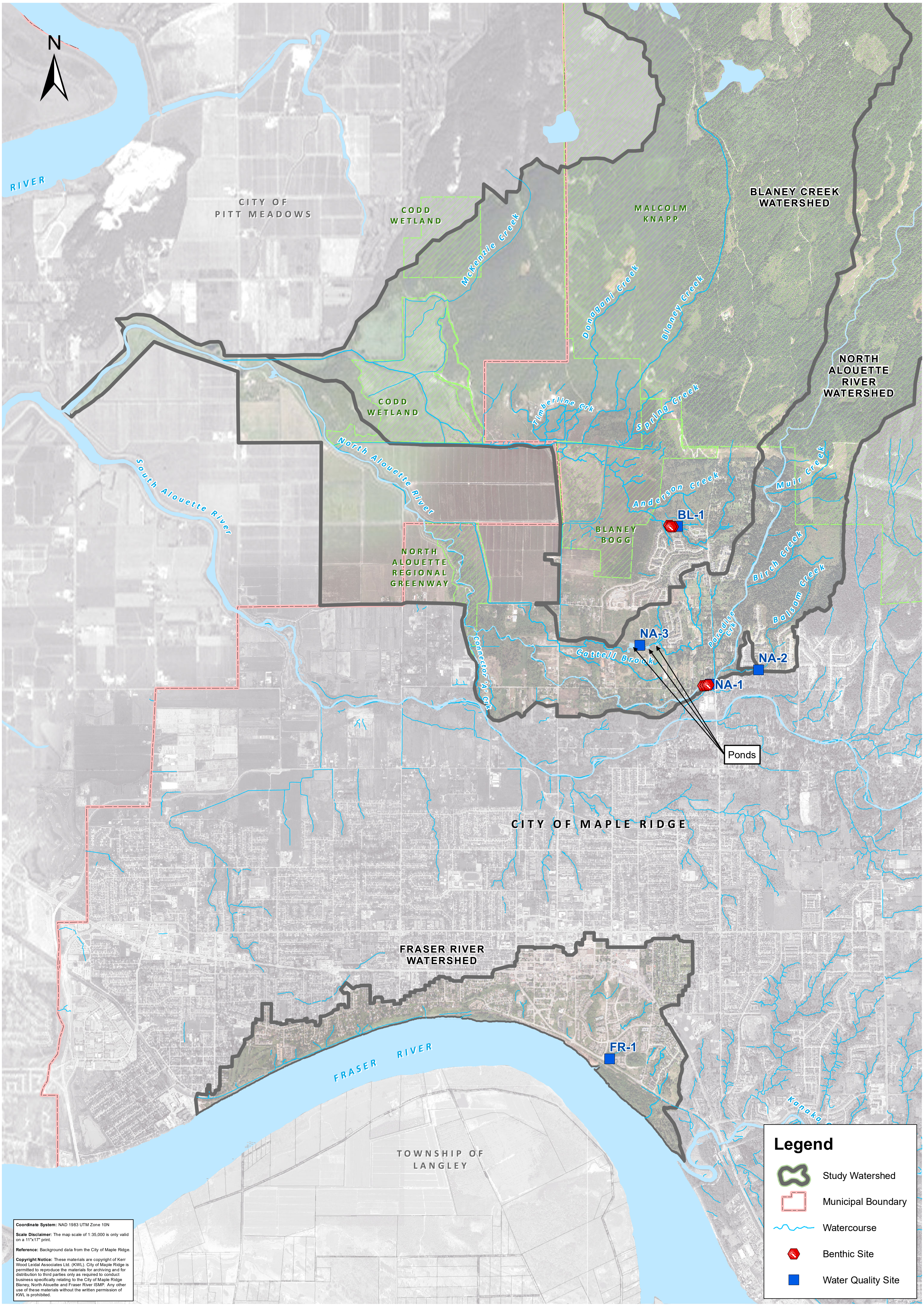
Scale Disclaimer: The map scale of 1:30,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No.	173-188
Date	March 2021
Scale	1:30,000

Invasive Species and Field Inventory

Figure 6-6



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date March 2021
Scale 1:35,000

Water Quality Monitoring Sites

Figure 6-7

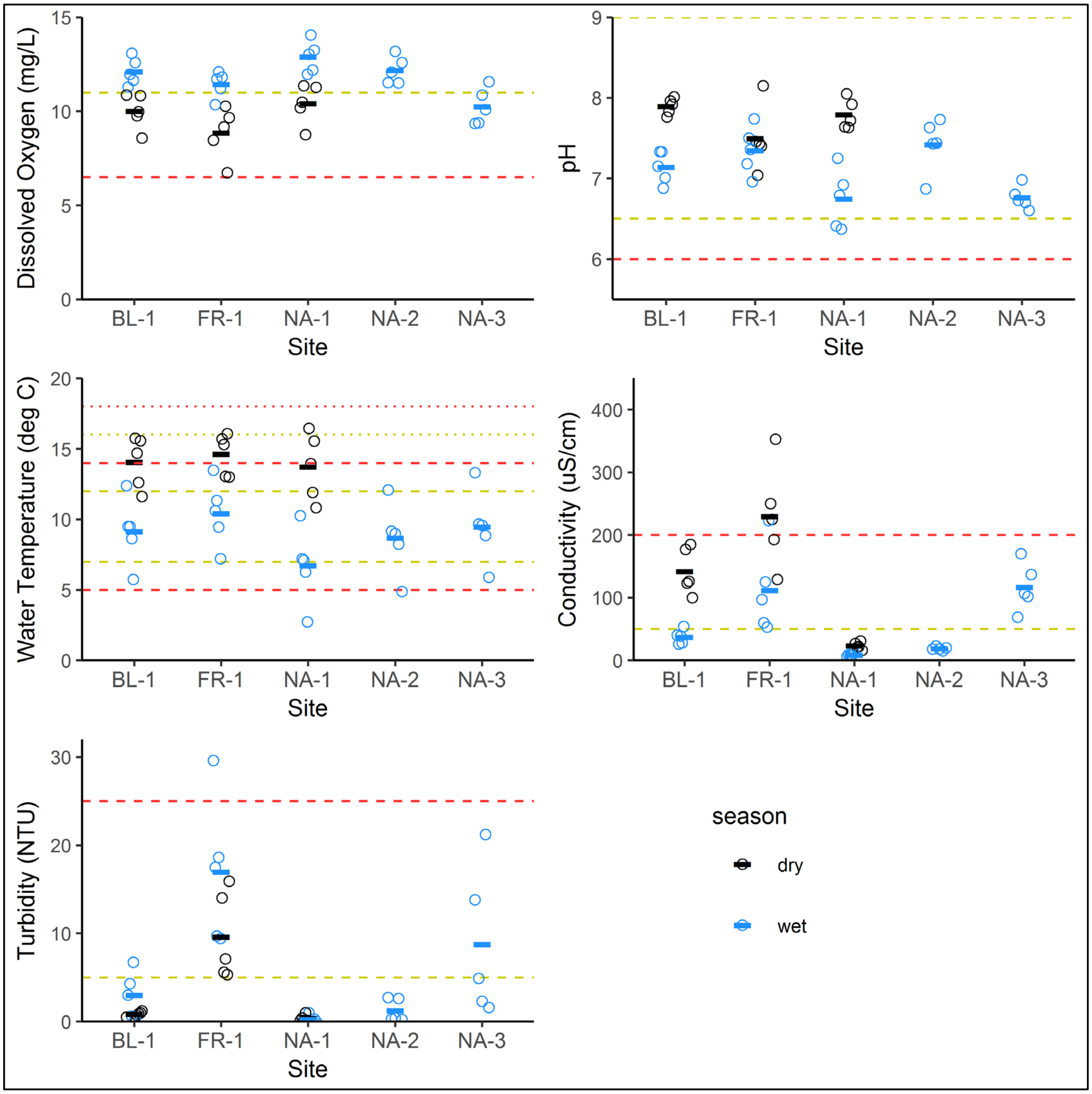


Figure 6-8: MAMF General Water Quality Parameters for Five Sampling Sites
Points represent individual samples. Bars represent mean values. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively. Dotted yellow and red lines indicate thresholds for summer low flow conditions only.

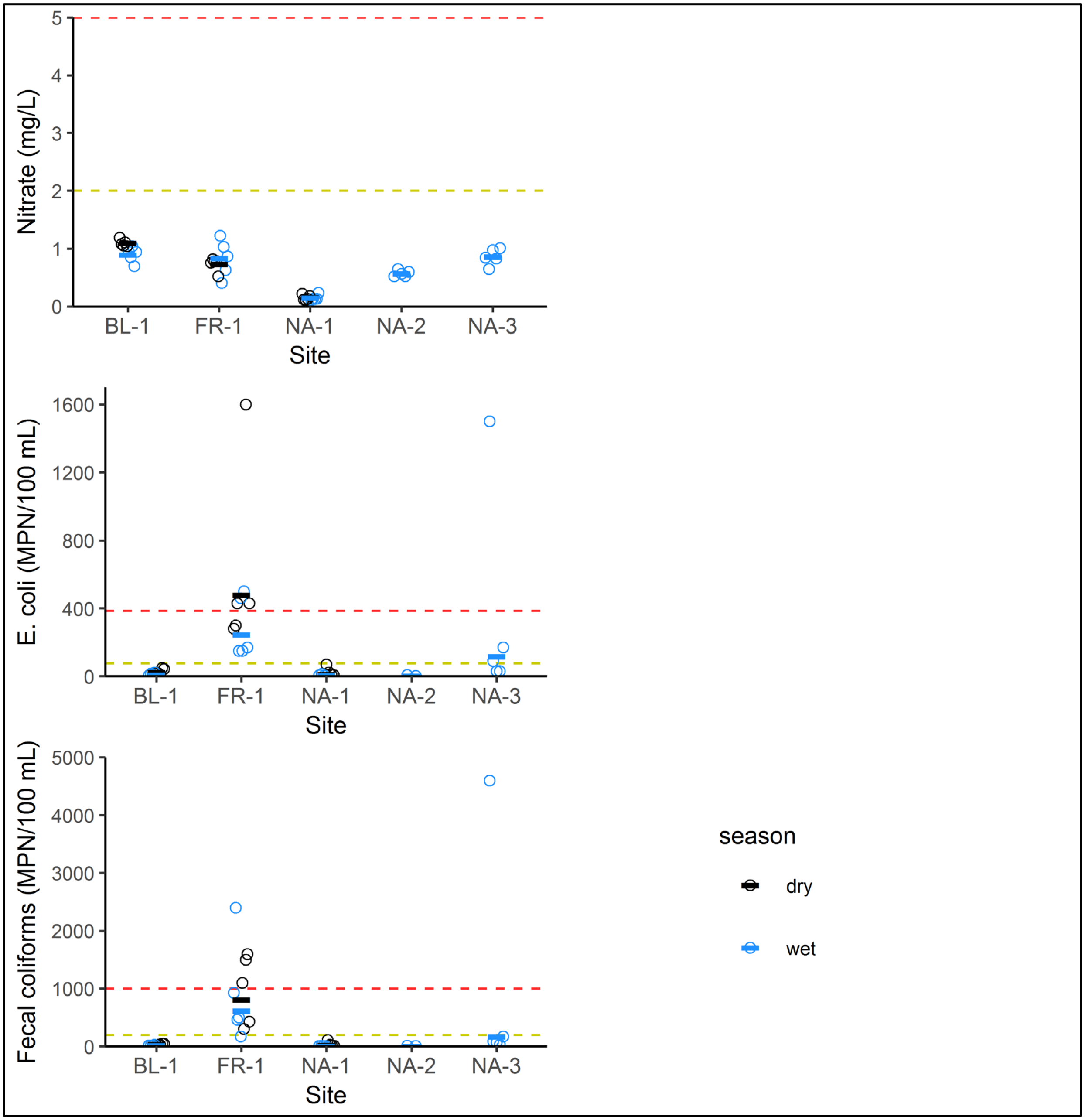


Figure 6-9: MAMF Nutrient and Microbiological Concentrations for Five Sampling Sites
Points represent individual samples. Bars represent mean values for nitrate and geometric mean values for E. coli and fecal coliforms. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively.

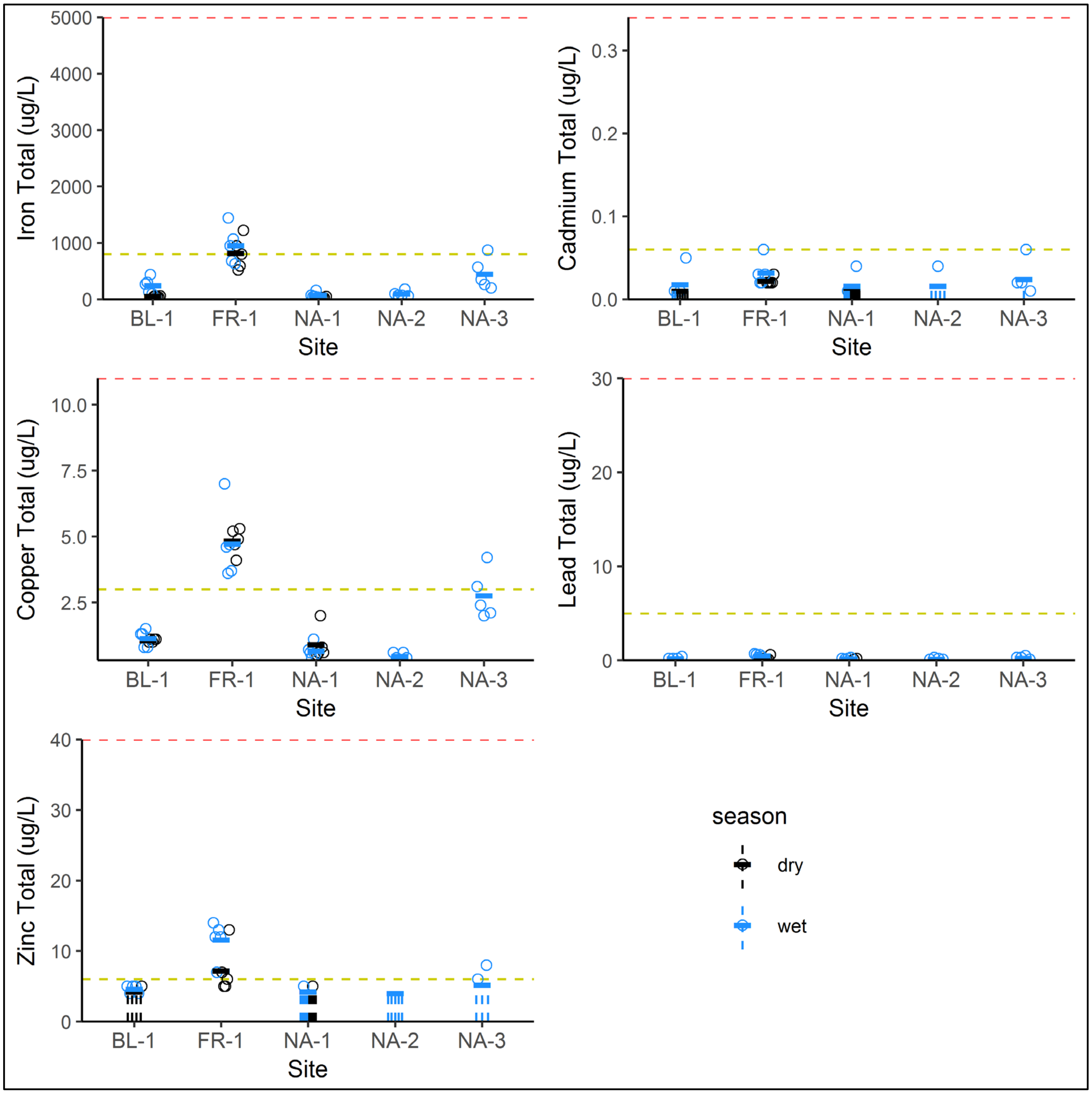


Figure 6-10: MAMF Total Metal Concentrations

Points represent individual samples. Vertical dashed blue and black lines represent sample results that were below detection limit (upper extent of dashed lines are detection limits). Bars represent mean values (detection limit used to calculate means for non-detect samples). Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively.

6.5 Priority Environmental Concerns

Based on the review of background information, field habitat assessment, and stakeholder engagement, KWL identified the following priority concerns and recommendations for protecting fish and aquatic habitat within the study's watersheds. General locations of priority environmental concerns are shown in Figure 6-11 and have been identified as potential projects in Table 17-1.

Development Impacts

- Future development has the potential to impact: rare and sensitive ecosystems and species at risk within Blaney Creek and its tributaries, Blaney Bog, Anderson Creek, and Roslyn Creek (KWL survey); high quality fish habitat in the Upper North Alouette River; high quality of water within Balsam and Birch Creek; and high quality riparian habitat along North Alouette River and Connector A Creek. These ecosystems should be protected as they are key habitat areas for many aquatic and terrestrial species.
- Clearing of riparian vegetation has occurred throughout Cattell Brook and little to no riparian cover remains along sections of the stream (KWL survey). Riparian planting of native vegetation along the stream can help improve both the riparian and aquatic habitat as well as help protect against bank erosion.
- Channel alteration in Fraser River tributaries: loss of natural banks and channel habitat due to riprap being placed in channels (KWL observation). For bank protection works natural bank stabilization methods can be used instead of riprap.
- Development of Silver Valley within the Cattell Brook catchment has led to concerns regarding existing stormwater controls and the potential impacts on high quality fish habitat located downstream (AVA, pers. comm.). Rain gardens were installed throughout the Silver Valley development to mitigate stormwater runoff impacts in 2004. Concerns voiced by AVA include the following:
- It is not known if the implemented systems will remain effective over time or will decrease in their effectiveness due to sedimentation as monitoring was only completed during the first three years after installation.
- The rain garden capture rate is only constructed for events up to the 6-month, 24 hour return period. Two out of the three first storm events monitored between 2005 and 2006 were above the 6-month, 24-hour return period and therefore large amounts of surface overflow from these events occurred. Although the system does reduce stormwater runoff there is still a concern regarding the amount of runoff that is not captured and treated by these systems.

  Long-term monitoring of stormwater controls are needed to determine if the introduction of contaminants from large volumes of stormwater runoff from entering the aquatic environment.

Agriculture Impacts

- Water withdrawals from the North Alouette River in the spring by cranberry farms for frost protection coincides with the outmigration of salmon fry and may lead to fry mortality (M. Coultier-Boisvert, pers. comm., 2016). It is not known at this time if current licenced water withdrawals are adequately protective of environmental flows needed for the proper functioning of the aquatic ecosystem as an environmental flow needs study has not been completed for the watershed. Also, illegal withdrawals have occurred previously within the North Alouette River and an investigation was documented in 2009. No illegal water withdrawals were observed during the field work completed for this ISMP however, it is important to ensure all water withdrawals are occurring legally, within their permitted rates and volumes, and that landowners are aware of current regulations. Charges can be laid under the federal *Fisheries Act*, and provincial *Dike Maintenance Act* and *Water Sustainability Act* for illegal water withdrawal. Although this is out of the City's jurisdiction, the City of Maple Ridge can work with the BC Ministry of Forests Lands Natural Resources Operations and Rural Development (BC FLNFRORD) and the City of Pitt Meadows to ensure that landowners are aware of current regulations.
- Water quality issues downstream of agricultural areas within the North Alouette River and Blaney Creek may exist. Issues may include high stream temperatures from the lack of riparian area and elevated levels of herbicides and pesticides within the water column from surrounding blueberry and cranberry farms (M. Coultier-Boisvert, pers. comm.). Locations, where poor water quality may exist, should be identified so additional water quality sampling can be completed. If water quality is found to be poor remedial actions can be taken to help reduce negative impacts to salmonid spawning and rearing habitats. Actions may include working with local farmers to help reduce their impact on the adjacent streams.
- Anderson Creek which runs through Blaney Bog was modified by the construction of a dyke/canal system in the early 1900s. The purpose of this modification was for agricultural purposes (Piteau Associates, 2001). It is not known if the existing dike currently serves a purpose (McKenna, 2001). In addition to the Anderson Creek channelization, multiple dikes exist throughout the lower watershed of the North Alouette River, Blaney Creek, and Cattell Brook (KWL field survey; M. Coulter-Boisvert, pers. comm. 2016). Both channelization and diking along streams lead to reductions in instream rearing and spawning habitat and alterations in natural stream flows (Wilcock and Essery 1991). The current state of these dikes and channels should be reviewed to determine if they are still required or if restoration of this sensitive habitat can be completed.

Impacts to Fish and Fish Habitat

- During the outmigration of fry in the lower Blaney Creek and North Alouette River, predation is high. This is due to these sections of watershed having little cover from predators. Riparian cover has been lost due to agriculture and diking (Banford and Bailey 1979). Mitigation measures such as increasing riparian cover, instream habitat complexity, and stream connectivity can be implemented to reduce predation pressures on outmigrating fry.
- Major water quality issues have been identified in the Fraser River catchment and Cattell Brook, while minor water quality issues have been identified in the North Alouette River and Blaney Creek (KWL monitoring). The Fraser River catchment is a historical urban area with lasting water quality issues. Although this catchment has had long-term water quality issues, the concept of shifting baselines, which is the situation in which over time knowledge is lost because people don't perceive changes that are actually taking place, should not reduce the importance of addressing. Both recent and historical water quality data show that Cattell Brook has had ongoing issues. This stream flows through residential and lowland agricultural areas where water flow is slow and high levels of overland runoff contribute to the poor water quality observed.

- The culvert located at 232 Street in Anderson Creek is a known fish passage barrier and the culvert located at 141 Avenue in Anderson Creek is a potential fish passage barrier and has been identified as hydraulically undersize (KWL survey). Replacement of both culverts should be a priority to allow fish migration as well as reduce the risk of flooding.
- Excluding the two culverts mentioned above and the buried channel section in Cattell Brook, four additional anthropogenic potential/flow-dependent/partial fish passage barriers have been identified. This includes the following: a culvert under 136 Avenue along Cattell Brook, a culvert under Balsam Street along Balsam Creek, a culvert under 233 Street along Balsam Creek, and a culvert under 223rd Street along a Fraser River tributary (see Figure 6-7). These potential barriers should be investigated further to determine if they are full barriers to fish passage. If any of these culverts become designated as a fish passage barrier, culvert replacement should become a priority.
- Bank erosion has been identified along an unnamed tributary to the Fraser River adjacent to the private properties at 22233 River Road and 22532 Brickwood Close as well as along Blaney Creek adjacent to 144 Ave. at a storm outfall pipe (KWL Survey). Protection of these banks is important not only for adjacent properties but as well as the instream aquatic habitat (i.e. reducing stream flows to create potential rearing habitat).
- The invasive aquatic fish species common carp (*Cyprinus carpio*) has been identified in Anderson Creek. This species has the potential to spread throughout the lower watersheds of Blaney Creek and North Alouette River, negatively impacting native species, the nutrient cycle, and instream vegetation. Creating and restoring instream habitat can help offset the impacts created by the introduction of common carp. In addition, the public should be informed regarding the negative impacts of introducing non-native fish species into stream ecosystems.
- Some creeks and streams in the City of Maple Ridge online mapping system have been identified as being mapped and/or classified incorrectly. Many of the identified streams are tributaries that connect to larger creek systems (AVA, pers. comm.). Identifying these locations and ensuring the data is up to date is important when planning restoration or city projects.
- Invasive plant species have been observed throughout all three watersheds. However, Japanese knotweed (*Fallopia japonica*) and giant hogweed (*Heracleum mantegazzianum*) are of particular concern. Both species can cause infrastructure damage and the species giant hogweed is toxic and is a risk to public health. These invasive plant species should be removed, prioritizing the removal of giant hogweed first followed by Japanese knotweed.
- Significant amounts of riprap have been observed within and along the stream channels of the Fraser River and North Alouette watersheds. An artificial riprap weir and fall have been installed within a tributary of the Fraser River located between Anderson Place and Wood Street to create a pond feature. By removing these features and restoring the instream channel with step-pool habitat units, would improve the immediate habitat as well as upstream access for resident fishes. In addition, sections of riprap have been installed along the stream channel adjacent to 230A Street in the North Alouette watershed. Removing excess riprap and using bioengineering for bank protection can help improve the instream habitat for resident fishes.

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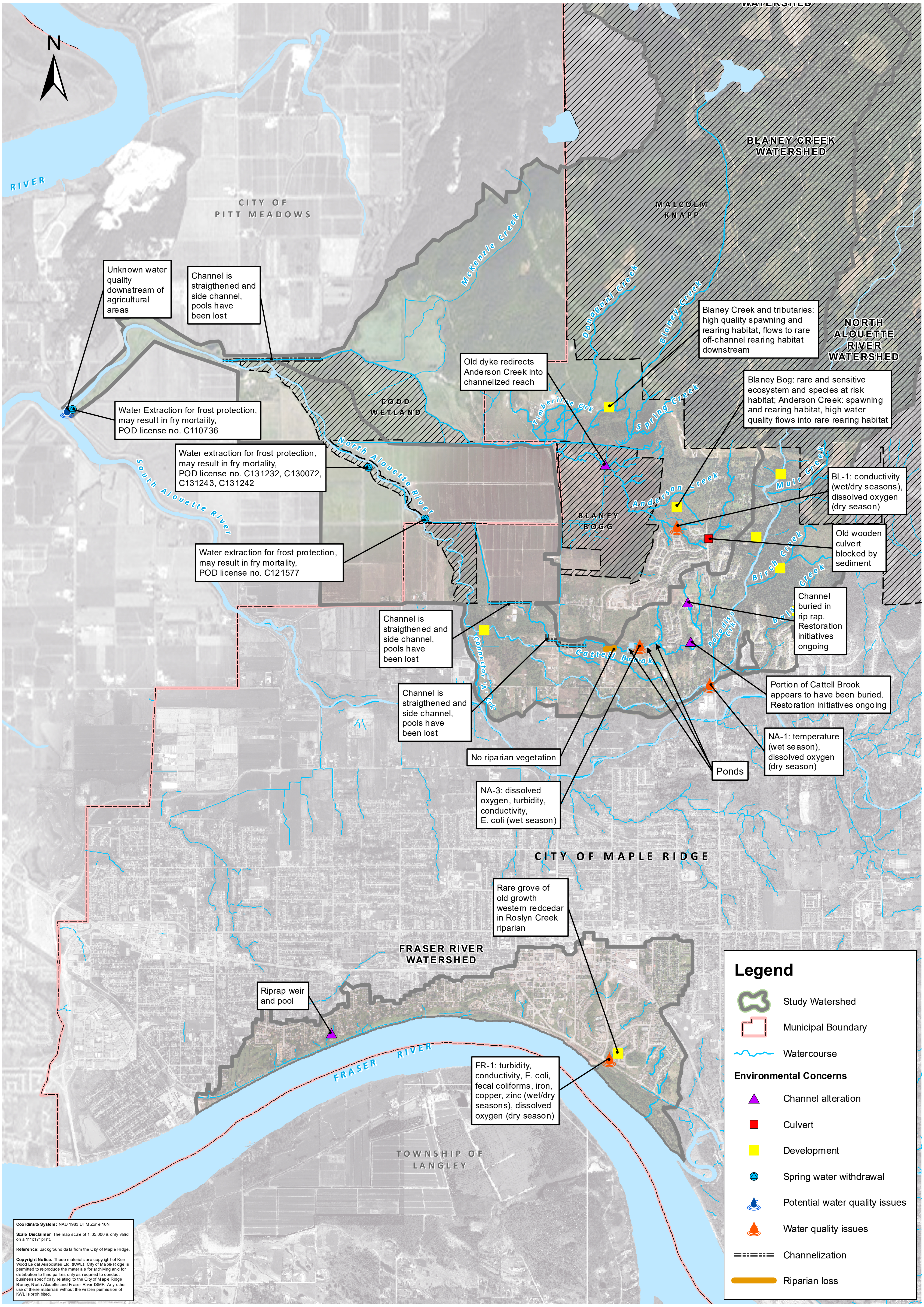
City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Unknown water quality downstream of agricultural areas

Channel is straightened and side channel, pools have been lost

Water Extraction for frost protection, may result in fry mortaiity, POD license no. C110736

Water extraction for frost protection, may result in fry mortality, POD license no. C131232, C130072, C131243, C131242

Water extraction for frost protection, may result in fry mortality, POD license no. C121577

Old dyke redirects Anderson Creek into channelized reach

Blaney Creek and tributaries: high quality spawning and rearing habitat, flows to rare off-channel rearing habitat downstream

Blaney Bog: rare and sensitive ecosystem and species at risk habitat; Anderson Creek: spawning and rearing habitat, high water quality flows into rare rearing habitat

BL-1: conductivity (wet/dry seasons), dissolved oxygen (dry season)

Old wooden culvert blocked by sediment

Channel buried in rip rap. Restoration initiatives ongoing

Channel is straightened and side channel, pools have been lost

Channel is straightened and side channel, pools have been lost

Portion of Cattell Brook appears to have been buried. Restoration initiatives ongoing

No riparian vegetation

NA-1: temperature (wet season), dissolved oxygen (dry season)

Ponds

NA-3: dissolved oxygen, turbidity, conductivity, E. coli (wet season)

Rare grove of old growth western redcedar in Roslyn Creek riparian

Riprap weir and pool

FR-1: turbidity, conductivity, E. coli, fecal coliforms, iron, copper, zinc (wet/dry seasons), dissolved oxygen (dry season)

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date October 2020
Scale 1:35,000

Priority Environmental Points of Concern

Figure 6-11

7. Existing Drainage Assessment

7.1 GIS Layer of Existing Drainage System

The City provided GIS databases (layers) for a wide variety of data. This includes municipal boundary, catchment boundary, zoning, topographic contours, drainage features, roads, and rainfall stations. The GIS drainage features included streams locations, ditches, culverts, storm sewers, storm manholes, pump stations, and storm detention facilities. Each feature contains the length, size, material, inverts, upstream manhole name, and downstream manhole name, where applicable and available.

A desktop analysis of the stormwater drainage infrastructure was undertaken to assess the quality and completeness of the GIS data and identify gaps and errors in the data prior to undertaking the field inventory. The drainage layer was missing some pipe sizes and pipe materials information, as well as some upstream and downstream invert elevations. The missing information was filled in as much as possible using as-built drawings provided by the City. The manhole GIS Layer contained the rim elevations used for ground elevations in the model. Missing rim elevations were interpreted based on the digital elevation model (DEM) and two metre topographic contours. A field survey was conducted by KWL to collect culvert and manhole data that were missing from the GIS information and as-built drawings. A 2019 culvert survey along 224th St. north of 132nd Ave was completed at request of the city and the data was incorporated into the model in the same year, see Appendix A for details.

The detention systems GIS layer contained the area, location, type of facility, and as-built drawing number for each detention facility. The orifice diameters and elevations, overflow types and elevations, and structure elevations and volumes were obtained from as-built drawings in PDF format, where available.

Additional information for the channel geometry of the North Alouette River was obtained from cross-section data used in the Alouette Rivers Floodplain Analyses (NHC, 2010 and 2016). Channel geometry of minor tributaries in the Blaney, North Alouette and Fraser River watersheds were generated from Lidar.

In general, the GIS data, the as-built information, and the survey information provided a complete representation of the drainage system. Very few assumptions on drainage component sizes or elevations needed to be made during the course of modelling. The assumptions that were made are not expected to adversely affect the accuracy of the modelled flows or water levels. Where storm sewer data was assumed, the capacity assessment for those areas indicate the assumed nature and prior to pursuing recommended upgrades for these pipes, the assumed sizing from this study should be confirmed.

7.2 Existing Land Use Assessment

The existing land use within the Blaney, North Alouette and Fraser River watersheds is presented in Figure 7-1. The watersheds of Blaney Creek and North Alouette River are mainly forested with some agricultural within the floodplains and mixed suburban and urban residential areas. The Fraser River watershed is urbanized with denser development found near the city centre of Maple Ridge. Table 7-1 summarizes the existing land use and imperviousness of all three watersheds.

Table 7-1: Blaney, North Alouette and Fraser River Watersheds Existing Land Use

Study Area / Land Use	Area (ha)	% Total Area	Impervious Area (ha)	Land Use % Impervious	% Impervious of Total Area
Blaney & North Alouette Watersheds					
Agricultural	700	11%	187	27%	3%
Commercial / Industrial	1	0%	0	29%	0%
High Density Residential	4	0%	3	78%	0%
Institutional	3	0%	2	47%	0%
Low Density Residential	27	0%	10	38%	0%
Medium Density Residential	55	1%	32	58%	0%
Parks / Grasslands	86	1%	17	20%	0%
Right of Way	51	1%	40	78%	1%
Suburban Residential	207	3%	36	17%	1%
Woodlands / Forested	5421	83%	8	0%	0%
Total	**6,557**	**100%**	**335**	**5%**	**5%**
Fraser River Watershed					
Agricultural	0	0%	0	0%	0%
Commercial / Industrial	56	16%	46	82%	13%
High Density Residential	49	14%	38	78%	11%
Institutional	3	1%	2	80%	1%
Low Density Residential	78	23%	31	40%	9%
Medium Density Residential	18	5%	12	65%	3%
Parks / Grasslands	42	12%	8	20%	2%
Right of Way	67	20%	54	80%	16%
Suburban Residential	9	3%	2	20%	1%
Woodlands / Forested	20	6%	1	5%	0%
Total	**342**	**100%**	**194**	**57%**	**57%**

7.3 PCSWMM Model Development

PCSWMM was used to simulate the watershed hydrology and upland hydraulics for pipes that are 400 mm in diameter and larger. PCSWMM uses inputs such as rainfall and catchment characteristics (area, slope, soil type, etc.) to estimate catchment flows. Further details of the modelling process and model input and parameters may be found in Appendix F.

The existing conditions model was calibrated and validated using flow monitoring data collected at five flow monitoring locations in the Blaney, North Alouette and Fraser River watersheds, listed in Table 7-2. All three watersheds upstream of their gauges were calibrated individually and all calibrated parameters were applied to their respective catchments. Detailed information on the calibration process and its results can be found in Appendix F. In general, calibration resulted in conservative flows, overestimating flow peaks by 2 to 20%, with higher overestimates on Anderson Creek.

Table 7-2: Flow Monitoring Site Summary

Monitoring Station	Active Period
North Alouette River at 232 St. Hydrometric Station (WSC)	1911 to present
Anderson Creek Hydrometric Station (KWL)	September 2016 to June 2018
Fraser River Tributary Hydrometric Station (KWL)	September 2016 to June 2018
Balsam Creek Hydrometric Station (KWL)	November 2016 to June 2018
Cattell Brook Hydrometric Station (KWL)	November 2016 to June 2018

7.4 Peak Flow Estimates

Peak flows were estimated for all pipes and culverts in the study watersheds. As noted above, the calibration resulted in conservative peak flows, with the model producing flow peaks that were higher than recorded flows. The model in this study was developed at a watershed scale to provide indications of drainage infrastructure performance, to allow for long range planning and budgeting. Prior to undertaking upgrades, detailed estimates of design flows must be undertaken for each project.

Secondary flow estimate checks were completed to compare existing land use peak flow estimates with other Lower Mainland unit peak flow estimates for the 10-year, and 100-year storm events and were found to be reasonable. This comparison is summarized in Table 7-3.

Table 7-3: Unit Peak Flow Comparison

Location	Peak Flow (L/s/ha)	
	10-year	100-year
Largely Un-developed Catchments		
Blaney Creek @ 224 St. – 1494ha – 1% TIA	27	30
Spring Creek @ Blaney Creek Confluence – 167ha – 2% TIA	30	35
Balsam @ Balsam St.– 34ha – 0% TIA	17	28
Partington Creek @ Victoria Dr. (Coquitlam) – 442ha – 3% TIA	25	39
Mackay Creek @ Montroyal Dr. (North Vancouver) – 363ha – 12% TIA	36	58

Location	Peak Flow (L/s/ha)	
	10-year	100-year
Largely Developed Catchments		
Fraser River Tributary @ 227 St. and Haney Bypass – 54ha – 51% TIA	46	67
166 St. Creek (Surrey) – 133ha – 50% TIA		63

In general, the unit flows from the model were in line with estimates for similar creeks.

7.5 Existing Drainage System Assessment

As per the City's Design Criteria Manual design storms were used to assess pipe capacity and real storm events from September 1996, October 2003, September 2004 and March 2007 were used to assess the detention facility performance.

Appendix F describes the design storms that were used to assess the drainage system. This work did not include design storms that meet ARDSA criteria and the drainage system was not assessed as to whether or not the ARDSA criteria is met in the agricultural areas.

Storm Sewer Capacity Assessment

The capacity of the storm sewer system (pipes with diameter 400 mm and larger) were assessed for the existing land use scenario. Storm sewers were evaluated using 10-year and 100-year peak flow estimates and flagging surcharging time greater than 15 minutes and over 30 centimeters. Infrastructure age and condition were not considered in this assessment.

Appendix G provides details for the hydrotechnical assessment of the storm system. Of the 329 total pipe conduits in the watersheds, the flow in 27 pipes exceeded the minor system design criteria for the 10-year existing land use instantaneous peak flows. Of the 38 pipes in the major system, the flow in 9 pipes exceeded the design criteria for the 100-year existing land use. The pipes that don't meet the above criteria or estimated undersized pipes, for the minor and major system are summarized in Table 7-4 and a more detailed capacity assessment can be found in Appendix G. Figure 7-2 shows all potentially undersized major and minor infrastructure, assessed with their respective design events.

Note that there are pipes smaller than 400 mm shown in the table of results; these pipes were included in the models and the assessment because they are either downstream of a pipe that is larger than 400 mm diameter, or they are downstream of a detention facility and were included to assess the performance.

Table 7-4: Storm Sewers Undersized for Existing Land Use Conditions

Pipe Size (mm)	Total Length (m)	% of Total System	100-yr Major		10-yr Minor	
			Length Undersized (m)	% of Total System Undersized	Length Undersized (m)	% of Total System Undersized
<200	36	0.2%	0	0.0%	0	0.0%
200	0	0.0%	0	0.0%	0	0.0%
250	171	1.0%	65	0.4%	0	0.0%
300	338	1.9%	49	0.3%	0	0.0%

Pipe Size (mm)	Total Length (m)	% of Total System	100-yr Major		10-yr Minor	
			Length Undersized (m)	% of Total System Undersized	Length Undersized (m)	% of Total System Undersized
375	821	4.7%	0	0.0%	105	0.6%
450	5602	32.1%	40	0.2%	613	3.5%
525	2131	12.2%	157	0.9%	327	1.9%
600	3840	22.0%	0	0.0%	342	2.0%
675	696	4.0%	143	0.8%	0	0.0%
750	1556	8.9%	0	0.0%	0	0.0%
900	972	5.6%	0	0.0%	0	0.0%
1050	491	2.8%	0	0.0%	0	0.0%
1200	538	3.1%	0	0.0%	0	0.0%
>1200	264	1.5%	0	0.0%	0	0.0%
Total	17456	**100%**	455	2.6%	1387	7.9%

Culvert Capacity Assessment

Culverts in the Blaney, North Alouette and Fraser River watershed were assessed for the 10-year conveyance capacity for driveway culverts and 100-year conveyance capacity for creek culverts and 200-year conveyance for culverts under arterial roads. Culverts were assessed using a hydraulic grade line (HGL) threshold of 1% and checking for surcharging. Culverts that had an HGL greater than 1% and had surcharging at the inlet were flagged as undersized. Undersized culverts were identified at multiple locations under the existing conditions and have been summarized in Table 7-5 and located in Figure 7-2, a more detailed summary of undersized culverts can be seen in Appendix G.

Table 7-5: Summary of Undersized Culverts in Existing Conditions

Culvert Size (mm)	Total Number	% of Total Culverts	Existing Land Use Summary	
			Number Undersized	% of Total Undersized
< 300	0	0.0%	0	0.0%
300 - 524	7	14.9%	5	10.6%
525 - 699	21	44.7%	6	12.8%
700 - 1499	15	31.9%	5	10.6%
1500 - 2000	3	6.4%	0	0.0%
> 2000	1	2.1%	0	0.0%
Total	**47**	**100%**	16	34.0%

Existing Detention Facility Assessment

Nine existing detention ponds were assessed as shown on Figure G-3. Each detention pond was evaluated individually based on its design, as far as was known from information available on as-built drawings provided by the City. Real storm events from September 1996, October 2003, September 2004 and March 2007 were used to assess the detention facilities. Table 7-6 summarizes the results of the detention pond report; more detail on the results may be found in Table G-14 of Appendix G.

Table 7-6: Summary of the Detention Pond Assessment under Existing Conditions

Category	Number of Detention Ponds
Adequate volume, water level does not exceed design water level by 10 cm or more, meets criteria	5
Volume approaching capacity (95% capacity used) or design water level is exceeded by 10cm or more, adjustments may be required in the future	5
Inadequate volume to meet criteria*	1
*Water level exceeds the banks of pond.	

Detailed results are provided in Table G-15 in Appendix G.

7.6 Application of Design Criteria for Mitigation

Under the *City of Maple Ridge Design Criteria Manual*, new development must adhere to a stormwater management plan that mitigates the runoff from impervious areas to meet specific criteria. The design and mitigation criteria are shown in Table 7-7. Agricultural drainage is subject to Agricultural and Rural Development Subsidiary Agreement (ARDSA) criteria developed by the province of BC. With agricultural areas in the North Alouette and Blaney floodplain, a lowland drainage study would be required to assess the ARDSA criteria.

Table 7-7: Summary of Maple Ridge Stormwater Design and Mitigation Criteria

Criteria	Applicable Return Period	Intent
Minor System Design	10-year	Conveyance of runoff from all storms up to the minor design event.
Major System Design	100-year	Conveyance of runoff from major storms up the major design event.
Tier A Mitigation	< 2-year	Capture and infiltrate 90% of average annual rainfall.
Tier B Mitigation	2-year	Detain the 2-year post-development peak flow to 2-year forested pre-development release rate.
Tier C Mitigation	10-year	Detain the 10-year post-development peak flow to 2-year pre-development release rate.

Criteria	Applicable Return Period	Intent
	100-year	In some cases (Morse, Cattel, Millionaire and other sensitive systems) detain the 100-year post-development peak flow to 2-year pre-development release rate.

The mitigation criteria for Tiers A, B, and C are used somewhat differently for application to different land use categories. The table below summarizes typical applications of the criteria, however in reality there are numerous factors considered for every site in implementing the mitigation criteria.

Table 7-8: Application of Maple Ridge Stormwater Design Criteria for Mitigation of Development

Tier	Single-Family (Infill)	Single-Family (Greenfield)	Multi-Family	Industrial / Commercial / Institutional
A	300 - 350 mm Topsoil*	300 - 350 mm Topsoil*	Yes*	Yes*
B	Sump w/ 20 mm orifice[ǂ]	Sump w/ 20 mm orifice[ǂ]	Yes*	Yes*
C	No (not applied)	Yes	Yes	Yes

*Tier A & B goals are targeted but are not always achieved due to limitations of soil permeability, slopes, orifice minimum size, & space limitations.

ǂ Minimum orifice size for functionality is 20 mm; this does not represent a design release rate.

Further detail regarding the application of the Tier A criteria is shown in Figure 7-3. This figure illustrates the considerations and decision-making that contribute a determination of whether and to what extent the Tier A criteria must be implemented for a proposed development case. The modelling approach for the stormwater system for the ISMP considered incorporation of the mitigation criteria that is expected to impact the design flows for the system. The Tier C design criteria detains a 10-year event and thus is the only tier of concern at the 10-year return period level of service, which is the design event for the Minor System. However, the City does not rely on detention facilities that do not yet exist to reduce the sizing of conveyance infrastructure, therefore only existing detention infrastructure, ponds and in-line detention, were incorporated into the models. Potential future detention was not accounted for in the models. The Tier A and B criteria were not modelled, as they apply to 2-year return period events and smaller, however their potential impacts or benefits to the future land use were assessed as described in Section 8.1.

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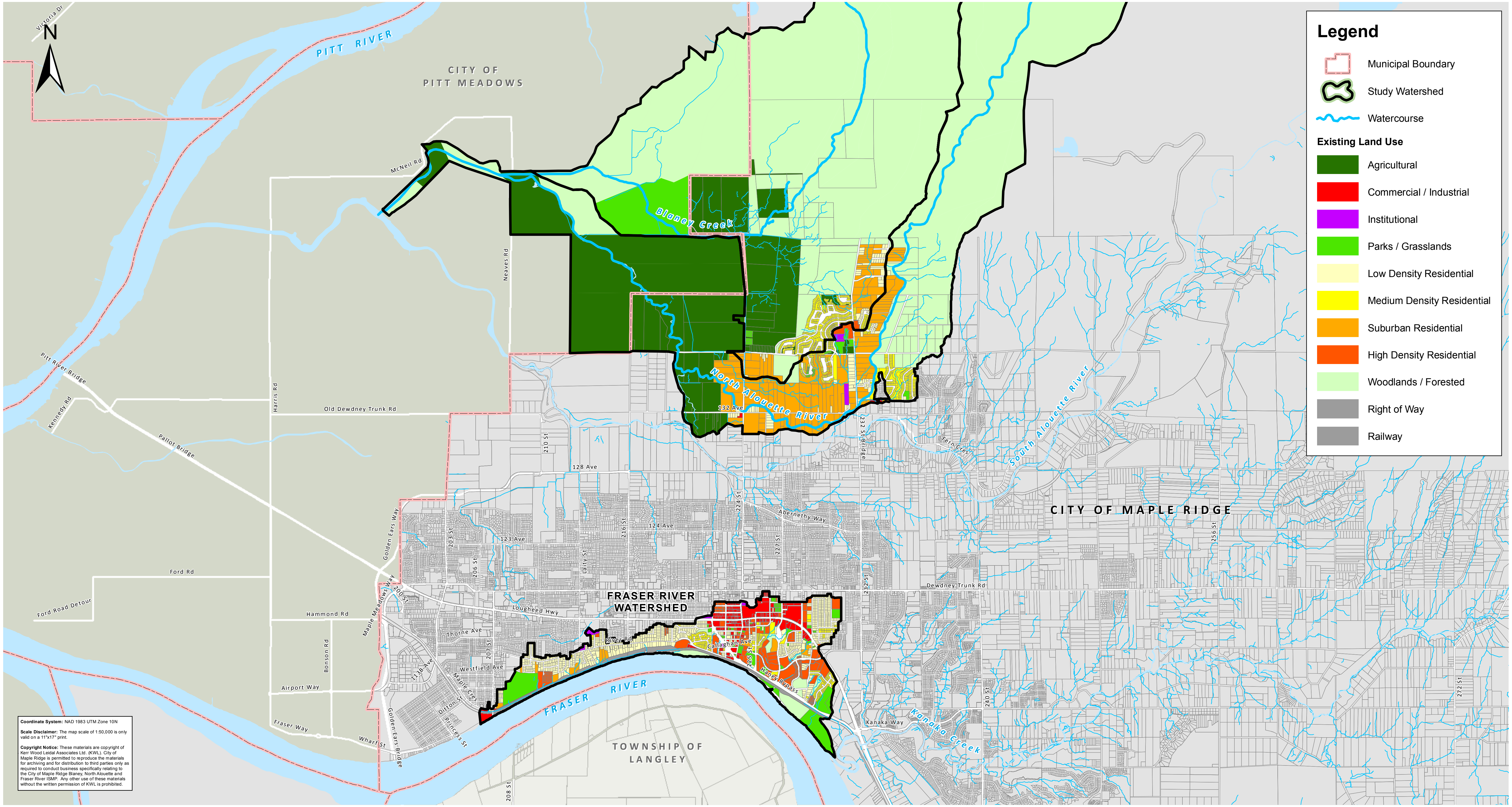


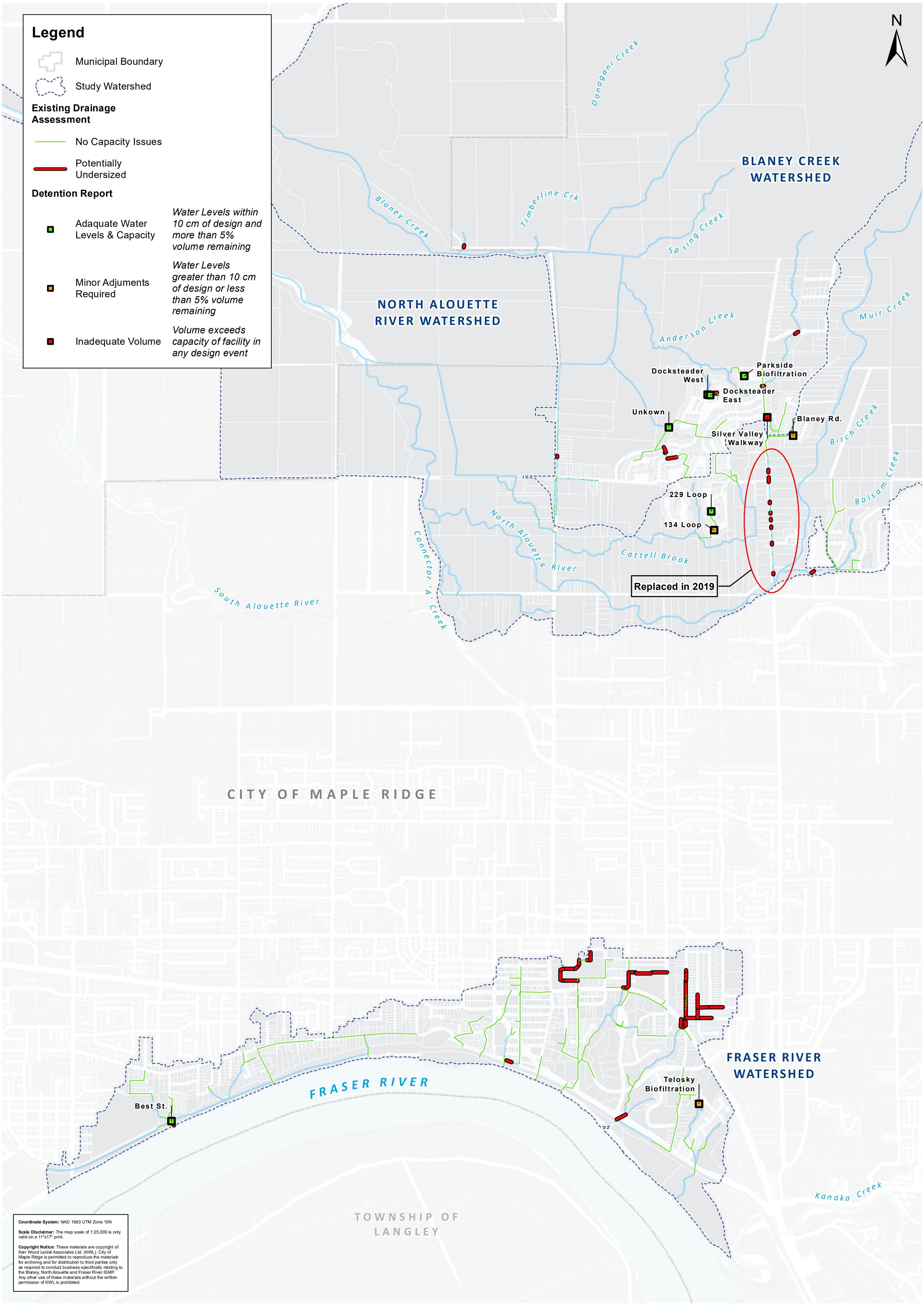
Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:50,000 is only valid on a 11"x17" print.

Project No.	173-188
Date	April 2017
Scale	1:50,000

Existing Land Use

Figure 7-1



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:25,000 is only valid on a 11"x17" print.

Project No. 173-188
Date August 2020
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Potentially Undersized Existing Infrastructure

Figure 7-2

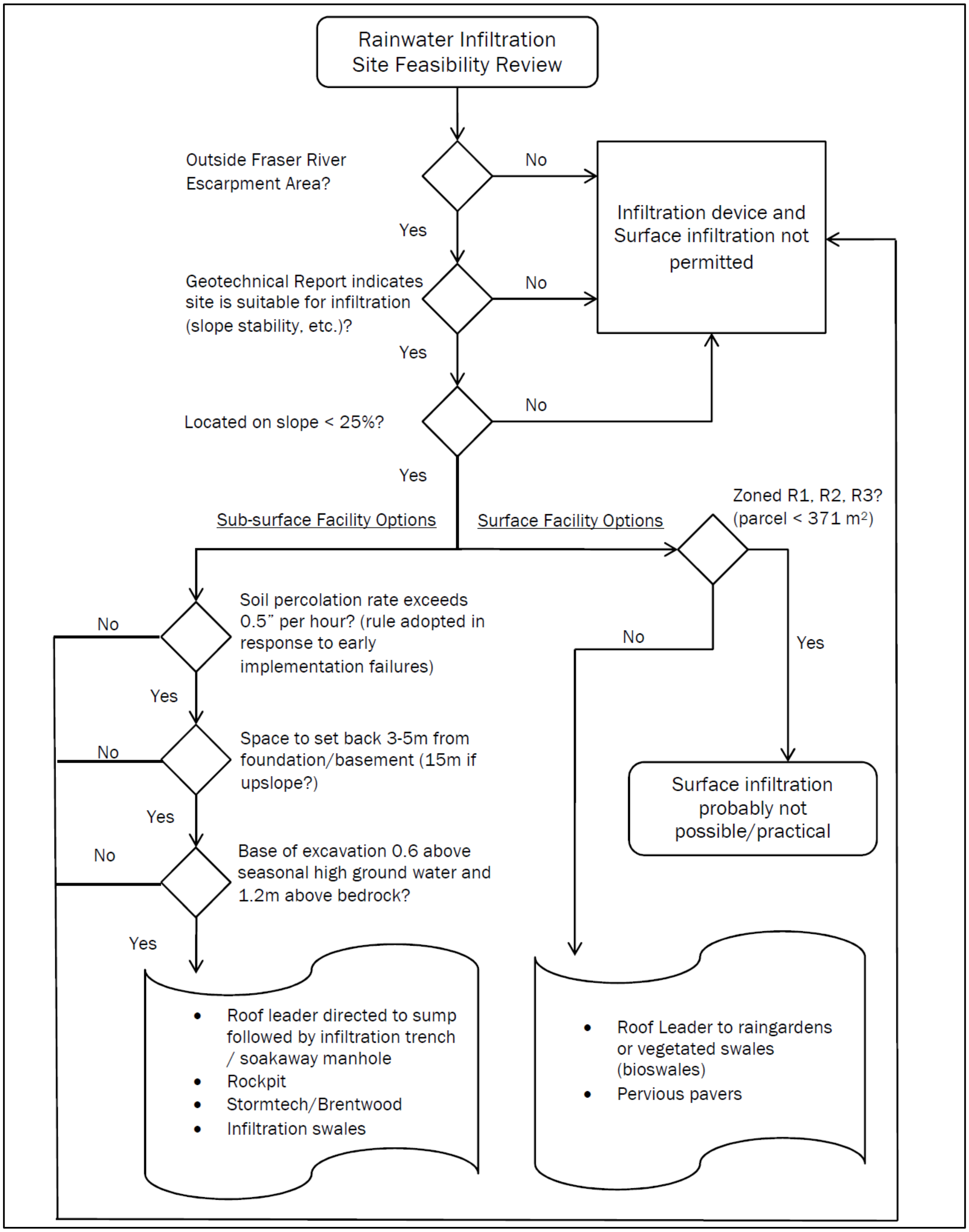

Figure 7-3: Flowchart Illustration of Decision-Making Process for Application of Tier A Mitigation Criteria
(Source: City of Maple Ridge)

8. Future Drainage Assessment

8.1 Future Land Use Conditions

The future land use for the ISMP was developed by using OCP GIS data received from the City and any neighbourhood/community planning land uses which superseded the OCP data. This data can be seen in Figure 7-2 and Table 8-1. Future impervious percentage for all lots was assigned by applying the base impervious percentage values found in Table 8-1 to the corresponding land use. Actual land use impervious values for individual lots may vary from the base impervious percentage if they were adjusted in the existing conditions and are not expected to change for the future (OCP) conditions.

Table 8-1: Future Land Use Percent Impervious Assumptions

Land Use	Base % Impervious
Suburban Residential*	**20%**
Low Density Residential	**60%**
Medium Density Residential	**70%**
High Density Residential	**85%**
Commercial / Industrial	**90%**
Institutional	**80%**
Parks / Grasslands / Conservation	**20%**
Cultivated Fields (Agricultural)	**30%**
Woodlands / Forested	**5%**
Eco-Cluster Development	**20 – 55%**
Rights of Way**	**80%**
*Lots 0.5 ha or larger **KWL added land use	

The OCP planning horizon is 2031, which is not very far in the future, and City staff expressed concern with the assumption that existing developed land uses in the Fraser River watershed would redevelop to higher impervious coverages within the OCP planning horizon. Therefore, it was determined that only land uses expected to develop/re-develop under the OCP and within that time horizon would be considered to change from existing conditions for the future (OCP) conditions scenario. GIS was used to assess the changes in land use between the existing land use and the OCP, and the following categories were identified as likely changing:

1. **Greenfield:** Lots or Subcatchments that are currently designated as Agricultural, Park, Forest, or Grasslands under existing conditions but are designated Commercial, Industrial, Residential, etc., in the OCP.
2. **Infill:** Lots or Subcatchments that are expected to redevelop but stay in the same zoning category and;
3. **Conversion:** Lots or Subcatchments that will be re-zoned in the future but will not be considered **Greenfield**, (i.e., a conversion from commercial to high-density residential).

Further review and consideration of the rate of re-development of existing single-family lots within the older areas of the Fraser River watershed indicated that the rate of re-development of these lots was quite low, and the resulting impact to changing impervious coverage was approximately 0.5%. Thus, in the future modelling scenarios the infill re-development of single-family lots was ignored as essentially unchanging.

As per the discussions with the City, special attention was given to parcels that are located in areas designated as 'Eco-Cluster'. The lots in these areas are expected to develop as low, medium or high-density residential where the developed area is clustered together, and a significant portion of the lot is set aside to be 'Conservation' green space. To account for the green spaces that will be set aside, the lots designated 'Eco-Cluster' were considered to be 50% developed, such that half the lot would be green space and half the lot would be designated with the percent impervious coverage assumption that matches the planned future land use. The process of accounting for 'Conservation' or 'Eco-Cluster' Development resulted in these lots having an impervious range of 20 – 55%, as seen in Table 8-1.

The overall future conditions impervious area is shown in Table 8-2.

Table 8-2: Summary of Watershed Impervious Cover for Future Conditions

Study Area / Land Use	OCP - Future - Land Use				
	Area (ha)	% Total Area	Impervious Area (ha)	Land Use % Impervious	% Impervious of Total Area
North Alouette Watershed					
Agricultural	296	7%	89	30%	2%
Commercial / Industrial	0	0%	0	0%	0%
High Density Residential	13	0%	11	85%	0%
Institutional	5	0%	4	80%	0%
Low Density Residential	28	1%	17	60%	0%
Medium Density Residential	65	2%	40	62%	1%
Parks / Grasslands	93	2%	20	21%	0%
Right of Way	36	1%	27	77%	1%
Suburban Residential	10	0%	2	20%	0%
Woodlands / Forested	3449	86%	172	5%	4%
Total	**3995**	**100%**	**382**		**10%**
Fraser River Watershed					
Agricultural	0	0%	0	0%	0%
Commercial / Industrial	28	8%	25	90%	7%
High Density Residential	5	1%	4	85%	1%
Institutional	3	1%	2	80%	1%
Low Density Residential	112	33%	67	60%	20%
Medium Density Residential	48	14%	34	70%	10%
Parks / Grasslands	59	17%	12	20%	3%

Study Area / Land Use	OCP - Future - Land Use				
	Area (ha)	% Total Area	Impervious Area (ha)	Land Use % Impervious	% Impervious of Total Area
Right of Way	88	26%	68	78%	20%
Suburban Residential	0	0%	0	0%	0%
Woodlands / Forested	0	0%	0	0%	0%
Total	**342**	**100%**	**212**		**62%**
Blaney Creek Watershed					
Agricultural	433	17%	130	30%	5%
Commercial / Industrial	0	0%	0	0%	0%
High Density Residential	2	0%	1	85%	0%
Institutional	0	0%	0	0%	0%
Low Density Residential	5	0%	3	60%	0%
Medium Density Residential	63	2%	38	61%	1%
Parks / Grasslands	151	6%	36	24%	1%
Right of Way	16	1%	12	80%	0%
Suburban Residential	63	2%	13	21%	1%
Woodlands / Forested	1829	71%	91	5%	4%
Total	**2561**	**100%**	**325**		**12%**

8.2 Storm Sewer Assessment

The major and minor conveyance system for the future conditions assessment was evaluated with the same criteria outlined in Section 7 under an unmitigated future land use condition. The same storm durations and distributions from the existing conditions models were applied to all future scenarios. Appendix G provides more details for the hydrotechnical assessment of the future storm system.

The future conditions assessment without climate change resulted in 1 additional pipe exceeding the minor system design criteria for the 10-year future land use instantaneous peak flow and 1 additional pipe exceeding the design criteria for the 100-year peak flow. Undersized pipes for the minor and major system are summarized in Table 8-3 and a more detailed capacity assessment can be found in Appendix G. A figure (Figure 8-1) of all undersized infrastructure under future conditions is presented at the end of this Section.

Details on the models and modelling process are not repeated in the future drainage system assessment section to reduce duplication of information. A general summary of undersized culverts and major system pipes in the future (OCP) with a more detailed layout in Appendix G.

Table 8-3: Storm Sewers Undersized for Future Land Use Conditions

Pipe Size (mm)	Total Length (m)	% of Total System	100-yr Major		10-yr Minor	
			Length Undersized (m)	% of Total System Undersized	Length Undersized (m)	% of Total System Undersized
<200	36	0.2%	0	0.0%	0	0.0%
200	0	0.0%	0	0.0%	0	0.0%
250	171	1.0%	65	0.4%	0	0.0%
300	338	1.9%	49	0.3%	0	0.0%
375	821	4.7%	0	0.0%	105	0.6%
450	5602	32.1%	70	0.4%	656	3.8%
525	2131	12.2%	157	0.9%	327	1.9%
600	3840	22.0%	0	0.0%	342	2.0%
675	696	4.0%	143	0.8%	0	0.0%
750	1556	8.9%	0	0.0%	0	0.0%
900	972	5.6%	0	0.0%	0	0.0%
1050	491	2.8%	0	0.0%	0	0.0%
1200	538	3.1%	0	0.0%	0	0.0%
>1200	264	1.5%	0	0.0%	0	0.0%
Total	17456	**100%**	484	2.8%	1430	8.2%

Culvert Capacity Assessment

Culverts in the Blaney, North Alouette and Fraser River watershed were assessed under future conditions with the same criteria and rainfall inputs as the existing assessment described in Section 7.5. Under unmitigated future conditions with no climate change there are no additional culverts that fail the criteria outlined in Section 7-4.

The bridge over Blaney Creek at 224 St. is well above the modelled surface of the 100-year return period event in the future conditions assessment[12]. The results of modelling for the bridges on the North Alouette River are not reported here as the flood assessment for the North Alouette River was studied and reported on separately.

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[12] Note that this bridge is modelled based on the available information at the time of the work but that the bridge and the channel below it were not surveyed for this project; therefore the modeled representation of the bridge may potentially have missing or inaccurate information.

Detention Reporting with Future Land Use

The reporting of the detention facilities was completed in the same way as the existing scenario, the detailed future detention summary is in Table G-14 and can be seen spatially in Figure G-6 in Appendix G. The general summary of the detention reporting is in Table 8-4.

Because the ponds are typically built to detain runoff from a catchment that is usually built out at the same time, the future (OCP) conditions had no significant effects on the predicted water levels and volumes of the existing ponds.

Table 8-4: Summary of the Detention Pond Assessment under Future Conditions

Category	Number of Detention Ponds
Adequate volume and water level does not exceed design water level by 10 cm or more, meets criteria	4
Volume approaching capacity (95% capacity used) or design water level is exceeded by 10cm or more, minor adjustments may be required in the future	3
Inadequate volume to meet criteria*	2
*Assessed as water level exceeds the banks of pond.	

8.3 Climate Change System Assessment

The effect of climate change in the models was simulated by increasing the rainfall amounts for the design storms by a fixed percentage for each of two climate change scenarios, a 10% increase and a 20% increase in storm rainfall amount. These values for rainfall increase for climate change are in accordance with recommendations from APEGBC[13] and from Metro Vancouver[14] and the specific values are consistent with work being done on other City ISMPs. To modify the design storms, each storm duration rainfall amount was increased by 10% to represent the effect of climate change in 2050 and by 20% to represent the effect of climate change in the year 2080. The results of the climate change scenarios are shown in the following sections.

To model the impact of climate change, a 10% climate change increase was applied to each time step in the hydraulic model for the recorded rainfall from the *City of Maple Ridge Design Criteria Manual* to simulate the 10% increase scenario, and the rainfall for each time step was multiplied by 20% to simulate the 20% increase scenario.

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[13] APEGBC. Legislated Flood Assessments in a Changing Climate. June 2010, v.1.1.
[14] Metro Vancouver. Climate Projections for Metro Vancouver. Report, June 2016.

Climate Change Storm Sewer Assessment

The major and minor conveyance system for the future climate change conditions assessment was evaluated with the same criteria as outlined in Section 7 under unmitigated future land use and incorporating the effect of climate change in the year 2050 and 2080. The same storm durations and distributions from the existing conditions models were scaled up by 10% and 20% applied to the future land use model. Appendix G provides more details for the hydrotechnical assessment of the future storm system.

The future conditions assessment under the effect of climate change in 2050 resulted in 6 additional pipes exceeding the minor system design criteria for the 10-year future land use instantaneous peak flow and 6 more minor pipes exceeding the design criteria for the 2080 peak flow. Of the major pipes assessed under a 2050 climate change scenario there were an additional 6 that did not meet the criteria and no additional pipes that did not meet the criteria in 2080. A summary of the minor and major climate change results are in Table 8-5 and Table 8-6 with more details of the capacity assessment to be found in Appendix G.

Table 8-5: Storm Sewers Undersized Under 2050 Climate Change

Pipe Size (mm)	Total Length (m)	% of Total System	100-yr Major		10-yr Minor	
			Length Undersized (m)	% of Total System Undersized	Length Undersized (m)	% of Total System Undersized
<200	36	0.2%	0	0.0%	0	0.0%
200	0	0.0%	0	0.0%	0	0.0%
250	171	1.0%	65	0.4%	0	0.0%
300	338	1.9%	49	0.3%	0	0.0%
375	821	4.7%	0	0.0%	105	0.6%
450	5602	32.1%	254	1.5%	664	3.8%
525	2131	12.2%	159	0.9%	338	1.9%
600	3840	22.0%	0	0.0%	504	2.9%
675	696	4.0%	143	0.8%	0	0.0%
750	1556	8.9%	4	0.0%	175	1.0%
900	972	5.6%	0	0.0%	0	0.0%
1050	491	2.8%	0	0.0%	0	0.0%
1200	538	3.1%	0	0.0%	0	0.0%
>1200	264	1.5%	0	0.0%	0	0.0%
Total	**17456**	**100%**	**675**	**3.9%**	**1786**	**10.2%**

Table 8-6: Storm Sewers Undersized Under 2080 Climate Change

Pipe Size (mm)	Total Length (m)	% of Total System	100-yr Major		10-yr Minor	
			Length Undersized (m)	% of Total System Undersized	Length Undersized (m)	% of Total System Undersized
<200	36	0.2%	0	0.0%	0	0.0%
200	0	0.0%	0	0.0%	0	0.0%
250	171	1.0%	65	0.4%	0	0.0%
300	338	1.9%	49	0.3%	0	0.0%
375	821	4.7%	0	0.0%	175	1.0%
450	5602	32.1%	254	1.5%	829	4.8%
525	2131	12.2%	159	0.9%	449	2.6%
600	3840	22.0%	0	0.0%	504	2.9%
675	696	4.0%	143	0.8%	0	0.0%
750	1556	8.9%	4	0.0%	175	1.0%
900	972	5.6%	0	0.0%	0	0.0%
1050	491	2.8%	0	0.0%	0	0.0%
1200	538	3.1%	0	0.0%	0	0.0%
>1200	264	1.5%	0	0.0%	0	0.0%
Total	**17456**	**100%**	**675**	**3.9%**	**2134**	**12.2%**

Climate Change Culvert Capacity Assessment

Culverts in the Blaney, North Alouette and Fraser River watershed were assessed under future conditions with the same criteria as the existing assessment described in Section 7.5. Unmitigated future land use was used in the model in conjunction and a 10% increase to rainfall events to estimate the effect of climate change in 2050 and 20% increase to reflect the effect of climate change in 2080. Under unmitigated future conditions with climate change there are 2 additional culverts that do not meet the assessment criteria in the 2050 scenario and 2 more that do not meet the assessment criteria under 2080 conditions. A brief summary of these culverts are in Table 8-7 and in Figure 8-2, with a more detailed summary in Appendix G.

Table 8-7: Summary of Undersized Culverts Under 2050 Climate Change Conditions

Culvert Size (mm)	Total Number	% of Total Culverts	2050 with Future Land Use Summary	
			Number Undersized	% of Total Culverts Undersized
< 300	0	0.0%	0	0.0%
300 - 524	7	14.9%	5	10.6%
525 - 699	21	44.7%	6	12.8%
700 - 1499	15	31.9%	6	12.8%
1500 - 2000	3	6.4%	1	2.1%
> 2000	1	2.1%	0	0.0%
Total	**47**	**100%**	**18**	**38.3%**

Table 8-8: Summary of Undersized Culverts Under 2080 Climate Change Conditions

Culvert Size (mm)	Total Number	% of Total Culverts	2080 with Future Land Use Summary	
			Number Undersized	% of Total Culverts Undersized
< 300	0	0.0%	0	0.0%
300 - 524	7	14.9%	6	12.8%
525 - 699	21	44.7%	6	12.8%
700 - 1499	15	31.9%	7	14.9%
1500 - 2000	3	6.4%	1	2.1%
> 2000	1	2.1%	0	0.0%
Total	**47**	**100%**	**20**	**42.6%**

Detention Reporting with Future Land Use and Climate Change

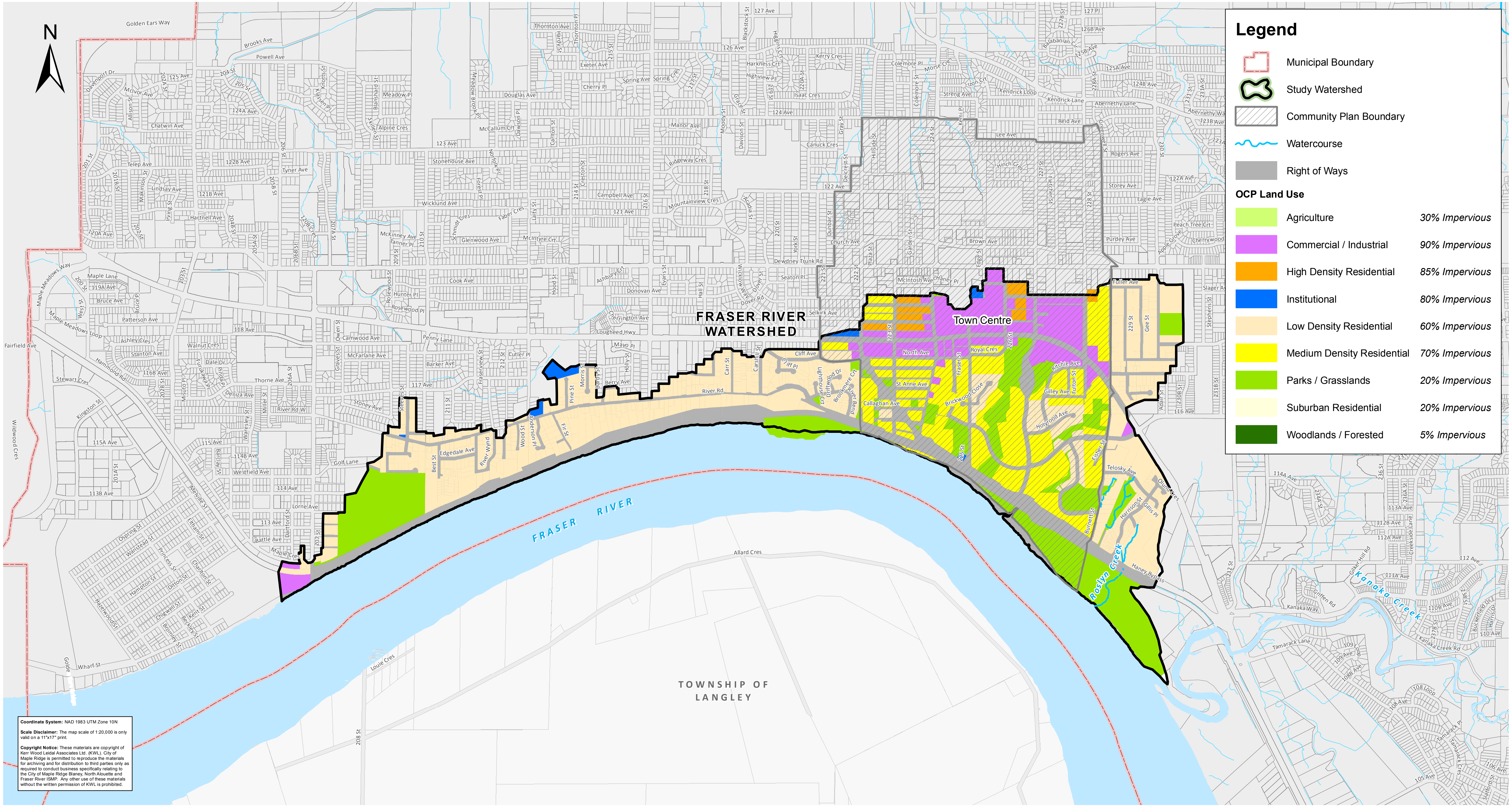
The reporting of the future detention facilities with climate change was completed in the same way as for the existing scenario. A future unmitigated land use scenario was used in the model with a 10% increase to the required detention design storms to represent the effect of climate change in 2050 and a 20% increase to the design storms to represent the effect of climate change in 2080. The increase in rainfall for climate change did result in poorer performance of the detention ponds, as would be expected. A summary of detention pond performance under future land use with climate change conditions is in Table 8-9 and Table 8-10 and can be seen spatially in Figure 8-2. For a more detailed summary of the detention facilities, refer to Table G-14 in Appendix G.

Table 8-9: Summary of the Detention Pond Assessment Under 2050 Climate Change Conditions

Category	Number of Detention Ponds
Adequate volume and water level does not exceed design water level by 10 cm or more, meets criteria	4
Volume approaching capacity (95% capacity used) or design water level is exceeded by 10cm or more, minor adjustments may be required in the future	2
Inadequate volume to meet criteria*	3
*Assessed by water level exceeding the banks of pond.	

Table 8-10: Summary of the Detention Pond Assessment Under 2080 Climate Change Conditions

Category	Number of Detention Ponds
Adequate volume and water level does not exceed design water level by 10 cm or more, meets criteria	0
Volume approaching capacity (95% capacity used) or design water level is exceeded by 10cm or more, minor adjustments may be required in the future	4
Inadequate volume to meet criteria*	5
*Assessed by water level exceeding the banks of pond.	



Legend

▢	Municipal Boundary	
▢	Study Watershed	
▨	Community Plan Boundary	
〰	Watercourse	
■	Right of Ways	

OCP Land Use

■	Agriculture	*30% Impervious*
■	Commercial / Industrial	*90% Impervious*
■	High Density Residential	*85% Impervious*
■	Institutional	*80% Impervious*
■	Low Density Residential	*60% Impervious*
■	Medium Density Residential	*70% Impervious*
■	Parks / Grasslands	*20% Impervious*
■	Suburban Residential	*20% Impervious*
■	Woodlands / Forested	*5% Impervious*

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:20,000 is only valid on a 11"x17" print.

Project No. 173-188
Date July 2017
Scale 1:20,000

OCP Land Use - Fraser River Watershed

Figure 8-1a

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City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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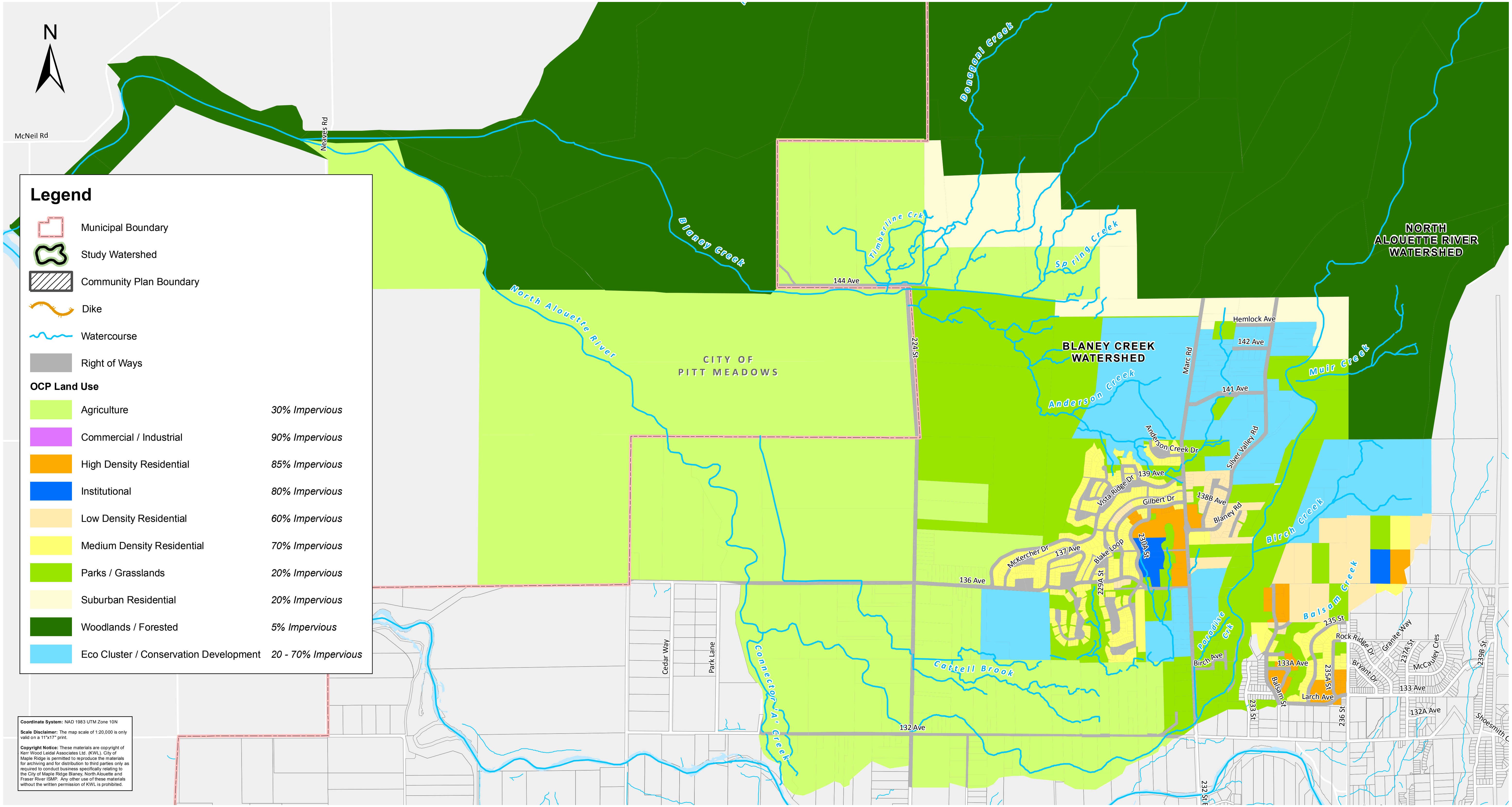
consulting engineers



Legend

- Municipal Boundary
- Study Watershed
- Community Plan Boundary
- Dike
- Watercourse
- Right of Ways

OCP Land Use

🟩	Agriculture	*30% Impervious*
🟪	Commercial / Industrial	*90% Impervious*
🟧	High Density Residential	*85% Impervious*
🟦	Institutional	*80% Impervious*
🟨	Low Density Residential	*60% Impervious*
🟨	Medium Density Residential	*70% Impervious*
🟩	Parks / Grasslands	*20% Impervious*
⬜	Suburban Residential	*20% Impervious*
🟩	Woodlands / Forested	*5% Impervious*
🟦	Eco Cluster / Conservation Development	*20 - 70% Impervious*

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:20,000 is only valid on a 11"x17" print.

Project No. 173-188
Date July 2017
Scale 1:20,000

OCP Land Use - Blaney Creek / North Alouette River Watershed

Figure 8-1b

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\Draft_Final\173188_Fig8-2_UndersizedFutureLandUse.mxd Date Saved: 8/17/2020 11:52:37 AM | Author: BWhitehouse

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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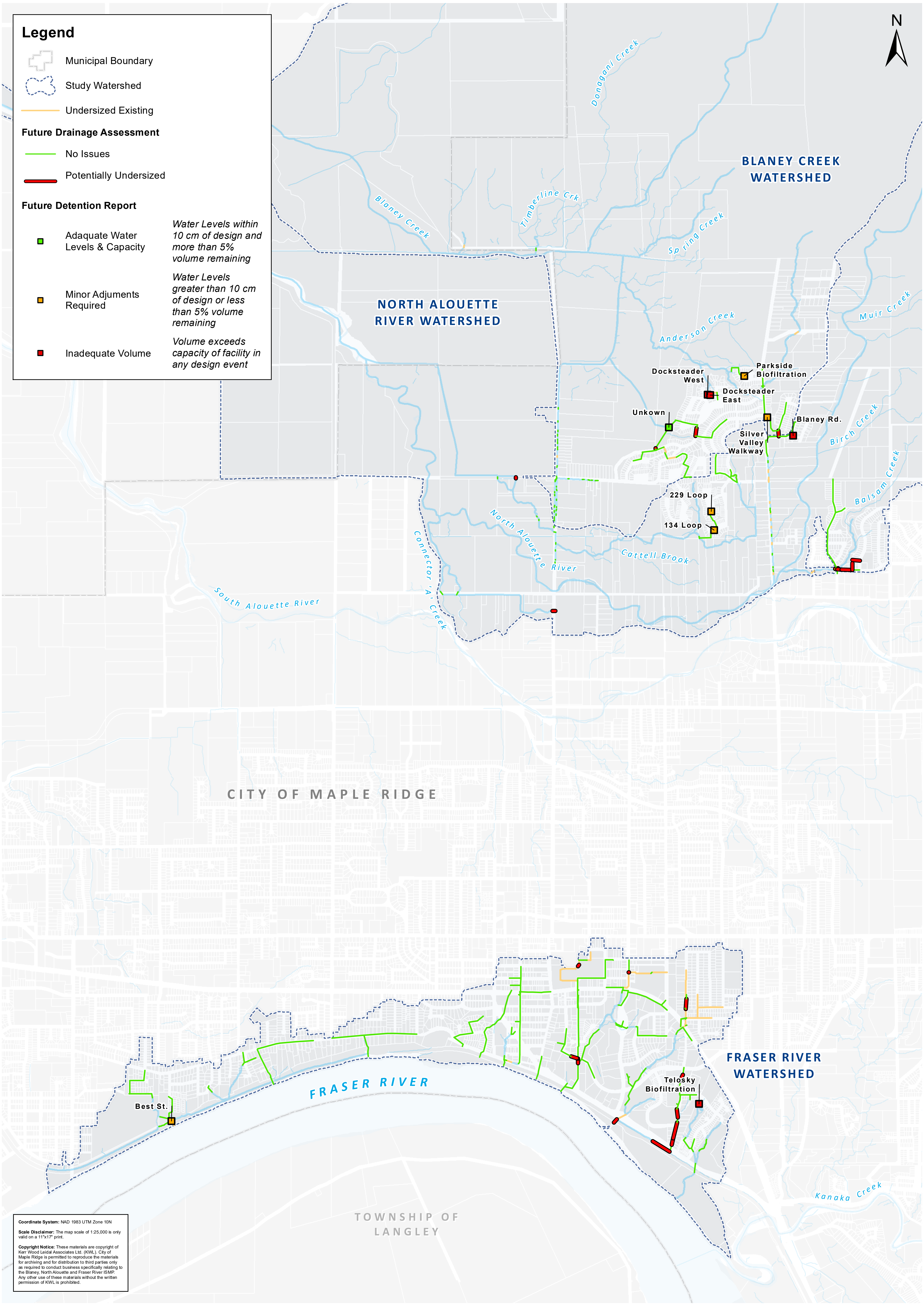
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:25,000 is only valid on a 11"x17" print.

Project No. 173-188

Date August 2020

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1:25,000

Potentially Undersized Future Infrastructure

Figure 8-2

9. Watershed Health Analysis

The health of a watershed is estimated based on the Watershed Health Tracking System (WHTS) from the ISMP Template. The WHTS is a tool for assessing watershed health based on measuring three characteristics of any given watershed:

1. Impervious area coverage i.e., total impervious area (TIA) as a percentage (%);
2. Riparian forest integrity (RFI) as a percentage (%); and
3. Benthic Index of Biological Integrity (B-IBI) – which assesses the diversity and abundance of creek bed taxa.

These are discussed in the following subsections.

9.1 Impervious Coverage of the Watersheds

The impervious coverage of the watersheds was estimated in the Phase 1 work as part of the land use analysis. The TIA percent impervious area for the existing conditions was estimated based on land use and air photo information. The TIA values used for the WHTS differ slightly from those presented in the Stage 1 reporting as the calculations were revised to be consistent with the watershed areas used for calculating RFI and/or for benthic sampling. The TIA values used for WHTS for each of the watersheds are shown in Table 9-1.

The future TIA values were developed based on the future conditions (OCP) land use analysis of future that determined future TIA as discussed in Section 8.1.

9.2 Existing Riparian Forest Cover Assessment

Watershed forest cover was mapped using high-resolution orthophotos provided by the City (2011, 2015 and 2016) and ESRI orthophoto base mapping for areas not covered by the City orthophotos. Riparian forest cover was calculated by including all forest cover within 30 m of the centreline of each stream.

In Phase 1 of the ISMP, the calculations of watershed forest cover and Riparian Forest Integrity (RFI) were calculated based on the total area and stream length of the within each watershed, and varied from low in the Fraser tributaries watershed to high in the North Alouette River watershed. The North Alouette River watershed had the highest watershed forest cover (82.1%) and RFI (61.6%) of the three watersheds. Blaney Creek watershed also had a high watershed forest cover (73.3%), but a lower RFI (45.6%). Both of these watersheds have large tracts of forest in their upper watersheds, within the Malcolm Knapp Research Forest, but much of the riparian forest in their lower reaches has been lost. The Fraser River watershed has lost most of its forest cover, and has a very low RFI of 12.0%.

Table 9-1: Watershed Forest Cover and Riparian Forest Integrity

Catchment	Total Area (ha)	Watershed Forest Cover		Riparian Forest		
		(ha)	(%)	Buffer Area (ha)	Forested Area (ha)	Integrity (RFI) (%)
North Alouette River	4072	3344	82%	231	142	62%
Blaney Creek	2558	1876	73%	203	92	46%
Fraser River	3602	83	23%	203	24	12%

To use the RFI metric in the WHTS, the RFI was in several cases re-calculated to account for variations based on sub-watershed (e.g., Anderson Creek as opposed to the larger watershed of Blaney Creek) and the exact boundary of the watershed to the point where B-IBI was measured. In addition, while the entire Fraser River catchment was evaluated in Phase 1, it was felt inappropriate to use that aggregate value for the WHTS, so the RFI was calculated for the Fraser River tributary on which water quality sampling was done. The new results for RFI are shown below in Table 9-2.

9.3 Watershed Health Tracking System

The results for these key watershed health indicators are summarized in Table 9-2, Table 9-3, and Figure 9-1.

Table 9-2: Watershed Health Indicators

Watershed	Existing RFI (%)	Existing TIA (%)	Existing B-IBI*
Anderson Creek – Upstream of hydrometric station	82	15	37.4
North Alouette River – Upstream of 232 St. bridge	89	1	24
Fraser River Tributary – Entire sub-catchment	51	57	Not measured
Balsam Creek – Upstream of confluence with North Alouette	87	22	Not measured
Cattell Brook – Upstream of confluence with North Alouette	52	28	Not measured
Blaney Creek – Maple Ridge only	54	13	Not measured
* Only 2 B-IBI measurements were made as this is the minimum required to meet the MAMF guidelines of one measurement per watershed; No B-IBI sampling was done in the Fraser River watershed as the channels are not natural creeks and the B-IBI rating system cannot be applied for those locations.			

Table 9-3: Theoretical Watershed Health Based on Imperviousness

Watershed Health	Watershed Impervious Area
Stressed (minor changes to watershed health)	1 – 10%
Impacted (moderate changes to watershed health)	11 – 25%
Degraded (severe changes to watershed health)	26 – 100%
Reference: Schueler (1994)	

The study watersheds have a range of values for TIA and RFI, indicative of the differences between some of the smaller creeks which are more impacted by the level of development within their watersheds, and the larger watersheds which have significant undeveloped land area.

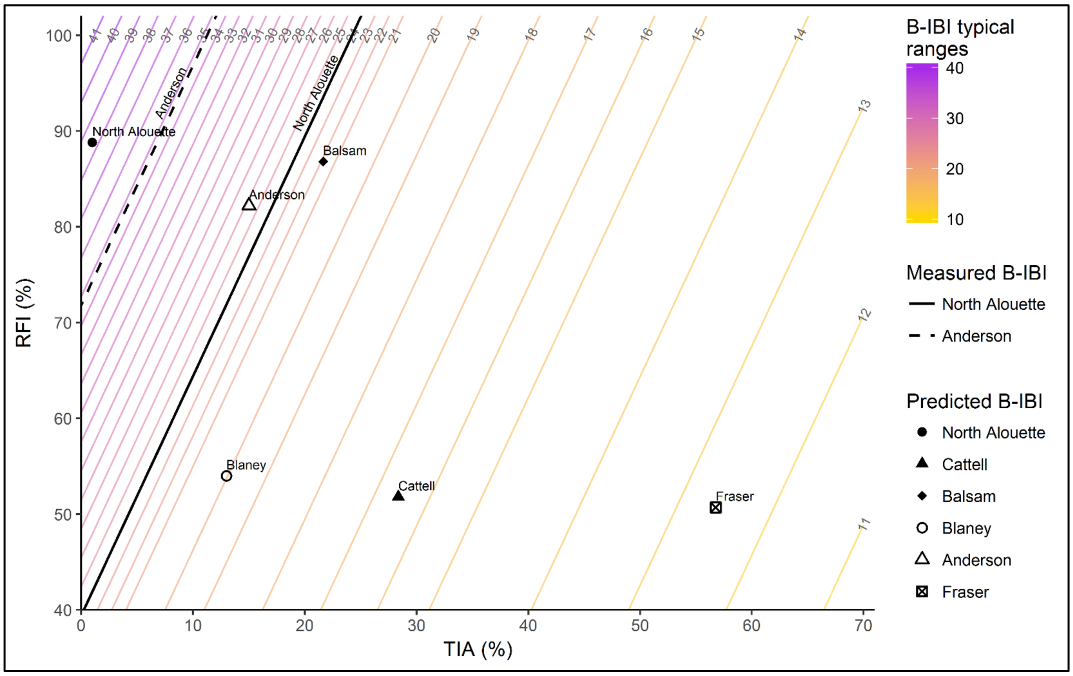

Figure 9-1: Watershed Health Tracking System for ISMP Study Creeks and River

The WHTS tool categorizes watershed health: the higher the riparian forest integrity and the lower impervious coverage, the higher B-IBI scores should be, and the better the watershed health. Generally, as the impervious coverage in a watershed increases and the riparian forest cover decreases, the health of a watershed degrades, and the B-IBI score decreases as well.

The B-IBI scores for both Anderson Creek and North Alouette River indicate relatively healthy watersheds. However, it is interesting that the B-IBI value for Anderson Creek is higher than is predicted by the watershed TIA and RFI. While it is difficult to ascertain exactly why, this may suggest that stormwater source controls used in the Silver Valley developments in this watershed have been effective at offsetting at least some of the impacts of that development. On the other hand, the measure B-IBI for the North Alouette River is lower than is predicted by the watershed TIA and RFI. There are undoubtedly many contributing factors to this discrepancy as well, but two things, in particular, may be significant:

1. The North Alouette watershed is a larger watershed than most that were used to develop the WHTS relationships and it may not fit very well into that model.
2. There may be conditions other than TIA and RFI that are impacting the benthic organisms in the North Alouette River, such as active logging in the upstream watershed, or pollutant sources such as forestry roads that are not reflected accurately in the TIA and RFI measurements.

Impacts of Future Development

If future increases in impervious area are not mitigated, the watershed would be expected to become further impacted. Changing riparian forest cover also affects the health of a watershed, though with the City of Maple Ridge's Watercourse Protection Development Permit, which stipulates a 30 m riparian setback, it is expected that the existing riparian forest cover will be largely protected from future development. This level of riparian protection is noted as a significant benefit toward preserving water health for the future. The goal of the ISMP is to provide a plan that allows for development but provides for mitigation and enhancements such that watershed health would be maintained. Figure 9-2 illustrates that future development (increasing impervious area and decreasing forest cover), if unmitigated, would be expected to reduce the watershed health as evaluated by the B-IBI. The predicted future value is only shown for the two creeks for which B-IBI was measured.

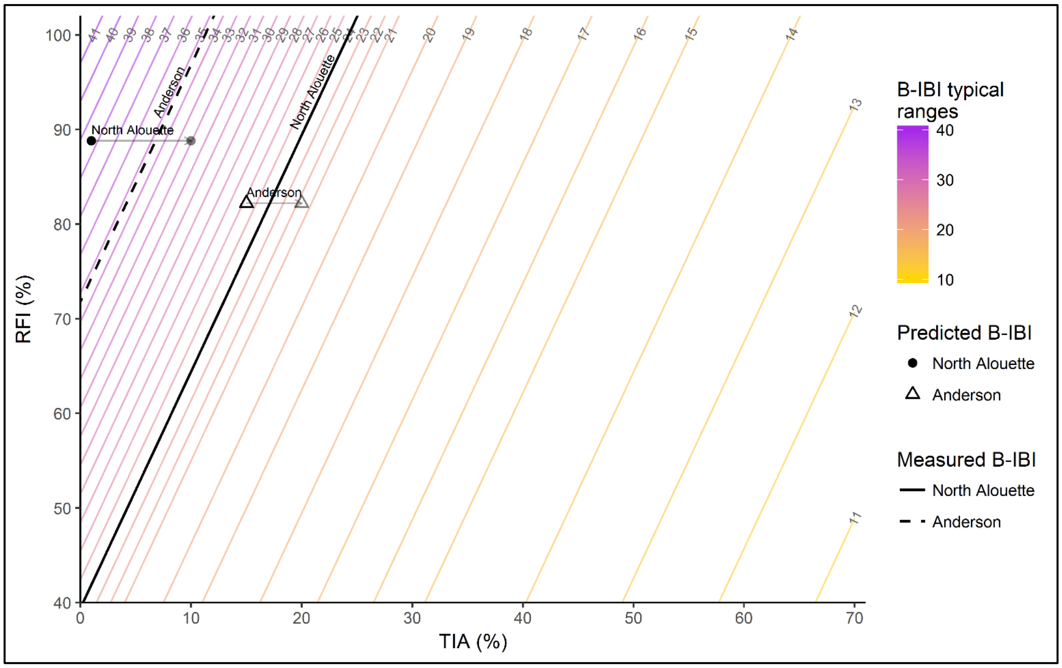

Figure 9-2: Predicted Future Values for Watershed Health Tracking System If TIA not Mitigated

10. Mitigating Impacts of Development

Increased impervious cover in developed areas leads to increased peak flows and runoff volumes as well as introduction of pollutants, which can adversely impact the health of watersheds through increased risk of flooding, erosion, and impaired water quality. Impaired watershed health occurs at low levels of imperviousness: at 10% imperviousness biodiversity and abundance is affected and at 30% imperviousness urban watersheds in the Pacific Northwest cannot sustain abundant populations of cold-water fish. The effects of development on the flow regime and overall watershed health is illustrated in Figure 10-1.

10.1 Sustainable Practices to Manage Runoff

Sustainable stormwater management should create conditions to mimic nature's way of managing rainfall, with the goal to mitigate impacts on the health of streams, lakes and aquatic life. The objectives of stormwater management may include, among other things, flood mitigation, erosion control, disconnecting impervious areas, increased groundwater recharge, removal of pollutants and restored stream hydrology. Sustainable stormwater systems include many different types of measures to achieve these goals, from on-lot control features to end-of-pipe large-scale solutions. The sustainable management of stormwater is characterized by source control using infiltration as far as possible, followed by detention and retention near the source, delayed or slowed conveyance with reduced runoff rates, and finally regional practices with large flow capacities and storage volumes.

Source controls play a key role in managing 2-year (MAR) storms and smaller rain events, but additional stormwater infrastructure must be provided to safely convey stormwater for the larger events. For stormwater quality improvement, the same system approach should be implemented; from source control to end-of-pipe using multiple practices. Stormwater management practices benefit from different processes to reduce stormwater volumes and/or peak flows, e.g. infiltration, evapotranspiration and retention/detention, and to remove pollutants, e.g. filtration, sedimentation, plant uptake, microbial degradation and sorption. Therefore, mitigation of adverse stormwater effects is more effective when several processes are achieved in a single management practice, or even better when several practices are used in combination.

Stormwater retrofits provide stormwater management in developed areas where management practices are lacking or are inadequate. Retrofits include both new installations and upgrades to existing technologies.

Practices to Manage Tier A Events

As defined in the CMR *Design Criteria Manual* (see Table 4-2), Tier A mitigation should address 2-year return period events, meaning that 90% of the average annual rainfall should be captured and infiltrated, evapotranspired or re-used at the source.

Tier A events should be mitigated with on-lot and on-street source control techniques with the purpose to reduce the quantity of stormwater. Source control technologies to manage Tier A events include for example rain barrels and tanks, permeable pavements, infiltration trenches and bioretention facilities.

In the Fraser River Escarpment Area, stormwater retrofit techniques must not rely on infiltration to the groundwater system to handle Tier A events as additional water could destabilize the escarpment slopes. For areas that drain directly to the Fraser River without draining to one of the small ephemeral streams on the escarpment, Tier A and B do not need to be required as the increases in volume and rate of flow would not impact the Fraser River. Only water quality treatment should be required in these areas. However, for areas of the escarpment that drain to the ephemeral small streams, Tier A and B should be met via non-infiltrative methods. Rain barrels, tanks and green roofs can be used for temporary storage of stormwater to reduce peak runoff and runoff volumes. Practices such as permeable pavement and trenches can be constructed with an impermeable liner and an underdrain, to avoid infiltration to the native soil while providing temporary storage before discharge into the stormwater sewer system.

Rain barrels and cistern tanks can collect rainwater to be reused or slowly drained, providing some of the same benefits as infiltration. Rain barrels and tanks collect a relatively small volume compared to the runoff volume from a roof during larger rain events and are most efficient for Tier A events. Collected stormwater is mainly reused for residential irrigation purposes and car washing. More advanced rain harvesting systems with treatment could lead to alternative uses including toilet flushing, ornamental water features, arena ice making, fire fighting, and industrial uses.

Green roofs consist of vegetation and a growing medium, planted over a waterproof membrane to protect the building from water and roots. Extensive green roofs with a lightweight thin layer of growing medium (approximately 50-150 mm) is suitable for retrofit projects on existing buildings. Intensive green roofs have deeper growing media to allow for shrubs and trees to grow and are usually accessible. Because of the added weight, intensive green roofs are mostly used for new construction. Green roofs help delay and reduce peak flows and decreases runoff volumes through retention of water in the growing medium and subsequent evaporation. Extensive green roofs retain approximately 50-75% of the annual precipitation and can only reduce peak flows until saturated, hence complementary facilities are needed to mitigate Tier A and B events.

Permeable paving allows stormwater to drain through the surface material into an underlying stone reservoir, where it infiltrates into the underlying native soil or is removed by a subsurface drain. Permeable paving is beneficial in highly developed areas as the method does not require additional land. It can be used on parking lots, sidewalks, pedestrian walkways and plazas, biking trails, and low-volume roads such as emergency access lanes.

Infiltration practices such as dry wells and infiltration trenches are subsurface facilities that temporarily store and infiltrate stormwater. Runoff is stored in an excavated pit backfilled with coarse stone aggregate. The water is further infiltrated into the surrounding naturally permeable soil while excess water is conveyed to other practices or to the drainage system, e.g. through an underdrain (optional in areas where the natural soils have high infiltration capacity). Infiltration practices can significantly reduce both peak stormwater flows and volumes and may also provide a reduction in pollutant loads. Infiltration practices can also be designed for mitigating larger storm events (Tier B and C events) for detention and rate control.

Bioretention systems, also called engineered rain gardens and bio-swales, provide the same benefits of infiltration and add additional benefits of:

- Water quality treatment by filtration through growing media soils, and
- Flow attenuation in ponding above the planted surface of the facility.

Practices to Manage Tier B and C Events

Tier B mitigation should control runoff from larger events through detention and release to watercourses or drainage systems at a controlled rate. Typically, these events are to be managed through detention in combination with infiltration and exfiltration. Control technologies for Tier B events include for example detention facilities such as dry and wet ponds, roof top storage, and underground tanks, infiltration facilities (see Tier A events), exfiltration trenches, vegetated bio-swales, and bioretention.

In the Fraser River Escarpment Area where infiltration is not acceptable, underground concrete vault structures or rigid (plastic, steel, or aluminum) pipes with capped ends provide retrofit opportunities for management of Tier B or C events where required. Water stored in the underground structures is released to a storm sewer or receiving stream at rates designed to reduce peak flows. The underground systems can be installed under parking lots, roads, and other paved surfaces in commercial, industrial, and residential areas. In the Escarpment Area, facilities such as swales and bioretention can be constructed with an impermeable liner and an underdrain to avoid infiltration into soil.

Practices for mitigation of Tier C events should reduce flooding by providing sufficient hydraulic capacity to contain and convey runoff from extreme storms exceeding the MAR. Tier C is separated into the minor (control of 10-year events) and major (conveyance of 100-year events) system: the minor system can include drainage facilities similar to those designed to manage Tier B events, whereas the major system comprises all drainage routes that are designed to convey runoff from the 100-year event.

Exfiltration trenches consist of a perforated or slotted pipe located within an excavated trench filled with coarse gravel. The system provides storage for runoff during a storm event and allows water to percolate through the gravel envelope into the surrounding soil. By attenuating runoff volume, exfiltration trenches may also reduce pollutant loads in stormwater. Exfiltration systems can be used in place of conventional storm sewer pipes, i.e. requiring a minimal surface footprint, in places where infiltration is possible. They are suitable for mitigating runoff from roofs, walkways, parking lots and low-to medium traffic roads, but should be used with pre-treatment for runoff from pollutant-generating surfaces such as roads and parking lots.

Vegetated swales are designed with gently sloping sides to convey stormwater at a slower, controlled rate. Swales can provide storage and attenuate peak flows, reduce runoff volumes through infiltration and evapotranspiration, and improve water quality mainly through sedimentation and filtration of particles. Swales can be incorporated in most development situations and as swales are linear features, they are ideal for management of runoff from highways, residential roads and common areas in residential sub-divisions, and parking lots. Also, existing drainage ditches can be retrofitted to swales. Swales need to be sized properly for the underlying soils and the contributing impervious area in order to function correctly.

Bioretention, including practices such as rain gardens, bioswales, and planters, are shallow landscaped depressions, based on engineered soils (growing medium) and native plants, that mimics a vegetated ecosystem to reduce peak runoff through ponding, infiltration and slow release into sewer system. Through evapotranspiration, and if infiltration into native soil is allowed, bioretention may also lead to reduced runoff volumes. Physical, chemical and biological processes of soil and plants are effective for improving stormwater quality. Bioretention systems have a flexible layout and can be applied to a wide range of development, from small, individual lots to large areas divided into multiple small drainages. The systems are well-suited for highly impervious areas and can be applied in new development, redevelopments and retrofits.

Dry ponds are vegetated depressions designed to temporarily store runoff on the surface and either release it at a controlled rate through an outlet (i.e. *detention pond*) or infiltrate it gradually into the ground (called *infiltration basins*). Dry ponds are ideal for managing larger storm events and are primarily designed to control peak flows. To some degree, dry ponds may also improve water quality by allowing sediment and pollutants to settle out at the bottom. Dry ponds can be located at the end of the treatment train to accommodate occasional excess overflow of other stormwater management practices. Dry ponds require larger areas than many other stormwater facilities and may be difficult to implement in highly urbanized areas. However, they are only filled temporarily during and after heavier storms, and dry ponds can therefore be integrated into the landscape as useful, accessible public space, for example a playing field or other green recreational spaces.

Wet ponds, or *retention ponds*, provide temporary storage for excess water in a permanent pool. Wet ponds can provide both attenuation of peak flows and water treatment, although water volumes are not reduced. The retention time promotes pollutant removal mainly through sedimentation. Wet ponds are end-of-pipe solutions, used when upstream opportunities for source control and infiltration have been fully employed. Their use is limited in highly urbanized areas because of their large footprint.

10.2 Using Green Infrastructure for Stormwater Management

Green infrastructure is an integral part of sustainable stormwater management but is also a concept that goes far beyond stormwater. The concept often includes various aspects of urban planning where natural systems, or engineered systems that mimic natural systems, are used to promote ecosystem services in urban landscapes, including climate change adaptation, pollution abatement, increased biodiversity, heat island reduction (energy and greenhouse gas savings), and improved human health and well-being.

Green infrastructure for stormwater management should create conditions to mimic nature's way of managing rainfall, with the goal to provide ecosystem services such as flood mitigation, erosion control, pollution reduction, and groundwater recharge. Green infrastructure includes both:

- structural stormwater management practices, such as infiltration facilities, bioretention and green roofs, and
- non-structural approaches such as minimizing impervious areas and increasing urban forests and retaining trees.

The City of Vancouver is an example of a municipality that is prioritizing green infrastructure in development and redevelopment conditions. Vancouver adopted the Rain City Strategy in late 2019 to provide direction and policies that emphasize the use of green infrastructure to benefit hydrology and provide all the social and environmental benefits discussed above.

The co-benefits of green infrastructure solutions should always be considered as part of the cost-benefit discussion for development approaches and servicing. Consideration of all of the benefits of green infrastructure makes additional expense for green infrastructure justifiable from a public, taxpayer and end user perspective.

This is of concern for urban areas where additional green space and biodiversity can make a large difference to the environmental systems and the quality of life for residents in the urban context. Recent studies have even assessed a benefit to children's development from increased availability of green space in an urban context[15]. In light of this, preservation of existing green spaces should always be a consideration, even within the Town Centre and within areas already planned and zoned for development, as the same amount of green space lost in an urban area may represent a higher fraction of the neighbourhood green space vs. that amount in a suburban or rural context.

While greenfield development has the advantage of starting with much more green space potential, essentially all of the development in a greenfield context has impacts on the watershed. In the greenfield context, green infrastructure and sustainable stormwater management practices provide means of reducing the impacts and environmental losses in the watershed. The use of green infrastructure in greenfield development supports a long-term approach to watershed health in preserving as much of the natural systems as possible in the landscape where they would naturally occur.

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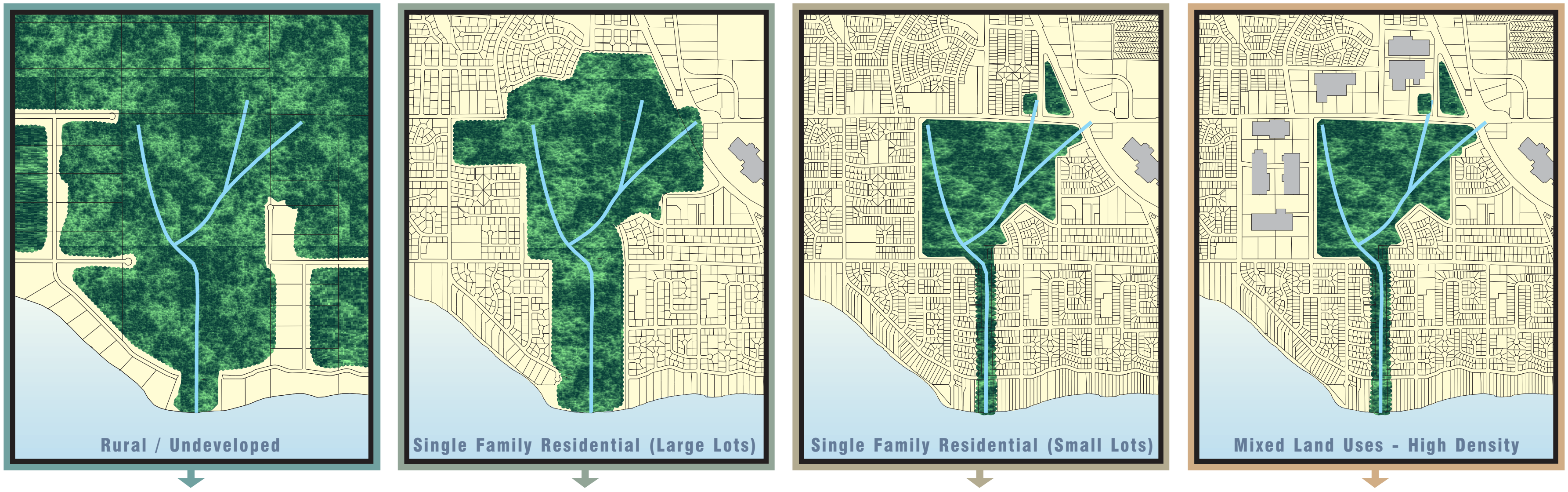
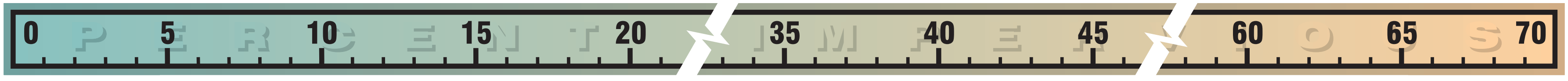
[15] https://www.theguardian.com/environment/2020/aug/24/children-raised-greener-areas-higher-iq-study

STORMWATER IMPACTS OF INCREASING URBANIZATION

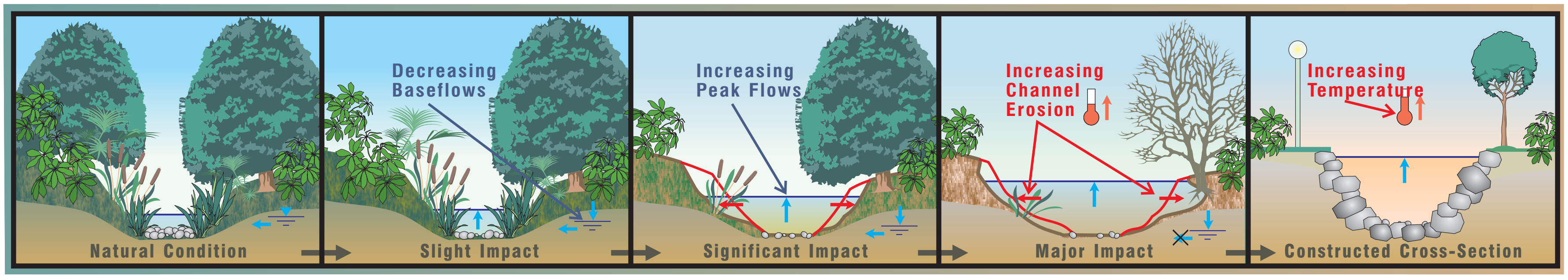
INCREASING URBANIZATION (NO BEST MANAGEMENT PRACTICES)



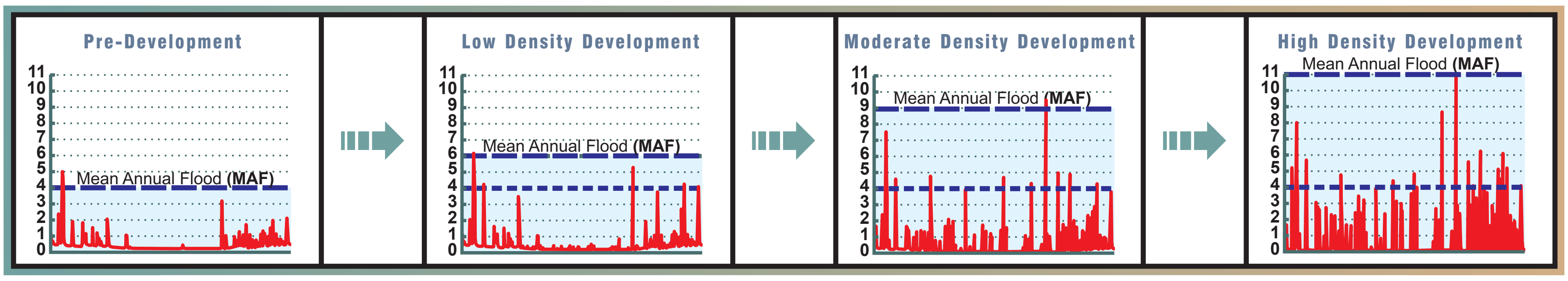
PROPORTION OF IMPERVIOUS LAND AREA (%)



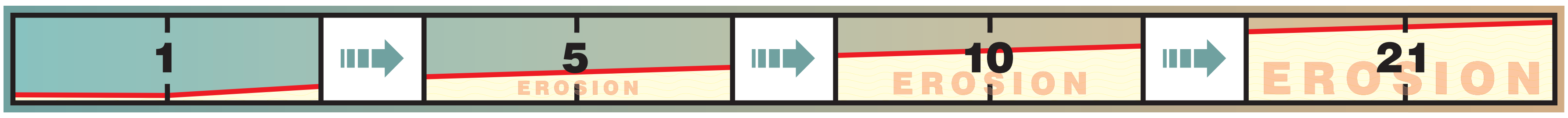
EFFECT ON WATER QUALITY AND AQUATIC HABITAT



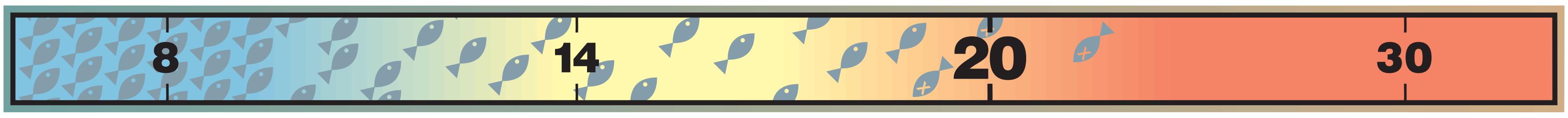
EFFECT ON TYPICAL YEAR HYDROGRAPH



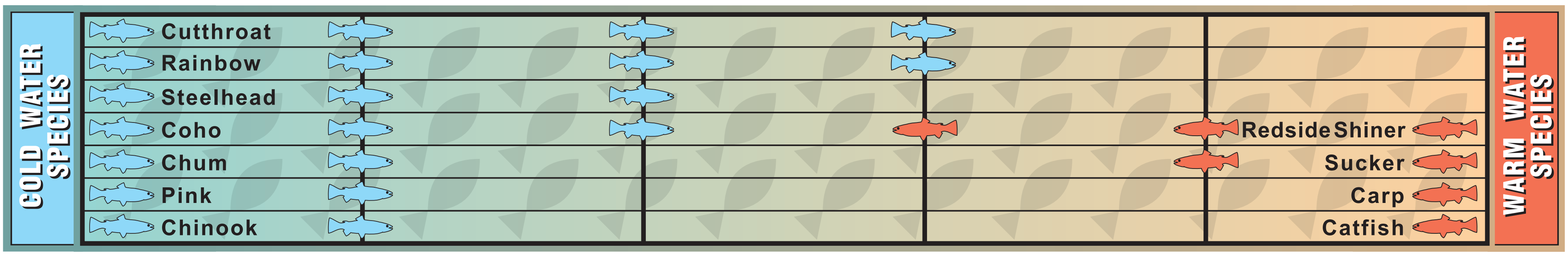
NUMBER OF STORM EVENTS AT OR ABOVE PREDEVELOPMENT MEAN ANNUAL FLOOD



RATIO OF MEAN ANNUAL FLOOD TO WINTER BASE FLOW



EFFECT ON DIVERSITY AND ABUNDANCE OF THE FISHERIES RESOURCE



EFFECT ON BIOTIC INDICATORS FOR BENTHIC ORGANISMS

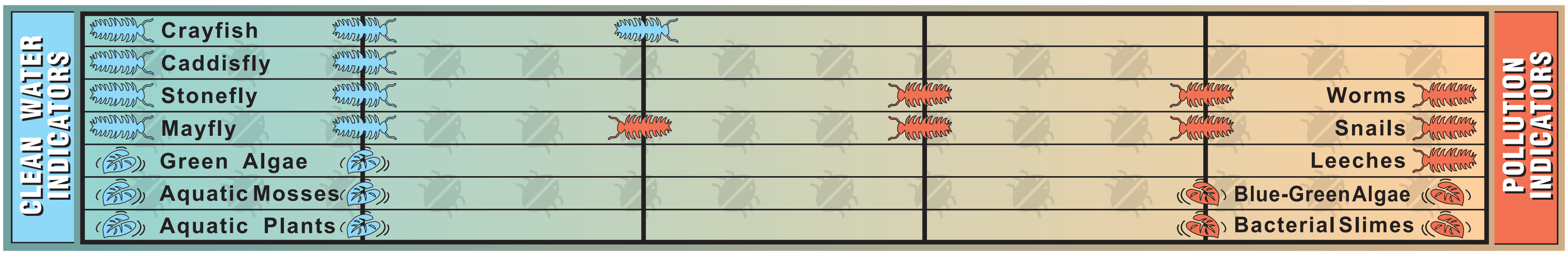


Figure 10-1

10.3 Stormwater BMP Types for Reference

Low Impact Development Practices

Low Impact Development (LID) is a design with nature approach that reduces a development's ecological footprint. LID concepts embodied at the planning stage, often affords more opportunities to reduce the overall negative effects of development and reduce costs. Requirements for expensive traditional stormwater infrastructure may also be reduced as less runoff will be generated.

There are many best management practices (BMPs) commonly used in LID, however it is not always possible to incorporate all of them into a development, and even with adoption of all available LID options, there will still be changes to the hydrologic regime relative to the pre-development conditions and some additional measures or facilities will often be required. LID practices are most effective in mitigating adverse stormwater effects when used in combination with other BMPs, such as constructed source controls and detention. The *Puget Sound Action Team's LID Technical Guidance Manual*[16] is an excellent resource for LID planning and design.

Reduced Road Widths

Traditional road pavement widths may be larger than they need to be, particularly for streets that are residential access only, and not thoroughfares. Road widths can be narrowed to a minimum that allows necessary traffic flow, but that discourages excess traffic and excess speed, both of which are beneficial in a family- and pedestrian-oriented neighbourhood. Road widths do, however, need to meet the community's needs for utility and emergency vehicle access and these requirements will often determine acceptable minimum road widths.

Reduced Building Footprints

Building footprints, and impervious roof area, may be reduced without compromising floor area by increasing building height. This also allows greater flexibility to develop layouts that preserve naturally vegetated areas and provide space for infiltration facilities. Some relaxation of building height restrictions may be necessary to allow this type of design.

Reduced Parking Standards

Reducing the required number of parking spaces for a development reduces the impervious area and encourages pedestrian and public transit-friendly communities. Reducing the required parking spaces also reduces development costs.

Limiting Surface Parking

Limiting surface parking and restricting parking to below building roof areas, also directly reduces the impervious area in a development.

Pervious Parking Surfaces

Use of pervious paving materials rather than impervious concrete or asphalt can reduce the runoff generated from parking areas. Pervious materials may include pavers, reinforced clean crushed gravel, reinforced turf, or engineered permeable pavements.

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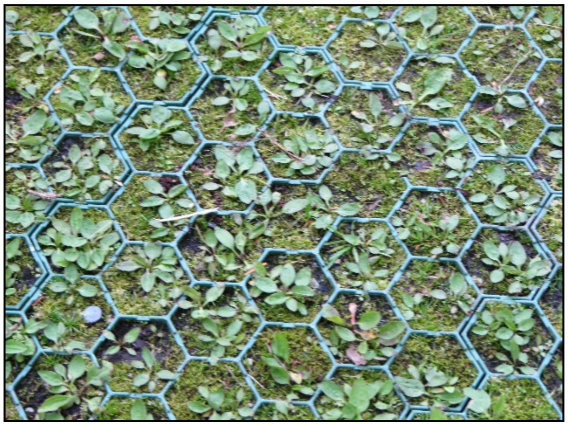
[16] Low-Impact Development Technical Guidance Manual Puget Sound, 2005. http://www.psparchives.com/our_work/stormwater/lid.htm

Reinforced Clean Crushed Gravel



Geogrid

Building Compact Communities

A complete and compact development plan preserves more natural watershed features and significantly reduces imperviousness. In some cases, compact communities have up to 75% less roadway pavement per dwelling unit, and parking needs are reduced because local services are more accessible by pedestrians and via public transit.

Preserving Naturally Significant Features

Preservation of natural areas in a watershed is always an important consideration, which can provide recreational as well as environmental benefits but some natural areas perform special aquatic ecosystem functions and as such are vital to maintaining watershed health. These areas, which include riparian forests, wetlands, floodplains and natural infiltration depressions with highly permeable soils, are particularly important to inventory and protect from alteration.

Stormwater Source Control Technologies

Stormwater source controls reduce the runoff that is discharged to the stream network by managing the water balance at the site level. Source controls play a key role in achieving Rainwater Management Criteria for volume reduction, water quality treatment, and runoff control and can be very effective at reducing runoff volumes and peak runoff rates from events smaller than the 50% of 2-year storm. Though they do provide some flow-detention benefits for the 2-year storms, source controls have limited ability to reduce peak runoff rates from large storms and must be designed with adequate overflow capacity. Additional stormwater infrastructure must be provided to safely convey stormwater off-site for the larger events.

Several standard source control technologies are described below. The *Metro Vancouver Stormwater Source Control Design Guidelines*[17] is an excellent reference for source control BMP design advice.

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[17] Metro Vancouver, Stormwater Source Control Design Guidelines, 2005 http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm

Absorbent Landscaping

Absorbent Landscaping

Absorbent Landscaping

Natural topsoil is generally permeable. The vegetation on topsoil provides a layer of organic matter which is mixed into the soil by worms and micro-organisms, creating voids, which allow rain water to percolate through, and making the soil more structurally capable of providing storage in the void spaces when saturated.

Standard construction practice is often to strip the existing topsoil, compact or excavate a site surface to the desired grade, and then cover it with a thin layer of imported topsoil. Although lawns and other ornamental landscaping will establish a vegetated surface, both the original surface and subsurface flows and storage capacities have been altered and surface runoff will be increased. Instead of stripping and removing original topsoil it should be stored and replaced on the site and augmented with organic matter and sand to improve soil structure and increase macropore development.

To increase absorbency, surface soils should have a minimum organic content to facilitate plant growth and a soil depth sufficient to meet the 50% of 2-year rainfall capture target. Increased soil depths also provide retention for runoff from adjacent hard surfaces. Surface vegetation should include herbaceous groundcovers with a thickly matted rooting zone, deciduous trees, or evergreens.

Some maintenance over the long term is required for the absorbent landscape to continue to provide stormwater benefits. Maintenance activities may include replacing soils that have eroded and replanting dead or dying vegetation.

Surface Infiltration Facilities

Rainfall runoff is stored at or near the surface in a layer of absorbent soil, sand, gravel, or rock, and/or on the ground surface in a ponding area. The stored runoff that infiltrates into the soil becomes interflow and augments groundwater in the sub-surface.

Surface infiltration facilities can look like normal vegetated swales or ponds, and can be aesthetically landscaped and integrated into the design of open spaces. They include bioretention facilities and rain gardens. Both surface and sub-surface infiltration facilities can be effective at the lot level, as well as at the neighbourhood level, where individual lot sizes or layouts don't support on-lot facilities or where more permeable soils or groundwater recharge areas are located off-site. Surface infiltration facilities can, depending on their design, provide some level of water quality treatment as well.

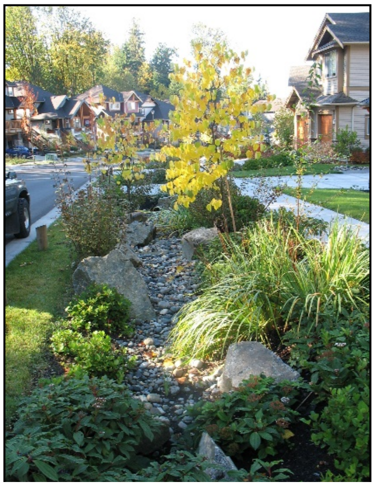
Surface infiltration can be combined with detention, where the detention release rate allows sufficient time for infiltration through the pond. Infiltration facilities are highly dependent on the hydrologic properties of the sub-surface soils.

Surface infiltration can also be promoted by the used of permeable pavers or other pervious surfacing materials.

Bio-Retention Facilities

If infiltration rates are low, such as is likely in clay and till soils, bio-retention facilities can be designed to store the volume reduction target in soil and rock trench voids and infiltrate it slowly over time.

Where applicable, a retention facility may also be designed as a baseflow augmentation facility that retains the design capture volume in a tank or pond and releases it at baseflow rates. These rates are very low, and are based on measured summer baseflows in a watercourse divided by the contributing watershed area, and then applied to the area of the site contributing runoff. Baseflow augmentation facilities discharge the capture volume to the downstream stormwater system or watercourse at a maximum of the determined baseflow rates. Any volumes above the capture volume must be allowed to bypass the baseflow augmentation facility.



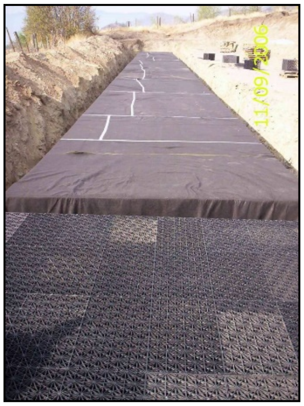
Bio-Retention Swale

Bio-Retention Swale

Sub-surface Infiltration Facilities

A similar design process is used for sub-surface infiltration as for surface infiltration facilities. The main advantage of sub-surface facilities is that they often have vertical walls and do not require as much dedicated ground area, allowing them to be located beneath paved impervious areas.

Sub-surface facilities must be located at least 0.5 m above the level of the seasonal high water table so that they can discharge through the sides and bottom of the structure and will not merely store infiltrated groundwater. Generally, the deeper an infiltration facility is located, the less-effective it will be. Subsurface infiltration facilities can be as simple as a trench filled with clean, free-draining rock that is protected from soil by a permeable membrane. There are numerous open-chamber products available commercially for subsurface infiltration as well.



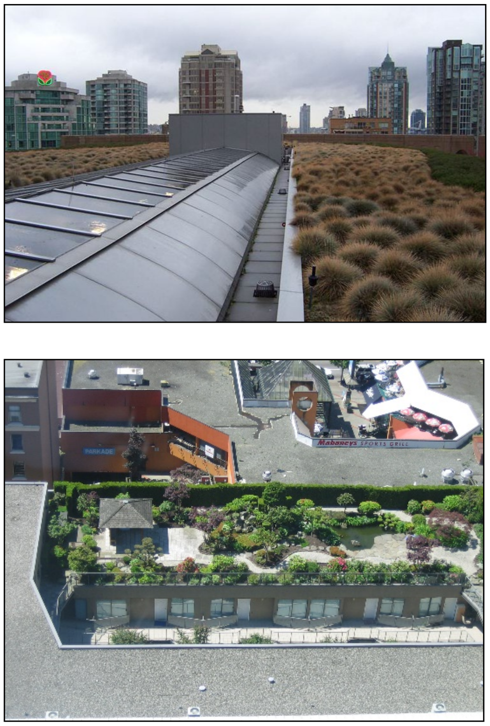
Sub-Surface Infiltration

Green Roofs

Installing a green roof rather than a conventional impervious roof can significantly reduce the volume and rate of runoff from a building lot particularly for the smaller, more frequent storm events.

A green roof is essentially a roof with a layer of absorbent soil and vegetation on top of a drainage collection layer or system. Rainfall is absorbed or stored by the soil and vegetation for later evapotranspiration. The green roof has a limited storage capacity, so any excess rainfall percolates through and is collected by a drainage system. The excess rainfall is then routed to the ground for detention and conveyance.

Green roofs are more expensive to build as they have structural costs as well as landscaping costs and do require maintenance to ensure their ongoing functionality. However, when compared with land costs for alternate facilities in high density urban areas, the costs for a green roof may be favourable. Green roofs also have other benefits, in addition to stormwater benefits, that can include heating or cooling cost savings by insulating the building, aesthetic benefits, air quality benefits, and reduced solar gain that decreases the urban heat island effect. Green roofs should only be designed and constructed by qualified professionals as structural engineering, building envelope and landscape design as well as stormwater engineering are all critical components. Green roofs are the preferable source control in areas where ground surface controls are not possible. For more information on green roofs readers are referred to the *Green Roofs for Healthy Cities* website.



Green Roof

Rainwater Re-use

Rainwater re-use is commonly afforded by residential rain barrels which are effectively retention facilities for roof runoff. Limitations of rain barrels are that rainfall is seldom a reliable source for water during the dryer seasons and rain barrels are often not large enough to store the 50% of 2-year capture target. The most significant reductions in runoff volume from re-use are achieved by capturing and re-using rainwater for indoor grey-water uses, or for commercial and industrial applications with high water consumption rates or where water supplies are limited. Recycling rainwater reduces demands from surface waters and reservoirs and can reduce supply infrastructure costs. Rainwater re-use can also be combined with infiltration facilities.

Re-Use Tank

Re-Use Rain Barrel

Water Quality Best Management Practices

Changes in land use, loss of natural biofiltration capacity, increases in impervious area, and pollutant laden runoff associated with urban development can contribute to reduced water quality which impacts fish and fish habitat. BMPs designed to capture and treat runoff need to be incorporated into RWMPs.

Water Quality BMPs are physical, structural or management practices that reduce or prevent water quality degradation. Many of these are the same as, or similar to those used for runoff volume reduction and rate control and but have ancillary benefits for water quality. Source control remains the key means of reducing introduction of toxic and hazardous materials or organic and inorganic contaminants, originating from land and water use or as a result of commercial or industrial spills. Without source control, runoff water quality is limited by the effectiveness of treatment technology.

Treatment controls are point-source water quality management measures. They are generally constructed facilities and are often individual installations incorporated into the stormwater management infrastructure. They should be designed on a site-specific basis, after examining all alternative treatment technologies, and selecting the best available options based on cost and effectiveness. These controls should be designed and constructed by appropriately qualified environmental professionals.

Water Quality Best Practical Technologies

Several technologies have the ability to provide both water quality benefits and runoff control. Water quality benefits are derived from contaminant removal mechanisms that use biological and physical processes. Runoff control is accomplished by improving stormwater detention and retention which reduces peak runoff discharge rates and volumes.

Biofilters

Biofilters are vegetated filter strips, swales and rain gardens that remove deleterious substances, notably particulate contaminants, though some combination of physical (e.g.: adsorption) and biological (biodegradation) removal mechanisms. Biofilter technology is suitable for sheet flow runoff, typical of large linear impervious developments like roadways and parking lots.

Urban Forests and Leave Strips

Depending on the extent of tree canopy and ground cover retained, runoff reduction and pollutant removal can be achieved by maintaining natural well functioning urban forested areas. The contaminant removal processes forests and natural vegetation provide include: filtration, adsorption, absorption, and biological uptake and conversion by plant life. Urban forests also provide habitat refuges for many species whose habitats have been fragmented while riparian leave strips along watercourses, provide critical fish and wildlife habitat.

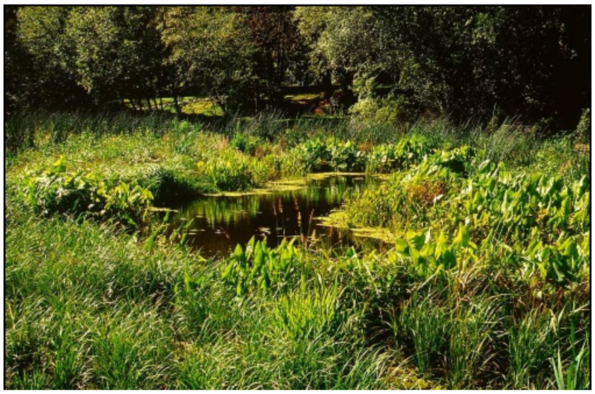
Infiltration Systems

Infiltration systems generally require pre-treatment for water quality to prevent clogging and binding-off of the permeable materials and contamination of underlying aquifers. Physical removal of deleterious substances by filtration and adsorption, as well as conversion of soluble pollutants by bacteria, also occurs within the infiltrating soils.

Constructed Wetlands

Physical, biological and chemical processes combine in wetlands to remove contaminants and either surface or subsurface flow wetlands can be constructed specifically to treat stormwater runoff. Constructed wetlands also offer retention benefits and can create preferred habitats for aquatic and terrestrial wildlife species. **The use of existing natural wetlands to treat stormwater however is not an acceptable practice**.

Small Wetland



Wetland

Wet Detention Ponds

Permanent wet ponds remove pollutants and other deleterious substances through physical processes such as sedimentation, filtration, absorption and adsorption and through biological mechanisms such as: uptake and conversion by plants, and microbial degradation. Wet ponds can also detain flows thereby contributing to rate control and volume reduction objectives. General design parameters need to include: vegetation types (floating, emergent and submergent vegetation), water depth and ponding area, and will often require consideration of detailed pond specific operational parameters.

Oil and Grit Separators

Oil and grit separators are suitable for spill control and removal of floatable petroleum-based contaminants as well as coarse grit and sediment from small areas, such as gas stations, automotive service areas and parking lots. Oil and grit separators have limited application in large-scale stormwater runoff applications, and should be limited to small area generation sites.

Oil Grit Separator

Oil Grit Separator

Construction Best Practices

Construction Best Practices for instream stormwater management works include timing of the works to minimize impacts. Timing windows should be adhered to in order to minimize impacts to fish and wildlife and specifically to avoid sensitive periods for certain life history stages of fish (e.g.; adult spawning, egg and alevin intergravel incubation). Where information is available on critical life history stages and timing for any identified Species at Risk, these times should also be avoided. Clearing should only be undertaken immediately in advance of work, and only during vegetation clearing timing windows, where these have been identified for protection of nesting birds. To the extent possible, work should be restricted to cells and undertaken in a systematic manner to limit the area disturbed at any given time. Works should only be undertaken during favourable weather conditions and low water conditions.

Measures must be taken to prevent the release, from any work site, of silt, sediment, sediment-laden water, raw concrete, concrete leachate, or any other *deleterious substance* into any ditch, watercourse, stream, or storm sewer system. The work area should be isolated from flowing water as much as possible and diversions around the site should be provided for overland flow paths. Ensuring that all equipment used on-site is in good working order, and having a ready spill containment kit and staff trained in its use, are also critical measures.

For further information on managing erosion and sediment discharges during construction, see the Erosion and Sediment Control section of the *Land Development Guidelines and the* *Standards and Best Practices for Instream Works*.[18]

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[18] BC Ministry of Water, Land and Air Protection's *Standards and Best Practices for Instream Works* (draft March 2004) http://wlapwww.gov.bc.ca/sry/iswstdsbpsmarch2004.pdf.

Stormwater Detention Systems

The rainwater detention objective is to limit the post-development runoff to the pre-development rate, volume, and approximate shape of the hydrograph for the 50% MAR, and 2-year/24-hour storm events and to maintain, as closely as possible, the natural pre-development flow pattern in the receiving watercourse.

These detention levels have been adopted to address increases in impervious areas in developments and the environmental impacts (e.g. stream erosion, sedimentation; loss of riparian habitat, changes in stream morphology, etc.) that are occurring due to the more frequent, smaller storm events being rapidly conveyed off hard surfaces into fish bearing waters.

Groundwater Recharge Systems

Stormwater infiltration systems can provide many benefits to urban streams, including recharge of the groundwater that feeds cool water into streams between rainfall events. This groundwater is critical for streams in the summer, when rainfall amounts tend to be small and infrequent. Groundwater which is slowly discharged back into streams as seepage can constitute all or part of a stream's baseflow in the summer months. This baseflow can be critical for fish and fish habitat during extended periods of little or no precipitation and runoff. It maintains preferred spawning conditions for several salmon species which key on groundwater seepage areas for spawning and egg incubation.

In areas with well-draining soils, stormwater runoff from a site can be collected and discharged into an infiltration system where there are no conventional stormwater systems, which reduces the costs of providing conveyance to an off-site discharge point. This is called on-site disposal of stormwater and allows all local runoff to be used for groundwater recharge. There will be a limit on the volume of water that can be disposed of up to the hydraulic capacity of the soil and on-site disposal should not be used without consideration of the groundwater table and the geotechnical stability of the site. On-site disposal is typically considered on a per lot basis, rather than as a neighbourhood or regional facility.

11. Long-Term Vision for the Watershed

11.1 Visioning Process and Development

The need for ISMP studies to be done is defined by the commitment of the member municipalities to the Metro Vancouver Integrated Liquid Waste and Resource Management Plan, approved by the Province in 2011, which re-iterates an earlier commitment to doing ISMPs for all watersheds where the receiving water streams may be impacted by development.

Part of the ISMP process is setting the overall goal for the health of the watershed as a vision statement. The Vision for the longer-term health of the Blaney, North Alouette and Fraser River watersheds was developed by starting with existing goals and opportunities within City documents and incorporating the intent and purpose of the ISMP process as defined in the Template for Integrated Stormwater Management Planning[19]. In addition, a workshop with City staff from multiple departments provided more refined input on City approaches and preferences to strengthen the Vision and the associated goals and objectives.

The Vision below is based on existing City policies and objectives combined with goals from the ISMP Template and was circulated to City staff for comment.

11.2 ISMP Vision

The proposed vision for the watersheds incorporates existing City goals and policies, with the purpose and intent of the ISMP Template as directed in the terms of reference for this ISMP and as approved by City Council. The vision relies on documents and policies that have been approved by City Council and City staff as a solid foundation for promoting the future of the study watershed in an integrated, holistic manner.

The vision for the ISMP strives to achieve the goals set out in the ISMP Template to preserve and enhance watershed health and to meet the priorities of the City’s Strategic Plan 2019-2022 including:

- Community Safety
- Intergovernmental Relations
- Growth
- Community Pride & Spirit and
- Natural Environment.

ISMP Vision Statement

In a City inspired by nature, we aspire to:

- Preserve and improve the health of the watersheds - where we live, work, and play - while we allow for development as planned in our Official Community Plan.
- Prepare for changes in climate and weather patterns and work to ensure the safety of our communities within our watersheds.

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[19] Kerr Wood Leidal Associates Ltd., 2005. Template for Integrated Stormwater Management 2005, Draft Report for Greater Vancouver Regional District, December 2005. As accessed at: http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/ISMP_Template_2005v2.pdf

ISMP Principles and Approaches for Meeting the Vision

The ISMP will achieve the vision through the following principles and approaches that provide context for how the ISMP vision will be achieved. These principles and approaches were developed using internal stakeholder input gathered during the visioning workshop for the ISMP. They present the intent for how the City can achieve the Vision for the ISMP study watersheds.

1. Preserve the natural hydrological cycle including groundwater recharge through retention of high value natural features and implementation of measures that mimic the natural cycle.
    - Retention of high value natural features: Retaining soil (erosion and sediment control), protecting steep slopes form degradation, identifying key high value natural features (e.g. creeks, riparian areas, wetlands) and protecting them.
    - Implementation of measures that mimic the natural cycle: Continue implementing Low Impact Development principles, stormwater rate control, and water-wise consumption.
2. Use a collaborative approach when setting stormwater policies and targets.
    - Conduct goal setting collaboratively with input from staff in multiple different departments and levels within the municipal structure.
    - Communicate with adjacent municipalities, regional and provincial governments and other stakeholders to assess internal and cross-boundary effects of potential objectives and how they fulfill regional initiatives.
3. Protect and support good stewardship of agricultural land to preserve its contribution to community character, the local economy and environmental value.
4. Anticipate and respond to the impacts of climate change on land, infrastructure, and receiving waters.
5. Protect persons, property and landscape from flooding by mitigating impacts of future development, having adequate stormwater conveyance capacity and by appropriate use and development of floodplains.
6. Support development that is densifying in the urban environment and has pathway networks that provides access to natural features, within limits that protect the natural features themselves. Enhance public education along with public access in the watersheds to benefit public understanding of the natural features and the community's interactions with those features.
7. Monitor the watershed health and other key performance indicators and adapt policies and mechanisms in the future as needed to continue to preserve and enhance watershed health over the long-term, updating the ISMP periodically, and as required by the City's commitment to the ISMP process, to maintain it as a living document.

12. Proposed Conveyance System Upgrades

While conveyance of flows is only a part of the stormwater management overall, the City has a primary duty to protect public safety and provide and maintain safe flow routes for drainage at the minor and major service level. Potential infrastructure upgrades are proposed when the modelling results show that the existing minor or major drainage system is unable to provide adequate conveyance for the 10-year (Minor) or 100-year (Major) design event. These potential upgrades are based on the current modelling results for the existing and future (OCP) land use scenarios as discussed in Stages 1 and 2 of the ISMP. The potential projects in this capital upgrade program indicate the locations identified by modelling results as being undersized infrastructure and provide planning-level budgets that cover preliminary and detailed designs and construction in current day costs. During preliminary design, the design flows to each pipe should be reviewed including checking the tributary catchment area in detail, which may change between now and then, and using the most up-to-date design criteria including updated IDF curves and the latest climate change projections available at that time

Potential upgrades to storm sewer infrastructure have been prioritized by considering whether a pipe is part of the major or minor system, the severity of surcharging at the inlet of a pipe, and the relative magnitude of upgrades required; due to data limitations, infrastructure age and condition was not included in the prioritization at this time. This prioritization criteria are summarized in the following table.

The details of the prioritization are included in the Appendix G, and are summarized below.

12.1 Prioritization

Priority 1 infrastructure upgrades are recommended due to the existing major drainage system not providing adequate conveyance for the existing land use 100-year event or 200-year event for culverts under arterial and collector roads. Flooding hazard & consequence is the highest at priority 1 infrastructure due to inadequate overland flow routes & potential blockages for emergency services. This priority also includes detention facilities that overtop their banks under existing land use and climate conditions. It is recommended that infrastructure condition be assessed and infrastructure in poor condition be integrated into this priority.

Priority 2 upgrades are minor system infrastructure does not provide adequate conveyance for the 10-year event under existing land use. This infrastructure has adequate overland flow routes if flooding occurs and generally will not cut off critical access routes for emergency services. This priority also includes detention facilities that exceed their design water levels under existing land use and climate conditions.

Priority 3 upgrades are minor or major system infrastructure that adequately convey flow under existing land use conditions but cannot convey flow under future land use with or without climate change. These upgrades are recommended to take place with future development.

The prioritization criteria are summarized in Table 12-1 and shown spatially in Figure 12-1.

Table 12-1: Prioritization Criteria for Drainage Upgrades

Time Horizon		Criteria	
Priority 1	Short Term Plan	Existing infrastructure inadequately conveys/stores existing flow/volume	Storm Sewers with No overland flow route & creek culverts and detention facilities that overtop
Priority 2	Medium Term Plan		Storm Sewers with overland flow route, driveway culverts and detention facilities that exceed their design water levels
Priority 3	Long Term Plan	Existing infrastructure adequately conveys/stores existing flow/volume, but not future flow	All infrastructure not meeting the criteria in the future condition scenarios

Some undersized storm sewers, culverts, or bridges are not a priority to upgrade if the area is not experiencing any problematic flooding. Because minor storm sewers are sized to convey the 10-year event, if they are slightly undersized it would mean that if/when the surcharged water level reached the ground surface it would be safely conveyed along the safe major overland flow path (road in most cases).

For culverts, if the roadway/access is not overtopped but the water level is close to the embankment level or surcharges the culvert crown or bridge low chord, the crossing upgrade is a lower priority. Therefore, Priority 3 upgrades have been included in the upgrade table, but are not necessarily a priority to construct and therefore have been categorized as upgrade over the long term.

12.2 Storm Sewers and Culvert Upgrades and Costing

Upgrade Sizing

All storm sewers were sized to convey their respective incoming flow with no surcharging; 10-year flow for minor system storm sewers and 100-year flow for major system. Culverts were sized to convey the respective incoming flows with no estimated surcharging and no impact to adjacent properties; 200-year flow for culverts under arterial and collector, 100-year flow for watercourse culvert not under arterial and collector roads and 10-year for all other culverts. Only culverts that were surveyed, added from as-built information or were in the City's GIS database were assessed and sized. As mentioned in Section 5.3, there were culverts found in the field that were not in the GIS database provided; to support a more robust culvert assessment it is recommended that the City continue to populate its culvert inventory.

In all cases, the sizing for upgrades is based on the future land use conditions and for 2080 climate change rainfall.

As noted above, sizing of the conveyance upgrades in the ISMP is conceptual in nature and should be revisited during preliminary design.

An additional consideration for culvert sizing is safe bear passage. Wildsafe BC noted that 5 bears were hit by cars in 2019 and suggested that culverts be sized for safe bear passage. The City is advised to consult further with Wildsafe BC on this issue to better understand costs/benefits/options. No costing for further upgrading culverts to accommodate bear passage is included in the capital cost estimates below.

Class ‘C’ Cost Estimate

A Class ‘C’ Cost Estimate was completed for the pipes and culverts that were identified as having insufficient capacity for their required storm events. The summaries of upgrade costs for the existing and future land use scenarios are listed in the Table 12-2 below. The Class ‘C’ cost estimates are based on infrastructure cost per unit length and accounts for general site conditions such as depth, paving and earthworks, it does not account for potential relocation or shutdown of services. Also included in the Class ‘C’ cost estimates are allowances for:

- Mobilization and Demobilization (6%),
- Insurance and Bonding (2%),
- Engineering (15%),
- Contingency (30%), and
- Market material cost fluctuations (10%).

Table 12-2: Storm Sewer and Culvert Upgrade Cost Estimates

Conduit ID[1]	Existing Size (mm)	Required Size[2] (mm)	Subtotal Costs[3]	Total Costs[4]
Priority 1 – Short Term Plan				
Fraser Watershed Storm Sewer				
FRB072FRB355	525	900	$253,000	$412,000
FRB331FRB330	675	1050	$175,000	$285,000
FRb356FRb331	675	1350	$801,000	$1,306,000
FRB357FRB072	525	900	$69,000	$112,000
FRB358FRB357	525	1050	$925,000	$1,508,000
		Fraser Storm Sewer Subtotal	**$2,223,000**	**$3,623,000**
Blaney Watershed Storm Sewer				
NAa003NAa002	450	525	$50,000	$82,000
NAa064NAa116	300	525	$39,000	$64,000
NAa066NAa065	250	525	$481,000	$784,000
NAa116NAa101	300	525	$142,000	$231,000
		Blaney Storm Sewer Subtotal	**$712,000**	**$1,161,000**
		Priority 1 Storm Sewer Subtotal	**$2,935,000**	**$4,784,000**
Fraser Watershed Culverts				
In322In321	1200	1500	$866,000	$1,412,000
Blaney Watershed Culverts				
In1760In1761	675	1200 (x2)	$338,000	$551,000
In1756In1757	900	1200	$103,000	$168,000
		Blaney Culverts Subtotal	**$441,000**	**$719,000**

Conduit ID[1]	Existing Size (mm)	Required Size[2] (mm)	Subtotal Costs[3]	Total Costs[4]
North Alouette Watershed Culverts				
In1276In1272	820	1350	$131,000	$214,000
Priority 1 Culvert Subtotal			**$1,438,000**	**$2,345,000**
Priority 1 Total			**$4,373,000**	**$7,129,000**
Priority 2 – Medium Term Plan				
Fraser Watershed Storm Sewers				
In1041	450	675	$191,000	$311,000
FRb431FRb410	450	1050	$215,000	$350,000
FRb411FRb431	450	1050	$153,000	$249,000
FRb410FRb285	450	900	$62,000	$101,000
FRB354FRB127	600	1350	$103,000	$168,000
FRB348FRB350	450	900	$268,000	$437,000
FRB297FRB293	450	675	$302,000	$492,000
FRB295FRB294	400	900	$129,000	$210,000
FRB294FRB293	450	900	$135,000	$220,000
FRB293FRB289	500	1200	$158,000	$258,000
FRB291FRB289	450	1050	$381,000	$621,000
FRb289CB3744	600	1050	$172,000	$280,000
FRB285FRB284	375	900	$465,000	$758,000
FRB283FRB282	525	675	$142,000	$231,000
FRB282FRB281	525	750	$79,000	$129,000
FRB281FRB280	600	1350	$183,000	$298,000
FRB280FRB279	450	600	$87,000	$142,000
FRb280	450	525	$39,000	$64,000
FRb157FRb283	525	1050	$419,000	$683,000
FRb133FRb132	450	675	$93,000	$152,000
FRb132FRb430	525	900	$59,000	$96,000
FRB131FRB130	525	900	$85,000	$139,000
FRB129FRB128	525	1050	$74,000	$121,000
FRB128FRB354	525	1050	$198,000	$323,000
FRB127FRB126	600	1050	$213,000	$347,000
FRB126FRB125	600	1050	$79,000	$129,000
FRB125FRB124	600	1050	$372,000	$606,000
Fraser Storm Sewer Subtotal			**$4,856,000**	**$7,915,000**

Conduit ID[1]	Existing Size (mm)	Required Size[2] (mm)	Subtotal Costs[3]	Total Costs[4]
		Priority 2 Storm Sewer Subtotal	**$4,856,000**	**$7,915,000**
Fraser Watershed Culvert				
In795In791	450	750	$123,000	$200,000
North Alouette Watershed Culvert				
In1748In1749	600	900 (x2)	$72,000	$117,000
		Priority 2 Culvert Subtotal	**$195,000**	**$317,000**
		Priority 2 Total	**$5,051,000**	**$8,232,000**
Priority 3 – Long Term Plan				
Fraser Watershed Storm Sewers				
FRb355FRb356	450	525	$36,000	$59,000
FRB139FRB136	450	750	$88,000	$143,000
FRB233FRB232	600	675	$285,000	$465,000
FRB232FRB118	600	750	$130,000	$212,000
FRb229In359	750	1050	$360,000	$587,000
FRB136FRB135	450	600	$34,000	$55,000
FRB135FRB102	750	900	$85,000	$139,000
FRB130FRB129	525	675	$40,000	$65,000
FRB311FRB283	375	450	$96,000	$156,000
FRB247FRB088	450	675	$119,000	$194,000
FRB239FRB238	525	900	$179,000	$292,000
FRB235FRB234	450	525	$126,000	$205,000
		Fraser Storm Sewer Subtotal	**$1,578,000**	**$2,572,000**
Blaney Watershed Storm Sewers				
NAa002In1203	750	900	$36,000	$59,000
NAa099NAa098	450	525	$221,000	$360,000
NAa148NAa153	525	750	$94,000	$153,000
NAa109NAa110	450	600	$106,000	$173,000
		Blaney Storm Sewer Subtotal	**$457,000**	**$745,000**

Conduit ID[1]	Existing Size (mm)	Required Size[2] (mm)	Subtotal Costs[3]	Total Costs[4]
North Alouette Watershed Storm Sewers				
SAd008SAd005	525	600	$35,000	$57,000
SAd009SAd009	450	525	$176,000	$287,000
SAd012SAd009	450	525	$200,000	$326,000
SAd014SAd013	450	525	$200,000	$326,000
		North Alouette Storm Sewer Subtotal	**$611,000**	**$996,000**
		Priority 3 Storm Sewer Subtotal	**$2,646,000**	**$4,313,000**
Fraser Watershed Culvert				
In2559In2558	1800	900*	$329,000	$536,000
North Alouette Watershed Culverts				
In2512In2511	1100	1350	$166,000	$271,000
In1709In1710	900 (x2)	1350	$159,000	$259,000
In1691In1692	450	675	$63,000	$103,000
		North Alouette Culvert Subtotal	**$388,000**	**$633,000**
		Priority 3 Culvert Subtotal	**$717,000**	**$1,169,000**
		Priority 3 Total	**$3,363,000**	**$5,482,000**
Watershed Summary				
		Fraser Watershed Total Cost	**$9,975,000**	**$16,258,000**
		Blaney Watershed Total Cost	**$1,610,000**	**$2,625,000**
		North Alouette Watershed Total Cost	**$1,202,000**	**$1,960,000**
See pipes listed in Tables G-1 to G-13 of Appendix G				

Notes:

Pink shading indicates major infrastructure and Yellow indicates minor infrastructure Blue text indicates infrastructure upgrades that will require coordination with other jurisdictions.

1. See digital GIS for location of conduits.
2. Infrastructure was sized to a future land use under the 2080 climate change rainfall.
3. Pipe cost include manholes every 100m and culverts include headwall costs with earth works and riprap.
4. Costs with allowances applied.

* Add beside existing culvert

12.3 North Alouette River Flood Protection

As previously noted, no new analysis of flooding along the North Alouette River was completed as part of this ISMP. It is recommended that the City continue with implementing the flood protection plans as recommended in the *North Alouette and South Alouette Rivers Additional Floodplain Analysis* report completed by NHC in 2016.

12.4 Areas with No Drainage Servicing

Some blocks within the developed urban area are not serviced by a storm sewer or a roadside ditch. For example, within this ISMP Study area, an approximately 10 ha area with no clear drainage servicing is located within the Fraser River Escarpment. Opportunities for drainage improvements within this area are limited. The City's Escarpment policy titled Control of Surficial and Groundwater Discharge in the Area Bounded by 207 Street, 124 Avenue, 224 Street and the Crest of the Fraser River Escarpment limits opportunities for on-site drainage in this area. The policy includes these statements:

- Storm drainage ditches or buried storm services shall be provided where existing roads, residential and commercial run-off causes ponding of water.
- No ground water discharge of new construction residential, commercial, road or parking areas shall be allowed. All such drainage shall be carried to storm water ditches or sewers
- Landscape ponding is not permitted.
- Swimming pools are not permitted to drain into rock pits

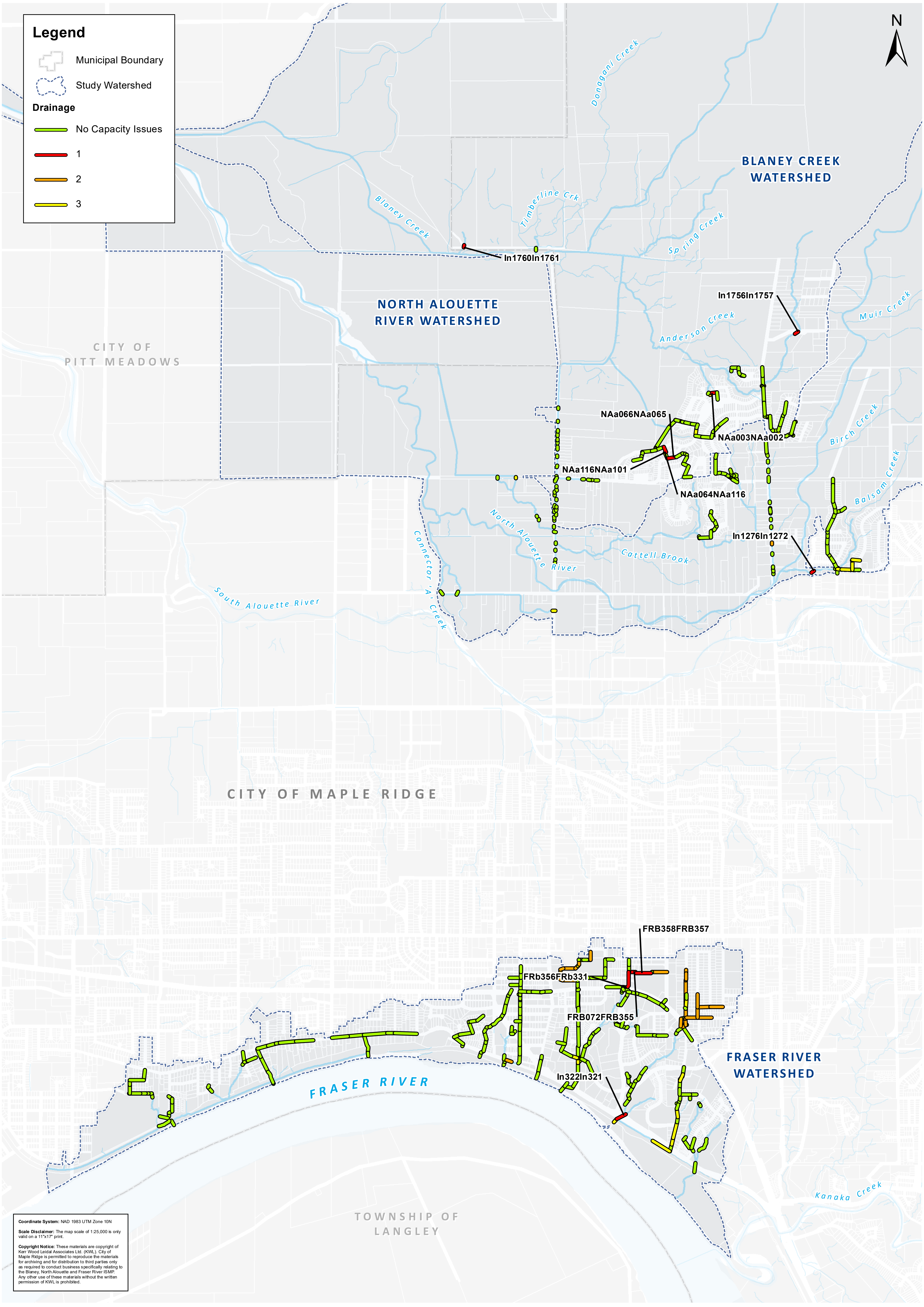
Actions to improve drainage within the Escarpment are limited to extending the storm sewer network. To date, this has been accomplished at the cost of the benefitting property owners, through a Local Area Servicing bylaw. The City is completing a review of the Fraser River Escarpment policy in 2021/2022. Through that review, the City could declare drainage servicing extensions in this area a strategic or community goal and thus increase the City's share towards drainage Local Area Servicing.

Extending drainage services into areas with no drainage servicing will require upfront planning to address some challenging issues. It is recommended the City undertake drainage plans that consider the following:

- Challenges in grade and potential for underground utility conflicts
- Where is the overland flow path for these areas, and should consideration be given to conveying the 100 year storm in-pipe
- Climate change
- For properties that will need to discharge to a natural watercourse, approval under the water sustainability act is required, and design must ensure environmental protection is provided.

City of Maple Ridge
Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:25,000 is only valid on a 11"x17" print.

Project No. 173-188
Date March 2020
Scale 0 100 200 400 (m)
1:25,000

Prioritized Upgrades

Figure 12-1

13. Proposed Detention Facility Program

13.1 Detention Facility Assessment

A detention facility simulation and assessment was completed to estimate the effectiveness of the flow control facilities and to understand which facilities may need to be upgraded under the existing, future and future land use with climate change scenarios. Each detention pond was evaluated individually based on its design, and the water levels and capacity remaining for each pond was reported.

In the drainage assessment in Appendix G the detention facility performance is summarized in Tables G-15 to G-18 and Figures G-5 to G-8. Each facility's performance under each design event used in the hydrologic & hydraulic model is summarized. Facilities that are estimated to have water levels that exceed their banks or no capacity remaining under a given design event should be considered. Severity of a water level exceeding the banks of a facility needs to be considered. Four facilities have water levels exceed their banks under 100-year design storms. These facilities most likely do not require large modifications due to system-wide inundation that occurs during a 100-year event. A detailed study of safe overland flow routes due to flooding at a facility and a slight increase in volume would be a better option for those facilities. One pond, the Silver Valley Walkway facility that is estimated to have water levels that exceed its banks in all scenarios, would require more intensive modifications such as removing flow control plates or reducing overflow levels to prevent flooding during smaller design storms.

Facilities that have estimated water levels that exceed their design water levels by small margins (<10cm), or have no water levels that exceed the design water level, seem to be operating as intended and should not be of concern. Facilities that have water levels that exceed their design by 10cm or more but have adequate capacity remaining should be considered for slight modifications, possibly to the outlet or should have a detailed assessment completed to better assess potential modifications.

Detention Program Options

It is not clear that changes to the existing detention facilities are required, merely that they may be warranted based on the high-level assessment in this ISMP. The existing detention ponds were designed at different times and likely using slightly different assumptions as to rainfall and runoff levels relative to those used to model the catchments for this ISMP. The fact that the current evaluation has identified ponds that seem undersized, does not mean that the ponds were designed incorrectly for the criteria and design processes at the time.

It is therefore difficult to determine specific modifications that would be recommended to improve pond performance, in part because the release rates are not known for the majority of existing detention facilities. A further study could be completed that reviews the effects of pond modifications on the flows in the receiving creek and assesses whether additional flow restriction or detention volume in the existing ponds is needed to improve the flows into the stream. The next steps that are provided in Table 13-1 could be undertaken to rectify water level or volume issues in the identified facilities. The water levels and storage volumes for a given storm event in the facilities can be adjusted in a variety of ways.

Some suggested methods to reduce water levels and increase available volume under a given event are as summarized in Table 13-1 below. No costs have been estimated for modifications to increase existing detention pond performance at this time. If modifications to existing detention are pursued, the specific modifications chosen can be costed closer to the time of the work.

Table 13-1: Detention Facility Performance Summary and Next Steps

Facility	Assumptions	Performance Summary	Next Steps
Best St.	• Volume derived from LiDAR • Design Water Level • Orifice invert	• Water levels and volumes are relative to assumed volumes and water levels. • Hard to perform assessment.	• Collect facility data and perform analysis to determine performance.
Telsoky Bioinfiltration	None – Parameters based on as-built information	• Water levels greater than 10cm in future 2050 and future 2080 scenarios but no volume issues associated in the same future scenarios.	None
229 Loop		• High water levels & exceeded volumes occur only under 100yr future events. High water levels occur under all 100yr events. • Limited volume under 10/25yr future 2050 and 2080 events.	• Slightly increase outlet size to reduce future pond volumes & water levels in future climate change conditions. • Undertake detention facility study to determine risk of pond potentially overtopping in 100-year events.
134 Loop		• High water levels occur in 10/25yr future events but have no volume concerns. • High water levels occur under all 100yr events. • Limited volume and exceeded volume under 100yr future climate change events.	• Slightly increase outlet size to reduce future pond volumes and water levels in future climate change conditions. • Undertake detention facility study to determine risk of pond potentially overtopping in 100-year events.
Blaney Rd.	• Volume derived from LiDAR	• High water levels only occur under 100yr events. • No Volume concerns.	• Collect facility data storage capacity data to better determine performance.
Silver Valley Walkway	None	• High water levels and exceeded volumes occur under all events.	• Increase storage capacity, or; • Divert more flow away from the facility, or, • Plan for orifice plate removal in high water conditions to allow increased outlet flow without overtopping. • Undertake detailed detention facility study to determine risk of pond potentially overtopping.
Parkside Biofiltration		• High water levels only occur under 100yr future 2080 climate change event.	None
Docksteader East		• High water levels under 100yr future 2080 climate change event.	None
Docksteader West			

Detention Modification Prioritization

Prioritization for modifications and upgrades to detention facilities are recommended in Table 13-2 below. Higher priority was put on facilities that had their water levels exceed their banks under any design event vs. facilities that had adequate volume remaining; facilities where the design water levels were exceeded in smaller design events were given the highest priority. Facilities with adequate volume remaining but had water levels that exceed the design water levels by more than 10 cm were the next highest priority. Land use and climate change conditions were also considered, and facilities with estimated deficiencies under existing conditions ranking higher than facilities with estimated deficiencies under any future conditions.

Table 13-2: Detention Facility Prioritization

Priority Level	Facility	Term
Highest Priority	Silver Valley Walkway	Short Term
Medium Priority	229 Loop	Medium Term
	134 Loop	Long Term
	Blaney Rd.	
	Parkside Biofiltration	
Lowest Priority	Best St.	

13.2 Potential Options for Detention Facility Management

More detail of the potential options for addressing deficiencies noted in the previous section are:

1) **Detailed Studies:** The detention facility assessment for this project includes assumptions for detention facility information that was not available. For example, the expected release rates from the detention were not readily available and the detention volumes were based on as-built drawings or on aerial imagery where the volume was not provided. Despite the missing or assumed information, the results in Section 13.1 indicate which detention facilities are at risk of underperforming; for these ponds, a detailed study could be done to more accurately assess facility performance. A detailed study that investigates the preservation of pre-development flows would ideally establish a target release rate and develop a more accurate storage curve for each facility. The estimated actual release rate could be compared to the target release rate and the comparison of expected maximum water levels could be refined.

2) **Outlet Modification:** Facilities that have adequate volume but have estimated water levels that exceed their design water levels by more than 10 cm could undergo outlet medications to drop peak water levels to a more desirable peak. Outlet modifications can also be performed to prevent water levels exceeding a facility's banks but that could entail large modifications. Before any outlet modifications take place it is recommended that a pre-development release rate be established at every facility to determine if an outlet or weir can be enlarged to reduce peak water levels and still keep the facility within the desired pre-development release rate range.

3) **Increase the detention volume:** A detailed detention facility study should be undertaken to determine if the facilities identified above having incoming flow volumes that are estimated to exceed the facilities' storage may need detention volume expansion to detain the required design storms. Increasing the detention volume would preserve the current estimated release rates in the facilities, however, it is likely difficult to find the space needed for the additional volume in built-out areas. As these facilities are already built, expansion of the existing facilities would likely be done by the City. This option may be further refined in future drainage studies, as the next 10 to 12 years may bring changes in the understanding of the future risks and impacts of climate change, which could increase the need for additional storage volume.

4) **Apply stricter criteria elsewhere**: To offset the underperformance of existing detention facilities, it may be possible to use stricter criteria for the design of future facilities. Essentially, development upstream or nearby in the same watershed could overcompensate to release at lower rates or further reduce runoff beyond what is already established. Further modelling of the combined catchments and detention would be needed to ascertain the volumes needed at alternative locations to achieve the desired detention. Negotiation with developers may need to be considered to achieve this in future development.

14. Preventing and Mitigating Watercourse Erosion

14.1 Erosion Concerns from Field Work

Erosion sites of concern were identified in Section 5.1 of the report. As discussed, sites of significant erosion were identified based on previous reports, reviewed in the field, and assigned a relative severity level of low, moderate or high, based on a visual assessment.

Three sites of concern were identified and documented, at:

1. 22532 Brickwood,
2. 22233 River Rd., and
3. Blaney Creek at 224 St.

Based on the field reconnaissance, in general, the rate of erosion throughout the watersheds seems normal at this time, but this conclusion would change if monitoring shows the erosion in these or other sites worsening rapidly.

14.2 Risk of Erosion due to Future Changes in Land Use

As illustrated in Figure 10-1 in Section 10 of this ISMP, the increasing impervious surfaces of roofs, roads, parking and patios that are part of development have detrimental impacts on the receiving streams through changing runoff patterns including increased erosion of the stream bed and cross-section. Therefore evaluating and mitigating the expected erosion for the study watersheds is a key part of the ISMP.

Stage 2 of the ISMP work included modelling flows resulting from future land use changes in the study watersheds. The future land use scenario modelled incorporated the expected land use changes in the study watersheds based on the City of Maple Ridge Official Community Plan (OCP) and based on discussions of development patterns with City staff. This work provided peak flow values for the design (10-year return period) storm for the future conditions. Table 14-1, compares the future conditions peak flows to the existing conditions peak flows at outfall locations discharging into the study creeks.

The future land use scenario used in the model includes expected future development, which typically causes increase in runoff volume and in peak flows downstream of the development. For this work, the modelling incorporated a restriction on flows from new subdivision developments to mimic the effects of required detention. This restriction limits the post-development 10-year return period flow to the pre-development 2-year return period flow. This is meant to account for detention that would be incorporated as part of future development based on the City's design criteria. While the future detention is not used for infrastructure sizing, it is incorporated here so the predicted changes in flow velocity are not too conservative.

Table 14-1: Changes in Velocity for the 10-year Design Storm at Modelled Outfalls

Outfall ID	Existing Scenario Velocity at Outfall (m/s)	Future Scenario Velocity at Outfall (m/s)	Percentage Change Existing to Future (%)	Percentage Velocity Change in Nearby Creek (%)
Fraser River Study Area				
FRa027In916	5.01	5.44	9%	2%
FRa086In1114	4.2	4.26	1%	2%
FRa044In913	5.24	6.23	19%	4%
FRa052In904	2.63	2.74	4%	4%
FRb001In165	2.89	2.82	-2%	-4%
In1163FRb371	1	1	0%	2%
FRb329In2549	3.58	3.63	1%	-4%
FRb437In2387	4.63	4.64	0%	0%
FRb374In1833	4.97	4.71	-5%	-2%
FRb278In379	7.52	9.71	29%	13%
FRB176In317	4.25	4.24	0%	0%
FRb249In360	3.13	3.1	-1%	-1%
In161In160	2.62	2.62	0%	0%
In163In164	0.76	0.76	0%	1%
Blaney and N. Alouette Study Areas				
NAa099In1887	4.72	4.79	1%	2%*
LBIn1192	6.89	7.05	2%	2%*
In2467In2468	1.76	1.76	0%	0%
In2209NAa325	2.98	2.79	-6%	-2%
NAa326NAa325	4.03	4.11	2%	-2%
E_INTAKENAa001	3.45	3.46	0%	1%
W_INTAKENAa001	3.2	3.21	0%	1%
NAa125NAa124	2.4	2.44	2%	3%
In1758In1759	4.27	4.27	0%	0%
NAa165In1758In1759	2.86	2.89	1%	0%
NAa231In2466	1.25	1.31	5%	0%
In2512In2511	2.46	2.43	-1%	10%
SAd005SAd034	15.73	12.13	-23%	10%

* These values are averaged as model instability at this location provides an unreliable peak flow for the section of creek that is adjacent to these outfalls. This section of creek was added to the model with assumed cross-section and slope to connect the outfall locations to the downstream channel and may not be an accurate representation of the creek channel conditions.

The outfall locations from Table 14-1 are shown on a map in Figure 14-1.

A few of the outfalls show increases in velocity that may be of concern. In particular, outfalls FRa044In913 and FRb278In379 (highlighted in light grey in Table 14-1) in the Fraser River Study area, show increases due to projected changes in land use upstream. The velocities from these catchments are relatively high even in the existing land use scenario, so these drainages may need energy dissipation or revetment to resist erosion at higher flows. Note that the future land use in the catchments for these two outfalls is expected to increase due to infill/conversion development and this will occur relatively slowly over time. These small creeks should be monitored to determine if flows cause increased erosion in these creeks over time.

In the Blaney Creek and North Alouette study areas, the percentage increases in velocity at the outfalls are minimal, and in some cases the velocity is predicted to decrease. The decreases are due to the effect of detaining the post-development 10-year return period event to the 2-year return period event pre-development flow.

In addition to the changes in velocities at the outfalls, the velocities in the creeks were checked at nearby locations as well. The only concern based on the creek velocities is for Balsam Creek, which is the receiving creek for the two outfalls at the bottom of the table. A large proportion of the catchment for Balsam Creek is expected to develop under the current OCP and it appears that flows in the creek may be expected to increase at the 10-year return period level despite the detention for new development that is included in the modelling. This may be due to the fact that detention for individual developments would be designed to mitigate peak flows for the governing peak durations for each development catchment rather than for the 24-hour event which governs for the peak flow in the creek itself. This is how the future detention was simulated in the future conditions modelling. This indicates that Balsam Creek may be at risk for increase in velocities from future development even with detention for the new development, if the detention design does not take into account the cumulative effects of development on the receiving creek.

Note that this analysis only incorporates the effects of detention on the 10-year return period design storm flows and does not account for any detention implemented for lower-return period storms such as for Tier B mitigation in the City's Design Criteria Manual. The watershed-scale modelling used for the ISMP was not set up to adequately simulate or incorporate mitigation that is targeted at lower return-period (more frequent) events due to modelling limitations on incorporating volume control mitigation on a watershed-scale. Therefore, this modelling effort is not able to adequately test or assess the effects of 2-year or 5-year return period detention on the flows in the downstream receiving streams. In general, it is understood that increased development does increase peak flows and volumes and exacerbate erosion in creeks at return periods less than the 10-year return period.

14.3 Current Mitigation Approach

The City of Maple Ridge Engineering Design Criteria includes multiple levels of detention. The City's current approach for detention includes multiple performance objectives. The full criteria are found in the City's Design Criteria Manual, and the detention portions of the criteria are summarized below:

Tier B Mitigation	2-year	Detain the 2-year post-development peak flow to 2-year forested pre-development release rate.
Tier C Mitigation	10-year	Detain the 10-year post-development peak flow to 2-year pre-development release rate. In Some Cases: Detain the 100-year post-development peak flow to 10-year or 2-year pre-development release rate.

The City's current criteria provides for significant detention for new development providing for stricter or additional detention when it is deemed to be necessary due to sensitive environmental conditions.

It is noted that based on discussions with City staff, there are some exceptions in application of the detention criteria in certain development contexts. The criteria are applied for new development over a certain size, but Tier C detention is not applied to single family lot re-development or infill development.

The criteria are applied to analysis of the development catchment and the detention sizing process does not account for cumulative effects of multiple developments on the downstream receiving stream in the watershed. While it is not practical for individual developments to assess the expected cumulative effects, that is one of the reasons for modelling the study watersheds as a whole in the ISMP, in order to assess at a larger scale the risk of impacts to the stream from increasing flows from development, as discussed above.

The criteria include design to mitigate peak flow increases at multiple return periods, including the 2-year and 10-year return periods. To achieve this in a design, multiple design modelling runs or spreadsheet calculations are needed and a multistage outlet is required. The City staff should ensure that it is clear that all of those return periods are important for the design for both flood control and to minimize erosion. However, it should be noted that events smaller than the 2-year return period may also be responsible for causing erosion in streams.

Research has indicated that peak flow detention to predevelopment conditions is not always enough to prevent increased erosion due to development flows in cases where the stream bed and bank material is highly susceptible to erosion. One study[20] has advocated for over-detention of flows to a sediment-stable release rate that is much lower than predevelopment peak flows. The City's Tier C detention criteria, which detains the 10-year return period flow to the 2-year predevelopment flow is already providing significant detention in accordance with this principle and should not need to be revised to provide further detention or to lower rates.

In the coastal BC climate, the preferred approach to mitigate flows below the 2-year return period is to emphasize volume control and infiltration of the rainfall volume for smaller storms. This volume control will help to mitigate the risk of erosion from frequently occurring events smaller than the 2-year event.

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[20] Bledsoe, "Stream Erosion Potential and Stormwater Management Strategies" in *Journal of Water Resources Planning and Management*, Vol. 128, No. 6, November 1, 2002.

14.4 Recommended Actions for Erosion Mitigation

Based on the field work, modelling results, and criteria discussion above, the following are recommended for improving the erosion mitigation that the City has in place already.

- Continue to use and implement the three-tiered approach to mitigation of flows from development.
- Continue to work with developers and consultants to apply the existing criteria, particularly emphasizing the benefits of multi-return period detention design.
- For the three identified erosion sites of concern:
    - Monitor the identified erosion sites of concern on a regular basis, checking and photographing the sites every year, if possible, to assess if the erosion becomes significantly worse or the rate of erosion appears to increase. If after a few years of monitoring the sites appear to be stabilizing, that period can be lengthened.
    - If, after monitoring, any of the erosion sites appear to be rapidly degrading, consider instream repairs for the sites. The damaging effects of in-stream work to do repairs need to be mitigated and must be balanced with the need to stabilize the erosion site when considering whether repair and restoration is warranted.
    - For the site on Blaney Creek where the 144 St. outfall is being undermined, encourage the property owner(s) on the removal of the protruding section of pipe to prevent the collapse of the pipe. There is a private road above this location that could be compromised and if there are concerns for safety due to the steep bank fencing above the bank could be considered. This location is identified as an area for potential environmental restoration to stabilize the bank (see Section 16) in the future. This location exists on private property, downstream of the UBC Malcolm Knapp Research Forest.
- Consider implementing a City-wide assessment framework for tracking and monitoring bank erosion.

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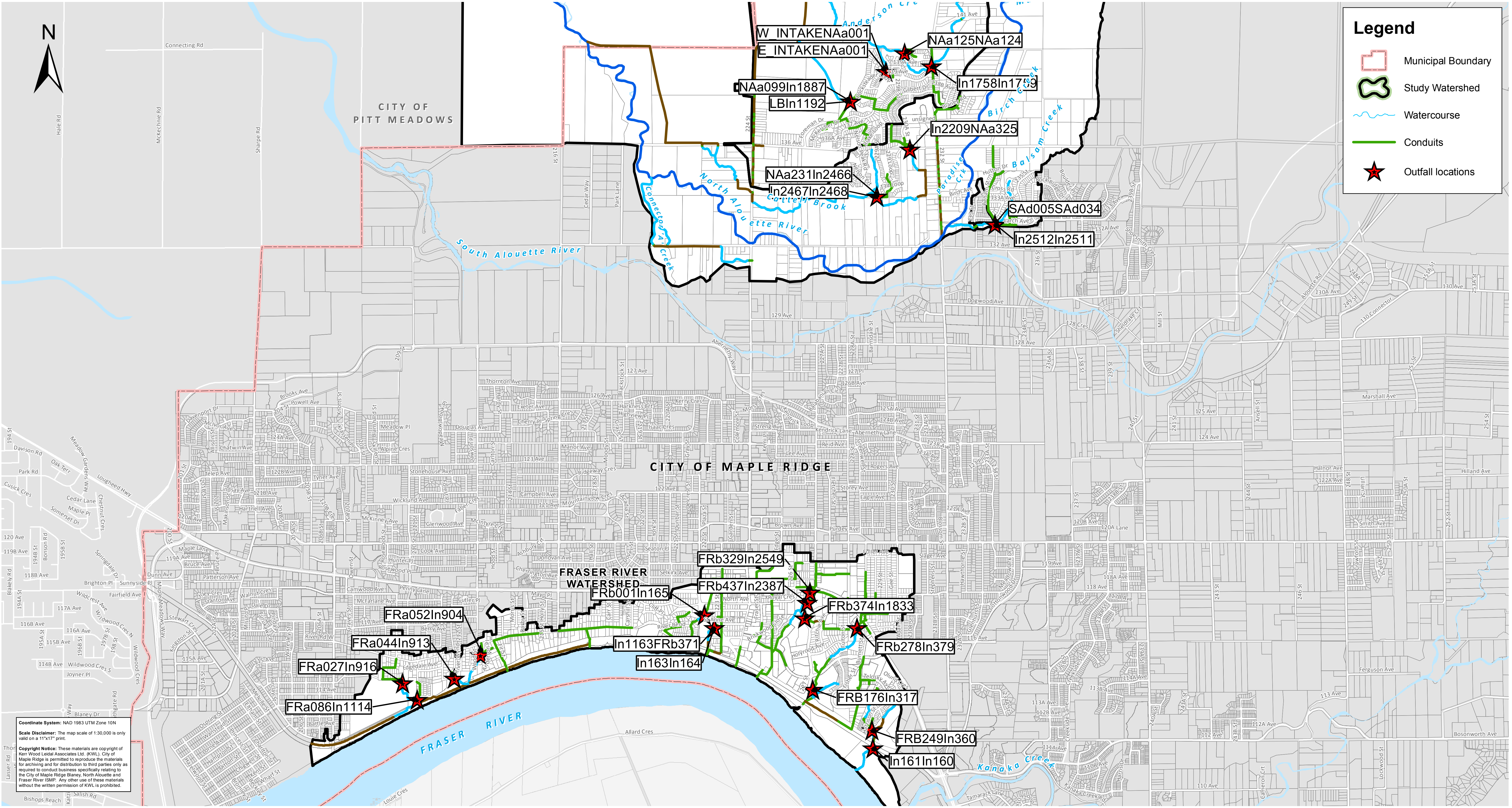
City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:30,000 is only valid on a 11"x17" print.

Project No.	173-188
Date	November 2017
Scale	1:30,000

Outfall Locations Checked for Velocity Change

Figure 14-1

15. Bylaw and Policy Recommendations

15.1 Existing Stormwater Design Criteria

To protect and restore the health of streams, lakes and aquatic life and counteract the negative impacts of development, stormwater management strives to maintain or mimic natural hydrologic processes. Sensitive forested areas such as riparian zones should be protected from development as these areas may provide natural features, functions and conditions that are vital for maintaining stream health and support fish life. The three Tier Criteria approach, discussed in Section 4.2, was developed to provide the same functions – flood control, erosion mitigation, and water quality protection – to mitigate stormwater and protect watershed health but in developed areas.

Proper management of stormwater can lead to avoided costs for flooding, reduced needs for infrastructure upgrades, and increased property value. Healthy watersheds can also provide other benefits, called ecosystem services, that are necessary for community well-being but that are difficult to monetize, such as water filtration and storage, nutrient cycling, and recreation. By protecting natural areas from development and mitigating stormwater in developed areas using the three Tier approach, valuable ecosystem services provided by healthy watersheds are also protected.

The City's existing stormwater design criteria was defined and discussed in Section 4.2.

Implementation of Tier A and B Criteria

It is recognized that there are numerous barriers and limitations to implementation of the Tier A and Tier B criteria. Some of the noted barriers include: soil permeability, steep slopes, space limitations due to infiltration and property line setbacks, and maintenance concerns. With the criteria not fully applied for Tier A and Tier B, there is concern that the effects of development will not be fully mitigated and the downstream receiving creeks will be impacted by upstream development. In particular, the Tier A and Tier B criteria for control of runoff volume do not appear to be fully implemented for single-family development within the City. This creates a gap between what the criteria is intended to achieve, and the effect of the criteria once implemented. Recommendations below are targeted at minimizing that gap to better preserve the health of the watersheds.

Despite the challenges noted above, the existing criteria is robust compared to other local and regional criteria and full implementation of the mitigation criteria would be expected to be effective.

Completeness of Criteria

The City's Stormwater Design Criteria (part of the City's Maple Ridge Subdivision and Development Servicing By-law), as shown above, covers all the necessary water quantity ranges of rainfall and storms, but does not cover water quality. There is no water quality treatment or performance standard as part of the criteria[21]. If water quality treatment is added, the criteria would be in accordance with both the Stormwater Guidebook for British Columbia, 2002 and with the 2001 DFO Draft Guideline for Stormwater Management[22].

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[21] However the City's Watercourse Protection bylaw does call generally for compliance with water quality requirements of DFO guidelines

[22] Urban Stormwater Guidelines and Best Management Practices For Protection Of Fish And Fish Habitat, Draft Discussion Document. Department of Fisheries and Oceans, 2001.

In addition, as of 2017, Metro Vancouver released specific minimum guidelines for stormwater management for single-family lots. These guidelines represent a minimum level of mitigation expected on single-family lots across the region. The City's Tier A criteria, if implemented, exceed the minimum requirements of the Metro Vancouver Baseline, however, the baseline criteria could form a fall-back for cases where Tier A criteria is unable to be met on single-family lots.

Drainage Design in the Fraser River Escarpment Area

The Fraser River Escarpment Area is subject to slope failures; the largest known slide (the Haney Slide) happened in 1880 when approximately 10 ha of land slid into the river, partially blocking the channel and causing a displacement wave that submerged land and destroyed boats and docks along the river. The land mass in the area is unconsolidated glaciomarine sediment consisting of silts and clays. The Fraser River Escarpment Policies (outlined in Table 4-2) were prepared to help mitigate erosion and avoid slope failures on the escarpment. Tier A and B events should be managed through other means than infiltration and exfiltration in the Escarpment Area, for example by using green roofs, rainwater tanks and underground cisterns with slow release to the stormwater sewer system (see section 17-1). As landscape ponding is not permitted in the area, management of larger storm events in wet and dry ponds, swales, and wetlands is also prohibited. To meet the performance targets described for Tier C, storm sewers in this area may need to be designed to provide sufficient capacity to convey runoff from 10- and up to 100-year events.

15.2 Proposed Enhancement of Mitigation Criteria

Water Quality Criteria

While water quality is discussed in the bullets under the Design Criteria's "D2.1. Responsibility", there is no reference under Tier A, B or C to any volume or level of treatment required for quality improvement. The emphasis on the wording in Section D2.1 is on identifying and treating "pollution sources", which is a critical part of the stormwater management plan. However, this approach misses the non-point-sources of pollution, and recent research increasingly indicates the importance of recognizing and treating non-point-sources of pollution to protect watershed health. In particular, research from Washington State indicates that road runoff is harmful to even adult salmon to the point of being fatal when the runoff is undiluted[23]. Therefore, greater emphasis should be placed on treating runoff from roads, driveways and parking areas. This can be challenging to achieve, but is likely to become increasingly important as research and studies of watershed health continue to emphasize the importance of this need and the criticality of improving water quality of runoff to protect and support salmon survival.

To improve the City's criteria to address the gap relating to water quality, it is recommended that the Tier A wording and criteria be revised to include water quality. Possible wording that could be added to the end of the paragraph: "This runoff volume must be treated to remove pollutants from any vehicle-accessible surfaces such as roads, parking areas, and driveways". Additional information on suggested treatment methods and approaches could be added in Section "D2.5 Stormwater Management Plan" of the Design Criteria Manual. Consideration should be given to developing different treatment criteria for different land use types. There are challenges in implementing water quality improvement, particularly with respect to driveways; it will be possible to implement in some cases and may not be possible in others.

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[23] https://www.seattletimes.com/seattle-news/environment/whats-killing-coho-study-points-to-urban-road-runoff/

The City should also define the volume and criteria for treatment. It is suggested as a starting point that the following criteria, based on that developed for an update to the DFO Land Development Guidelines, be considered:

> "Collect and treat the runoff volume from impervious areas for the 6-month, 24-hour rainfall event. This is equivalent to 90% of the average total annual rainfall. The 6-month, 24-hour rainfall event may be approximated as 72% of the 2-year, 24-hour rainfall event, which can be obtained from IDF curves. For the City of Maple Ridge, this gives 53 mm rainfall as the desired target for treatment. Water quality treatment systems should be designed to remove 80% by mass of the total inflow of sediment (TSS) for particulate greater than 50 µm particle size."

This criteria may not always be achievable, but it is a scientifically based goal that is consistent with water quality targets in other jurisdictions. It is more likely to be achieved for engineered facilities along roads and commercial parking areas, and is less likely to be fully achieved for driveways and other small pavement areas where it may be challenging to route and capture the flow for treatment.

A further clarification may be needed for single-family residential infill development. The minimum standard for this type of development is set out by the "Region-wide Baseline for On-Site Stormwater Management" (Baseline) released by Metro Vancouver[24]. For single-family infill developments, the minimum standard for water quality treatment is a practice standard where one of three approaches should be used for infill development to provide water quality treatment for the driveway or parking areas. See below Single-Family sub-section for more discussion on this.

Application of Criteria

In order to improve the application of the existing criteria, the City will need to work with developers to close the gap between the intent of the Tier A and B criteria, and the design of stormwater management practices to achieve the criteria. While it can be challenging to design for this level of mitigation, it is critical to continue to improve the design of facilities to meet these criteria fully in order to mitigate the effects of development. Recommendations for improving the application of the criteria include:

- Adjust the minimum level of soil required on residential lots to 450 mm to increase absorptive capacity and bring current practice in line with the Metro Vancouver Baseline's minimum standard. This can be applied for all land uses, including single-family. In conjunction with this, the City can encourage minimizing land clearing to only the construction area for development along with retention of soil structure and mature vegetation where possible.
- Reduce the minimum allowed orifice size for sumps to 10 mm. For small lots this is still allows a flow larger than a 'baseflow-equivalent' release rate, but this would improve performance relative to the current practice (16.5 or 20 mm) and is in accordance with the Metro Vancouver Stormwater Source Control Design Guideline. A basket-shaped mesh cage may be fixed over the upstream side of the orifice, or a horizontal orifice on the underside of a tee may be used to reduce the likelihood of clogging. Or a vortex flow restrictor valve may be used with a larger orifice to reduce the orifice flow.
- Require that stormwater management plans determine whether the proposed on-site measures fully meet the Tier A and B criteria, and what the gap is if they cannot. For subdivisions, require that the plan include regional measures to close that gap and fully meet the criteria. This may require some negotiation between the City and the developer, as there may be cases where off-site facilities located within public rights of way are needed to close that gap.

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[24] http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/Region-wideBaselineOnsiteStormwaterManagement-Feb2017.pdf

- Consult with developers in the process of changing and improving implementation, providing education as well as opportunities to provide feedback
- Develop an approach to apply the Tier A and Tier B criteria to existing and new roads within the City. This is recognized as a significant challenge for municipalities in general, but management of road runoff is one of the most significant gaps in municipal stormwater management across the province. A specific study may be warranted to brainstorm ideas, assess options, model effectiveness, and select approaches. This would allow City staff confidence to move forward with recommending and requiring approved practices for design of new, re-constructed, and expanded roads. However, the priority for road runoff should be water quality treatment, and implementation of Tier A and Tier B criteria for roads should be secondary to implementation of water quality improvement.
- Augment and improve water quality criteria as discussed above.

Align Single-Family Development with the Metro Vancouver Baseline

The Metro Vancouver Baseline is targeted at providing a workable approach for infill development of single-family lots, but it also effectively provides a minimum standard for new single-family development. The recommendation is that the baseline be used as a minimum standard for all single-family development, whether it occurs at subdivision-scale or single lot scale. There are key aspects that need to be incorporated in single-family development for the Baseline to be met. These include:

- Creating a formal limit of 70% of the lot area on the allowable impervious area on single-family lots. This is necessary to allow the other elements of the baseline to provide the desired level of mitigation on the lots. The City's new zoning bylaw includes wording that effectively provides this limit by requiring a minimum of 40% of a residential zoned lot to "maintained as landscape area with a permeable surface"[25]
- Requiring 450 mm of absorbent soil on all landscaped areas (including turf) of the lot.
- Allowing roof leader disconnection to the landscaped areas of the lot. This is a critical element of the Baseline approach as the absorbent soil only provides the desired volumetric capture for the lot as a whole when the roof water is discharged to the landscape for absorption. This requires that the stormwater management plan include a grading plan that provides a safe overland flow route for excess runoff that cannot be absorbed to drain to an inlet to the storm sewer system. Roof leader disconnection is not currently permitted in Maple Ridge except with the most permeable soil conditions. It is recommended the City explore soil conditions and design approaches for scenarios in which roof leader disconnection might be further accepted and encouraged.
- Requiring a water quality practice for each driveway or parking space on the lot.
    a. Drain to a permeable surface, such as soil, vegetation, or gravel, or
    b. Use permeable paving, or
    c. Collect and drain runoff through a sump prior to discharging to a storm sewer.
- Adapt and adopt the standard drawings from the Metro Vancouver Baseline for use in Maple Ridge to encourage and support the use of on-lot BMPs for residential use and assist the design community in providing robust design of on-lot BMPs.

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[25] Maple Ridge Zoning Bylaw No. 7600-2019, Part 405.1, Landscape and Permeable Surface Requirements.

It is recognized there are challenges with achieving even these simple measure on private lots, and the City may wish to consider approaching the solution from the municipal street and providing water quality treatment/mitigation for the flows from the streets, including runoff from driveways from single family lots. The City has high-level encouragement for Green Infrastructure, and is recommended to do a feasibility study to determine areas that would benefit from roadside treatment options – similar to City of Vancouver, Bellingham, Seattle, Portland, etc. There are considerations for maintenance and appearance of such facilities.

15.3 Protect Natural Systems as Natural Assets

It is increasingly recognized that natural systems provide a wide variety of services to society that have significant value and which should be recognized. Recent studies in BC[26][27] have calculated and documented the values of various natural assets in order to show that the services provided by the natural systems have value that exceeds the value of man-made infrastructure that might be used to replace the natural assets and provide a portion of the same services.

The City of Maple Ridge has a wealth of natural areas that provide benefits and services to the public such as:

- Support public health with green spaces for recreation, relaxation and mental health;
- Trees and vegetation support and benefit air quality;
- Green spaces mitigate the heat island effect of development and provide natural cooling which reduces energy consumption and green house gas emissions;
- Trees and green spaces intercept rainfall and provide stormwater management services including:
    - Interception of rainfall by vegetation,
    - Infiltration or absorption of rainwater into the ground and feeding of groundwater to support other uses such as drinking water and irrigation and to provide slow exfiltration of groundwater into the creeks as baseflows through the summer months,
    - Attenuation of flows in natural ponding/storage areas,
    - Provide resiliency for increasing rainfall and runoff flows due to climate change, and
    - Soil and vegetation support water quality in creeks and receiving waters through biofiltration; and
- Unique ecosystems such as Blaney Bog provide biodiversity and preservation of such areas supports resiliency of the large ecosystem.
    - Particularly valuable fish habitat was identified in two locations, the 800-metre section of Blaney Creek upstream of the 224th Street bridge and the North Alouette River upstream of the 232nd Street bridge, where 13% of the river area supports 63.8% of the fish biomass. The City is advised to work with other agencies to explore how this valuable aquatic habitat can be effectively protected.

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[26] *Towards An Eco-Asset Strategy in the Town of Gibsons,* 2016, and https://gibsons.ca/sustainability/natural-assets/.
[27] Municipal Natural Assets Initiative: City of Nanaimo, BC, at https://mnai.ca/media/2018/07/MNAI_Nanaimo-Final.pdf

It is recommended that the City build up documentation of the many natural assets that the City possess, linking the assets with the services they provide. This should be viewed as a long-term effort and will be part of understanding the roles and benefits of natural assets at the City. A better understanding of the City's natural assets will also help the City staff to be able to account for these assets and the benefits they provide in planning work and decision-making about development proposals. Among the assets to document and track are streams and rivers, ponds, wetlands, bogs, old growth forests, aquifers and aquifer recharge areas, parks and green spaces, and any high quality or high value habitat areas.

This work to document and understand the natural assets will be a preliminary phase in developing a long-term natural asset management strategy for the City. An understanding and accounting of the natural assets that the City relies on can provide support for protection and maintenance of the natural assets in a way that is similar to how man-made infrastructure assets are maintained and budgeted for, in order to protect and retain these natural assets for the future.

15.4 Other Policy Recommendations

Utilize Existing Policies

The City has in place policies and measures that address many of the concerns raised in past reports and in stakeholder consultation for the ISMP. The City should value the work already done, and utilize and apply the existing policies, as well as review the policies regularly and update them when needed. Some of the key policies that support watershed health and the Vision of the ISMP include:

- Watercourse Protection Bylaw to protect the integrity of natural streams.
- Erosion and Sediment Control (ESC) Schedules and requirements to control sediment on development sites and prevent it entering and impact the storm drainage system and downstream receiving waters.
- Municipal Urban Tree Management Strategy to protect and manage urban trees, particularly large trees that provide multiple stormwater and societal benefits.
- Pesticide Use Control Bylaw to ban cosmetic use of pesticides.
- Soil Deposit Bylaw to regulate the use and application of fill materials.
- Streamside Protection Bylaw to protect riparian areas.
- Natural Features Development Permit to protect natural features and green space during development.
- Ongoing invasive species management work.
- Ecological Network Management Strategy to protect wildlife corridors (planned).
- Green Infrastructure Strategy (in development).

Enhance Existing Programs and Policies

In addition to the stormwater design criteria improvements recommended above, other enhancements to existing programs and policies are also recommended for the City's consideration.

Incorporate Climate Change

Climate change processes are already affecting the performance and level of service of stormwater infrastructure in BC as documented by studies by municipalities and others. Climate change should be incorporated in planning and sizing for stormwater infrastructure including sewers, culverts, and detention ponds. This can be accomplished by providing one or more predictive IDF curves to represent expected future climate change rainfall for use in sizing stormwater facilities. Alternatively, the City could specify a percentage increase in the rainfall amounts from the existing IDF curves in order to account for climate change. Metro Vancouver has developed guidance to assist municipalities in planning for and incorporating climate change in their service delivery.

However, much existing infrastructure that is already constructed is not sized for increased climate change flows and has a service life that extends well into the time frame of expected climate change impacts. Municipalities need to incorporate resiliency for climate change to accommodate the expected changes without wholesale upgrade of the infrastructure systems. Recommended aspects of resiliency planning include:

- Retrofitting of green infrastructure and street trees in public spaces in existing developed areas to mitigate the effects of increased rainfall (particularly evergreen trees that will remain effective at reducing runoff volumes during wet winter months).
- Promoting infiltrating green infrastructure/ source control facilities to support creek baseflows as summers become hotter and drier.
- Study and assessment of overland flow routes and potential for flooding due to increased overland flows with climate change.
- Encouraging homeowners who have reverse graded driveways and basement connections to the minor system to retrofit their homes with backflow prevention devices and sump pumps.
- Re-assessment of the potential impacts of large-scale flooding on communities and municipal assets and planning for management, mitigation, and recovery through advance emergency management planning, should large flooding events occur.

Erosion and Sediment Control Practices and Monitoring

The City outlines requirements for Erosion and Sediment Control (ESC) on land development construction sites in its Watercourse Protection bylaw. The bylaw requires that a developer's qualified professional develop ESC plans and provide regular monitoring reports. The City's Environment staff follow up on public complaints, carrying out routine inspections on under-achieving sites. Monitoring of development sites must continue until all surfaces are stabilized with permanent treatment such as sod and landscaping.

City staff have indicated that a challenge is that ESC plans are being prepared, implemented and maintained by professionals from different disciplines having a range of training and knowledge in ESC and stormwater management. It is recommended that professionals preparing ESC plans and overseeing and monitoring the implementation of ESC plans be required to have ESC-specific training, education and certification. This will better ensure that the City's resources are protected from ESC related issues associated with development, infrastructure and construction projects. Additionally, the City would benefit from requiring a quantitative approach to ESC planning such as the Revised Universal Soil Loss Equation (RUSLE).

Promote Green Infrastructure to Mitigate Impacts of Development

Green infrastructure uses vegetation, soils, and engineered practices to mimic natural hydrologic and ecological functions as much as possible, with the purpose to manage wet weather impacts and create healthier urban environments by providing several environmental, economic, and health benefits. Green infrastructure can be designed to reduce negative impacts of development on runoff, e.g. by providing flood protection, volume reduction, and pollution capture, as well as providing multiple other benefits such as groundwater recharge, runoff temperature reduction, heat island effect mitigation, CO_2 reduction, and biodiversity. Green infrastructure can vary in size and scope, from lot level to watershed scale, to offset development impacts of development and climate change.

The important role of green infrastructure in creating a more sustainable community and improving the built environment, was acknowledged already in the Centre Area Plan[28] (adopted in November 2008). The City is also currently developing a Green Infrastructure Management Strategy. The City can consider regulatory, funding and finance strategies and incentives to encourage developers to follow the vision of integrating green infrastructure in the Town Centre and other areas, including major corridors. Strategies and incentives that could be investigated further include, but are not limited to:

- Stormwater fees or area-specific development cost charges dedicated to fund stormwater management, planning, and outreach activities within a specified area. Can be combined with reduced stormwater fees or charges in exchange for green infrastructure practices;
- Special assessment fees for new development in environmentally sensitive areas or land integral to the City's green infrastructure policy;
- Stormwater tax to support construction of stormwater management facilities and green infrastructure;
- Review zoning and subdivision regulations to enhance opportunities for green infrastructure; and
- Develop design guidance and standards for green infrastructure in Maple Ridge to clarify what is allowed, efficient and best practice. This will include specifications for products and materials, such as standard bioretention media, as well as monitoring and maintenance requirements.
- Encourage bio-engineering methods for bank stabilization and erosion remediation rather than riprap, and consider including in the Engineering Design Criteria Manual as the preferred approach.

Related to this topic, is the "Haney Clay" soil type and the limitations this is may pose to rainwater infiltration into the subsoil. Stakeholders have reported this clay provides almost no infiltration, therefore increased impervious lot coverage in such areas may have little effect on overall stormwater runoff rates under saturated surface conditions. Additionally, this clay is seen as a major limitation on the performance of green infrastructure initiatives involving infiltration, such as increased depth of topsoil. The City is advised to retain a geotechnical engineering consultant to document information on the characteristics, extent and depths of Haney Clay in Maple Ridge. The additional information will facilitate discussions on implementation of green infrastructure in Maple Ridge.

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[28] Section 10.4 of the Maple Ridge Official Community Plan Bylaw No. 7060-2014

Allow for Off-Site Stormwater Management

In cases where full on-site stormwater management compliance is not achievable, the City may consider allowing property owners to achieve (a portion of) their obligation off-site. These off-site management facilities could be placed on adjacent private property provided by the developer, on adjacent public property (with sufficient lifecycle maintenance funding provided), on public property elsewhere, or on a third-party private property. If off-site stormwater management is used, this may reduce the developable area of the offsite property as the area of the off-site facility would be set aside and could not be developed. In all cases, it is important to ensure long-term operation and maintenance of facilities and an operation and maintenance agreement is strongly recommended. The maintenance plan should lay out required maintenance activities and frequencies, documentation of maintenance and monitoring activities, assessment of facility performance and responsible parties for all maintenance activities.

Where stormwater management targets cannot be fully achieved on-lot, it must be recognized that the closest available space in which to manage the excess water is likely to be the adjacent road right-of-way. The City will need to specifically consider the use of the road right-of-way for stormwater management in order to meet the Tier A and B criteria for development. This approach has been used successfully[29] in Maple Ridge in the Silver Maples subdivision. While maintenance and other concerns must also be considered, the road right-of-way provides the most immediately available space to implement off-site stormwater management.

In the cases where the off-site facility is on public land, the City would take ownership of and maintain it, through funding provided by the property owner. Some municipalities in BC charge a fee for properties where stormwater source control compliance is not achieved, and the funding is dedicated to stormwater management projects on public land. Off-site stormwater management on adjacent public property would use public rights-of-way such as streets or sidewalks for this purpose.

Where stormwater compliance cannot be met on adjacent land, for example in the Fraser River Escarpment area, on sites with geotechnical constraints, or in small subdivisions, developers should provide compensation measures to the City and construct off-site stormwater management infrastructure elsewhere. It is recommended that the City identify sites for and prioritize off-site management projects it would like to see constructed to fulfill stormwater objectives.

Off-site stormwater management on a third-party private property makes sense where stormwater fees are enforced; this approach is employed in several cities around the US and a few in Canada. An owner of a site installs stormwater management facilities that are large enough to accept additional runoff from a site where stormwater management is technically infeasible. Property owners who accept additional runoff are then rewarded with lower stormwater fees. However, the applicability of an off-site stormwater management program in Maple Ridge, and how such a program could be structured, would require further investigation.

Harmonize Maintenance Levels of Service for Green Infrastructure with Funding

The City of Maple Ridge has been at the forefront of implementing on-lot and roadside green infrastructure practices with the subdivision developments in the Silver Valley area that incorporate:

- Roof leader disconnection
- Absorbent landscaping on lots

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[29] Post-construction monitoring of the roadside infiltration rain gardens showed that they met the 90% capture target of the Tier A criteria.

- Roadside rain gardens to treat road and driveway runoff
- Rain garden and detention facilities

The City first addressed the need for dedicated maintenance funding through Local Area Servicing contracts, but as the benefits of the green infrastructure are more broadly shared across the community, placing this on a few homeowners may not be an equitable approach. Also, managing a growing number of such unique area-specific contracts is not considered efficient. The City is currently seeking a more streamlined and equitable approach to its maintenance of a growing number of green infrastructure assets.

City staff have reported instances where there is a discrepancy between public expectations for landscaping aesthetics and the funding set aside for green infrastructure maintenance. The City would benefit from establishing target levels of service for green infrastructure maintenance (both functional and aesthetic) and reconciling these service levels with maintenance funding. Going forward, it will be important to:

- Consult maintenance staff during the design of green infrastructure
- Communicate with the public on the benefits of green infrastructure and how it will look in an as-maintained (not new) state
- Allocate funding for maintenance based on service level targets
- Ensure that increases to maintenance budgets keep pace with the implementation of green infrastructure occurring through development as well as retrofits to existing areas

The Green Infrastructure Pilot Program recommended in this ISMP (Section 17.4) will support the above goals, allowing the City to:

- construct and assess different options for green infrastructure designs
- demonstrate the as-maintained state of different green infrastructure designs
- optimize aesthetics versus maintenance funding
- develop accepted designs to include in the City’s Design Criteria Manual for replication
- establish unit maintenance costs associated with different design types for budgeting purposes.

Recognizing Value of Green Stormwater Infrastructure and Best Management Practices

It is recommended the City prioritise establishing maintenance service levels for green stormwater infrastructure and best management practices due to the important benefits provided. Stormwater source controls are not merely an alternative form for provision of drainage services and they should be supported and have funding and maintenance provided for the suite of services they provide to the City and the residents of Maple Ridge including:

- Stormwater management including conveyance
- Water quality treatment to remove pollutants from runoff and prevent their discharge and accumulation in the receiving waters from the stream to the ocean, supporting:
    - clean water,
    - recreational water uses,
    - fisheries habitat and values, and

  - wildlife including waterfowl
- Invasive plant species management
- Flow and volume mitigation to reduce erosion and wear, and prevent the need for repairs, on receiving stream reaches
- Resiliency against nuisance flooding from increased magnitude of storm events due to the changing climate
- Temperature mitigation for runoff from pavement in the warm season to support cool water temperatures for fish habitat
- Mitigation of the heat island effect of increasing summer air temperatures in paved urban areas by breaking up the pavement with green space and shade
- Supporting plant, insect, and small bird biodiversity, including pollinator-friendly vegetation
- Social and mental health benefits of green spaces for residents in the urban/suburban context
- Reduction in CO_2 supporting the fight against climate change
- Reducing air pollution and improving breathability in urban areas

Enhance Protection for Sensitive Areas

As discussed in Section 16 and Table 16-1, there are several regionally important areas of sensitive ecosystems that should be protected from development and other impacts. While significant protections are in place, expansion of some of these would be beneficial, including:

- Increase riparian setbacks beyond the minimum regulatory requirements in sensitive areas,
- Provide dedication where possible of these sensitive protected areas to park conservation, and
- Require environmental impact assessments for development adjacent to or draining to sensitive areas.

Additionally, the City of Maple Ridge should continue to use the Watercourse Protection Development Permit which is based on the 2001 Streamside Protection Regulation (SPR) under the Provincial Fish Protection Act [1997] for all development and building permits within 50 m of the top of bank from watercourses and wetlands. Many scientific studies have shown that a wider riparian area, particularly a forested riparian area, is associated with better stream health and the City has retained the current policy in the interest of supporting and maintaining healthy riparian areas. To clarify, a permit is required for development occurring within 50 m of the top of bank. This is different from the stream setback requirement.

Wildsafe BC supports wildlife corridors for the safe movement of wildlife. Wildsafe indicates the suggested minimum distance for a wildlife corridor based on the topography of Maple Ridge is 50 to 100 meters. While these setbacks may be challenging to achieve, they might be accomplished as part of dedicated protection for the sensitive areas.

Enhance Invasive Plant Species Management

The City has an ongoing program for removing invasive plant species within public lands as reported by private citizens and City staff. The City retains contractors to undertake the removal of invasive plants, focusing on Japanese Knotweed. The City's efforts are augmented by volunteer groups such as ARMS and KEEPS (removing plants other than Knotweed) as well as Metro Vancouver.

For publicly held land, knotweed is generally considered to be under control within the City's developed parks; however, knotweed is known to exist in greenbelt areas, ditches and undeveloped road rights of ways.

On private property, the City's bylaw regulating 'Untidy and Unsightly Premises' requires homeowners to manage Noxious Weeds, including Japanese Knotweed. The City's Environmental staff investigate reports of Knotweed by private citizens or other agencies and work with the City's Bylaw department and homeowners to effect their removal.

For new developments, the City of Maple Ridge requires the removal of invasive plants and restoration with native species within riparian areas. This is part of the Development Permit for any lands being developed within 50 m of a watercourse. A maintenance and monitoring period of 5 years is part of this agreement to ensure invasive species do not re-populate the area.

In order to effectively control the proliferation of invasive plant species, the City requires information on the extent of infestation and how it is trending. The City is therefore recommended to invest in improved invasive plant species mapping. The most effective way to accomplish this may be through remote sensing technology. The City is advised to explore the cost and feasibility of mapping invasive plant species using LiDAR and hyperspectral imagery. Employing this advanced technology could allow for a City-wide map showing the locations of invasive plant species. Trends identified through periodic mapping would help the City prioritize and identify funding requirements for managing these invasive plant species.

Protect Well Capture Zones and Aquifers from Contamination

There are over 400 registered[30] groundwater wells in Maple Ridge, used mainly for domestic drinking water purposes. To avoid contamination of water wells from stormwater infiltration facilities, a minimum horizontal setback distance of 60 m is recommended, as outlined in the BC Ministry of Environment *Underground Stormwater Infiltration* documentation[31]. The protective setback distance should be determined based on site-specific conditions, such as groundwater flow directions and the vulnerability of the water well. Aquifers located in the Blaney Creek, North Alouette Catchments and Fraser River Catchments are generally moderately vulnerable to contamination from surface sources with limited natural protection against contamination introduced at the ground surface. Although low permeability soils such as till, silt and clay, are found in the catchments (see Figure 4-1), shallow water tables lead to increased vulnerability in most cases. Infiltration of runoff may pose a higher risk to groundwater contamination in these vulnerable areas. Well-capture zones should be considered and the need to pre-treat stormwater to reduce the pollutant loads be investigated as part of the infiltration facility planning and design process.

Investigation of well and aquifer characteristics, such as hydraulic gradient, groundwater flow direction and velocities, and recharge rates, was out of scope for this ISMP but could be mapped separately in a future study.

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[30] According to the he BC Groundwater Wells and Aquifers mapping (https://apps.nrs.gov.bc.ca/gwells/). Not all groundwater wells used for domestic purposes are registered, as registration was voluntary until 2016.

[31] http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/underground_stormwater_infiltration-2014.pdf

Promote Regional Development Planning

In general, development planning tends to focus on the area of the proposed development, and does not consider downstream impacts in the planning for individual sites. The City could consider re-aligning development planning to better consider regional issues, values, and solutions, by instituting regional planning processes for areas where development is or is expected to be widespread. These efforts could take the form of area plans or neighbourhood plans and would ideally be used to influence the development planning for individual sites.

Regional planning approaches may also be of use outside of the new development context to guide infill and re-development such as conversion of land use to other types and to coordinate with other stakeholders relative to specific issues that could include logging, quarry development, and agricultural use changes such as greenhouse installations.

Regional planning can be a mechanism of utilizing larger-scale planning efforts, and incorporating the values and recommendations from the larger plans, into site-scale planning. Regional planning can also help provide leadership for the development of community stormwater detention facilities that can benefit a development area or mitigate the anticipated impacts of climate change on existing neighbourhoods.

Promote Public Education and Awareness

The process of developing this ISMP included consultation with City staff, stakeholder groups, the general public and others at varying levels. While there are normal differences of opinion on different aspects of watershed health across and even within different groups, there is evidence that increasing the levels of communication both within the City between departments and between the City and the public would be beneficial. Increased communication and awareness of the City's efforts and programs that support watershed health would improve public confidence in the City's efforts, and improve coordination between the City and stakeholder groups that have close ties to watershed health.

News Items and Notices

Education and outreach can take many forms. The City already has numerous public information and outreach programs in place such as the Maple Ridge This Week newsletter, and website and Facebook news postings. City staff can take advantage of these resources to promote and raise awareness of small and large efforts that support watershed health in different ways. Notice of success stories, completed projects, and issues resolved can provide positive feedback that the City is putting effort into good works and solving problems.

Funding and Collaborating with Stakeholder Groups

The City gives funding annually to KEEPS (www.keeps.org) and ARMS (www.alouetteriver.org), who both do education and outreach and engage in restoration projects. The City can build on the relationships with these groups, and others such as the AVA, to develop and promote joint projects, and highlight the benefit to the community of providing public funding to these groups. In addition, the City may find support and collaboration with agencies, such DFO, BC FLNRORD, BC MoE, BC MoAFF, and with other jurisdictions such as Pitt Meadows and Metro Vancouver Parks, to pursue restoration and enhancement work, as well as coordinate on policies and work toward common goals and benefits.

Educational Signage

Educational signage and kiosks in public areas can raise awareness of the benefits of natural features and systems as well as highlight projects that the City has done. In particular, signage that explains the mutual benefits of natural systems and mimicking natural hydrologic benefits with flood and rainwater management can increase the public perception of the links and benefits of these types of systems. Green infrastructure systems in particular can benefit from education signage as the public may not otherwise be aware that they are highly designed systems that provide multiple benefits and require maintenance and protection to remain effective.

School Programs

The City can work with schools to develop age-appropriate presentations, information packages, or mini-field trip programs. Such programs could engage children's awareness of the natural systems that need protection as well as understanding of the interactions of the natural world and the built world. Earth Day provides a key opportunity to talk about and understand both people's impacts on the environment and the wide variety of things that people can do to reduce those impacts. Stormwater management, conservation and water management and linking runoff to impacts on fish and watershed health is a great topic for Earth Day, for kids and grown-ups.

Celebrate Success

Maple Ridge can take the opportunity to celebrate the current practices and policies that work to protect and enhance the health of the City's watersheds and natural systems. One of the key successes achieved to date has been progressive riparian watercourse setbacks and designation of environmentally sensitive protection areas. The City could create a recurring news items to post on its website to highlight the current beneficial policies and raise awareness of what the City is already doing to protect and preserve watershed health.

The City could highlight how important the remaining natural assets are by posting news items and/or web pages that describe the natural assets the multiple services and benefits they provide our community, including the hydrologic benefits related to stormwater management and the 3 tier stormwater criteria.

Publishing monitoring data on the City's major watersheds would allow the public to share in knowledge regarding the health of creeks and rivers in the City. And over time, publishing the changing water quality and watershed health values would show the City's progress and success (or the need for additional efforts) in maintaining and improving those values.

Dialog with External Stakeholders

The Blaney Creek and North Alouette River watersheds are affected by the stewardship of several stakeholders. For example, the North Alouette River is occupied by the Malcolm Knapp Research Forest (MKRF), Golden Ears Provincial Park, Metro Vancouver parkland, the Agricultural Land Reserve and private landowners. The Blaney Creek Watershed is occupied by the UBC MKRF, part of Woodlot W0037 licensed to the UBC MKRF, Metro Vancouver, the Agricultural Land Reserve and private landowners. Both watersheds exist within the traditional territories of the Katzie and Kwantlen First Nations.

Discussion and coordination with other jurisdictions on dikes, filling of land in the lowland areas, sediment concerns, and agricultural concerns (water withdrawls, quality of runoff water, need for riparian vegetation/habitat complexity adjacent watercourses) would help promote and maintain watershed health. As an affected party of the actions of others, the City needs to maintain and expand dialog with the external stakeholders that can directly affect the health of the watersheds. The City could engage to be part of a watershed co-operation group that could include:

- UBC Malcolm Knapp Research Forest,
- The Province of BC (Ministries of Agriculture, Environment, and FLNRORD)

- BC Parks
- The City of Pitt Meadows
- Metro Vancouver Regional Parks
- First Nations
- Fisheries and Oceans Canada
- Agricultural Land Commission
- Stewardship groups

The City could coordinate watershed co-operation groups for the Blaney, Alouettes (North and South), and Kanaka Watersheds. Developing draft terms of references would allow for a review of the potentially significant staff time and budget requirements for the groups. This would assist in identifying the City's commitment costs for these groups and priority setting for this work relative to other initiatives.

There is widespread concern among stewardship groups that agricultural activities may be harmful to watershed health in various ways. These groups would be very supportive of increased discussion, education, and coordination with the City, the Province and others on understanding and reducing impacts from agriculture.

The Province and DFO were interested in potential improvements to waterways. FLNRORD expressed interest in seeing "mitigation measures such as increasing riparian cover, instream habitat complexity, and stream connectivity. . . to reduce predation pressures on outmigrating [salmon] fry. DFO staff mentioned the lack of riparian vegetation/habitat complexity in the downstream agricultural flatlands for outmigrating fry and asked about enhancement projects. Again, this is a situation where increased collaboration between various agencies and groups could result in watershed health improvements, while considering dike configuration and maintenance requirements.

The BC Ministry of Agriculture, Food and Fisheries promotes an Environmental Farm Plan Program (EFP) which supports farmers achieve improved environmental stewardship over their lands[32]. The EFP considers erosion control structures, vegetation, stream crossings, biodiversity, etc. The EFP is delivered by a 3rd party, the B.C. Agricultural Research & Development Corporation (ARDCorp), and grant funding is available to select participants for implementing environmental measures. Farmers can alternatively opt to achieve Salmon-Safe Agricultural Certification[33]" through the Salmon-Safe BC program delivered by the Fraser Basin Council. The City could work with the BC MoAFF, ALC, Pitt Meadows and others to encourage farmers to participate in the EFP or the Salmon-Safe Certification program.

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[32] https://ardcorp.ca/programs/environmental-farm-plan/
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/environmental-farm-planning/efp-reference-guide/full_efp_reference_guide.pdf
[33] https://www.salmonsafe.ca/agriculture-site-certification

16. Proposed Environmental Measures for Maintaining and Enhancing Watershed Health

Maintaining and enhancing the health and integrity of the Blaney, North Alouette, and Fraser watersheds will require an overarching strategy, political will, enforcement, participation of all levels of government, and collaboration with stakeholders and people active in the community.

Based on the assessments completed for this ISMP, there are 26 projects proposed to maintain and enhance watershed health. See Table 16-2 and Figure 16-1 to Figure 16-3 for details of these projects. Projects 1-7 have been identified as projects that will maintain watershed health, while Projects 8–26 have been identified as projects that will improve stream or watershed health over and above the existing condition.

As many of the proposed projects can be adjusted to suit budget needs a potential cost range has been provided. The cost of each project will depend on factors such as scope, stakeholder/volunteer involvement, and funding availability.

Projects have been categorized as high, medium and low priority projects based on project type (i.e. protection, restoration), the importance to overall biodiversity and ecological health of the catchments and ease of implementation.

As with any projects that impact streams within the province, these projects have been identified in accordance with the BC Environmental Mitigation Policy[34] – in particular the mitigation hierarchy. Impacts should be avoided, minimized, and restored on-site wherever possible prior to considering offsets/compensation.

Protection of Existing, High-Value Natural Ecosystems and Habitats as Natural Assets

The North Alouette and Blaney watersheds contain sensitive and regionally significant ecosystems that provide habitat for large populations of salmon, diverse wildlife, and many endangered species. To maintain and enhance the health of these watersheds, and protect the natural asset values of these system, these ecosystems must be protected. Metro Vancouver Regional Parks has been working to protect these ecosystems through ongoing acquisition of lands for the Codd Wetland Ecological Conservancy Area and the Blaney Bog Regional Park Reserve.

Codd Island Wetland Ecological Conservancy Area
(Source: CMR)

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[34] https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/laws-policies-standards-guidance/environmental-guidance-and-policy/environmental-mitigation-policy

For this ISMP, seven of the proposed environmental projects (all high priority) involve protecting existing ecosystems of high value. Some of the major values to protect for the Blaney and North Alouette watersheds are outlined below and summarized in Figure 16-1 and Figure 16-2. For details on fish and wildlife habitat values see Appendix C, Sections C.3 and C.5. Project numbers 1 to 7 in Table 16-1 describe the projects that aid in the protection of existing, high-value natural ecosystems and habitats. Figure 16-1 to Figure 16-3 shows the projects' locations.

The Fraser River watershed has been extensively altered by development and has lost much of its original habitat. Although there is no table for values in the Fraser watershed, there is a project to protect a very rare grove of old-growth western redcedar and Sitka spruce in the riparian area of Roslyn Creek (Table 16-2, Project 6).

Blaney Creek Watershed

Together, the Codd Wetland and Blaney Bog form the largest area of off-channel salmonid rearing habitat within the Alouette watershed and provide some of the most important off-channel habitat for rearing juvenile salmon in the lower Fraser River (Gebauer 2001, Gebauer 2002). Juvenile coho, coastal cutthroat trout, and rainbow trout all use the wetland channels, and Chinook smolts are likely to use them for refuge and feeding. Characteristics of these areas that make them particularly good rearing habitat are low gradient channels, flooding, inflow of well-oxygenated water from Blaney, Spring, and Anderson Creeks with good water quality, macroinvertebrates, and cover from overhanging vegetation and undercut banks. The upper reaches of Blaney and Anderson Creeks provide excellent spawning habitat for salmonids.

Blaney Bog is the only documented mound bog-stream fen complex in the Fraser Lowlands and is a site of high biodiversity (Downarowicz 2003). It provides high-quality habitat for many rare and endangered species, including Great Blue Heron, Green Heron, American Bittern, Peregrine Falcon, Northern Red-legged Frog, and Pacific Water Shrew. Sandhill Cranes forage and roost in the bog, and suitable nesting habitat is present (Summers 2001).

North Alouette Watershed

The North Alouette provides extensive, high-quality spawning habitat that supports large populations of salmon. In the 80s and 90s, up to 4600 chum, 200 coho, and 3500 pink returned to the North Alouette to spawn (MOE 2016). Water quality is very important for all phases of the salmon life cycle, especially for eggs, alevins, and juveniles. Balsam Creek, which had excellent water quality during 2016 monitoring, flows into the North Alouette upstream of the longest stretch of high-quality spawning habitat. Water quality in Balsam Creek had no exceedances of MAMF guidelines and had the best water quality out of all of the sites that were monitored. The North Alouette had only two exceedances of MAMF guidelines. Birch Creek is probably also a source of high-quality water. The North Alouette and its tributaries also provide productive benthic invertebrate communities for fishes. Appendix C Section C.3 provides more details on spawning habitat, and Appendix D Sections D.1 and D.2 provides more details on water quality monitoring.

It is noted that there is widening support of protection and restoration projects in Canada and a recent report from the Canadian Parks and Wilderness Society[35] describes the commitments needed on this front stating:

> "Governments should incent natural solutions to climate change, and recognize that protecting and restoring nature can help mitigate climate change impacts"

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[35] https://cpaws.org/wp-content/uploads/2019/07/CPAWS_ParksReport2019_fnl_web2.pdf

> "Governments should work together to develop connectivity strategies at regional, national, and continental scales to ensure wildlife can move unimpeded through the landscape in response to changing climatic conditions."

Environmental Restoration and Enhancement Projects

In addition to protecting existing high-value natural ecosystems and habitats, habitat restoration and enhancement can be completed throughout each watershed to help improve the current conditions of both aquatic and terrestrial habitats. Numerous projects for all three watersheds have been identified including invasive plant species removal, riparian planting, restoring off-channel habitat, creek daylighting, and removing excess riprap from within and along stream channels. Over the three watersheds a total of four restoration projects and two enhancement projects have been identified. Recommended projects (project numbers 8-13) are listed below in Table 16-1 and are located on Figure **16-1** to Figure 16-3.

In future, additional work could be done to assess historical agricultural dikes and ditching to determine if they are still needed or can be modified or removed in order to restore additional habitat area. Agencies such has FLNRORD, DFO and Metro Vancouver Parks have expressed interest in supporting such research and restoration work.

Erosion Repairs

Bank erosion occurs when the bank gradually wears away during periods of high streamflow. Although this process occurs naturally, the development of the surrounding landscape can lead to greater overland flows of water, further accelerating the erosion process. Erosion can cause two major water quality issues to streams, excess nutrients and excess sediment, both of which negatively impact aquatic life and their habitat (Castro and Reckendorf, 1995). Three locations have been identified where erosion of the stream bank is occurring, two in the Fraser River watershed and one in the Blaney Creek watershed. Both locations in the Fraser River watershed are along unnamed tributaries adjacent to private property while the location in the Blaney River watershed is along Blaney Creek and adjacent to a storm outfall adjacent to private property. Although erosion is occurring adjacent to private property it can still lead to impacts such as sedimentation or debris jams further downstream. Erosion of particular sites are typically due to changes upstream in the watershed. For example, erosion in Blaney Creek may be attributed to logging or road construction that occurs in the headwaters of the stream. Repair of erosion sites should use bio-engineering methods rather than riprap whenever possible to enhance the riparian area. Recommended projects (project numbers 1-16) are listed below in Table 16-1 and are located on Figure 16-1 to Figure 16-3. As the sites are adjacent to private property, the City will want to maintain a dialogue with the property owners regarding the erosion sites and any planned projects.

Fish Passage

As salmon and other aquatic species require access to freshwater habitat for rearing and spawning, barriers to fish passage can impede this movement, negatively impacting their populations. Fish passage barriers can be natural (i.e., falls, beaver dams) or anthropogenic (i.e., culvert, rock weirs) in nature. Anthropogenic barriers are the focus for removal as they are an outcome of urban development. One known and one potential (high probability) barriers to fish passage were identified in the Blaney Creek watershed which includes two culverts located along Anderson Creek. Replacement of these culverts would help provide access to additional upstream spawning and rearing habitat. In addition, four potential fish passage barriers have been identified throughout the three watersheds. These potential barriers should be investigated to determine if they are truly fish barriers and if removal would be required to open up access to upstream habitat. Removal of barriers to fish passage (project numbers 17-19) are listed below in Table 16-2 and are located on Figure 16-1 to Figure 16-3.

Water Research and Management

Through the development of this ISMP, areas located within all three watersheds have been identified as either having a potential impact to aquatic habitat and/or having poor water quality. Agriculture and stormwater are the focus of these areas located within the watersheds.

Agriculture is a dominant land-use in the lower North Alouette and Blaney Creek watersheds. Historical diking in Blaney Bog, spring water withdrawals for surrounding cranberry farms, and high nutrient concentrations from run-off all have the potential to pose a major constraint on the productivity of fish stocks migrating through these watersheds. Additional research is needed to investigate whether the potential constraints identified are indeed impacting fish productivity and by how much. Collaboration with the City of Pitt Meadows is important for ensuring a watershed approach is taken.

In addition to research, stormwater runoff has been identified as a source of poor water quality within areas of urban development in the North Alouette and Fraser River watersheds. Poor water quality ranges from low dissolved oxygen and high turbidity to high levels of *Escherichia coli* (*E. coli*) and fecal coliforms and heavy metals. As poor water quality greatly impacts fish and their aquatic habitat, opportunities to help mitigate against the negative impacts should be identified.

Water research and stormwater management projects are listed below in Table 16-1 as project numbers 20-22 and 23-24, respectively and are located on Figure 16-1 to Figure 16-3.

Public Engagement and Education

Public engagement is a way of bringing together community members such as citizens, non-profit organizations, businesses, and government together to help solve public problems. Engagement helps reach out to the broader community as well as allowing the community to be active participants. Communicating with the public can range from informing and education to involving and collaborating with the public. In terms of this ISMP, public engagement and education can be used to help inform the public regarding invasive aquatic species and how they can help prevent further spread within the watershed, as well as using engagement as a tool to help identify and collect additional information that may be of importance to add to the City of Maple Ridge online mapping system. Stewardship groups such as ARMS and AVA are also potential partners in restoration and enhancement efforts, who may be able to collaborate with the City to pursue funding as well as provide volunteer manpower for some types of work. Further information regarding public engagement are shown in Table 16-1, project numbers 25-26. The City may be able to collaborate with the federal government and others in future initiatives as part of the Pacific Salmon Strategy Initiative[36], which includes “integrated management and collaboration” as one of its four pillars.

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[36] https://www.dfo-mpo.gc.ca/campaign-campagne/pss-ssp/index-eng.html

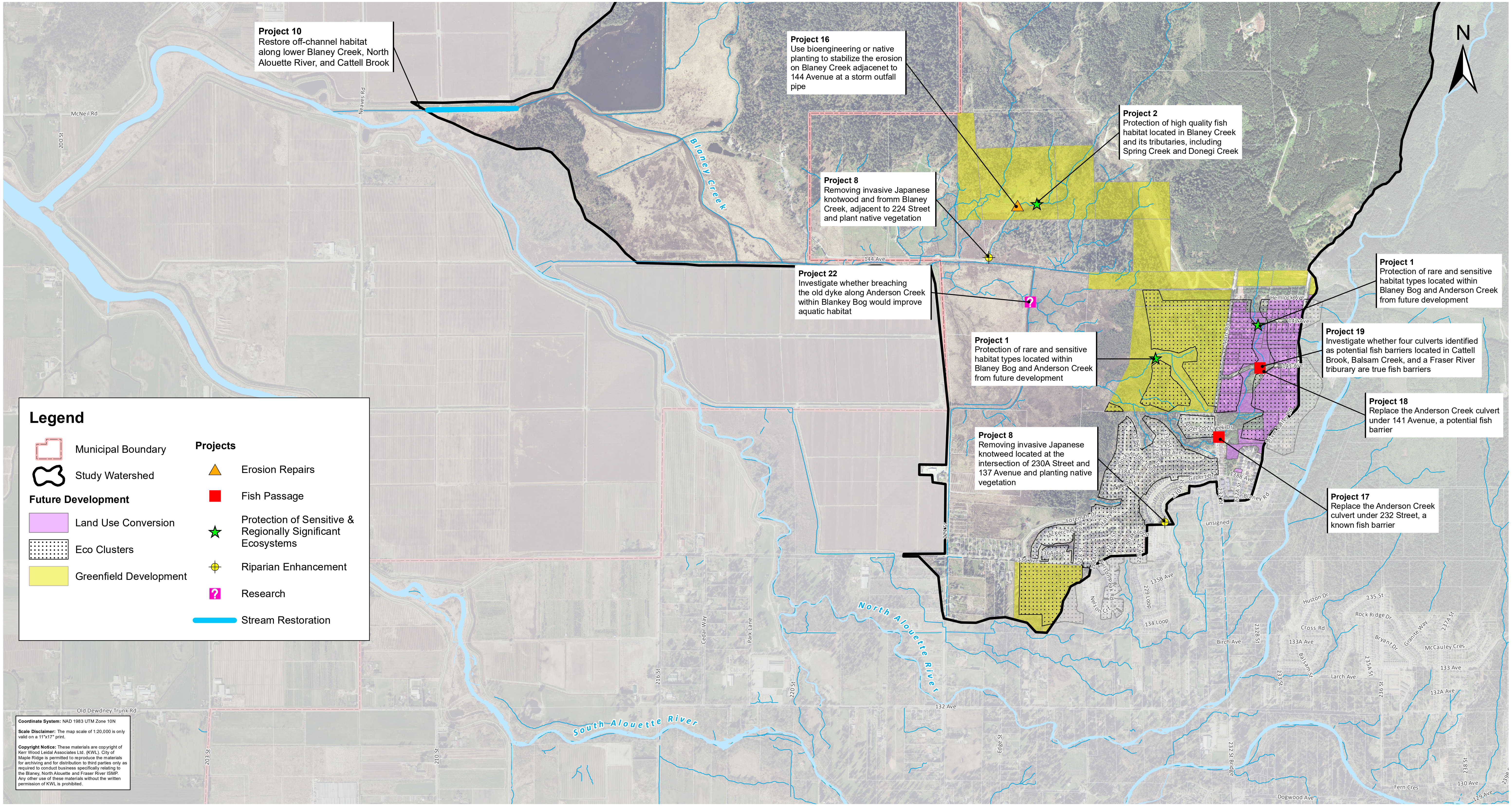
Table 16-1: Projects to Maintain and Improve Watershed Health

No.	Project	Watershed	Rationale	Benefit	Strategies	Estimated Cost	Priority
Protection of Sensitive and Regionally Significant Ecosystems							
1	Protection of rare and sensitive habitat types located in Blaney Bog and Anderson Creek from future development.	Blaney Creek	Both Blaney Bog and Anderson Creek are rare bog-fen wetlands and are regionally significant habitats for many endangered species and juvenile salmonids.	1. Protection of rare, regionally significant ecosystems, species at risk habitat, and one of the more important areas for rearing salmonids in the lower Fraser River. 2. Unique amenity for residents. 3. Help provide flood mitigation.	1. Require 30 m or more riparian setback for development of greenfield sites, land use conversion, and infill development in sensitive and regionally significant ecosystems. 2. Change zoning of high value areas (e.g, 30+ m riparian setbacks, rare ecosystems, habitat for endangered species, wetlands, and steep banks) to park/conservation. 3. Require all developers to prepare environmental impact assessments as well as set aside conservation areas. Impact assessments and conservation areas will require approval by city as well as consultation with the public and other stakeholders. 4. Require all developers to install, maintain, and meet the most stringent best practices for stormwater management. Developers should also be responsible for third party compliance monitoring (e.g. long term water quality both pre and post construction). 5. Acquire lands that are hazardous to build on (i.e. low floodplains, frequently flooded areas, steep banks and gullies, and along river channels). 6. Work with Metro Vancouver Parks to expand the existing Blaney Bog Regional Reserve. 7. Work with non-profits that acquire land for conservation, with the option of public access for amenity.	None for City of Maple Ridge (less area for future development)	High
2	Protection of high quality fish habitat located in Blaney Creek and its tributaries, including Spring Creek and Donegani Creek.	Blaney Creek	These streams provide high quality rearing and spawning habitat for salmonids, which is regionally limited.	1. Protection of one of the most important areas for rearing salmonids in the lower Fraser and contains high quality spawning habitat.			
3	Protection of high quality water within Balsam Creek from potential impacts of future development.	North Alouette	A source of high quality water to excellent spawning habitat located in the North Alouette, which is regionally limited.	1. Protection of high quality water for spawning salmon downstream.			
4	Protection of high quality fish habitat within the Upper North Alouette River from potential impacts of future development.	North Alouette	These streams provide high quality spawning habitat for salmonids, which is regionally limited.	1. Protection of excellent spawning habitat.			
5	Protection of high quality water within Birch Creek from potential impacts of future development.	North Alouette	A source of high quality water to excellent spawning habitat located in the North Alouette, which is regionally limited.	1. Protection of high quality water for spawning salmon downstream.			
6	Protection of rare old growth riparian habitat along Roslyn Creek.	Fraser River	A rare stand of old growth western redcedar & Sitka spruce exist in an area designated as low density residential.	1. Protection of rare old growth forest patch. 2. Unique amenity for residents. 3. Protection of high value habitat for endangered species. 4. Protection of a wildlife corridor.			
7	Protection of high quality riparian habitat along North Alouette River and Connector A Creek (north of equestrian centre, south of Tim's Trail).	North Alouette	A high quality riparian area exists along these stream systems providing cover, nutrients, and a source of food for both terrestrial and aquatic species.	1. Protection of high value habitat for aquatic and terrestrial species. 2. Unique amenity for residents. 3. Protection of a wildlife corridor.		Cost of private land	
Riparian Enhancement							
8	Remove invasive species and plant native tree and shrub species along riparian areas to help improve both riparian and aquatic habitat.	All Watersheds	To help control the establishment of the invasive plant species, Japanese knotweed and giant hogweed throughout the watersheds.	1. Lower the risk to public health (giant hogweed) and infrastructure (Japanese knotweed). 2. Create higher quality riparian habitat.	Prioitize removal sites by giant hogweed then Japanese knotweed.	$3 - $20K [1] plus city staff time	Medium
9	Planting of native tree and shrub species along Cattell Brook where riparian clearing has occurred.	North Alouette	Sections of Cattell Brook have tittle to no riparian cover due to land clearing.	1. Create higher quality riparian and aquatic habitat. 2. Help protect against bank erosion.	Develop a relationship with the adjacent landowner and create an incentive to conduct riparian planting. Partner with stewardship groups for planting.	$3 - $10K [1]	
Stream Restoration							
10	Restore off-channel habitat along lower Blaney Creek, North Alouette River, and Cattell Brook.	Blaney Creek North Alouette	Sections along these streams have been channelized, reducing in instream habitat for rearing salmonids.	1. Increase the area of rearing habitat for juvenile salmonids. 2. Increase the hydraulic capacity of the streams potentially mitigating flooding. 3. Potentially help offset the negative impacts created by the introduction of the invasive aquatic species, common carp (*Cyprinus carpio*).	Conduct a feasibility study to determine most effective project site. Complete design and build.	$20 - $40K [1]	Medium
11	Daylight portion of Cattell Brook located along cranberry fields north of 136th Avenue and west of 224 Street.	North Alouette	A section of the creek appears to be buried on private property. Buried systems could exacerbate local flooding in the area.	1. Daylighting would increase habitat quality for resident fishes 2. Increase the hydraulic capacity of Cattell Brook.	Develop relationship with landowner, creating an incentive to restore the buried section into a natural feature. Complete design and build.	$100 - $600K depending on alignment & constraints	
12	Remove the riprap weir from the tributary of the Fraser River located between Anderson Place and Wood Street. Channel to be restored and riparian area enhanced.	Fraser River	An artificial riprap weir and fall have been installed within the creeks channel to form a pond. Some surrounding riparian vegetation has also been removed. This weir potentially blocks fish passage.	1. Increase habitat quality for resident fishes 2. Provide access to upstream for resident fishes	Replace the pond with step-pools. Perform riparian planting.	$10 - $20K	Low
13	Remove sections of riprap that have been placed within and along the stream channel adjacent to 230A Street and perform stream channel restoration such as bioengineering or native planting to stabilize banks.	North Alouette	A section of the stream channel has been filled with riprap reducing the quality of fish habitat.	1. Improve habitat for resident fishes 2. Improve habitat for wildlife (access to water)	Remove the riprap. Complete design and build to restore the channel.	$10 - $30K	
Erosion Repairs							
14	Use bioengeering or native planting to stabilize the erosion on the Fraser River tributary adjacent to the property at 22532 Brickwood Close.	Fraser River	A 10 m long by 2 m high erosion site is occuring on the streams right bank near a private property.	1. Bank stabilization would reduce the erosion risk to the private property. 2. Help improve fish habitat.	Complete design of bank stabilization and bioengineering techniques. Build.	$15 - $30K	Medium
15	Use bioengeering or native plantings to stabilize the erosion on the Fraser River tributary adjacent to the property at 22233 River Road.	Fraser River	A 7 m long by 2 m high erosion site is occuring on the streams right bank near a private property.	1. Bank stabilization would reduce the erosion risk to the private property. 2. Help improve fish habitat.	Complete design of bank stabilization and bioengineering techniques. Build.	$15 - $30K	
16	Use bioengeering or native plantings to stabilize the erosion on Blaney Creek adjacent to 144 Avenue at a storm outfall pipe.	Blaney Creek	A 40 m long by 2.5 m high erosion site is occuring on the streams right bank at storm outfall pipe.	1. Bank stabilization would reduce the erosion risk to municipal infrastructure. 2. Help improve fish habitat.	Complete design of bank stabilization and bioengineering techniques. Build.	$15 - $30K	
Fish Passage							
17	Replace the Anderson Creek culvert under 232 Street, a known fish barrier.	Blaney Creek	The culvert is an old wooden culvert plugged with sediment.	1. Replacement would provide access to ~500 m^2 of excellent spawning and rearing habitat for resident trout.	Complete design and build.	$400 - $600K	Medium
18	Replace the Anderson Creek culvert under 141 Avenue, a potential fish barrier.	Blaney Creek	The culvert is undersized for the stream and therefore may be potential velocity barrier.	1. Replacement would provide access to ~550 m^2 of excellent spawning and rearing habitat for resident trout. 2. Replacement would increase the hydraulic capacity of the culvert reducing the risk for flooding.	Replace during future development or during culvert upgrades.	$400 - $600K	Low
19	Investigate whether four culverts identified as potential fish barriers located in Cattell Brook, Balsam Creek, and a Fraser River tributary are true fish barriers.	Blaney Creek North Alouette Fraser River	Unknown if the four identified culverts located throughout all three watersheds are fish passage barriers. If so, they are reducing access to additional spawning and rearing habitat upstream.	1. Investigating would determine is culverts are true fish barriers. 2. If culverts are true fish barriers replacement would open up additional area of spawning and rearing habitat.	Review culverts under different flow conditions	$5 - $15K	Low
Research							
20	Investigate whether water withdrawals in the spring by cranberry farms for frost protecting is killing outmigrating salmon fry.	North Alouette	The withdrawal of water from the North Alouette during the spring may be killing salmon fry as they migrate downstream. This potentially may pose a major constraint on the productivity of stocks.	1. Provide results for informed management. 2. Opportunity to partner with other stakeholders.	Retain consultant or partner with university, Alouette River Management Society, or other group.	$5 - $30K [1] less if partnering with non-profit or university	High
21	Investigate the water quality downstream of agricultural areas to determine if there are impacts occuring to aquatic habitat.	Blaney Creek North Alouette	No water quality testing completed during ISMP downstream of agricultural areas, critical area for fishes	1. Provide results for informed management 2. Opportunity to partner with other stakeholders	Retain consultant or partner with university, Alouette River Management Society, or other group.	$3 - $30K[1] less if partnering with non-profit or university	Medium
22	Investigate whether breaching the old dyke located in Anderson Creek within Blaney Bog would help improve aquatic habitat.	Blaney Creek	Channelization of Anderson Creek by an old dyke historically used for agricultural purposes. This has led to a reduction in both fish rearing and spawning habitat by the alteration in natural flows.	Breaching the dyke may help improve fish habitat within Blaney Bog.	Collaborate with Metro Vancouver Parks.	$5 - $15K	Low
Stormwater Management							
23	Identify opportunities within the Cattell Brook catchment to help mitigate the poor water quality observed during sampling by using stormwater treatment.	North Alouette	Numerous water quality issues observed within the catchment including: low dissolved oxygen, high turbidity and conductivity, and high levels of *Escherichia coli (E.coli).*	1. Improve habitat for fish, ampbhibians, & other wildlife 2. Meet MAMF water quality targets	1. Cost sharing with residents 2. Require during redevelopment/development	$5 - $100K	Medium
24	Identify opportunities within the Fraser River catchment to help mitigate the poor water quality observed during sampling by using stormwater treatment.	Fraser River	Poor water quality issues observed within the catchment including: low dissolved oxygen, high turbidity and conductivity, and high levels of *Escherichia coli* (*E.coli*), fecal foliforms, iron, copper, and zinc.	1. Improve habitat for fish, ampbhibians, & other wildlife 2. Meet MAMF water quality targets	1. Cost sharing with residents 2. Require during redevelopment/development	$5 - $100K	Low
Public Engagement							
25	Use different platforms (i.e. website, signage) to educate the public on both invasive aquatic species .	Blaney Creek North Alouette	The invasive aquatic species, common carp (*Cyprinus carpio*), has been found in Anderson Creek. This species has the potential to spread throughout the two watersheds and can negatively impact native aquatic species.	1. Public is aware that releasing non-native species into any aquatic system may cause detrimental effects.	1. Collaborate with Metro Vancouver Parks and the Ministry of Forests, Lands, and Natural Resources Operations and Rural Development. 2. Implement signage along main walking trail systems and have information available on the City's website.	$5 - $10K[1] plus city staff time	Low
26	Review the City of Maple Ridge online mapping system	All Watersheds	Ensure creeks and stream data is mapped and/or classified correctly. Collect additional data for the online mapping system.	1. Important for individuals to see when planning restoration or city projects	1. Work with non-profits within the watershed. 2. Field reconnaisance and desktop GIS review.	$10 - 20K plus city staff time	Low

1. depending on scope

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP



Project 10
Restore off-channel habitat along lower Blaney Creek, North Alouette River, and Cattell Brook

Project 16
Use bioengineering or native planting to stabilize the erosion on Blaney Creek adjacenet to 144 Avenue at a storm outfall pipe

Project 2
Protection of high quality fish habitat located in Blaney Creek and its tributaries, including Spring Creek and Donegi Creek

Project 8
Removing invasive Japanese knotwood and fromm Blaney Creek, adjacent to 224 Street and plant native vegetation

Project 22
Investigate whether breaching the old dyke along Anderson Creek within Blankey Bog would improve aquatic habitat

Project 1
Protection of rare and sensitive habitat types located within Blaney Bog and Anderson Creek from future development

Project 1
Protection of rare and sensitive habitat types located within Blaney Bog and Anderson Creek from future development

Project 19
Investigate whether four culverts identified as potential fish barriers located in Cattell Brook, Balsam Creek, and a Fraser River triburary are true fish barriers

Project 18
Replace the Anderson Creek culvert under 141 Avenue, a potential fish barrier

Project 8
Removing invasive Japanese knotweed located at the intersection of 230A Street and 137 Avenue and planting native vegetation

Project 17
Replace the Anderson Creek culvert under 232 Street, a known fish barrier

Legend

▭	Municipal Boundary
▭	Study Watershed

Future Development

🟪	Land Use Conversion
▦	Eco Clusters
🟨	Greenfield Development

Projects

▲	Erosion Repairs
🟥	Fish Passage
★	Protection of Sensitive & Regionally Significant Ecosystems
⊕	Riparian Enhancement
?	Research
━	Stream Restoration

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:20,000 is only valid on a 11"x17" print.

Project No.	173.188
Date	April 2020
Scale	1:20,000

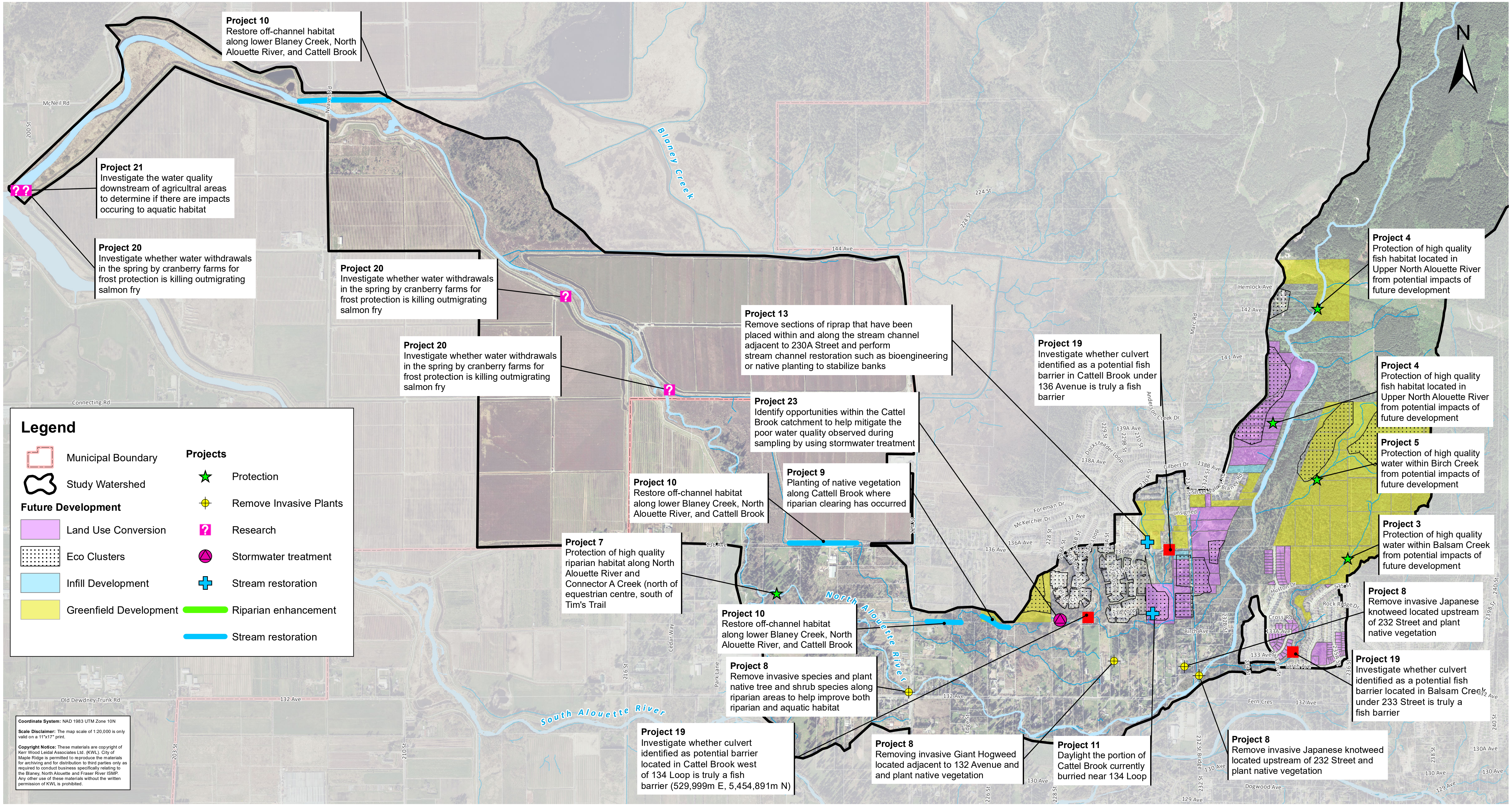
Projects to Maintain and Enhance Watershed Health

Figure 16-1

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\20200430\173188_Fig16-2_Project_Enhance_Watershed_Health_North_Alouette.mxd Date Saved: 2020-04-15 3:50:12 PM | Author: rtaylor

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP



Project 10
Restore off-channel habitat along lower Blaney Creek, North Alouette River, and Cattell Brook

Project 21
Investigate the water quality downstream of agricultural areas to determine if there are impacts occuring to aquatic habitat

Project 20
Investigate whether water withdrawals in the spring by cranberry farms for frost protection is killing outmigrating salmon fry

Project 20
Investigate whether water withdrawals in the spring by cranberry farms for frost protection is killing outmigrating salmon fry

Project 20
Investigate whether water withdrawals in the spring by cranberry farms for frost protection is killing outmigrating salmon fry

Project 13
Remove sections of riprap that have been placed within and along the stream channel adjacent to 230A Street and perform stream channel restoration such as bioengineering or native planting to stabilize banks

Project 23
Identify opportunities within the Cattel Brook catchment to help mitigate the poor water quality observed during sampling by using stormwater treatment

Project 9
Planting of native vegetation along Cattell Brook where riparian clearing has occurred

Project 10
Restore off-channel habitat along lower Blaney Creek, North Alouette River, and Cattell Brook

Project 7
Protection of high quality riparian habitat along North Alouette River and Connector A Creek (north of equestrian centre, south of Tim's Trail

Project 10
Restore off-channel habitat along lower Blaney Creek, North Alouette River, and Cattell Brook

Project 8
Remove invasive species and plant native tree and shrub species along riparian areas to help improve both riparian and aquatic habitat

Project 19
Investigate whether culvert identified as potential barrier located in Cattel Brook west of 134 Loop is truly a fish barrier (529,999m E, 5,454,891m N)

Project 8
Removing invasive Giant Hogweed located adjacent to 132 Avenue and and plant native vegetation

Project 11
Daylight the portion of Cattel Brook currently buried near 134 Loop

Project 19
Investigate whether culvert identified as a potential fish barrier in Cattell Brook under 136 Avenue is truly a fish barrier

Project 4
Protection of high quality fish habitat located in Upper North Alouette River from potential impacts of future development

Project 4
Protection of high quality fish habitat located in Upper North Alouette River from potential impacts of future development

Project 5
Protection of high quality water within Birch Creek from potential impacts of future development

Project 3
Protection of high quality water within Balsam Creek from potential impacts of future development

Project 8
Remove invasive Japanese knotweed located upstream of 232 Street and plant native vegetation

Project 19
Investigate whether culvert identified as a potential fish barrier located in Balsam Creek under 233 Street is truly a fish barrier

Project 8
Remove invasive Japanese knotweed located upstream of 232 Street and plant native vegetation

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:20,000 is only valid on a 11"x17" print.

Project No. 173.188
Date April 2020
Scale 1:20,000

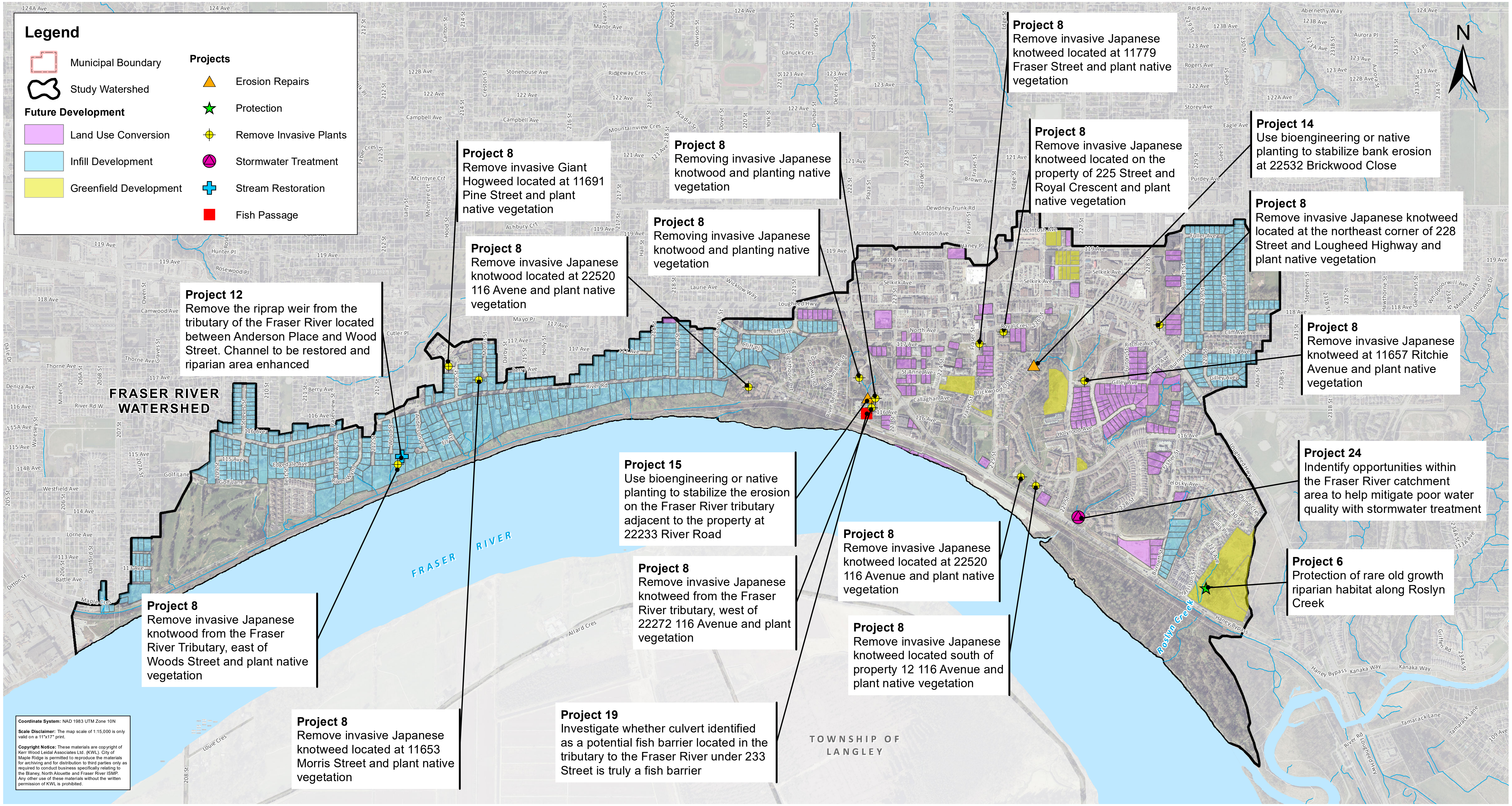
Projects to Maintain and Enhance Watershed Health

Figure 16-2

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\20200430\173188_Fig16-3_Project_Enhance_Watershed_Health_Fraser_River.mxd Date Saved: 2020-04-30 2:04:42 PM | Author: rtaylor

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP



Legend

- Municipal Boundary
- Study Watershed

Future Development

- 🟪 Land Use Conversion
- 🟦 Infill Development
- 🟨 Greenfield Development

Projects

- ▲ Erosion Repairs
- ★ Protection
- ⊕ Remove Invasive Plants
- ● Stormwater Treatment
- ✚ Stream Restoration
- 🟥 Fish Passage

Project 12
Remove the riprap weir from the tributary of the Fraser River located between Anderson Place and Wood Street. Channel to be restored and riparian area enhanced

Project 8
Remove invasive Giant Hogweed located at 11691 Pine Street and plant native vegetation

Project 8
Remove invasive Japanese knotwood located at 22520 116 Avene and plant native vegetation

Project 8
Removing invasive Japanese knotwood and planting native vegetation

Project 8
Removing invasive Japanese knotwood and planting native vegetation

Project 8
Remove invasive Japanese knotweed located at 11779 Fraser Street and plant native vegetation

Project 8
Remove invasive Japanese knotweed located on the property of 225 Street and Royal Crescent and plant native vegetation

Project 14
Use bioengineering or native planting to stabilize bank erosion at 22532 Brickwood Close

Project 8
Remove invasive Japanese knotweed located at the northeast corner of 228 Street and Lougheed Highway and plant native vegetation

Project 8
Remove invasive Japanese knotweed located at 11657 Ritchie Avenue and plant native vegetation

Project 15
Use bioengineering or native planting to stabilize the erosion on the Fraser River tributary adjacent to the property at 22233 River Road

Project 24
Indentify opportunities within the Fraser River catchment area to help mitigate poor water quality with stormwater treatment

Project 8
Remove invasive Japanese knotweed located at 22520 116 Avenue and plant native vegetation

Project 8
Remove invasive Japanese knotweed from the Fraser River tributary, west of 22272 116 Avenue and plant native vegetation

Project 6
Protection of rare old growth riparian habitat along Roslyn Creek

Project 8
Remove invasive Japanese knotwood from the Fraser River Tributary, east of Woods Street and plant native vegetation

Project 8
Remove invasive Japanese knotweed located south of property 12 116 Avenue and plant native vegetation

Project 8
Remove invasive Japanese knotweed located at 11653 Morris Street and plant native vegetation

Project 19
Investigate whether culvert identified as a potential fish barrier located in the tributary to the Fraser River under 233 Street is truly a fish barrier

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:15,000 is only valid on a 11"x17" print.

Project No.	173.188
Date	April 2020
Scale	1:15,000

Projects to Maintain and Enhance Watershed Health

Figure 16-3

Table 16-2: Important Ecosystems and Ecosystem Components to Protect by Watershed

Ecosystem / Importance		Key Species (Life Stage)	Select Components to Protect
Blaney Watershed			
Blaney Bog - Terrestrial	• Only documented mound bog-stream fen complex in the Fraser Lowlands • High biodiversity • Habitat for endangered species	• Great Blue Heron (foraging) • Green Heron • American Bittern (nesting, other) • Peregrine Falcon • Sandhill Crane (nesting habitat available) • Northern Red-legged Frog (mating, juvenile) • Pacific Water Shrew (likely)	• Mound bog-stream fen ecosystem • Water quality from upstream (Anderson Creek, Spring Creek, Blaney Creek)
Blaney Bog – Aquatic[1]	• Largest area of off-channel salmonid rearing habitat within the Alouette watershed • Among most important off channel wetland habitat for rearing salmon in the lower Fraser River	• Coho salmon (juvenile) • Chinook salmon (juvenile, smolts) • Cutthroat trout (juvenile) • Rainbow trout (juvenile)	• High water quality from upstream • Channel complexity • Undercut banks • Abundant macroinvertebrates • Overhanging vegetation • Hydrology • Productive benthic invertebrates (esp. Anderson)
Blaney Creek	• High quality spawning habitat	• Chum salmon • Coho salmon • Cutthroat trout • Rainbow (spawners, eggs, alevins, fry)	• High water quality • Gravel/cobble substrates with low embeddedness • Intact riparian forest • Woody debris and stable banks (shade, nutrient inputs) • Hydrology (flow and volume)
North Alouette Watershed			
Terrestrial	• Wildlife corridor • Holds banks in place • Fish shade & cover	• Black bear (all stages) • Cougar (all stages)	• Riparian forest • Intact banks
Aquatic	• High quality spawning habitat • Rearing habitat	• Coho salmon • Chum salmon (spawners, eggs, alevins, fry)	• High water quality (Birch Creek, Balsam Creek, upper North Alouette River) • Gravel/cobble substrates with low embeddedness • Intact riparian forest • Woody debris and stable banks (shade, nutrient inputs) • Hydrology (flow and volume) • Productive benthic invertebrates (esp. Balsam Creek)
1. including lower portions of Anderson, Spring, Blaney Creeks			

17. Monitoring and Adaptive Management Plan

17.1 Monitoring Plan

Condition 7 of the BC Minister of Environment's approval of Metro Vancouver's 2011 Integrated Liquid Waste Resource Management Plan (ILWRMP) requires that all municipalities, with coordination from Metro Vancouver, monitor stormwater to assess and report on the effectiveness of ISMP implementation. To fulfill this provincial requirement, Metro Vancouver and its member municipalities have developed a Monitoring and Adaptive Management Framework for Stormwater (MAMF) (Metro Vancouver, 2014). The MAMF takes a weight of evidence approach, using several types of monitoring and indicators to develop an overall assessment of watershed conditions. Through repeated sampling, watershed health and the response to specific watershed protection measures and management actions can be tracked over time.

The MAMF provides direction on the general types of monitoring to be utilized for higher gradient, lower gradient, and piped systems (see Table 17-1), the methods and parameters to be used for monitoring, and the reporting required.

Table 17-1: Standard MAMF Monitoring Program Elements Based on Stream Type

Stream Type	Water Quality	Hydrometric	Benthic Invertebrate
Lower Gradient	Yes	Yes (natural channels only)	No
Higher Gradient	Yes	Yes	Yes
Piped Systems	Yes	No	No

Based on the MAMF, all of the creeks within the study area are classified as higher gradient streams (average channel slope >1%). Therefore, monitoring and performance indicators to be included in the program include those for water quality, flows and benthic invertebrates.

Monitoring Framework

The following sections detail the recommended monitoring framework for tracking ISMP implementation including the impact of development and re-development, the effectiveness of mitigation measures, and the influence of stormwater management activities on creek health in the Blaney Creek, North Alouette River, and Fraser River watersheds.

Monitoring Parameters

Table 17-2 provides the recommended parameters for monitoring implementation of the ISMP. The core monitoring parameters in the framework, based on MAMF requirements, can be grouped into three categories:

- Water quality monitoring indicators – selected general water quality parameters, nutrient, bacteriological parameters, and metals;
- Flow monitoring Indicators – seven flow-related metrics characterizing watershed hydrology; and
- Benthic invertebrate biomonitoring indicators – benthic index of biotic integrity (B-IBI) scores and mean taxa richness.

Table 17-2: Summary of ISMP Performance Monitoring Indicators

Performance Indicator	Indicator Type	Baseline Data Available?	Short-term Trend/Target	Long-term Target
Water Quality Performance Indicators				
Dissolved Oxygen	Primary	Yes, sampled as part of ISMP development	Increasing	All parameters Good or Satisfactory as per MAMF classification levels
pH	Secondary		Stable	
Water Temperature	Primary		Decreasing in dry season	
Conductivity	Secondary		Decreasing	
Turbidity	Primary		Decreasing in wet season	
Nutrients (Nitrate as N)	Primary		Decreasing	
Bacteriological Parameters (*E. coli* and fecal coliform)	Primary		Decreasing, esp. in wet season	
Metals (Fe, Cd, Cu, Pb, Zn)	Primary		Decreasing, esp. in wet season	
Flow Monitoring Performance Indicators				
T_{Qmean}	Primary	Yes	Stable or increasing	Same as short-term
Low Pulse Count			Stable or decreasing	
Low Pulse Duration			Stable or increasing	
Summer Baseflow (L/s)			Stable	
Winter Baseflow (L/s)			Stable or increasing	
High Pulse Count			Stable or decreasing	
High Pulse Duration (days)			Stable of increasing	
Benthic Invertebrate Biomonitoring Performance Indicators				
B-IBI Scores	Primary	Yes, sampled as part of ISMP development	Stable or increasing	Category Fair or higher as per MAMF
Mean Taxa Richness	Primary		Stable or increasing	
Additional Recommended Performance Indicators				
No. of Erosion Sites	Supplemental	Yes	Decreasing	No high consequence sites
Effective Impervious Area (EIA)	Supplemental	Yes	n/a (for tracking only)	n/a (for tracking only)
Riparian Forest Integrity (RFI)	Supplemental	Yes	Stable or increasing	Increasing
No. of Species and Locations of Spawners	Supplemental	No	Stable or increasing	Increase in spawners from current levels
No. of Fish Passage Barriers	Supplemental	Yes	Decreasing	No human-made passage barriers

Several supplemental performance monitoring indicators have also been recommended: number of erosion sites, effective impervious area (EIA), riparian forest integrity (RFI), number of returning spawning salmon, and number of fish passage barriers. These indicators should be included as resources allow. The inclusion of these additional indicators will provide a more comprehensive assessment of watershed health and ISMP implementation over time.

The table also indicates the priority of each parameter for measurement (primary or secondary), whether baseline data has or is being collected, and sets short- and long-term targets for trends for different parameters.

It is recommended to add dissolved organic carbon and water hardness to the suite of parameters for the MAMF water quality monitoring, as this would make the understanding of the toxicity risks to fish more robust. Metals loading should be assessed for both total and dissolved metals in order to better understand risks and compare to the BC Water Quality Guidelines.

Monitoring Locations

MAMF water quality and flow monitoring sites have been established in the Blaney River, North Alouette, and Fraser River watersheds. In total, five sites were selected by the City of Maple Ridge with advice from KWL. Similarly, two benthic invertebrate sampling reaches were established in Blaney Creek and North Alouette River watersheds close to water quality monitoring sites with suitable conditions (e.g., presence of appropriate substrates for sampling). Figure 6-7 shows the selected monitoring locations.

It is proposed that future water quality, flow monitoring, and benthic invertebrate sampling be completed at these locations. Table 17-3 below provides location details for these recommended long-term monitoring sites.

Table 17-3: Summary of Water Quality, Flow Monitoring and Benthic Invertebrate Sample Sites

Monitoring Type	Location of Monitoring Site	Site ID (Refer to Figure 6-7)	UTM Coordinates (Zone 10)
Blaney River Watershed			
Water Quality and Flow	425 m downstream of 232 St, 125 m north of 139A Ave, and 100 m west of Anderson Creek Dr	BL-1	530218 5456041
Benthic Invertebrate	Approximately 475 m downstream of 232 St, 50 m downstream of water quality monitoring site	BL-1	530137 5456071
North Alouette Watershed			
Water Quality and Flow	50 m downstream of bridge at 232 St, downstream of Water Survey of Canada hydrometric station (Station 08MH006)	NA-1	530530 5454468
Benthic Invertebrate	70 m downstream of bridge at 232 St, 20 m downstream of water quality monitoring site	NA-1	530146 5454466
Water Quality and Flow	3 m downstream of culvert at Balsam St	NA-2*	531035 5454625
Water Quality and Flow	50 m downstream of two stormwater detention ponds, west of 134 Loop, and south of Nelson Peak Dr	NA-3*	529861 5454865

Monitoring Type	Location of Monitoring Site	Site ID (Refer to Figure 6-7)	UTM Coordinates (Zone 10)
Fraser River Watershed			
Water Quality and Flow	Upstream end of culvert under Haney Bypass, northeast of intersection at 227 St and Haney Bypass	FR-1	529519 5450726
*Sites NA-2 and NA-3 were sampled in the wet season only.			

Monitoring Program

The proposed monitoring program focuses on answering two essential questions:

1. Is development/redevelopment negatively impacting the ecological health of creeks?
2. How effective are stormwater management activities in mitigating impacts to the overall health of the creeks?

Table 17-4 summarizes the proposed monitoring program for the Blaney, North Alouette, and Fraser River ISMP, including monitoring components, methods, sites, monitoring frequency, and recommended implementation approach. Both existing and future proposed components have been included. To implement the program, the City should:

- Conduct water quality and benthic invertebrate sampling every five years at a minimum (every three years recommended);
- Continue hydrometric and rainfall monitoring throughout watersheds;
- Conduct annual erosion monitoring at high risk priority sites;
- Track implementation of mitigation measures, including LID/source control BMPs (Tier A implementation) and detention facilities (Tier B and C implementation), and habitat enhancement projects in a GIS database;
- Conduct desktop monitoring of changes in effective impervious area (EIA) and riparian forest integrity (RFI) from aerial photos and GIS-based analysis (this could be implemented on a city-wide basis for all of the City's ISMPs); and
- The city should work with local Stream-keepers and other stewardship groups for data collection and restoration projects.

Table 17-4: Proposed Monitoring Program for Blaney Creek, North Alouette River, and Fraser River Watershed ISMP

Monitoring Program Component	Method	Monitoring Locations	Monitoring Frequency	Recommended Implementation Approach
Water Quality Monitoring	5 samples in 30 days in dry & wet seasons as per MAMF	5 sites (3 in North Alouette, 1 in Blaney, 1 in Fraser)	Every 5 years at a minimum, every 3 years recommended	Establish rotating City-wide monitoring program

Monitoring Program Component	Method	Monitoring Locations	Monitoring Frequency	Recommended Implementation Approach
Flow Monitoring	Flow gauges	5 sites (3 in North Alouette, 1 in Blaney, 1 in Fraser)	Ongoing	Continue as part of hydrometric program
Benthic Invertebrate Monitoring	Fall sampling (three replicates in 30 m reach) as per MAMF	2 sites (1 in North Alouette, 1 in Blaney)	Every 5 years at a minimum, every 3 years recommended	Establish rotating City-wide monitoring program
Erosion Monitoring	Regular field inspections where access is feasible Consider implementing a City-wide assessment framework for tracking and monitoring bank erosion and coordinate with habitat and other characterization and observation	All major creeks (as assessed in ISMP)	Compile data every 5 years	Establish rotating City-wide monitoring program
Effective Impervious Area (EIA) Assessments	GIS-based analysis of development/redevelopment and areas where mitigation has been applied	All watersheds	Every 5 years	Incorporate fields (TIA & estimated EIA) in cadastral GIS and populate using as-built submissions & airphotos
On-lot Mitigation Adoption by Parcel	Create and update inventory of BMPs including detention facilities in City's GIS system	Whole watershed	Ongoing	Update inventory as part of building permit close-out
Riparian Forest Integrity (RFI) Assessments	GIS-based analysis of orthophotos	All watersheds	Every 5 years	Undertake as part of regular City-wide analyses for all ISMPs
Salmon Population Monitoring	Spawner surveys	All watersheds	Annually	Partner with local Stream-keepers or other stewardship groups
Fish Passage Barrier Assessments	Update GIS inventory	All watersheds	Ongoing	Update inventory as projects are completed

The collection of data and its full review (listed above) for the watershed health indicators should be conducted once every five years (four full reviews during the 20-year expected implementation timeline). After the implementation period is complete, monitoring should continue once every five years. It is expected the ISMP will be revisited and updated within that timeframe; the ILWRMP commits to a 12 year cycle for reviewing and updating ISMPs.

The City may also wish to consider implementing a program to track and aggregate infiltration testing results within the City's GIS system. Testing results are provided for individual development applications, and the City could develop a system for retaining and mapping this information. This would internally support the City's understanding of the spatial variation and distribution of tested infiltration rates across the City, which would in turn support the City's implementation of Tier A criteria.

The City's Zoning Bylaw counts permeable elements such as non-grouted bricks and pavers or crushed rock as part of the 40% lot area to be maintained as "Landscaped area with a permeable surface." The City is recommended to track installation, success and challenges encountered over of these non-vegetative permeable elements as implemented over the long-term. If void spaces in certain types of installations are filling with fine sediment and ceasing to function as pervious surfaces, the City must provide more strict criteria regarding what types of installations may be considered permeable elements.

Stakeholders have indicated that there is interest in making the monitoring data from the MAMF and other monitoring public. The City may wish to consider how to aggregate data across ISMPs and create a web portal to access and view the current and historical monitoring data. This could also include reporting on MAMF metrics in the form of a 'report card' indicating trends in the metrics over time.

17.2 Adaptive Management Plan

Maintaining and enhancing the ecological health of a watershed is best achieved through adaptive management. Using an adaptive management approach for ISMP implementation allows for regular feedback on the effectiveness of measures recommended in the ISMP such that informed decisions can be made about future measures based on whether watershed goals are being achieved. In cases where existing measures are not achieving results, changes can be made to improve their effectiveness, or new measures can be taken. Monitoring also allows assessment of progress towards the plan's goal and reporting to decision-makers, stakeholders, and the public. Adaptive management is also recommended to ensure mitigation of development impacts and improvements in watershed health are achieved in the most cost-effective manner.

Within the MAMF, measures taken to mitigate the impacts of land development on watershed health are defined as Adaptive Management Practices (AMPs). These include measures under a variety of functional categories such as source controls, runoff detention, and infiltration facilities, runoff pollution control, runoff treatment, outreach and education, and mitigation of construction impacts. The iterative process of carefully collecting, analyzing, and interpreting data will allow for the effectiveness of these AMPs to be assessed, and if not achieving the desired results, to change measures, or to target different priority areas. The process requires proper planning but also flexibility as stormwater management practices and knowledge evolve over time and new technologies have become accessible.

The basis for adaptive management is long-term monitoring of the indicators listed in the proposed monitoring plan described above. If the monitoring results indicate issues in aquatic health, previously implemented AMPs should be re-evaluated or new, more appropriate AMPs should be implemented to mitigate the problem. Analysis of monitoring data should occur on a regular basis. The indicators selected in the monitoring program do not all have to move in a particular direction to show improvement or degradation in watershed health.

The full suite of indicators should be reviewed in regular cycles to:

- note changes or trends in particular indicators;
- evaluate possible causes of those changes;
- determine if changes in the indicators represent an impact;
- evaluate if observed changes are expected or unforeseen; and
- review the goals, elements, and implementation plan of the ISMP to assess if changes should be made to the plan to remain on track and achieve the overall stormwater goals over the implementation timeline for the ISMP.

The collection of data and its full review (listed above) for the watershed health indicators should be conducted once every five years. After the implementation period is complete, monitoring should continue once every five years.

Municipality-Wide Adaptive Management Plan

As recommended in the Metro Vancouver MAMF, rather than preparing an adaptive management plan for each drainage system, municipalities will prepare a plan for adaptive management on a municipal wide basis. A municipal adaptive management plan will prioritize issues arising from the water quality; flow monitoring and benthic results in all systems monitored to date and then schedule measures to address the highest priority issues first. Phasing adaptive management actions will also help to keep costs manageable.

It is also recommended that the results of the dry and wet in situ sampling be used to further guide the adaptive management process in these watersheds.

Adaptive Management for the First Five Years

The primary focus for adaptive management for the first five years after completion of the ISMP will be to:

- Set up tracking systems in accordance with Table 17-4 for metrics that are not currently tracked;
- Further investigate concerns and issues identified in 2016 monitoring and baseline analysis, such as impaired water quality and river flooding;
- Evaluate trends of metrics at the end of five years (compare to 2016 report card information gathered) and assess whether results indicate that:
    - trends are in the desired directions;
    - issues and concerns have been mitigated or improved; and
    - revised mitigation or management approaches are needed.

The review and evaluation of trends and issues at the end of the first five years will set the priorities for the next five years of monitoring, review of data, and adaptation of programs and policies.

17.3 Funding Strategies

Existing Funding Sources

Funding sources for each category of solutions are identified below. These funding sources are linked with existing City funding mechanisms. The City may choose to take an asset management approach for program funding in the future, which would require adjustments in how projects seek and obtain funding.

- Funding strategies for some environmental projects identified in Table 17-1 may be done with staff and volunteer time, and below where grant funding may be applicable for eligible projects. Environmental enhancements may also be completed with funds from the City of Maple Ridge capital program for enhancements done in conjunction with culvert or other infrastructure upgrades.
- On-lot development mitigation could be funded by property owners/developers.
- Culvert upgrades will be funded by the City of Maple Ridge capital program funds. The City will need to review timelines and estimated costs of upgrades and assess the existing capital funding program with regards to the recommended timelines for upgrades.
- Funding for storm sewer upgrades would come from the City’s capital plan program to address existing infrastructure that is undersized or at the end of its service life. Any storm sewer upgrades needed to address development growth should come from development cost charges (DCC) to developers.
- Any internal City costs such as for development plan review, monitoring and site inspections would be incorporated into the City’s operating costs. Such costs are not estimated in the ISMP as the City would be better able to understand any internal changes in operations or level of effort needed.

Potential Funding Sources

Examples of potential funding sources that may be used for the ISMP implementation are described below. This list is not exhaustive and additional sources are available.

Stormwater Utility Approach

Some municipalities across Canada have created a utility for stormwater infrastructure. The City of Victoria implemented a stormwater utility in 2016 to fund the management of its stormwater. Instead of charging a flat fee, the City of Victoria uses impervious lot percentage as the main factor in determining the rate per parcel. By basing the fee on impervious percentage, it provides residents and businesses a practical reason to limit the amount of impervious surfaces on the site. It also creates the opportunity for incentives for residents and businesses to implement source controls.

This funding mechanism is well suited to an asset management approach to funding stormwater infrastructure upgrades, should the City initiate an asset management program.

Regional DCCs

For servicing upgrades required for an area of new development the City could explore a regional DCC approach that would pool funds and upgrades for a larger area that a single development or subdivision to address wider servicing issues. A regional DCC approach could also potentially be used for natural asset management, where development in a stream watershed would contribute funds for maintenance and enhancement projects for the receiving stream.

Municipalities for Climate Innovation Program (MCIP) – Federation of Canadian Municipalities

This fund is a five-year, $75-million program that helps municipalities prepare for, and adapt to, climate change, and to reduce emissions of greenhouse gases (GHGs). Delivered by the Federation of Canadian Municipalities (FCM) and funded by the Government of Canada, MCIP is available to all municipalities and their partners. Projects to address stormwater quality are included in the eligible scope of the program.

Additional information: https://fcm.ca/en/programs/municipalities-climate-innovation-program

Green Municipal Fund – Federation of Canadian Municipalities

This fund finances capital projects that improve air, water and land and reduce greenhouse gas emissions. Capital projects funded involve the retrofitting, construction, replacement, or purchase and installation of fixed assets or infrastructure that will improve environmental performance in municipal, energy, transportation, waste, or water.

Additional information: https://fcm.ca/en/funding/gmf/capital-projects-funding

EcoAction Community Funding Program – Environment and Climate Change Canada

This program provides funding for projects that will protect, rehabilitate, enhance and sustain the natural environment. The program supports projects that address clean air, clean water, climate change, and nature.

The program provides up to $100,000 per project for a maximum duration of 36 months. A minimum of 50% of the total project value must come from sources other than the Government of Canada.

The funding is available for non-government, non-profit groups and organizations. Partnerships with groups that are eligible is encouraged.

Clean Water and Wastewater Fund (CWWF) – Infrastructure Canada

This program targets projects that will contribute to the rehabilitation of both water treatment and distribution infrastructure as well as initiatives that improve asset management, system optimization, and planning for future upgrades. To deliver this fund, Canada has entered a Bilateral Agreement (BA) with provinces and territories, where provinces and territories are responsible for identifying projects in collaboration with municipalities.

Additional Information: https://www.infrastructure.gc.ca/plan/cwwf-fepeu-eng.html

Habitat Conservation Trust Foundation Enhancement & Restoration Grants

Each year approximately $6 million dollars in Enhancement and Restoration (E&R) Grants are awarded which focus on the following:

- Native freshwater fish, wildlife, and their habitats;
- Have the potential to achieve a significant conservation outcome; and
- Align with our purposes as laid out in the Wildlife Act.

There is no upper limit on funding requests but there is a 5-year limit to project funding. Budgets typically range from $10,000 to over $100,000 annually. A priority of the foundation is to support habitat enhancement and restoration and proposals for on-the-ground habitat enhancement and/or restoration activities are strongly encouraged.

The British Columbia Salmon Restoration and Innovation Fund

This fund is intended to ensure the fish and seafood sector in BC is positioned for long-term environmental and economic sustainability and support the protection and restoration of wild Pacific salmon and other BC fish stocks. The fund supports

- innovation to encourage the development of new technologies to:
    - increase productivity
    - help meet conservation and sustainability objectives, including the protection and restoration of wild BC stocks, including Pacific salmon
- infrastructure to encourage capital investments in new products, processes or technologies to support the:
    - advancement of sustainable fishing practices
    - protection and restoration of wild BC stocks, including Pacific salmon
- science partnerships to support collaborations with academia and other research institutions to:
    - improve our knowledge and understanding of impacts to wild stocks
    - develop sustainable fishing practices

Those who are eligible to apply are British Columbia-based:

- Indigenous groups
- commercial enterprises, including fishers, aquaculturists and seafood processors
- universities and academics
- industry associations
- other organizations, such as research institutions and stewardship groups

Funding is available to support project activities until March 31, 2024 and opportunities to apply may be provided throughout the year based on the availability of funding.

17.4 Recommended Implementation Programs

The work of this ISMP strives to incorporate multiple aspects and considerations for drainage, flood protection, watershed health, and environmental and social values. Opportunities have been identified for work that can be done in the future to support the goals of the ISMP and to investigate aspects that have not been fully addressed in this work. This section discusses some recommended programs and opportunities that support the objectives and identified needs of the ISMP.

Additional Water Quality Monitoring and Improvement

The proposed water quality monitoring is in accordance with the City's commitments to the province to continue monitoring consistent with the MAMF which is focussed on monitoring stream health using typical parameters. Should the City choose to do so, there are other possibilities for water quality monitoring to expand the understanding of the quality of stormwater runoff before it reaches the creeks.

In-pipe or end-of-pipe monitoring – The City could conduct in-pipe or end-of-pipe monitoring to assess the quality of stormwater runoff. This could assist with designing water quality treatment facilities, either for green infrastructure or for grey infrastructure treatment, by developing TSS loading and particle distribution curves to support design, as well as determining mass loading and concentrations. Or testing could identify the contaminants of concern in the runoff to refine the design of treatment facilities to target those contaminants.

Agricultural runoff testing – There was concern raised by stakeholders that chemicals such as fertilizers, herbicides and pesticides could be entering the receiving streams in runoff from farming operations. However, it is unclear to what extent this is an issue for the receiving waters. Further testing could be carried out to better understand the chemicals and loadings of chemicals associated with farm runoff. This would be critical prior to trying to address such concerns with operational changes, treatment, or other controls.

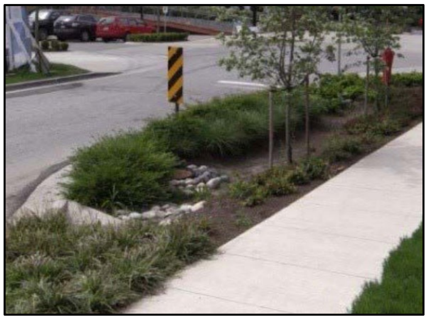
Coordination for agricultural operations improvements – The stakeholder consultation for this work highlighted that there are multiple agencies that are concerned with agricultural operations and have jurisdiction over some aspect of such operations. Though oversight of agricultural operations is outside of the City's jurisdiction, the City may look for future opportunities to consult and coordinate with agencies such as the Ministry of Agriculture, Food and Fisheries, the Agricultural Land Commission, and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development, in order to be aware of and to be able to help promote better agricultural practices. This could include raising awareness of grant opportunities for farmers, educating the public about initiatives such as the Environmental Farm and Salmon Safe programs, and information sharing if the City becomes aware of specific concerns related to agricultural operations.

Green Infrastructure Pilot Program

The City is already working on a Green Infrastructure Strategy to support the implementation of green infrastructure practices throughout the City. In addition to and following this work, it is recommended the City pursue more detailed implementation projects such as:

Public realm water quality pilot program – It is recommended that the City pursue development of a pilot program for water quality treatment of road runoff. This pilot program would focus on:

- reducing existing stormwater pollution impacts on sensitive aquatic environments
- developing designs that optimize water quality treatment, future maintenance expenditures and visual aesthetics
- creating visible, monitored and documented examples of green infrastructure to address concerns some have that natural, more dynamic systems provide unpredictable performance
- providing educational benefits through signage
- achieving social benefits of green space and biodiversity.



In addition to targeting improvements to stormwater runoff quality entering specific sensitive aquatic environments, the City could implement the pilot projects in coordination with other planned upgrade work to roadways. Further program considerations are provided below.

- The main goal of the pilot program will be to treat the pollutant loading from existing roads and improve the current developed situation, rather than tying the work to proposed or future development
- An initial study is needed to identify and assess the need for retrofit treatment at specific locations within the City, by identifying sensitive habitat areas that receive runoff piped directly from road surfaces, with higher quality habitat and higher traffic volume roads being prioritized as more critical for intervention. This could be combined with targeted water quality sampling to identify contaminants of concern at specific locations, in order to design customized treatment if needed.
- Planning should incorporate the practical advantage of finding opportunities to combine these retrofits with road resurfacing, or other work in the right of way
- As the program advances, projects should be identified that treat an area larger than a single inlet catchment area, incorporating, for example, several curb bump-out infiltration facilities along a multi-block stretch of road that is being upgraded, rather that simply inserting a single bump-out location
- Green infrastructure practices should be prioritized and implemented if possible, to provide the multiple social and sustainability benefits of these practices
- Green infrastructure practices include infiltration rain gardens, infiltration swales and street tree infiltration cells and any vegetation treatment from simple to complex may be used so long as it is designed to suit the expected flows for the site
- Where space and usage limitations do not allow for green infrastructure practices, structural treatment units such as oil/grit and vortex separators could be considered to provide the desired treatment benefits for roads that have been identified as draining to sensitive habitat areas.
- Implementation planning can be implemented a on 5-year horizon scale for funding purposes to fit with the current capital planning process
- Initially 1 major project per year should be planned (City-wide, not only within this ISMP area), including design and construction, to create ongoing momentum for a long term program, with the initial commitment to plan and fund 5 projects over 5 years. An initial estimate for budgeting purposes would be approximately $100,000 per year ($150,000 in the first year), for planning, design and construction of a moderate facility of about 50 m^2. For a series of smaller facilities, i.e. curb bump-outs, the construction cost per square metre will be higher than for a single facility.
- Opportunities to effectively measure water quality before and after implementation should be sought in order to validate the design and the beneficial effect on downstream aquatic habitat. This will add to the project budget but provide valuable information on the benefit of the program. (see recommendation on In-pipe or end-of-pipe monitoring, above, section 17.4.)
- When prioritizing locations for implementing pilot projects, consideration may be given to locations where pollutants of emerging concern may be concentrated, such as those associated with automobile tires[37] and runoff for certain roofing materials[38]

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[37] https://dtsc.ca.gov/wp-content/uploads/sites/31/2021/06/2021-Product-Chemical-Profile-for-Motor-Vehicle-Tires-Containing-6PPD-Discussion-Draft_ADA.pdf

[38] https://www.sciencedirect.com/science/article/abs/pii/S0269749119330751?via%3Dihub

- The ultimate goal should be to adapt this program and continue and expand it into the future, to create a long term commitment to improvement in the quality of water entering the watercourses within the City and to the enhancement of the health of the watersheds.

Neighbourhood-scale GI planning – While the ISMP identified specific projects for environmental enhancement opportunities, it does not go so far as to identify specific projects for green infrastructure implementation. This work would be best done on a local or neighbourhood scale to be able to understand and identify opportunities in coordination with local goals and planning efforts. This is work that could be undertaken in conjunction with other planning work that focuses at a local scale and could thus find synergies with other planning initiatives that would be able to coordinate with green infrastructure such as road re-design, utility upgrades, bike or pedestrian path improvements, or landscape improvements.

Master Drainage Plans and Lowland Drainage Studies

Master Drainage Plans

The modelling of the drainage system completed for this ISMP has limitations in the level of detail incorporated due to the watershed-scale size of the models. The City is recommended to develop sub-watershed (200 – 300 ha) Master Drainage Plans (MDPs) to further examine the issues and upgrades needed in each catchment.

MDPs should be all-pipes models and include greater level of detail than the watershed models. The more detailed and focused MDP's can target a more refined assessment of drainage, including:

<u>For existing developed urban areas</u>

- Review trends and updated expectations for land use changes associated with rezonings/single family conversions as well as single family infill re-development
- Undertake sensitivity analyses to review the potential cumulative effects of developments achieving or under-achieving on stormwater management goals
- Review impacts and options related to the sensitivity analyses including a possible need for greater investment in source controls and stormwater detention to accommodate ongoing increases in imperviousness
- Develop plans and budgets for providing stormwater servicing to parcels in urban areas having no drainage servicing. Plans and budgets would assess in greater detail needs to implement downstream capacity upgrades as well as options for local measures that would mitigate increases in runoff rates.

<u>For areas with active greenfield development</u>

- Develop and maintain detailed catchment level hydrologic/hydraulic models for:
    - development engineers to use in reviewing the potential impact of localized detention relative to the timing of runoff peaks downstream
    - support of Regional Development Planning. Maintaining catchment level models would facilitate collaboration with the development community on potential stormwater detention facilities serving multiple developments. This said, the preference as noted by BC FLNRORD is to minimize reliance on offset detention in favour of retaining native vegetation and associated habitats onsite. Where possible, stormwater should be managed through retention of pre-existing, natural systems.

The more rigorous modeling associated with the MDPs can further test and predict (beyond the base assumptions of this ISMP) trends in runoff rates associated with ongoing development in the existing urban area, review control options and identify capital upgrades to accommodate increases in runoff that are not expected to be mitigated locally. The capital upgrade projects would be included in an update to the City's Development Cost Charge Bylaw.

Lowland Drainage Studies

Lowland flooding within the ALR lands of the Blaney and North Alouette watersheds is one of the key concerns identified by residents and stakeholders for the ISMP study area. Lowland flooding attributed to major river flooding has already been assessed by the Northwest Hydraulic Consultants North and South Alouette Rivers floodplain analysis. However, lowland drainage studies for the ALR lands are also recommended for the purpose of reviewing drainage infrastructure and its performance relative to rainwater runoff from the local catchments. These studies would be carried out at a more detailed level than was done as part of the ISMP watershed-level modeling. The studies would include assessment using ARDSA criteria for agricultural drainage.

The prioritization for MDPs and lowland flood studies should be reviewed for the City as a whole, prioritizing catchments with more people, structures and infrastructure at risk, to the extent possible. Costs for these lowland drainage studies will vary based on catchment size and complexity, as well as the range of solution options considered and modelled, but will likely be in the range of $100K - $200K.

The City may be able to pursue these studies with contributions from DCC funding as the studies will further assess the impacts of development on the drainage system.

The results of the MDPs and lowland drainage studies would provide input and recommendations that can be incorporated into the City's Development Cost Charge bylaws, design criteria, overall asset management program and decisions regarding future development options.

Overland Flood Path Study

The City has identified that there is only limited information on overland flood paths for the 100-year event in existing urban areas. It is recommended that the City consider a future project to assess and review major overland flood paths using a risk assessment framework. This may be done in two stages using desktop analysis of digital terrain models and hydraulic modelling output, followed by site reconnaissance for areas of particular interest or concern.

18. Recommendations

This section summarizes the recommendations from this project as a list for easy reference.

Recommended Conveyance System Upgrades

1. The City should pursue upgrade of undersized conveyance system elements in accordance with the prioritized upgrades in Table 12-2. These upgrades may require further modelling in addition to detailed design and should be prioritized for further investigation as part of Master Drainage Plans and Lowland Drainage Studies as described under Future Work. The City is recommended to consult with Wildsafe BC and review cost impacts of potentially sizing certain culverts to accommodate safe bear passage.
2. It is recommended that the City continue with implementing the flood protection plans as recommended in the *North Alouette and South Alouette Rivers Additional Floodplain Analysis* report completed by NHC in 2016.
3. For areas where there is no existing drainage servicing, it is recommended the City undertake drainage plans for these areas in accordance with the discussion in Section 12.4.
4. Climate change should be incorporated in planning and sizing for stormwater infrastructure including sewers, culverts, and detention ponds (see bylaw and policy recommendations). The upgrade recommendations in this ISMP include upgrade sizing for climate change for the 2080 planning horizon.
5. The modelling of the drainage system completed for this ISMP has limitations in the level of detail incorporated due to the watershed-scale size of the models as well as use of a single modeling scenario for Tier A/B attainment and catchment percent imperviousness. The City is recommended to develop sub-watershed (200 – 300 ha) Master Drainage Plans (MDPs) to further examine the issues, emerging trends and upgrades needed in each catchment.
6. The City has identified that there is only limited information on overland flood paths for the 100-year event in existing urban areas. It is recommended that the City consider a future project to assess and review major overland flood paths using a risk assessment framework.

Proposed Detention Facility Program

7. The City should undertake to perform a more detailed study of the Silver Valley Walkway detention facility to assess its performance and determine if remediation or other action is needed to address lack of capacity and/or performance relative to the City's detention criteria. Other ponds as noted in Table 13-2 may need to be assessed but are lower priority.
8. Should further detailed assessment indicate that modifications are needed for pond performance, the City may consider outlet modification, increasing pond volume, or providing additional detention volume elsewhere, as discussed in Section 13.2.

Erosion Mitigation Recommendations

9. The City should continue to use and implement the three-tiered approach to mitigation of flows from development and continue to work with developers and consultants to apply the existing criteria, particularly emphasizing the benefits of multi-return period detention design.
10. The City should clarify that design for detention facilities includes modelling of multiple return period design events and/or multiple durations in order to minimize long duration peak flows. To design to mitigate peak flow increases at multiple return periods, multiple design modelling runs or spreadsheet calculations are needed and a multistage outlet may be required.
11. For the three identified erosion sites of concern, it is recommended the City consider the potential actions described in Section 14.4, including regular monitoring of the documented erosion sites.
12. It is recommended that the City consider implementing a City-wide assessment framework for tracking and monitoring bank erosion, as noted in the monitoring plan in Section 17.1.

Bylaw and Policy Recommendations for Mitigation of Impacts

13. It is recommended the City capitalize on the existing robust stormwater design criteria and work to improve implementation of the Tier A and B criteria in particular. The continued use and promotion of stormwater source controls in particular is recommended to increase the level of achievement relative to the Tier A and Tier B criteria. Source control and Low Impact Development options are discussed extensively in Section 10, including how they can be applied to support achieving the Tier A and B criteria.
14. It is recommended that water quality treatment be added as a requirement to the engineering design criteria, to complete the suite of criteria for addressing the hydrologic impacts of development. Specific water quality treatment criteria are recommended in Section 15.2.
15. Some additions to the existing engineering design criteria are recommended to align the City's approach for on-site stormwater management for single family infill development lots with the Metro Vancouver Region Wide Baseline for On-Site Stormwater Management, as discussed in Section 15.2.
16. It is recommended that the City consult with developers in the process of changing and improving on-site implementation of criteria, providing education as well as opportunities to provide feedback.
17. It is recommended that the City develop an approach to apply the Tier A and Tier B criteria to existing and new roads within the City. This is recognized as a significant challenge for municipalities in general, but management of road runoff is one of the most significant gaps in municipal stormwater management across the province.
18. Climate change should be incorporated in planning and sizing for stormwater infrastructure including sewers, culverts, and detention ponds. Options to do this are discussed in Section 15.4.
19. It is recommended that the City move toward requiring professionals involved with planning, overseeing and monitoring Erosion and Sediment Controls (ESC) on land development construction sites to have ESC-specific training, education and certification. Further, it is recommended that the City require a quantitative approach to ESC design work such as the Revised Universal Soil Loss Equation (RUSLE).

20. The City should consider regulatory, funding and finance strategies and incentives to encourage developers to follow the vision of integrating green infrastructure in the Town Centre and other areas, including major corridors, to support improved stormwater management performance as well as to emphasize and incorporate the multiple environmental and social benefits of green infrastructure.
21. To support implementation of green infrastructure, the City is advised to retain a geotechnical engineering consultant to document information on the characteristics, extent and depths of Haney Clay in Maple Ridge. The additional information will facilitate discussions on implementation of green infrastructure in Maple Ridge.
22. In cases where full on-site stormwater management compliance with the three Tiers is not achievable, the City may consider allowing property owners to achieve (a portion of) their obligation off-site. It must be recognized that the closest available space in which to manage the excess water is likely to be the adjacent road right-of-way, and this will require consideration of aesthetics as well as ongoing maintenance funding. The City will need to specifically consider the use of the road right-of-way for stormwater management in order to meet the Tier A and B criteria for development.
23. It is recommended that the City pursue development of a pilot program for water quality treatment of road runoff as discussed in Section 17.4. This pilot program would focus on reducing existing stormwater pollution impacts on sensitive aquatic environments, developing designs that optimize water quality treatment, aesthetics and maintenance costs, creating visible examples of green infrastructure, providing educational benefits through signage, and achieving social benefits of green space and biodiversity.
24. To avoid contamination of water wells from stormwater infiltration facilities, a minimum horizontal setback distance of 60 m is recommended. The protective setback distance should be determined based on site-specific conditions, such as groundwater flow directions and the vulnerability of the water well.
25. The City could consider re-aligning development planning to better consider regional issues, values, and solutions, by instituting regional planning processes for areas where development is or is expected to be widespread. These efforts could take the form of area plans or neighbourhood plans and would be used to influence the development planning for individual sites.
26. Increasing the levels of communication both within the City between departments and between the City and the public is recommended. Increased communication and awareness of the City's efforts and programs that support watershed health would improve public confidence in the City's efforts, and improve coordination between the City and stakeholder groups that have close ties to watershed health. Options to promote this are discussed in Section 15.4.

Asset Management Recommendations

27. It is recommended that the City build up documentation of the many natural assets that the City possess, linking the assets with the services they provide. Among the assets to document and track are streams and rivers, ponds, wetlands, bogs, old growth forests, aquifers and aquifer recharge areas, parks and green spaces, and any high quality or high value habitat areas. This work will be a preliminary phase in developing a long-term natural asset management strategy for the City.
28. It is recommended that the City establish maintenance levels of service for green infrastructure and harmonize these with funding. Stormwater source controls are not merely an alternative form for provision of drainage services and they should be supported and maintained for the full suite of services they provide to the City and the resident of Maple Ridge, as discussed in Section 15.4.

Recommended Environmental Measures

29. As discussed in Section 16 and Table 16-1, there are several regionally important areas of sensitive ecosystems that should be protected from development and other impacts. While significant protections are in place, expansion of some of these would be beneficial, as discussed in Section 15.4.

30. The North Alouette and Blaney watersheds contain sensitive and regionally significant ecosystems that provide habitat for large populations of salmon, diverse wildlife, and many endangered species. To maintain and enhance the health of these watersheds, and protect the natural asset values of these system, these ecosystems must be protected. As such, seven of the projects (all high priority) recommended in Section 16 involve protecting existing ecosystems of high value. Increasing setbacks for high value areas will have the additional benefit of providing a wildlife corridor for the safe movement of wildlife.

31. Habitat restoration and enhancement are recommended to be completed throughout each watershed to help improve the current conditions of both aquatic and terrestrial habitats, as described in Table 16-1.

32. Repair of erosion sites should use bio-engineering methods rather than riprap whenever possible to enhance the riparian area. Recommended projects (project numbers 1-16) are listed in Table 16-1 and are located on Figure 16-1 to Figure 16-3. As the sites are on or adjacent to private property, the City will want to confirm its jurisdictional responsibility and access rights, maintain a dialogue with the property owners regarding the erosion sites and any planned projects.

33. The City is encouraged to seek options for implementing bio-engineering methods over rip-rap at interfaces between watercourses and drainage outfall channels.

34. One known and one potential (high probability) barriers to fish passage were identified in the Blaney Creek watershed which includes two culverts located along Anderson Creek. Replacement of these culverts would help provide access to additional upstream spawning and rearing habitat. Four potential fish passage barriers have been identified throughout the three watersheds and these potential barriers should be investigated to determine if they are truly fish barriers and if removal would be required to open up access to upstream habitat.

35. Areas located within all three watersheds have been identified as either having a potential impact to aquatic habitat and/or having poor water quality. Additional research is needed to investigate whether the potential issues identified are indeed impacting fish productivity and by how much. Collaboration with the City of Pitt Meadows is important for ensuring a watershed approach is taken.

36. As discussed in Section 16, it is recommended that the City continue to pursue public engagement on environmental concerns, which helps reach out to the broader community as well as allowing the community to be active participants. Stewardship groups such as ARMS and AVA are also potential partners in restoration and enhancement efforts, who may be able to collaborate with the City to pursue funding as well as provide volunteers for some types of work.

37. The City is recommended to collaborate with DFO, BC FLNRORD, City of Pitt Meadows, BC MoAFF and others to seek opportunities and funding to achieve increased riparian cover and instream habitat complexity to reduce predation pressures on outmigrating salmon fry in agricultural lowland watercourses. This work must be done with consideration for dike configuration and maintenance needs.

38. Work to maintain summer base flows in streams (see Recommendation 10 – Tier A).

39. Improve aquatic habitat by improving water quality in streams (see Recommendations 14, 19, 20, 21, and 22).
40. The City could coordinate watershed co-operation groups for the Blaney, Alouettes (North and South), and Kanaka Watersheds. Some of the entities that may be interested to be part of a watershed co-operation group are: UBC Malcolm Knapp Research Forest, The Province of BC (Ministries of Agriculture, Food & Fisheries, Environment, and FLNRORD), BC Parks, The City of Pitt Meadows, Metro Vancouver, First Nations, DFO, Agricultural Land Commission, Stewardship groups.

Monitoring and Adaptive Management

41. It is recommended that the City pursue an ongoing monitoring program as described in Section 17.1. The monitoring program incorporates the MAMF framework from Metro Vancouver and provides a monitoring framework for tracking ISMP implementation including the impact of development and re-development, the effectiveness of mitigation measures, and the influence of stormwater management activities on creek health in the Blaney Creek, North Alouette River, and Fraser River watersheds.
42. The City is recommended to implement the monitoring program laid out in Table 17.1, which incorporates:
    - Conduct water quality and benthic invertebrate sampling every five years at a minimum;
    - Continue hydrometric and rainfall monitoring throughout watersheds;
    - Conduct annual erosion monitoring at high risk priority sites;
    - Track implementation of public and private mitigation measures, including LID/source control BMPs (Tier A implementation) and detention facilities (Tier B and C implementation), pervious surface implementation, and habitat enhancement projects in a GIS database;
    - Conduct desktop monitoring of changes in effective impervious area (EIA) riparian forest integrity (RFI) from aerial photos and GIS-based analysis (this could be implemented on a city-wide basis for all of the City’s ISMPs); and
    - The city should seek opportunities to work with local Stream-keepers and other stewardship groups on restoration projects.
43. Additional water quality monitoring, beyond the MAMF requirements, is recommended, including agricultural runoff testing, and in-pipe or end-of-pipe monitoring, to better understand the pollutant contributions in runoff to the receiving streams.
44. It is recommended to add dissolved organic carbon and water hardness to the suite of parameters for the MAMF water quality monitoring, as this would make the understanding of the toxicity risks to fish more robust
45. The City is recommended to invest in improved invasive plant species mapping.
46. Connect annually with ARMS, DFO and others to request available data on salmon escapements to local watercourses. Data collection can be challenging and salmon escapement counts are affected by parameters both local and global. However, salmon populations are a key component of watershed health and the City should maintain an awareness of trends.

47. The City is recommended to pursue collaboration and coordination with the City of Pitt Meadows as well as provincial agencies to discuss, understand, and plan approaches to improve agricultural impacts on the receiving streams.
48. The City is recommended to implement a City-wide adaptive management program for its ISMPs rather than coordinate separate programs for the different watersheds. The primary focus for adaptive management for the first five years after completion of the ISMP will be to:
    - Set up tracking systems in accordance with Table 17-4 for metrics that are not currently tracked;
    - Further investigate concerns and issues identified in 2016 monitoring and baseline analysis, such as impaired water quality;
    - Evaluate trends of metrics at the end of five years (compare to 2016 report card information gathered) and assess whether results indicate that:
        - trends are in the desired directions;
        - issues and concerns have been mitigated or improved; or
        - revised mitigation or management approaches are needed.

Report Submission

Prepared by:

KERR WOOD LEIDAL ASSOCIATES LTD.

Laurel Morgan
MORGAN
34108
4 Oct. 2021

Laurel Morgan, M.Sc., P.Eng.
Project Manager

Larissa Low

Larissa Low, M.Sc., B.I.T.
Junior Biologist

Patrick Lilley
2021-10-04
R.P. Bio
#1969

Patrick Lilley, M.Sc., R.P.Bio.
Senior Biologist

D. Zabil

David Zabil, M.A.Sc., P.Eng.
Modelling Lead

Reviewed by:

CW Campbell

Crystal Campbell, P.Eng.
Technical Reviewer

PERMIT TO PRACTICE
KERR WOOD LEIDAL ASSOCIATES LTD.
Authorized Registrant (initials) LM
Date 2021-10-04
PERMIT NUMBER: 1000696
Engineers & Geoscientists, British Columbia (EGBC)

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of the City of Maple Ridge for the Blaney, North Alouette, and Fraser River Integrated Stormwater Management Planning. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

This document represents KWL's best professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, expressed or implied, is made.

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Revision History

Revision #	Date	Status	Revision	Author
0	October 2021	Final	Issued as final for client copy.	LM et al.

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Appendix A

Desktop and Field Drainage Review

Appendix A – Desktop and Field Drainage Review

Contents

Tables

Appendix A – Desktop and Field Drainage Review

A. Desktop Review

A.1 Background Information

The available background reports are summarized in the following table.

Table A-1: Background Reports

Background Reports	
Reports	
North Alouette and South Alouette Rivers Additional Floodplain Analysis– Phase 2 Report	2016
Bridge Inspection Reports	2015
Culvert Inspection Reports	2015
North Alouette and South Alouette Rivers Assessment and Floodplain Analysis– Phase 1 Report	2010
North Alouette River at 132 Ave Causes/Mitigation of Bank Erosion at 22592 132 Ave	2007
Silver Ridge Stormwater Monitoring Program	2006
North Alouette River Assessment of Channel Behavior and Hydraulics	2004
Silver Valley Master Drainage Plan Review	2000
Silver Valley Drainage Plan	1995
District of Maple Ridge Drainage Survey	1985
Data	
City of Maple Ridge Design Rainfall Data	2016
City of Maple Ridge Rainfall Monitoring Data (2010-2014)	2014
GIS Data	
City of Maple Ridge Stormwater Drainage System	2016
City of Maple Ridge Digital Base Mapping (road, water course, zoning, drainage)	2016
City of Maple Ridge Orthophoto, LiDAR and Surficial Geology mapping	2015
Urban Systems Watershed Boundary	2016
Citizen Complaints	2016
Rainfall Stations and Rainfall Catchment Boundary	2016
City of Maple Ridge Digital Base Mapping (road, water course, zoning, drainage)	2015

Appendix A – Desktop and Field Drainage Review

A.2 Historical Drainage Issues

Drainage Complaints

The historical complaints related to the storm system and drainage were provided by the City and reviewed as background for the ISMP. Historical drainage complaints included items such as storm sewer backup, river flooding, inlet blockages, ditch and creek erosion and maintenance needs, storm system capacity issues, and beaver dams.

North Alouette River Flood History

- November 3-5, 1955. Flow not available. Flooding caused home evacuation, jog jam and dike breach.
- December 26-27, 1980. Peak flow was estimated to be 118 m^3/s. Flooding caused bank erosion and house damage.
- November 1990. Peak flow was estimate to be 140 m^3/s
- November 1995. Peak flow was estimate to be 81 m^3/s. Flooding caused family evacuation and home destroyed.
- March 2007. Peak flow was in the order of 245 m^3/s. Flooding caused significantly damage to many properties on the right bank

Historical Drainage Studies

- 1985 District of Maple Ridge Drainage Survey

A.3 Historical Bank Erosion

The following items indicating historical erosion concerns in the watersheds have been reviewed for the ISMP.

- 1985 District of Maple Ridge Drainage Survey
- NHC 2004 and 2007: Existing erosion on North Alouette River at 132 Ave was cause by recent flood history (1998, 2003, 2005), confinement of the meander bend upstream, and increases in sediment supplied to the channel. The construction of the new bridge in 1996 has negligible influence to the erosion. (NHC, 2004)
- NHC 2010: bank erosion arises naturally as a river channel shifts over time. It can also occur as a result of anthropogenic changes to the river, i.e. bridge or bank hardening.
- NHC 2016: property on the north bank of north Alouette River just upstream of the 224 St. Bridge is affected by the erosion on the outside bend of the river due to the meandering planform.

Since these items were documented, the 2nd and 4th bullet items have been addressed by the City and are no longer of concern.

Appendix A – Desktop and Field Drainage Review

Field Review

A.4 Engineering Field Inventory

The engineering field inventories were completed between October 1 and December 1, 2016. The inventory included an investigation of the following locations:

- South Alouette Connector
- Cattell Brook (along 224 St. and downstream),
- Balsam Creek (North Alouette to Balsam St.),
- Anderson Creek (Downstream of 232 St.); and
- The Fraser River tributaries.

Watercourses were traversed on foot and locations of interest were identified and recorded with the GIS collector application on an iPad. Measurements, photographs and additional observations were recorded as attributes associated with the GPS positions to create a comprehensive GIS database. The field inventory and locations of interest are shown on Figure 6-9 in the main text of the Phase 1 report.

Field inventory work included the gathering or updating information of culverts, erosion sites, deposition sites, obstructions and locations of interest.

A.5 Erosion

Sites of significant erosion were identified, reviewed in the field, and assigned a relative severity level of low, moderate or high, based on a visual assessment that took into account the following parameters:

- total height and length of eroded bank;
- apparent rate of erosion; and
- apparent capacity of bank material to resist further erosion.

Note that this visual assessment was conducted by KWL field staff and represents their best judgement in the field, but this is not equivalent to the assessment of a geotechnical engineer.

In addition to rating the severity of these sites, a simple qualitative risk framework was used to assess relative risk associated with erosion. Erosion sites were identified and visually assessed to assign a hazard and consequence level:

- Low, moderate, or high hazard based on the measured height of visible scour
- Low, moderate, or high consequence based on the proximity of manmade features (sheds, fences, buildings, retaining structures, etc.) to the eroding bank
- This was based on a visual assessment that took into account the perceived level of risk to human life, property damage or destruction and wildlife habitat. Table A-3 summarizes the erosion ratings and locations:

Appendix A – Desktop and Field Drainage Review

Table A-2: Summary of Observed Severe Erosion Sites

	Erosion				
	Measured Approx.		Observed		
ID	Length (m)	Height (m)	Location (Left, Right)	Hazard (Low, Med, High)	Consequence (Low, Med, High)
Near Brickwood Close	10	2.0	Right Bank	High	High
River Rd. near River Bend.	7	2.0	Right Bank	High	High
Blaney Creek at 144Ave.	40	2.5	Right Bank	High	High
Severity Ratings based on erosion area: Low = less than 10 m^2, Moderate = 10 to 50 m^2, High = greater than 50 m^2 Consequence Ratings: High = roads or buildings at risk, Moderate = private property at risk, Low = all others Refer to Figure 6-9 in the main Phase1 Report for location of the erosion sites.					

Of the three locations mentioned in Table A-3, the Brickwood Close and River Rd. locations are only ones that pose any concern to private property. The Brickwood location erosion can be seen in Photo's A-1 and the River Rd. erosion site can be seen in Photo A-2. The Blaney erosion site seen occurs directly under an outfall but no private property is at risk. The Blaney location only poses a risk to the 144 Ave. outfall, as shown in Photo A-3.

Photo A-1: Bank Erosion near Brickwood Close Facing North West

Photo A-2: Bank Erosion @ River Rd. near River Bend Facing Southwest

Appendix A – Desktop and Field Drainage Review

Photo A-3: Bank Erosion @ 144 Ave on Blaney Creek

As creek gradients decline, floods become the dominant process. The general form of the channel at any point is dictated by discharge and sediment load, as well as the integrated effect of factors such as climate, vegetation, soils, geology and basin physiography. Channels adjust to increases in discharge, such as those associated with watershed development, but accurate predictions of change are challenging for a number of reasons (Booth and Henshaw 2001). Based on the field reconnaissance, the rate of erosion and throughout the watershed seems normal and the consequences of the erosion sites appear to be minimal.

A.6 Deposition and Obstructions

Observed channel obstructions were classified by whether they appeared to be natural or anthropogenic. There was only one natural obstruction in the form of a beaver dam located at the end of 136 Ave. in Cattell Brook; no anthropogenic obstructions were recorded. Deposition was observed and recorded, however, due to the physiological characteristic of Blaney Creek and North Alouette River main channels there were no areas of deposition identified that would be likely cause any consequences in the near future.

Deposition was recorded in a ditch along 232 St. between 132 Ave. and 132 Ave. Since the field inventory, improvements works of the 232 St. corridor have taken place and the sediment deposition issue has been resolved.

Appendix B

Survey

Appendix B – Survey

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Appendix B – Survey

B. Introduction

Kerr Wood Leidal Associates Ltd. (KWL) undertook survey of a number of culverts and manholes in the Blaney, North Alouette River, and Fraser River watersheds as part of the ISMP process to fill in gaps in available data provided by the City. In particular, the survey targeted culverts and storm manholes where missing information would make modelling of these pieces of infrastructure difficult or the results unreliable.

Not all missing information was able to be filled in by the survey allowance that was budgeted for the ISMP work. Some culvert and manhole survey was not possible due to inaccessible locations, including ravine or fenced areas, railroad right-of-way, or locations in busy roads such as Lougheed Highway.

Surveys were carried out between November 21 and November 25, 2016 around Maple Ridge, allowing measurement of invert elevations, opening sizes, lengths, material types, , and general arrangement of the crossings. A total of 17 individual culverts were surveyed at these 13 locations as 4 crossings had multiple culverts in parallel.

All surveyed culverts and manholes can be seen in Figures B-1 & B-2.

B.1 Equipment and Survey Procedure

Survey control points and corresponding values were established at all 16 culvert locations using a high accuracy Trimble R8 real time kinematic (RTK) GPS receiver operating on Can-Net Virtual Reference Station Network 3.0. Municipal survey control monuments in the City of Maple Ridge were located and elevations and positional accuracy of the RTK GPS were confirmed. These ties allowed confirmation of horizontal positional accuracy against published UTM NAD83 coordinates, and confirmation of vertical positional accuracy against published geodetic elevations. All survey was conducted in UTM NAD 83.

Photographs were taken at all crossings.

B.2 Culvert and Manhole Invert Elevations

All elevations were derived from observations by GPS operating on Can-Net Virtual Reference Station Network 3.0 with ties to municipal survey control monuments to confirm elevations. Can-Net operates in NAD83 for horizontal positioning and CGVD28 for vertical positioning with the local GVRD geoid model applied to Metro Vancouver for higher accuracies in this region. KWL measurements with the RTK GPS to municipal monuments were found to be 0.01 to 0.05 m higher than published elevations over the duration of the survey.

Appendix B – Survey

B.3 GIS Data

The culvert information collected was entered into a GIS database which included the same fields as are used by the City's GIS mapping. This will allow integration of surveyed information into the City's GIS by City's Staff. The GIS data is provided digitally. The location of the culvert end points will be contained in the GIS spatial data and the tabular GIS data for each culvert will include the attributes as listed in Table B-1.

Table B-1: Culvert Attributes

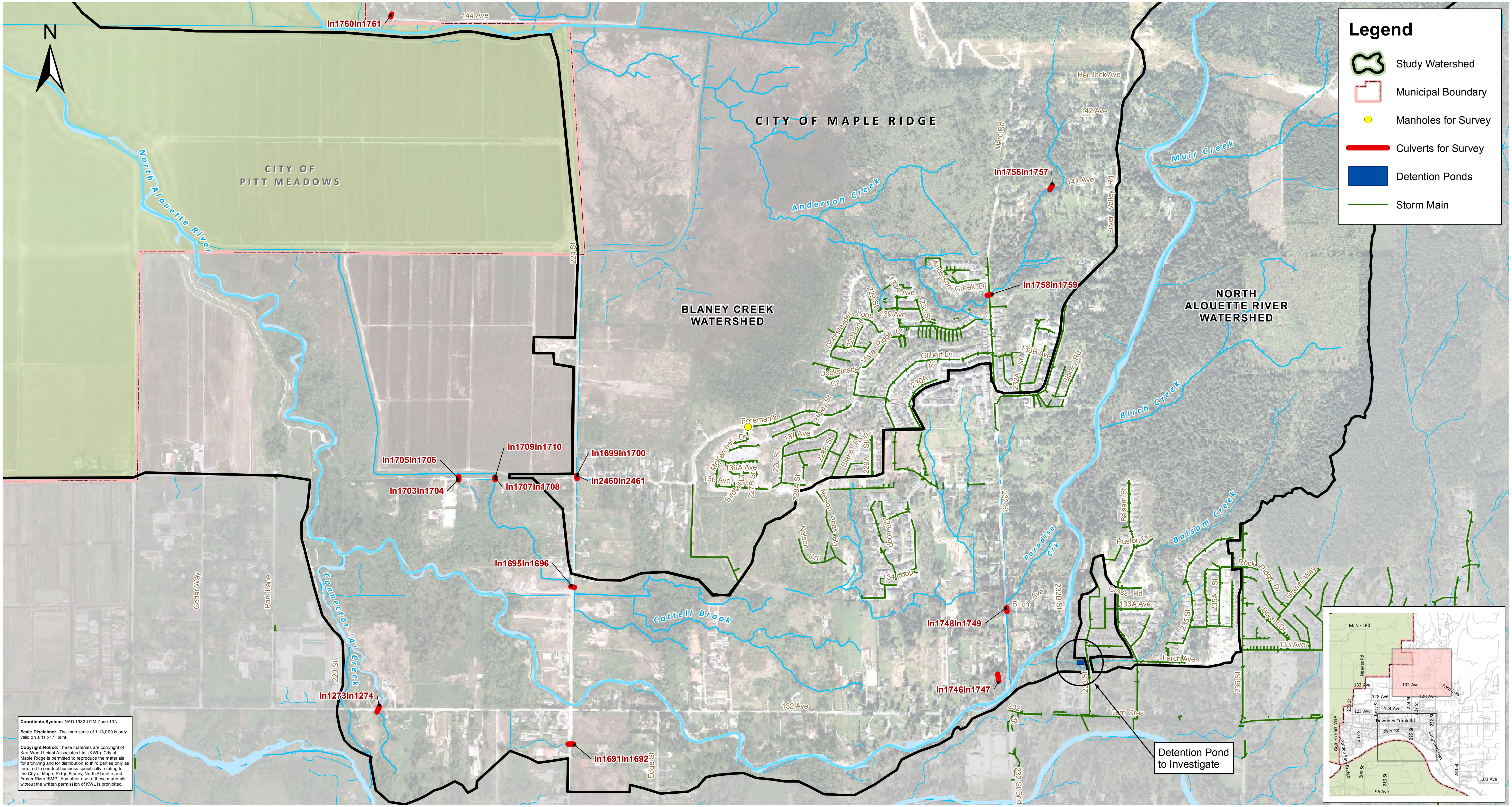
Attribute	Example Culvert
Type (shape)	Circular
CulvertTyp (shape code)	3
Material	Concrete
Height (mm)	750
Width (mm)	750
ID_Pipe	1334
As-built (length m)	15.8
US_Elev (invert m Geodetic)	81.49
DS_Elev (invert m Geodetic)	81.34
StatusLife	As-built
Owner	City of Maple Ridge

Path: O:\0100-0199\173-188\430-GIS\MXD-Rp\173188_FigB1A_B_Culvert_Survey.mxd Date Saved: 07/04/2017 8:26:01 AM | Author: BWhitehouse

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:13,000 is only valid on a 11"x17" print.

Project No.	173-188
Date	September 2020
Scale	1:13,000

Culvert/Manhole Survey Locations

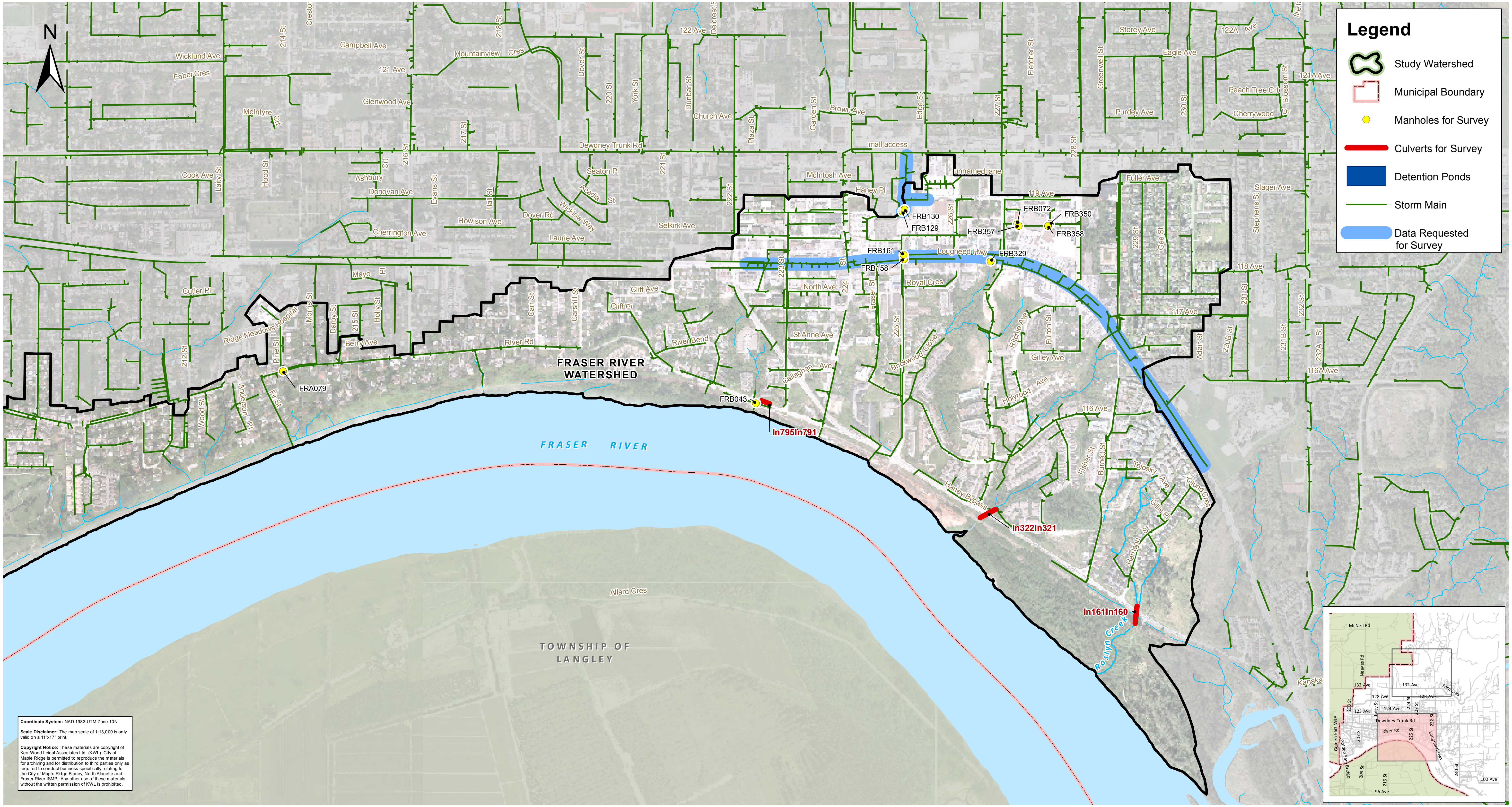
Figure B1-A

Path: O:\0100-0199\173-188\430-GIS\MXD-Rp\173188_FigB1A_B_Culvert_Survey.mxd Date Saved: 07/04/2017 8:26:01 AM | Author: BWhitehouse

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Legend

Study Watershed

Municipal Boundary

● Manholes for Survey

🟥 Culverts for Survey

🟦 Detention Ponds

Storm Main

Data Requested for Survey

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:13,000 is only valid on a 11"x17" print.

Project No. 173-188

Date September 2020

Scale 1:13,000

Culvert/Manhole Survey Locations

Figure B1-B

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Appendix C

Aquatic Species and Habitat Inventory

Appendix C – Aquatic Species and Habitat Inventory

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Appendix C – Aquatic Species and Habitat Inventory

C. Aquatic Species and Habitat Inventory

C.2 Introduction

This Appendix describes the methods and results for the environmental inventory and assessment undertaken from August 2016 to March 2017 as part of the first phase of development of the Blaney, North Alouette, and Fraser River Integrated Stormwater Management Plan (ISMP). The ISMP is being developed by Kerr Wood Leidal Associates (KWL) for the City of Maple Ridge. The work program included the following components:

- An inventory of aquatic species and habitats;
- An assessment of forest cover in riparian corridors and overall watersheds;
- An assessment of terrestrial species and wildlife habitat; and
- Analysis of water quality and benthic invertebrate data (in Appendix D).

The purpose of the assessments were: (1) to assess status and trends in watershed conditions and the overall health of the Blaney, North Alouette, and Fraser River watersheds; (2) to identify priority environmental issues to be addressed in the ISMP; and (3) to identify environmental enhancement opportunities within the study area. Depending on the assessment, the work included collation and review of existing information, field inventories, and data summarization and analysis.

Study Area

The study area is composed of three major watersheds/catchments:

The **Blaney Cree**k watershed is approximately 2,574 ha. Its headwaters are on the south slope of Gwendoline Peak and drain Placid, Loon, Lost, and Blaney Lakes. Its main tributaries, listed in order from upstream to downstream and beginning at the headwaters, are Loon Creek, Spring Creek, Anderson Creek, Donegani Creek, and McKenzie Creek.

The **North Alouette River** watershed is approximately 3,983 ha. Its headwaters drain the west aspect of Golden Ears and the east slopes of Gwendoline Peak. The North Alouette River originates at an elevation of 311 m. It has several tributaries along its upper 8 km and flows through a densely wooded canyon. The stream emerges from the canyon 10 km upstream of the South Alouette confluence, forming a meandering channel across the plain. Tributaries along its lower reaches include Cattell, Connector A, Paradise, Balsam, Birch, and Muir Creeks. The final 6 km are slough-like and have been dredged and diked. This section flows through agricultural lands in Pitt Meadows prior to converging with the South Alouette and discharging to the Pitt River.

At 342 ha, the **Fraser River** watershed is the smallest of the three watersheds under study. Draining south to the Fraser River, this catchment is fully developed and entirely within the urban containment boundary. There are approximately four small tributaries to the Fraser River within the catchment in addition to piped drainage.

Appendix C – Aquatic Species and Habitat Inventory

Sources of Background Information and Data

The following inventory and assessment for the three watersheds is a synthesis of publicly available government and consultant data, previous habitat assessments, data from stewardship groups, and the results of a new field inventory completed as part of the ISMP. Key sources of information and data included:

- City of Maple Ridge orthographic photographs (2011 and 2015) and GIS data (CMR 2016);
- City of Maple Ridge steam mapping data from 1996–2014;
- EcoCAT: The Ecological Reports Catalogue (MOE 2016a), including multiple reports;
- Fisheries Inventories Information System (MOE 2016b);
- BC Conservation Data Centre (MOE 2016c);
- ESRI basemap orthophotos (for areas for which CMR orthophotos were not available);
- National Hydro Network Primary Directed Flow Mapping (Government of Canada 2017);
- Province of BC 1:50,000 Stream Centreline Mapping;
- *Blaney Bog & Adjacent Uplands Summary of Existing Biophysical Information* (Gebauer 2002) report;
- *Codd Island Wetlands Summary of Existing Biophysical Information* (Gebauer 2001) report;
- *An assessment of fish habitat for Anderson Creek and Cattell Brook, Maple Ridge, B.C.* (Shead et al. 1999) report;
- *Lower Fraser Valley Streams Strategic Review, Volume 1* (DFO 1999) report;
- *Study of the tributaries of the North and South Alouette Rivers* (Davies 1996) report;
- Consulting reports prepared for the City of Maple Ridge;
- Metro Vancouver Parks resources and reports;
- Other publicly available sources;
- Alouette River Management Society (ARMS) website, reports, and personal communications;
- Alouette Valley Association (AVA) personal communications;
- Alouette Field Naturalists personal communications; and
- A biophysical inventory of Blaney Creek, North Alouette River, and Fraser River tributaries conducted by KWL in September and October 2016.

Appendix C – Aquatic Species and Habitat Inventory

C.3 Aquatic Species and Habitat Inventory

Fish Species Presence and Distribution

The Alouette River watershed (including the North and South Alouette Rivers and its tributaries) supports 32 species of fish (Table C-1). The North Alouette River and Blaney Creek support a subset of these species (Figure C-1).

Fish communities in the Alouette watershed have been severely impacted by dam construction. Construction of the Alouette Dam from 1924 to1928 and the Stave Lake diversion cut off access to upstream habitat and reduced flows to the South Alouette River. As a result, sockeye and Chinook salmon were extirpated from the watershed. Pink salmon were extirpated in 1960 due to gravel removal and habitat alteration (ARMS 2016a).

Over the last 30 years, efforts have been made to re-establish salmon stocks lost from the watershed. Pinks were reintroduced in 1985 and Chinook were reintroduced from Chilliwack stocks in 1997 (Borick-Cunningham 2012). The Alouette River Sockeye Reanadromization Project is a collaboration between ARMS, the Katzie First Nation, Fisheries and Oceans Canada (DFO), BC Ministry of Environment (MOE), CMR, BC Hydro, and LGL Consulting. The project is aimed at building up sockeye returns and working towards construction of a fish ladder at the dam. In 2007, sockeye returned to the Alouette River for the first time since their extirpation (ARMS 2016b). These fish were kokanee that had been released from the reservoir in a test to see whether salmon would survive passing the dam spillway. Among other things, this project has determined the feasibility of reintroducing sockeye to the Alouette Watershed (Gaboury and Bocking 2004), tested survival of salmon over the spillway, trucked adult sockeye above the dam, and collected brood stock to rear hatchery sockeye and release into Alouette Lake to increase the population (ARMS 2016c).

Table C-1: Fish Species Present North and South Alouette Watersheds

Species Code[1]	Common Name	Scientific Name	Reference
CH	Chinook salmon	*Oncorhynchus tshawytscha*	A
CO	Coho salmon	*Oncorhynchus kisutch*	A
CM	Chum salmon	*Oncorhynchus keta*	A
PK	Pink salmon	*Oncorhynchus gorbuscha*	A
SK	Sockeye salmon	*Oncorhynchus nerka*	A
KO	Kokanee	*Oncorhynchus nerka*	A
ST	Steelhead	*Oncorhynchus mykiss*	A
CCT	Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*	A
RB	Rainbow trout	*Oncorhynchus mykiss*	A
DV	Dolly varden	*Salvelinus malma*	A
LT	Lake trout	*Salvelinus namaycush*	A
BT	Bull trout	*Salvelinus confluentus*	A
BCB	Black crappie	*Pomoxis nigromaculatus*	B

Appendix C – Aquatic Species and Habitat Inventory

Species Code[1]	Common Name	Scientific Name	Reference
BMC	Brassy minnow	*Hybognathus hankinsoni*	A
BSU	Bridgelip sucker	*Catostomus columbianus*	B
BNH	Brown catfish (formerly brown bullhead)	*Ameiurus nebulosus*	A
CP	Common carp	*Cyprinus carpio*	A
CSU	Largescale sucker	*Catostomus macrocheilus*	A
LNC	Longnose dace	*Rhinichthys cataractae*	A
LSU	Longnose sucker	*Catostomus catostomus*	A
MW	Mountain whitefish	*Prosopium williamsoni*	A
NSC	Northern pikeminnow	*Ptycheilus oregonensis*	A
-	Oriental weatherfish	*Misgurnus anguillicaudatus*	A
PCC	Peamouth chub	*Mylocheilus caurinus*	A
CAS	Prickly sculpin	*Cottus asper*	A
PMB	Pumpkinseed	*Lepomis gibbosus*	A
RSC	Redside shiner	*Richardsonius balteatus*	A
RL	River lamprey	*Lampetra ayresi*	A
TSB	Threespine stickleback	*Gasterosteus aculeatus*	A
EU	Eulachon	*Thaleichthys pacificus*	B

References: A = MOE 2016b, B = Gaboury and Bocking 2004
[1] Desrochers 1997

Blaney Creek

Coho, chinook, and chum salmon, coastal cutthroat trout, rainbow trout/steelhead, and four other fish species have been recorded in Blaney Creek (Table C-2). Historical escapements of adult salmon to Blaney Creek averaged 1457 chum (maximum 4770) from 1988 to 1997 and 126 coho (maximum 353) from 1989 to 2000 (MOE 2016b).

The introduced common carp (*Cyprinus carpio*) has been recorded in Blaney Creek (Shead et al. 1999). Carp can have negative effects on native fish and amphibian species and aquatic plants.

Table C-2: Fish Species Recorded in Blaney Creek

Species Code[1]	Common Name	Scientific Name	Reference
CO	Coho salmon	*Oncorhynchus kisutch*	A
CM	Chum salmon	*Oncorhynchus keta*	A
CH	Chinook salmon	*Oncorhynchus tshawytscha*	B
ST	Steelhead	*Oncorhynchus mykiss*	A
RB	Rainbow trout	*Oncorhynchus mykiss*	A

Appendix C – Aquatic Species and Habitat Inventory

Species Code[1]	Common Name	Scientific Name	Reference
CT	Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*	A
CAS	Sculpin species	*Cottus spp.*	A
TSB	Threespine stickleback	*Gasterosteus aculeatus*	A
PCC	Peamouth chub	*Mylocheilus caurinus*	B
CC	Common carp	*Cyprinus carpio*	B

References: A = MOE 2016b, B = Shead et al. 1999
[1]Desrochers 1997

North Alouette River

Coho, chum, and pink salmon, coastal cutthroat trout, rainbow trout/steelhead, and nine other fish species have been recorded in the North Alouette River (Table C-3). The North Alouette River is not as productive as the South Alouette because waterfalls restrict upstream access (DFO 1999). Historical escapements to the North Alouette River averaged 1781 chum (maximum 4600) from 1988 to 1997 and 98 coho (maximum 200) from 1987 to 1996. Pink averaged 507 returning adults (maximum 3500) from 1985 to 1993 (MOE 2016b)

The North Alouette is stocked with chum fry from the Fraser Regional Corrections Centre – Alouette River Management Society hatchery (Allco Hatchery). There are records of stocking with rainbow trout as recently as 1984, steelhead in 1986, and cutthroat trout in 1987 (MOE 2016b).

Birch Creek is not believed to be fish-bearing, and fish presence is unknown in Muir Creek (Davies 1996).

Table C-3: Fish Species Recorded in the North Alouette River

Species Code[1]	Common Name	Scientific Name	Reference
CO	Coho salmon	*Oncorhynchus kisutch*	A
CM	Chum salmon	*Oncorhynchus keta*	A
PK	Pink salmon	*Oncorhynchus gorbuscha*	A
ST	Steelhead	*Oncorhynchus mykiss*	A
RB	Rainbow trout	*Oncorhynchus mykiss*	A
CT	Coastal cutthroat trout	*Oncorhynchus clarkii clarkii*	A
CAS	Prickly sculpin	*Cottus asper*	A
CAL	Coastrange scuplin	*Cottus aleuticus*	B
TSB	Threespine stickleback	*Gasterosteus aculeatus*	A
PMP	Pumpkinseed	*Lepomis gibbosus*	A
NSC	Northern pikeminnow	*Ptycheilus oregonensis*	A
PCC	Peamouth chub	*Mylocheilus caurinus*	A
CMC	Chiselmouth	*Acrocheilus alutaceus*	C

Appendix C – Aquatic Species and Habitat Inventory

Species Code[1]	Common Name	Scientific Name	Reference
RL	River lamprey	*Lampetra ayresi*	B
BL	Western brook lamprey	*Lampetra richardsoni*	C
Sources: A = MOE 2016b, B = Pearson Ecological 2008; C = Shead et al. 1999 [1]Desrochers 1997			

Fraser River Tributaries

Only two species of fish have been recorded in the Fraser River catchment: coho salmon and threespine stickleback (Table C-4). Fish species found in the Fraser River may be present in these small tributaries if they are accessible from the main stem.

Table C-4: Fish Species Recorded in the Fraser River Catchment

Species Code[1]	Common Name	Scientific Name	Reference
CO	Coho salmon	*Oncorhynchus kisutch*	A
TSB	Threespine stickleback	*Gasterosteus aculeatus*	A
References: A = MOE 2016b [1]Desrochers 1997			

Biophysical Inventory

KWL biologists carried out a field inventory of Blaney Creek, the North Alouette River, and Fraser River tributaries in September and October of 2016 (September 29, October 12, 25, and 26). In the Blaney and North Alouette watersheds, the inventory included areas below the Malcolm Knapp Research Forest. Detailed aquatic habitat surveys were completed at 38 sites (12 in Blaney, 20 in North Alouette, and 6 in the Fraser River watersheds; Figure C-5).

The detailed surveys focused on assessing fish habitat values, including:

- Physical channel measurements and morphology;
- Substrate composition;
- Spawning habitat based on substrate composition;
- Rearing habitat based on instream cover, large woody debris (LWD), and pools;
- Potential obstruction and barriers to fish passage;
- Condition of the riparian area;
- Existing fish habitat enhancements;
- Points of concern for fish and aquatic habitat (habitat degradation, outfalls, etc.);
- Presence of invasive plants; and
- Potential locations for future habitat enhancements.

The survey was based on the Stream Inventory Standards and Procedures section of *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory: Standards and Procedures* (Resource Inventory Committee 2001) with a simplified sampling design. Fish sampling was not within the scope of this project.

Detailed survey sites were concentrated in the middle area of the Blaney and North Alouette watersheds, falling mainly in the developed areas of the City (Figure C-5). Photographs and a summary of each site can be found in the Site Summaries and Photographs section on page C-42.

Appendix C – Aquatic Species and Habitat Inventory

Habitat Quality for Fishes

Spawning Habitat

The most abundant spawning gravels in the watersheds are found in the middle and upper reaches of the North Alouette River, Blaney Creek upstream of Blaney Bog, in Anderson Creek upstream of Blaney Bog, and in Balsam Creek (Figure C-2). These watersheds provide excellent spawning habitat for salmon and trout. The creeks in the Fraser River watershed provides little spawning habitat.

Most salmon spawn in the central and lower reaches of the North Alouette River (Photo C-1; DFO 1999). Coho and chum spawn mainly in the middle and upper reaches of Blaney Creek (DFO 1999). Coho migrate upstream in the last half of September and spawn from October to mid-December in Blaney Creek and until the end of December in the North Alouette River. Chum salmon arrive in the first half of October, and spawn from October to November. ARMS conducts spawning surveys in the North Alouette. From October 6 to December 29, 2013, volunteers counted 133 chum, 9 pink, 14 coho, and 6 unidentified live spawners and 37 unidentified dead spawners in the North Alouette River. Coho spawn in Cattell Brook but spawning habitat is limited as fine substrates are abundant. In Balsam Creek, coho spawners are found as far upstream as Balsam Street. Chum spawners are not usually found in Balsam Creek due to its small size, and do not pass the Balsam Street culvert (R. Davies, pers. comm., 2016). Unidentified trout (either rainbow trout or coastal cutthroat trout) were observed spawning in Balsam Creek upstream of the Balsam Street culvert during the field inventory.

Rearing Habitat

The North Alouette and Blaney watersheds provide extensive areas of rearing habitat for juvenile salmon and trout (Figure C-2). The Fraser River watershed provides little rearing habitat due to extensive loss of creeks, loss of riparian habitat, lack of woody debris and pools, and fragmentation. The most important areas for rearing salmonids are:

- North Alouette River, middle and upper reaches;
- Blaney Creek, middle and upper reaches;
- Anderson Creek, throughout;
- Blaney Bog, including sections of Blaney, Spring, and Anderson Creeks;
- Codd Wetland, including sections of the North Alouette River and Blaney Creek;
- Cattell Brook, lower reaches; and
- Paradise Creek, lowest reach.

Coho juveniles feed and find shelter throughout the upper reaches of the North Alouette and Blaney watersheds. The middle and upper reaches of the North Alouette provide extensive cover, channel complexity, large woody debris, and pools (DFO 1999). A DFO study found that the reach of the North Alouette from 232nd St upstream for 2.2 km contained 63.8% of the fish biomass of the river within only 13% of the total area of the river. Likewise, the 800 m reach of Blaney Creek upstream of 224th St (5.3% of total area) was the only length of the creek that supported salmonids. This was likely due to the greater cover and lower disturbance in these reaches compared to the lower reaches, and the presence of upstream barriers (Griffith & Russel 1980). Coastal cutthroat trout are present throughout Anderson Creek, and juvenile coho use the lower sections up to the gully west of 232nd St, and have been abundant at sampling sites. Juvenile salmonids overwinter in the lower sections of Cattell Brook. In periods of high water in the North Alouette River, juveniles use the lower reach of Paradise Creek as refuge (Davies 1996).

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The watershed also contains Blaney Bog Regional Park (115 ha) and a portion of the Codd Wetland Ecological Conservancy Area (101 ha). Together, the Codd Wetland and Blaney Bog form the largest area of off-channel salmonid rearing habitat within the Allouette watershed, and provide some of the most important off channel wetland habitat for rearing salmon in the lower Fraser River (Gebauer 2001). Juvenile coho, coastal cutthroat trout, and rainbow trout all use the wetland channels, and Chinook smolts are likely to use them for refuge and feeding. Characteristics of the areas that make them particularly good rearing habitat are low gradient channels, flooding, inflow of well-oxygenated water from Blaney, Spring, and Anderson Creeks with high water quality, macroinvertebrates, and cover from overhanging vegetation and undercut banks (Photo C-2).

Photo C-1: High quality spawning habitat in the North Alouette River (site NA10)

Photo C-2: High quality rearing habitat in Spring Creek, within Blaney Bog (site SP1)

Barriers to Fish Passage

Based on background information and the field inventory, the following barriers were identified (Figure C-4, Table C-5):

- North Alouette Watershed: two definite barriers, two potential, one partial (some species only), and one unknown (stakeholder identified as a potential barrier after the KWL field inventory had been completed, status unknown; AVA, pers. comm., 2016);
- Blaney Watershed: three definite barriers, one potential; and
- Fraser Watershed: one flow-dependent barrier.

Restoration efforts should focus on anthropogenic barriers such as culverts where fish passage historically occurred.

Appendix C – Aquatic Species and Habitat Inventory

Table C-5: Barriers to Fish Migration

Stream	Barrier Type	Barrier Level	Description	UTM Easting / Northing[1]
North Alouette River				
North Alouette River	Falls	Yes	Impassable falls, upstream limit for spawning salmon; estimated from Griffith and Russell (1980)	531254 / 5456792
Cattell Brook	Culvert	Potential	Culvert under 136 Ave; Masse Environmental Consultants Ltd (2012) identified as low priority; KWL field investigation showed that the culvert is a potential barrier but not high priority	530441 / 5455259
Cattell Brook	Culvert	Unknown	Possible barrier (AVA, pers. comm., 2016); status as barrier unconfirmed; further investigation recommended	530000 / 5454888
Cattell Brook	Buried section	Yes	Section of Cattell Brook at 13449 232 St appears to have been buried	530350 / 5454912
Birch Creek	Chute-cascade	Potential	Cascade down steep bank to North Alouette, fish passage into Birch Creek unlikely (Davies 1996)	530919 / 5455458
Balsam Creek	Culvert	Partial (some species only)	Culvert under Balsam St; Masse Environmental Consultants Ltd. (2012) identified as high priority and recommended streambed simulation; KWL field observations suggest inlet grate and cobbles may be potential barrier; chum spawners don't go above culvert (R. Davies, pers. comm., 2016); further investigation recommended	530257 / 5456049
Blaney Creek				
Blaney Creek	Falls	Yes	Impassable falls, upstream limit of passage for spawning salmon (DFO 1999, MOE 2016)	529861 / 5457535
Anderson Creek	Culvert	Yes	Inlet grate on 232 St culvert plugged with sediment and debris creating 0.70 m drop; outlet not visible; old wooden culvert (Photo C-4); resident said gravel trucks were parked on road for several weeks straight and could be source of sediment; unidentified fish (possibly juvenile trout) observed in outlet pool	530518 / 5455932
Anderson Creek	Culvert	Potential	0.2 m drop into 0.20 m plunge pool at relatively higher water levels; long steep culvert with no baffles	530759 / 5456303
Anderson Creek	Falls	Yes	Bedrock falls, upstream limit of passage for spawning salmon	530257 / 5456046
Fraser River Tributaries				
Tributary to Fraser River	Culvert	Flow-dependent	Debris and leaf jam behind culvert grate at invert, jam resulting in potentially impassable conditions during low flows	528685 / 5451203

[1] UTM Zone 10U

Table C-6: Stream Characteristics and Fish Habitat at Survey Sites

Watershed	Site Code	Segment Description	Wetted Width (m)	Bankful Width (m)	Riffle Depth (m)	Bankful Depth (m)	Morphology	Fish Presence	Substrate (%)						% Embeddedness	Spawning Gravels	Spawning Type	Total Cover (%)	LWD	Rearing Habitat	Bank Stability	Crown Closure (%)	Gradient (%)
									Boulder	Cobble	Gravel	Fines	Bedrock	Organic									
North Alouette	**North Alouette River**																						
	NA1	Upstream of confluence with South Alouette	35	45	3	4	RUN	ANADROMOUS	0	0	0	90	0	10	100	NONE	-	5	FEW	MODERATE	STABLE	0	0.5
	NA2	Just east of Neaves Rd bridge	12	15	2.5	3	FLAT	ANADROMOUS	0	0	0	90	0	10	100	NONE	-	8	FEW	ABUNDANT	MODERATELY STABLE	0	0.5
	NA5	Just upstream of Tim's trail footbridge	9	12	0.1	0.3	RIFFLE-POOL	ANADROMOUS	1	5	80	10	0	0	2	EXTENSIVE	BOTH	15	ABUNDANT	ABUNDANT	MODERATELY STABLE	41-70%	2
	NA6	Crossing under 132 Ave	9	11	0.25	0.55	RIFFLE-POOL	ANADROMOUS	0	30	65	5	0	0	3	EXTENSIVE	BOTH	15	ABUNDANT	ABUNDANT	MODERATELY STABLE	1-20%	3
	NA7	Upstream of 132 Ave bridge	11	14	0.1	0.3	RIFFLE-POOL	ANADROMOUS	0	20	75	5	0	0	2	EXTENSIVE	ANADROMOUS SALMON	8	NONE	MODERATE	MODERATELY STABLE	21-40%	2
	NA8	Downstream of 232 St bridge	11	13	0.15	0.6	RIFFLE-POOL	ANADROMOUS	5	35	50	10	0	0	3	EXTENSIVE	BOTH	5	FEW	ABUNDANT	MODERATELY STABLE	1-20%	2.5
	NA9	Upstream of 232 St bridge	12	14	0.2	0.5	RIFFLE-POOL	ANADROMOUS	5	50	35	10	0	0	3	EXTENSIVE	BOTH	3	NONE	MODERATE	MODERATELY STABLE	21-40%	2.5
	NA10	Approximately 900 m upstream of 232 St bridge	10	12	0.1	0.3	RIFFLE-POOL	ANADROMOUS	15	30	50	5	0	0	2	EXTENSIVE	BOTH	10	ABUNDANT	ABUNDANT	STABLE	21-40%	3
	NA11	Within UBC Malcolm Knapp Research Forest	8	10	1	3	STEP-POOL	UNKNOWN	0	0	0	0	100	0	0	NONE	-	15	NONE	LITTLE	STABLE	71-90%	20
	Balsam Creek																						
	BA1	Downstream of 233 St culvert	1.7	2	0.03	0.25	RIFFLE-POOL	ANADROMOUS	0	20	50	30	0	0	8	EXTENSIVE	TROUT/CHAR	20	ABUNDANT	LITTLE	MODERATELY STABLE	41-70%	2
	BA2	Upstream of development boundary	1.2	1.5	0.08	0.15	RIFFLE-POOL	UNKNOWN	5	35	60	5	0	0	2	EXTENSIVE	BOTH	25	ABUNDANT	ABUNDANT	STABLE	71-90%	3
	Paradise Creek																						
	PA1	Ditch running beside 232 St	0.4	0.6	0.05	0.1	RIFFLE-POOL	UNKNOWN	30	10	10	50	0	0	10	LITTLE	TROUT/CHAR	1	NONE	NONE	MODERATELY STABLE	21-40%	4
	Cattell Brook																						
	CA1	Along footpath approx. 50 m west of parking lot at western terminus of 136 Ave	4	5	1.5	1.7	FLAT	UNKNOWN	0	0	0	50	0	50	100	NONE	-	25	FEW	MODERATE	STABLE	1-20%	0.5
	CA2	West of 224 St	2	2.4	0.2	0.35	FLAT	UNKNOWN	0	0	0	50	0	0	100	NONE	-	10	FEW	LITTLE	STABLE	0	0.5
	CA3	Downstream of wooded area, within rhododendron nursery	1.6	2	0.08	0.15	RIFFLE-POOL	UNKNOWN	0	5	15	75	0	5	80	LITTLE	TROUT/CHAR	3	FEW	LITTLE	STABLE	1-20%	1
	CA4	Downstream of detainment ponds	6	6	1.5	1.5	POOL	UNKNOWN	0	0	0	50	0	50	100	NONE	-	50	ABUNDANT	MODERATE	STABLE	41-70%	0.5
	CA5	Downstream of confluence of tributaries	0	0.6	0	0.15	RIFFLE	ABSENT	0	0	0	80	0	20	100	NONE	-	5	FEW	NONE	STABLE	41-70%	1
	CA6	East tributary, downstream of 136 Ave culvert	1	1.2	0.04	0.25	RIFFLE-POOL	UNKNOWN	0	20	70	10	0	0	20	LITTLE	TROUT/CHAR	15	FEW	MODERATE	MODERATELY STABLE	41-70%	3
	CA7	West tributary, upstream of 36 Ave culvert	1	1.2	0.03	0.15	RIFFLE-POOL	UNKNOWN	0	10	50	40	0	0	50	LITTLE	TROUT/CHAR	5	FEW	LITTLE	MODERATELY STABLE	41-70%	3
	Connector A Creek																						
	CO1	Upstream of confluence with North Alouette River	8	8	1	1.5	SLOUGH	UNKNOWN	0	0	0	50	0	50	100	NONE	-	25	FEW	MODERATE	STABLE	1-20%	0

Table C-6: Stream Characteristics and Fish Habitat at Survey Sites

Watershed	Site Code	Segment Description	Wetted Width (m)	Bankful Width (m)	Riffle Depth (m)	Bankful Depth (m)	Morphology	Fish Presence	Substrate (%)						% Embeddedness	Spawning Gravels	Spawning Type	Total Cover (%)	LWD	Rearing Habitat	Bank Stability	Crown Closure (%)	Gradient (%)
									Boulder	Cobble	Gravel	Fines	Bedrock	Organic									
Blaney	**Blaney Creek**																						
	BL1	Just east of Neaves Rd bridge	8	11	2	2.7	RUN	ANADROMOUS	0	0	0	90	0	10	100	NONE	-	2	NONE	LITTLE	STABLE	0	0.5
	BL3	Running parallel to 144 Ave, west of 224 St	8	9	1.5	1.7	RUN	ANADROMOUS	0	0	0	50	0	50	100	NONE	-	4	FEW	MODERATE	STABLE	1-20%	0.5
	BL4	Upstream of confluence with Spring Ck	3.5	4.5	0.15	0.35	RIFFLE-POOL	ANADROMOUS	0	30	55	15	0	0	4	EXTENSIVE	BOTH	20	ABUNDANT	ABUNDANT	STABLE	1-20%	3
	Anderson Creek																						
	AN1	Upstream of confluence with Blaney Creek	2.3	2.3	0.5	0.7	FLAT	ANADROMOUS	0	0	0	50	0	50	100	NONE	-	50	NONE	MODERATE	STABLE	1-20%	0.5
	AN2	Mainstem in forest upstream of Blaney Bog	1.8	2.4	0.15	0.25	CASCADE-POOL	UNKNOWN	15	30	20	20	5	0	8	EXTENSIVE	BOTH	15	ABUNDANT	ABUNDANT	STABLE	71-90%	8
	AN3	Upstream of 232 St culvert	1.5	2	0.1	0.3	RIFFLE-POOL	UNKNOWN	20	30	40	10	0	0	3	EXTENSIVE	BOTH	12	FEW	ABUNDANT	STABLE	>90%	4
	AN4	Downstream of 141 Ave culvert	1	2	0.08	0.3	RIFFLE-POOL	UNKNOWN	5	30	50	5	0	0	3	EXTENSIVE	BOTH	20	ABUNDANT	ABUNDANT	STABLE	41-70%	3
	AN6	Upstream of BC Hydro right-of-way	1	1.2	0.05	0.2	RIFFLE-POOL	UNKNOWN	5	40	40	15	0	0	5	EXTENSIVE	TROUT/CHAR	10	ABUNDANT	LITTLE	STABLE	71-90%	5
	AN7	Tributary to Anderson Creek, with confluence downstream of falls. Site is upstream of ravine.	0.3	0.6	0.01	0.08	RIFFLE-POOL	ABSENT	0	5	15	60	0	20	75	NONE	-	10	NONE	NONE	STABLE	71-90%	6
	AN8	Tributary to Anderson Creek	0.9	0.9	0.02	0.1	RIFFLE-POOL	UNKNOWN	0	0	50	50	0	0	50	LITTLE	TROUT/CHAR	18	ABUNDANT	LITTLE	STABLE	41-70%	4
	Spring Creek																						
	SP1	Upstream of confluence with Blaney Creek. Still in lowland bog section.	10	11	1	1.5	FLAT	ANADROMOUS	0	10	20	60	0	10	60	LITTLE	BOTH	20	ABUNDANT	ABUNDANT	STABLE	1-20%	0.5
	Timberline Creek																						
	TI1	Just upstream of 144 Ave culvert	3	3.5	0.4	0.8	BEAVER POND	ANADROMOUS	1	1	1	60	0	37	100	NONE	-	10	FEW	MODERATE	STABLE	0	0.5
Fraser	**Fraser Tributaries**																						
	FR1	East tributary, site is upstream of the confluence with west tributary upstream of Haney Bypass culvert	0.25	0.6	0.2	0.4	RIFFLE-POOL	UNKNOWN	0	0	5	95	0	0	95	NONE	TROUT/CHAR	25	FEW	NONE	MODERATELY STABLE	71-90%	1
	FR2	West tributary, site is upstream of the confluence with east tributary upstream of Haney Bypass culvert	0.8	1.7	0.03	0.3	RIFFLE-POOL	UNKNOWN	5	10	55	30	0	0	60	LITTLE	TROUT/CHAR	15	FEW	LITTLE	MODERATELY STABLE	>90%	2
	FR3	Between 223 St and River Bend	0.9	1.5	0.02	0.2	RIFFLE-POOL	UNKNOWN	5	10	50	45	0	0	70	LITTLE	TROUT/CHAR	5	FEW	LITTLE	MODERATELY STABLE	71-90%	2
	FR4	Unnamed tributary to Fraser River between Wood Rd and Anderson Pl, south of River Rd	0.8	1.2	0.05	0.25	RIFFLE	UNKNOWN	5	15	10	70	0	0	75	LITTLE	TROUT/CHAR	20	ABUNDANT	LITTLE	MODERATELY STABLE	71-90%	5
	Roslyn Creek																						
	RO1	Channel running parallel to Fortis right-of-way	1.2	1.2	0.3	0.4	FLAT	UNKNOWN	0	0	0	50	0	50	100	NONE	-	80	NONE	LITTLE	MODERATELY STABLE	>90%	0.5
	RO2	Non-classified drainage, draining into RO1	0.1	0.7	0	0.07	OTHER	ABSENT	0	0	0	50	0	50	100	NONE	-	20	FEW	NONE	STABLE	>90%	0

Appendix C – Aquatic Species and Habitat Inventory

Aquatic Habitat Ratings and Values by Watercourse

North Alouette River and Tributaries

The **North Alouette River** provides extensive good to excellent aquatic habitat for spawning and rearing salmon, trout, and other aquatic organisms. Bankfull width ranges from approximately 45 m in the lower slough-like reach near the confluence with the South Alouette, narrowing to 12–15 m in the middle reaches, to 10 m in the upper bedrock canyon section (Table C-6). The lower reaches are slough-like and constrained by setback dikes through agricultural areas. The morphology of the middle reaches is riffle-pool, providing extensive spawning habitat. During the survey, 85 chum spawners were counted between 224 St and 232 St, although many more were present. Upstream of 232 St, the North Alouette flows through a constrained valley (Photo C-1). This section provides very high quality fish habitat, with extensive spawning gravels for salmon and trout, side channels, abundant LWD in the channel, very active LWD recruitment, overhanging vegetation, and pools. Natural processes of LWD recruitment and channel movement were occurring, creating complex habitat for many ages and species of fish. Numerous chum were spawning in this section during the survey.

Cattell Brook has been altered throughout its course, and provides moderate to poor fish habitat (Shead et al. 1999). The stream has been channelized, straightened, and modified for drainage purposes. One section downstream of 136 Ave appears to have been completely buried and diverted through one or several pipes (Photo C-3). The lower reach has been straightened. The middle reaches of Cattell Brook between 224 St and 232 St provide some moderate fish habitat with high instream cover and abundant LWD. During the survey, there were extensive flooded areas that may be used by rearing coho. These flooded areas were downstream of three ponds (3630 m², 950 m², and 280 m² in area) that are continuous with Cattell Brook. The smallest two ponds have been modified to function as stormwater detention ponds. All three provide habitat for rearing fish and amphibians in various life stages. Bankfull width in Cattell Brook ranges from 5 m in the lower channelized section, to 2 m upstream of 224 St in riffle-pool stretches and 6 m in flooded areas, to 1 m in its headwaters. There are old beaver dams in at least two places along Cattell Brook.

Balsam Creek provides moderate to good fish habitat downstream of 233 St and excellent fish habitat above the current development boundary. Bankfull width is 1.5–2 m. Spawning gravels are extensive, but chum do not usually use Balsam Creek due to its small size. During the survey, spawning trout were observed upstream of the Balsam St culvert, and suitable spawning gravels for trout are present throughout its length. Above the current development boundary, cover is high. LWD is abundant throughout.

Paradise Creek provides important off-channel habitat during periods of high flow in the North Alouette River, but most of its length has been straightened and the downstream half (approximately 300 m long) now flows within a ditch on the east side of 232 St with low habitat value.

Connector A Creek is a slow-moving or stagnant channel that connects the North and South Alouette Rivers, and provides moderate fish habitat. It provides backwater refuge for juvenile salmonids during periods of high flow in both rivers. It had a bankfull width of 8 m where surveyed. Some of its riparian vegetation has been cleared, and LWD is uncommon.

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Blaney Creek and Tributaries

Blaney Creek provides a mix of moderate fish habitat in its lower reaches and excellent fish habitat in its upper reaches. Downstream of Blaney Bog, Blaney Creek is fairly homogenous, with a slough-like morphology. Some sections have been straightened, and the channel is constricted by dikes. As a result, off-channel habitat that was present historically has been lost. Aquatic plants are abundant in this section. Around Blaney Bog, Blaney Creek becomes shallower, and transitions to a riffle-pool morphology upstream of its confluence with Spring Creek. Upstream of this transition, the stream provides excellent spawning habitat for salmon and trout, and abundant rearing habitat for juvenile salmonids. LWD is abundant, and cover is high. Thirteen chum spawners were observed during the survey in this section.

Anderson Creek provides excellent rearing habitat for juvenile salmonids in its lower reach, and excellent trout spawning and rearing habitat upstream of the bedrock falls that form a barrier for adult salmon. Upstream of Blaney Bog, the stream has high cover and abundant LWD. Bankfull width ranges from 2–2.4 m along most of its length. Excellent water quality contributes to this stream's high aquatic habitat values (see Appendix D).

Spring Creek provides excellent rearing habitat for juvenile salmonids while it is within Blaney Bog, with a bankfull width of 11 m, abundant cover, deep pools, and abundant LWD.

Timberline Creek is made up of multiple tributaries draining a flat area upstream of 144 Ave providing moderate fish habitat. The entire lowland area experiences seasonal flooding, and a beaver dam was present just upstream of the 144 Ave crossing during the survey. This area provides backwater refuge and rearing habitat for juvenile salmonids during flood conditions, and seasonally wetted areas for breeding amphibians. Average bankfull width is 3.5 m. The lowland area has been mowed and is dominated by reed canarygrass (*Phalaris arundinacea*).

Donegani Creek flows into the flat area drained by Timberline Creek. The creek was not surveyed as part of the biophysical inventory, but its habitat characteristics are likely similar to Timberline Creek.

Fraser River Tributaries

In the Fraser River catchment, several **unnamed tributaries** to the Fraser River provide predominantly poor fish habitat due to extensive loss of natural riparian vegetation, low flows, lack of pools and LWD, high percentage of fines, high embeddedness, and rip-rap bank protection. Observed bankful widths ranged from 0.6–1.7 m. Fish access from the Fraser River is unknown. Water quality was generally poor (see Appendix D).

Roslyn Creek provides poor fish habitat upstream of the Haney Bypass. The channel runs parallel to a FortisBC pipeline right-of-way and may have been realigned during construction of the pipeline. There was little flow in the low gradient channel. Bankfull width was 1.2 m and there was dense reed canarygrass growing into the channel.

Previous Enhancement Projects

DFO ran an upwelling gravel incubator program for chum salmon on Blaney Creek from 1972 to 1977, which released a total of 3,208,506 fry during operation (Banford and Bailey 1979).

The Allco Hatchery is a community hatchery run as a collaboration between the Fraser Regional Corrections Centre and ARMS. In 2014, the hatchery released 646,168 chum fry and 36,412 coho fry to the North Alouette River, both from South Alouette stock (ARMS, unpublished data).

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The hatchery releases approximately 400,000 chum fry each year to the North Alouette (M. Coulter-Boisvert, pers. comm., 2016).

An off-channel rearing pond connected to the North Alouette River was installed north of equestrian centre (M. Coulter-Boisvert, pers. comm., 2016).

Priority Fish and Aquatic Habitat Issues

Based on the review of background information, habitat assessment findings, and stakeholder engagement, the following priority concerns for fish and aquatic habitat have been identified in the three watersheds (Figure C-5):

Development Impacts

- Channel alteration in Fraser River tributaries: loss of natural banks and channel habitat due to riprap being placed in channels (KWL survey). For bank protection works natural bank stabilization methods can be used instead of riprap.
- Future development has the potential to impact: rare and sensitive ecosystems and species at risk within Blaney Creek and its tributaries, Blaney Bog, Anderson Creek, and Roslyn Creek (KWL survey); high quality fish habitat in the Upper North Alouette River; high quality of water within Balsam and Birch Creek; and high quality riparian habitat along North Alouette River and Connector A Creek. These ecosystems should be protected as they are key habitat areas for many aquatic and terrestrial species.
- Clearing of riparian vegetation has occurred throughout Cattell Brook and little to no riparian cover remains along sections of the stream (KWL survey). Riparian planting of native vegetation along the stream can help improve both the riparian and aquatic habitat as well as help protect against bank erosion.
- Development of Silver Valley within the Cattell Brook catchment has led to concerns regarding existing stormwater controls and the potential impacts on high quality fish habitat located downstream (AVA, pers. comm.). Rain gardens were installed throughout the Silver Valley development to mitigate stormwater runoff impacts in 2004. Concerns voiced by AVA include the following:
    - It is not known if the implemented systems will remain effective over time or will decrease in their effectiveness due to sedimentation as monitoring was only completed during the first three years after install.
    - The rain garden capture rate is only constructed for events up to the 6-month, 24 hour return period. Two out of the three first storm events monitored between 2005 and 2006 were above the 6-month, 24-hour return period and therefore large amounts of surface overflow from these events occurred. Although the system does reduce stormwater runoff there is still a concern regarding the amount of runoff that is not captured and treated by these systems.

  Long-term monitoring and maintenance of stormwater controls are needed to help reduce the introduction of contaminants and large volumes of stormwater runoff from entering the aquatic environment.

Appendix C – Aquatic Species and Habitat Inventory

Agriculture Impacts

- Water withdrawals from the North Alouette River in the spring by cranberry farms for frost protection coincides with the outmigration of salmon fry and concerns have been raised that this practice may lead to fry mortality (M. Coultier-Boisvert, pers. comm., 2016). It is not known at this time if current licenced water withdrawals are adequately protective of environmental flows needed for the proper functioning of the aquatic ecosystem as an environmental flow needs study has not been completed for the watershed. Also, illegal withdrawals have occurred previously within the North Alouette River and an investigation was documented in 2009. No illegal water withdrawals were observed during the field work completed for this ISMP however, it is important to ensure all water withdrawals are occurring legally, within their permitted rates and volumes, and that landowners are aware of current regulations. Charges can be laid under the federal *Fisheries Act*, and provincial *Dike Maintenance Act* and *Water Sustainability Act* for illegal water withdrawal. Although this is out of the City's jurisdiction, the City of Maple Ridge can work with the BC Ministry of Environment and Climate Change Strategy (BC MOE) and Fisheries and Oceans Canada (DFO) to ensure that landowners are aware of current regulations.
- Water quality issues downstream of agricultural areas within the North Alouette River and Blaney Creek may exist as agricultural nonpoint source pollution is a known source resulting in poor water quality downstream in lakes and streams (EPA, 2005). Issues may include high stream temperatures from the lack of riparian area, excess stream sedimentation from soil runoff after plowing and elevated levels of herbicides and pesticides within the water column from surrounding blueberry and cranberry farms (M. Coultier-Boisvert, pers. comm.). Locations where poor water quality may exist should be identified so additional water quality sampling can be completed. If water quality is found to be poor remedial actions can be taken to help reduce negative impacts to salmonid spawning and rearing habitats. As the river flows through both the City of Maple Ridge and the City of Pitt Meadows the municipalities can work collaboratively to address this issue.
- Anderson Creek which runs through Blaney Bog was modified by the construction of a dyke/canal system in the early 1900s. The purpose of this modification was for agricultural purposes (Piteau Associates, 2001). It is not known if the existing dike currently serves a purpose (McKenna, 2001). In addition to the Anderson Creek channelization, multiple dikes exist throughout the lower watershed of the North Alouette River, Blaney Creek, and Cattell Brook (KWL survey; M. Coulter-Boisvert, pers. comm. 2016). Both channelization and diking along streams lead to reductions in instream rearing and spawning habitat and alterations in natural stream flows (Wilcock and Essery 1991). The current state of these dikes and channels should be reviewed to determine if they are still required or if restoration of this sensitive habitat can be completed.

Impacts to Fish and Fish Habitat

- During the outmigration of fry in the lower Blaney Creek and North Alouette River, predation is high. This is due to these sections of watershed having little cover from predators. Riparian cover has been lost due to agriculture and diking (Banford and Bailey 1979). Mitigation measures such as increasing riparian cover, instream habitat complexity, and stream connectivity can be implemented to reduce predation pressures on outmigrating fry.
- Major water quality issues have been identified in the Fraser River catchment and Cattell Brook, while minor water quality issues have been identified in the North Alouette River and Blaney Creek (KWL monitoring). The Fraser River catchment is a historical urban area with lasting water quality issues. Although this catchment has had long-term water quality issues, the concept of shifting

baselines, which is the situation in which over time knowledge is lost because people don't perceive changes that are actually taking place, should not reduce the importance of addressing. Both recent and historical water quality data show that Cattell Brook has had ongoing issues. This stream flows through residential and lowland agricultural areas where water flow is slow and high levels of overland runoff contribute to the poor water quality observed.

- The culvert located at 232 Street in Anderson Creek is a known fish passage barrier and the culvert located at 141 Avenue in Anderson Creek is a potential fish passage barrier and has been identified as hydraulically undersize (KWL survey). Replacement of both culverts should be a priority to allow fish migration as well as reduce the risk of flooding.
- Excluding the two culverts mentioned above and the buried channel section in Cattell Brook, four additional anthropogenic potential/flow-dependent/partial fish passage barriers have been identified. This includes the following: a culvert under 136 Avenue along Cattell Brook, a culvert under Balsam Street along Balsam Creek, a culvert under 233 Street along Balsam Creek, and a culvert under 223rd Street along a Fraser River tributary (see Figure 6-7). These potential barriers should be investigated further to determine if they are full barriers to fish passage. If any of these culverts become designated as a fish passage barrier, culvert replacement should become a priority.
- Bank erosion has been identified along an unnamed tributary to the Fraser River adjacent to the private properties at 22233 River Road and 22532 Brickwood Close as well as along Blaney Creek adjacent to 144 Avenue at a storm outfall pipe (KWL Survey). Protection of these banks is important not only for adjacent properties but as well as the instream aquatic habitat (i.e. reducing stream flows to create potential rearing habitat).
- The invasive aquatic fish species common carp (*Cyprinus carpio*) has been identified in Anderson Creek. This species has the potential to spread throughout the lower watersheds of Blaney Creek and North Alouette River, negatively impacting native species, the nutrient cycle, and instream vegetation. Creating and restoring instream habitat can help offset the impacts created by the introduction of common carp. In addition, the public should be informed regarding the negative impacts of introducing non-native fish species into stream ecosystems.
- Invasive plant species have been observed throughout all three watersheds. However, Japanese knotweed (*Fallopia japonica*) and giant hogweed (*Heracleum mantegazzianum*) are of particular concern. Both species can cause infrastructure damage and the species giant hogweed is toxic and is a risk to public health. These invasive plant species should be removed, prioritizing the removal of giant hogweed first followed by Japanese knotweed.
- Significant amounts of riprap have been observed within and along the stream channels of the Fraser River and North Alouette watersheds. An artificial riprap weir and fall have been installed within a tributary of the Fraser River located between Anderson Place and Wood Street to create a pond feature. By removing these features and restoring the instream channel with step-pool habitat units, would improve the immediate habitat as well as upstream access for resident fishes. In addition, sections of riprap have been installed along the stream channel adjacent to 230A Street in the North Alouette watershed. Removing excess riprap and using bioengineering for bank protection can help improve the instream habitat for resident fishes.

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Photo C-3: Cattell Brook emerges from three pipes (one not shown) with unknown origins, potentially buried

Photo C-4: Anderson Creek culvert at 232 St is an old wood stave culvert and is clogged by sediment and debris, creating a fish barrier

Three environmental concerns previously identified during stakeholder engagement and field review are no longer considered a priority based on updated information received from the City of Maple Ridge.[1]

Potential Aquatic Habitat Enhancement Projects

The following projects have been identified as opportunities to enhance or restore aquatic habitat in the three watersheds:

- Replace Anderson Creek culvert at 232 St, which is currently a barrier.
- Investigate piped section of Cattell Brook and look at options for restoring natural channel.
- Add streambank complexing and/or riparian planting in middle reaches of North Alouette River to increase cover and improve rearing habitat. Banks are currently extensively armoured with rip-rap, and reaches lack LWD and LWD complexes, and rip-rap does not provide cover.

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[1] Environmental concerns no longer considered a priority include the following:

- Previously piped and buried sections of Cattell Brook have since been daylighted and diverted around the subdivision in September 2019;
- The ability to use fill of unknown quality has been addressed through the implementation of the Maple Ridge Soil Deposit Regulation Bylaw on May 8, 2018. The bylaw addresses the issue of soil quality for fill and requires tracking of soil from its source to placement. Although sources for fill material is now being tracked soil placed prior to the implementation of this bylaw still has the potential to be of environmental concern. Therefore, during site re-development, any suspected fill materials should be tested as per BC's Environmental Management Act (2003) and remediated if above the provincial guidelines; and
- The removal of gravel occurred in the North Alouette River under the 224 Street and 132 Avenue Bridges in 2011 and 2013, respectively. The gravel removal was completed under the two bridges to reduce the risk and occurrence of flooding within the immediate area. The gravel removal was based on Northwest Hydraulic Consultants (NHC) recommendation. Approvals were received from both Fisheries and Oceans Canada (DFO) and the Ministry of Forests, Lands, and Natural Resources Operations and Rural Operations (MFLNRORD). Best management practices were in place and all works were monitored by an environmental professional the potential to be of environmental concern.

- Develop management plan for potential gravel removal and log jam removal for flood mitigation in North Alouette River. Plan needs to consider timing and magnitude of removals to protect fish and fish habitat, especially spawning adults, incubating eggs, alevin, and fry.
- Create policy on how to improve existing stormwater management features. :
- Create a policy on watercourse debris removal such as log jams. Discussions would need to take place regarding how the City wants to implement the policy. Input and advice should be considered from a qualified environmental professional as well as the City's operations team.
- Reconfigure and restore backwater ponding areas/abandoned channel sections along 232 Ave, west of 224 St, to provide additional high-water storage to help alleviate flooding and provide rearing and/or refuge areas for juvenile fish (M. Coulter-Boisvert, pers. comm., 2016). A recent off-channel enhancement project on the South Alouette River west of 232 St, with an intake off the main stem, provides an example.
- Remove dike that cuts through the original path of Anderson Creek in Blaney Bog to increase accessibility and complexity of off-channel rearing habitat in this reach (Shead et al., 1999).
- Plant native shrubs and trees along banks of Cattell Brook at nursery (22673 132 Ave) where banks are bare, and along entire creek where landowners are agreeable.

Recommendations for further study include:

- Investigate whether salmon fry are being entrapped and killed by water withdrawals by cranberry farms during outmigration in the spring.
- Conduct water quality monitoring downstream of agricultural areas and test for pesticide levels, nitrates, and phosphates.
- Test sediment quality of fill sites filled prior to the implementation of the Maple Ridge Soil Deposit Regulation Bylaw (Bylaw No. 7412-2017), and water quality of water draining from fill sites. Testing of fill material can be completed during the redevelopment of a property when ground disturbance occurs. Not all fill sites require immediate testing.

C.4 Riparian and Watershed Forest Cover Assessment

Watershed forest cover was mapped using high-resolution orthophotos (2011 and 2015) provided by the City of Maple Ridge as well as ESRI orthophoto base mapping for areas where high-resolution orthophotos were not available. Riparian Forest Integrity (RFI) was calculated as the proportion of area covered by forest within 30 m of the centreline of all permanent watercourses.

Watershed forest cover and RFI values varied from low in the Fraser tributaries watershed to high in the North Alouette River watershed (Figure C-6, Table C-7). The North Alouette River watershed had both the highest watershed forest cover (82.1%) and the highest RFI (61.6%) of the three watersheds. Blaney Creek watershed also had a high watershed forest cover (73.3%), but a lower RFI (45.6%). Both of these watersheds have large tracts of forest in their upper watersheds, within the Malcolm Knapp Research Forest, but much of the riparian forest in their lower reaches has been lost. The Fraser River watershed has lost most of its forest cover, and has a very low RFI of 12.0%.

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Table C-7: Watershed and Riparian Forest Cover

Catchment	Total Area (ha)	Watershed Forest Cover		Riparian Forest Cover		
		Area (ha)	Cover (%)	Buffer Area (ha)	Forested Area (ha)	Integrity (RFI) (%)
North Alouette						
North Alouette River (total with Blaney Creek)	6553.1	5147.3	78.5%	434.1	235.2	54.2%
North Alouette River (without Blaney Creek)	4041.6	3193.6	79.0%	228.1	142.0	62.3%
North Alouette River (without Blaney Creek, City of Maple Ridge only)	-	-	-	189.6	141.8	74.8%
North Alouette (upstream of 232 St benthic invertebrate monitoring site)	-	-	-	97.7	86.7	88.8%*
Cattell Brook	-	-	-	50.1	26.0	51.8%*
Balsam Creek	-	-	-	10.7	9.3	86.8%*
Blaney						
Blaney Creek (total)	2511.4	1953.7	77.8%	206.0	93.2	45.2%
Blaney Creek (and Spring) upstream of 104 Ave, no Anderson Creek or Blaney Bog tributaries	-	-	-	51.0	38.7	75.8%*
Blaney Creek (City of Maple Ridge only)	-	-	-	149.2	80.7	54.1%
Anderson Creek	-	-	-	35.9	20.7	57.6%
Anderson Creek (upstream of benthic monitoring site)	-	-	-	13.4	11.0	82.2%*
Fraser						
Fraser Tributaries (total)	340.5	89.3	26.2%	47.7	24.2	50.7%*
*RFI values used for Watershed Health Tracking System						

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Potential Changes in Riparian Forest Integrity Based on Stream Protection Regulation

To ensure stream are protected within the City of Maple Ridge a Watercourse Protection Development Permit is required for all development and building permits within 50 m of the top of bank from watercourses and wetlands. This development permit is based on the 2001 Streamside Protection Regulation (SPR) under the Provincial *Fish Protection Act [1997]*. Streamside protection and enhancement areas were based on two main criteria: the width of existing or potential vegetation next to a stream, and the types of stream (permanent or non-permanent, fish bearing or non-fish bearing). In 2005, the government repealed the *SPR* and brought into force the new Riparian Areas Regulation (RAR). RAR requires any land alteration within 30 m of a stream or lake to which land alteration will occur to obtain a development permit under the RAR Development Permit Area (DPA). In 2016 the Fish Protection Act was re-titled the *Riparian Areas Protection Act*, and in 2019 the Riparian Areas Regulation was amended and became the Riparian Areas Protection Regulation.

Updating the City of Maple Ridge’s stream protection to align with current Riparian Areas Protection Regulation (RAPR) would result in a reduction of 20 m of streamside habitat (50 m down to 30 m) along fish bearing streams leading to an overall reduction in the City’s Riparian Forest Integrity. It is recommended that the City of Maple Ridge continue to implement the Watercourse Protection Development Permit for all development and buildings permits within 50 m of the top of bank from watercourses and wetlands.

Potential Areas for Riparian Corridor Restoration

The following potential areas have been identified where native riparian vegetation could be planted to restore natural riparian forest and increase RFI values for these watersheds:

- Throughout Cattell Brook;
- Middle and lower reaches of Blaney Creek;
- Lower reaches of North Alouette River; and
- All creeks within Fraser River watershed, protection of existing forest patches from future development (e.g., Roslyn Creek riparian corridor) and replanting riparian areas during redevelopment.

C.5 Terrestrial Species and Habitat Assessment

The Blaney and North Alouette watersheds also contain diverse and regionally unique terrestrial and wetland habitats. Up to 24 species at risk are either known from or have the potential to occur in these watersheds. Many historic wetland areas have been lost due to widespread conversion of wetlands to agricultural and residential areas. Protecting the habitat that remains is critical for conserving these populations.

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Terrestrial Habitats

Several significant areas of wildlife habitat are present in the three study watersheds:

Blaney Bog

Blaney Bog is a unique bog-fen wetland complex located in the Blaney Creek watershed and administered as a Regional Park Reserve area by Metro Vancouver Regional Parks (Figure C-6). The 147 ha bog (114 ha protected as park) is located at the south-western foot of an upland area comprised of the foothills of Golden Ears and its associated ridge, including the Malcolm Knapp Research Forest and the Silver Valley neighbourhood. The complex is made up of mound bog-stream fen in the south and east and stream fen area in the northwest. Blaney Bog is the only documented mound bog-stream fen complex in the Fraser Lowlands and is a site of high biodiversity (Downarowicz 2003). It provides high quality habitat for many rare and endangered species, including Great Blue Heron (*Ardea Herodias fannini*), Green Heron (*Butorides virescens*), American Bittern (*Botaurus lentiginosus*), Peregrine Falcon (*Falco peregrinus anatum*), Northern Red-legged Frog (*Rana aurora*), and Pacific Water Shrew (*Sorex bendirii*). Sandhill Cranes (*Antigone canadensis*) forage and roost in the bog, and suitable nesting habitat is present (Summers 2001). Bog laurel (*Kalmia microphylla occidentalis*), Labrador tea (*Rhododendron groenlandicum*), cloudberry (*Rubus chamaemorus*), bog cranberry (*Vaccinium oxycoccos*), bog blueberry (*Vaccinium uliginosum*), cotton-grass (*Eriophorum chamissonis*), round-leaved sundew (*Drosera rotundifolia*), woolgrass (*Scirpus cyperinus*), and 16 species of mosses (*Sphagnum* species, others) grow in the unique acidic soil conditions of the bog (Summers 2001).

Codd Wetland

Codd Wetland (101 ha) is one of the last undiked wetlands in Pitt Meadows. The wetlands are administered by Metro Vancouver Regional Parks as an Ecological Conservancy Area. Most of the area is classified as fen habitat, dominated by reed canarygrass (*Phalaris arundinacea*). The following species also grow in areas of low and tall shrubland: sweet gale (*Myrica gale*), hardhack (*Spiraea douglasii*), red-osier dogwood (*Cornus stolonifera*), Pacific crabapple (*Malus fusca*), black hawthorn (*Crataegus douglasii*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosea*), black twinberry (*Lonicera involucrata*), thimbleberry (*Rubus parviflorus*), Pacific willow (*Salix lasiandra*), scouler willow (*Salix scouleriana*), Sitka willow (*Salix sitchensis*), black cottonwood (*Populus balsamifera*), and red alder (*Alnus rubra*) (Gebauer 2001). These habitats provide nesting and perching habitats for songbirds. Smaller areas of forest include Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), grand fir (*Abies grandis*), red alder, paper birch (*Betula papyrifera*), bigleaf maple (*Acer macrophyllum*), and western flowering dogwood (*Cornus nuttallii*). Raptors roost and nest in these trees. Many of the rare and endangered wildlife species present in Blaney Bog also use Codd Wetlands and breed there. Sandhill Cranes nest and forage within in the Codd Wetlands (Summers 2001). The wetlands provide critical off-channel habitat for juvenile salmonids (Gebauer 2001).

Codd Island Wetlands Ecological Conservancy Area also includes a smaller area farther south (see Figure C-6) that includes a section of the North Alouette River and its riparian forest. Many large Sitka spruce (*Picea sitchensis*) are present in this area, and the plant community is rare and regionally significant (Henderson & Ryder 2006). Red-tailed Hawks have nested in the area.

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Malcolm Knapp Research Forest

The Malcolm Knapp Research Forest, managed by the University of British Columbia, makes up the upper 5,157 ha of the Blaney and North Alouette watersheds. It provides an extensive wilderness and multi-use forestry area with lowland and upland forest, alpine lakes, streams, riparian areas, and wetlands. There is some logging activity within the area for research and teaching purposes, and several forest service roads. The area is home to large mammals such as Black Bear (*Ursus americanus*), Cougar (*Puma concolor*), Coyote (*Canis latrans*), and Mule Deer (*Odocoileus hemionus*). Several species at risk have been recorded within the Research Forest, including Coastal Tailed Frog (*Ascaphus truei*), Great Blue Heron (*Ardea herodias fannini*), Pacific Water Shrew (*Sorex bendirii*), and Emma’s Dancer (*Argia emma*), a rare dragonfly species.

Significant Riparian Habitats

There are several significant, high value areas of riparian forest within the study area. These riparian forests act as wildlife corridors, allowing bears, racoons, cougars, deer, coyotes, and other wildlife to travel between upland forests, along the rivers, to lowland wetlands and the Fraser River.

North Alouette River upstream of Codd Wetland

An additional riparian and wetland area with large Sitka spruce is present just south of the southern extent of Codd Wetland. This area is located on the north-east portion of the Maple Ridge Equi-sport Centre lot (21973 132 Ave).

North Alouette River upstream of 232 St

This area along the North Alouette River provides very high quality riparian forest habitat for wildlife, and a travel corridor to the lower watershed (Photo C-5). The forest is composed of mature western redcedar, Sitka spruce, western hemlock, bigleaf maple, red alder, and black cottonwood. Dense patches of salmonberry grow along the banks. Dead standing wildlife trees are present.

Balsam Creek

The riparian forest of Balsam Creek provides high quality wildlife habitat and a travel corridor from the extensive forested area in the upper watershed and the North Alouette River. Residents reported black bears (mother with cubs and solitary male) regularly use the riparian forest as a travel corridor. Cougars have also been reported at the Balsam Street crossing. Upstream of Balsam Street, the forest is made up of mature western hemlock, western redcedar, bigleaf maple, and red alder. There is a dense understory of salmonberry, sword fern (*Polystichum munitum*), and beaked hazelnut (*Corylus cornuta*).

Lower Cattell Brook

There are two significant patches of riparian forest on Cattell Brook between 224 St and 232 St. Both sections have mature stands of western redcedar, western hemlock, Douglas-fir, Sitka spruce, red alder, and black cottonwood, with salmonberry, willow, and Himalayan blackberry (*Rubus armeniacus*) along Cattell Brook. The upstream patch has significant wetland areas continuous with the stream, which flood during high water and provide habitat for waterfowl and amphibians. The downstream patch has wetted areas disconnected from the stream, which provide habitat for amphibians.

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Roslyn Creek

There is a rare grove of old growth western redcedar and Sitka spruce in the riparian area of Roslyn Creek, in the Fraser River watershed (Photo C-6). This habitat provides unique habitat for wildlife species that rely on old growth forests, and should be protected and enhanced.

Photo C-5: High quality riparian habitat on the North Alouette River upstream of 232 St

Photo C-6: Grove of old growth western redcedar and Sitka spruce in riparian forest along Roslyn Creek in the Fraser River watershed

Wildlife

Species at Risk

There are 24 species at risk that are present or potentially present in the study area (Table C-8).

The North Alouette River, Blaney Creek, and their tributaries provide important foraging habitat for Great Blue Herons. Historically, there have been ten Great Blue Heron colonies in the Alouette watershed, with four in the Blaney and North Alouette watersheds (Mitchell 2012). In 2012, only the Alouette River Colony was active, which had been in decline. The colony did not produce any fledged young from 2010 to 2012 (Mitchell 2012). A new heron nesting site in the Malcolm Knapp Research Forest was identified in 2013 within the North Alouette watershed (Mitchell 2013).

The Georgia Depression population of Sandhill Cranes was removed from the provincial Red List (Endangered) in 2006, although it is limited in size and habitat, and continues to lose habitat (Harding 2010). Sandhill Cranes nest and forage within in Codd Wetland (Summers 2001). They also forage and roost in Blaney Bog, and suitable nesting habitat is present (Summers 2001).

Northern Red-legged Frogs were recorded breeding at Blaney Bog in 2012. Coastal Tailed Frog were recorded in the headwaters of the North Alouette River (Mitchell 2013). In 2013, many adult Western Toads (*Anaxyrus boreas*) were observed migrating on a road in the Malcolm Knapp Research Forest, indicating that breeding occurred nearby.

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Table C-8: Species at Risk Present or Potentially Present in the Blaney, North Alouette and Fraser River Watersheds

Common Name	Scientific Name	Conservation Status			Status and Habitat in Watershed	Reference
		BC List[1]	COSEWIC[2]	*SARA*[3]		
Fish						
Coastal Cutthroat Trout	*Oncorhynchus clarkii clarkii*	Blue	-	-	Present in Blaney and North Alouette watersheds	MOE 2016b, MOE 2016c
Brassy Minnow	*Hybognathus hankinsoni*	Blue	-	-	Present in the North and South Alouette Watersheds	MOE 2016b
Amphibians and Reptiles						
Northern Red-legged Frog	*Rana aurora*	Blue	SC (2015)	1-SC	Breeding in Blaney Bog	Mitchell 2013
Coastal Tailed Frog	*Ascaphus truei*	Blue	SC (2011)	1-SC (2003)	Headwaters of North Alouette River	Mitchell 2013
Birds						
Great Blue Heron, *fannini* subspecies	*Ardea herodias fannini*	Blue	SC (2008)	-	Forage throughout lower watershed, new nesting site in UBC Malcolm Knapp Research Forest	Mitchell 2012, Mitchell 2013, MOE 2016c, M. Sather (Alouette Field Naturalists) pers. comm. 2016
Green Heron	*Butorides virescens*	Blue	-	-	Expected to nest in Codd Island Wetland, observed along North Alouette River between Neaves Rd and 224 St	Gebauer 2001, Henderson & Ryder 2006
Black-crowned Night Heron	*Nycticorax nycticorax*	Red	-	-	Along North Alouette River	Geoff Clayton pers. comm. in Henderson & Ryder 2006
American Bittern	*Botaurus lentiginosus*	Blue	-	-	Breed in Blaney Bog and Codd Island Wetlands, observed in Blaney Bog, and in North Alouette riparian north of 132 Ave	Gebauer 2001, Henderson & Ryder 2006
Peregrine Falcon, *anatum* subspecies	*Falco peregrinus anatum*	Red	SC (2007)	1-SC (2012)	Observed in Blaney Bog, waterbirds provide abundant prey	Gebauer 2001

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Common Name	Scientific Name	Conservation Status			Status and Habitat in Watershed	Reference
		BC List[1]	COSEWIC[2]	*SARA*[3]		
Band-tailed Pigeon	*Patagioenas fasciata*	Blue	SC (2008)	1-SC (2011)	Observed in riparian forest of North Alouette River north of 132 Ave	Henderson & Ryder 2006, M. Sather (Alouette Field Naturalists) pers. comm. 2016
Barn Owl	*Tyto alba*	Red	T (2010)	1-SC (2003)	Roosts in riparian forest north of 132 Ave, potential roosting in abandoned buildings east of Codd Island Wetlands	Henderson & Ryder 2006, Gebauer 2001
Short-eared Owl	*Asio flammeus*	Blue	SC (2008)	1-SC (2012)	Along North Alouette River, suitable nesting habitat especially in Codd Island Wetlands and Blaney Bog	Geoff Clayton pers. comm. in Henderson & Ryder 2006
Black Swift	*Cypseloides niger*	Blue	E (2015)	-	Observed over riparian area of North Alouette River north of 132 Ave	Henderson & Ryder 2006
Olive-sided Flycatcher	*Contopus cooperi*	Blue	T (2007)	1-T (2010)	In forest along North Alouette River north of 132 Ave	Henderson & Ryder 2006
Barn Swallow	*Hirundo rustica*	Blue	T (2011)	-	Observed in either Blaney Bog, Codd Island Wetland, or Blaney Creek	M. Sather (Alouette Field Naturalists) pers. comm. 2016
Double-crested Cormorant	*Phalacrocorax auritus*	Blue	NAR (1978)	-	Observed in either Blaney Bog, Codd Island Wetland, or Blaney Creek	M. Sather (Alouette Field Naturalists) pers. comm. 2016
Yellow-breasted Chat	*Icteria virens*	Red	E (2001)	1-E (2003)	Reported as breeding by Alouette Field Naturalists member but not confirmed by others (S. Barrett, MWLAP, pers. comm., 2001)	Gebauer 2001, Self 2002
Western Meadowlark (Georgia Depression Population)	*Sturnella neglect* pop. 1	Red	-	-	Reported but breeding status uncertain	Gebauer 2001

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Common Name	Scientific Name	Conservation Status			Status and Habitat in Watershed	Reference
		BC List[1]	COSEWIC[2]	*SARA*[3]		
Mammals						
Pacific Water Shrew	*Sorex bendirii*	Red	E (2016)	1-E (2003)	Historic occurrence south end of Loon Lake and north end of Blaney Lake; 1973, 1974; likely present in Codd Island Wetland and Blaney Bog	MOE 2016c, Gebauer 2001
Keen's Long-eared Myotis	*Myotis keenii*	Blue	DD (2003)	3-SC (2005)	Potential; uses coastal forest habitats, tree cavities, rock crevices, small caves for roosting	Gebauer 2001
Western Big-eared Bat	*Corynorhinus townsendii*	Blue	-	-	May forage over wetland habitats, use abandoned buildings as summer roosts	Gebauer 2001
Plants						
Pointed rush	*Juncus oxymeris*	Blue	-	-	Recorded in Sturgeon Slough, polygon extends into Blaney Creek and watershed, in 1973	MOE 2016c
Mountain Sneezeweed	*Helenium autumnale* var. *grandiflorum*	Blue	-	-	Marshy banks, lowland, At Neaves Road Bridge, North Alouette River, 1971	MOE 2016c
Invertebrates						
Grappletail	*Octogomphus specularis*	Red	-	-	Blaney Ck, at road crossing south of Blaney Lake, UBS research forest, 1985, 1990; also in upper North Alouette River, N and Sh of Jacob's lake	MOE 2016c
Emma's Dancer	*Argia emma*	Blue	-	-	UBC research forest, north of Haney, Blaney Creek at road crossing about 100 m SW of Blaney Lake outlet, 1985; also S of Jacob's lake	MOE 2016c

[1] Blue: Special Concern; Red: Extirpated, Endangered, or Threatened

[2] SC: Special Concern; T: Threatened; E: Endangered; DD: Data Deficient

[3] 1-SC: Schedule 1 Special Concern; 1-T: Schedule 1 Threatened; 1-E: Schedule 1 Endangered; 3-SC: Schedule 3 Special Concern

"-" indicates no status

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Other Wildlife

In addition to the 24 species at risk listed in above, there are 101 species of birds, 20 species of mammals, 4 species of amphibians, and 1 species of reptile recorded in the study area (Table C-9).

Table C-9: Other Wildlife Species Present in Blaney, North Alouette, and Fraser River Watersheds

Common Name	Scientific Name	Location(s)	Reference
Birds			
Wood Duck	*Aix sponsa*	See Note 1	Alouette Field Naturalists[2]
Gadwall	*Anas strepera*	See Note 1	Alouette Field Naturalists[2]
American Wigeon	*Anas americana*	See Note 1	Alouette Field Naturalists[2]
Northern Shoveler	*Anas clypeata*	See Note 1	Alouette Field Naturalists[2]
Ring-necked Duck	*Aythya collaris*	See Note 1	Alouette Field Naturalists[2]
Mallard	*Anas platyrhynchos*	See Note 1	Alouette Field Naturalists[2]
Northern Pintail	*Anas acuta*	See Note 1	Alouette Field Naturalists[2]
Hooded Merganser	*Lophodytes cucullatus*	See Note 1	Alouette Field Naturalists[2], observed by KWL
Bufflehead	*Bucephala albeola*	See Note 1	Alouette Field Naturalists[2]
Green-winged Teal	*Anas crecca*	See Note 1	Alouette Field Naturalists[2]
Harlequin Ducks	*Histrionicus histrionicus*	Along North Alouette River	Geoff Clayton pers. comm. in Henderson & Ryder 2006
Lesser Scaup	*Aythya affinis*	Codd Island Wetlands, Polder Ridge Marsh	Gebauer 2001
Canada Goose	*Branta canadensis*	See Note 1	Alouette Field Naturalists[2]
Trumpeter Swan	*Cygnus buccinator*	Along North Alouette River	Geoff Clayton pers. comm. in Henderson & Ryder 2006
Pied-billed Grebe	*Podilymbus podiceps*	See Note 1	Alouette Field Naturalists[2]
Ring-necked Pheasant	*Phasianus colchicus*	North Alouette north of 132 Ave	Henderson & Ryder 2006
Turkey Vulture	*Cathartes aura*	See Note 1	Alouette Field Naturalists[2]
Northern Harrier	*Circus cyaneus*	See Note 1	Alouette Field Naturalists[2]
Bald Eagle	*Haliaeetus leucocephalus*	See Note 1	Alouette Field Naturalists[2], Observed by KWL
Osprey	*Pandion haliaetus*	See Note 1	Alouette Field Naturalists[2]
Sharp-shinned Hawk	*Accipiter striatus*	See Note 1	Alouette Field Naturalists[2]
Cooper’s Hawk	*Accipiter cooperii*	See Note 1	Alouette Field Naturalists[2]
Red-tailed Hawk	*Buteo jamaicensis*	See Note 1	Alouette Field Naturalists[2], Henderson & Ryder 2006
Northern Harrier	*Circus cyaneus*	Along North Alouette River	Geoff Clayton pers. comm. in Henderson & Ryder 2006
American Kestrel	*Falco sparverius*	See Note 1	Alouette Field Naturalists[2]

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Common Name	Scientific Name	Location(s)	Reference
Merlin	*Falco columbarius*	See Note 1	Observed by KWL
Virginia Rail	*Rallus limicola*	See Note 1	Alouette Field Naturalists[2]
American Coot	*Fulica amaricana*	See Note 1	Alouette Field Naturalists[2]
Sandhill Crane	*Antigone canadensis*	See Note 1	Alouette Field Naturalists[2], Henderson & Ryder 2006
Killdeer	*Charadrius vociferus*	See Note 1	Alouette Field Naturalists[2]
Spotted Sandpiper	*Actilis macularia*	Along North Alouette River	Henderson & Ryder 2006
Great Horned owl	*Bubo virginianus*	Observed and pellets in forest along North Alouette River north of 132 Ave	Henderson & Ryder 2006
Northern Saw-whet Owl	*Aegolius acadicus*	Forest along North Alouette River north of 132 Ave	Henderson & Ryder 2006
Northern Pymgy-Owl	*Glaucidium gnoma*	Golden Ears Provincial Park	
Common Nighthawk	*Chordelles minor*	Over North Alouette riparian north of 132 Ave	Henderson & Ryder 2006
Greater Yellowlegs	*Tringa melanoleuca*	See Note 1	Alouette Field Naturalists[2]
Lesser Yellowlegs	*Tringa flavipes*	See Note 1	Alouette Field Naturalists[2]
Wilson’s Snipe	*Gallinago delicata*	See Note 1	Alouette Field Naturalists[2]
Glaucous-winged Gull	*Larus glaucescens*	See Note 1	Alouette Field Naturalists[2]
Rock Pigeon	*Columba livia*	See Note 1	Alouette Field Naturalists[2]
Mourning Dove	*Zenaida macroura*	See Note 1	Alouette Field Naturalists[2]
Belted Kingfisher	*Megaceryle alcyon*	See Note 1	Alouette Field Naturalists[2], Observed by KWL
Rufous Hummingbird	*Selasphorus rufus*	See Note 1	Alouette Field Naturalists[2]
Red-breasted Sapsucker	*Sphyrapicus ruber*	Sign in forest along North Alouette River	Henderson & Ryder 2006
Downy Woodpecker	*Picoides pubescens*	Forest along North Alouette River	Henderson & Ryder 2006
Hairy Woodpecker	*Picoides villosus*	See Note 1	Alouette Field Naturalists[2]
Northern Flicker	*Colaptes auratus*	See Note 1	Alouette Field Naturalists[2]
Pileated Woodpecker	*Dryocopus pileatus*	Along North Alouette River	Henderson & Ryder 2006
Western Wood-Pewee	*Contopus sordidulus*	Forest along North Alouette River	Henderson & Ryder 2006
Willow Flycatcher	*Empidonax traillii*	Along North Alouette River edge	Henderson & Ryder 2006

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Common Name	Scientific Name	Location(s)	Reference
Eastern Kingbird	*Tyrannus tyrannus*	See Note 1	Alouette Field Naturalists[2], Henderson & Ryder 2006
Western Kingbird	*Tyrannus verticalis*	Along North Alouette River	Geoff Clayton pers. comm. in Henderson & Ryder 2006
Northern Shrike	*Lanius excubitor*	See Note 1	Alouette Field Naturalists[2]
Cassin's Vireo	*Vireo cassinii*	Forest along North Alouette River	Henderson & Ryder 2006
Hutton's Vireo	*Vireo huttoni*	Forest along North Alouette River	Henderson & Ryder 2006
Warbling Vireo	*Vireo gilvus*	Along North Alouette River	Henderson & Ryder 2006
Red-eyed Vireo	*Vireo olivaceus*	Forest along North Alouette River	Henderson & Ryder 2006
Steller's Jay	*Cyanocitta stelleri*	See Note 1	Alouette Field Naturalists[2]
Northwestern Crow	*Corvus caurinus*	See Note 1	Alouette Field Naturalists[2]
Common Raven	*Corvus corax*	See Note 1	Alouette Field Naturalists[2]
Tree Swallow	*Tachycineta bicolor*	Feeding over area beside North Alouette River north of 132 Ave	Henderson & Ryder 2006
Violet-green Swallow	*Tachycineta thalassina*	See Note 1	Alouette Field Naturalists[2]
Rough-winged Swallow	*Stelgidopteryx serripennis*	See Note 1	Alouette Field Naturalists[2]
Cliff Swallow	*Petrochelidon pyrrhonota*	See Note 1	Alouette Field Naturalists[2]
Black-capped Chickadee	*Poecile atricapillus*	See Note 1	Alouette Field Naturalists[2]
Chestnut-backed Chickadee	*Poecile rufescens*	Along North Alouette River	Henderson & Ryder 2006
Bushtit	*Psaltriparus minimus*	See Note 1	Alouette Field Naturalists[2]
Red-breasted Nuthatch	*Sitta canadensis*	Forest along North Alouette River	Henderson & Ryder 2006
Brown Creeper	*Certhia americana*	Forest along North Alouette River, old nests	Henderson & Ryder 2006
Bewick's Wren	*Thryomanes bewickii*	See Note 1	Alouette Field Naturalists[2]
Marsh Wren	*Cistothorus palustris*	See Note 1	Alouette Field Naturalists[2]
Pacific Wren	*Troglodytes pacificus*	Forest along North Alouette River	Henderson & Ryder 2006
American Dipper	*Cinclus mexicanus*	See Note 1	Alouette Field Naturalists[2], Observed by KWL
Golden-crowned Kinglet	*Regulus satrapa*	Forest along North Alouette River	Henderson & Ryder 2006
Ruby-crowned Kinglet	*Regulus calendula*	Forest along North Alouette River	Henderson & Ryder 2006

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Common Name	Scientific Name	Location(s)	Reference
Swainson's Thrush	*Catharus ustulatus*	See Note 1	Alouette Field Naturalists[2]
Varied Thrush	*Ixoreus naevius*	See Note 1	Alouette Field Naturalists[2]
American Robin	*Turdus migratorius*	See Note 1	Alouette Field Naturalists[2]
Gray Catbird	*Dumetella carolinensis*	See Note 1	Alouette Field Naturalists[2]
Cedar Waxwing	*Bombycilla cedrorum*	See Note 1	Alouette Field Naturalists[2]
European Starling	*Sturnus vulgaris*	See Note 1	Alouette Field Naturalists[2]
Orange-crowned Warbler	*Oreothlypis celata*	See Note 1	Alouette Field Naturalists[2]
Common Yellowthroat	*Geothlypis trichas*	See Note 1	Alouette Field Naturalists[2]
Yellow Warbler	*Setophaga petechial*	See Note 1	Alouette Field Naturalists[2]
Yellow-rumped Warbler	*Setophaga coronate*	See Note 1	Alouette Field Naturalists[2]
MacGillvray's Warbler	*Oporornis tolmei*	Forest along North Alouette River	Henderson & Ryder 2006
Wilson's Warbler	*Wilsonia pusilla*	Forest along North Alouette River	Henderson & Ryder 2006
Western Tanager	*Piranga ludoviciana*	Forest along North Alouette River	Henderson & Ryder 2006
Spotted Towhee	*Pipilo maculatus*	See Note 1	Alouette Field Naturalists[2]
Savannah Sparrow	*Passerculus sandwichensis*	See Note 1	Alouette Field Naturalists[2]
Fox Sparrow	*Passerella iliaca*	See Note 1	Alouette Field Naturalists[2]
Song Sparrow	*Melospiza melodia*	See Note 1	Alouette Field Naturalists[2]
White-crowned Sparrow	*Zonotrichia leucophrys*	See Note 1	Alouette Field Naturalists[2]
Dark-eyed Junco	*Junco hyemalis*	See Note 1	Alouette Field Naturalists[2]
Black-headed Grosbeak	*Pheucticus melanocephalus*	Forest along North Alouette River	
Red-winged Blackbird	*Agelaius phoeniceus*	See Note 1	Alouette Field Naturalists[2]
Brown-headed Cowbird	*Molothrus ater*	See Note 1	Alouette Field Naturalists[2]
Purple Finch	*Haemorhous purpureus*	See Note 1	Alouette Field Naturalists[2]
Red Crossbill	*Loxia curvirostra*	Forest along North Alouette River	Henderson & Ryder 2006
Pine Siskin	*Spinus pinus*	Forest along North Alouette River	Henderson & Ryder 2006
American Goldfinch	*Spinus tristis*	See Note 1	Alouette Field Naturalists[2]

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Common Name	Scientific Name	Location(s)	Reference
Mammals			
Coyote	*Canis latrans*	Tracks, scat, observed	Henderson & Ryder 2006, Observed by KWL
Mule Deer	*Odocoileus hemionus*		Observed by KWL
Beaver[3]	*Castor canadensis*	Along North Alouette River, den and bank tunnels, trails, dam on Cattell Brook	Henderson & Ryder 2006, observed by KWL
Black Bear	*Ursus americanus*	In riparian of Balsam Creek and North Alouette River	Reported by residents
Cougar	*Puma concolor*	Around Balsam Creek	Reported by residents
Eastern Grey Squirrel	*Sciurus carolinensis* ssp. *pennsylvanicus*	East side of North Alouette River, north of 132 Ave	Henderson & Ryder 2006
Northern Flying Squirrel	*Glaucomys sabrinus* ssp. *oregonensis*	Nest on Sitka Spruce limb, observed at cavity in tree	Henderson & Ryder 2006
Douglas' Squirrel	*Tamiasciurus douglasii* ssp. *mollipilosu*	Forest along North Alouette River	Henderson & Ryder 2006
Long-tailed Vole	*Microtus longicaudus*	Dead in bog area	Henderson & Ryder 2006
Townsend's Vole	*Microtus townsendii* ssp. *townsendii*	Alongside dyke along North Alouette River	Henderson & Ryder 2006
Southern Redbacked vole	*Myodes gapperi*	Blaney Bog	Huizing 2002
Creeping Vole	*Microcotus oregoni*	Blaney Bog	Huizing 2002
Deer Mouse	*Peromyscus maniculatus*	Blaney Bog	Huizing 2002
Dusky Shrew	*Sorex monticolus*	Blaney Bog	Huizing 2002
Vagrant Shrew	*Sorex vagrans*	Blaney Bog	Huizing 2002
Muskrat	*Ondatra zibethicus* ssp. *spatulata*	In channel	Henderson & Ryder 2006
Pacific Jumping Mouse	*Zapus trinotatus* ssp. *trinotatus*	Seen on high ground	Henderson & Ryder 2006
Raccoon	*Procyon lotor*	Forest, river's edge, scat, trails, sleeping	Henderson & Ryder 2006
River Otter	*Lontra Canadensis*	Swimming in North Alouette River	Henderson & Ryder 2006
Mink	*Mustela vison*	Around North Alouette River north of 132 Ave	Geoff Clayton, pers. comm. in Henderson & Ryder 2006

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Common Name	Scientific Name	Location(s)	Reference
Amphibians			
Long-toed Salamander	*Ambystoma macrodactylum*	Away from Blaney Creek, high ground in mosses	Henderson & Ryder 2006
Rough-skinned Newt	*Taricha granulosa*	In wet channel on North Alouette north of 132 Ave	Henderson & Ryder 2006
Pacific Treefrog	*Hyla regilla*	Various locations	Henderson & Ryder 2006
Red-legged Frog	*Rana aurora*	Forest, wet areas of forest along North Alouette River north of 132 Ave	Henderson & Ryder 2006
Reptiles			
Common Garter Snake	*Thamnophis sirtalis*	In rocks along North Alouette River, edge of channel, north of 132 Ave	Henderson & Ryder 2006
Notes: [1]Found in at least one of: Blaney Bog, Codd Wetland, or Blaney Creek [2]Michael Sather, pers. comm., 2016 [3]Evidence from beaver dams			

Invasive Plant Species

Invasive plant species are present in the study area, mainly in developed areas. Mapping of invasive plants was limited to Japanese knotweed (*Fallopia sachalinensis*) encountered during field survey work, and was not comprehensive. Five sites with Japanese knotweed were mapped that were not in the City of Maple Ridge's database: one beside Blaney Creek, two beside the North Alouette River, and two beside an unnamed tributary to the Fraser River (Figure C-7). This species can damage roads, sidewalks, and other infrastructure. Himalayan blackberry (*Rubus armeniacus*) was common in riparian areas throughout the developed portion of the study area. Both species can have detrimental effects on native vegetation.

Purple loosestrife (*Lythrum salicaria*) is present in some wetland areas in the watershed (Gebauer 2001). Several introduced plants are growing in the disturbed areas around Codd Wetland and along the North Alouette River where it is diked, including Himalayan blackberry, cutleaf evergreen blackberry (*Rubus laciniatus*), Scotch broom (*Cytisus scoparius*), giant knotweed (*Fallopia sachalinensis*), pineapple weed (*Matricaria discoidea*), and thistles (*Cirsium* spp.) (Gebauer 2001).

The City of Maple Ridge has been actively managing Japanese knotweed as well as Giant hogweed (City of Maple Ridge, 2020), which was not encountered during the field survey. To help control the spread of these species, the City is incorporating the following initiatives (City of Maple Ridge, 2014):

- Participating with other municipalities in the development of a regional invasive species strategy for Metro Vancouver. This strategy is led by the Invasive Species Council of Metro Vancouver (ISCMV);

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- The District has undertaken inventories of invasive plants during different project works throughout the municipality as well as the collection of locations of invasive plants reported by the public;
- Training staff to be able to identify these invasive species and how to safely remove them;
- Working with local stakeholder groups to share knowledge regarding invasive species locations; and
- The District has developed educational material on its website regarding identification, management, and control of noxious weeds with a focus on Japanese knotweed and Giant hogweed.

The District of Maple Ridge currently requires the removal of invasive plants and restoration with native species within riparian areas of new developments. This is part of the Development Permit for any lands being developed within 50 m of a watercourse. A maintenance and monitoring period of 5 years is part of this agreement to ensure invasive species do not re-populate the area.

Habitat Areas to be Protected

There are several high-value wildlife habitat patches and priority areas to protect within the study area:

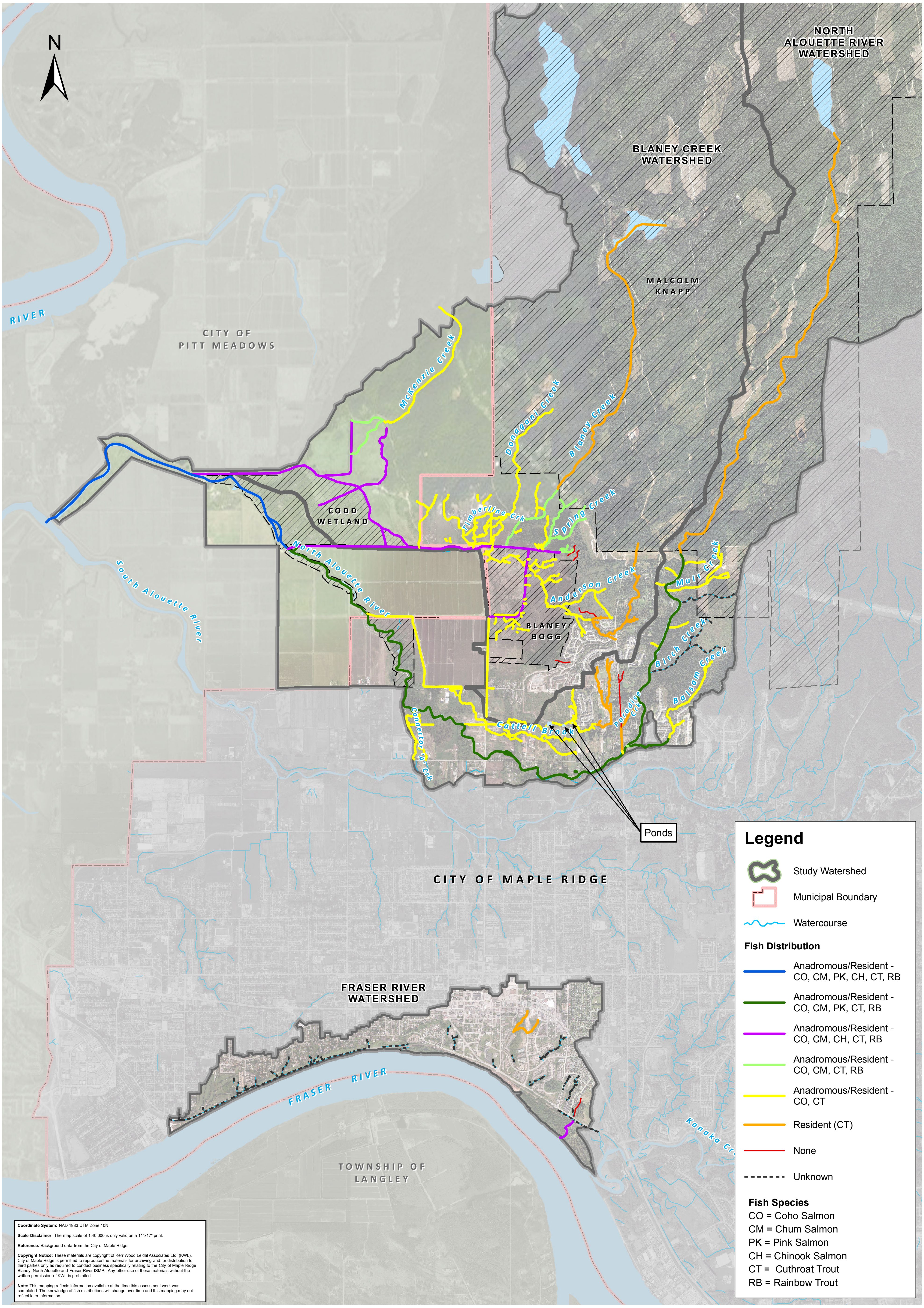
- Blaney Bog;
- Codd Wetland;
- Coniagas Ranche Ltd. Properties, part of which is now incorporated in the Codd Wetland Ecological Conservancy Area (Henderson & Ryder 2006);
- Malcolm Knapp Research Forest;
- Significant piparian areas (forest, wetland, or shrub), especially where connected to larger terrestrial and wetland habitat areas;
- Old growth grove in the Roslyn Creek riparian corridor, threatened by future development;
- Large intact wetland areas; and
- Large intact forest patches.

Potential Habitat Areas to be Enhanced

There is opportunity to enhance the following areas or undertake the following actions to increase the value of habitat areas for wildlife:

- Blaney Bog: Flood out hardhack, allow seasonal flooding, create open pools, pollution mitigation (species to benefit: Red-legged Frog, Pacific Water Shrew, Great Blue Heron), breach dyke cutting Anderson Creek in half (Mitchell 2013); and
- Codd Wetland and adjacent Ducks Unlimited Wetland: Remove or breach dikes while maintaining some portion of existing Ducks Unlimited pond and remove non-native species to benefit Red-legged Frog, Pacific Water Shrew, Great Blue Heron, and Western Toad (Mitchell 2013).

- Riparian forests:
    - Throughout Cattell Brook;
    - Middle and lower reaches of Blaney Creek;
    - Lower reaches of North Alouette River; and
    - All creeks within Fraser River watershed.
- Treat and remove Japanese knotweed patches and replace with dense plantings of native shrubs and trees.



Legend

	Study Watershed
	Municipal Boundary
	Watercourse

Fish Distribution

🟦	Anadromous/Resident - CO, CM, PK, CH, CT, RB
🟩	Anadromous/Resident - CO, CM, PK, CT, RB
🟪	Anadromous/Resident - CO, CM, CH, CT, RB
🟩	Anadromous/Resident - CO, CM, CT, RB
🟨	Anadromous/Resident - CO, CT
🟧	Resident (CT)
🟥	None
- - - -	Unknown

Fish Species

CO = Coho Salmon
CM = Chum Salmon
PK = Pink Salmon
CH = Chinook Salmon
CT = Cuthroat Trout
RB = Rainbow Trout

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:40,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Note: This mapping reflects information available at the time this assessment work was completed. The knowledge of fish distributions will change over time and this mapping may not reflect later information.

Project No.	173-188
Date	March 2017
Scale	1:40,000

Fish Distributions

Figure C - 1

Path: O:\0100-0199\173-188\430-GIS\MXD-Rp\173188_Fig2_Salmonid.mxd Date Saved: 3/29/2017 10:18:24 AM | Author: jlau

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
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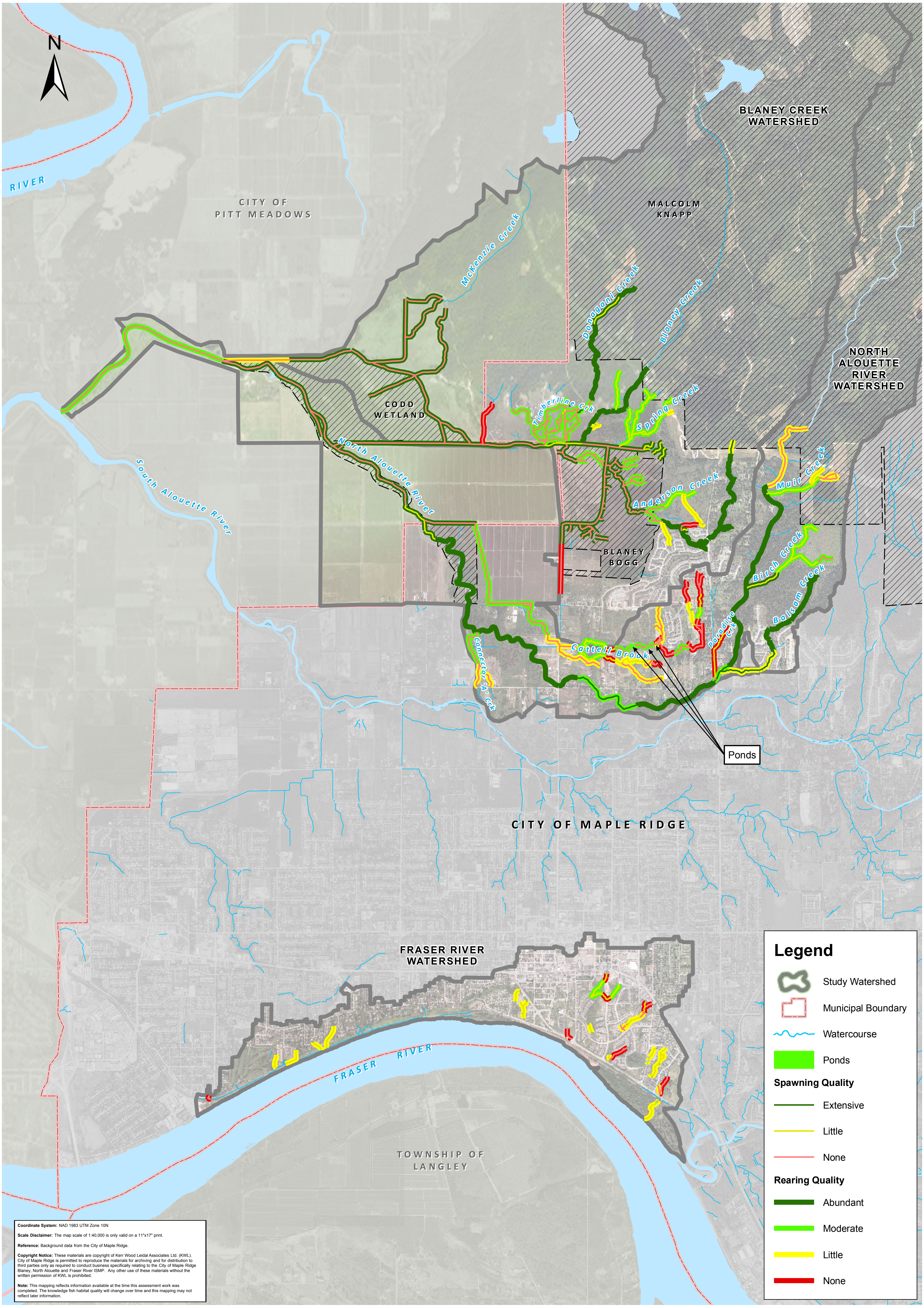


Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:40,000 is only valid on a 11"x17" print.

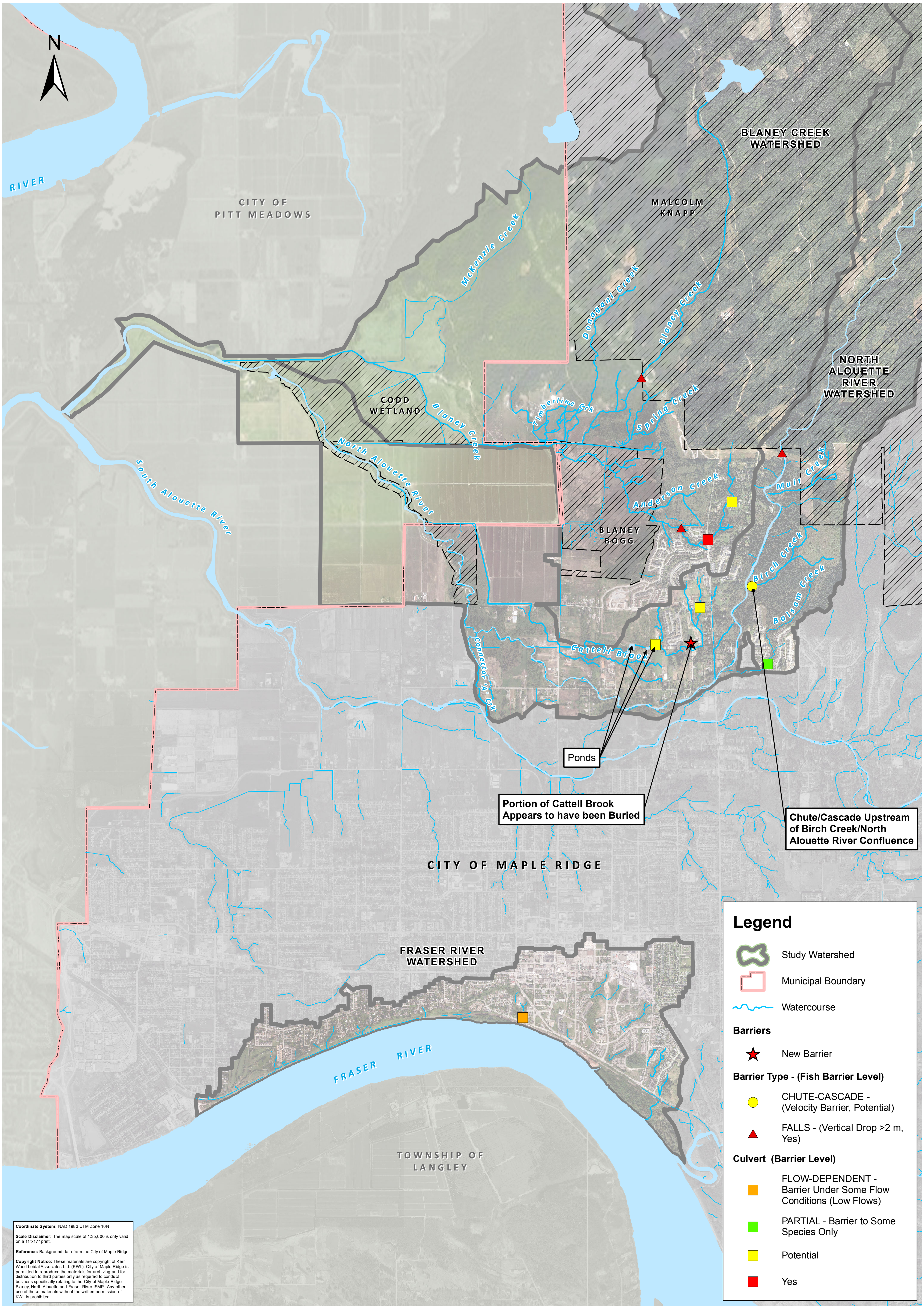
Reference: Background data from the City of Maple Ridge.

Note: This mapping reflects information available at the time this assessment work was completed. The knowledge fish habitat quality will change over time and this mapping may not reflect later information.

Project No.	173-188
Date	March 2017
Scale	1:35,000

Salmonid Spawning and Rearing Habitat

Figure C - 2



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date March 2017
Scale 1:35,000

Barriers to Fish Passage

Figure C - 3

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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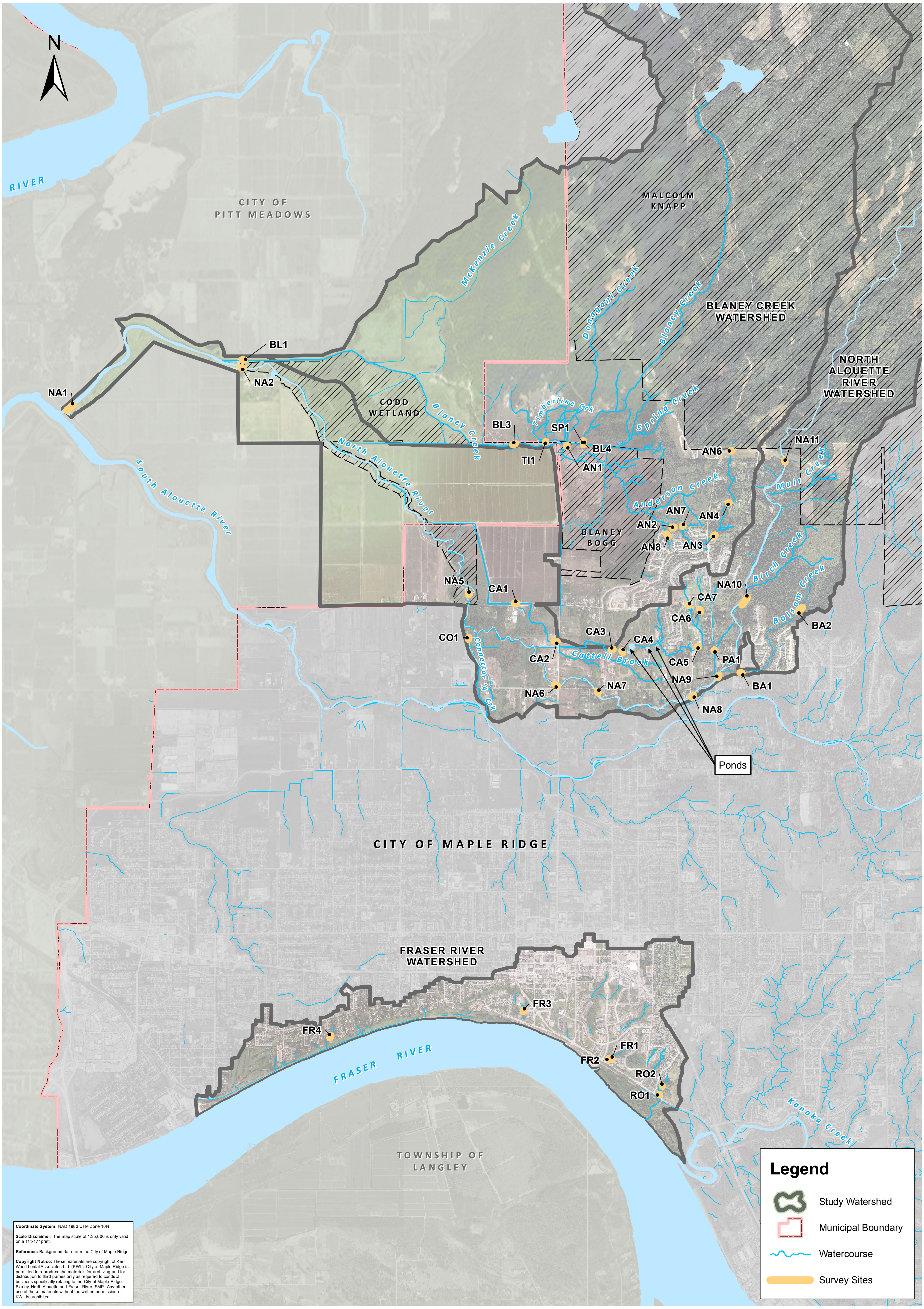


Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

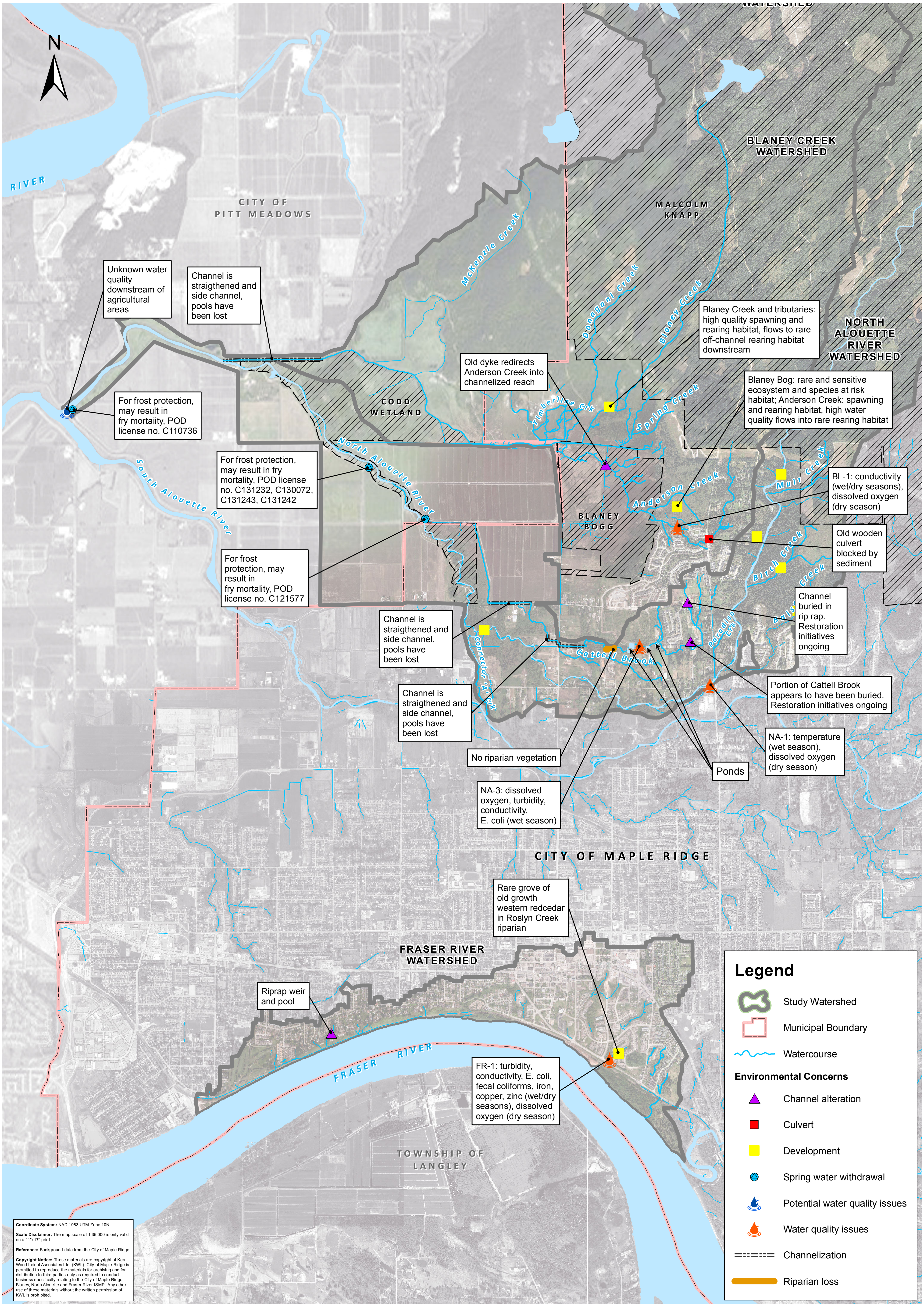
Legend

▨	Study Watershed
🟥	Municipal Boundary
〰	Watercourse
▬	Survey Sites

Project No. 173-188
Date March 2017
Scale 1:35,000

Stream Survey Sites at Representative Locations

Figure C - 4



Legend

⬭	Study Watershed
▭	Municipal Boundary
〰	Watercourse

Environmental Concerns

▲	Channel alteration
🟥	Culvert
🟨	Development
●	Spring water withdrawal
💧	Potential water quality issues
💧	Water quality issues
=:=:=:=	Channelization
▬	Riparian loss

Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date August 2020
Scale 1:35,000

Priority Environmental Points of Concern

Figure C- 5

Path: O:\0100-0199\173-188\430-GIS\MXD-Rp\173188_Fig6_Riparian.mxd Date Saved: 3/29/2017 12:10:30 PM | Author: jlau

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

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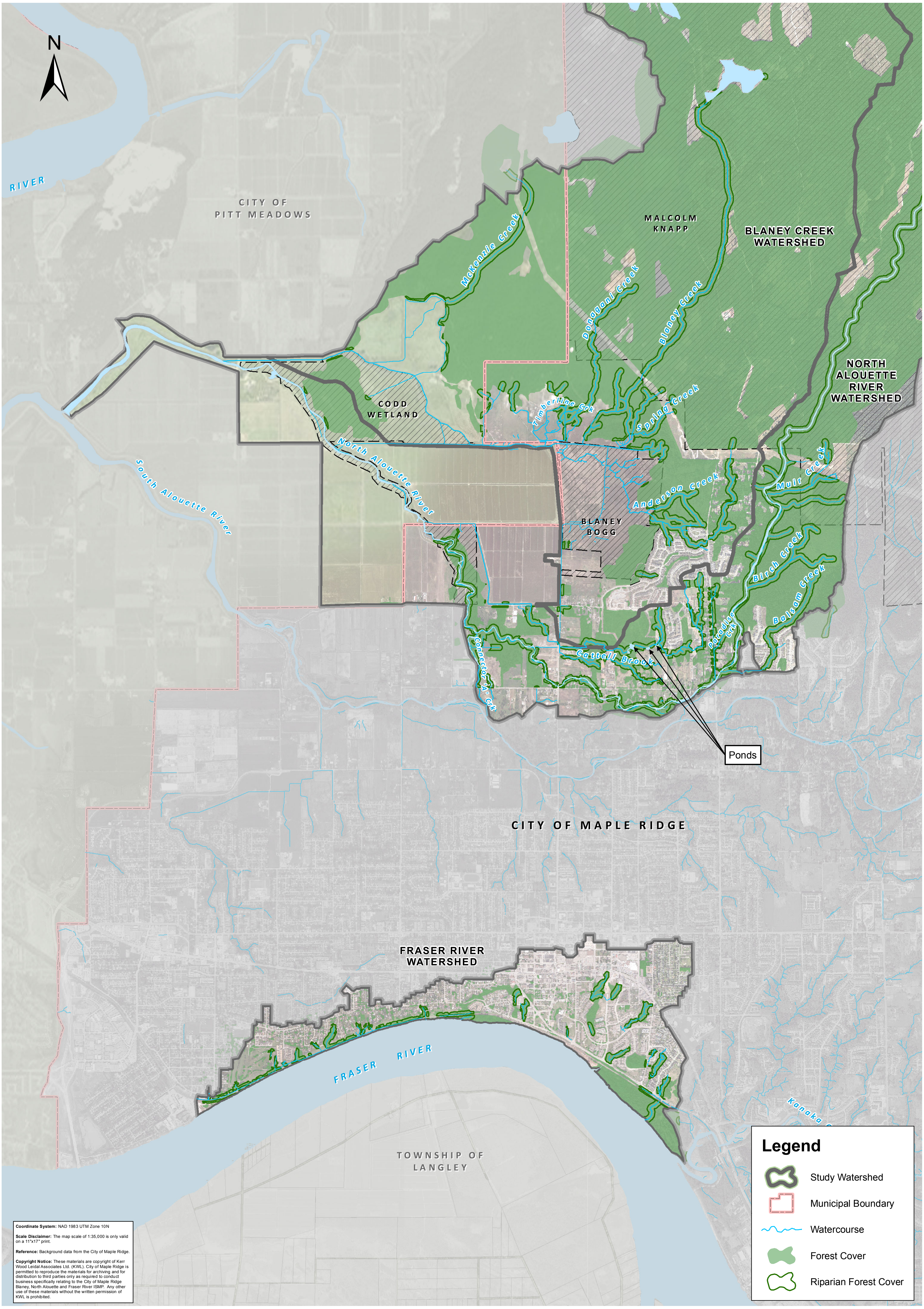


Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Project No. 173-188
Date March 2017
Scale 1:35,000

Riparian Forest Integrity and Watershed Forest Cover

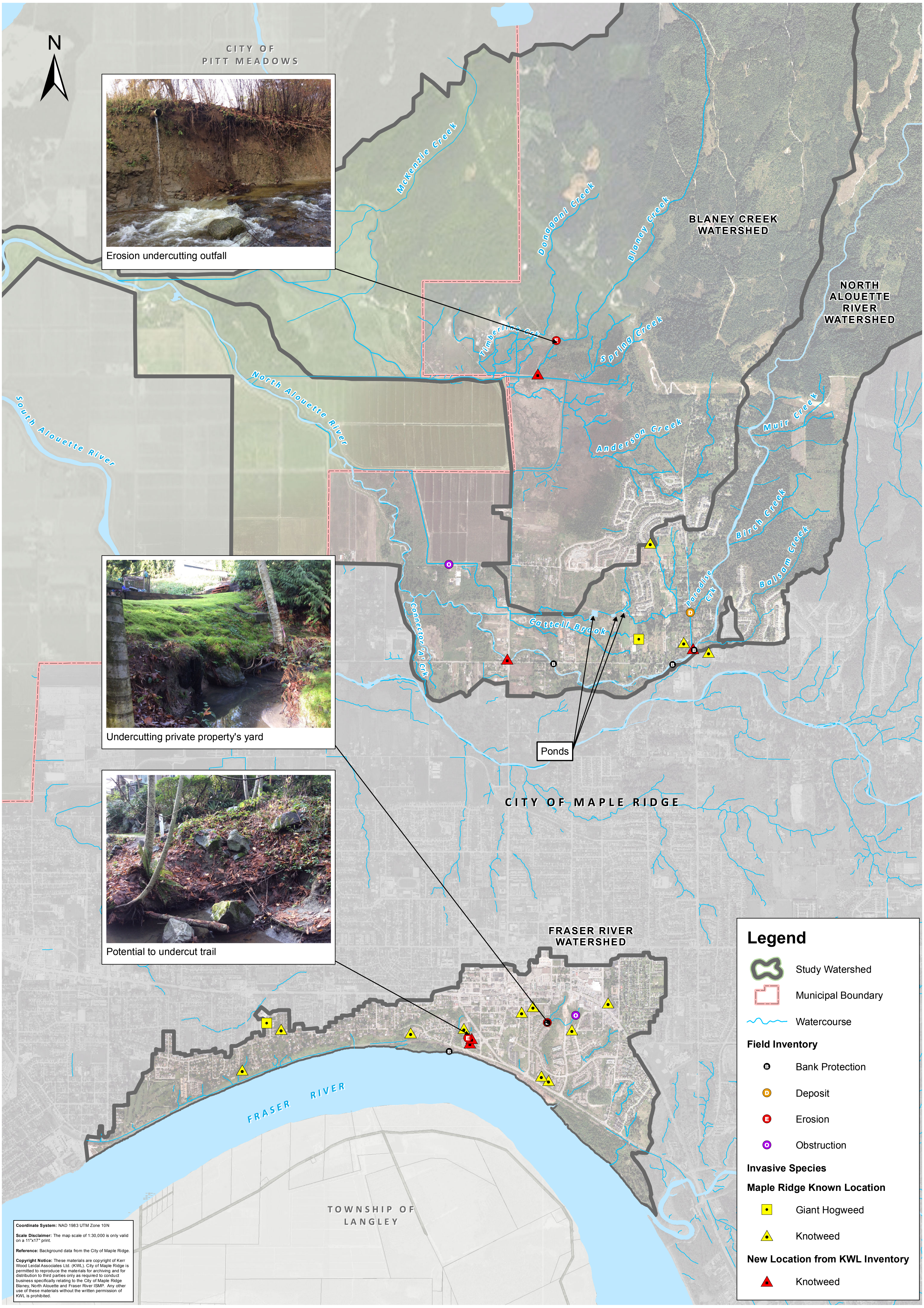
Figure C - 6

Path: O:\0100-0199\173-188\430-GIS\MXD-Rp\173188_Fig7_JapaneseKnotweed.mxd Date Saved: 3/29/2017 12:13:37 PM | Author: jlau

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:30,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

Legend

- Study Watershed
- Municipal Boundary
- Watercourse

Field Inventory

- B Bank Protection
- D Deposit
- E Erosion
- O Obstruction

Invasive Species

Maple Ridge Known Location

- 🟨 Giant Hogweed
- ▲ Knotweed

New Location from KWL Inventory

- ▲ Knotweed

Project No. 173-188
Date March 2017
Scale 1:30,000

Invasive Species and Field Inventory

Figure C - 7

Appendix C – Aquatic Species and Habitat Inventory

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit of APPENDIX C for the Blaney, North Alouette, and Fraser River ISMP. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

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Revision History

Revision #	Date	Status	Revision	Author
0	September 2021	Final		LRL

Appendix C – Aquatic Species and Habitat Inventory

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Appendix C – Aquatic Species and Habitat Inventory

Site Summaries and Photographs

Site Summaries and Photographs

North Alouette River	**Site: NA1**
September 29, 2016	Upstream of confluence with South Alouette


Photo C-1: Looking Upstream


Photo C-2: Looking Downstream


Photo C-3: Typical Riffle


Photo C-4: Typical Substrate Conditions

Wetted width:	35 m	Instream cover:	5%	Spawning gravel:	NONE
Bankfull width:	45 m	LWD:	FEW	Rearing habitat:	MODERATE

General comments: Dense instream vegetation in patches. Slough like channel between dykes. Land use is farmland. There is a 5-15 m riparian buffer between the river and the dyke vegetated with mainly shrubs and reed canarygrass. Most cover provided by instream vegetation. Dominated by reed canarygrass, hardhack, with black hawthorne, Himalayan blackberry, and willows. Some cascara and black twinberry.

Site Summaries and Photographs

North Alouette River	**Site: NA2**
September 29, 2016	Just east of Neaves Rd bridge

Photo C-5: Looking Upstream

Photo C-6: Looking Downstream

Photo C-7: Typical Riffle

Photo C-8: Typical Substrate Conditions

Wetted width:	12 m	Instream cover:	8%	Spawning gravel:	None
Bankfull width:	15 m	LWD:	Few	Rearing habitat:	Abundant

General comments: Slough like section with dykes. Slow velocity channel with more complexity than NO1. Some curves and woody debris. More heterogeneous channel. Some large off channel ponds off left bank. Reed canarygrass and hardhack dominant.

Site Summaries and Photographs

North Alouette River **Site: NA5**

September 29, 2016 Just upstream of Tim's trail footbridge

Photo C-9: Looking Upstream

Photo C-10: Looking Downstream

Photo C-11: Typical Riffle

Photo C-12: Typical Substrate Conditions

Wetted width:	9 m	Instream cover:	15%	Spawning gravel:	Extensive
Bankfull width:	12 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Excellent spawning gravels in this section especially for trout. Unmodified channel. Excellent fish habitat. Gravels are mainly 10-80 mm in diameter. Abundant cover and channel complexity. Good range of cover. Diverse riparian forest and shrubs. Sitka spruce, western redcedar, red alder, Pacific ninebark, hardhack, red-osier dogwood, black cottonwood.

Site Summaries and Photographs

North Alouette River **Site: NA6**

October 26, 2016 Crossing under 132 Ave

Photo C-13: Looking Upstream

Photo C-14: Looking Downstream

Photo C-15: Typical Riffle

Photo C-16: Typical Substrate Conditions

Wetted width:	9 m	Instream cover:	15%	Spawning gravel:	Extensive
Bankfull width:	11 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Excellent spawning gravels for salmonids. Good to excellent fish habitat. 7 adult chum observed. High quality spawning habitat. Complex channel with pools, bars. Good cover, diverse. Black locust, black cottonwood, red-osier dogwood, English ivy, Japanese knotweed, Pacific ninebark, willow, thimbleberry, red alder.

Site Summaries and Photographs

North Alouette River **Site: NA7**

October 26, 2016 Upstream of 132 Ave bridge

Photo C-17: Looking Upstream

Photo C-18: Looking Downstream

Photo C-19: Typical Riffle

Photo C-20: Typical Substrate Conditions

Wetted width:	11 m	Instream cover:	10%	Spawning gravel:	Extensive
Bankfull width:	14 m	LWD:	Few	Rearing habitat:	Moderate

General comments: Excellent spawning gravels. Abundant chum spawning in reach. Excellent spawning habitat with over 50 chum spawning in reach during survey. Lacks woody debris and channel complexity typical of upstream reaches. Encroachment from back yards and rip rap bank armouring. Western redcedar, red alder, bigleaf maple, Sitka spruce, one fir species (amabilis or grand).

Site Summaries and Photographs

North Alouette River **Site: NA8**

October 26, 2016 Downstream of 232 St bridge

Photo C-21: Looking Upstream

Photo C-22: Looking Downstream

Photo C-23: Typical Riffle

Photo C-24: Typical Substrate Conditions

Wetted width:	11 m	Instream cover:	5%	Spawning gravel:	Extensive
Bankfull width:	13 m	LWD:	Few	Rearing habitat:	Abundant

General comments: Excellent spawning habitat. Significant rip rap armouring. Lacks LWD. Significant bank armouring with large angular rip rap. Chum present, spawning. Western redcedar, bigleaf maple, red alder, beaked hazelnut, Himalayan blackberry, western hemlock.

Site Summaries and Photographs

North Alouette River **Site: NA9**

October 26, 2016 Upstream of 232 St bridge

Photo C-25: Looking Upstream

Photo C-26: Looking Downstream

Photo C-27: Typical Riffle

Photo C-28: Typical Substrate Conditions

Wetted width:	12 m	Instream cover:	3%	Spawning gravel:	Extensive
Bankfull width:	14 m	LWD:	None	Rearing habitat:	Moderate

General comments: Good spawning habitat with large sections of homogenous riffle. Encroachment from houses and bank protection. Chum spawning. Western redcedar, black cottonwood, beaked hazelnut, bigleaf maple.

Site Summaries and Photographs

North Alouette River	**Site: NA10**
October 26, 2016	Approximately 900 m upstream of 232 St bridge

Photo C-29: Looking Upstream

Photo C-30: Looking Downstream

Photo C-31: Typical Riffle

Photo C-32: Typical Substrate Conditions

Wetted width:	10 m	Instream cover:	10%	Spawning gravel:	Extensive
Bankfull width:	12 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Natural channel processes in place. Excellent fish habitat. Good cover. Side channels. LWD recruitment high. Chum spawners present. Excellent cover for large channel. Mature western redcedar, Sitka spruce, western hemlock, bigleaf maple, red alder, black cottonwood.

Site Summaries and Photographs

North Alouette River	**Site: NA11**
October 26, 2016	Within UBC Malcolm Knapp Research Forest


Photo C-33: Looking Upstream


Photo C-34: Looking Downstream


Photo C-35: Typical Riffle


Photo C-36: Typical Substrate Conditions

Wetted width:	8 m	Instream cover:	15%	Spawning gravel:	None
Bankfull width:	10 m	LWD:	None	Rearing habitat:	Little

General comments:	River has step-pool morphology. Steep bedrock canyon section. Flows are too high, too many falls for significant rearing. Western redcedar, western hemlock.

Site Summaries and Photographs

Balsam Creek **Site: BA1**

October 25, 2016 Downstream of 233 St culvert

Photo C-37: Looking Upstream

Photo C-38: Looking Downstream

Photo C-39: Typical Riffle

Photo C-40: Typical Substrate Conditions

Wetted width:	1.7 m	Instream cover:	20%	Spawning gravel:	Extensive
Bankfull width:	2 m	LWD:	Abundant	Rearing habitat:	Little

General comments: Moderate fish habitat if flows were higher. Both banks armoured with D500-D700 mm rip rap at least 3 years ago based on regrowth. Resident says spawners can get up to the culvert at 233 St but not past. Potentially the invert is the barrier. Sitka spruce, western redcedar, bigleaf maple.

Site Summaries and Photographs

Balsam Creek	**Site: BA2**
October 25, 2016	Upstream of development boundary


Photo C-41: Looking Upstream


Photo C-42: Looking Downstream


Photo C-43: Typical Riffle


Photo C-44: Typical Substrate Conditions

Wetted width:	1.2 m	Instream cover:	25%	Spawning gravel:	Extensive
Bankfull width:	1.5 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Unmodified channel. Natural channel with high quality wildlife habitat in riparian. Abundant spawning for trout and some smaller patches suitable for salmon. Excellent rearing with abundant cover and moderate channel complexity. Excellent cover. Western hemlock, western redcedar, bigleaf maple, red alder, salmonberry, sword fern, beaked hazelnut.

Site Summaries and Photographs

Paradise Creek **Site: PA1**

October 26, 2016 Ditch running beside 232 St

Photo C-45: Looking Upstream

Photo C-46: Looking Downstream

Photo C-47: Typical Riffle

Photo C-48: Typical Substrate Conditions

Wetted width:	0.4 m	Instream cover:	1%	Spawning gravel:	Little
Bankfull width:	0.6 m	LWD:	None	Rearing habitat:	None

General comments: Couldn't find actual creek upstream of ditch along 232 St. Poor access through private property and no apparent confluence with ditch. 232 St is immediately on right bank.

Site Summaries and Photographs

Cattell Brook **Site: CA1**

October 12, 2016 Along footpath approx. 50 m west of parking lot at western terminus of 136 Ave

Photo C-49: Looking Upstream

Photo C-50: Looking Downstream

Photo C-51: Typical Riffle

Photo C-52: Typical Substrate Conditions

Wetted width:	4 m	Instream cover:	25%	Spawning gravel:	None
Bankfull width:	5 m	LWD:	Few	Rearing habitat:	Moderate

General comments: Affected by one beaver dam downstream. Channel is ditch-like running between footpath and field with riparian strip. Beaver dam upstream. Reed canarygrass, willows, common cattail, red alder, Pacific ninebark, hardhack.

Site Summaries and Photographs

Cattell Brook **Site: CA2**

October 12, 2016 West of 224 St

Photo C-53: Looking Upstream

Photo C-54: Looking Downstream

Photo C-55: Typical Riffle

Photo C-56: Typical Substrate Conditions

Wetted width:	2 m	Instream cover:	10%	Spawning gravel:	None
Bankfull width:	2.4 m	LWD:	Few	Rearing habitat:	Little

General comments: One or two cobble. Fairly flat, slow moving creek with one small beaver dam 0.5 m tall. Low quality fish habitat. Channel is overgrown with reed canary grass and is very slow moving. Most native vegetation removed. Mainly reed canarygrass, hardhack, and Himalayan blackberry. Narrow riparian strip between two properties.

Site Summaries and Photographs

Cattell Brook **Site: CA3**

October 25, 2016 Downstream of wooded area, within rhododendron nursery

Photo C-57: Looking Upstream

Photo C-58: Looking Downstream

Photo C-59: Typical Riffle

Photo C-60: Typical Substrate Conditions

Wetted width:	1.6 m	Instream cover:	3%	Spawning gravel:	Little
Bankfull width:	2 m	LWD:	Few	Rearing habitat:	Moderate

General comments: Segment downstream of forested section with ponds. Much of riparian vegetation removed, with some Himalayan blackberry. Low quality fish habitat based on low cover, high fines, and uniform channel. Very little cover. Left bank mostly bare. Right bank has blackberry. Left bank is mostly rhododendrons back from bank at least 1 m. Right bank is blackberry dominated, with some black cottonwood, Sitka spruce, non-native walnut, beaked hazelnut, and red alder farther back.

Site Summaries and Photographs

Cattell Brook **Site: CA4**

October 25, 2016 Downstream of detainment ponds

Photo C-61: Looking Upstream

Photo C-62: Looking Downstream

Photo C-63: Typical Riffle

Photo C-64: Typical Substrate Conditions

Wetted width:	6 m	Instream cover:	50%	Spawning gravel:	None
Bankfull width:	6 m	LWD:	Abundant	Rearing habitat:	Moderate

General comments: Channel is mainly a flooded still pool 1-1.8 m deep. Standing pool channel is flooded due to recent rains and spilling into reed canary grass wetlands on sides of channel. Some mature forest. One small beaver dam. Good cover. Mature western redcedar, western hemlock, Douglas fir, Sitka spruce, with some red alder, black cottonwood, and Himalayan blackberry, salmonberry, and willows.

Site Summaries and Photographs

Cattell Brook **Site: CA5**

October 25, 2016 Downstream of confluence of tributaries

Photo C-65: Looking Upstream

Photo C-66: Looking Downstream

NA

Photo C-67: Typical Riffle

Photo C-68: Typical Substrate Conditions

Wetted width:	0 m	Instream cover:	5%	Spawning gravel:	None
Bankfull width:	0.6 m	LWD:	Few	Rearing habitat:	None

General comments: No water in channel, and herbaceous plants and grasses growing in bottom of channel. No flow. No obvious scour. Strange outfall appears to drain the upland area. Unknown where Cattell brook originally went. Right bank is residential with young fir trees. It appears that Cattell Brook was buried and piped in the past.

Site Summaries and Photographs

Cattell Brook **Site: CA6**

October 25, 2016 East tributary, downstream of 136 Ave culvert

Photo C-69: Looking Upstream

Photo C-70: Looking Downstream

Photo C-71: Typical Riffle

Photo C-72: Typical Substrate Conditions

Wetted width:	1 m	Instream cover:	15%	Spawning gravel:	Little
Bankfull width:	1.2 m	LWD:	Few	Rearing habitat:	Moderate

General comments: Moderate fish habitat. Amount of flow here doesn't make sense with no flow in downstream segment CA5. Cattell Brook was likely buried and piped downstream of this site. Decent cover for small shallow channel.

Site Summaries and Photographs

Cattell Brook **Site: CA7**

October 25, 2016 West tributary, upstream of 36 Ave culvert

Photo C-73: Looking Upstream

Photo C-74: Looking Downstream

Photo C-75: Typical Riffle

Photo C-76: Typical Substrate Conditions

Wetted width:	1 m	Instream cover:	5%	Spawning gravel:	Little
Bankfull width:	1.2 m	LWD:	Few	Rearing habitat:	Little

General comments: Poor fish habitat. Upstream section filled in with rip rap. Mainly non-native walnut and Himalayan blackberry.

Site Summaries and Photographs

Connector A Creek **Site: CO1**

October 26, 2016 Upstream of confluence with North Alouette River

Photo C-77: Looking Upstream

Photo C-78: Looking Downstream

Photo C-79: Typical Riffle

Photo C-80: Typical Substrate Conditions

Wetted width:	8 m	Instream cover:	25%	Spawning gravel:	None
Bankfull width:	8 m	LWD:	Few	Rearing habitat:	Moderate

General comments: Still water with small amount of flow downstream to North Alouette River. Moderate rearing habitat but little flow. Flooded at time of survey. Large Sitka spruce and western redcedar trees are widely spaced on banks with shrub and small trees in between, with reed canarygrass. Paper birch, black cottonwood, red-osier dogwood, hardhack.

Site Summaries and Photographs

Blaney Creek **Site: BL1**

September 29, 2016 Just east of Neaves Rd bridge

Photo C-81: Looking Upstream

Photo C-82: Looking Downstream

Photo C-83: Typical Riffle

Photo C-84: Typical Substrate Conditions

Wetted width:	8 m	Instream cover:	2%	Spawning gravel:	None
Bankfull width:	11 m	LWD:	None	Rearing habitat:	Little

General comments: Slough-like section with dyke on right bank. Homogenous channel with little complexity. Channelized between dykes. Straightened. Undercuts do not provide cover at this water level. Would provide cover at bankfull water levels. Mainly reed canarygrass, hardhack, and Himalayan blackberry.

Site Summaries and Photographs

Blaney Creek	**Site: BL3**
October 12, 2016	Running parallel to 144 Ave, west of 224 St

Photo C-85: Looking Upstream

Photo C-86: Looking Downstream

Photo C-87: Typical Riffle

Photo C-88: Typical Substrate Conditions

Wetted width:	8 m	Instream cover:	4%	Spawning gravel:	None
Bankfull width:	11 m	LWD:	Few	Rearing habitat:	Moderate

General comments: Appears to be no gravels. Channel appears straightened between road and farm field. Slow-flowing channel section with relatively homogenous structure and low complexity. Dense aquatic plants. Cover is low, mainly from instream vegetation and overhanging shrubs. 5 m riparian strips. Road on right bank and farm field on left bank.

Site Summaries and Photographs

Blaney Creek **Site: BL4**

October 12, 2016 Upstream of confluence with Spring Ck

Photo C-89: Looking Upstream

Photo C-90: Looking Downstream

Photo C-91: Typical Riffle

Photo C-92: Typical Substrate Conditions

Wetted width:	3.5 m	Instream cover:	20%	Spawning gravel:	Extensive
Bankfull width:	4.5 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Excellent spawning gravels. Channel complexity is good, with bars, pools, and scour pools. Excellent spawning and rearing habitat. Abundant LWD. 14 chum spawners observed. Excellent cover for stream. Salmonberry, red-osier dogwood, hardhack, Japanese

Site Summaries and Photographs

Anderson Creek	**Site: AN1**
October 12, 2016	Upstream of confluence with Blaney Creek

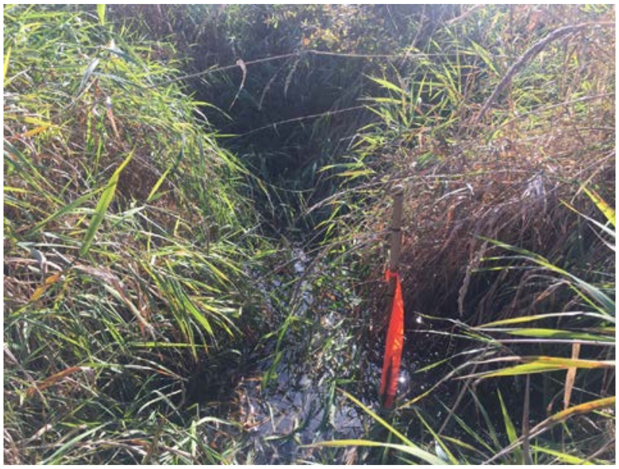

Photo C-93: Looking Upstream

Photo C-94: Looking Downstream

Photo C-95: Typical Riffle

Photo C-96: Typical Substrate Conditions

Wetted width:	2.3 m	Instream cover:	50%	Spawning gravel:	None
Bankfull width:	2.3 m	LWD:	None	Rearing habitat:	Moderate

General comments: Channel is deeply cut into floodplain. Segment of Anderson Creek within Blaney Bog. Low gradient, deeply incised channel. Cover is mainly overhanging reed canarygrass and hardhack. Deep incised channel functions as pool habitat. Open floodplain mostly reed canarygrass and hardhack.

Site Summaries and Photographs

Anderson Creek	**Site: AN2**
October 26, 2016	Mainstem in forest upstream of Blaney Bog

Photo C-97: Looking Upstream

Photo C-98: Looking Downstream

Photo C-99: Typical Riffle

Photo C-100: Typical Substrate Conditions

Wetted width:	1.8 m	Instream cover:	50%	Spawning gravel:	Extensive
Bankfull width:	2.4 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Significant fines. Excellent fish habitat. Good cover and some patches of gravel suitable for spawning, especially trout. Good range of cover. Bigleaf maple, western hemlock, western redcedar, beaked hazelnut, vine maple, salmonberry, red alder.

Site Summaries and Photographs

Anderson Creek **Site: AN3**

October 25, 2016 Upstream of 232 St culvert

Photo C-101: Looking Upstream

Photo C-102: Looking Downstream

Photo C-103: Typical Riffle

Photo C-104: Typical Substrate Conditions

Wetted width:	1.5 m	Instream cover:	12%	Spawning gravel:	Extensive
Bankfull width:	2 m	LWD:	Few	Rearing habitat:	Abundant

General comments: Good fish habitat. Decent cover and spawning gravels, especially small patches for trout. Western redcedar, bigleaf maple, vine maple.

Site Summaries and Photographs

Anderson Creek **Site: AN4**

October 25, 2016 Downstream of 141 Ave culvert

Photo C-105: Looking Upstream

Photo C-106: Looking Downstream

Photo C-107: Typical Riffle

Photo C-108: Typical Substrate Conditions

Wetted width:	1 m	Instream cover:	20%	Spawning gravel:	Extensive
Bankfull width:	2 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Good fish habitat and good rearing habitat. Complex channel with good cover. Western redcedar, red alder, western hemlock, bigleaf maple.

Site Summaries and Photographs

Anderson Creek **Site: AN6**

October 26, 2016 Upstream of BC Hydro right-of-way.

Photo C-109: Looking Upstream

Photo C-110: Looking Downstream

Photo C-111: Typical Riffle

Photo C-112: Typical Substrate Conditions

Wetted width:	1 m	Instream cover:	10%	Spawning gravel:	Extensive
Bankfull width:	1.2 m	LWD:	Abundant	Rearing habitat:	Little

General comments: Right-of-way section has wetland side channel areas. 20 m upstream of right-of-way, a 5 m long culvert goes under fence. Western redcedar, red alder, western hemlock, bigleaf maple.

Site Summaries and Photographs

Tributary to Anderson Creek	**Site: AN7**
October 26, 2016	Tributary to Anderson Creek, with confluence downstream of falls. Site is upstream of ravine.

Photo C-113: Looking Upstream

Photo C-114: Looking Downstream

Photo C-115: Typical Riffle

Photo C-116: Typical Substrate Conditions

Wetted width:	0.3 m	Instream cover:	10%	Spawning gravel:	None
Bankfull width:	0.6 m	LWD:	None	Rearing habitat:	None

General comments:	Very small channel cut below ground approx 0.6 m. Poor fish habitat. Very low flow and small channel. Dominated by red alder saplings, with some black cottonwood and western redcedar. Dense salmonberry shrub layer and some Himalayan blackberry.

Site Summaries and Photographs

Tributary to Anderson Creek	**Site: AN8**
October 26, 2016	Tributary to Anderson Creek

Photo C-117: Looking Upstream

Photo C-118: Looking Downstream

Photo C-119: Typical Riffle

Photo C-120: Typical Substrate Conditions

Wetted width:	0.9 m	Instream cover:	18%	Spawning gravel:	Little
Bankfull width:	0.9 m	LWD:	Abundant	Rearing habitat:	Little

General comments: Small tributary of Anderson Creek originating in 30 m buffer in development. Bigleaf maple, black cottonwood, red alder, western redcedar, western hemlock, salmonberry.

Site Summaries and Photographs

Spring Creek	**Site: SP1**
October 12, 2016	Upstream of confluence with Blaney Creek. Still in lowland bog section.

Photo C-121: Looking Upstream

Photo C-122: Looking Downstream

Photo C-123: Typical Riffle

Photo C-124: Typical Substrate Conditions

Wetted width:	10 m	Instream cover:	20%	Spawning gravel:	Little
Bankfull width:	11 m	LWD:	Abundant	Rearing habitat:	Abundant

General comments: Deep channel, substrates likely mainly fines and organics. Lowland section is deep and wide relative to Blaney Creek at their confluence. Appears channelized as it is straight in this section. Likely transitions to riffle-pool upstream of Blaney Bog with gradient change. Lowland channel is slow-moving and influenced by bog. Highly coloured purple water, likely from bog. Provides excellent rearing habitat for salmonid juveniles due to low velocity flow, deep pools, woody debris, instream vegetation. Abundant instream vegetation. Good cover for rearing. Several large western redcedars on left bank. Hardhack and reed canarygrass dominant. Small patch of hard-stemmed bulrush (tule) and rushes on right bank at confluence with Blaney Creek.

Site Summaries and Photographs

Timberline Creek **Site: TI1**

October 12, 2016 Just upstream of 144 Ave culvert

Photo C-125: Looking Upstream

Photo C-126: Looking Downstream

Photo C-127: Typical Riffle

Photo C-128: Typical Substrate Conditions

Wetted width:	m	Instream cover:	10%	Spawning gravel:	None
Bankfull width:	m	LWD:	Few	Rearing habitat:	Moderate

General comments: Few larger substrates below beaver dam but mainly fines above. Channel has three tributaries above beaver dam and one on right bank downstream of beaver pond running parallel with road. Beaver pool, multiple tributary channel complex in a flat area upstream of 144 Ave. Cover is mainly from pools upstream of beaver dam. Riparian vegetation is mainly hardhack, grasses, reed canarygrass, rushes.

Site Summaries and Photographs

Tributary to Fraser River	**Site: FR1**
September 29, 2016	East tributary, site is upstream of the confluence with west tributary upstream of Haney Bypass culvert

Photo C-129: Looking Upstream

Photo C-130: Looking Downstream

Photo C-131: Typical Riffle

Photo C-132: Typical Substrate Conditions

Wetted width:	0.25 m	Instream cover:	25%	Spawning gravel:	None
Bankfull width:	0.6 m	LWD:	Few	Rearing habitat:	None

General comments: Channel incised into soft sediment. Low fish habitat based on very low flows, mostly fine substrates. One large Douglas fir. One large Sitka spruce. Red alder, western redcedar, bigleaf maple, vine maple, Himalayan blackberry, skunk cabbage, salmonberry, black cottonwood.

Site Summaries and Photographs

Tributary to Fraser River **Site: FR2**

September 29, 2016 West tributary, site is upstream of the confluence with east tributary upstream of Haney Bypass culvert


Photo C-133: Looking Upstream


Photo C-134: Looking Downstream


Photo C-135: Typical Riffle


Photo C-136: Typical Substrate Conditions

Wetted width:	0.8 m	Instream cover:	15%	Spawning gravel:	Little
Bankfull width:	1.7 m	LWD:	Few	Rearing habitat:	Little

General comments: Two deep spots with filamentous algae masses on bottom. Some rip rap armouring and blown out rip rap in channel, D200 mm. Would provide moderate rearing habitat with more flow. One larger pool with undercut provides some complexity. Rip rap armouring along right bank close to confluence. Red alder dominant, bigleaf maple and vine maple are common, and a couple western redcedars. Some unidentified cherry, Himalayan blackberry, red-osier dogwood, sword fern, black cottonwood.

Site Summaries and Photographs

Tributary to Fraser River **Site: FR3**

September 29, 2016 Between 223 St and River Bend


Photo C-137: Looking Upstream


Photo C-138: Looking Downstream


Photo C-139: Typical Riffle


Photo C-140: Typical Substrate Conditions

Wetted width:	0.9 m	Instream cover:	5%	Spawning gravel:	Little
Bankfull width:	1.5 m	LWD:	Few	Rearing habitat:	Little

General comments: High embeddedness. Signs of sedimentation from upstream and some erosion in bends. Trail along right bank encroaches and has rip rap protection. Extensive English ivy. Would provide moderate rearing with higher flows and more pools, woody debris, and shrub cover. Many mature bigleaf maples. Several western redcedar. Red alder, horse chestnut (non-native), Indian plum, vine maple, beaked hazelnut, English ivy, black cottonwood, salmonberry, Himalayan blackberry.

Site Summaries and Photographs

Tributary to Fraser River	**Site: FR4**
September 29, 2016	Unnamed tributary to Fraser River between Wood Rd and Anderson Pl, south of River Rd

Photo C-141: Looking Upstream

Photo C-142: Looking Downstream

Photo C-143: Typical Riffle

Photo C-144: Typical Substrate Conditions

Wetted width:	0.8 m	Instream cover:	20%	Spawning gravel:	Little
Bankfull width:	1.2 m	LWD:	Abundant	Rearing habitat:	Little

General comments: High amount of fines. Some of the boulder and cobble are rip rap bank armouring that has fallen into stream. Mature riparian first section surrounded by residential. Stream has high proportion of fines and high embeddedness. Would provide moderate rearing habitat with higher flows. Unknown fish passage from Fraser River. Culvert under driveway. Some rip rap bank protection. Large red alder and bigleaf maple trunks over stream. Mature western redcedar, bigleaf maple, Sitka spruce, red alder forest, with understory of Himalayan blackberry, salmonberry, English ivy, beaked hazelnut, walnut (non-native), sword fern, paper birch.

Site Summaries and Photographs

Roslyn Creek **Site: RO1**

September 29, 2016 Channel running parallel to Fortis right-of-way

Photo C-145: Looking Upstream

Photo C-146: Looking Downstream

Photo C-147: Typical Riffle

Photo C-148: Typical Substrate Conditions

Wetted width:	1.2 m	Instream cover:	80%	Spawning gravel:	Little
Bankfull width:	1.2 m	LWD:	None	Rearing habitat:	Little

General comments: Channel may have been realigned for right-of-way construction and pipe installation. Channel does not match air photo on ArcGIS Collector mapping application. Channel runs parallel to Fortis pipeline right-of-way on west side. Drainage from slope to the east joins just upstream of Haney Bypass, but the area is low gradient and there is not clear confluence. Poor fish habitat. Riparian vegetation is mainly willows and reed canary grass covering channel. Some policeman’s helmet (non-native). One larger willow tree and several black cottonwood.

Site Summaries and Photographs

Roslyn Creek **Site: RO2**

September 29, 2016 Non-classified drainage, draining into RO1 (Roslyn Creek)

Photo C-149: Looking Upstream

Photo C-150: Looking Downstream

Photo C-151: Typical Riffle

Photo C-152: Typical Substrate Conditions

Wetted width:	0.1 m	Instream cover:	20%	Spawning gravel:	None
Bankfull width:	0.7 m	LWD:	Few	Rearing habitat:	None

General comments: Non-classified drainage. Mature coniferous trees abundant. Western red cedar over 1.5 m in diameter, and Sitka spruce over 1 m in diameter. Red-osier dogwood, red alder, Himalayan blackberry, yellow archangel (non-native). Old growth trees provide perches for roosting owls.

Appendix D

Water Quality and Benthic Invertebrate Monitoring

Appendix D – Water Quality and Benthic Invertebrate Monitoring

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Appendix D – Water Quality and Benthic Invertebrate Monitoring

D Water Quality and Benthic Invertebrate Monitoring

This Appendix includes the results of a background review and analysis of existing water quality and benthic invertebrate monitoring in the Blaney, North Alouette, and Fraser River watersheds. It also summarizes the results of the Monitoring and Adaptive Management Framework monitoring of water quality and benthic invertebrates that KWL conducted in 2016 (KWL, 2020).

D.1 Previous Water Quality and Benthic Invertebrate Monitoring

Previous Monitoring in the Study Watersheds

Table D-1 summarizes the existing data on water quality and benthic invertebrate monitoring that has been carried out in Blaney Creek, the North Alouette River, and their tributaries.

Table D-1: Previous Water Quality and Benthic Invertebrate Monitoring

Stream	Monitoring Type	Monitoring Results	Source
Blaney Creek	Flow Monitoring	• Naturalized summer 7-day mean low flow was 3% of the mean annual flow • Potential demand (domestic, irrigation, and industrial uses) is 66% of the naturalized summer 7-day mean flow	Nener & Wernick 1997
North Alouette River	Nutrient and Flow Monitoring	• Dissolved ammonia tended to increase from 233 St to 208 St. • At downstream site, half of 15 dissolved ammonia measurements exceeded 80th percentile, none at upstream site, no measurements likely to exceed 30-day criteria for total ammonia • Water is generally soft (hardness <75 mg/L) • pH can be slightly acidic from rainfall and there is low capacity of soils to buffer rain • Naturalized summer 7-day mean flow is 7% of the mean annual flow • Potential August and September water demand (domestic, irrigation and industrial uses) is <1% of naturalized summer 7-day mean flow	Nener & Wernick 1997

Appendix D – Water Quality and Benthic Invertebrate Monitoring

Stream	Monitoring Type	Monitoring Results	Source
	Water Quality Objectives Attainment Monitoring	• From 1990 to 1993, objectives for dissolved oxygen, turbidity, and fecal coliforms usually not met, but usually only by a small amount	MWLAP 1996
	Water Quality Monitoring	• Ministry of Environment data available for 1990-1992 for two sites on the North Alouette River	MOE 1991, MOE 1993, MOE unpublished data
Anderson Creek	Water Quality and Benthic Invertebrates	• High food production, high numbers of pollution intolerant species, and high diversity indicated excellent stream health in 1998	Walsh & Krzesinska 1998
Cattell Brook	Water Quality and Benthic Invertebrates	• Moderate food production, lack of pollution intolerant species, major species present were pollution tolerant aquatic worms, stream health rated as poor	Walsh & Krzesinska 1998
Paradise Creek	Water Quality and Benthic Invertebrates	• Stream health rated as good despite drying up before reaching North Alouette in sampling year, provides refuge area for juvenile salmonids during storm events	Walsh & Krzesinska 1998
Balsam Creek	Water Quality and Benthic Invertebrates	• Excellent stream health, water quality, and productivity	Walsh & Krzesinska 1998

1994 Anderson Creek Water Quality Monitoring

As part of the Silver Valley Master Drainage Plan, UMA Environmental monitored water quality at two sites on Anderson Creek in 1994: one at 232 St (partial development), and one control site within the Malcolm Knapp Research Forest, upstream of the BC Hydro right-of-way (undeveloped). Sites were sampled on April 18, 1994 during base flow conditions (Table D-2; UMA Environmental 1995). The report noted the following:

- The 232 St site (partial development) had low nutrient loading, high dissolved oxygen, and low concentrations of coliforms. No metals exceeded Canadian Council of Ministers of the Environment – Canadian Environmental Quality Guidelines – Water Quality Guidelines for the Protection of Aquatic Life (Freshwater).
- The Malcolm Knapp Research Forest site (undeveloped) had low nutrient loading, and high dissolved oxygen. Aluminum and iron concentrations slightly exceeded CCME guidelines for protection of aquatic life guidelines.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

1997 & 1998 ARMS Water Quality and Benthic Invertebrate Monitoring

Alouette River Management Society (ARMS) conducted water quality and benthic invertebrate monitoring in 1997 and 1998 in the North Alouette River, Balsam Creek, Paradise Creek, Cattell Brook, and Anderson Creek (Walsh & Krzesinska 1997, Walsh & Krzesinska 1998). The results for Anderson Creek are shown in Table D-2, to compare with those from 1994. The largest difference is that temperature in Anderson Creek at 232 St more than doubled from 1994 to 1997/1998. However, direct comparison of these values is not totally reliable, because there was only one sample for 1994. In addition, rainfall and flow may have been different between years, which is difficult to account for given the one-time sampling in 1994.

Table D-2: Water Quality Parameters for Anderson Creek, 1994–1998

Parameter	April 18, 1994[1]		Feb–Apr 1997[2]	Feb–Apr 1998[3]
	Malcolm Knapp Research Forest (undeveloped)	232 St (partial development)	232 St	232 St
Temperature (°C)	3.0	3.1	6.4	7.0
DO (mg/L)	12.5	12.3	12.4	12.2
BOD5 (mg/L)	6.0	5.8	-	-
COD (mg/L)	5.3	9	-	-
TSS (mg/L)	<1	<1	-	-
Turbidity (NTU)	0.8	0.9	-	1.17
pH	6.81	6.8	6.5	7.2
Fecal Coliforms (CFU/100 mL)	0	7	-	-
Total Phosphorous (mg/L)	0.007	0.006	-	-
Total Nitrogen (mg/L)	0.3	0.2	-	-

Sources:
[1] UMA Environmental 1995 (one time sample)
[2] Walsh & Krzesinska 1997 (average of 7 samples)
[3] Walsh & Krzesinska 1998 (average of unknown # of samples, likely 8)

Appendix D – Water Quality and Benthic Invertebrate Monitoring

2004–2016 Environment and Climate Change Canada Water Quality Monitoring

As part of a federal long-term Water Quality Monitoring and Surveillance program, Environment and Climate Change Canada (ECCC) has collected water quality data from the North Alouette River upstream of the 132 Ave bridge every two weeks since March 2, 2004(Environment and Climate Change Canada 2016). An analysis of data from 2004 to May 10, 2016 was undertaken for the 13 water quality parameters that are part of Metro Vancouver's *Monitoring and Adaptive Management Framework for Stormwater* (MAMF). The analysis showed that water quality in the river is generally good, with consistently low conductivity, turbidity, nutrients, pathogens, and dissolved metals (Figure D-1, Figure D-2, and Figure D-3). Three minor exceptions to these results are:

- Dissolved oxygen values are frequently below 11 mg/L (median of 10 mg/L in 2010, median of 11 mg/L in 2005-2006, 2008-2009), but never falling below 6.5 mg/L over 12 years (Figure D-1);
- pH is consistently acidic (yearly medians range from 6.40 to 6.81); and
- Several winters where water temperatures fell to 0°C or slightly above freezing.

The data were also analyzed to find peaks in some of the measured parameters. The following dates coincided with peaks in some total metal concentrations, likely due to major runoff events:

- January 20, 2005: peaks in total cerium, chromium, cobalt, gallium, iron, lanthanum, manganese, tin, and vanadium;
- November 25, 2014: peaks in total beryllium, aluminum, cerium, cesium, chromium, cobalt, gallium, iron, lanthanum, lead, manganese, vanadium, and yttrium; and
- July 23, 2014: peaks in total antimony, bismuth, cadmium, chromium, copper, iron, rubidium, tin, and zinc.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

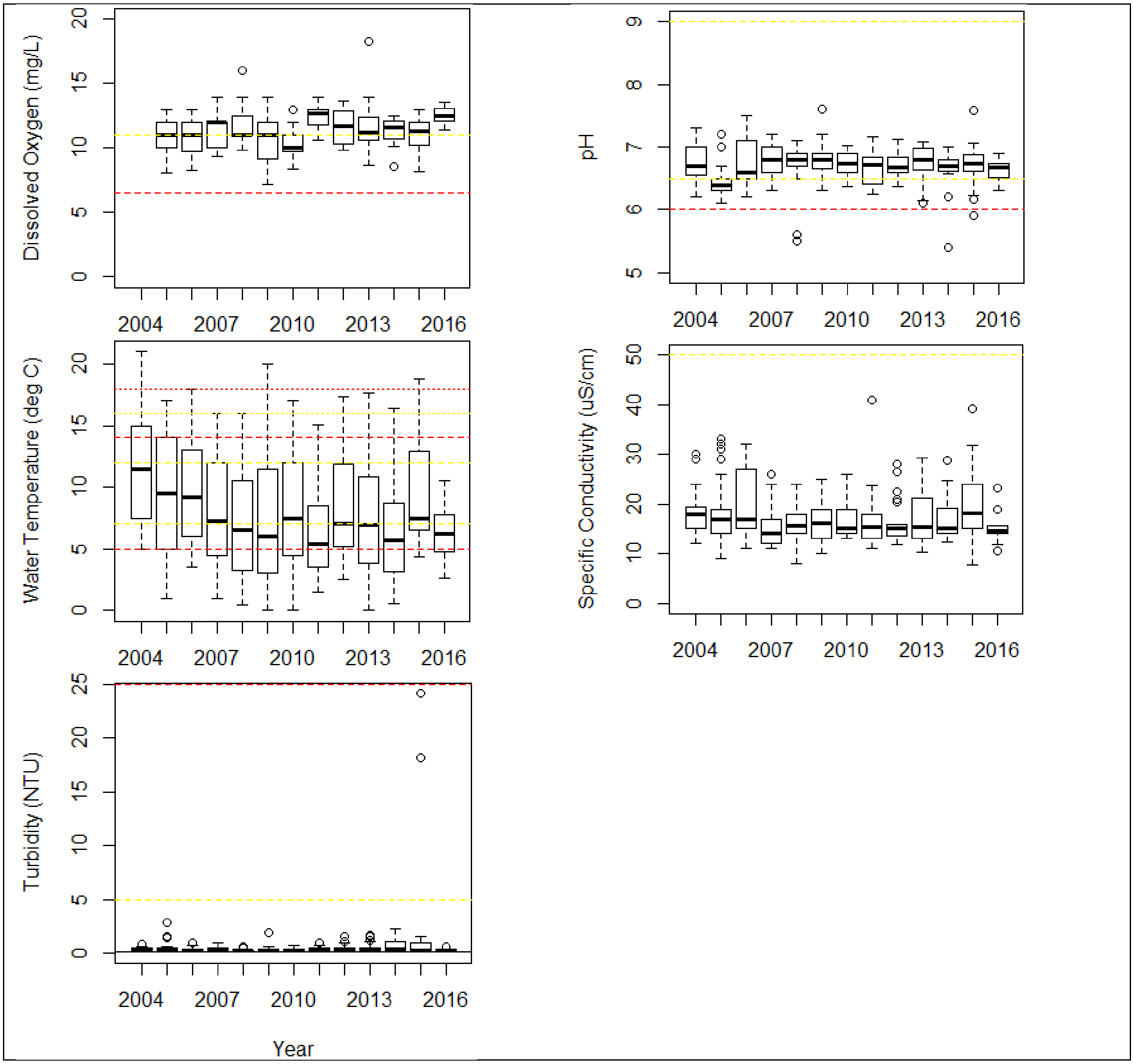


Figure D-1: Boxplots of Environment and Climate Change Canada biweekly water quality monitoring data for general water quality parameters from the North Alouette River at 132 St, 2004 to 2016. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively. Dotted yellow and red lines indicate thresholds for summer low flow conditions only. Black horizontal line indicates lower detection limit if present. Middle, bottom, and top of boxes are median, first, and third quartiles respectively, whiskers extend to greatest/lowest value within 1.5 times the interquartile range. Points are observations outside the whiskers.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

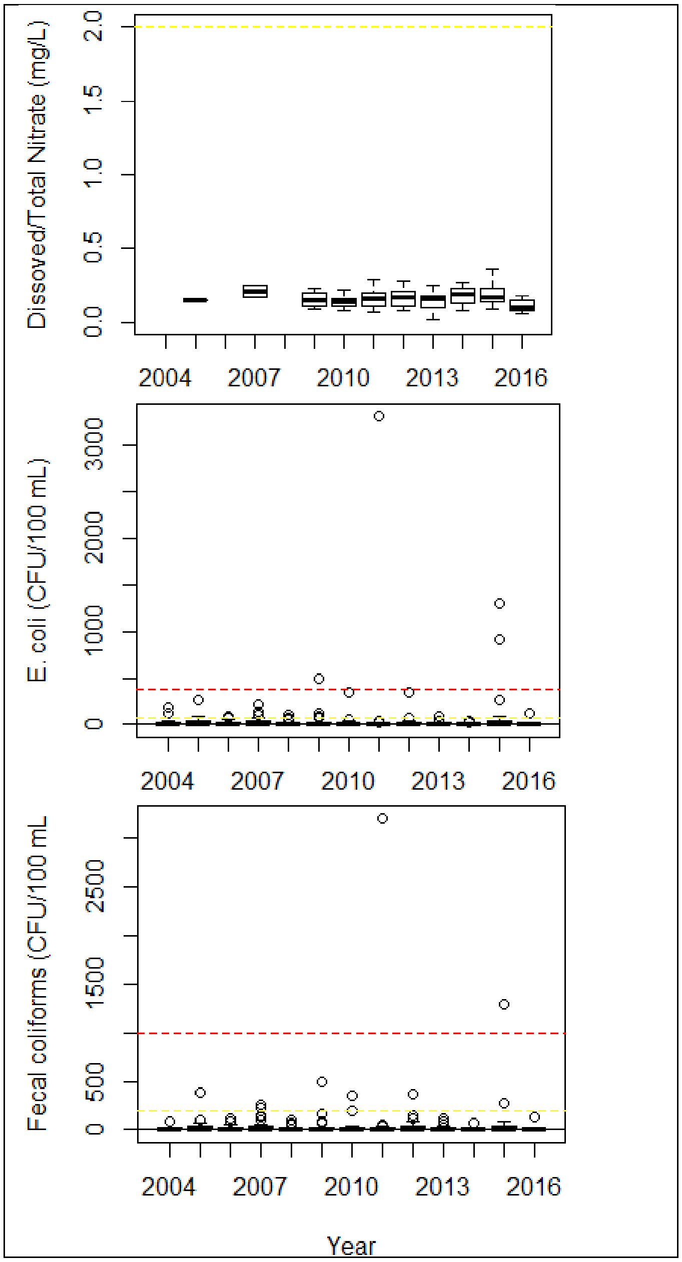


Figure D-2: Boxplots of Environment and Climate Change Canada biweekly water quality monitoring data for nutrients and microbiological indicators from the North Alouette River at 132 St, 2004 to 2016. Dissolved nitrate is from 2005 to 2015, total nitrate is from 2015 to 2016. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively. Black horizontal line indicates lower detection limit if present. Middle, bottom, and top of boxes are median, first, and third quartiles respectively, whiskers extend to greatest/lowest value within 1.5 times the interquartile range. Points are observations outside the whiskers.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

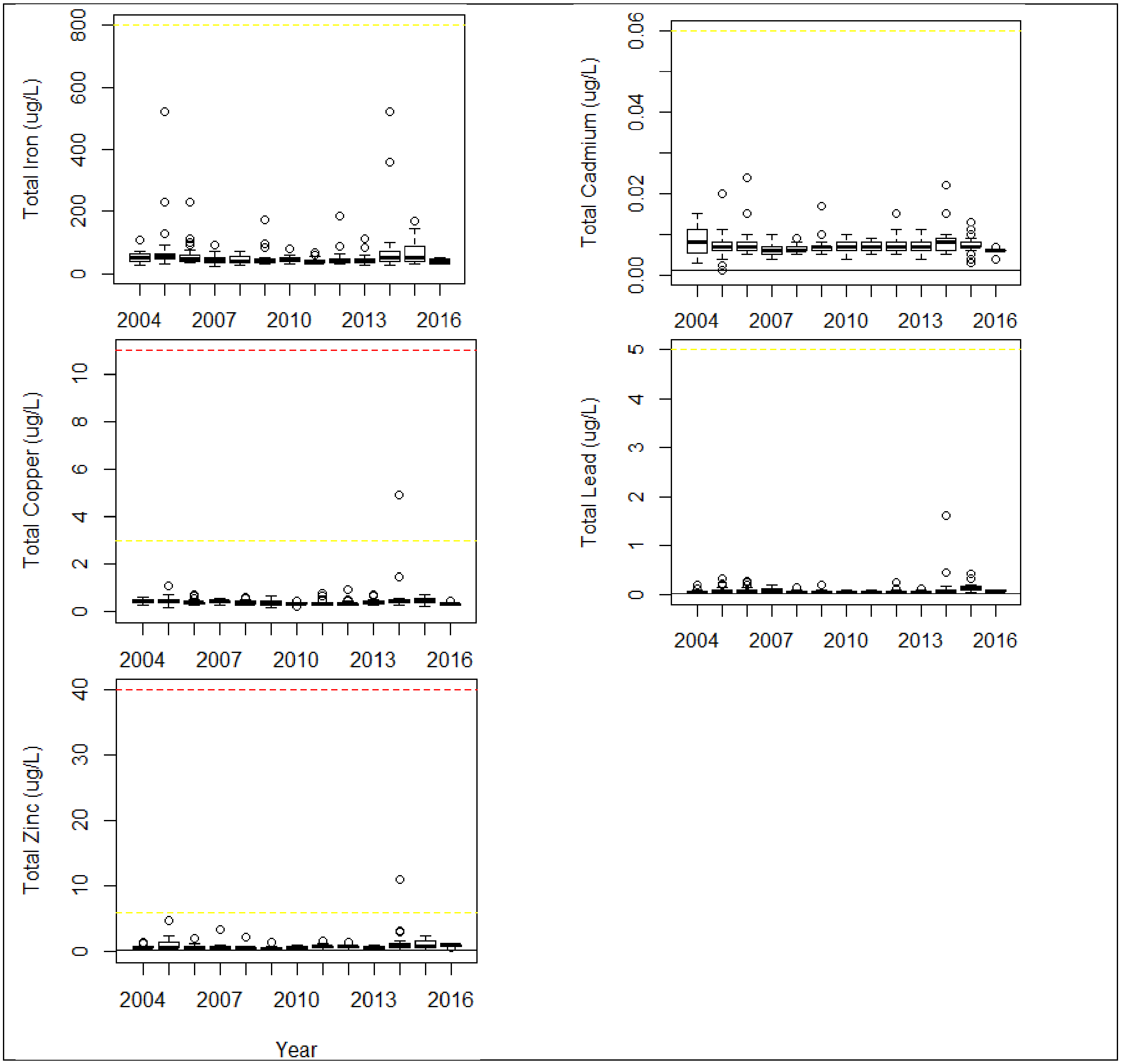


Figure D-3: Boxplots of Environment and Climate Change Canada biweekly water quality monitoring data for total metal concentrations from the North Alouette River at 132 St, 2004 to 2016. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively. Black horizontal line indicates lower detection limit if present. Middle, bottom, and top of boxes are median, first, and third quartiles respectively, whiskers extend to greatest/lowest value within 1.5 times the interquartile range. Points are observations outside the whiskers.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

D.2 2016 MAMF Water Quality and Benthic Invertebrate Monitoring

In support of its Integrated Stormwater Management Planning (ISMP) program, the City of Maple Ridge has been undertaking hydrometric (flow), water quality, and benthic invertebrate monitoring across several City watersheds. The collected data are being used to inform the development of Integrated Stormwater Management Plans (ISMPs) for these watersheds and to establish a baseline on which to assess and report on watershed health and the effectiveness of ISMPs over time. The monitoring followed the direction of Metro Vancouver's *Monitoring and Adaptive Management Framework for Stormwater* (Metro Vancouver 2014) and is part of the City's program aimed at meeting the City's provincial requirements for monitoring under the approval of Metro Vancouver's 2011 ILWRMP.

This section summarizes the results of water quality and benthic invertebrate monitoring conducted by KWL in the Blaney, North Alouette, and Fraser River watersheds in 2016 and 2017. A full monitoring report, *2016 Water Quality and Benthic Invertebrate Monitoring in the Blaney, North Alouette, and Fraser River Watersheds*, was submitted to the City of Maple Ridge in April 2017. The final report was submitted in August 2020. One year of hydrometric data is also being collected at all five sites and results of this monitoring will be reported on separately.

Monitoring Site Locations

Water quality monitoring sites were determined by the City of Maple Ridge with advice from KWL. Table D-3 provides details on the five water quality monitoring locations sampled in late summer 2016 (dry season sampling) and late fall 2016 (wet season sampling). Two sites, NA-2 and NA-3, were sampled in the wet season only. All five sites are considered higher gradient systems under the MAMF.

Table D-3: Water Quality Monitoring Site Locations

Site ID	Site Description	ISMP Study Area	Location Details
BL-1	Anderson Creek west of Anderson Creek Dr	Blaney	Approximately 425 m downstream of 232 St, 125 m north of 139A Ave, and 100 m west of Anderson Creek Dr
NA-1	North Alouette River at 232 St	North Alouette	50 m downstream of bridge at 232 St, downstream of Water Survey of Canada hydrometric station (Station 08MH006)
NA-2*	Balsam Creek at Balsam St	North Alouette	3 m downstream of culvert at Balsam St
NA-3*	Cattell Brook south of Nelson Peak Dr	North Alouette	50 m downstream of two stormwater detention ponds, west of 134 Loop, and south of Nelson Peak Dr
FR-1	227 Street Creek at Haney Bypass	Fraser River	At upstream end of culvert under Haney Bypass, northeast of intersection at 227 St and Haney Bypass
*Sites NA-2 and NA-3 were sampled in the wet season only.			

Appendix D – Water Quality and Benthic Invertebrate Monitoring

Benthic invertebrate sampling was undertaken at the Anderson Creek and North Alouette River sites, in a reach nearest to the water quality monitoring site location where suitable sampling riffles were present. Due to a lack of suitable sampling riffles, sampling was not conducted in 227 Street Creek. Distance between the water quality monitoring site and the benthic invertebrate sampling reaches ranged from 20 m (North Alouette River) to 50 m downstream of the water quality monitoring location (Anderson Creek).

Table D-4 provides details on the specific benthic invertebrate sampling reach sampled in each creek in late summer 2016 and its location relative to the water quality monitoring site.

Table D-4: Benthic Invertebrate Monitoring Site Locations

Site ID	Creek Name	ISMP Study Area	Location of Downstream End of Sampling Reach
BL-1	Anderson Creek	Blaney	Approximately 475 m downstream of 232 St, 50 m downstream of water quality monitoring site
NA-1	Alouette River	North Alouette	70 m downstream of bridge at 232 St, 20 m downstream of water quality monitoring site

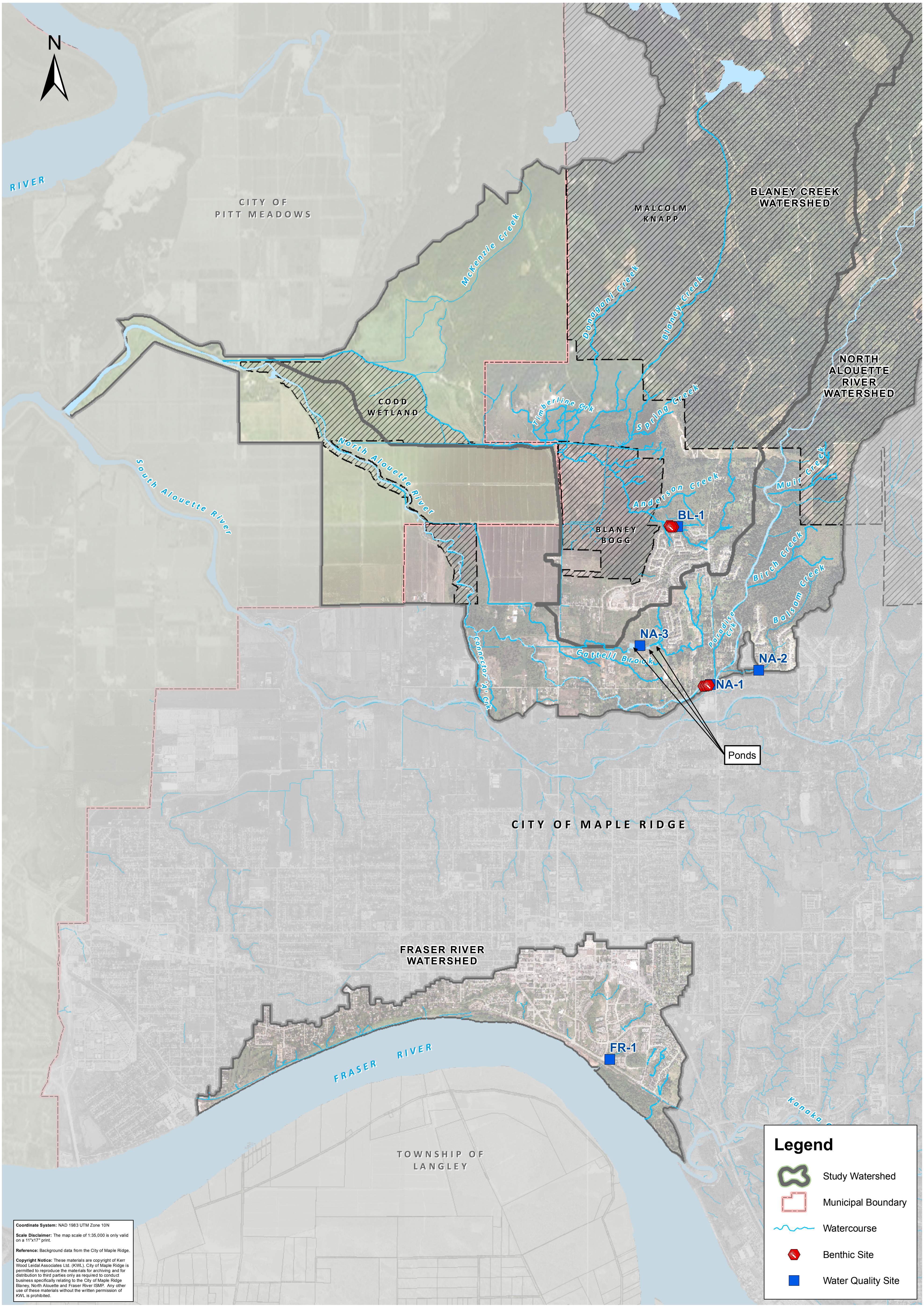
Figure D-4 provides an overview of the water quality monitoring and benthic invertebrate sampling site locations. Larger-scale maps and site photographs showing both the specific water quality monitoring and benthic invertebrate sampling locations for each creek can be found in the full MAMF report.

Path: O:\0100-0199\173-188\430-GIS\MXD-Rp\173188_Fig8_WaterQuality.mxd Date Saved: 3/31/2017 3:07:56 PM | Author: jlau

City of Maple Ridge

Blaney, North Alouette and Fraser River ISMP

KERR WOOD LEIDAL
consulting engineers



Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:35,000 is only valid on a 11"x17" print.

Reference: Background data from the City of Maple Ridge.

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Project No. 173-188

Date March 2017

Scale 1:35,000

Water Quality Monitoring Sites

Figure 8

Appendix D – Water Quality and Benthic Invertebrate Monitoring

Methods

Water Quality Monitoring

Dry season water quality monitoring was conducted in 2016 on August 30 and September 7, 12, 16 and 22. Wet season water quality monitoring was conducted in 2016 on November 9, 22, and 24, and December 2 and 12. Benthic invertebrate sampling was conducted on September 16, 2016. General methods and parameters followed those outlined in the MAMF. For the water quality monitoring, Table D-5 summarizes the parameters collected and whether they are core MAMF or additional monitoring parameters.

Detailed methods, including details on quality assurance/quality control (QA/QC), laboratory methods, and full laboratory results, can be found in the full MAMF report.

Table D-5: Core MAMF and Additional Monitoring Parameters

	Parameter	Units	Core MAMF Parameters	Additional Parameters
General In-situ Parameters	Dissolved Oxygen	mg/L and %	X	
	pH	(relative units)	X	
	Water Temperature	°C	X	
	Conductivity	µs/cm	X	
	Specific Conductivity	µs/cm^C		X
	Turbidity	NTU	X	
	Total Dissolved Solids	g/L		X
	Salinity	-		X
	Oxygen Reduction Potential (ORP)	-		X
Nutrients	Nitrate (as Nitrogen)	mg/L	X	
Microbiological	*Escherichia coli* (*E. coli*)	MPN/100 mL or CFU/100 mL	X	
	Fecal Coliforms	MPN/100 mL or CFU/100 mL	X	
Metals	Total Metals	mg/L	X	X
	Dissolved Metals	mg/L		X
General Lab Parameters	Alkalinity (Speciated)	mg/L		X
	Hardness (as $CaCO_3$)	mg/L		X

Appendix D – Water Quality and Benthic Invertebrate Monitoring

Benthic Invertebrate Sampling

Field sampling was conducted on September 16, 2016 as per MAMF protocols. At each site, three replicate samples were taken for analysis (three jars per stream). Each jar consisted of a composite of three Surber sampler placements. The three replicate samples making up the composite sample at the site, where possible, were collected within a 50 m long sampling reach.

Preserved samples were packed and transported to the lab for taxonomic analysis, again following MAMF protocols. A quality assurance/quality control program was utilized. The full report provides further details.

Based on the laboratory taxonomy results, scores were calculated for ten metrics composing the Benthic Index of Biotic Integrity (B-IBI). Metric scores were added together to determine the B-IBI score for each sample. Mean B-IBI scores for each site were calculated as the average of the three replicated sample B-IBI scores. Unique taxa for each site were identified and summed to calculate total taxa richness (composite of three replicate samples).

Detailed methods, including details on quality assurance/quality control (QA/QC), laboratory methods, and full laboratory results, can be found in the full MAMF report.

Results

Summary

Balsam Creek had excellent water quality, with all water quality parameters falling in the MAMF Good category (Figure D-5, Figure D-6, and Figure D-7). Anderson Creek and the North Alouette River generally had good water quality. Conductivity and dissolved oxygen (dry season) were in the Satisfactory or Needs Attention categories in Anderson Creek. Temperature (wet season) and dissolved oxygen (dry season) were in the Satisfactory or Needs Attention categories for the North Alouette River. Cattell Brook had several water quality issues, with dissolved oxygen, turbidity, conductivity, and *E. coli* (wet season) all in Satisfactory or Needs Attention categories. The Fraser River tributary had poor water quality, with turbidity, conductivity, *E. coli*, fecal coliforms, iron, copper, zinc (wet/dry seasons), and dissolved oxygen (dry season) all falling in Satisfactory or Needs Attention categories.

Anderson Creek had a mean B-IBI score of 34.7 for Anderson Creek and 44 taxa of invertebrates. The North Alouette had a mean B-IBI score of 24.0 and 32 taxa. Biological conditions were fair in Anderson Creek and poor in the North Alouette River, based on the biological condition rankings found in the MAMF that correspond to these B-IBI scores (Metro Vancouver 2014).

Full results, including details on the parameters that exceeded regional (yellow or red categories as per the MAMF colour coding system), provincial, or federal water quality guidelines can be found in the full MAMF report. Full MAMF Results Report Sheets and Lab Results can be found at the end of this Appendix.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

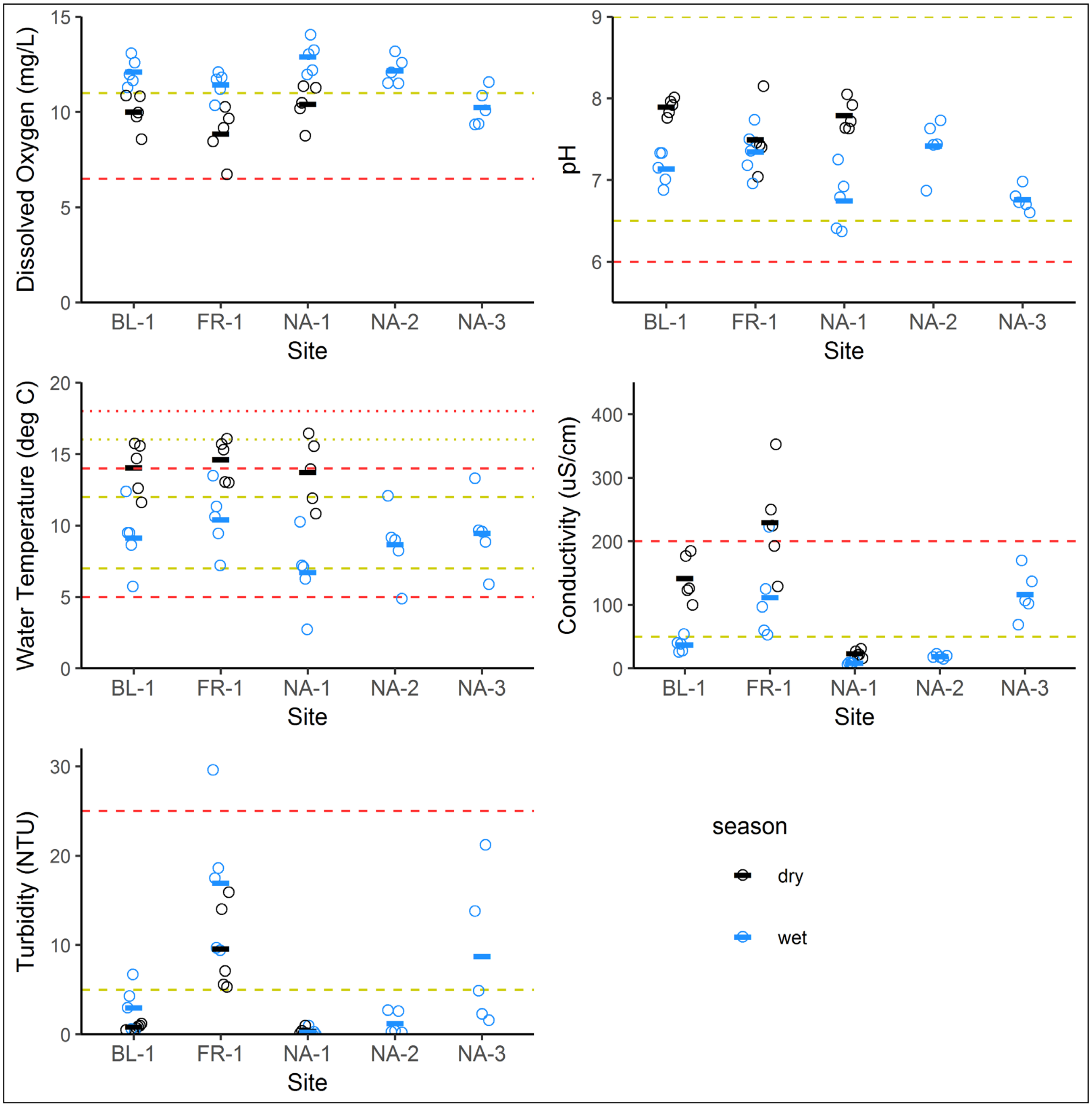

Figure D-5: Boxplots of City of Maple Ridge MAMF water quality monitoring data for general water quality parameters for the five sampling sites, 2016. Points represent individual samples. Bars represent mean values. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively. Dotted yellow and red lines indicate thresholds for summer low flow conditions only.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

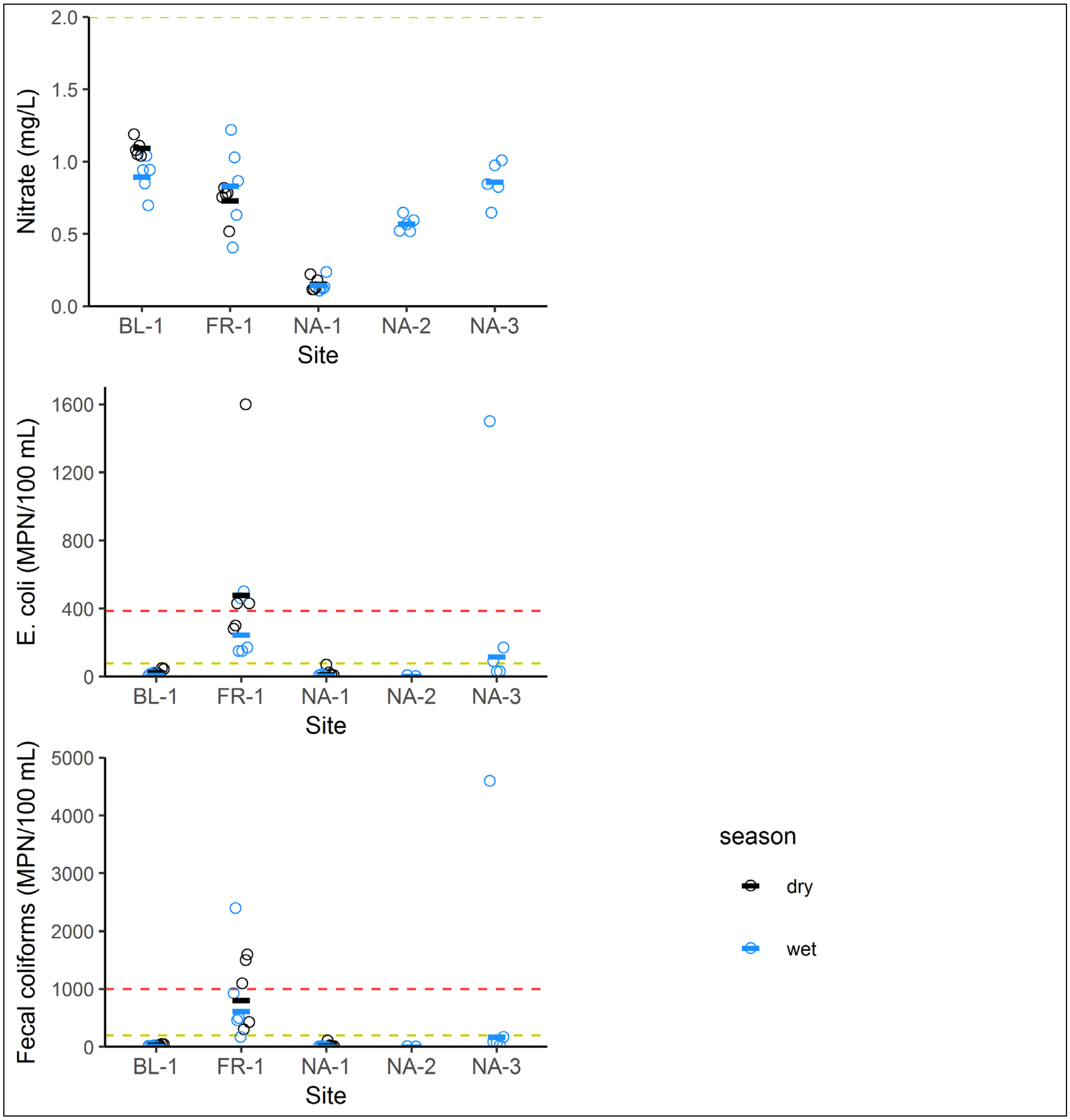

Figure D-6: Boxplots of City of Maple Ridge MAMF water quality monitoring data for nutrients and microbiological indicators for the five sampling sites, 2016. Points represent individual samples. Bars represent mean values for nitrate and geometric mean values for *E. coli* and fecal coliforms. Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

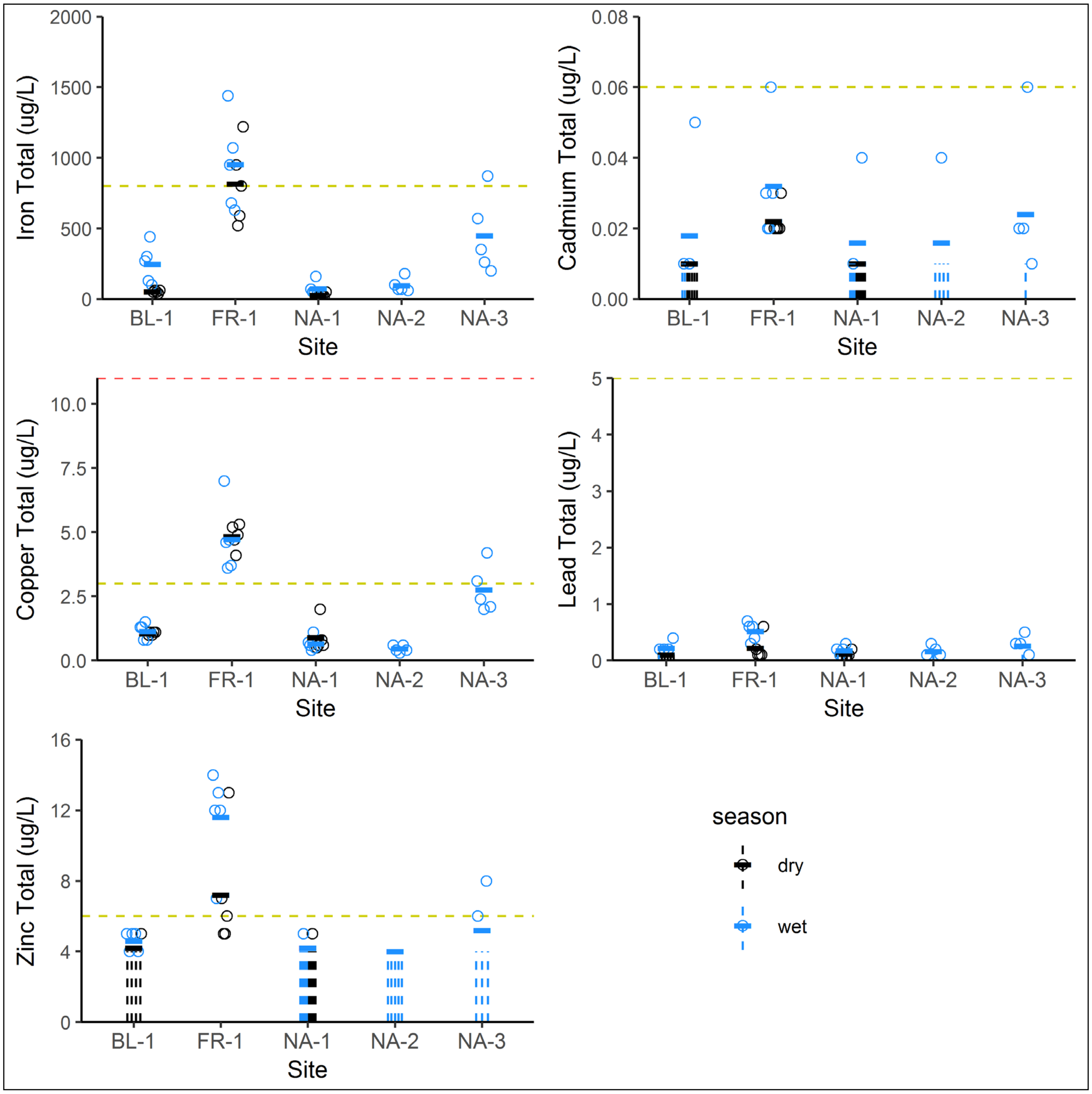

Figure D-7: Boxplots of City of Maple Ridge MAMF water quality monitoring data for total metal concentrations for the five sampling sites, 2016. Points represent individual samples. Vertical dashed blue and black lines represent sample results that were below detection limit (upper extent of dashed lines are detection limits). Bars represent mean values (detection limit used to calculate means for non-detect samples). Dashed yellow and red lines indicate MAMF Satisfactory and Needs Attention thresholds, respectively.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

D.3 Priority Issues and Summary

Based on the existing water quality and benthic invertebrate analysis and the MAMF monitoring, the following issues and results have been identified to guide further monitoring and adaptive management:

- Lower than expected B-IBI scores for Anderson Creek and the North Alouette River: scores are lower than would be expected for a watershed with high levels of riparian forest integrity and low levels of total impervious area. The B-IBI score for Anderson Creek and North Alouette River may be attributed to the urbanization located upstream.
- Poor water quality in Fraser River tributary: turbidity, conductivity, *E. coli*, fecal coliforms, iron, copper, zinc, and dissolved oxygen exceeded guidelines in 2016.
- Several water quality concerns in Cattell Brook: historical water quality problems and low benthic invertebrate diversity, and dissolved oxygen, turbidity, conductivity, and *E. coli* exceeded guidelines in 2016.
- Historically good water quality in North Alouette River with some issues; dissolved oxygen values below 11 mg/L, consistently acidic pH, and several winters with cold water temperatures (~0°C). Monitoring in 2016 showed a continuation of this pattern.
- Good water quality in Anderson Creek; only conductivity and dissolved oxygen exceeded guidelines in 2016.
- Excellent water quality in Balsam Creek; no exceedances in 2016.

Appendix D – Water Quality and Benthic Invertebrate Monitoring

Statement of Limitations

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Revision History

Revision #	Date	Status	Revision Description	Author
0	September 2021	Final		LRL

Appendix D – Water Quality and Benthic Invertebrate Monitoring

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Appendix D – Water Quality and Benthic Invertebrate Monitoring

MAMF Monitoring Results Report

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

	Drainage Name:	Blaney Creek			**Municipality:**	City of Maple Ridge	
	WATER QUALITY MONITORING RESULTS						
	Site Location and Site Number:	BL-1 (Anderson Creek west of Anderson Creek Drive)					
	Water Quality Site UTM Zone:	10N	**Easting:**	530218	**Northing:**	5456063	
	Wet Season	**Monitoring Date:**	2016-11-09	2016-11-22	2016-11-24	2016-12-02	2016-12-12
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	9.15	12.39	9.49	9.49	8.64	5.74
	Dissolved Oxygen (mg/L)	12.12	11.29	11.97	13.09	11.65	12.59
	Turbidity (NTU)	3.0	3.0	4.3	0.6	6.7	0.3
	E.coli (MPN/100ml)	12	7	15	9	23	<2
	Fecal Coliforms (MPN/100ml)	16	15	15	9	30	<2
	Nitrate (as Nitrogen, mg/L)	0.894	0.942	0.850	1.040	0.697	0.943
	Total Iron (ug/L)	248	270	300	130	440	100
	Total Cadmium (ug/L)*	0.02	0.01	0.01	0.01	0.05	0.01
	Total Copper (ug/L)*	1.1	1.3	1.3	0.8	1.5	0.8
	Total Lead (ug/L)*	0.2	0.2	0.2	0.2	0.4	0.1
	Total Zinc (ug/L)*	5	5	4	5	5	4
Secondary	Conductivity (uS/cm)	37	40	26	39	28	54
	pH (rel. units)	7.14	7.15	7.33	7.33	6.88	7.01
	Dry Season	**Monitoring Date:**	2016-08-30	2016-09-07	2016-09-12	2016-09-16	2016-09-22
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	14.05	15.74	14.69	12.61	15.58	11.62
	Dissolved Oxygen (mg/L)	10.00	9.76	9.97	10.82	8.58	10.86
	Turbidity (NTU)	0.9	0.7	0.9	1.0	1.2	0.5
	E.coli (MPN/100ml)	24	22	17	9	50	43
	Fecal Coliforms (MPN/100ml)	32	22	30	23	50	43
	Nitrate (as Nitrogen, mg/L)	1.094	1.190	1.080	1.050	1.110	1.040
	Total Iron (ug/L)	52	50	60	50	40	60
	Total Cadmium (ug/L)*	0.01	0.01	0.01	0.01	0.01	0.01
	Total Copper (ug/L)*	1.1	1.0	1.1	1.0	1.1	1.1
	Total Lead (ug/L)*	0.1	0.1	0.1	0.1	0.1	0.1
	Total Zinc (ug/L)*	4	4	4	4	4	5
Secondary	Conductivity (uS/cm)	142	177	123	126	185	100
	pH (rel. units)	7.90	7.76	7.83	7.96	7.92	8.01
	FLOW MONITORING RESULTS						
	Hydrometric Site UTM Zone:		**Easting:**		**Northing:**		
	Monitoring Period						
		Value	**Trend** **Stable, Increasing, Decreasing (S, D, I)***			**Target***	
	MAD (L/s)						
	TQ Mean					S or I	
	Low Pulse Count					S or D	
	Low Pulse Duration (Days)					S or I	
	Summer Baseflow (L/s)					S	
	Winter Baseflow (L/s)					S or I	
	High Pulse count					S or D	
	High Pulse Suration (Days)					S or I	
	BIOMONITORING RESULTS						
	Biomonitoring Site UTM Zone:	10N	**Easting:**	530142	**Northing:**	5456064	
	Monitoring Date:	Sept. 16, 2016					
		SCORE	**Pre-Dvpt Value or Trend (S, D or I)***			**Trend Target ***	
	B-IBI Score	34.7				S or I	
	Total Taxa Richness	44				S or I	

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: North Alouette River **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

Site Location and Site Number: NA-1 (North Alouette River at 232 St)

Water Quality Site UTM Zone: 10N **Easting:** 530523 **Northing:** 5454484

	Wet Season	**Monitoring Date:**	2016-11-09	2016-11-22	2016-11-24	2016-12-02	2016-12-12
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	6.72	10.26	7.21	7.11	6.27	2.74
	Dissolved Oxygen (mg/L)	12.90	11.96	13.04	14.05	12.19	13.25
	Turbidity (NTU)	0.3	1.0	0.0	0.0	0.3	0.0
	E.coli (MPN/100ml)	5	7	14	3	4	2
	Fecal Coliforms (MPN/100ml)	5	7	14	4	4	2
	Nitrate (as Nitrogen, mg/L)	0.146	0.107	0.129	0.123	0.133	0.237
	Total Iron (ug/L)	74	70	50	50	160	40
	Total Cadmium (ug/L)*	0.02	0.01	0.01	0.01	0.04	0.01
	Total Copper (ug/L)*	0.7	0.7	0.6	0.4	1.1	0.5
	Total Lead (ug/L)*	0.2	0.2	0.1	0.2	0.3	0.1
	Total Zinc (ug/L)*	4	4	4	4	5	4
Secondary	Conductivity (uS/cm)	9	6	9	8	8	13
	pH (rel. units)	6.75	6.41	7.25	6.79	6.37	6.92
	Dry Season	**Monitoring Date:**	2016-08-30	2016-09-07	2016-09-12	2016-09-16	2016-09-22
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	13.74	16.45	13.94	11.91	15.56	10.82
	Dissolved Oxygen (mg/L)	10.41	10.19	10.48	11.36	8.75	11.27
	Turbidity (NTU)	0.3	0.1	0.4	0.1	1.0	0.1
	E.coli (MPN/100ml)	12	70	23	9	2	9
	Fecal Coliforms (MPN/100ml)	16	110	30	15	2	9
	Nitrate (as Nitrogen, mg/L)	0.153	0.221	0.117	0.115	0.132	0.180
	Total Iron (ug/L)	28	20	30	20	20	50
	Total Cadmium (ug/L)*	0.01	0.01	0.01	0.01	0.01	0.01
	Total Copper (ug/L)*	0.9	0.5	0.6	2.0	0.8	0.6
	Total Lead (ug/L)*	0.1	0.1	0.1	0.2	0.1	0.1
	Total Zinc (ug/L)*	4	4	4	4	4	5
Secondary	Conductivity (uS/cm)	23	27	21	22	31	16
	pH (rel. units)	7.79	7.64	8.05	7.63	7.72	7.92

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone: **Easting:** **Northing:**

Monitoring Period

	Value	**Trend** **Stable, Increasing, Decreasing (S, D, I)***	**Target***
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone: 10N **Easting:** 530489 **Northing:** 5454514

Monitoring Date: Sept. 16, 2016

	SCORE	**Pre-Dvpt Value or Trend (S, D or I)***	**Trend Target ***
B-IBI Score	24.0		S or I
Total Taxa Richness	32		S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: North Alouette River **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

Site Location and Site Number:	NA-2 (Balsam Creek at Balsam Street)				
Water Quality Site UTM Zone:	10N	**Easting:**	531021	**Northing:**	5454636

	Wet Season	**Monitoring Date:**	2016-11-09	2016-11-22	2016-11-24	2016-12-02	2016-12-12
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	8.68	12.09	9.17	8.99	8.25	4.88
	Dissolved Oxygen (mg/L)	12.18	11.52	12.08	13.19	11.50	12.59
	Turbidity (NTU)	1.2	2.7	0.3	0.4	2.6	0.2
	E.coli (MPN/100ml)	3	9	3	4	2	2
	Fecal Coliforms (MPN/100ml)	3	9	3	4	2	2
	Nitrate (as Nitrogen, mg/L)	0.569	0.522	0.647	0.565	0.518	0.595
	Total Iron (ug/L)	96	100	70	70	180	60
	Total Cadmium (ug/L)*	0.02	0.01	0.01	0.01	0.04	0.01
	Total Copper (ug/L)*	0.5	0.6	0.4	0.3	0.6	0.4
	Total Lead (ug/L)*	0.2	0.1	0.1	0.3	0.2	0.1
	Total Zinc (ug/L)*	4	4	4	4	4	4
Secondary	Conductivity (uS/cm)	19	18	23	18	15	20
	pH (rel. units)	7.42	6.87	7.63	7.43	7.44	7.73

	Dry Season	**Monitoring Date:**					
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	-					
	Dissolved Oxygen (mg/L)	-					
	Turbidity (NTU)	-					
	E.coli (CFU/100ml)	-					
	Fecal Coliforms (CFU/100ml)	-					
	Nitrate (as Nitrogen, mg/L)	-					
	Total Iron (ug/L)	-					
	Total Cadmium (ug/L)*	-					
	Total Copper (ug/L)*	-					
	Total Lead (ug/L)*	-					
	Total Zinc (ug/L)*	-					
Secondary	Conductivity (uS/cm)	-					
	pH (rel. units)	-					

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					

	Value	**Trend** **Stable, Increasing, Decreasing (S, D, I)***	**Target***
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Date:					

	SCORE	**Pre-Dvpt Value or Trend (S, D or I)***	**Trend Target ***
B-IBI Score			S or I
Total Taxa Richness			S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: North Alouette River **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

	Site Location and Site Number:	NA-3 (Cattell Brook south of Nelson Peak Drive)					
	Water Quality Site UTM Zone:	10N	**Easting:**	529845	**Northing:**	5454879	
	Wet Season	**Monitoring Date:**	2016-11-09	2016-11-22	2016-11-24	2016-12-02	2016-12-12
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	9.462	13.32	9.66	9.58	8.86	5.89
	Dissolved Oxygen (mg/L)	10.25	9.34	9.38	10.86	10.08	11.57
	Turbidity (NTU)	8.8	13.8	4.9	2.3	21.2	1.6
	E.coli (MPN/100ml)	116	1500	91	30	30	170
	Fecal Coliforms (MPN/100ml)	173	4600	91	73	30	170
	Nitrate (as Nitrogen, mg/L)	0.860	0.845	0.646	0.974	0.825	1.010
	Total Iron (ug/L)	450	570	350	260	870	200
	Total Cadmium (ug/L)*	0.02	0.02	0.01	0.02	0.06	0.01
	Total Copper (ug/L)*	2.8	3.1	2.4	2.0	4.2	2.1
	Total Lead (ug/L)*	0.3	0.3	0.1	0.3	0.5	0.1
	Total Zinc (ug/L)*	5	6	4	4	8	4
Secondary	Conductivity (uS/cm)	117	69	170	107	102	137
	pH (rel. units)	6.76	6.80	6.73	6.98	6.70	6.60
	Dry Season	**Monitoring Date:**					
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	-					
	Dissolved Oxygen (mg/L)	-					
	Turbidity (NTU)	-					
	E.coli (CFU/100ml)	-					
	Fecal Coliforms (CFU/100ml)	-					
	Nitrate (as Nitrogen, mg/L)	-					
	Total Iron (ug/L)	-					
	Total Cadmium (ug/L)*	-					
	Total Copper (ug/L)*	-					
	Total Lead (ug/L)*	-					
	Total Zinc (ug/L)*	-					
Secondary	Conductivity (uS/cm)	-					
	pH (rel. units)	-					

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					

	Value	Trend Stable, Increasing, Decreasing (S, D, I)*	Target*
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Date:					

	SCORE	Pre-Dvpt Value or Trend (S, D or I)*	Trend Target *
B-IBI Score			S or I
Total Taxa Richness			S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness

MONITORING RESULTS REPORT SHEET - HIGHER GRADIENT DRAINAGE

Drainage Name: Fraser River **Municipality:** City of Maple Ridge

WATER QUALITY MONITORING RESULTS

	Site Location and Site Number:	FR-1 (227 Street Creek at Haney Bypass)					
	Water Quality Site UTM Zone:	10N	**Easting:**	529502	**Northing:**	5450747	
	Wet Season	**Monitoring Date:**	2016-11-09	2016-11-22	2016-11-24	2016-12-02	2016-12-12
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	10.42	13.49	10.62	11.34	9.44	7.21
	Dissolved Oxygen (mg/L)	11.44	10.35	11.72	12.10	11.21	11.82
	Turbidity (NTU)	17.0	29.6	17.5	9.7	18.6	9.4
	E.coli (MPN/100ml)	245	150	460	150	500	170
	Fecal Coliforms (MPN/100ml)	614	930	2400	460	500	170
	Nitrate (as Nitrogen, mg/L)	0.831	1.220	0.406	1.030	0.632	0.867
	Total Iron (ug/L)	954	1440	950	680	1070	630
	Total Cadmium (ug/L)*	0.03	0.03	0.02	0.02	0.06	0.03
	Total Copper (ug/L)*	4.7	7.0	4.6	3.6	4.7	3.7
	Total Lead (ug/L)*	0.5	0.7	0.6	0.3	0.6	0.4
	Total Zinc (ug/L)*	12	14	12	7	13	12
Secondary	Conductivity (uS/cm)	112	97	60	125	53	223
	pH (rel. units)	7.35	7.18	7.50	7.36	6.96	7.74
	Dry Season	**Monitoring Date:**	2016-08-30	2016-09-07	2016-09-12	2016-09-16	2016-09-22
		AVERAGE	**1**	**2**	**3**	**4**	**5**
Priority Indicators	Temperature (Celsius)	14.62	15.70	15.30	13.04	16.08	13.00
	Dissolved Oxygen (mg/L)	8.85	8.45	9.16	10.27	6.73	9.66
	Turbidity (NTU)	9.6	14.0	5.6	7.1	5.3	15.9
	E.coli (MPN/100ml)	478	280	300	430	1600	430
	Fecal Coliforms (MPN/100ml)	806	1100	300	1500	1600	430
	Nitrate (as Nitrogen, mg/L)	0.730	0.754	0.819	0.776	0.784	0.518
	Total Iron (ug/L)	816	950	520	590	800	1220
	Total Cadmium (ug/L)*	0.02	0.02	0.02	0.02	0.02	0.03
	Total Copper (ug/L)*	4.8	5.2	4.7	4.1	4.9	5.3
	Total Lead (ug/L)*	0.2	0.2	0.1	0.1	0.1	0.6
	Total Zinc (ug/L)*	7	7	5	5	6	13
Secondary	Conductivity (uS/cm)	230	250	225	193	353	129
	pH (rel. units)	7.50	7.46	7.04	7.43	7.40	8.15

FLOW MONITORING RESULTS

Hydrometric Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Period					

	Value	Trend Stable, Increasing, Decreasing (S, D, I)*	Target*
MAD (L/s)			
TQ Mean			S or I
Low Pulse Count			S or D
Low Pulse Duration (Days)			S or I
Summer Baseflow (L/s)			S
Winter Baseflow (L/s)			S or I
High Pulse count			S or D
High Pulse Suration (Days)			S or I

BIOMONITORING RESULTS

Biomonitoring Site UTM Zone:		**Easting:**		**Northing:**	
Monitoring Date:					

	SCORE	Pre-Dvpt Value or Trend (S, D or I)*	Trend Target *
B-IBI Score			S or I
Total Taxa Richness			S or I

Notes: For flow assessment see Table 5 Hydrologic Response to Land Development; *For metals rank value assumes hardness

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6082235
PO NUMBER		**RECEIVED / TEMP**	2016-08-30 15:53 / 9°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-08
PROJECT INFO	Stormwater Monitoring	**COC NUMBER**	NO#

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis . Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

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REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6082235
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-08

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6082235
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-08

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Coliforms, Total (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6082235
REPORTED 2016-09-08

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6082235-01) [Water] Sampled: 2016-08-30 13:10							
Anions							
Nitrate (as N)	**1.19**	N/A	0.010	mg/L	N/A	2016-09-01	
General Parameters							
Alkalinity, Total (as CaCO3)	**54**	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Bicarbonate (as CaCO3)	**54**	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Calculated Parameters							
Hardness, Total (as CaCO3)	**65.2**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-02	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Barium, dissolved	**0.019**	N/A	0.005	mg/L	N/A	2016-09-02	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-09-02	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-02	
Calcium, dissolved	**20.3**	N/A	0.2	mg/L	N/A	2016-09-02	
Chromium, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-09-02	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-02	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-02	
Iron, dissolved	**0.018**	N/A	0.010	mg/L	N/A	2016-09-02	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-09-02	
Magnesium, dissolved	**3.51**	N/A	0.01	mg/L	N/A	2016-09-02	
Manganese, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	2016-09-02	
Molybdenum, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	2016-09-02	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-02	
Potassium, dissolved	**1.67**	N/A	0.02	mg/L	N/A	2016-09-02	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Silicon, dissolved	**8.7**	N/A	0.5	mg/L	N/A	2016-09-02	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-02	
Sodium, dissolved	**15.6**	N/A	0.02	mg/L	N/A	2016-09-02	
Strontium, dissolved	**0.107**	N/A	0.001	mg/L	N/A	2016-09-02	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-02	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-02	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-02	
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	2016-09-02	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6082235
REPORTED 2016-09-08

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6082235-01) [Water] Sampled: 2016-08-30 13:10, Continued							
Dissolved Metals, Continued							
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-02	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-02	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Total Metals							
Aluminum, total	**0.051**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Barium, total	**0.021**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Boron, total	**0.029**	N/A	0.004	mg/L	2016-09-02	2016-09-02	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-02	2016-09-02	
Calcium, total	**21.3**	N/A	0.2	mg/L	2016-09-02	2016-09-02	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-02	2016-09-02	
Copper, total	**0.0010**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Iron, total	**0.05**	N/A	0.01	mg/L	2016-09-02	2016-09-02	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Lithium, total	**0.0004**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Magnesium, total	**3.63**	N/A	0.01	mg/L	2016-09-02	2016-09-02	
Manganese, total	**0.0032**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-01	2016-09-01	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Potassium, total	**1.76**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Silicon, total	**10.1**	N/A	0.5	mg/L	2016-09-02	2016-09-02	
Silver, total	**0.00005**	N/A	0.00005	mg/L	2016-09-02	2016-09-02	
Sodium, total	**15.9**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Strontium, total	**0.121**	N/A	0.001	mg/L	2016-09-02	2016-09-02	
Sulfur, total	**4**	N/A	1	mg/L	2016-09-02	2016-09-02	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-02	2016-09-02	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	2016-09-02	2016-09-02	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-02	2016-09-02	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-02	2016-09-02	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Microbiological Parameters							
Coliforms, Total	**80**	N/A	2	MPN/100 mL		2016-08-31	
Coliforms, Fecal	**22**	N/A	2	MPN/100 mL		2016-08-31	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6082235-01) [Water] Sampled: 2016-08-30 13:10, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**22**	N/A	2	MPN/100 mL		2016-08-31	
Sample ID: NA-1 (North Alouette River) (6082235-02) [Water] Sampled: 2016-08-30 13:45							
Anions							
Nitrate (as N)	**0.221**	N/A	0.010	mg/L	N/A	2016-09-01	
General Parameters							
Alkalinity, Total (as CaCO3)	**8**	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Bicarbonate (as CaCO3)	**8**	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Calculated Parameters							
Hardness, Total (as CaCO3)	**9.59**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-09-02	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Barium, dissolved	**0.006**	N/A	0.005	mg/L	N/A	2016-09-02	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Boron, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-09-02	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-09-02	
Calcium, dissolved	**3.1**	N/A	0.2	mg/L	N/A	2016-09-02	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-02	
Copper, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	2016-09-02	
Iron, dissolved	**0.014**	N/A	0.010	mg/L	N/A	2016-09-02	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Magnesium, dissolved	**0.46**	N/A	0.01	mg/L	N/A	2016-09-02	
Manganese, dissolved	**0.0012**	N/A	0.0002	mg/L	N/A	2016-09-02	
Molybdenum, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	2016-09-02	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-02	
Potassium, dissolved	**0.27**	N/A	0.02	mg/L	N/A	2016-09-02	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Silicon, dissolved	**3.1**	N/A	0.5	mg/L	N/A	2016-09-02	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-02	
Sodium, dissolved	**1.94**	N/A	0.02	mg/L	N/A	2016-09-02	
Strontium, dissolved	**0.013**	N/A	0.001	mg/L	N/A	2016-09-02	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-09-02	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6082235
REPORTED 2016-09-08

Sample ID: NA-1 (North Alouette River) (6082235-02) [Water] Sampled: 2016-08-30 13:45, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-02	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-02	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-02	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-02	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-02	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Total Metals							
Aluminum, total	**0.034**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Barium, total	**0.005**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Boron, total	**0.019**	N/A	0.004	mg/L	2016-09-02	2016-09-02	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-02	2016-09-02	
Calcium, total	**3.3**	N/A	0.2	mg/L	2016-09-02	2016-09-02	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-02	2016-09-02	
Copper, total	**0.0005**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Iron, total	**0.02**	N/A	0.01	mg/L	2016-09-02	2016-09-02	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Magnesium, total	**0.47**	N/A	0.01	mg/L	2016-09-02	2016-09-02	
Manganese, total	**0.0013**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-01	2016-09-01	
Molybdenum, total	**0.0005**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Potassium, total	**0.27**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Silicon, total	**3.6**	N/A	0.5	mg/L	2016-09-02	2016-09-02	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-02	2016-09-02	
Sodium, total	**2.00**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Strontium, total	**0.015**	N/A	0.001	mg/L	2016-09-02	2016-09-02	
Sulfur, total	**1**	N/A	1	mg/L	2016-09-02	2016-09-02	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-02	2016-09-02	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-02	2016-09-02	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-02	2016-09-02	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-02	2016-09-02	

SAMPLE ANALYTICAL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6082235
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-08

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6082235-02) [Water] Sampled: 2016-08-30 13:45, Continued							
Total Metals, Continued							
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Microbiological Parameters							
Coliforms, Total	**130**	N/A	2	MPN/100 mL		2016-08-31	
Coliforms, Fecal	**110**	N/A	2	MPN/100 mL		2016-08-31	
E. coli (MPN)	**70**	N/A	2	MPN/100 mL		2016-08-31	
Sample ID: FR-1 (227 St Creek) (6082235-03) [Water] Sampled: 2016-08-30 13:45							
Anions							
Nitrate (as N)	**0.754**	N/A	0.010	mg/L	N/A	2016-09-01	
General Parameters							
Alkalinity, Total (as CaCO3)	**124**	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Bicarbonate (as CaCO3)	**124**	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-01	
Calculated Parameters							
Hardness, Total (as CaCO3)	**106**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-02	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Arsenic, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-09-02	
Barium, dissolved	**0.012**	N/A	0.005	mg/L	N/A	2016-09-02	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Boron, dissolved	**0.039**	N/A	0.004	mg/L	N/A	2016-09-02	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-09-02	
Calcium, dissolved	**25.6**	N/A	0.2	mg/L	N/A	2016-09-02	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Cobalt, dissolved	**0.00014**	N/A	0.00005	mg/L	N/A	2016-09-02	
Copper, dissolved	**0.0040**	N/A	0.0002	mg/L	N/A	2016-09-02	
Iron, dissolved	**0.133**	N/A	0.010	mg/L	N/A	2016-09-02	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Lithium, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	2016-09-02	
Magnesium, dissolved	**10.2**	N/A	0.01	mg/L	N/A	2016-09-02	
Manganese, dissolved	**0.0524**	N/A	0.0002	mg/L	N/A	2016-09-02	
Molybdenum, dissolved	**0.0028**	N/A	0.0001	mg/L	N/A	2016-09-02	
Nickel, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-09-02	
Phosphorus, dissolved	**0.03**	N/A	0.02	mg/L	N/A	2016-09-02	
Potassium, dissolved	**3.23**	N/A	0.02	mg/L	N/A	2016-09-02	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-02	
Silicon, dissolved	**6.9**	N/A	0.5	mg/L	N/A	2016-09-02	

SAMPLE ANALYTICAL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6082235
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-08

Sample ID: FR-1 (227 St Creek) (6082235-03) [Water] Sampled: 2016-08-30 13:45, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-02	
Sodium, dissolved	**23.3**	N/A	0.02	mg/L	N/A	2016-09-02	
Strontium, dissolved	**0.139**	N/A	0.001	mg/L	N/A	2016-09-02	
Sulfur, dissolved	**1**	N/A	1	mg/L	N/A	2016-09-02	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-02	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-02	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-02	
Uranium, dissolved	**0.00009**	N/A	0.00002	mg/L	N/A	2016-09-02	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-02	
Zinc, dissolved	**0.004**	N/A	0.004	mg/L	N/A	2016-09-02	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-02	
Total Metals							
Aluminum, total	**0.515**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Arsenic, total	**0.0012**	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Barium, total	**0.016**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Boron, total	**0.057**	N/A	0.004	mg/L	2016-09-02	2016-09-02	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-09-02	2016-09-02	
Calcium, total	**26.6**	N/A	0.2	mg/L	2016-09-02	2016-09-02	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Cobalt, total	**0.00035**	N/A	0.00005	mg/L	2016-09-02	2016-09-02	
Copper, total	**0.0052**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Iron, total	**0.95**	N/A	0.01	mg/L	2016-09-02	2016-09-02	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Magnesium, total	**10.2**	N/A	0.01	mg/L	2016-09-02	2016-09-02	
Manganese, total	**0.0725**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-01	2016-09-01	
Molybdenum, total	**0.0026**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Nickel, total	**0.0016**	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Phosphorus, total	**0.07**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Potassium, total	**3.44**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-02	2016-09-02	
Silicon, total	**8.7**	N/A	0.5	mg/L	2016-09-02	2016-09-02	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-02	2016-09-02	
Sodium, total	**23.2**	N/A	0.02	mg/L	2016-09-02	2016-09-02	
Strontium, total	**0.155**	N/A	0.001	mg/L	2016-09-02	2016-09-02	
Sulfur, total	**3**	N/A	1	mg/L	2016-09-02	2016-09-02	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-02	2016-09-02	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-02	2016-09-02	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6082235-03) [Water] Sampled: 2016-08-30 13:45, Continued							
Total Metals, Continued							
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-02	2016-09-02	
Titanium, total	**0.021**	N/A	0.005	mg/L	2016-09-02	2016-09-02	
Uranium, total	**0.00010**	N/A	0.00002	mg/L	2016-09-02	2016-09-02	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-09-02	2016-09-02	
Zinc, total	**0.007**	N/A	0.004	mg/L	2016-09-02	2016-09-02	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	2016-09-02	2016-09-02	
Microbiological Parameters							
Coliforms, Total	**3000**	N/A	2	MPN/100 mL		2016-08-31	
Coliforms, Fecal	**1100**	N/A	2	MPN/100 mL		2016-08-31	
E. coli (MPN)	**280**	N/A	2	MPN/100 mL		2016-08-31	
Sample ID: Field Blank (6082235-04) [Water] Sampled: 2016-08-30 12:15							
Microbiological Parameters							
Coliforms, Total	**ND**	N/A	2	MPN/100 mL		2016-08-31	
E. coli (MPN)	**ND**	N/A	2	MPN/100 mL		2016-08-31	

APPENDIX 1: QUALITY CONTROL DATA

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6I0046										
Blank (B6I0046-BLK1)				Prepared: 2016-09-01, Analyzed: 2016-09-01						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I0046-BLK2)				Prepared: 2016-09-01, Analyzed: 2016-09-01						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6I0046-BS1)				Prepared: 2016-09-01, Analyzed: 2016-09-01						
Nitrate (as N)	3.91	0.010	mg/L	4.00		98	93-108			
LCS (B6I0046-BS2)				Prepared: 2016-09-01, Analyzed: 2016-09-01						
Nitrate (as N)	3.93	0.010	mg/L	4.00		98	93-108			
Dissolved Metals, Batch B6I0149										
Blank (B6I0149-BLK1)				Prepared: 2016-09-02, Analyzed: 2016-09-02						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B6I0149, Continued										
Blank (B6I0149-BLK1), Continued				Prepared: 2016-09-02, Analyzed: 2016-09-02						
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Duplicate (B6I0149-DUP1)		**Source: 6082235-01**		Prepared: 2016-09-02, Analyzed: 2016-09-02						
Aluminum, dissolved	< 0.005	0.005	mg/L		< 0.005				11	
Antimony, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.020	0.005	mg/L		0.019				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.018	0.004	mg/L		0.009				13	
Cadmium, dissolved	< 0.00001	0.00001	mg/L		< 0.00001				27	
Calcium, dissolved	20.0	0.2	mg/L		20.3			2	8	
Chromium, dissolved	0.0015	0.0005	mg/L		0.0007				14	
Cobalt, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				10	
Copper, dissolved	0.0008	0.0002	mg/L		0.0009				28	
Iron, dissolved	0.017	0.010	mg/L		0.018				14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0003	0.0001	mg/L		0.0003				14	
Magnesium, dissolved	3.39	0.01	mg/L		3.51			4	6	
Manganese, dissolved	0.0008	0.0002	mg/L		0.0008				9	
Molybdenum, dissolved	0.0007	0.0001	mg/L		0.0008			9	19	
Nickel, dissolved	0.0002	0.0002	mg/L		< 0.0002				21	
Phosphorus, dissolved	< 0.02	0.02	mg/L		< 0.02				14	
Potassium, dissolved	1.61	0.02	mg/L		1.67			4	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	8.9	0.5	mg/L		8.7			2	12	
Silver, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	15.1	0.02	mg/L		15.6			3	6	
Strontium, dissolved	0.111	0.001	mg/L		0.107			3	6	
Sulfur, dissolved	1	1	mg/L		2				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	0.00004	0.00002	mg/L		0.00004				14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		< 0.004				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	

Dissolved Metals, Batch B6I0149, Continued

Matrix Spike (B6I0149-MS1) **Source: 6082235-02** Prepared: 2016-09-02, Analyzed: 2016-09-02

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony, dissolved	0.370	0.0001	mg/L	0.400	< 0.0001	93	76-114			
Arsenic, dissolved	0.182	0.0005	mg/L	0.200	< 0.0005	91	81-115			
Barium, dissolved	0.877	0.005	mg/L	1.00	0.006	87	80-113			
Beryllium, dissolved	0.0872	0.0001	mg/L	0.100	< 0.0001	87	69-109			
Cadmium, dissolved	0.0898	0.00001	mg/L	0.100	0.00001	90	83-110			
Chromium, dissolved	0.392	0.0005	mg/L	0.400	< 0.0005	98	85-115			
Cobalt, dissolved	0.389	0.00005	mg/L	0.400	< 0.00005	97	86-114			
Copper, dissolved	0.410	0.0002	mg/L	0.400	0.0008	102	82-119			
Iron, dissolved	2.00	0.010	mg/L	2.00	0.014	99	80-116			
Lead, dissolved	0.207	0.0001	mg/L	0.200	< 0.0001	103	83-112			
Manganese, dissolved	0.367	0.0002	mg/L	0.400	0.0012	92	62-131			
Nickel, dissolved	0.370	0.0002	mg/L	0.400	< 0.0002	92	81-115			
Selenium, dissolved	0.109	0.0005	mg/L	0.100	< 0.0005	109	79-115			
Silver, dissolved	0.101	0.00005	mg/L	0.100	< 0.00005	101	69-121			
Thallium, dissolved	0.103	0.00002	mg/L	0.100	< 0.00002	103	84-115			
Vanadium, dissolved	0.372	0.001	mg/L	0.400	< 0.001	93	83-113			
Zinc, dissolved	0.931	0.004	mg/L	1.00	< 0.004	93	82-115			

Reference (B6I0149-SRM1) Prepared: 2016-09-02, Analyzed: 2016-09-02

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.224	0.005	mg/L	0.233		96	58-142			
Antimony, dissolved	0.0462	0.0001	mg/L	0.0430		108	75-125			
Arsenic, dissolved	0.426	0.0005	mg/L	0.438		97	81-119			
Barium, dissolved	3.48	0.005	mg/L	3.35		104	83-117			
Beryllium, dissolved	0.217	0.0001	mg/L	0.213		102	80-120			
Boron, dissolved	1.87	0.004	mg/L	1.74		108	74-117			
Cadmium, dissolved	0.219	0.00001	mg/L	0.224		98	83-117			
Calcium, dissolved	8.0	0.2	mg/L	7.69		104	76-124			
Chromium, dissolved	0.455	0.0005	mg/L	0.437		104	81-119			
Cobalt, dissolved	0.130	0.00005	mg/L	0.128		102	76-124			
Copper, dissolved	0.884	0.0002	mg/L	0.844		105	84-116			
Iron, dissolved	1.35	0.010	mg/L	1.29		105	74-126			
Lead, dissolved	0.119	0.0001	mg/L	0.112		106	72-128			
Lithium, dissolved	0.112	0.0001	mg/L	0.104		108	60-140			
Magnesium, dissolved	7.29	0.01	mg/L	6.92		105	81-119			
Manganese, dissolved	0.342	0.0002	mg/L	0.345		99	84-116			
Molybdenum, dissolved	0.440	0.0001	mg/L	0.426		103	83-117			
Nickel, dissolved	0.863	0.0002	mg/L	0.840		103	74-126			
Phosphorus, dissolved	0.49	0.02	mg/L	0.495		99	68-132			
Potassium, dissolved	3.10	0.02	mg/L	3.19		97	74-126			
Selenium, dissolved	0.0351	0.0005	mg/L	0.0331		106	70-130			
Sodium, dissolved	19.5	0.02	mg/L	19.1		102	72-128			
Strontium, dissolved	0.913	0.001	mg/L	0.916		100	84-113			
Thallium, dissolved	0.0397	0.00002	mg/L	0.0393		101	57-143			
Uranium, dissolved	0.285	0.00002	mg/L	0.266		107	85-115			
Vanadium, dissolved	0.872	0.001	mg/L	0.869		100	87-113			
Zinc, dissolved	0.866	0.004	mg/L	0.881		98	72-128			

General Parameters, Batch B6I0094

Blank (B6I0094-BLK1) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

General Parameters, Batch B6I0094, Continued

Blank (B6I0094-BLK2) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6I0094-BLK3) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6I0094-BS1) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	106	2	mg/L	100		106	96-108			

LCS (B6I0094-BS3) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	101	2	mg/L	100		101	96-108			

LCS (B6I0094-BS5) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			

Duplicate (B6I0094-DUP1) **Source: 6082235-01** Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	52	2	mg/L		54			4	10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L		< 1				10	
Alkalinity, Bicarbonate (as CaCO3)	52	2	mg/L		54			4	10	
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L		< 1				10	
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L		< 1				10	

Total Metals, Batch B6I0033

Blank (B6I0033-BLK1) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	< 0.00002	0.00002	mg/L							

Reference (B6I0033-SRM1) Prepared: 2016-09-01, Analyzed: 2016-09-01

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	0.00403	0.00002	mg/L	0.00486		83	50-150			

Total Metals, Batch B6I0102

Blank (B6I0102-BLK1) Prepared: 2016-09-02, Analyzed: 2016-09-02

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6I0102, Continued										
Blank (B6I0102-BLK1), Continued				Prepared: 2016-09-02, Analyzed: 2016-09-02						
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Duplicate (B6I0102-DUP1)	**Source: 6082235-01**			Prepared: 2016-09-02, Analyzed: 2016-09-02						
Aluminum, total	0.058	0.005	mg/L		0.051			13	29	
Antimony, total	0.0001	0.0001	mg/L		0.0002				31	
Arsenic, total	< 0.0005	0.0005	mg/L		< 0.0005				15	
Barium, total	0.021	0.005	mg/L		0.021				9	
Beryllium, total	< 0.0001	0.0001	mg/L		< 0.0001				16	
Bismuth, total	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, total	0.010	0.004	mg/L		0.029			94	29	
Cadmium, total	< 0.00001	0.00001	mg/L		< 0.00001				33	
Calcium, total	21.0	0.2	mg/L		21.3			1	12	
Chromium, total	< 0.0005	0.0005	mg/L		0.0008				12	
Cobalt, total	< 0.00005	0.00005	mg/L		< 0.00005				13	
Copper, total	0.0010	0.0002	mg/L		0.0010			< 1	37	
Iron, total	0.05	0.01	mg/L		0.05			10	18	
Lead, total	< 0.0001	0.0001	mg/L		< 0.0001				23	
Lithium, total	0.0003	0.0001	mg/L		0.0004				19	
Magnesium, total	3.75	0.01	mg/L		3.63			3	10	
Manganese, total	0.0033	0.0002	mg/L		0.0032			3	13	
Molybdenum, total	0.0007	0.0001	mg/L		0.0007			4	20	
Nickel, total	< 0.0002	0.0002	mg/L		< 0.0002				28	
Phosphorus, total	0.02	0.02	mg/L		< 0.02				24	
Potassium, total	1.80	0.02	mg/L		1.76			2	13	
Selenium, total	< 0.0005	0.0005	mg/L		< 0.0005				24	
Silicon, total	10.7	0.5	mg/L		10.1			6	11	
Silver, total	< 0.00005	0.00005	mg/L		0.00005				18	
Sodium, total	16.2	0.02	mg/L		15.9			2	10	
Strontium, total	0.124	0.001	mg/L		0.121			2	9	
Sulfur, total	3	1	mg/L		4				24	
Tellurium, total	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Thorium, total	< 0.0001	0.0001	mg/L		< 0.0001				18	
Tin, total	< 0.0002	0.0002	mg/L		< 0.0002				18	
Titanium, total	< 0.005	0.005	mg/L		< 0.005				32	
Uranium, total	0.00004	0.00002	mg/L		0.00004				14	
Vanadium, total	0.001	0.001	mg/L		0.001				17	
Zinc, total	< 0.004	0.004	mg/L		< 0.004				8	

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6I0102, Continued										
Duplicate (B6I0102-DUP1), Continued		**Source: 6082235-01**		Prepared: 2016-09-02, Analyzed: 2016-09-02						
Zirconium, total	< 0.0001	0.0001	mg/L		< 0.0001				60	
Reference (B6I0102-SRM1)				Prepared: 2016-09-02, Analyzed: 2016-09-02						
Aluminum, total	0.373	0.005	mg/L	0.303		123	81-129			
Antimony, total	0.0538	0.0001	mg/L	0.0511		105	88-114			
Arsenic, total	0.129	0.0005	mg/L	0.118		110	88-114			
Barium, total	0.846	0.005	mg/L	0.823		103	72-104			
Beryllium, total	0.0542	0.0001	mg/L	0.0496		109	76-131			
Boron, total	3.98	0.004	mg/L	3.45		115	75-121			
Cadmium, total	0.0518	0.00001	mg/L	0.0495		105	89-111			
Calcium, total	12.3	0.2	mg/L	11.6		106	86-121			
Chromium, total	0.264	0.0005	mg/L	0.250		105	89-114			
Cobalt, total	0.0411	0.00005	mg/L	0.0377		109	91-113			
Copper, total	0.539	0.0002	mg/L	0.486		111	91-115			
Iron, total	0.56	0.01	mg/L	0.488		115	77-124			
Lead, total	0.205	0.0001	mg/L	0.204		101	92-113			
Lithium, total	0.430	0.0001	mg/L	0.403		107	85-115			
Magnesium, total	4.47	0.01	mg/L	3.79		118	78-120			
Manganese, total	0.122	0.0002	mg/L	0.109		112	90-114			
Molybdenum, total	0.216	0.0001	mg/L	0.198		109	90-111			
Nickel, total	0.267	0.0002	mg/L	0.249		107	90-111			
Phosphorus, total	0.24	0.02	mg/L	0.227		107	85-115			
Potassium, total	8.03	0.02	mg/L	7.21		111	84-113			
Selenium, total	0.120	0.0005	mg/L	0.121		99	85-115			
Sodium, total	8.91	0.02	mg/L	7.54		118	82-123			
Strontium, total	0.419	0.001	mg/L	0.375		112	88-112			
Thallium, total	0.0824	0.00002	mg/L	0.0805		102	91-114			
Uranium, total	0.0300	0.00002	mg/L	0.0306		98	85-120			
Vanadium, total	0.413	0.001	mg/L	0.386		107	86-111			
Zinc, total	2.72	0.004	mg/L	2.49		109	85-111			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6082235
REPORTED 2016-09-08

		6082235-01	6082235-02	6082235-03	6082235-04
		Water	**Water**	**Water**	**Water**
		2016-08-30	**2016-08-30**	**2016-08-30**	**2016-08-30**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	1.19	0.221	0.754	
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	54	8	124	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	54	8	124	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	65.2	9.59	106	
Dissolved Metals	Aluminum, dissolved (mg/L)	< 0.005	0.011	< 0.005	
	Antimony, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	0.0007	
	Barium, dissolved (mg/L)	0.019	0.006	0.012	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.009	0.005	0.039	
	Cadmium, dissolved (mg/L)	< 0.00001	0.00001	0.00001	
	Calcium, dissolved (mg/L)	20.3	3.1	25.6	
	Chromium, dissolved (mg/L)	0.0007	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00014	
	Copper, dissolved (mg/L)	0.0009	0.0008	0.0040	
	Iron, dissolved (mg/L)	0.018	0.014	0.133	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0003	< 0.0001	0.0006	
	Magnesium, dissolved (mg/L)	3.51	0.46	10.2	
	Manganese, dissolved (mg/L)	0.0008	0.0012	0.0524	
	Molybdenum, dissolved (mg/L)	0.0008	0.0005	0.0028	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0010	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	0.03	
	Potassium, dissolved (mg/L)	1.67	0.27	3.23	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	8.7	3.1	6.9	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	15.6	1.94	23.3	
	Strontium, dissolved (mg/L)	0.107	0.013	0.139	
	Sulfur, dissolved (mg/L)	2	< 1	1	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00004	< 0.00002	0.00009	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
Total Metals	Aluminum, total (mg/L)	0.051	0.034	0.515	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6082235
REPORTED 2016-09-08

		6082235-01	6082235-02	6082235-03	6082235-04
		Water	**Water**	**Water**	**Water**
		2016-08-30	**2016-08-30**	**2016-08-30**	**2016-08-30**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Total Metals	Antimony, total (mg/L)	0.0002	0.0002	0.0003	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0012	
	Barium, total (mg/L)	0.021	0.005	0.016	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.029	0.019	0.057	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00002	
	Calcium, total (mg/L)	21.3	3.3	26.6	
	Chromium, total (mg/L)	0.0008	< 0.0005	0.0008	
	Cobalt, total (mg/L)	< 0.00005	< 0.00005	0.00035	
	Copper, total (mg/L)	0.0010	0.0005	0.0052	
	Iron, total (mg/L)	0.05	0.02	0.95	
	Lead, total (mg/L)	< 0.0001	< 0.0001	0.0002	
	Lithium, total (mg/L)	0.0004	< 0.0001	0.0009	
	Magnesium, total (mg/L)	3.63	0.47	10.2	
	Manganese, total (mg/L)	0.0032	0.0013	0.0725	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0007	0.0005	0.0026	
	Nickel, total (mg/L)	< 0.0002	< 0.0002	0.0016	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.07	
	Potassium, total (mg/L)	1.76	0.27	3.44	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	10.1	3.6	8.7	
	Silver, total (mg/L)	0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	15.9	2.00	23.2	
	Strontium, total (mg/L)	0.121	0.015	0.155	
	Sulfur, total (mg/L)	4	1	3	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.021	
	Uranium, total (mg/L)	0.00004	< 0.00002	0.00010	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.002	
	Zinc, total (mg/L)	< 0.004	< 0.004	0.007	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0002	
Microbiological Parameters	Coliforms, Total (MPN/100 mL)	80	130	3000	ND
	Coliforms, Fecal (MPN/100 mL)	22	110	1100	
	E. coli (MPN) (MPN/100 mL)	22	70	280	ND

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CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC#

PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning	DATE: 30-Aug-16 TIME: 15:50	RECEIVED BY: HM WI	DATE: 30-Aug-16 TIME: 15:53
PROJECT: 173.191 Blaney, North Alouette, Fraser Rive		PROJECT INFO: Stormwater Monitoring	

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION:
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐
Regs on Report? ☒

REPORT TO:
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐
EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

...O ☐
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

6082235

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)
BL-1 (Anderson Creek)		✓			6	30-Aug-16	13:10				
NA-1 (North Alouette River)		✓			6	30-Aug-16	13:45				
FR-1 (227 St Creek)		✓			6	30-Aug-16	12:15				
Field Blank		✓			1	30-Aug-16	12:15				
Trip Blank		✓			1	30-Aug-16	11:00				

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☐	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☒ *E. coli* ☒	ASBESTOS	Nitrate - N							**HOLD**
BL-1 (Anderson Creek)								✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)								✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)								✓	✓		✓				✓	✓		✓							
Field Blank																✓									
Trip Blank																									✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 8.6 ICE: Y ☐ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT: N

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6090440
PO NUMBER		**RECEIVED / TEMP**	2016-09-07 16:23 / 5°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-15
PROJECT INFO	Stormwater Monitoring	**COC NUMBER**	NO#

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6090440
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-15

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090440
REPORTED 2016-09-15

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090440
REPORTED 2016-09-15

Sample ID: BL-1 (Anderson Creek) (6090440-01) [Water] Sampled: 2016-09-07 14:20

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**1.08**	N/A	0.010	mg/L	N/A	2016-09-09	
General Parameters							
Alkalinity, Total (as CaCO3)	**45**	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Bicarbonate (as CaCO3)	**45**	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Calculated Parameters							
Hardness, Total (as CaCO3)	**52.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.018**	N/A	0.005	mg/L	N/A	2016-09-09	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-09-09	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Barium, dissolved	**0.017**	N/A	0.005	mg/L	N/A	2016-09-09	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Boron, dissolved	**0.008**	N/A	0.004	mg/L	N/A	2016-09-09	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-09	
Calcium, dissolved	**16.4**	N/A	0.2	mg/L	N/A	2016-09-09	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-09	
Copper, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-09-09	
Iron, dissolved	**0.019**	N/A	0.010	mg/L	N/A	2016-09-09	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-09-09	
Magnesium, dissolved	**2.68**	N/A	0.01	mg/L	N/A	2016-09-09	
Manganese, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-09-09	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-06	2016-09-08	
Molybdenum, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	2016-09-09	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-09	
Potassium, dissolved	**1.50**	N/A	0.02	mg/L	N/A	2016-09-09	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Silicon, dissolved	**7.3**	N/A	0.5	mg/L	N/A	2016-09-09	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-09	
Sodium, dissolved	**7.35**	N/A	0.02	mg/L	N/A	2016-09-09	
Strontium, dissolved	**0.093**	N/A	0.001	mg/L	N/A	2016-09-09	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-09	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-09	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-09	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090440
REPORTED 2016-09-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6090440-01) [Water] Sampled: 2016-09-07 14:20, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-09-09	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-09	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-09	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Total Metals							
Aluminum, total	**0.049**	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Barium, total	**0.015**	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Boron, total	**0.012**	N/A	0.004	mg/L	2016-09-08	2016-09-08	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-08	2016-09-08	
Calcium, total	**17.1**	N/A	0.2	mg/L	2016-09-08	2016-09-08	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-08	2016-09-08	
Copper, total	**0.0011**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Iron, total	**0.06**	N/A	0.01	mg/L	2016-09-08	2016-09-08	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Lithium, total	**0.0010**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Magnesium, total	**2.72**	N/A	0.01	mg/L	2016-09-08	2016-09-08	
Manganese, total	**0.0036**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-06	2016-09-08	
Molybdenum, total	**0.0006**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Potassium, total	**1.56**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Silicon, total	**7.3**	N/A	0.5	mg/L	2016-09-08	2016-09-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-08	2016-09-08	
Sodium, total	**8.27**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Strontium, total	**0.091**	N/A	0.001	mg/L	2016-09-08	2016-09-08	
Sulfur, total	**2**	N/A	1	mg/L	2016-09-08	2016-09-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-08	2016-09-08	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Uranium, total	**0.00003**	N/A	0.00002	mg/L	2016-09-08	2016-09-08	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-08	2016-09-08	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-08	2016-09-08	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Microbiological Parameters							
Coliforms, Fecal	**30**	N/A	2	MPN/100 mL		2016-09-08	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6090440-01) [Water] Sampled: 2016-09-07 14:20, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**17**	N/A	2	MPN/100 mL		2016-09-08	
Sample ID: NA-1 (North Alouette River) (6090440-02) [Water] Sampled: 2016-09-07 14:45							
Anions							
Nitrate (as N)	**0.117**	N/A	0.010	mg/L	N/A	2016-09-09	
General Parameters							
Alkalinity, Total (as CaCO3)	**7**	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Bicarbonate (as CaCO3)	**7**	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Calculated Parameters							
Hardness, Total (as CaCO3)	**8.40**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.040**	N/A	0.005	mg/L	N/A	2016-09-09	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-09	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Boron, dissolved	**0.006**	N/A	0.004	mg/L	N/A	2016-09-09	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-09-09	
Calcium, dissolved	**2.8**	N/A	0.2	mg/L	N/A	2016-09-09	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-09	
Copper, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	2016-09-09	
Iron, dissolved	**0.023**	N/A	0.010	mg/L	N/A	2016-09-09	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Magnesium, dissolved	**0.37**	N/A	0.01	mg/L	N/A	2016-09-09	
Manganese, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	2016-09-09	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-06	2016-09-08	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	2016-09-09	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-09	
Potassium, dissolved	**0.20**	N/A	0.02	mg/L	N/A	2016-09-09	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Silicon, dissolved	**2.2**	N/A	0.5	mg/L	N/A	2016-09-09	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-09	
Sodium, dissolved	**1.21**	N/A	0.02	mg/L	N/A	2016-09-09	
Strontium, dissolved	**0.011**	N/A	0.001	mg/L	N/A	2016-09-09	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-09-09	

SAMPLE ANALYTICAL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6090440
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-15

Sample ID: NA-1 (North Alouette River) (6090440-02) [Water] Sampled: 2016-09-07 14:45, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-09	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-09	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-09	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-09	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-09	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Total Metals							
Aluminum, total	**0.040**	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Boron, total	**0.006**	N/A	0.004	mg/L	2016-09-08	2016-09-08	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-08	2016-09-08	
Calcium, total	**2.9**	N/A	0.2	mg/L	2016-09-08	2016-09-08	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-08	2016-09-08	
Copper, total	**0.0006**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Iron, total	**0.03**	N/A	0.01	mg/L	2016-09-08	2016-09-08	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Magnesium, total	**0.37**	N/A	0.01	mg/L	2016-09-08	2016-09-08	
Manganese, total	**0.0011**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-06	2016-09-08	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Potassium, total	**0.22**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Silicon, total	**2.3**	N/A	0.5	mg/L	2016-09-08	2016-09-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-08	2016-09-08	
Sodium, total	**1.62**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Strontium, total	**0.011**	N/A	0.001	mg/L	2016-09-08	2016-09-08	
Sulfur, total	< 1	N/A	1	mg/L	2016-09-08	2016-09-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-08	2016-09-08	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-08	2016-09-08	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-08	2016-09-08	

Sample ID: NA-1 (North Alouette River) (6090440-02) [Water] Sampled: 2016-09-07 14:45, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-08	2016-09-08	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Microbiological Parameters							
Coliforms, Fecal	**30**	N/A	2	MPN/100 mL		2016-09-08	
E. coli (MPN)	**23**	N/A	2	MPN/100 mL		2016-09-08	

Sample ID: FR-1 (227 St Creek) (6090440-03) [Water] Sampled: 2016-09-07 13:35

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.819**	N/A	0.010	mg/L	N/A	2016-09-09	
General Parameters							
Alkalinity, Total (as CaCO3)	**105**	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Bicarbonate (as CaCO3)	**105**	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-11	
Calculated Parameters							
Hardness, Total (as CaCO3)	**105**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.014**	N/A	0.005	mg/L	N/A	2016-09-09	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-09	
Arsenic, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	2016-09-09	
Barium, dissolved	**0.015**	N/A	0.005	mg/L	N/A	2016-09-09	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Boron, dissolved	**0.058**	N/A	0.004	mg/L	N/A	2016-09-09	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-09	
Calcium, dissolved	**26.2**	N/A	0.2	mg/L	N/A	2016-09-09	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	
Cobalt, dissolved	**0.00012**	N/A	0.00005	mg/L	N/A	2016-09-09	
Copper, dissolved	**0.0043**	N/A	0.0002	mg/L	N/A	2016-09-09	
Iron, dissolved	**0.194**	N/A	0.010	mg/L	N/A	2016-09-09	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Lithium, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	2016-09-09	
Magnesium, dissolved	**9.48**	N/A	0.01	mg/L	N/A	2016-09-09	
Manganese, dissolved	**0.0527**	N/A	0.0002	mg/L	N/A	2016-09-09	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-06	2016-09-08	
Molybdenum, dissolved	**0.0024**	N/A	0.0001	mg/L	N/A	2016-09-09	
Nickel, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-09	
Phosphorus, dissolved	**0.03**	N/A	0.02	mg/L	N/A	2016-09-09	
Potassium, dissolved	**3.24**	N/A	0.02	mg/L	N/A	2016-09-09	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-09	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6090440-03) [Water] Sampled: 2016-09-07 13:35, Continued							
Dissolved Metals, Continued							
Silicon, dissolved	**6.2**	N/A	0.5	mg/L	N/A	2016-09-09	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-09	
Sodium, dissolved	**24.2**	N/A	0.02	mg/L	N/A	2016-09-09	
Strontium, dissolved	**0.146**	N/A	0.001	mg/L	N/A	2016-09-09	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-09	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-09	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-09	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-09	
Uranium, dissolved	**0.00007**	N/A	0.00002	mg/L	N/A	2016-09-09	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-09	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-09	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-09	
Total Metals							
Aluminum, total	**0.217**	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Arsenic, total	**0.0010**	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Barium, total	**0.015**	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Boron, total	**0.057**	N/A	0.004	mg/L	2016-09-08	2016-09-08	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-09-08	2016-09-08	
Calcium, total	**26.4**	N/A	0.2	mg/L	2016-09-08	2016-09-08	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Cobalt, total	**0.00019**	N/A	0.00005	mg/L	2016-09-08	2016-09-08	
Copper, total	**0.0047**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Iron, total	**0.52**	N/A	0.01	mg/L	2016-09-08	2016-09-08	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Magnesium, total	**9.34**	N/A	0.01	mg/L	2016-09-08	2016-09-08	
Manganese, total	**0.0570**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-06	2016-09-08	
Molybdenum, total	**0.0023**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Nickel, total	**0.0011**	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Potassium, total	**3.29**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-08	2016-09-08	
Silicon, total	**6.4**	N/A	0.5	mg/L	2016-09-08	2016-09-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-08	2016-09-08	
Sodium, total	**25.9**	N/A	0.02	mg/L	2016-09-08	2016-09-08	
Strontium, total	**0.148**	N/A	0.001	mg/L	2016-09-08	2016-09-08	
Sulfur, total	**2**	N/A	1	mg/L	2016-09-08	2016-09-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-08	2016-09-08	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090440
REPORTED 2016-09-15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6090440-03) [Water] Sampled: 2016-09-07 13:35, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-08	2016-09-08	
Titanium, total	**0.008**	N/A	0.005	mg/L	2016-09-08	2016-09-08	
Uranium, total	**0.00008**	N/A	0.00002	mg/L	2016-09-08	2016-09-08	
Vanadium, total	**0.001**	N/A	0.001	mg/L	2016-09-08	2016-09-08	
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-09-08	2016-09-08	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	2016-09-08	2016-09-08	
Microbiological Parameters							
Coliforms, Fecal	**300**	N/A	2	MPN/100 mL		2016-09-08	
E. coli (MPN)	**300**	N/A	2	MPN/100 mL		2016-09-08	
Sample ID: Field Blank (6090440-04) [Water] Sampled: 2016-09-07 14:45							
Anions							
Nitrate (as N)	< 0.010	N/A	0.010	mg/L	N/A	2016-09-09	

APPENDIX 1: QUALITY CONTROL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6090440
REPORTED 2016-09-15

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6I0524										
Blank (B6I0524-BLK1)				Prepared: 2016-09-09, Analyzed: 2016-09-09						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I0524-BLK2)				Prepared: 2016-09-10, Analyzed: 2016-09-10						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6I0524-BS1)				Prepared: 2016-09-09, Analyzed: 2016-09-09						
Nitrate (as N)	3.96	0.010	mg/L	4.00		99	93-108			
LCS (B6I0524-BS2)				Prepared: 2016-09-10, Analyzed: 2016-09-10						
Nitrate (as N)	3.99	0.010	mg/L	4.00		100	93-108			
Dissolved Metals, Batch B6I0278										
Blank (B6I0278-BLK1)				Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Duplicate (B6I0278-DUP1)	**Source: 6090440-01**			Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B6I0278-MS1)	**Source: 6090440-02**			Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, dissolved	0.00025	0.00002	mg/L	0.000250	< 0.00002	99	70-130			
Reference (B6I0278-SRM1)				Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, dissolved	0.00493	0.00002	mg/L	0.00486		101	50-150			
Dissolved Metals, Batch B6I0488										
Blank (B6I0488-BLK1)				Prepared: 2016-09-09, Analyzed: 2016-09-09						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B6I0488, Continued										
Blank (B6I0488-BLK1), Continued				Prepared: 2016-09-09, Analyzed: 2016-09-09						
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Duplicate (B6I0488-DUP1)	**Source: 6090440-01**			Prepared: 2016-09-09, Analyzed: 2016-09-09						
Aluminum, dissolved	0.018	0.005	mg/L		0.018				11	
Antimony, dissolved	0.0001	0.0001	mg/L		0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.016	0.005	mg/L		0.017				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.008	0.004	mg/L		0.008				13	
Cadmium, dissolved	< 0.00001	0.00001	mg/L		< 0.00001				27	
Calcium, dissolved	16.3	0.2	mg/L		16.4			< 1	8	
Chromium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				14	
Cobalt, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				10	
Copper, dissolved	0.0010	0.0002	mg/L		0.0010			4	28	
Iron, dissolved	0.019	0.010	mg/L		0.019				14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0003	0.0001	mg/L		0.0003				14	
Magnesium, dissolved	2.69	0.01	mg/L		2.68			< 1	6	
Manganese, dissolved	0.0015	0.0002	mg/L		0.0007			75	9	RPD
Molybdenum, dissolved	0.0007	0.0001	mg/L		0.0006			4	19	
Nickel, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				21	
Phosphorus, dissolved	< 0.02	0.02	mg/L		< 0.02				14	
Potassium, dissolved	1.50	0.02	mg/L		1.50			< 1	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	7.2	0.5	mg/L		7.3			< 1	12	

Dissolved Metals, Batch B6I0488, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Duplicate (B6I0488-DUP1), Continued	**Source: 6090440-01**			Prepared: 2016-09-09, Analyzed: 2016-09-09						
Silver, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	7.50	0.02	mg/L		7.35			2	6	
Strontium, dissolved	0.092	0.001	mg/L		0.093			1	6	
Sulfur, dissolved	2	1	mg/L		2				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	0.00003	0.00002	mg/L		0.00003				14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		< 0.004				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	
Matrix Spike (B6I0488-MS1)	**Source: 6090440-02**			Prepared: 2016-09-09, Analyzed: 2016-09-09						
Antimony, dissolved	0.419	0.0001	mg/L	0.400	< 0.0001	105	76-114			
Arsenic, dissolved	0.219	0.0005	mg/L	0.200	< 0.0005	110	81-115			
Barium, dissolved	1.11	0.005	mg/L	1.00	< 0.005	110	80-113			
Beryllium, dissolved	0.106	0.0001	mg/L	0.100	< 0.0001	106	69-109			
Cadmium, dissolved	0.105	0.00001	mg/L	0.100	0.00001	105	83-110			
Chromium, dissolved	0.407	0.0005	mg/L	0.400	< 0.0005	102	85-115			
Cobalt, dissolved	0.417	0.00005	mg/L	0.400	< 0.00005	104	86-114			
Copper, dissolved	0.431	0.0002	mg/L	0.400	0.0006	108	82-119			
Iron, dissolved	2.23	0.010	mg/L	2.00	0.023	111	80-116			
Lead, dissolved	0.215	0.0001	mg/L	0.200	< 0.0001	107	83-112			
Manganese, dissolved	0.412	0.0002	mg/L	0.400	0.0008	103	62-131			
Nickel, dissolved	0.409	0.0002	mg/L	0.400	< 0.0002	102	81-115			
Selenium, dissolved	0.109	0.0005	mg/L	0.100	< 0.0005	109	79-115			
Silver, dissolved	0.110	0.00005	mg/L	0.100	< 0.00005	110	69-121			
Thallium, dissolved	0.106	0.00002	mg/L	0.100	< 0.00002	106	84-115			
Vanadium, dissolved	0.396	0.001	mg/L	0.400	< 0.001	99	83-113			
Zinc, dissolved	1.13	0.004	mg/L	1.00	< 0.004	113	82-115			
Reference (B6I0488-SRM1)				Prepared: 2016-09-09, Analyzed: 2016-09-09						
Aluminum, dissolved	0.220	0.005	mg/L	0.233		94	58-142			
Antimony, dissolved	0.0441	0.0001	mg/L	0.0430		103	75-125			
Arsenic, dissolved	0.437	0.0005	mg/L	0.438		100	81-119			
Barium, dissolved	3.50	0.005	mg/L	3.35		104	83-117			
Beryllium, dissolved	0.219	0.0001	mg/L	0.213		103	80-120			
Boron, dissolved	1.71	0.004	mg/L	1.74		98	74-117			
Cadmium, dissolved	0.216	0.00001	mg/L	0.224		96	83-117			
Calcium, dissolved	7.8	0.2	mg/L	7.69		102	76-124			
Chromium, dissolved	0.407	0.0005	mg/L	0.437		93	81-119			
Cobalt, dissolved	0.123	0.00005	mg/L	0.128		96	76-124			
Copper, dissolved	0.814	0.0002	mg/L	0.844		96	84-116			
Iron, dissolved	1.29	0.010	mg/L	1.29		100	74-126			
Lead, dissolved	0.114	0.0001	mg/L	0.112		101	72-128			
Lithium, dissolved	0.112	0.0001	mg/L	0.104		108	60-140			
Magnesium, dissolved	6.84	0.01	mg/L	6.92		99	81-119			
Manganese, dissolved	0.330	0.0002	mg/L	0.345		96	84-116			
Molybdenum, dissolved	0.428	0.0001	mg/L	0.426		100	83-117			
Nickel, dissolved	0.804	0.0002	mg/L	0.840		96	74-126			
Phosphorus, dissolved	0.48	0.02	mg/L	0.495		97	68-132			
Potassium, dissolved	3.10	0.02	mg/L	3.19		97	74-126			
Selenium, dissolved	0.0323	0.0005	mg/L	0.0331		97	70-130			
Sodium, dissolved	17.7	0.02	mg/L	19.1		93	72-128			
Strontium, dissolved	0.885	0.001	mg/L	0.916		97	84-113			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090440
REPORTED 2016-09-15

Dissolved Metals, Batch B6I0488, Continued

Reference (B6I0488-SRM1), Continued Prepared: 2016-09-09, Analyzed: 2016-09-09

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Thallium, dissolved	0.0392	0.00002	mg/L	0.0393		100	57-143			
Uranium, dissolved	0.262	0.00002	mg/L	0.266		98	85-115			
Vanadium, dissolved	0.793	0.001	mg/L	0.869		91	87-113			
Zinc, dissolved	0.893	0.004	mg/L	0.881		101	72-128			

General Parameters, Batch B6I0579

Blank (B6I0579-BLK1) Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6I0579-BLK2) Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6I0579-BLK3) Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6I0579-BLK4) Prepared: 2016-09-12, Analyzed: 2016-09-12

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6I0579-BS1) Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			

LCS (B6I0579-BS3) Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	103	2	mg/L	100		103	96-108			

LCS (B6I0579-BS5) Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			

LCS (B6I0579-BS7) Prepared: 2016-09-12, Analyzed: 2016-09-12

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			

Duplicate (B6I0579-DUP1) **Source: 6090440-01** Prepared: 2016-09-11, Analyzed: 2016-09-11

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	45	2	mg/L		45			< 1	10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L		< 1				10	
Alkalinity, Bicarbonate (as CaCO3)	45	2	mg/L		45			< 1	10	
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L		< 1				10	
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L		< 1				10	

Total Metals, Batch B6I0279

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6I0279, Continued										
Blank (B6I0279-BLK1)				Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, total	< 0.00002	0.00002	mg/L							
Duplicate (B6I0279-DUP1)		**Source: 6090440-01**		Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B6I0279-MS1)		**Source: 6090440-02**		Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, total	0.00023	0.00002	mg/L	0.000250	< 0.00002	91	70-130			
Reference (B6I0279-SRM1)				Prepared: 2016-09-06, Analyzed: 2016-09-08						
Mercury, total	0.00476	0.00002	mg/L	0.00486		98	50-150			
Total Metals, Batch B6I0404										
Blank (B6I0404-BLK1)				Prepared: 2016-09-08, Analyzed: 2016-09-08						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Reference (B6I0404-SRM1)				Prepared: 2016-09-08, Analyzed: 2016-09-08						
Aluminum, total	0.305	0.005	mg/L	0.303		101	81-129			
Antimony, total	0.0534	0.0001	mg/L	0.0511		105	88-114			
Arsenic, total	0.124	0.0005	mg/L	0.118		105	88-114			
Barium, total	0.821	0.005	mg/L	0.823		100	72-104			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090440
REPORTED 2016-09-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6I0404, Continued										
Reference (B6I0404-SRM1), Continued				Prepared: 2016-09-08, Analyzed: 2016-09-08						
Beryllium, total	0.0490	0.0001	mg/L	0.0496		99	76-131			
Boron, total	3.43	0.004	mg/L	3.45		99	75-121			
Cadmium, total	0.0506	0.00001	mg/L	0.0495		102	89-111			
Calcium, total	12.0	0.2	mg/L	11.6		103	86-121			
Chromium, total	0.262	0.0005	mg/L	0.250		105	89-114			
Cobalt, total	0.0399	0.00005	mg/L	0.0377		106	91-113			
Copper, total	0.526	0.0002	mg/L	0.486		108	91-115			
Iron, total	0.54	0.01	mg/L	0.488		111	77-124			
Lead, total	0.207	0.0001	mg/L	0.204		101	92-113			
Lithium, total	0.370	0.0001	mg/L	0.403		92	85-115			
Magnesium, total	4.25	0.01	mg/L	3.79		112	78-120			
Manganese, total	0.110	0.0002	mg/L	0.109		101	90-114			
Molybdenum, total	0.209	0.0001	mg/L	0.198		105	90-111			
Nickel, total	0.261	0.0002	mg/L	0.249		105	90-111			
Phosphorus, total	0.24	0.02	mg/L	0.227		105	85-115			
Potassium, total	8.10	0.02	mg/L	7.21		112	84-113			
Selenium, total	0.132	0.0005	mg/L	0.121		109	85-115			
Sodium, total	8.32	0.02	mg/L	7.54		110	82-123			
Strontium, total	0.394	0.001	mg/L	0.375		105	88-112			
Thallium, total	0.0837	0.00002	mg/L	0.0805		104	91-114			
Uranium, total	0.0302	0.00002	mg/L	0.0306		99	85-120			
Vanadium, total	0.398	0.001	mg/L	0.386		103	86-111			
Zinc, total	2.67	0.004	mg/L	2.49		107	85-111			

QC Qualifiers:

RPD Relative percent difference (RPD) of duplicate analysis are outside of control limits for unknown reason(s).

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6090440
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-15

		6090440-01	6090440-02	6090440-03	6090440-04
		Water	**Water**	**Water**	**Water**
		2016-09-07	**2016-09-07**	**2016-09-07**	**2016-09-07**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	1.08	0.117	0.819	< 0.010
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	45	7	105	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	45	7	105	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	52.1	8.40	105	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.018	0.040	0.014	
	Antimony, dissolved (mg/L)	0.0001	< 0.0001	0.0002	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	0.0008	
	Barium, dissolved (mg/L)	0.017	< 0.005	0.015	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.008	0.006	0.058	
	Cadmium, dissolved (mg/L)	< 0.00001	0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	16.4	2.8	26.2	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00012	
	Copper, dissolved (mg/L)	0.0010	0.0006	0.0043	
	Iron, dissolved (mg/L)	0.019	0.023	0.194	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0003	< 0.0001	0.0007	
	Magnesium, dissolved (mg/L)	2.68	0.37	9.48	
	Manganese, dissolved (mg/L)	0.0007	0.0008	0.0527	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0006	0.0004	0.0024	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0009	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	0.03	
	Potassium, dissolved (mg/L)	1.50	0.20	3.24	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	7.3	2.2	6.2	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	7.35	1.21	24.2	
	Strontium, dissolved (mg/L)	0.093	0.011	0.146	
	Sulfur, dissolved (mg/L)	2	< 1	2	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00003	< 0.00002	0.00007	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	

		6090440-01	6090440-02	6090440-03	6090440-04
		Water	**Water**	**Water**	**Water**
		2016-09-07	**2016-09-07**	**2016-09-07**	**2016-09-07**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.049	0.040	0.217	
	Antimony, total (mg/L)	< 0.0001	< 0.0001	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0010	
	Barium, total (mg/L)	0.015	< 0.005	0.015	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.012	0.006	0.057	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00002	
	Calcium, total (mg/L)	17.1	2.9	26.4	
	Chromium, total (mg/L)	< 0.0005	< 0.0005	0.0005	
	Cobalt, total (mg/L)	< 0.00005	< 0.00005	0.00019	
	Copper, total (mg/L)	0.0011	0.0006	0.0047	
	Iron, total (mg/L)	0.06	0.03	0.52	
	Lead, total (mg/L)	< 0.0001	0.0001	0.0001	
	Lithium, total (mg/L)	0.0010	0.0002	0.0009	
	Magnesium, total (mg/L)	2.72	0.37	9.34	
	Manganese, total (mg/L)	0.0036	0.0011	0.0570	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0006	0.0003	0.0023	
	Nickel, total (mg/L)	< 0.0002	< 0.0002	0.0011	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.06	
	Potassium, total (mg/L)	1.56	0.22	3.29	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	7.3	2.3	6.4	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	8.27	1.62	25.9	
	Strontium, total (mg/L)	0.091	0.011	0.148	
	Sulfur, total (mg/L)	2	< 1	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.008	
	Uranium, total (mg/L)	0.00003	< 0.00002	0.00008	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.001	
	Zinc, total (mg/L)	< 0.004	< 0.004	0.005	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0001	
Microbiological Parameters	Coliforms, Fecal (MPN/100 mL)	30	30	300	
	E. coli (MPN) (MPN/100 mL)	17	23	300	

CA

ANAL

Caring Ab

6090440

BC V6V 2K9
-1599
BC V1X 5C3
-3893
AB T5S 1H7
9700

CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC# ______ PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning	DATE: 07-Sep-16 TIME: 16:20	RECEIVED BY: HM WI	DATE: 07-Sep-16 TIME: 16:23
PROJECT: 173.191 Blaney ISMP		PROJECT INFO: Stormwater Monitoring	

REPORT TO:

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐
EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

INVOICE TO: SAME AS REPORT TO ☐

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

TURNAROUND TIME REQUESTED:

Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other* ______
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION: Regs on Report? ☒

Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

ANALYSES REQUESTED:

No Total Coliforms

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	MATRIX: OTHER WATER	MATRIX: SOIL	MATRIX: OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	SAMPLING: TIME HH:MM	COMMENTS: CHLORINATED	COMMENTS: FILTERED	COMMENTS: PRESERVED	COMMENTS: (e.g. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ E. coli ☒	ASBESTOS	Nitrate - N							HOLD
BL-1 (Anderson Creek)		✓			6	07-Sep-16	14:20												✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)		✓			6	07-Sep-16	14:45												✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)		✓			6	07-Sep-16	13:35												✓	✓		✓				✓	✓		✓							
Field Blank		✓			1	07-Sep-16	14:45																						✓							
Trip Blank		✓			1	07-Sep-16	12:30																													✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐

Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):

60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply): ______

*** OTHER INSTRUCTIONS:**

Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:

CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:

COOLER 1 (°C): 5.1 ICE: Y ☐ N ☐
COOLER 2 (°C): ______ ICE: Y ☐ N ☐
COOLER 3 (°C): ______ ICE: Y ☐ N ☐
CUSTODY SEALS INTACT:

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6090754
PO NUMBER		**RECEIVED / TEMP**	2016-09-12 14:25 / 9°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-19
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6090754
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-19

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6090754
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-19

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221 E	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090754
REPORTED 2016-09-19

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6090754-01) [Water] Sampled: 2016-09-12 12:30							
Anions							
Nitrate (as N)	**1.05**	N/A	0.010	mg/L	N/A	2016-09-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**48**	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Bicarbonate (as CaCO3)	**48**	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Calculated Parameters							
Hardness, Total (as CaCO3)	**54.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.017**	N/A	0.005	mg/L	N/A	2016-09-14	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-09-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Barium, dissolved	**0.016**	N/A	0.005	mg/L	N/A	2016-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Boron, dissolved	**0.015**	N/A	0.004	mg/L	N/A	2016-09-14	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-14	
Calcium, dissolved	**16.9**	N/A	0.2	mg/L	N/A	2016-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-14	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-14	
Iron, dissolved	**0.015**	N/A	0.010	mg/L	N/A	2016-09-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-09-14	
Magnesium, dissolved	**2.95**	N/A	0.01	mg/L	N/A	2016-09-14	
Manganese, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	2016-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-15	2016-09-15	
Molybdenum, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	2016-09-14	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-14	
Potassium, dissolved	**1.54**	N/A	0.02	mg/L	N/A	2016-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Silicon, dissolved	**8.4**	N/A	0.5	mg/L	N/A	2016-09-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-14	
Sodium, dissolved	**8.84**	N/A	0.02	mg/L	N/A	2016-09-14	
Strontium, dissolved	**0.096**	N/A	0.001	mg/L	N/A	2016-09-14	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-14	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: BL-1 (Anderson Creek) (6090754-01) [Water] Sampled: 2016-09-12 12:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Total Metals							
Aluminum, total	**0.042**	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Barium, total	**0.016**	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Boron, total	**0.018**	N/A	0.004	mg/L	2016-09-13	2016-09-14	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-13	2016-09-14	
Calcium, total	**19.2**	N/A	0.2	mg/L	2016-09-13	2016-09-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-13	2016-09-14	
Copper, total	**0.0010**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Iron, total	**0.05**	N/A	0.01	mg/L	2016-09-13	2016-09-14	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Magnesium, total	**3.04**	N/A	0.01	mg/L	2016-09-13	2016-09-14	
Manganese, total	**0.0029**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-15	2016-09-15	
Molybdenum, total	**0.0006**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Potassium, total	**1.55**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Silicon, total	**8.3**	N/A	0.5	mg/L	2016-09-13	2016-09-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-13	2016-09-14	
Sodium, total	**8.92**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Strontium, total	**0.098**	N/A	0.001	mg/L	2016-09-13	2016-09-14	
Sulfur, total	**2**	N/A	1	mg/L	2016-09-13	2016-09-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-13	2016-09-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	2016-09-13	2016-09-14	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-13	2016-09-14	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-13	2016-09-14	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**23**	N/A	3.0	MPN/100 mL	N/A	2016-09-13	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090754
REPORTED 2016-09-19

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6090754-01) [Water] Sampled: 2016-09-12 12:30, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-09-13	
Sample ID: NA-1 (North Alouette River) (6090754-02) [Water] Sampled: 2016-09-12 12:50							
Anions							
Nitrate (as N)	**0.115**	N/A	0.010	mg/L	N/A	2016-09-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**8**	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Bicarbonate (as CaCO3)	**8**	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Calculated Parameters							
Hardness, Total (as CaCO3)	**8.27**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.041**	N/A	0.005	mg/L	N/A	2016-09-14	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-14	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-09-14	
Calcium, dissolved	**2.7**	N/A	0.2	mg/L	N/A	2016-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-14	
Copper, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-09-14	
Iron, dissolved	**0.019**	N/A	0.010	mg/L	N/A	2016-09-14	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-09-14	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Magnesium, dissolved	**0.38**	N/A	0.01	mg/L	N/A	2016-09-14	
Manganese, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	2016-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-15	2016-09-15	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	2016-09-14	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-14	
Potassium, dissolved	**0.21**	N/A	0.02	mg/L	N/A	2016-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Silicon, dissolved	**2.6**	N/A	0.5	mg/L	N/A	2016-09-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-14	
Sodium, dissolved	**1.41**	N/A	0.02	mg/L	N/A	2016-09-14	
Strontium, dissolved	**0.012**	N/A	0.001	mg/L	N/A	2016-09-14	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-09-14	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6090754-02) [Water] Sampled: 2016-09-12 12:50, Continued							
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-14	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Total Metals							
Aluminum, total	**0.040**	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Boron, total	**0.006**	N/A	0.004	mg/L	2016-09-13	2016-09-14	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-13	2016-09-14	
Calcium, total	**3.0**	N/A	0.2	mg/L	2016-09-13	2016-09-14	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-13	2016-09-14	
Copper, total	**0.0020**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Iron, total	**0.02**	N/A	0.01	mg/L	2016-09-13	2016-09-14	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Magnesium, total	**0.38**	N/A	0.01	mg/L	2016-09-13	2016-09-14	
Manganese, total	**0.0009**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-15	2016-09-15	
Molybdenum, total	**0.0004**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Potassium, total	**0.21**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Silicon, total	**2.6**	N/A	0.5	mg/L	2016-09-13	2016-09-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-13	2016-09-14	
Sodium, total	**1.36**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Strontium, total	**0.012**	N/A	0.001	mg/L	2016-09-13	2016-09-14	
Sulfur, total	< 1	N/A	1	mg/L	2016-09-13	2016-09-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-13	2016-09-14	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-13	2016-09-14	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-13	2016-09-14	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6090754-02) [Water] Sampled: 2016-09-12 12:50, Continued							
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-13	2016-09-14	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**15**	N/A	3.0	MPN/100 mL	N/A	2016-09-13	
E. coli (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-09-13	
Sample ID: FR-1 (227 St Creek) (6090754-03) [Water] Sampled: 2016-09-12 11:50							
Anions							
Nitrate (as N)	**0.776**	N/A	0.010	mg/L	N/A	2016-09-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**101**	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Bicarbonate (as CaCO3)	**101**	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-15	
Calculated Parameters							
Hardness, Total (as CaCO3)	**90.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.015**	N/A	0.005	mg/L	N/A	2016-09-14	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-14	
Arsenic, dissolved	**0.0009**	N/A	0.0005	mg/L	N/A	2016-09-14	
Barium, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-09-14	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Boron, dissolved	**0.065**	N/A	0.004	mg/L	N/A	2016-09-14	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	2016-09-14	
Calcium, dissolved	**21.9**	N/A	0.2	mg/L	N/A	2016-09-14	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	
Cobalt, dissolved	**0.00013**	N/A	0.00005	mg/L	N/A	2016-09-14	
Copper, dissolved	**0.0035**	N/A	0.0002	mg/L	N/A	2016-09-14	
Iron, dissolved	**0.219**	N/A	0.010	mg/L	N/A	2016-09-14	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Lithium, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	2016-09-14	
Magnesium, dissolved	**8.59**	N/A	0.01	mg/L	N/A	2016-09-14	
Manganese, dissolved	**0.0505**	N/A	0.0002	mg/L	N/A	2016-09-14	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-15	2016-09-15	
Molybdenum, dissolved	**0.0023**	N/A	0.0001	mg/L	N/A	2016-09-14	
Nickel, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-09-14	
Phosphorus, dissolved	**0.03**	N/A	0.02	mg/L	N/A	2016-09-14	
Potassium, dissolved	**2.94**	N/A	0.02	mg/L	N/A	2016-09-14	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-14	

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PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090754
REPORTED 2016-09-19

Sample ID: FR-1 (227 St Creek) (6090754-03) [Water] Sampled: 2016-09-12 11:50, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Silicon, dissolved	**6.7**	N/A	0.5	mg/L	N/A	2016-09-14	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-14	
Sodium, dissolved	**23.6**	N/A	0.02	mg/L	N/A	2016-09-14	
Strontium, dissolved	**0.130**	N/A	0.001	mg/L	N/A	2016-09-14	
Sulfur, dissolved	**1**	N/A	1	mg/L	N/A	2016-09-14	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-14	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-14	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-14	
Uranium, dissolved	**0.00006**	N/A	0.00002	mg/L	N/A	2016-09-14	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-14	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-14	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-14	
Total Metals							
Aluminum, total	**0.235**	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Arsenic, total	**0.0011**	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Barium, total	**0.013**	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Boron, total	**0.066**	N/A	0.004	mg/L	2016-09-13	2016-09-14	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-09-13	2016-09-14	
Calcium, total	**23.9**	N/A	0.2	mg/L	2016-09-13	2016-09-14	
Chromium, total	**0.0007**	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Cobalt, total	**0.00023**	N/A	0.00005	mg/L	2016-09-13	2016-09-14	
Copper, total	**0.0041**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Iron, total	**0.59**	N/A	0.01	mg/L	2016-09-13	2016-09-14	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Magnesium, total	**8.98**	N/A	0.01	mg/L	2016-09-13	2016-09-14	
Manganese, total	**0.0580**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-15	2016-09-15	
Molybdenum, total	**0.0024**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Nickel, total	**0.0013**	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Potassium, total	**3.04**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-13	2016-09-14	
Silicon, total	**6.7**	N/A	0.5	mg/L	2016-09-13	2016-09-14	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-13	2016-09-14	
Sodium, total	**23.6**	N/A	0.02	mg/L	2016-09-13	2016-09-14	
Strontium, total	**0.129**	N/A	0.001	mg/L	2016-09-13	2016-09-14	
Sulfur, total	**2**	N/A	1	mg/L	2016-09-13	2016-09-14	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-13	2016-09-14	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: FR-1 (227 St Creek) (6090754-03) [Water] Sampled: 2016-09-12 11:50, Continued

Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-13	2016-09-14	
Titanium, total	**0.011**	N/A	0.005	mg/L	2016-09-13	2016-09-14	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	2016-09-13	2016-09-14	
Vanadium, total	**0.001**	N/A	0.001	mg/L	2016-09-13	2016-09-14	
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-09-13	2016-09-14	
Zirconium, total	**0.0004**	N/A	0.0001	mg/L	2016-09-13	2016-09-14	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**1500**	N/A	3.0	MPN/100 mL	N/A	2016-09-13	
E. coli (MPN)	**430**	N/A	3.0	MPN/100 mL	N/A	2016-09-13	

Sample ID: Field Blank (6090754-04) [Water] Sampled: 2016-09-12 11:50

Microbiological Parameters							
Coliforms, Fecal (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-09-13	
E. coli (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-09-13	

APPENDIX 1: QUALITY CONTROL DATA

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6I0790										
Blank (B6I0790-BLK1)				Prepared: 2016-09-14, Analyzed: 2016-09-14						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I0790-BLK2)				Prepared: 2016-09-15, Analyzed: 2016-09-15						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I0790-BLK3)				Prepared: 2016-09-15, Analyzed: 2016-09-15						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6I0790-BS1)				Prepared: 2016-09-14, Analyzed: 2016-09-14						
Nitrate (as N)	3.99	0.010	mg/L	4.00		100	93-108			
LCS (B6I0790-BS2)				Prepared: 2016-09-15, Analyzed: 2016-09-15						
Nitrate (as N)	3.98	0.010	mg/L	4.00		100	93-108			
LCS (B6I0790-BS3)				Prepared: 2016-09-15, Analyzed: 2016-09-15						
Nitrate (as N)	3.99	0.010	mg/L	4.00		100	93-108			
Dissolved Metals, Batch B6I0675										
Blank (B6I0675-BLK1)				Prepared: 2016-09-14, Analyzed: 2016-09-14						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

Dissolved Metals, Batch B6I0675, Continued

Blank (B6I0675-BLK1), Continued Prepared: 2016-09-14, Analyzed: 2016-09-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							

Reference (B6I0675-SRM1) Prepared: 2016-09-14, Analyzed: 2016-09-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.225	0.005	mg/L	0.233		97	58-142			
Antimony, dissolved	0.0473	0.0001	mg/L	0.0430		110	75-125			
Arsenic, dissolved	0.441	0.0005	mg/L	0.438		101	81-119			
Barium, dissolved	3.30	0.005	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.208	0.0001	mg/L	0.213		97	80-120			
Boron, dissolved	1.79	0.004	mg/L	1.74		103	74-117			
Cadmium, dissolved	0.224	0.00001	mg/L	0.224		100	83-117			
Calcium, dissolved	7.6	0.2	mg/L	7.69		99	76-124			
Chromium, dissolved	0.441	0.0005	mg/L	0.437		101	81-119			
Cobalt, dissolved	0.133	0.00005	mg/L	0.128		104	76-124			
Copper, dissolved	0.918	0.0002	mg/L	0.844		109	84-116			
Iron, dissolved	1.38	0.010	mg/L	1.29		107	74-126			
Lead, dissolved	0.121	0.0001	mg/L	0.112		108	72-128			
Lithium, dissolved	0.105	0.0001	mg/L	0.104		101	60-140			
Magnesium, dissolved	6.91	0.01	mg/L	6.92		100	81-119			
Manganese, dissolved	0.344	0.0002	mg/L	0.345		100	84-116			
Molybdenum, dissolved	0.431	0.0001	mg/L	0.426		101	83-117			
Nickel, dissolved	0.864	0.0002	mg/L	0.840		103	74-126			
Phosphorus, dissolved	0.52	0.02	mg/L	0.495		104	68-132			
Potassium, dissolved	3.18	0.02	mg/L	3.19		100	74-126			
Selenium, dissolved	0.0361	0.0005	mg/L	0.0331		109	70-130			
Sodium, dissolved	19.8	0.02	mg/L	19.1		104	72-128			
Strontium, dissolved	0.885	0.001	mg/L	0.916		97	84-113			
Thallium, dissolved	0.0403	0.00002	mg/L	0.0393		103	57-143			
Uranium, dissolved	0.271	0.00002	mg/L	0.266		102	85-115			
Vanadium, dissolved	0.896	0.001	mg/L	0.869		103	87-113			
Zinc, dissolved	0.878	0.004	mg/L	0.881		100	72-128			

Dissolved Metals, Batch B6I0873

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B6I0873, Continued										
Blank (B6I0873-BLK1) Prepared: 2016-09-15, Analyzed: 2016-09-15										
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Reference (B6I0873-SRM1) Prepared: 2016-09-15, Analyzed: 2016-09-15										
Mercury, dissolved	0.00509	0.00002	mg/L	0.00486		105	50-150			
General Parameters, Batch B6I0838										
Blank (B6I0838-BLK1) Prepared: 2016-09-15, Analyzed: 2016-09-15										
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							
LCS (B6I0838-BS1) Prepared: 2016-09-15, Analyzed: 2016-09-15										
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			
Microbiological Parameters, Batch B6I0667										
Blank (B6I0667-BLK1) Prepared: 2016-09-13, Analyzed: 2016-09-13										
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							
Total Metals, Batch B6I0725										
Blank (B6I0725-BLK1) Prepared: 2016-09-13, Analyzed: 2016-09-14										
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							

Total Metals, Batch B6I0725, Continued

Blank (B6I0725-BLK1), Continued Prepared: 2016-09-13, Analyzed: 2016-09-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							

Reference (B6I0725-SRM1) Prepared: 2016-09-13, Analyzed: 2016-09-14

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.286	0.005	mg/L	0.303		94	81-129			
Antimony, total	0.0538	0.0001	mg/L	0.0511		105	88-114			
Arsenic, total	0.117	0.0005	mg/L	0.118		99	88-114			
Barium, total	0.794	0.005	mg/L	0.823		96	72-104			
Beryllium, total	0.0483	0.0001	mg/L	0.0496		97	76-131			
Boron, total	3.55	0.004	mg/L	3.45		103	75-121			
Cadmium, total	0.0491	0.00001	mg/L	0.0495		99	89-111			
Calcium, total	12.4	0.2	mg/L	11.6		107	86-121			
Chromium, total	0.253	0.0005	mg/L	0.250		101	89-114			
Cobalt, total	0.0394	0.00005	mg/L	0.0377		105	91-113			
Copper, total	0.537	0.0002	mg/L	0.486		110	91-115			
Iron, total	0.53	0.01	mg/L	0.488		109	77-124			
Lead, total	0.221	0.0001	mg/L	0.204		108	92-113			
Lithium, total	0.407	0.0001	mg/L	0.403		101	85-115			
Magnesium, total	3.98	0.01	mg/L	3.79		105	78-120			
Manganese, total	0.108	0.0002	mg/L	0.109		99	90-114			
Molybdenum, total	0.206	0.0001	mg/L	0.198		104	90-111			
Nickel, total	0.251	0.0002	mg/L	0.249		101	90-111			
Phosphorus, total	0.22	0.02	mg/L	0.227		97	85-115			
Potassium, total	7.71	0.02	mg/L	7.21		107	84-113			
Selenium, total	0.132	0.0005	mg/L	0.121		109	85-115			
Sodium, total	8.25	0.02	mg/L	7.54		109	82-123			
Strontium, total	0.374	0.001	mg/L	0.375		100	88-112			
Thallium, total	0.0910	0.00002	mg/L	0.0805		113	91-114			
Uranium, total	0.0303	0.00002	mg/L	0.0306		99	85-120			
Vanadium, total	0.374	0.001	mg/L	0.386		97	86-111			
Zinc, total	2.44	0.004	mg/L	2.49		98	85-111			

Total Metals, Batch B6I0874

Blank (B6I0874-BLK1) Prepared: 2016-09-15, Analyzed: 2016-09-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	< 0.00002	0.00002	mg/L							

Reference (B6I0874-SRM1) Prepared: 2016-09-15, Analyzed: 2016-09-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	0.00478	0.00002	mg/L	0.00486		98	50-150			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090754
REPORTED 2016-09-19

		6090754-01	6090754-02	6090754-03	6090754-04
		Water	**Water**	**Water**	**Water**
		2016-09-12	**2016-09-12**	**2016-09-12**	**2016-09-12**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	1.05	0.115	0.776	
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	48	8	101	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	48	8	101	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	54.4	8.27	90.1	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.017	0.041	0.015	
	Antimony, dissolved (mg/L)	0.0001	< 0.0001	0.0002	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	0.0009	
	Barium, dissolved (mg/L)	0.016	< 0.005	0.011	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.015	< 0.004	0.065	
	Cadmium, dissolved (mg/L)	< 0.00001	0.00001	0.00002	
	Calcium, dissolved (mg/L)	16.9	2.7	21.9	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00013	
	Copper, dissolved (mg/L)	0.0009	0.0007	0.0035	
	Iron, dissolved (mg/L)	0.015	0.019	0.219	
	Lead, dissolved (mg/L)	< 0.0001	0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0003	< 0.0001	0.0006	
	Magnesium, dissolved (mg/L)	2.95	0.38	8.59	
	Manganese, dissolved (mg/L)	0.0006	0.0006	0.0505	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0006	0.0004	0.0023	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0010	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	0.03	
	Potassium, dissolved (mg/L)	1.54	0.21	2.94	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	8.4	2.6	6.7	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	8.84	1.41	23.6	
	Strontium, dissolved (mg/L)	0.096	0.012	0.130	
	Sulfur, dissolved (mg/L)	2	< 1	1	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00003	< 0.00002	0.00006	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6090754
REPORTED 2016-09-19

		6090754-01	6090754-02	6090754-03	6090754-04
		Water	**Water**	**Water**	**Water**
		2016-09-12	**2016-09-12**	**2016-09-12**	**2016-09-12**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.042	0.040	0.235	
	Antimony, total (mg/L)	< 0.0001	< 0.0001	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0011	
	Barium, total (mg/L)	0.016	< 0.005	0.013	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.018	0.006	0.066	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00002	
	Calcium, total (mg/L)	19.2	3.0	23.9	
	Chromium, total (mg/L)	< 0.0005	< 0.0005	0.0007	
	Cobalt, total (mg/L)	< 0.00005	< 0.00005	0.00023	
	Copper, total (mg/L)	0.0010	0.0020	0.0041	
	Iron, total (mg/L)	0.05	0.02	0.59	
	Lead, total (mg/L)	< 0.0001	0.0002	0.0001	
	Lithium, total (mg/L)	0.0003	< 0.0001	0.0007	
	Magnesium, total (mg/L)	3.04	0.38	8.98	
	Manganese, total (mg/L)	0.0029	0.0009	0.0580	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0006	0.0004	0.0024	
	Nickel, total (mg/L)	< 0.0002	< 0.0002	0.0013	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.06	
	Potassium, total (mg/L)	1.55	0.21	3.04	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	8.3	2.6	6.7	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	8.92	1.36	23.6	
	Strontium, total (mg/L)	0.098	0.012	0.129	
	Sulfur, total (mg/L)	2	< 1	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.011	
	Uranium, total (mg/L)	0.00004	< 0.00002	0.00007	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.001	
	Zinc, total (mg/L)	< 0.004	< 0.004	0.005	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0004	
Microbiological Parameters	Coliforms, Fecal (MPN) (MPN/100 mL)	23	15	1500	< 3.0
	E. coli (MPN) (MPN/100 mL)	9.1	9.1	430	< 3.0

CARO ANALYTICAL
Caring About Results.

* 6 0 9 0 7 5 4 *

CHAIN OF CUSTODY RECORD

COC#

PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning	DATE: 12-Sep-16 TIME: 14:25	RECEIVED BY: HM WI	DATE: 12-Sep-16 TIME: 14:25
PROJECT: 173.191 Blaney ISMP		PROJECT INFO: Stormwater Monitoring	

REPORT TO:
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐ EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION: Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	MATRIX: OTHER WATER	MATRIX: SOIL	MATRIX: OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	SAMPLING: TIME HH:MM	COMMENTS: CHLORINATED	COMMENTS: FILTERED	COMMENTS: PRESERVED	COMMENTS: (e.g. flow/volume media ID/notes)
1	BL-1 (Anderson Creek)		✓			6	12-Sep-16	12:30				
2	NA-1 (North Alouette River)		✓			6	12-Sep-16	12:50				
3	FR-1 (227 St Creek)		✓			6	12-Sep-16	11:50				
4	Field Blank		✓			1	12-Sep-16	~~10:00~~	←			11:50
5	Trip Blank		✓			1	12-Sep-16	10:00				

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ *E. coli* ☒	ASBESTOS	Nitrate - N							HOLD
BL-1 (Anderson Creek)								✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)								✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)								✓	✓		✓				✓	✓		✓							
Field Blank															✓										
Trip Blank																									✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application: Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls.

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 8.9 ICE: Y ☐ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT: NA

CERTIFICATE OF ANALYSIS

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
200 - 4185A Still Creek Dr
Burnaby, BC V5C 6G9

TEL (604) 294-2088
FAX (604) 294-2090

ATTENTION Patrick Lilley
WORK ORDER 6091257

PO NUMBER
RECEIVED / TEMP 2016-09-16 17:06 / 5°C
PROJECT 173.191 Blaney, North Alouettem, Fraser River
REPORTED 2016-09-26
PROJECT INFO Stormwater Monitoring

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091257
REPORTED 2016-09-26

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6091257
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-26

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6091257-01) [Water] Sampled: 2016-09-16 12:00							
Anions							
Nitrate (as N)	**1.11**	N/A	0.010	mg/L	N/A	2016-09-20	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**52**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Bicarbonate (as CaCO3)	**52**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Calculated Parameters							
Hardness, Total (as CaCO3)	**52.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.015**	N/A	0.005	mg/L	N/A	2016-09-19	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-19	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Barium, dissolved	**0.015**	N/A	0.005	mg/L	N/A	2016-09-19	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Boron, dissolved	**0.011**	N/A	0.004	mg/L	N/A	2016-09-19	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-19	
Calcium, dissolved	**16.1**	N/A	0.2	mg/L	N/A	2016-09-19	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-19	
Copper, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	2016-09-19	
Iron, dissolved	**0.013**	N/A	0.010	mg/L	N/A	2016-09-19	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-09-19	
Magnesium, dissolved	**3.03**	N/A	0.01	mg/L	N/A	2016-09-19	
Manganese, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-09-19	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-21	2016-09-22	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	2016-09-19	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-19	
Potassium, dissolved	**1.40**	N/A	0.02	mg/L	N/A	2016-09-19	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Silicon, dissolved	**7.6**	N/A	0.5	mg/L	N/A	2016-09-19	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-19	
Sodium, dissolved	**8.31**	N/A	0.02	mg/L	N/A	2016-09-19	
Strontium, dissolved	**0.094**	N/A	0.001	mg/L	N/A	2016-09-19	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-19	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-19	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-19	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091257
REPORTED 2016-09-26

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6091257-01) [Water] Sampled: 2016-09-16 12:00, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00007**	N/A	0.00002	mg/L	N/A	2016-09-19	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-19	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-19	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Total Metals							
Aluminum, total	**0.042**	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Barium, total	**0.016**	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Boron, total	**0.016**	N/A	0.004	mg/L	2016-09-19	2016-09-20	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-19	2016-09-20	
Calcium, total	**17.8**	N/A	0.2	mg/L	2016-09-19	2016-09-20	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-19	2016-09-20	
Copper, total	**0.0011**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Iron, total	**0.04**	N/A	0.01	mg/L	2016-09-19	2016-09-20	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Magnesium, total	**3.32**	N/A	0.01	mg/L	2016-09-19	2016-09-20	
Manganese, total	**0.0025**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-21	2016-09-22	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Potassium, total	**1.61**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Silicon, total	**8.7**	N/A	0.5	mg/L	2016-09-19	2016-09-20	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-19	2016-09-20	
Sodium, total	**9.08**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Strontium, total	**0.102**	N/A	0.001	mg/L	2016-09-19	2016-09-20	
Sulfur, total	**3**	N/A	1	mg/L	2016-09-19	2016-09-20	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-19	2016-09-20	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	2016-09-19	2016-09-20	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-19	2016-09-20	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-19	2016-09-20	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Microbiological Parameters							
Coliforms, Fecal	**50**	N/A	2	MPN/100 mL		2016-09-17	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6091257-01) [Water] Sampled: 2016-09-16 12:00, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**50**	N/A	2	MPN/100 mL		2016-09-17	
Sample ID: NA-1 (North Alouette River) (6091257-02) [Water] Sampled: 2016-09-16 14:30							
Anions							
Nitrate (as N)	**0.132**	N/A	0.010	mg/L	N/A	2016-09-20	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**8**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Bicarbonate (as CaCO3)	**8**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Calculated Parameters							
Hardness, Total (as CaCO3)	**8.14**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.033**	N/A	0.005	mg/L	N/A	2016-09-19	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-19	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Boron, dissolved	**0.004**	N/A	0.004	mg/L	N/A	2016-09-19	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-19	
Calcium, dissolved	**2.6**	N/A	0.2	mg/L	N/A	2016-09-19	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Cobalt, dissolved	**0.00005**	N/A	0.00005	mg/L	N/A	2016-09-19	
Copper, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-09-19	
Iron, dissolved	**0.027**	N/A	0.010	mg/L	N/A	2016-09-19	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Magnesium, dissolved	**0.40**	N/A	0.01	mg/L	N/A	2016-09-19	
Manganese, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-19	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-21	2016-09-22	
Molybdenum, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	2016-09-19	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-19	
Potassium, dissolved	**0.20**	N/A	0.02	mg/L	N/A	2016-09-19	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Silicon, dissolved	**2.4**	N/A	0.5	mg/L	N/A	2016-09-19	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-19	
Sodium, dissolved	**1.46**	N/A	0.02	mg/L	N/A	2016-09-19	
Strontium, dissolved	**0.012**	N/A	0.001	mg/L	N/A	2016-09-19	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-09-19	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: NA-1 (North Alouette River) (6091257-02) [Water] Sampled: 2016-09-16 14:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-19	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-19	
Uranium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	2016-09-19	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-19	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-19	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Total Metals							
Aluminum, total	**0.040**	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Boron, total	**0.008**	N/A	0.004	mg/L	2016-09-19	2016-09-20	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-19	2016-09-20	
Calcium, total	**2.9**	N/A	0.2	mg/L	2016-09-19	2016-09-20	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-19	2016-09-20	
Copper, total	**0.0008**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Iron, total	**0.02**	N/A	0.01	mg/L	2016-09-19	2016-09-20	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Magnesium, total	**0.44**	N/A	0.01	mg/L	2016-09-19	2016-09-20	
Manganese, total	**0.0009**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-21	2016-09-22	
Molybdenum, total	**0.0004**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Potassium, total	**0.23**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Silicon, total	**2.9**	N/A	0.5	mg/L	2016-09-19	2016-09-20	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-19	2016-09-20	
Sodium, total	**1.63**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Strontium, total	**0.013**	N/A	0.001	mg/L	2016-09-19	2016-09-20	
Sulfur, total	**1**	N/A	1	mg/L	2016-09-19	2016-09-20	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-19	2016-09-20	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-19	2016-09-20	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-19	2016-09-20	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6091257-02) [Water] Sampled: 2016-09-16 14:30, Continued							
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-09-19	2016-09-20	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Microbiological Parameters							
Coliforms, Fecal	<2	N/A	2	MPN/100 mL		2016-09-17	
E. coli (MPN)	<2	N/A	2	MPN/100 mL		2016-09-17	
Sample ID: FR-1 (227 St Creek) (6091257-03) [Water] Sampled: 2016-09-16 15:15							
Anions							
Nitrate (as N)	**0.784**	N/A	0.010	mg/L	N/A	2016-09-20	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**120**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Bicarbonate (as CaCO3)	**120**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Calculated Parameters							
Hardness, Total (as CaCO3)	**92.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.008**	N/A	0.005	mg/L	N/A	2016-09-19	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-19	
Arsenic, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-09-19	
Barium, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-09-19	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Boron, dissolved	**0.041**	N/A	0.004	mg/L	N/A	2016-09-19	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	2016-09-19	
Calcium, dissolved	**21.4**	N/A	0.2	mg/L	N/A	2016-09-19	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	
Cobalt, dissolved	**0.00013**	N/A	0.00005	mg/L	N/A	2016-09-19	
Copper, dissolved	**0.0033**	N/A	0.0002	mg/L	N/A	2016-09-19	
Iron, dissolved	**0.220**	N/A	0.010	mg/L	N/A	2016-09-19	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Lithium, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	2016-09-19	
Magnesium, dissolved	**9.36**	N/A	0.01	mg/L	N/A	2016-09-19	
Manganese, dissolved	**0.0553**	N/A	0.0002	mg/L	N/A	2016-09-19	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-21	2016-09-22	
Molybdenum, dissolved	**0.0022**	N/A	0.0001	mg/L	N/A	2016-09-19	
Nickel, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-19	
Phosphorus, dissolved	**0.04**	N/A	0.02	mg/L	N/A	2016-09-19	
Potassium, dissolved	**3.00**	N/A	0.02	mg/L	N/A	2016-09-19	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-19	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091257
REPORTED 2016-09-26

Sample ID: FR-1 (227 St Creek) (6091257-03) [Water] Sampled: 2016-09-16 15:15, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Silicon, dissolved	**5.9**	N/A	0.5	mg/L	N/A	2016-09-19	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-19	
Sodium, dissolved	**23.2**	N/A	0.02	mg/L	N/A	2016-09-19	
Strontium, dissolved	**0.134**	N/A	0.001	mg/L	N/A	2016-09-19	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-19	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-19	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-19	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-19	
Uranium, dissolved	**0.00008**	N/A	0.00002	mg/L	N/A	2016-09-19	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-19	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-19	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-19	
Total Metals							
Aluminum, total	**0.231**	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Arsenic, total	**0.0011**	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Barium, total	**0.015**	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Boron, total	**0.056**	N/A	0.004	mg/L	2016-09-19	2016-09-20	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-09-19	2016-09-20	
Calcium, total	**25.6**	N/A	0.2	mg/L	2016-09-19	2016-09-20	
Chromium, total	**0.0006**	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Cobalt, total	**0.00029**	N/A	0.00005	mg/L	2016-09-19	2016-09-20	
Copper, total	**0.0049**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Iron, total	**0.80**	N/A	0.01	mg/L	2016-09-19	2016-09-20	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Magnesium, total	**10.7**	N/A	0.01	mg/L	2016-09-19	2016-09-20	
Manganese, total	**0.0911**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-21	2016-09-22	
Molybdenum, total	**0.0026**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Nickel, total	**0.0013**	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Phosphorus, total	**0.07**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Potassium, total	**3.53**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-19	2016-09-20	
Silicon, total	**7.4**	N/A	0.5	mg/L	2016-09-19	2016-09-20	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-19	2016-09-20	
Sodium, total	**26.3**	N/A	0.02	mg/L	2016-09-19	2016-09-20	
Strontium, total	**0.154**	N/A	0.001	mg/L	2016-09-19	2016-09-20	
Sulfur, total	**3**	N/A	1	mg/L	2016-09-19	2016-09-20	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-19	2016-09-20	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091257
REPORTED 2016-09-26

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6091257-03) [Water] Sampled: 2016-09-16 15:15, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-19	2016-09-20	
Titanium, total	**0.009**	N/A	0.005	mg/L	2016-09-19	2016-09-20	
Uranium, total	**0.00009**	N/A	0.00002	mg/L	2016-09-19	2016-09-20	
Vanadium, total	**0.001**	N/A	0.001	mg/L	2016-09-19	2016-09-20	
Zinc, total	**0.006**	N/A	0.004	mg/L	2016-09-19	2016-09-20	
Zirconium, total	**0.0001**	N/A	0.0001	mg/L	2016-09-19	2016-09-20	
Microbiological Parameters							
Coliforms, Fecal	**1,600**	N/A	2	MPN/100 mL		2016-09-17	
E. coli (MPN)	**1,600**	N/A	2	MPN/100 mL		2016-09-17	
Sample ID: Field Blank (6091257-04) [Water] Sampled: 2016-09-16 13:30							
Anions							
Nitrate (as N)	< 0.010	N/A	0.010	mg/L	N/A	2016-09-20	HT1

Sample / Analysis Qualifiers:

HT1	The sample was prepared and/or analyzed past the recommended holding time.

APPENDIX 1: QUALITY CONTROL DATA

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6I1134										
Blank (B6I1134-BLK1)				Prepared: 2016-09-20, Analyzed: 2016-09-20						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I1134-BLK2)				Prepared: 2016-09-21, Analyzed: 2016-09-21						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6I1134-BS1)				Prepared: 2016-09-20, Analyzed: 2016-09-20						
Nitrate (as N)	3.98	0.010	mg/L	4.00		100	93-108			
LCS (B6I1134-BS2)				Prepared: 2016-09-21, Analyzed: 2016-09-21						
Nitrate (as N)	3.99	0.010	mg/L	4.00		100	93-108			
Duplicate (B6I1134-DUP1)		**Source: 6091257-01**		Prepared: 2016-09-20, Analyzed: 2016-09-20						
Nitrate (as N)	1.10	0.010	mg/L		1.11			< 1	10	
Matrix Spike (B6I1134-MS1)		**Source: 6091257-01**		Prepared: 2016-09-20, Analyzed: 2016-09-20						
Nitrate (as N)	5.01	0.010	mg/L	4.00	1.11	97	75-125			
Dissolved Metals, Batch B6I1029										
Blank (B6I1029-BLK1)				Prepared: 2016-09-19, Analyzed: 2016-09-19						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

Dissolved Metals, Batch B6I1029, Continued

Blank (B6I1029-BLK1), Continued Prepared: 2016-09-19, Analyzed: 2016-09-19

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							

Reference (B6I1029-SRM1) Prepared: 2016-09-19, Analyzed: 2016-09-19

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.235	0.005	mg/L	0.233		101	58-142			
Antimony, dissolved	0.0423	0.0001	mg/L	0.0430		98	75-125			
Arsenic, dissolved	0.448	0.0005	mg/L	0.438		102	81-119			
Barium, dissolved	3.23	0.005	mg/L	3.35		96	83-117			
Beryllium, dissolved	0.195	0.0001	mg/L	0.213		92	80-120			
Boron, dissolved	1.53	0.004	mg/L	1.74		88	74-117			
Cadmium, dissolved	0.225	0.00001	mg/L	0.224		100	83-117			
Calcium, dissolved	7.1	0.2	mg/L	7.69		92	76-124			
Chromium, dissolved	0.455	0.0005	mg/L	0.437		104	81-119			
Cobalt, dissolved	0.136	0.00005	mg/L	0.128		106	76-124			
Copper, dissolved	0.880	0.0002	mg/L	0.844		104	84-116			
Iron, dissolved	1.34	0.010	mg/L	1.29		104	74-126			
Lead, dissolved	0.102	0.0001	mg/L	0.112		91	72-128			
Lithium, dissolved	0.0889	0.0001	mg/L	0.104		85	60-140			
Magnesium, dissolved	7.29	0.01	mg/L	6.92		105	81-119			
Manganese, dissolved	0.356	0.0002	mg/L	0.345		103	84-116			
Molybdenum, dissolved	0.410	0.0001	mg/L	0.426		96	83-117			
Nickel, dissolved	0.880	0.0002	mg/L	0.840		105	74-126			
Phosphorus, dissolved	0.45	0.02	mg/L	0.495		91	68-132			
Potassium, dissolved	3.10	0.02	mg/L	3.19		97	74-126			
Selenium, dissolved	0.0335	0.0005	mg/L	0.0331		101	70-130			
Sodium, dissolved	19.4	0.02	mg/L	19.1		102	72-128			
Strontium, dissolved	0.886	0.001	mg/L	0.916		97	84-113			
Thallium, dissolved	0.0360	0.00002	mg/L	0.0393		91	57-143			
Uranium, dissolved	0.237	0.00002	mg/L	0.266		89	85-115			
Vanadium, dissolved	0.885	0.001	mg/L	0.869		102	87-113			
Zinc, dissolved	0.926	0.004	mg/L	0.881		105	72-128			

Dissolved Metals, Batch B6I1259

Dissolved Metals, Batch B6I1259, Continued

Blank (B6I1259-BLK1) Prepared: 2016-09-21, Analyzed: 2016-09-22

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Duplicate (B6I1259-DUP1) **Source: 6091257-01** Prepared: 2016-09-21, Analyzed: 2016-09-22

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	

Matrix Spike (B6I1259-MS1) **Source: 6091257-02** Prepared: 2016-09-21, Analyzed: 2016-09-22

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00026	0.00002	mg/L	0.000250	< 0.00002	104	70-130			

Reference (B6I1259-SRM1) Prepared: 2016-09-21, Analyzed: 2016-09-22

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00517	0.00002	mg/L	0.00486		106	50-150			

General Parameters, Batch B6I1536

Blank (B6I1536-BLK1) Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6I1536-BS1) Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	99	2	mg/L	100		99	96-108			

Duplicate (B6I1536-DUP1) **Source: 6091257-03** Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	122	2	mg/L		120			1	10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L		< 1				10	
Alkalinity, Bicarbonate (as CaCO3)	122	2	mg/L		120			1	10	
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L		< 1				10	
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L		< 1				10	

Total Metals, Batch B6I1087

Blank (B6I1087-BLK1) Prepared: 2016-09-19, Analyzed: 2016-09-20

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							

APPENDIX 1: QUALITY CONTROL DATA

Total Metals, Batch B6I1087, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Blank (B6I1087-BLK1), Continued				Prepared: 2016-09-19, Analyzed: 2016-09-20						
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Reference (B6I1087-SRM1)				Prepared: 2016-09-19, Analyzed: 2016-09-20						
Aluminum, total	0.337	0.005	mg/L	0.303		111	81-129			
Antimony, total	0.0535	0.0001	mg/L	0.0511		105	88-114			
Arsenic, total	0.129	0.0005	mg/L	0.118		110	88-114			
Barium, total	0.818	0.005	mg/L	0.823		99	72-104			
Beryllium, total	0.0482	0.0001	mg/L	0.0496		97	76-131			
Boron, total	3.47	0.004	mg/L	3.45		101	75-121			
Cadmium, total	0.0526	0.00001	mg/L	0.0495		106	89-111			
Calcium, total	11.6	0.2	mg/L	11.6		100	86-121			
Chromium, total	0.270	0.0005	mg/L	0.250		108	89-114			
Cobalt, total	0.0428	0.00005	mg/L	0.0377		113	91-113			
Copper, total	0.554	0.0002	mg/L	0.486		114	91-115			
Iron, total	0.55	0.01	mg/L	0.488		113	77-124			
Lead, total	0.204	0.0001	mg/L	0.204		100	92-113			
Lithium, total	0.382	0.0001	mg/L	0.403		95	85-115			
Magnesium, total	4.36	0.01	mg/L	3.79		115	78-120			
Manganese, total	0.118	0.0002	mg/L	0.109		108	90-114			
Molybdenum, total	0.206	0.0001	mg/L	0.198		104	90-111			
Nickel, total	0.272	0.0002	mg/L	0.249		109	90-111			
Phosphorus, total	0.24	0.02	mg/L	0.227		105	85-115			
Potassium, total	8.08	0.02	mg/L	7.21		112	84-113			
Selenium, total	0.134	0.0005	mg/L	0.121		111	85-115			
Sodium, total	8.56	0.02	mg/L	7.54		114	82-123			
Strontium, total	0.393	0.001	mg/L	0.375		105	88-112			
Thallium, total	0.0817	0.00002	mg/L	0.0805		102	91-114			
Uranium, total	0.0303	0.00002	mg/L	0.0306		99	85-120			
Vanadium, total	0.414	0.001	mg/L	0.386		107	86-111			
Zinc, total	2.65	0.004	mg/L	2.49		106	85-111			

Total Metals, Batch B6I1260

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Blank (B6I1260-BLK1)				Prepared: 2016-09-21, Analyzed: 2016-09-22						
Mercury, total	< 0.00002	0.00002	mg/L							
Duplicate (B6I1260-DUP1)	**Source: 6091257-01**			Prepared: 2016-09-21, Analyzed: 2016-09-22						
Mercury, total	< 0.00002	0.00002	mg/L		< 0.00002				20	
Matrix Spike (B6I1260-MS1)	**Source: 6091257-02**			Prepared: 2016-09-21, Analyzed: 2016-09-22						
Mercury, total	0.00027	0.00002	mg/L	0.000250	< 0.00002	108	70-130			
Reference (B6I1260-SRM1)				Prepared: 2016-09-21, Analyzed: 2016-09-22						
Mercury, total	0.00522	0.00002	mg/L	0.00486		107	50-150			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091257
REPORTED 2016-09-26

		6091257-01	6091257-02	6091257-03	6091257-04
		Water	**Water**	**Water**	**Water**
		2016-09-16	**2016-09-16**	**2016-09-16**	**2016-09-16**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	1.11	0.132	0.784	< 0.010
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	52	8	120	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	52	8	120	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	52.7	8.14	92.1	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.015	0.033	0.008	
	Antimony, dissolved (mg/L)	0.0002	< 0.0001	0.0002	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	0.0007	
	Barium, dissolved (mg/L)	0.015	< 0.005	0.011	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.011	0.004	0.041	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	0.00002	
	Calcium, dissolved (mg/L)	16.1	2.6	21.4	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	0.00005	0.00013	
	Copper, dissolved (mg/L)	0.0008	0.0007	0.0033	
	Iron, dissolved (mg/L)	0.013	0.027	0.220	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0003	< 0.0001	0.0005	
	Magnesium, dissolved (mg/L)	3.03	0.40	9.36	
	Manganese, dissolved (mg/L)	0.0007	0.0009	0.0553	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0007	0.0004	0.0022	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0009	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	0.04	
	Potassium, dissolved (mg/L)	1.40	0.20	3.00	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	7.6	2.4	5.9	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	8.31	1.46	23.2	
	Strontium, dissolved (mg/L)	0.094	0.012	0.134	
	Sulfur, dissolved (mg/L)	2	< 1	2	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00007	0.00002	0.00008	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091257
REPORTED 2016-09-26

		6091257-01	6091257-02	6091257-03	6091257-04
		Water	**Water**	**Water**	**Water**
		2016-09-16	**2016-09-16**	**2016-09-16**	**2016-09-16**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.042	0.040	0.231	
	Antimony, total (mg/L)	0.0001	< 0.0001	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0011	
	Barium, total (mg/L)	0.016	< 0.005	0.015	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.016	0.008	0.056	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00002	
	Calcium, total (mg/L)	17.8	2.9	25.6	
	Chromium, total (mg/L)	< 0.0005	< 0.0005	0.0006	
	Cobalt, total (mg/L)	< 0.00005	< 0.00005	0.00029	
	Copper, total (mg/L)	0.0011	0.0008	0.0049	
	Iron, total (mg/L)	0.04	0.02	0.80	
	Lead, total (mg/L)	< 0.0001	< 0.0001	0.0001	
	Lithium, total (mg/L)	0.0003	< 0.0001	0.0007	
	Magnesium, total (mg/L)	3.32	0.44	10.7	
	Manganese, total (mg/L)	0.0025	0.0009	0.0911	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0007	0.0004	0.0026	
	Nickel, total (mg/L)	< 0.0002	< 0.0002	0.0013	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.07	
	Potassium, total (mg/L)	1.61	0.23	3.53	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	8.7	2.9	7.4	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	9.08	1.63	26.3	
	Strontium, total (mg/L)	0.102	0.013	0.154	
	Sulfur, total (mg/L)	3	1	3	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.009	
	Uranium, total (mg/L)	0.00004	< 0.00002	0.00009	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.001	
	Zinc, total (mg/L)	< 0.004	< 0.004	0.006	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0001	
Microbiological Parameters	Coliforms, Fecal (MPN/100 mL)	50	<2	1,600	
	E. coli (MPN) (MPN/100 mL)	50	<2	1,600	

CA
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Caring

6091257

nd, BC V6V 2K9
279-1599
vna, BC V1X 5C3
765-3893
nton, AB T5S 1H7
489-9700

CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC# ______ PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning	DATE: 16-Sep-16 TIME: 17:05	RECEIVED BY: WJ TL	DATE: 16-Sep-16 TIME: 17:06
PROJECT: 173.191 Blaney ISMP		PROJECT INFO: Stormwater Monitoring	

REPORT TO:

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐ EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

INVOICE TO: SAME AS REPORT TO ☐

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

TURNAROUND TIME REQUESTED:

Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
*Contact Lab To Confirm. Surcharge May Apply

REGULATORY APPLICATION: Regs on Report? ☒

Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

	MATRIX:					SAMPLING:		COMMENTS:				ANALYSES REQUESTED:																								
CLIENT SAMPLE ID:	DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	DATE DD-MMM-YY	TIME HH:MM	CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ *E. coli* ☒	ASBESTOS	Nitrate - N							**HOLD**
BL-1 (Anderson Creek)		✓			6	16-Sep-16	12:00												✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)		✓			6	16-Sep-16	14:30												✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)		✓			6	16-Sep-16	15:15												✓	✓		✓				✓	✓		✓							
Field Blank		✓			1	16-Sep-16	13:30																						✓							
Trip Blank		✓			1	16-Sep-16	8:15																													✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐

Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):

60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply): ______

*** OTHER INSTRUCTIONS:**

Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:

CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:

COOLER 1 (°C): 5.4 ICE: Y ☑ N ☐
COOLER 2 (°C): ______ ICE: Y ☐ N ☐
COOLER 3 (°C): ______
CUSTODY SEALS INTACT: N

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6091630
PO NUMBER		**RECEIVED / TEMP**	2016-09-22 13:54 / 5°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-29
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6091630
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-29

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6091630
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-29

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221 E	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6091630
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-29

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: BL-1 (Anderson Creek) (6091630-01) [Water] Sampled: 2016-09-22 11:30

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**1.04**	N/A	0.010	mg/L	N/A	2016-09-29	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**41**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Bicarbonate (as CaCO3)	**41**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Calculated Parameters							
Hardness, Total (as CaCO3)	**45.5**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.019**	N/A	0.005	mg/L	N/A	2016-09-24	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	2016-09-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-09-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-24	
Calcium, dissolved	**14.1**	N/A	0.2	mg/L	N/A	2016-09-24	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-24	
Copper, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-09-24	
Iron, dissolved	**0.026**	N/A	0.010	mg/L	N/A	2016-09-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-24	
Magnesium, dissolved	**2.48**	N/A	0.01	mg/L	N/A	2016-09-24	
Manganese, dissolved	**0.0016**	N/A	0.0002	mg/L	N/A	2016-09-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-27	2016-09-27	
Molybdenum, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	2016-09-24	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-24	
Potassium, dissolved	**1.31**	N/A	0.02	mg/L	N/A	2016-09-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Silicon, dissolved	**7.0**	N/A	0.5	mg/L	N/A	2016-09-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-24	
Sodium, dissolved	**6.80**	N/A	0.02	mg/L	N/A	2016-09-24	
Strontium, dissolved	**0.081**	N/A	0.001	mg/L	N/A	2016-09-24	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-09-24	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-24	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6091630-01) [Water] Sampled: 2016-09-22 11:30, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-09-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-24	
Zinc, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-09-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Total Metals							
Aluminum, total	**0.042**	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Barium, total	**0.014**	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Boron, total	**0.010**	N/A	0.004	mg/L	2016-09-23	2016-09-24	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-23	2016-09-24	
Calcium, total	**14.9**	N/A	0.2	mg/L	2016-09-23	2016-09-24	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-23	2016-09-24	
Copper, total	**0.0011**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Iron, total	**0.06**	N/A	0.01	mg/L	2016-09-23	2016-09-24	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Magnesium, total	**2.64**	N/A	0.01	mg/L	2016-09-23	2016-09-24	
Manganese, total	**0.0022**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-27	2016-09-27	
Molybdenum, total	**0.0006**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Potassium, total	**1.45**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Silicon, total	**7.8**	N/A	0.5	mg/L	2016-09-23	2016-09-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-23	2016-09-24	
Sodium, total	**7.37**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Strontium, total	**0.088**	N/A	0.001	mg/L	2016-09-23	2016-09-24	
Sulfur, total	**3**	N/A	1	mg/L	2016-09-23	2016-09-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-23	2016-09-24	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Uranium, total	**0.00003**	N/A	0.00002	mg/L	2016-09-23	2016-09-24	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-23	2016-09-24	
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-09-23	2016-09-24	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**43**	N/A	3.0	MPN/100 mL	N/A	2016-09-23	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6091630-01) [Water] Sampled: 2016-09-22 11:30, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**43**	N/A	3.0	MPN/100 mL	N/A	2016-09-23	
Sample ID: NA-1 (North Alouette River) (6091630-02) [Water] Sampled: 2016-09-22 12:00							
Anions							
Nitrate (as N)	**0.180**	N/A	0.010	mg/L	N/A	2016-09-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**6**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Bicarbonate (as CaCO3)	**6**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Calculated Parameters							
Hardness, Total (as CaCO3)	**7.25**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.073**	N/A	0.005	mg/L	N/A	2016-09-24	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-24	
Calcium, dissolved	**2.4**	N/A	0.2	mg/L	N/A	2016-09-24	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-24	
Copper, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-09-24	
Iron, dissolved	**0.033**	N/A	0.010	mg/L	N/A	2016-09-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Magnesium, dissolved	**0.32**	N/A	0.01	mg/L	N/A	2016-09-24	
Manganese, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-09-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-27	2016-09-27	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-24	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-24	
Potassium, dissolved	**0.15**	N/A	0.02	mg/L	N/A	2016-09-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Silicon, dissolved	**2.3**	N/A	0.5	mg/L	N/A	2016-09-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-24	
Sodium, dissolved	**1.08**	N/A	0.02	mg/L	N/A	2016-09-24	
Strontium, dissolved	**0.010**	N/A	0.001	mg/L	N/A	2016-09-24	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-09-24	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6091630
REPORTED 2016-09-29

Sample ID: NA-1 (North Alouette River) (6091630-02) [Water] Sampled: 2016-09-22 12:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-24	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-09-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-24	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-09-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Total Metals							
Aluminum, total	**0.092**	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Boron, total	< 0.004	N/A	0.004	mg/L	2016-09-23	2016-09-24	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-09-23	2016-09-24	
Calcium, total	**2.5**	N/A	0.2	mg/L	2016-09-23	2016-09-24	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-09-23	2016-09-24	
Copper, total	**0.0006**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Iron, total	**0.05**	N/A	0.01	mg/L	2016-09-23	2016-09-24	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Magnesium, total	**0.34**	N/A	0.01	mg/L	2016-09-23	2016-09-24	
Manganese, total	**0.0011**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-27	2016-09-27	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Potassium, total	**0.17**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Silicon, total	**2.5**	N/A	0.5	mg/L	2016-09-23	2016-09-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-23	2016-09-24	
Sodium, total	**1.20**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Strontium, total	**0.011**	N/A	0.001	mg/L	2016-09-23	2016-09-24	
Sulfur, total	< 1	N/A	1	mg/L	2016-09-23	2016-09-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-23	2016-09-24	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-09-23	2016-09-24	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-09-23	2016-09-24	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6091630-02) [Water] Sampled: 2016-09-22 12:00, Continued							
Total Metals, Continued							
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-09-23	2016-09-24	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-09-23	
E. coli (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-09-23	
Sample ID: FR-1 (227 St Creek) (6091630-03) [Water] Sampled: 2016-09-22 11:00							
Anions							
Nitrate (as N)	**0.518**	N/A	0.010	mg/L	N/A	2016-09-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**63**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Bicarbonate (as CaCO3)	**63**	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-09-26	
Calculated Parameters							
Hardness, Total (as CaCO3)	**50.8**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.013**	N/A	0.005	mg/L	N/A	2016-09-24	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-09-24	
Arsenic, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-09-24	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	2016-09-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Boron, dissolved	**0.027**	N/A	0.004	mg/L	N/A	2016-09-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-09-24	
Calcium, dissolved	**12.5**	N/A	0.2	mg/L	N/A	2016-09-24	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	
Cobalt, dissolved	**0.00012**	N/A	0.00005	mg/L	N/A	2016-09-24	
Copper, dissolved	**0.0025**	N/A	0.0002	mg/L	N/A	2016-09-24	
Iron, dissolved	**0.170**	N/A	0.010	mg/L	N/A	2016-09-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Lithium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	2016-09-24	
Magnesium, dissolved	**4.77**	N/A	0.01	mg/L	N/A	2016-09-24	
Manganese, dissolved	**0.0382**	N/A	0.0002	mg/L	N/A	2016-09-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-09-27	2016-09-27	
Molybdenum, dissolved	**0.0014**	N/A	0.0001	mg/L	N/A	2016-09-24	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-09-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-09-24	
Potassium, dissolved	**1.92**	N/A	0.02	mg/L	N/A	2016-09-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-09-24	

Sample ID: FR-1 (227 St Creek) (6091630-03) [Water] Sampled: 2016-09-22 11:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Silicon, dissolved	**4.2**	N/A	0.5	mg/L	N/A	2016-09-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-09-24	
Sodium, dissolved	**12.9**	N/A	0.02	mg/L	N/A	2016-09-24	
Strontium, dissolved	**0.072**	N/A	0.001	mg/L	N/A	2016-09-24	
Sulfur, dissolved	**1**	N/A	1	mg/L	N/A	2016-09-24	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-09-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-09-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-09-24	
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	2016-09-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-09-24	
Zinc, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-09-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-09-24	
Total Metals							
Aluminum, total	**0.305**	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Arsenic, total	**0.0011**	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Barium, total	**0.011**	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Boron, total	**0.031**	N/A	0.004	mg/L	2016-09-23	2016-09-24	
Cadmium, total	**0.00003**	N/A	0.00001	mg/L	2016-09-23	2016-09-24	
Calcium, total	**14.1**	N/A	0.2	mg/L	2016-09-23	2016-09-24	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Cobalt, total	**0.00028**	N/A	0.00005	mg/L	2016-09-23	2016-09-24	
Copper, total	**0.0053**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Iron, total	**1.22**	N/A	0.01	mg/L	2016-09-23	2016-09-24	
Lead, total	**0.0006**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Magnesium, total	**5.60**	N/A	0.01	mg/L	2016-09-23	2016-09-24	
Manganese, total	**0.0594**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-09-27	2016-09-27	
Molybdenum, total	**0.0015**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Nickel, total	**0.0008**	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Phosphorus, total	**0.06**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Potassium, total	**2.31**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-09-23	2016-09-24	
Silicon, total	**5.4**	N/A	0.5	mg/L	2016-09-23	2016-09-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-09-23	2016-09-24	
Sodium, total	**15.0**	N/A	0.02	mg/L	2016-09-23	2016-09-24	
Strontium, total	**0.085**	N/A	0.001	mg/L	2016-09-23	2016-09-24	
Sulfur, total	**3**	N/A	1	mg/L	2016-09-23	2016-09-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-09-23	2016-09-24	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6091630
REPORTED 2016-09-29

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6091630-03) [Water] Sampled: 2016-09-22 11:00, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-09-23	2016-09-24	
Titanium, total	**0.010**	N/A	0.005	mg/L	2016-09-23	2016-09-24	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	2016-09-23	2016-09-24	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-09-23	2016-09-24	
Zinc, total	**0.013**	N/A	0.004	mg/L	2016-09-23	2016-09-24	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	2016-09-23	2016-09-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**430**	N/A	3.0	MPN/100 mL	N/A	2016-09-23	
E. coli (MPN)	**430**	N/A	3.0	MPN/100 mL	N/A	2016-09-23	
Sample ID: Field Blank (6091630-04) [Water] Sampled: 2016-09-22 12:00							
Microbiological Parameters							
Coliforms, Fecal (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-09-23	
E. coli (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-09-23	

Sample / Analysis Qualifiers:

HT1	The sample was prepared and/or analyzed past the recommended holding time.

APPENDIX 1: QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6091630
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-09-29

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6I1428										
Blank (B6I1428-BLK1)				Prepared: 2016-09-23, Analyzed: 2016-09-23						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I1428-BLK2)				Prepared: 2016-09-24, Analyzed: 2016-09-24						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I1428-BLK3)				Prepared: 2016-09-24, Analyzed: 2016-09-24						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6I1428-BS1)				Prepared: 2016-09-23, Analyzed: 2016-09-23						
Nitrate (as N)	3.99	0.010	mg/L	4.00		100	93-108			
LCS (B6I1428-BS2)				Prepared: 2016-09-24, Analyzed: 2016-09-24						
Nitrate (as N)	3.98	0.010	mg/L	4.00		100	93-108			
LCS (B6I1428-BS3)				Prepared: 2016-09-24, Analyzed: 2016-09-24						
Nitrate (as N)	3.94	0.010	mg/L	4.00		98	93-108			
Anions, Batch B6I1473										
Blank (B6I1473-BLK1)				Prepared: 2016-09-24, Analyzed: 2016-09-24						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I1473-BLK2)				Prepared: 2016-09-25, Analyzed: 2016-09-25						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6I1473-BLK3)				Prepared: 2016-09-25, Analyzed: 2016-09-25						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6I1473-BS1)				Prepared: 2016-09-24, Analyzed: 2016-09-24						
Nitrate (as N)	3.85	0.010	mg/L	4.00		96	93-108			
LCS (B6I1473-BS2)				Prepared: 2016-09-25, Analyzed: 2016-09-25						
Nitrate (as N)	3.85	0.010	mg/L	4.00		96	93-108			

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes

Anions, Batch B6I1473, Continued

LCS (B6I1473-BS3) Prepared: 2016-09-25, Analyzed: 2016-09-25

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Nitrate (as N)	3.87	0.010	mg/L	4.00		97	93-108			

Dissolved Metals, Batch B6I1384

Blank (B6I1384-BLK1) Prepared: 2016-09-23, Analyzed: 2016-09-23

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							

Reference (B6I1384-SRM1) Prepared: 2016-09-24, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.226	0.005	mg/L	0.233		97	58-142			
Antimony, dissolved	0.0464	0.0001	mg/L	0.0430		108	75-125			
Arsenic, dissolved	0.460	0.0005	mg/L	0.438		105	81-119			
Barium, dissolved	3.27	0.005	mg/L	3.35		98	83-117			
Beryllium, dissolved	0.197	0.0001	mg/L	0.213		93	80-120			
Boron, dissolved	1.49	0.004	mg/L	1.74		86	74-117			
Cadmium, dissolved	0.224	0.00001	mg/L	0.224		100	83-117			
Calcium, dissolved	7.4	0.2	mg/L	7.69		97	76-124			
Chromium, dissolved	0.439	0.0005	mg/L	0.437		101	81-119			
Cobalt, dissolved	0.131	0.00005	mg/L	0.128		102	76-124			
Copper, dissolved	0.868	0.0002	mg/L	0.844		103	84-116			
Iron, dissolved	1.30	0.010	mg/L	1.29		101	74-126			
Lead, dissolved	0.109	0.0001	mg/L	0.112		97	72-128			

Dissolved Metals, Batch B6I1384, Continued

Reference (B6I1384-SRM1), Continued Prepared: 2016-09-24, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Lithium, dissolved	0.0903	0.0001	mg/L	0.104		87	60-140			
Magnesium, dissolved	7.12	0.01	mg/L	6.92		103	81-119			
Manganese, dissolved	0.340	0.0002	mg/L	0.345		99	84-116			
Molybdenum, dissolved	0.424	0.0001	mg/L	0.426		100	83-117			
Nickel, dissolved	0.850	0.0002	mg/L	0.840		101	74-126			
Phosphorus, dissolved	0.54	0.02	mg/L	0.495		108	68-132			
Potassium, dissolved	3.15	0.02	mg/L	3.19		99	74-126			
Selenium, dissolved	0.0363	0.0005	mg/L	0.0331		110	70-130			
Sodium, dissolved	18.9	0.02	mg/L	19.1		99	72-128			
Strontium, dissolved	0.866	0.001	mg/L	0.916		95	84-113			
Thallium, dissolved	0.0381	0.00002	mg/L	0.0393		97	57-143			
Uranium, dissolved	0.253	0.00002	mg/L	0.266		95	85-115			
Vanadium, dissolved	0.852	0.001	mg/L	0.869		98	87-113			
Zinc, dissolved	0.952	0.004	mg/L	0.881		108	72-128			

Dissolved Metals, Batch B6I1582

Blank (B6I1582-BLK1) Prepared: 2016-09-27, Analyzed: 2016-09-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Blank (B6I1582-BLK2) Prepared: 2016-09-27, Analyzed: 2016-09-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Reference (B6I1582-SRM1) Prepared: 2016-09-27, Analyzed: 2016-09-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00477	0.00002	mg/L	0.00486		98	50-150			

Reference (B6I1582-SRM2) Prepared: 2016-09-27, Analyzed: 2016-09-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00466	0.00002	mg/L	0.00486		96	50-150			

General Parameters, Batch B6I1545

Blank (B6I1545-BLK1) Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6I1545-BLK2) Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6I1545-BS1) Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	100	2	mg/L	100		100	96-108			

LCS (B6I1545-BS2) Prepared: 2016-09-26, Analyzed: 2016-09-26

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	100	2	mg/L	100		100	96-108			

Microbiological Parameters, Batch B6I1440

Blank (B6I1440-BLK1) Prepared: 2016-09-23, Analyzed: 2016-09-23

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							

Microbiological Parameters, Batch B6I1440, Continued

Blank (B6I1440-BLK1), Continued Prepared: 2016-09-23, Analyzed: 2016-09-23

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							

Duplicate (B6I1440-DUP1) **Source: 6091630-01** Prepared: 2016-09-23, Analyzed: 2016-09-23

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	390	3.0	MPN/100 mL		460			16	102	
Coliforms, Fecal (MPN)	23	3.0	MPN/100 mL		43			61	107	
E. coli (MPN)	23	3.0	MPN/100 mL		43			61	105	

Total Metals, Batch B6I1381

Blank (B6I1381-BLK1) Prepared: 2016-09-23, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							

Duplicate (B6I1381-DUP1) **Source: 6091630-01** Prepared: 2016-09-23, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.044	0.005	mg/L		0.042			4	29	
Antimony, total	< 0.0001	0.0001	mg/L		< 0.0001				31	
Arsenic, total	< 0.0005	0.0005	mg/L		< 0.0005				15	
Barium, total	0.015	0.005	mg/L		0.014				9	
Beryllium, total	< 0.0001	0.0001	mg/L		< 0.0001				16	
Bismuth, total	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, total	0.009	0.004	mg/L		0.010				29	
Cadmium, total	< 0.00001	0.00001	mg/L		< 0.00001				33	

Total Metals, Batch B6I1381, Continued

Duplicate (B6I1381-DUP1), Continued **Source: 6091630-01** Prepared: 2016-09-23, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Calcium, total	15.1	0.2	mg/L		14.9			1	12	
Chromium, total	0.0005	0.0005	mg/L		< 0.0005				12	
Cobalt, total	< 0.00005	0.00005	mg/L		< 0.00005				13	
Copper, total	0.0012	0.0002	mg/L		0.0011			3	37	
Iron, total	0.06	0.01	mg/L		0.06			< 1	18	
Lead, total	< 0.0001	0.0001	mg/L		< 0.0001				23	
Lithium, total	0.0003	0.0001	mg/L		0.0003				19	
Magnesium, total	2.68	0.01	mg/L		2.64			2	10	
Manganese, total	0.0024	0.0002	mg/L		0.0022			10	13	
Molybdenum, total	0.0006	0.0001	mg/L		0.0006			4	20	
Nickel, total	< 0.0002	0.0002	mg/L		< 0.0002				28	
Phosphorus, total	< 0.02	0.02	mg/L		< 0.02				24	
Potassium, total	1.48	0.02	mg/L		1.45			2	13	
Selenium, total	< 0.0005	0.0005	mg/L		< 0.0005				24	
Silicon, total	7.8	0.5	mg/L		7.8			< 1	11	
Silver, total	< 0.00005	0.00005	mg/L		< 0.00005				18	
Sodium, total	7.44	0.02	mg/L		7.37			1	10	
Strontium, total	0.089	0.001	mg/L		0.088			< 1	9	
Sulfur, total	3	1	mg/L		3				24	
Tellurium, total	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Thorium, total	< 0.0001	0.0001	mg/L		< 0.0001				18	
Tin, total	< 0.0002	0.0002	mg/L		< 0.0002				18	
Titanium, total	< 0.005	0.005	mg/L		< 0.005				32	
Uranium, total	0.00003	0.00002	mg/L		0.00003				14	
Vanadium, total	< 0.001	0.001	mg/L		< 0.001				17	
Zinc, total	0.004	0.004	mg/L		0.005				8	
Zirconium, total	< 0.0001	0.0001	mg/L		< 0.0001				60	

Matrix Spike (B6I1381-MS1) **Source: 6091630-02** Prepared: 2016-09-23, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony, total	0.433	0.0001	mg/L	0.400	< 0.0001	108	84-125			
Arsenic, total	0.219	0.0005	mg/L	0.200	< 0.0005	109	85-116			
Barium, total	1.01	0.005	mg/L	1.00	< 0.005	100	87-114			
Beryllium, total	0.0921	0.0001	mg/L	0.100	< 0.0001	92	72-116			
Cadmium, total	0.103	0.00001	mg/L	0.100	< 0.00001	103	90-112			
Chromium, total	0.417	0.0005	mg/L	0.400	< 0.0005	104	89-120			
Cobalt, total	0.418	0.00005	mg/L	0.400	< 0.00005	105	88-120			
Copper, total	0.437	0.0002	mg/L	0.400	0.0006	109	88-125			
Iron, total	2.17	0.01	mg/L	2.00	0.05	106	88-119			
Lead, total	0.211	0.0001	mg/L	0.200	< 0.0001	106	89-118			
Manganese, total	0.412	0.0002	mg/L	0.400	0.0011	103	84-120			
Nickel, total	0.422	0.0002	mg/L	0.400	< 0.0002	106	87-119			
Selenium, total	0.105	0.0005	mg/L	0.100	< 0.0005	105	85-113			
Silver, total	0.104	0.00005	mg/L	0.100	< 0.00005	104	89-119			
Thallium, total	0.104	0.00002	mg/L	0.100	< 0.00002	104	92-119			
Vanadium, total	0.402	0.001	mg/L	0.400	< 0.001	101	87-117			
Zinc, total	1.02	0.004	mg/L	1.00	0.005	101	85-116			

Reference (B6I1381-SRM1) Prepared: 2016-09-23, Analyzed: 2016-09-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.314	0.005	mg/L	0.303		104	81-129			
Antimony, total	0.0549	0.0001	mg/L	0.0511		107	88-114			
Arsenic, total	0.129	0.0005	mg/L	0.118		110	88-114			
Barium, total	0.798	0.005	mg/L	0.823		97	72-104			
Beryllium, total	0.0458	0.0001	mg/L	0.0496		92	76-131			
Boron, total	2.92	0.004	mg/L	3.45		85	75-121			
Cadmium, total	0.0515	0.00001	mg/L	0.0495		104	89-111			
Calcium, total	11.4	0.2	mg/L	11.6		98	86-121			

APPENDIX 1: QUALITY CONTROL DATA

Total Metals, Batch B6I1381, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Reference (B6I1381-SRM1), Continued				Prepared: 2016-09-23, Analyzed: 2016-09-24						
Chromium, total	0.263	0.0005	mg/L	0.250		105	89-114			
Cobalt, total	0.0413	0.00005	mg/L	0.0377		109	91-113			
Copper, total	0.540	0.0002	mg/L	0.486		111	91-115			
Iron, total	0.54	0.01	mg/L	0.488		110	77-124			
Lead, total	0.206	0.0001	mg/L	0.204		101	92-113			
Lithium, total	0.369	0.0001	mg/L	0.403		91	85-115			
Magnesium, total	4.14	0.01	mg/L	3.79		109	78-120			
Manganese, total	0.112	0.0002	mg/L	0.109		103	90-114			
Molybdenum, total	0.206	0.0001	mg/L	0.198		104	90-111			
Nickel, total	0.265	0.0002	mg/L	0.249		107	90-111			
Phosphorus, total	0.22	0.02	mg/L	0.227		97	85-115			
Potassium, total	7.82	0.02	mg/L	7.21		109	84-113			
Selenium, total	0.129	0.0005	mg/L	0.121		107	85-115			
Sodium, total	8.07	0.02	mg/L	7.54		107	82-123			
Strontium, total	0.376	0.001	mg/L	0.375		100	88-112			
Thallium, total	0.0823	0.00002	mg/L	0.0805		102	91-114			
Uranium, total	0.0308	0.00002	mg/L	0.0306		101	85-120			
Vanadium, total	0.401	0.001	mg/L	0.386		104	86-111			
Zinc, total	2.50	0.004	mg/L	2.49		101	85-111			

Total Metals, Batch B6I1621

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Blank (B6I1621-BLK1)				Prepared: 2016-09-27, Analyzed: 2016-09-27						
Mercury, total	< 0.00002	0.00002	mg/L							
Reference (B6I1621-SRM1)				Prepared: 2016-09-27, Analyzed: 2016-09-27						
Mercury, total	0.00440	0.00002	mg/L	0.00486		90	50-150			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6091630
REPORTED 2016-09-29

		6091630-01	6091630-02	6091630-03	6091630-04
		Water	**Water**	**Water**	**Water**
		2016-09-22	**2016-09-22**	**2016-09-22**	**2016-09-22**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	1.04	0.180	0.518	
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	41	6	63	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	41	6	63	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	45.5	7.25	50.8	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.019	0.073	0.013	
	Antimony, dissolved (mg/L)	< 0.0001	< 0.0001	0.0002	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	0.0006	
	Barium, dissolved (mg/L)	0.013	< 0.005	0.007	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.009	< 0.004	0.027	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	14.1	2.4	12.5	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00012	
	Copper, dissolved (mg/L)	0.0010	0.0004	0.0025	
	Iron, dissolved (mg/L)	0.026	0.033	0.170	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0002	< 0.0001	0.0004	
	Magnesium, dissolved (mg/L)	2.48	0.32	4.77	
	Manganese, dissolved (mg/L)	0.0016	0.0009	0.0382	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0006	0.0002	0.0014	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0004	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	1.31	0.15	1.92	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	7.0	2.3	4.2	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	6.80	1.08	12.9	
	Strontium, dissolved (mg/L)	0.081	0.010	0.072	
	Sulfur, dissolved (mg/L)	2	< 1	1	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00003	0.00003	0.00004	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	0.005	< 0.004	0.009	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6091630
REPORTED 2016-09-29

		6091630-01	6091630-02	6091630-03	6091630-04
		Water	**Water**	**Water**	**Water**
		2016-09-22	**2016-09-22**	**2016-09-22**	**2016-09-22**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.042	0.092	0.305	
	Antimony, total (mg/L)	< 0.0001	< 0.0001	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0011	
	Barium, total (mg/L)	0.014	< 0.005	0.011	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.010	< 0.004	0.031	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00003	
	Calcium, total (mg/L)	14.9	2.5	14.1	
	Chromium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, total (mg/L)	< 0.00005	< 0.00005	0.00028	
	Copper, total (mg/L)	0.0011	0.0006	0.0053	
	Iron, total (mg/L)	0.06	0.05	1.22	
	Lead, total (mg/L)	< 0.0001	< 0.0001	0.0006	
	Lithium, total (mg/L)	0.0003	0.0001	0.0007	
	Magnesium, total (mg/L)	2.64	0.34	5.60	
	Manganese, total (mg/L)	0.0022	0.0011	0.0594	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0006	0.0003	0.0015	
	Nickel, total (mg/L)	< 0.0002	< 0.0002	0.0008	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.06	
	Potassium, total (mg/L)	1.45	0.17	2.31	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	7.8	2.5	5.4	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	7.37	1.20	15.0	
	Strontium, total (mg/L)	0.088	0.011	0.085	
	Sulfur, total (mg/L)	3	< 1	3	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.010	
	Uranium, total (mg/L)	0.00003	0.00002	0.00007	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.002	
	Zinc, total (mg/L)	0.005	0.005	0.013	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0002	
Microbiological Parameters	Coliforms, Fecal (MPN) (MPN/100 mL)	43	9.1	430	< 3.0
	E. coli (MPN) (MPN/100 mL)	43	9.1	430	< 3.0

ANALYTIC
Caring About R

6091630

V 2K9
X 5C3
5S 1H7

CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC# PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning
DATE: 22-Sep-16
TIME: 13:55

RECEIVED BY: WI TL
DATE: 22-Sep-16
TIME: 13:54

PROJECT: 173.191 Blaney ISMP
PROJECT INFO: Stormwater Monitoring

REPORT TO:
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐
EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION:
Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

6091630

ANALYSES REQUESTED:

BTEX ☐ VPH ☐ PHC F1 ☐ | VOC ☐ VPH ☐ | EPH ☐ PHC F2-F4 ☐ | PAH ☐ L/HEPH ☐ | PHENOLS Chlorinated ☐ Non-Chlor. ☐ | PCB ☐ GLYCOLS ☐ HAA ☐ | PESTICIDES ☐ ACID HERBICIDES ☐ | METALS - WATER TOTAL Hg ☒ | METALS - WATER DISSOLVED Hg ☒ | METALS - SOIL (SALM) ☐ inc. pH ☐ | pH ☐ EC ☐ ALK ☒ | TSS ☐ VSS ☐ TDS ☐ | BOD ☐ COD ☐ | TOG ☐ MOG ☐ | FECAL COLIFORMS ☒ HPC ☐ | TOTAL COLIFORMS ☐ E. coli ☒ | ASBESTOS | Nitrate - N | HOLD

CLIENT SAMPLE ID:	DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	DATE DD-MMM-YY	TIME HH:MM	CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX	VOC	EPH	PAH	PHENOLS	PCB	PESTICIDES	METALS - WATER TOTAL	METALS - WATER DISSOLVED	METALS - SOIL (SALM)	pH EC ALK	TSS VSS TDS	BOD COD	TOG MOG	FECAL COLIFORMS	TOTAL COLIFORMS	ASBESTOS	Nitrate - N	HOLD
BL-1 (Anderson Creek)		✓			6	22-Sep-16	11:30												✓	✓		✓				✓	✓		✓	
NA-1 (North Alouette River)		✓			6	22-Sep-16	12:00												✓	✓		✓				✓	✓		✓	
FR-1 (227 St Creek)		✓			6	22-Sep-16	11:00												✓	✓		✓				✓	✓		✓	
Field Blank		✓			1	22-Sep-16	12:00																				✓			
Trip Blank		✓			1	22-Sep-16	10:45																							✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls.

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 5.4 ICE: Y ☑ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT: N

CERTIFICATE OF ANALYSIS

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
200 - 4185A Still Creek Dr
Burnaby, BC V5C 6G9

TEL (604) 294-2088
FAX (604) 294-2090

ATTENTION Patrick Lilley
WORK ORDER 6110765

PO NUMBER
PROJECT 173.191 Blaney, North Alouettem, Fraser River
PROJECT INFO Stormwater Monitoring
RECEIVED / TEMP 2016-11-09 16:26 / 8°C
REPORTED 2016-11-17

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

TABLE OF CONTENTS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6110765
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-11-17

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6110765
REPORTED 2016-11-17

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221 E	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6110765
REPORTED 2016-11-17

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6110765-01) [Water] Sampled: 2016-11-09 13:45							
Anions							
Nitrate (as N)	**0.942**	N/A	0.010	mg/L	N/A	2016-11-10	
General Parameters							
Alkalinity, Total (as CaCO3)	**11**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Bicarbonate (as CaCO3)	**11**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Calculated Parameters							
Hardness, Total (as CaCO3)	**15.3**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.109**	N/A	0.005	mg/L	N/A	2016-11-17	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Barium, dissolved	**0.010**	N/A	0.005	mg/L	N/A	2016-11-17	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Boron, dissolved	**0.017**	N/A	0.004	mg/L	N/A	2016-11-17	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-17	
Calcium, dissolved	**4.8**	N/A	0.2	mg/L	N/A	2016-11-17	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Cobalt, dissolved	**0.00008**	N/A	0.00005	mg/L	N/A	2016-11-17	
Copper, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-11-17	
Iron, dissolved	**0.085**	N/A	0.010	mg/L	N/A	2016-11-17	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-17	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Magnesium, dissolved	**0.78**	N/A	0.01	mg/L	N/A	2016-11-17	
Manganese, dissolved	**0.0038**	N/A	0.0002	mg/L	N/A	2016-11-17	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-11-17	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-17	
Potassium, dissolved	**0.64**	N/A	0.02	mg/L	N/A	2016-11-17	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Silicon, dissolved	**3.9**	N/A	0.5	mg/L	N/A	2016-11-17	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-17	
Sodium, dissolved	**2.95**	N/A	0.02	mg/L	N/A	2016-11-17	
Strontium, dissolved	**0.039**	N/A	0.001	mg/L	N/A	2016-11-17	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-17	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6110765-01) [Water] Sampled: 2016-11-09 13:45, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-17	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-17	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Total Metals							
Aluminum, total	**0.298**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Barium, total	**0.013**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Boron, total	**0.008**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	2016-11-15	2016-11-16	
Calcium, total	**5.2**	N/A	0.2	mg/L	2016-11-15	2016-11-16	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Cobalt, total	**0.00014**	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Copper, total	**0.0013**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Iron, total	**0.27**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Magnesium, total	**0.82**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Manganese, total	**0.0117**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Potassium, total	**0.68**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Silicon, total	**4.1**	N/A	0.5	mg/L	2016-11-15	2016-11-16	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Sodium, total	**3.11**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Strontium, total	**0.039**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-15	2016-11-16	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Titanium, total	**0.008**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**15**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6110765-01) [Water] Sampled: 2016-11-09 13:45, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**7.3**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
Sample ID: NA-1 (North Alouette River) (6110765-02) [Water] Sampled: 2016-11-09 15:00							
Anions							
Nitrate (as N)	**0.107**	N/A	0.010	mg/L	N/A	2016-11-10	
General Parameters							
Alkalinity, Total (as CaCO3)	**1**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Bicarbonate (as CaCO3)	**1**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Calculated Parameters							
Hardness, Total (as CaCO3)	**3.85**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.212**	N/A	0.005	mg/L	N/A	2016-11-17	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	2016-11-17	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-11-17	
Calcium, dissolved	**1.3**	N/A	0.2	mg/L	N/A	2016-11-17	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Cobalt, dissolved	**0.00005**	N/A	0.00005	mg/L	N/A	2016-11-17	
Copper, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	2016-11-17	
Iron, dissolved	**0.045**	N/A	0.010	mg/L	N/A	2016-11-17	
Lead, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Magnesium, dissolved	**0.17**	N/A	0.01	mg/L	N/A	2016-11-17	
Manganese, dissolved	**0.0015**	N/A	0.0002	mg/L	N/A	2016-11-17	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-17	
Potassium, dissolved	**0.10**	N/A	0.02	mg/L	N/A	2016-11-17	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Silicon, dissolved	**1.7**	N/A	0.5	mg/L	N/A	2016-11-17	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-17	
Sodium, dissolved	**0.67**	N/A	0.02	mg/L	N/A	2016-11-17	
Strontium, dissolved	**0.007**	N/A	0.001	mg/L	N/A	2016-11-17	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-17	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6110765-02) [Water] Sampled: 2016-11-09 15:00, Continued							
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-17	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-17	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Total Metals							
Aluminum, total	**0.238**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Boron, total	< 0.004	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-15	2016-11-16	
Calcium, total	**1.3**	N/A	0.2	mg/L	2016-11-15	2016-11-16	
Chromium, total	**0.0007**	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Cobalt, total	**0.00006**	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Copper, total	**0.0007**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Iron, total	**0.07**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Magnesium, total	**0.17**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Manganese, total	**0.0028**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Potassium, total	**0.10**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Silicon, total	**1.6**	N/A	0.5	mg/L	2016-11-15	2016-11-16	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Sodium, total	**0.68**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Strontium, total	**0.006**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-15	2016-11-16	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-15	2016-11-16	

Sample ID: NA-1 (North Alouette River) (6110765-02) [Water] Sampled: 2016-11-09 15:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**7.3**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
E. coli (MPN)	**7.3**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	

Sample ID: FR-1 (227 St Creek) (6110765-03) [Water] Sampled: 2016-11-09 12:30

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**1.22**	N/A	0.010	mg/L	N/A	2016-11-10	
General Parameters							
Alkalinity, Total (as CaCO3)	**50**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Bicarbonate (as CaCO3)	**50**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Calculated Parameters							
Hardness, Total (as CaCO3)	**43.6**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.079**	N/A	0.005	mg/L	N/A	2016-11-17	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Arsenic, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-11-17	
Barium, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-11-17	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Boron, dissolved	**0.024**	N/A	0.004	mg/L	N/A	2016-11-17	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	2016-11-17	
Calcium, dissolved	**11.4**	N/A	0.2	mg/L	N/A	2016-11-17	
Chromium, dissolved	**0.0005**	N/A	0.0005	mg/L	N/A	2016-11-17	
Cobalt, dissolved	**0.00016**	N/A	0.00005	mg/L	N/A	2016-11-17	
Copper, dissolved	**0.0040**	N/A	0.0002	mg/L	N/A	2016-11-17	
Iron, dissolved	**0.144**	N/A	0.010	mg/L	N/A	2016-11-17	
Lead, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Lithium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	2016-11-17	
Magnesium, dissolved	**3.69**	N/A	0.01	mg/L	N/A	2016-11-17	
Manganese, dissolved	**0.0325**	N/A	0.0002	mg/L	N/A	2016-11-17	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	2016-11-17	
Nickel, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-11-17	
Phosphorus, dissolved	**0.03**	N/A	0.02	mg/L	N/A	2016-11-17	
Potassium, dissolved	**1.88**	N/A	0.02	mg/L	N/A	2016-11-17	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	

Sample ID: FR-1 (227 St Creek) (6110765-03) [Water] Sampled: 2016-11-09 12:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Silicon, dissolved	**5.6**	N/A	0.5	mg/L	N/A	2016-11-17	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-17	
Sodium, dissolved	**5.56**	N/A	0.02	mg/L	N/A	2016-11-17	
Strontium, dissolved	**0.075**	N/A	0.001	mg/L	N/A	2016-11-17	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-17	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-11-17	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-17	
Zinc, dissolved	**0.006**	N/A	0.004	mg/L	N/A	2016-11-17	
Zirconium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Total Metals							
Aluminum, total	**1.51**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Arsenic, total	**0.0010**	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Barium, total	**0.023**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Boron, total	**0.021**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Cadmium, total	**0.00003**	N/A	0.00001	mg/L	2016-11-15	2016-11-16	
Calcium, total	**12.4**	N/A	0.2	mg/L	2016-11-15	2016-11-16	
Chromium, total	**0.0022**	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Cobalt, total	**0.00066**	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Copper, total	**0.0070**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Iron, total	**1.44**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Lead, total	**0.0007**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Lithium, total	**0.0011**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Magnesium, total	**3.98**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Manganese, total	**0.0548**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, total	**0.0009**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Nickel, total	**0.0026**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Phosphorus, total	**0.10**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Potassium, total	**2.03**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Silicon, total	**7.7**	N/A	0.5	mg/L	2016-11-15	2016-11-16	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Sodium, total	**5.65**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Strontium, total	**0.075**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Sulfur, total	**2**	N/A	1	mg/L	2016-11-15	2016-11-16	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	

Analyte	**Result /** ***Recovery***	**Standard / Guideline**	**MRL /** ***Limits***	**Units**	**Prepared**	**Analyzed**	**Notes**
Sample ID: FR-1 (227 St Creek) (6110765-03) [Water] Sampled: 2016-11-09 12:30, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Tin, total	**0.0002**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Titanium, total	**0.059**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Uranium, total	**0.00006**	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Vanadium, total	**0.004**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Zinc, total	**0.014**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Zirconium, total	**0.0005**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**930**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
E. coli (MPN)	**150**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
Sample ID: NA-2 (Balsam Creek) (6110765-04) [Water] Sampled: 2016-11-09 13:20							
Anions							
Nitrate (as N)	**0.522**	N/A	0.010	mg/L	N/A	2016-11-10	
General Parameters							
Alkalinity, Total (as CaCO3)	**5**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Bicarbonate (as CaCO3)	**5**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Calculated Parameters							
Hardness, Total (as CaCO3)	**6.97**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.107**	N/A	0.005	mg/L	N/A	2016-11-17	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Boron, dissolved	**0.008**	N/A	0.004	mg/L	N/A	2016-11-17	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-17	
Calcium, dissolved	**2.1**	N/A	0.2	mg/L	N/A	2016-11-17	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-17	
Copper, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-11-17	
Iron, dissolved	**0.035**	N/A	0.010	mg/L	N/A	2016-11-17	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Magnesium, dissolved	**0.44**	N/A	0.01	mg/L	N/A	2016-11-17	
Manganese, dissolved	**0.0020**	N/A	0.0002	mg/L	N/A	2016-11-17	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6110765
REPORTED 2016-11-17

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-2 (Balsam Creek) (6110765-04) [Water] Sampled: 2016-11-09 13:20, Continued							
Dissolved Metals, Continued							
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-11-17	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-17	
Potassium, dissolved	**0.22**	N/A	0.02	mg/L	N/A	2016-11-17	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Silicon, dissolved	**3.7**	N/A	0.5	mg/L	N/A	2016-11-17	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-17	
Sodium, dissolved	**1.59**	N/A	0.02	mg/L	N/A	2016-11-17	
Strontium, dissolved	**0.020**	N/A	0.001	mg/L	N/A	2016-11-17	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-17	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-17	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-17	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Total Metals							
Aluminum, total	**0.188**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Barium, total	**0.006**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Boron, total	**0.004**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-15	2016-11-16	
Calcium, total	**2.2**	N/A	0.2	mg/L	2016-11-15	2016-11-16	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Cobalt, total	**0.00006**	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Copper, total	**0.0006**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Iron, total	**0.10**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Magnesium, total	**0.45**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Manganese, total	**0.0040**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Potassium, total	**0.23**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Silicon, total	**3.6**	N/A	0.5	mg/L	2016-11-15	2016-11-16	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-15	2016-11-16	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: NA-2 (Balsam Creek) (6110765-04) [Water] Sampled: 2016-11-09 13:20, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Sodium, total	**1.62**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Strontium, total	**0.020**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-15	2016-11-16	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
E. coli (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	

Sample ID: NA-3 (Cattall Brook) (6110765-05) [Water] Sampled: 2016-11-09 14:25

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.845**	N/A	0.010	mg/L	N/A	2016-11-11	
General Parameters							
Alkalinity, Total (as CaCO3)	**30**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Bicarbonate (as CaCO3)	**30**	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-10	
Calculated Parameters							
Hardness, Total (as CaCO3)	**33.3**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.041**	N/A	0.005	mg/L	N/A	2016-11-17	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-17	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	2016-11-17	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Boron, dissolved	**0.021**	N/A	0.004	mg/L	N/A	2016-11-17	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-17	
Calcium, dissolved	**10.5**	N/A	0.2	mg/L	N/A	2016-11-17	
Chromium, dissolved	**0.0010**	N/A	0.0005	mg/L	N/A	2016-11-17	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	2016-11-17	
Copper, dissolved	**0.0020**	N/A	0.0002	mg/L	N/A	2016-11-17	
Iron, dissolved	**0.088**	N/A	0.010	mg/L	N/A	2016-11-17	

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PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6110765
REPORTED 2016-11-17

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6110765-05) [Water] Sampled: 2016-11-09 14:25, Continued							
Dissolved Metals, Continued							
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-17	
Magnesium, dissolved	**1.73**	N/A	0.01	mg/L	N/A	2016-11-17	
Manganese, dissolved	**0.0330**	N/A	0.0002	mg/L	N/A	2016-11-17	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, dissolved	**0.0033**	N/A	0.0001	mg/L	N/A	2016-11-17	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-11-17	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-17	
Potassium, dissolved	**1.80**	N/A	0.02	mg/L	N/A	2016-11-17	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-17	
Silicon, dissolved	**3.9**	N/A	0.5	mg/L	N/A	2016-11-17	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-17	
Sodium, dissolved	**5.45**	N/A	0.02	mg/L	N/A	2016-11-17	
Strontium, dissolved	**0.079**	N/A	0.001	mg/L	N/A	2016-11-17	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-17	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-17	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-17	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-17	
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	2016-11-17	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-17	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-17	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-17	
Total Metals							
Aluminum, total	**0.633**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Barium, total	**0.017**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Boron, total	**0.018**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-11-15	2016-11-16	
Calcium, total	**10.9**	N/A	0.2	mg/L	2016-11-15	2016-11-16	
Chromium, total	**0.0009**	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Cobalt, total	**0.00028**	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Copper, total	**0.0031**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Iron, total	**0.57**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Lead, total	**0.0003**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Lithium, total	**0.0004**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Magnesium, total	**1.76**	N/A	0.01	mg/L	2016-11-15	2016-11-16	
Manganese, total	**0.0414**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-10	2016-11-10	
Molybdenum, total	**0.0037**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Nickel, total	**0.0006**	N/A	0.0002	mg/L	2016-11-15	2016-11-16	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6110765-05) [Water] Sampled: 2016-11-09 14:25, Continued							
Total Metals, Continued							
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Potassium, total	**1.83**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-15	2016-11-16	
Silicon, total	**4.3**	N/A	0.5	mg/L	2016-11-15	2016-11-16	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-15	2016-11-16	
Sodium, total	**5.39**	N/A	0.02	mg/L	2016-11-15	2016-11-16	
Strontium, total	**0.075**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Sulfur, total	**2**	N/A	1	mg/L	2016-11-15	2016-11-16	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-15	2016-11-16	
Titanium, total	**0.025**	N/A	0.005	mg/L	2016-11-15	2016-11-16	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	2016-11-15	2016-11-16	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-11-15	2016-11-16	
Zinc, total	**0.006**	N/A	0.004	mg/L	2016-11-15	2016-11-16	
Zirconium, total	**0.0005**	N/A	0.0001	mg/L	2016-11-15	2016-11-16	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**4600**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
E. coli (MPN)	**1500**	N/A	3.0	MPN/100 mL	N/A	2016-11-10	
Sample ID: Field Blank (6110765-06) [Water] Sampled: 2016-11-09 13:15							
Anions							
Nitrate (as N)	**0.016**	N/A	0.010	mg/L	N/A	2016-11-11	

APPENDIX 1: QUALITY CONTROL DATA

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6K0747										
Blank (B6K0747-BLK1)				Prepared: 2016-11-10, Analyzed: 2016-11-10						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6K0747-BLK2)				Prepared: 2016-11-11, Analyzed: 2016-11-11						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6K0747-BLK3)				Prepared: 2016-11-11, Analyzed: 2016-11-11						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6K0747-BS1)				Prepared: 2016-11-10, Analyzed: 2016-11-10						
Nitrate (as N)	3.97	0.010	mg/L	4.00		99	93-108			
LCS (B6K0747-BS2)				Prepared: 2016-11-11, Analyzed: 2016-11-11						
Nitrate (as N)	3.93	0.010	mg/L	4.00		98	93-108			
LCS (B6K0747-BS3)				Prepared: 2016-11-11, Analyzed: 2016-11-11						
Nitrate (as N)	4.00	0.010	mg/L	4.00		100	93-108			
Anions, Batch B6K0885										
Blank (B6K0885-BLK1)				Prepared: 2016-11-14, Analyzed: 2016-11-14						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6K0885-BLK2)				Prepared: 2016-11-15, Analyzed: 2016-11-15						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6K0885-BS1)				Prepared: 2016-11-14, Analyzed: 2016-11-14						
Nitrate (as N)	3.98	0.010	mg/L	4.00		99	93-108			
LCS (B6K0885-BS2)				Prepared: 2016-11-15, Analyzed: 2016-11-15						
Nitrate (as N)	4.01	0.010	mg/L	4.00		100	93-108			
Dissolved Metals, Batch B6K0745										

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B6K0745, Continued										
Blank (B6K0745-BLK1)				Prepared: 2016-11-10, Analyzed: 2016-11-10						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Reference (B6K0745-SRM1)				Prepared: 2016-11-10, Analyzed: 2016-11-10						
Mercury, dissolved	0.00509	0.00002	mg/L	0.00486		105	50-150			
Dissolved Metals, Batch B6K1094										
Blank (B6K1094-BLK1)				Prepared: 2016-11-17, Analyzed: 2016-11-17						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Reference (B6K1094-SRM1)				Prepared: 2016-11-17, Analyzed: 2016-11-17						
Aluminum, dissolved	0.244	0.005	mg/L	0.233		105	58-142			
Antimony, dissolved	0.0449	0.0001	mg/L	0.0430		104	75-125			
Arsenic, dissolved	0.459	0.0005	mg/L	0.438		105	81-119			
Barium, dissolved	3.31	0.005	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.213	0.0001	mg/L	0.213		100	80-120			
Boron, dissolved	1.60	0.004	mg/L	1.74		92	74-117			
Cadmium, dissolved	0.220	0.00001	mg/L	0.224		98	83-117			
Calcium, dissolved	7.6	0.2	mg/L	7.69		99	76-124			
Chromium, dissolved	0.458	0.0005	mg/L	0.437		105	81-119			
Cobalt, dissolved	0.133	0.00005	mg/L	0.128		104	76-124			

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes

Dissolved Metals, Batch B6K1094, Continued

Reference (B6K1094-SRM1), Continued Prepared: 2016-11-17, Analyzed: 2016-11-17

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Copper, dissolved	0.869	0.0002	mg/L	0.844		103	84-116			
Iron, dissolved	1.33	0.010	mg/L	1.29		103	74-126			
Lead, dissolved	0.105	0.0001	mg/L	0.112		94	72-128			
Lithium, dissolved	0.0984	0.0001	mg/L	0.104		95	60-140			
Magnesium, dissolved	6.89	0.01	mg/L	6.92		100	81-119			
Manganese, dissolved	0.358	0.0002	mg/L	0.345		104	84-116			
Molybdenum, dissolved	0.417	0.0001	mg/L	0.426		98	83-117			
Nickel, dissolved	0.870	0.0002	mg/L	0.840		104	74-126			
Phosphorus, dissolved	0.53	0.02	mg/L	0.495		107	68-132			
Potassium, dissolved	3.26	0.02	mg/L	3.19		102	74-126			
Selenium, dissolved	0.0313	0.0005	mg/L	0.0331		95	70-130			
Sodium, dissolved	19.3	0.02	mg/L	19.1		101	72-128			
Strontium, dissolved	0.933	0.001	mg/L	0.916		102	84-113			
Thallium, dissolved	0.0365	0.00002	mg/L	0.0393		93	57-143			
Uranium, dissolved	0.239	0.00002	mg/L	0.266		90	85-115			
Vanadium, dissolved	0.888	0.001	mg/L	0.869		102	87-113			
Zinc, dissolved	0.911	0.004	mg/L	0.881		103	72-128			

General Parameters, Batch B6K0729

Blank (B6K0729-BLK1) Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6K0729-BS1) Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			

Microbiological Parameters, Batch B6K0715

Blank (B6K0715-BLK1) Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							

Blank (B6K0715-BLK2) Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 2.2	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 2.2	3.0	MPN/100 mL							
E. coli (MPN)	< 2.2	3.0	MPN/100 mL							

Blank (B6K0715-BLK3) Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							

Blank (B6K0715-BLK4) Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 1.1	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 1.1	3.0	MPN/100 mL							
E. coli (MPN)	< 1.1	3.0	MPN/100 mL							

Duplicate (B6K0715-DUP1) **Source: 6110765-03** Prepared: 2016-11-10, Analyzed: 2016-11-10

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	24000	3.0	MPN/100 mL		46000			63	102	
Coliforms, Fecal (MPN)	11000	3.0	MPN/100 mL		930			169	107	RPD
E. coli (MPN)	1200	3.0	MPN/100 mL		150			156	105	

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6K0746										
Blank (B6K0746-BLK1)				Prepared: 2016-11-10, Analyzed: 2016-11-10						
Mercury, total	< 0.00002	0.00002	mg/L							
Reference (B6K0746-SRM1)				Prepared: 2016-11-10, Analyzed: 2016-11-10						
Mercury, total	0.00498	0.00002	mg/L	0.00486		102	50-150			
Total Metals, Batch B6K0914										
Blank (B6K0914-BLK1)				Prepared: 2016-11-15, Analyzed: 2016-11-16						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Blank (B6K0914-BLK2)				Prepared: 2016-11-15, Analyzed: 2016-11-16						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							

Total Metals, Batch B6K0914, Continued

Blank (B6K0914-BLK2), Continued Prepared: 2016-11-15, Analyzed: 2016-11-16

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							

Reference (B6K0914-SRM1) Prepared: 2016-11-15, Analyzed: 2016-11-16

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.300	0.005	mg/L	0.303		99	81-129			
Antimony, total	0.0546	0.0001	mg/L	0.0511		107	88-114			
Arsenic, total	0.116	0.0005	mg/L	0.118		98	88-114			
Barium, total	0.804	0.005	mg/L	0.823		98	72-104			
Beryllium, total	0.0484	0.0001	mg/L	0.0496		98	76-131			
Boron, total	3.40	0.004	mg/L	3.45		99	75-121			
Cadmium, total	0.0484	0.00001	mg/L	0.0495		98	89-111			
Calcium, total	11.3	0.2	mg/L	11.6		97	86-121			
Chromium, total	0.253	0.0005	mg/L	0.250		101	89-114			
Cobalt, total	0.0384	0.00005	mg/L	0.0377		102	91-113			
Copper, total	0.503	0.0002	mg/L	0.486		104	91-115			
Iron, total	0.49	0.01	mg/L	0.488		100	77-124			
Lead, total	0.202	0.0001	mg/L	0.204		99	92-113			
Lithium, total	0.394	0.0001	mg/L	0.403		98	85-115			
Magnesium, total	3.73	0.01	mg/L	3.79		99	78-120			
Manganese, total	0.109	0.0002	mg/L	0.109		100	90-114			
Molybdenum, total	0.207	0.0001	mg/L	0.198		105	90-111			
Nickel, total	0.249	0.0002	mg/L	0.249		100	90-111			
Phosphorus, total	0.22	0.02	mg/L	0.227		96	85-115			
Potassium, total	7.30	0.02	mg/L	7.21		101	84-113			
Selenium, total	0.127	0.0005	mg/L	0.121		105	85-115			
Sodium, total	7.63	0.02	mg/L	7.54		101	82-123			
Strontium, total	0.373	0.001	mg/L	0.375		100	88-112			
Thallium, total	0.0816	0.00002	mg/L	0.0805		101	91-114			
Uranium, total	0.0301	0.00002	mg/L	0.0306		98	85-120			
Vanadium, total	0.383	0.001	mg/L	0.386		99	86-111			
Zinc, total	2.53	0.004	mg/L	2.49		102	85-111			

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6110765
REPORTED 2016-11-17

Total Metals, Batch B6K0914, Continued

Reference (B6K0914-SRM2) Prepared: 2016-11-15, Analyzed: 2016-11-16

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.297	0.005	mg/L	0.303		98	81-129			
Antimony, total	0.0553	0.0001	mg/L	0.0511		108	88-114			
Arsenic, total	0.116	0.0005	mg/L	0.118		98	88-114			
Barium, total	0.827	0.005	mg/L	0.823		101	72-104			
Beryllium, total	0.0481	0.0001	mg/L	0.0496		97	76-131			
Boron, total	3.36	0.004	mg/L	3.45		97	75-121			
Cadmium, total	0.0496	0.00001	mg/L	0.0495		100	89-111			
Calcium, total	11.2	0.2	mg/L	11.6		96	86-121			
Chromium, total	0.252	0.0005	mg/L	0.250		101	89-114			
Cobalt, total	0.0381	0.00005	mg/L	0.0377		101	91-113			
Copper, total	0.501	0.0002	mg/L	0.486		103	91-115			
Iron, total	0.48	0.01	mg/L	0.488		99	77-124			
Lead, total	0.208	0.0001	mg/L	0.204		102	92-113			
Lithium, total	0.396	0.0001	mg/L	0.403		98	85-115			
Magnesium, total	3.66	0.01	mg/L	3.79		97	78-120			
Manganese, total	0.108	0.0002	mg/L	0.109		99	90-114			
Molybdenum, total	0.211	0.0001	mg/L	0.198		107	90-111			
Nickel, total	0.251	0.0002	mg/L	0.249		101	90-111			
Phosphorus, total	0.23	0.02	mg/L	0.227		100	85-115			
Potassium, total	7.19	0.02	mg/L	7.21		100	84-113			
Selenium, total	0.128	0.0005	mg/L	0.121		106	85-115			
Sodium, total	7.45	0.02	mg/L	7.54		99	82-123			
Strontium, total	0.378	0.001	mg/L	0.375		101	88-112			
Thallium, total	0.0834	0.00002	mg/L	0.0805		104	91-114			
Uranium, total	0.0315	0.00002	mg/L	0.0306		103	85-120			
Vanadium, total	0.381	0.001	mg/L	0.386		99	86-111			
Zinc, total	2.56	0.004	mg/L	2.49		103	85-111			

QC Qualifiers:

RPD	Relative percent difference (RPD) of duplicate analysis are outside of control limits for unknown reason(s).

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6110765
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-11-17

		6110765-01	6110765-02	6110765-03	6110765-04	6110765-05	6110765-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-11-09	**2016-11-09**	**2016-11-09**	**2016-11-09**	**2016-11-09**	**2016-11-09**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	0.942	0.107	1.22	0.522	0.845	0.016
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	11	1	50	5	30	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	11	1	50	5	30	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	15.3	3.85	43.6	6.97	33.3	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.109	0.212	0.079	0.107	0.041	
	Antimony, dissolved (mg/L)	< 0.0001	< 0.0001	0.0002	< 0.0001	0.0001	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	0.0007	< 0.0005	< 0.0005	
	Barium, dissolved (mg/L)	0.010	< 0.005	0.011	< 0.005	0.013	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.017	0.010	0.024	0.008	0.021	
	Cadmium, dissolved (mg/L)	< 0.00001	0.00001	0.00002	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	4.8	1.3	11.4	2.1	10.5	
	Chromium, dissolved (mg/L)	< 0.0005	< 0.0005	0.0005	< 0.0005	0.0010	
	Cobalt, dissolved (mg/L)	0.00008	0.00005	0.00016	< 0.00005	0.00009	
	Copper, dissolved (mg/L)	0.0009	0.0006	0.0040	0.0004	0.0020	
	Iron, dissolved (mg/L)	0.085	0.045	0.144	0.035	0.088	
	Lead, dissolved (mg/L)	0.0001	0.0002	0.0002	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0002	< 0.0001	0.0004	< 0.0001	0.0002	
	Magnesium, dissolved (mg/L)	0.78	0.17	3.69	0.44	1.73	
	Manganese, dissolved (mg/L)	0.0038	0.0015	0.0325	0.0020	0.0330	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0002	< 0.0001	0.0007	< 0.0001	0.0033	
	Nickel, dissolved (mg/L)	0.0002	< 0.0002	0.0010	0.0002	0.0002	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	0.03	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	0.64	0.10	1.88	0.22	1.80	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	3.9	1.7	5.6	3.7	3.9	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	2.95	0.67	5.56	1.59	5.45	
	Strontium, dissolved (mg/L)	0.039	0.007	0.075	0.020	0.079	
	Sulfur, dissolved (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	< 0.00002	< 0.00002	0.00003	< 0.00002	0.00004	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	0.006	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	0.0002	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6110765
REPORTED 2016-11-17

		6110765-01	6110765-02	6110765-03	6110765-04	6110765-05	6110765-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-11-09	**2016-11-09**	**2016-11-09**	**2016-11-09**	**2016-11-09**	**2016-11-09**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.298	0.238	1.51	0.188	0.633	
	Antimony, total (mg/L)	< 0.0001	< 0.0001	0.0002	0.0002	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0010	< 0.0005	< 0.0005	
	Barium, total (mg/L)	0.013	< 0.005	0.023	0.006	0.017	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.008	< 0.004	0.021	0.004	0.018	
	Cadmium, total (mg/L)	0.00001	< 0.00001	0.00003	< 0.00001	0.00002	
	Calcium, total (mg/L)	5.2	1.3	12.4	2.2	10.9	
	Chromium, total (mg/L)	< 0.0005	0.0007	0.0022	< 0.0005	0.0009	
	Cobalt, total (mg/L)	0.00014	0.00006	0.00066	0.00006	0.00028	
	Copper, total (mg/L)	0.0013	0.0007	0.0070	0.0006	0.0031	
	Iron, total (mg/L)	0.27	0.07	1.44	0.10	0.57	
	Lead, total (mg/L)	0.0002	0.0002	0.0007	0.0001	0.0003	
	Lithium, total (mg/L)	0.0002	< 0.0001	0.0011	< 0.0001	0.0004	
	Magnesium, total (mg/L)	0.82	0.17	3.98	0.45	1.76	
	Manganese, total (mg/L)	0.0117	0.0028	0.0548	0.0040	0.0414	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0003	< 0.0001	0.0009	< 0.0001	0.0037	
	Nickel, total (mg/L)	0.0003	< 0.0002	0.0026	< 0.0002	0.0006	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.10	< 0.02	< 0.02	
	Potassium, total (mg/L)	0.68	0.10	2.03	0.23	1.83	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	4.1	1.6	7.7	3.6	4.3	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	3.11	0.68	5.65	1.62	5.39	
	Strontium, total (mg/L)	0.039	0.006	0.075	0.020	0.075	
	Sulfur, total (mg/L)	< 1	< 1	2	< 1	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	0.008	< 0.005	0.059	< 0.005	0.025	
	Uranium, total (mg/L)	< 0.00002	0.00002	0.00006	< 0.00002	0.00007	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.004	< 0.001	0.002	
	Zinc, total (mg/L)	0.005	< 0.004	0.014	< 0.004	0.006	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0005	< 0.0001	0.0005	
Microbiological Parameters	Coliforms, Fecal (MPN) (MPN/100 mL)	15	7.3	930	9.1	4600	
	E. coli (MPN) (MPN/100 mL)	7.3	7.3	150	9.1	1500	

CA
ANALYT
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CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC# ☐ PAGE 1 OF 1

RELINQUISHED BY:	DATE: 09-Nov-16	RECEIVED BY:	DATE: 09-Nov-16
Peter deKoning	TIME: 16:23	HM VI	TIME: 16:23

PROJECT: 173.191 Blaney, North Alouette, Fraser Riv

PROJECT INFO: Stormwater Monitoring

REPORT TO:
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐
EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION: Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

ANALYSES REQUESTED:

	MATRIX:					SAMPLING:		COMMENTS:																												
CLIENT SAMPLE ID:	DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	DATE DD-MMM-YY	TIME HH:MM	CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☒ *E. coli* ☒	ASBESTOS	Nitrate - N							**HOLD**
BL-1 (Anderson Creek)		✓			6	09-Nov-16	13:45												✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)		✓			6	09-Nov-16	15:00												✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)		✓			6	09-Nov-16	12:30												✓	✓		✓				✓	✓		✓							
NA-2 (Balsam Creek)		✓			6	09-Nov-16	13:20												✓	✓		✓				✓	✓		✓							
NA-3 (Cattall Brook)		✓			6	09-Nov-16	14:25												✓	✓		✓				✓	✓		✓							
Field Blank		✓			1	09-Nov-16	13:15																						✓							
Trip Blank		✓			1	09-Nov-16	8:20																													✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 7.7 ICE: Y ☐ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT:

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6111570
PO NUMBER		**RECEIVED / TEMP**	2016-11-22 14:47 / 7°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-11-29
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis . Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

TABLE OF CONTENTS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111570
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-11-29

ANALYSIS INFORMATION

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111570
REPORTED 2016-11-29

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221 E	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111570
REPORTED 2016-11-29

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6111570-01) [Water] Sampled: 2016-11-22 12:20							
Anions							
Nitrate (as N)	**0.850**	N/A	0.010	mg/L	N/A	2016-11-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**14**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Bicarbonate (as CaCO3)	**14**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Calculated Parameters							
Hardness, Total (as CaCO3)	**18.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.043**	N/A	0.005	mg/L	N/A	2016-11-24	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	2016-11-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-11-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-24	
Calcium, dissolved	**5.8**	N/A	0.2	mg/L	N/A	2016-11-24	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Copper, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-11-24	
Iron, dissolved	**0.050**	N/A	0.010	mg/L	N/A	2016-11-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-24	
Magnesium, dissolved	**0.92**	N/A	0.01	mg/L	N/A	2016-11-24	
Manganese, dissolved	**0.0029**	N/A	0.0002	mg/L	N/A	2016-11-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-24	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Potassium, dissolved	**0.33**	N/A	0.02	mg/L	N/A	2016-11-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Silicon, dissolved	**3.8**	N/A	0.5	mg/L	N/A	2016-11-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Sodium, dissolved	**3.68**	N/A	0.02	mg/L	N/A	2016-11-24	
Strontium, dissolved	**0.038**	N/A	0.001	mg/L	N/A	2016-11-24	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-24	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-24	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6111570
REPORTED 2016-11-29

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6111570-01) [Water] Sampled: 2016-11-22 12:20, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-24	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Total Metals							
Aluminum, total	**0.277**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Barium, total	**0.011**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Boron, total	**0.010**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-23	2016-11-24	
Calcium, total	**5.9**	N/A	0.2	mg/L	2016-11-23	2016-11-24	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Cobalt, total	**0.00016**	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Copper, total	**0.0013**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Iron, total	**0.30**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Magnesium, total	**0.95**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Manganese, total	**0.0169**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Potassium, total	**0.39**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Silicon, total	**4.0**	N/A	0.5	mg/L	2016-11-23	2016-11-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Sodium, total	**3.69**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Strontium, total	**0.040**	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-23	2016-11-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Titanium, total	**0.009**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Zinc, total	**0.004**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**15**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6111570-01) [Water] Sampled: 2016-11-22 12:20, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**15**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
Sample ID: NA-1 (North Alouette River) (6111570-02) [Water] Sampled: 2016-11-22 13:30							
Anions							
Nitrate (as N)	**0.129**	N/A	0.010	mg/L	N/A	2016-11-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**4**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Bicarbonate (as CaCO3)	**4**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Calculated Parameters							
Hardness, Total (as CaCO3)	**4.62**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.109**	N/A	0.005	mg/L	N/A	2016-11-24	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Boron, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-24	
Calcium, dissolved	**1.5**	N/A	0.2	mg/L	N/A	2016-11-24	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-11-24	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Copper, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-11-24	
Iron, dissolved	**0.032**	N/A	0.010	mg/L	N/A	2016-11-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Magnesium, dissolved	**0.21**	N/A	0.01	mg/L	N/A	2016-11-24	
Manganese, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-11-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-24	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Potassium, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Silicon, dissolved	**1.9**	N/A	0.5	mg/L	N/A	2016-11-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Sodium, dissolved	**0.89**	N/A	0.02	mg/L	N/A	2016-11-24	
Strontium, dissolved	**0.007**	N/A	0.001	mg/L	N/A	2016-11-24	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-24	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6111570
REPORTED 2016-11-29

Sample ID: NA-1 (North Alouette River) (6111570-02) [Water] Sampled: 2016-11-22 13:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-24	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-24	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Total Metals							
Aluminum, total	**0.126**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Boron, total	**0.005**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-23	2016-11-24	
Calcium, total	**1.6**	N/A	0.2	mg/L	2016-11-23	2016-11-24	
Chromium, total	**0.0011**	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Copper, total	**0.0006**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Iron, total	**0.05**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Magnesium, total	**0.22**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Manganese, total	**0.0015**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Potassium, total	< 0.02	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Silicon, total	**2.0**	N/A	0.5	mg/L	2016-11-23	2016-11-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Sodium, total	**0.92**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Strontium, total	**0.008**	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-23	2016-11-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-23	2016-11-24	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111570
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-11-29

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6111570-02) [Water] Sampled: 2016-11-22 13:30, Continued							
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**14**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
E. coli (MPN)	**14**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
Sample ID: FR-1 (227 St Creek) (6111570-03) [Water] Sampled: 2016-11-22 11:30							
Anions							
Nitrate (as N)	**0.406**	N/A	0.010	mg/L	N/A	2016-11-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**31**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Bicarbonate (as CaCO3)	**31**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Calculated Parameters							
Hardness, Total (as CaCO3)	**29.0**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.017**	N/A	0.005	mg/L	N/A	2016-11-24	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Barium, dissolved	**0.005**	N/A	0.005	mg/L	N/A	2016-11-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Boron, dissolved	**0.012**	N/A	0.004	mg/L	N/A	2016-11-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-24	
Calcium, dissolved	**7.8**	N/A	0.2	mg/L	N/A	2016-11-24	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-11-24	
Cobalt, dissolved	**0.00007**	N/A	0.00005	mg/L	N/A	2016-11-24	
Copper, dissolved	**0.0022**	N/A	0.0002	mg/L	N/A	2016-11-24	
Iron, dissolved	**0.077**	N/A	0.010	mg/L	N/A	2016-11-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-11-24	
Magnesium, dissolved	**2.33**	N/A	0.01	mg/L	N/A	2016-11-24	
Manganese, dissolved	**0.0222**	N/A	0.0002	mg/L	N/A	2016-11-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	2016-11-24	
Nickel, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-11-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Potassium, dissolved	**0.68**	N/A	0.02	mg/L	N/A	2016-11-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6111570-03) [Water] Sampled: 2016-11-22 11:30, Continued							
Dissolved Metals, Continued							
Silicon, dissolved	**2.4**	N/A	0.5	mg/L	N/A	2016-11-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Sodium, dissolved	**3.78**	N/A	0.02	mg/L	N/A	2016-11-24	
Strontium, dissolved	**0.041**	N/A	0.001	mg/L	N/A	2016-11-24	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-24	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-24	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-24	
Zinc, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-11-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Total Metals							
Aluminum, total	**0.726**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Arsenic, total	**0.0006**	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Barium, total	**0.011**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Boron, total	**0.014**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-11-23	2016-11-24	
Calcium, total	**8.2**	N/A	0.2	mg/L	2016-11-23	2016-11-24	
Chromium, total	**0.0014**	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Cobalt, total	**0.00036**	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Copper, total	**0.0046**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Iron, total	**0.95**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Lead, total	**0.0006**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Lithium, total	**0.0008**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Magnesium, total	**2.59**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Manganese, total	**0.0430**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, total	**0.0007**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Nickel, total	**0.0012**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Phosphorus, total	**0.03**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Potassium, total	**0.80**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Silicon, total	**3.6**	N/A	0.5	mg/L	2016-11-23	2016-11-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Sodium, total	**3.90**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Strontium, total	**0.044**	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-23	2016-11-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-23	2016-11-24	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6111570-03) [Water] Sampled: 2016-11-22 11:30, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Titanium, total	**0.034**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Uranium, total	**0.00003**	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Zinc, total	**0.012**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Zirconium, total	**0.0005**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**2400**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
E. coli (MPN)	**460**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
Sample ID: NA-2 (Balsam Creek) (6111570-04) [Water] Sampled: 2016-11-22 12:00							
Anions							
Nitrate (as N)	**0.647**	N/A	0.010	mg/L	N/A	2016-11-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**6**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Bicarbonate (as CaCO3)	**6**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Calculated Parameters							
Hardness, Total (as CaCO3)	**9.92**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.042**	N/A	0.005	mg/L	N/A	2016-11-24	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Barium, dissolved	**0.005**	N/A	0.005	mg/L	N/A	2016-11-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Boron, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-11-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-24	
Calcium, dissolved	**3.0**	N/A	0.2	mg/L	N/A	2016-11-24	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Copper, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	2016-11-24	
Iron, dissolved	**0.021**	N/A	0.010	mg/L	N/A	2016-11-24	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Magnesium, dissolved	**0.58**	N/A	0.01	mg/L	N/A	2016-11-24	
Manganese, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-11-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-2 (Balsam Creek) (6111570-04) [Water] Sampled: 2016-11-22 12:00, Continued							
Dissolved Metals, Continued							
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Potassium, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Silicon, dissolved	**3.8**	N/A	0.5	mg/L	N/A	2016-11-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Sodium, dissolved	**2.29**	N/A	0.02	mg/L	N/A	2016-11-24	
Strontium, dissolved	**0.024**	N/A	0.001	mg/L	N/A	2016-11-24	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-24	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-24	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-24	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Total Metals							
Aluminum, total	**0.099**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Barium, total	**0.006**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Boron, total	**0.006**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-23	2016-11-24	
Calcium, total	**3.0**	N/A	0.2	mg/L	2016-11-23	2016-11-24	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Copper, total	**0.0004**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Iron, total	**0.07**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Magnesium, total	**0.60**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Manganese, total	**0.0028**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Potassium, total	< 0.02	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Silicon, total	**3.9**	N/A	0.5	mg/L	2016-11-23	2016-11-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	

SAMPLE ANALYTICAL DATA

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-2 (Balsam Creek) (6111570-04) [Water] Sampled: 2016-11-22 12:00, Continued							
Total Metals, Continued							
Sodium, total	**2.36**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Strontium, total	**0.025**	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-23	2016-11-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
E. coli (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
Sample ID: NA-3 (Cattall Brook) (6111570-05) [Water] Sampled: 2016-11-22 13:00							
Anions							
Nitrate (as N)	**0.646**	N/A	0.010	mg/L	N/A	2016-11-24	
General Parameters							
Alkalinity, Total (as CaCO3)	**39**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Bicarbonate (as CaCO3)	**39**	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-24	
Calculated Parameters							
Hardness, Total (as CaCO3)	**66.4**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-11-24	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Barium, dissolved	**0.015**	N/A	0.005	mg/L	N/A	2016-11-24	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Boron, dissolved	**0.052**	N/A	0.004	mg/L	N/A	2016-11-24	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-24	
Calcium, dissolved	**22.5**	N/A	0.2	mg/L	N/A	2016-11-24	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Cobalt, dissolved	**0.00013**	N/A	0.00005	mg/L	N/A	2016-11-24	
Copper, dissolved	**0.0012**	N/A	0.0002	mg/L	N/A	2016-11-24	
Iron, dissolved	**0.084**	N/A	0.010	mg/L	N/A	2016-11-24	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111570
REPORTED 2016-11-29

Sample ID: NA-3 (Cattall Brook) (6111570-05) [Water] Sampled: 2016-11-22 13:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Lithium, dissolved	**0.0007**	N/A	0.0001	mg/L	N/A	2016-11-24	
Magnesium, dissolved	**2.49**	N/A	0.01	mg/L	N/A	2016-11-24	
Manganese, dissolved	**0.0673**	N/A	0.0002	mg/L	N/A	2016-11-24	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, dissolved	**0.0038**	N/A	0.0001	mg/L	N/A	2016-11-24	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-24	
Potassium, dissolved	**1.52**	N/A	0.02	mg/L	N/A	2016-11-24	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-24	
Silicon, dissolved	**5.0**	N/A	0.5	mg/L	N/A	2016-11-24	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-24	
Sodium, dissolved	**17.3**	N/A	0.02	mg/L	N/A	2016-11-24	
Strontium, dissolved	**0.151**	N/A	0.001	mg/L	N/A	2016-11-24	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-11-24	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-24	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-24	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-24	
Uranium, dissolved	**0.00006**	N/A	0.00002	mg/L	N/A	2016-11-24	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-24	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-24	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-24	
Total Metals							
Aluminum, total	**0.166**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Barium, total	**0.017**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Boron, total	**0.053**	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-23	2016-11-24	
Calcium, total	**22.4**	N/A	0.2	mg/L	2016-11-23	2016-11-24	
Chromium, total	**0.0011**	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Cobalt, total	**0.00022**	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Copper, total	**0.0024**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Iron, total	**0.35**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Lithium, total	**0.0008**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Magnesium, total	**2.49**	N/A	0.01	mg/L	2016-11-23	2016-11-24	
Manganese, total	**0.0825**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-24	2016-11-27	
Molybdenum, total	**0.0040**	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Nickel, total	**0.0004**	N/A	0.0002	mg/L	2016-11-23	2016-11-24	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6111570
REPORTED 2016-11-29

Sample ID: NA-3 (Cattall Brook) (6111570-05) [Water] Sampled: 2016-11-22 13:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Potassium, total	**1.49**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-23	2016-11-24	
Silicon, total	**5.1**	N/A	0.5	mg/L	2016-11-23	2016-11-24	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-23	2016-11-24	
Sodium, total	**17.1**	N/A	0.02	mg/L	2016-11-23	2016-11-24	
Strontium, total	**0.151**	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-23	2016-11-24	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-23	2016-11-24	
Titanium, total	**0.007**	N/A	0.005	mg/L	2016-11-23	2016-11-24	
Uranium, total	**0.00007**	N/A	0.00002	mg/L	2016-11-23	2016-11-24	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-23	2016-11-24	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-23	2016-11-24	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-23	2016-11-24	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**91**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	
E. coli (MPN)	**91**	N/A	3.0	MPN/100 mL	N/A	2016-11-23	

Sample ID: Field Blank (6111570-06) [Water] Sampled: 2016-11-22 13:20

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Microbiological Parameters							
E. coli (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-11-23	

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6K1497										
Blank (B6K1497-BLK1)				Prepared: 2016-11-23, Analyzed: 2016-11-23						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6K1497-BLK2)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6K1497-BLK3)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6K1497-BS1)				Prepared: 2016-11-23, Analyzed: 2016-11-23						
Nitrate (as N)	4.07	0.010	mg/L	4.00		102	93-108			
LCS (B6K1497-BS2)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Nitrate (as N)	4.09	0.010	mg/L	4.00		102	93-108			
LCS (B6K1497-BS3)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Nitrate (as N)	4.06	0.010	mg/L	4.00		101	93-108			
Dissolved Metals, Batch B6K1550										
Blank (B6K1550-BLK1)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							

Dissolved Metals, Batch B6K1550, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Blank (B6K1550-BLK1), Continued				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							
Duplicate (B6K1550-DUP1)		**Source: 6111570-05**		Prepared: 2016-11-24, Analyzed: 2016-11-24						
Aluminum, dissolved	0.012	0.005	mg/L		0.011				11	
Antimony, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.015	0.005	mg/L		0.015				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.054	0.004	mg/L		0.052			4	13	
Cadmium, dissolved	0.00001	0.00001	mg/L		< 0.00001				27	
Calcium, dissolved	22.0	0.2	mg/L		22.5			2	8	
Chromium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				14	
Cobalt, dissolved	0.00014	0.00005	mg/L		0.00013				10	
Copper, dissolved	0.0013	0.0002	mg/L		0.0012			9	28	
Iron, dissolved	0.085	0.010	mg/L		0.084			< 1	14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0007	0.0001	mg/L		0.0007			1	14	
Magnesium, dissolved	2.45	0.01	mg/L		2.49			1	6	
Manganese, dissolved	0.0672	0.0002	mg/L		0.0673			< 1	9	
Molybdenum, dissolved	0.0038	0.0001	mg/L		0.0038			1	19	
Nickel, dissolved	0.0002	0.0002	mg/L		0.0002				21	
Phosphorus, dissolved	< 0.02	0.02	mg/L		< 0.02				14	
Potassium, dissolved	1.54	0.02	mg/L		1.52			1	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	4.9	0.5	mg/L		5.0			2	12	
Silver, dissolved	0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	17.0	0.02	mg/L		17.3			2	6	
Strontium, dissolved	0.150	0.001	mg/L		0.151			< 1	6	
Sulfur, dissolved	< 1	1	mg/L		2				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	

Dissolved Metals, Batch B6K1550, Continued

Duplicate (B6K1550-DUP1), Continued **Source: 6111570-05** Prepared: 2016-11-24, Analyzed: 2016-11-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	0.00007	0.00002	mg/L		0.00006				14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		< 0.004				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	

Reference (B6K1550-SRM1) Prepared: 2016-11-24, Analyzed: 2016-11-24

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.223	0.005	mg/L	0.233		96	58-142			
Antimony, dissolved	0.0444	0.0001	mg/L	0.0430		103	75-125			
Arsenic, dissolved	0.428	0.0005	mg/L	0.438		98	81-119			
Barium, dissolved	3.35	0.005	mg/L	3.35		100	83-117			
Beryllium, dissolved	0.212	0.0001	mg/L	0.213		100	80-120			
Boron, dissolved	1.71	0.004	mg/L	1.74		98	74-117			
Cadmium, dissolved	0.211	0.00001	mg/L	0.224		94	83-117			
Calcium, dissolved	7.9	0.2	mg/L	7.69		103	76-124			
Chromium, dissolved	0.442	0.0005	mg/L	0.437		101	81-119			
Cobalt, dissolved	0.128	0.00005	mg/L	0.128		100	76-124			
Copper, dissolved	0.857	0.0002	mg/L	0.844		101	84-116			
Iron, dissolved	1.27	0.010	mg/L	1.29		99	74-126			
Lead, dissolved	0.115	0.0001	mg/L	0.112		102	72-128			
Lithium, dissolved	0.107	0.0001	mg/L	0.104		103	60-140			
Magnesium, dissolved	6.90	0.01	mg/L	6.92		100	81-119			
Manganese, dissolved	0.339	0.0002	mg/L	0.345		98	84-116			
Molybdenum, dissolved	0.418	0.0001	mg/L	0.426		98	83-117			
Nickel, dissolved	0.854	0.0002	mg/L	0.840		102	74-126			
Phosphorus, dissolved	0.47	0.02	mg/L	0.495		94	68-132			
Potassium, dissolved	2.87	0.02	mg/L	3.19		90	74-126			
Selenium, dissolved	0.0340	0.0005	mg/L	0.0331		103	70-130			
Sodium, dissolved	18.7	0.02	mg/L	19.1		98	72-128			
Strontium, dissolved	0.896	0.001	mg/L	0.916		98	84-113			
Thallium, dissolved	0.0395	0.00002	mg/L	0.0393		101	57-143			
Uranium, dissolved	0.269	0.00002	mg/L	0.266		101	85-115			
Vanadium, dissolved	0.845	0.001	mg/L	0.869		97	87-113			
Zinc, dissolved	0.857	0.004	mg/L	0.881		97	72-128			

Dissolved Metals, Batch B6K1641

Blank (B6K1641-BLK1) Prepared: 2016-11-24, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Blank (B6K1641-BLK2) Prepared: 2016-11-24, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Duplicate (B6K1641-DUP2) **Source: 6111570-01** Prepared: 2016-11-24, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	

Matrix Spike (B6K1641-MS2) **Source: 6111570-02** Prepared: 2016-11-24, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00022	0.00002	mg/L	0.000250	< 0.00002	88	70-130			

Reference (B6K1641-SRM1) Prepared: 2016-11-24, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00466	0.00002	mg/L	0.00489		95	50-150			

Reference (B6K1641-SRM2) Prepared: 2016-11-24, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00461	0.00002	mg/L	0.00489		94	50-150			

General Parameters, Batch B6K1575

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6K1575, Continued										
Blank (B6K1575-BLK1)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							
Blank (B6K1575-BLK2)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							
Blank (B6K1575-BLK3)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							
LCS (B6K1575-BS1)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Alkalinity, Total (as CaCO3)	101	2	mg/L	100		101	96-108			
LCS (B6K1575-BS3)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Alkalinity, Total (as CaCO3)	101	2	mg/L	100		101	96-108			
LCS (B6K1575-BS5)				Prepared: 2016-11-24, Analyzed: 2016-11-24						
Alkalinity, Total (as CaCO3)	102	2	mg/L	100		102	96-108			
Microbiological Parameters, Batch B6K1481										
Blank (B6K1481-BLK1)				Prepared: 2016-11-23, Analyzed: 2016-11-23						
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							
Duplicate (B6K1481-DUP1)	**Source: 6111570-01**			Prepared: 2016-11-23, Analyzed: 2016-11-23						
Coliforms, Total (MPN)	1100	3.0	MPN/100 mL		1100			< 1	102	
Coliforms, Fecal (MPN)	93	3.0	MPN/100 mL		15			144	107	
E. coli (MPN)	93	3.0	MPN/100 mL		15			144	105	
Total Metals, Batch B6K1544										
Blank (B6K1544-BLK1)				Prepared: 2016-11-23, Analyzed: 2016-11-24						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							

Total Metals, Batch B6K1544, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Blank (B6K1544-BLK1), Continued				Prepared: 2016-11-23, Analyzed: 2016-11-24						
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Reference (B6K1544-SRM1)				Prepared: 2016-11-23, Analyzed: 2016-11-24						
Aluminum, total	0.307	0.005	mg/L	0.303		101	81-129			
Antimony, total	0.0524	0.0001	mg/L	0.0511		102	88-114			
Arsenic, total	0.118	0.0005	mg/L	0.118		100	88-114			
Barium, total	0.775	0.005	mg/L	0.823		94	72-104			
Beryllium, total	0.0494	0.0001	mg/L	0.0496		100	76-131			
Boron, total	3.41	0.004	mg/L	3.45		99	75-121			
Cadmium, total	0.0481	0.00001	mg/L	0.0495		97	89-111			
Calcium, total	11.5	0.2	mg/L	11.6		99	86-121			
Chromium, total	0.255	0.0005	mg/L	0.250		102	89-114			
Cobalt, total	0.0396	0.00005	mg/L	0.0377		105	91-113			
Copper, total	0.529	0.0002	mg/L	0.486		109	91-115			
Iron, total	0.52	0.01	mg/L	0.488		106	77-124			
Lead, total	0.212	0.0001	mg/L	0.204		104	92-113			
Lithium, total	0.411	0.0001	mg/L	0.403		102	85-115			
Magnesium, total	3.97	0.01	mg/L	3.79		105	78-120			
Manganese, total	0.109	0.0002	mg/L	0.109		100	90-114			
Molybdenum, total	0.198	0.0001	mg/L	0.198		100	90-111			
Nickel, total	0.251	0.0002	mg/L	0.249		101	90-111			
Phosphorus, total	0.21	0.02	mg/L	0.227		92	85-115			
Potassium, total	7.23	0.02	mg/L	7.21		100	84-113			
Selenium, total	0.130	0.0005	mg/L	0.121		107	85-115			
Sodium, total	7.74	0.02	mg/L	7.54		103	82-123			
Strontium, total	0.374	0.001	mg/L	0.375		100	88-112			
Thallium, total	0.0870	0.00002	mg/L	0.0805		108	91-114			
Uranium, total	0.0307	0.00002	mg/L	0.0306		100	85-120			
Vanadium, total	0.389	0.001	mg/L	0.386		101	86-111			
Zinc, total	2.51	0.004	mg/L	2.49		101	85-111			

Total Metals, Batch B6K1643

APPENDIX 1: QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111570
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6K1643, Continued										
Blank (B6K1643-BLK1)				Prepared: 2016-11-24, Analyzed: 2016-11-27						
Mercury, total	< 0.00002	0.00002	mg/L							
Blank (B6K1643-BLK2)				Prepared: 2016-11-24, Analyzed: 2016-11-27						
Mercury, total	< 0.00002	0.00002	mg/L							
Reference (B6K1643-SRM1)				Prepared: 2016-11-24, Analyzed: 2016-11-27						
Mercury, total	0.00488	0.00002	mg/L	0.00489		100	50-150			
Reference (B6K1643-SRM2)				Prepared: 2016-11-24, Analyzed: 2016-11-27						
Mercury, total	0.00460	0.00002	mg/L	0.00489		94	50-150			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111570
REPORTED 2016-11-29

		6111570-01	6111570-02	6111570-03	6111570-04	6111570-05	6111570-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-11-22	**2016-11-22**	**2016-11-22**	**2016-11-22**	**2016-11-22**	**2016-11-22**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	0.850	0.129	0.406	0.647	0.646	
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	14	4	31	6	39	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	14	4	31	6	39	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	18.4	4.62	29.0	9.92	66.4	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.043	0.109	0.017	0.042	0.011	
	Antimony, dissolved (mg/L)	< 0.0001	< 0.0001	0.0002	< 0.0001	< 0.0001	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Barium, dissolved (mg/L)	0.009	< 0.005	0.005	0.005	0.015	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.009	< 0.004	0.012	0.005	0.052	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	5.8	1.5	7.8	3.0	22.5	
	Chromium, dissolved (mg/L)	< 0.0005	0.0006	0.0006	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00007	< 0.00005	0.00013	
	Copper, dissolved (mg/L)	0.0007	0.0004	0.0022	0.0003	0.0012	
	Iron, dissolved (mg/L)	0.050	0.032	0.077	0.021	0.084	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0002	< 0.0001	0.0003	< 0.0001	0.0007	
	Magnesium, dissolved (mg/L)	0.92	0.21	2.33	0.58	2.49	
	Manganese, dissolved (mg/L)	0.0029	0.0007	0.0222	0.0010	0.0673	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0002	0.0001	0.0007	< 0.0001	0.0038	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0004	< 0.0002	< 0.0002	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	0.33	< 0.02	0.68	< 0.02	1.52	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	3.8	1.9	2.4	3.8	5.0	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	3.68	0.89	3.78	2.29	17.3	
	Strontium, dissolved (mg/L)	0.038	0.007	0.041	0.024	0.151	
	Sulfur, dissolved (mg/L)	< 1	< 1	< 1	< 1	2	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	0.00006	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	0.005	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111570
REPORTED 2016-11-29

		6111570-01	6111570-02	6111570-03	6111570-04	6111570-05	6111570-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-11-22	**2016-11-22**	**2016-11-22**	**2016-11-22**	**2016-11-22**	**2016-11-22**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.277	0.126	0.726	0.099	0.166	
	Antimony, total (mg/L)	< 0.0001	< 0.0001	0.0003	< 0.0001	0.0001	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005	
	Barium, total (mg/L)	0.011	< 0.005	0.011	0.006	0.017	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.010	0.005	0.014	0.006	0.053	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00002	< 0.00001	< 0.00001	
	Calcium, total (mg/L)	5.9	1.6	8.2	3.0	22.4	
	Chromium, total (mg/L)	< 0.0005	0.0011	0.0014	0.0005	0.0011	
	Cobalt, total (mg/L)	0.00016	< 0.00005	0.00036	< 0.00005	0.00022	
	Copper, total (mg/L)	0.0013	0.0006	0.0046	0.0004	0.0024	
	Iron, total (mg/L)	0.30	0.05	0.95	0.07	0.35	
	Lead, total (mg/L)	0.0002	0.0001	0.0006	< 0.0001	< 0.0001	
	Lithium, total (mg/L)	0.0003	0.0001	0.0008	0.0001	0.0008	
	Magnesium, total (mg/L)	0.95	0.22	2.59	0.60	2.49	
	Manganese, total (mg/L)	0.0169	0.0015	0.0430	0.0028	0.0825	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0002	0.0002	0.0007	< 0.0001	0.0040	
	Nickel, total (mg/L)	0.0003	0.0003	0.0012	0.0003	0.0004	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.03	< 0.02	< 0.02	
	Potassium, total (mg/L)	0.39	< 0.02	0.80	< 0.02	1.49	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	4.0	2.0	3.6	3.9	5.1	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	3.69	0.92	3.90	2.36	17.1	
	Strontium, total (mg/L)	0.040	0.008	0.044	0.025	0.151	
	Sulfur, total (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	0.009	< 0.005	0.034	< 0.005	0.007	
	Uranium, total (mg/L)	0.00002	0.00002	0.00003	< 0.00002	0.00007	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.002	< 0.001	< 0.001	
	Zinc, total (mg/L)	0.004	< 0.004	0.012	< 0.004	< 0.004	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0005	< 0.0001	< 0.0001	
Microbiological Parameters	Coliforms, Fecal (MPN) (MPN/100 mL)	15	14	2400	< 3.0	91	
	E. coli (MPN) (MPN/100 mL)	15	14	460	< 3.0	91	< 3.0

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PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning	DATE: 22-Nov-16 TIME: 14:45	RECEIVED BY: WJ TL	DATE: 22-Nov-16 TIME: 14:47
PROJECT: 173.191 Blaney, North Alouette, Fraser Riv		PROJECT INFO: Stormwater Monitoring	

REPORT TO:

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐ EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION:
Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

SAMPLED BY: Peter deKoning

611570

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ *E. coli* ☒	ASBESTOS	Nitrate - N							**HOLD**
BL-1 (Anderson Creek)		✓			6	22-Nov-16	12:20												✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)		✓			6	22-Nov-16	13:30												✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)		✓			6	22-Nov-16	11:30												✓	✓		✓				✓	✓		✓							
NA-2 (Balsam Creek)		✓			6	22-Nov-16	12:00												✓	✓		✓				✓	✓		✓							
NA-3 (Cattall Brook)		✓			6	22-Nov-16	13:00												✓	✓		✓				✓	✓		✓							
Field Blank		✓			1	22-Nov-16	13:20																				✓									
Trip Blank		✓			1	22-Nov-16	9:00																													✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 7.0 ICE: Y ☑ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT:

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6111767
PO NUMBER		**RECEIVED / TEMP**	2016-11-24 14:15 / 6°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-01
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

TABLE OF CONTENTS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111767
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-01

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111767
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-01

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221 E	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Most Probable Number / Multiple-Tube Fermentation	Kelowna
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111767
REPORTED 2016-12-01

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6111767-01) [Water] Sampled: 2016-11-24 11:15							
Anions							
Nitrate (as N)	**1.04**	N/A	0.010	mg/L	N/A	2016-11-26	
General Parameters							
Alkalinity, Total (as CaCO3)	**12**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Bicarbonate (as CaCO3)	**12**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Calculated Parameters							
Hardness, Total (as CaCO3)	**15.9**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.059**	N/A	0.005	mg/L	N/A	2016-11-29	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-29	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Barium, dissolved	**0.009**	N/A	0.005	mg/L	N/A	2016-11-29	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Boron, dissolved	**0.013**	N/A	0.004	mg/L	N/A	2016-11-29	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-29	
Calcium, dissolved	**5.0**	N/A	0.2	mg/L	N/A	2016-11-29	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Copper, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	2016-11-29	
Iron, dissolved	**0.056**	N/A	0.010	mg/L	N/A	2016-11-29	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-29	
Magnesium, dissolved	**0.82**	N/A	0.01	mg/L	N/A	2016-11-29	
Manganese, dissolved	**0.0034**	N/A	0.0002	mg/L	N/A	2016-11-29	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-29	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-29	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-11-29	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-29	
Potassium, dissolved	**0.63**	N/A	0.02	mg/L	N/A	2016-11-29	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Silicon, dissolved	**4.0**	N/A	0.5	mg/L	N/A	2016-11-29	
Silver, dissolved	**0.00008**	N/A	0.00005	mg/L	N/A	2016-11-29	
Sodium, dissolved	**3.18**	N/A	0.02	mg/L	N/A	2016-11-29	
Strontium, dissolved	**0.035**	N/A	0.001	mg/L	N/A	2016-11-29	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-29	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-29	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6111767-01) [Water] Sampled: 2016-11-24 11:15, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	2016-11-29	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-29	
Zinc, dissolved	**0.006**	N/A	0.004	mg/L	N/A	2016-11-29	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Total Metals							
Aluminum, total	**0.122**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Barium, total	**0.010**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Boron, total	**0.017**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	2016-11-28	2016-11-29	
Calcium, total	**5.4**	N/A	0.2	mg/L	2016-11-28	2016-11-29	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Cobalt, total	**0.00017**	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Copper, total	**0.0008**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Iron, total	**0.13**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Magnesium, total	**0.89**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Manganese, total	**0.0071**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-30	
Molybdenum, total	**0.0003**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Nickel, total	**0.0002**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Potassium, total	**0.67**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Silicon, total	**4.2**	N/A	0.5	mg/L	2016-11-28	2016-11-29	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Sodium, total	**3.45**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Strontium, total	**0.038**	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Sulfur, total	**1**	N/A	1	mg/L	2016-11-28	2016-11-29	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes

Sample ID: BL-1 (Anderson Creek) (6111767-01) [Water] Sampled: 2016-11-24 11:15, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Microbiological Parameters, Continued							
E. coli (MPN)	**9.1**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	

Sample ID: NA-1 (North Alouette River) (6111767-02) [Water] Sampled: 2016-11-24 12:15

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.123**	N/A	0.010	mg/L	N/A	2016-11-26	
General Parameters							
Alkalinity, Total (as CaCO3)	**2**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Bicarbonate (as CaCO3)	**2**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Calculated Parameters							
Hardness, Total (as CaCO3)	**3.83**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.161**	N/A	0.005	mg/L	N/A	2016-11-29	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-29	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Boron, dissolved	**0.006**	N/A	0.004	mg/L	N/A	2016-11-29	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	2016-11-29	
Calcium, dissolved	**1.3**	N/A	0.2	mg/L	N/A	2016-11-29	
Chromium, dissolved	**0.0007**	N/A	0.0005	mg/L	N/A	2016-11-29	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Copper, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-11-29	
Iron, dissolved	**0.050**	N/A	0.010	mg/L	N/A	2016-11-29	
Lead, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-29	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Magnesium, dissolved	**0.17**	N/A	0.01	mg/L	N/A	2016-11-29	
Manganese, dissolved	**0.0010**	N/A	0.0002	mg/L	N/A	2016-11-29	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-29	
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-29	
Potassium, dissolved	**0.10**	N/A	0.02	mg/L	N/A	2016-11-29	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Silicon, dissolved	**1.7**	N/A	0.5	mg/L	N/A	2016-11-29	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Sodium, dissolved	**0.68**	N/A	0.02	mg/L	N/A	2016-11-29	
Strontium, dissolved	**0.006**	N/A	0.001	mg/L	N/A	2016-11-29	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-29	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111767
REPORTED 2016-12-01

Sample ID: NA-1 (North Alouette River) (6111767-02) [Water] Sampled: 2016-11-24 12:15, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-29	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-11-29	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-29	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-29	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Total Metals							
Aluminum, total	**0.188**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Boron, total	**0.009**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	2016-11-28	2016-11-29	
Calcium, total	**1.3**	N/A	0.2	mg/L	2016-11-28	2016-11-29	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Copper, total	**0.0004**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Iron, total	**0.05**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Magnesium, total	**0.18**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Manganese, total	**0.0015**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-30	
Molybdenum, total	**0.0001**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Potassium, total	**0.09**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Silicon, total	**1.7**	N/A	0.5	mg/L	2016-11-28	2016-11-29	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Sodium, total	**0.62**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Strontium, total	**0.006**	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-28	2016-11-29	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-28	2016-11-29	

Sample ID: NA-1 (North Alouette River) (6111767-02) [Water] Sampled: 2016-11-24 12:15, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**3.6**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	
E. coli (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-11-25	

Sample ID: FR-1 (227 St Creek) (6111767-03) [Water] Sampled: 2016-11-24 10:30

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**1.03**	N/A	0.010	mg/L	N/A	2016-11-26	
General Parameters							
Alkalinity, Total (as CaCO3)	**67**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Bicarbonate (as CaCO3)	**67**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Calculated Parameters							
Hardness, Total (as CaCO3)	**60.5**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.025**	N/A	0.005	mg/L	N/A	2016-11-29	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-11-29	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Barium, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-11-29	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Boron, dissolved	**0.021**	N/A	0.004	mg/L	N/A	2016-11-29	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-29	
Calcium, dissolved	**15.4**	N/A	0.2	mg/L	N/A	2016-11-29	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Cobalt, dissolved	**0.00014**	N/A	0.00005	mg/L	N/A	2016-11-29	
Copper, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	2016-11-29	
Iron, dissolved	**0.112**	N/A	0.010	mg/L	N/A	2016-11-29	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Lithium, dissolved	**0.0006**	N/A	0.0001	mg/L	N/A	2016-11-29	
Magnesium, dissolved	**5.39**	N/A	0.01	mg/L	N/A	2016-11-29	
Manganese, dissolved	**0.0443**	N/A	0.0002	mg/L	N/A	2016-11-29	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-29	
Molybdenum, dissolved	**0.0011**	N/A	0.0001	mg/L	N/A	2016-11-29	
Nickel, dissolved	**0.0007**	N/A	0.0002	mg/L	N/A	2016-11-29	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-29	
Potassium, dissolved	**1.90**	N/A	0.02	mg/L	N/A	2016-11-29	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111767
REPORTED 2016-12-01

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6111767-03) [Water] Sampled: 2016-11-24 10:30, Continued							
Dissolved Metals, Continued							
Silicon, dissolved	**6.5**	N/A	0.5	mg/L	N/A	2016-11-29	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Sodium, dissolved	**7.80**	N/A	0.02	mg/L	N/A	2016-11-29	
Strontium, dissolved	**0.090**	N/A	0.001	mg/L	N/A	2016-11-29	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-11-29	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-29	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	
Uranium, dissolved	**0.00004**	N/A	0.00002	mg/L	N/A	2016-11-29	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-29	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-29	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Total Metals							
Aluminum, total	**0.516**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Arsenic, total	**0.0006**	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Barium, total	**0.015**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Boron, total	**0.026**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-11-28	2016-11-29	
Calcium, total	**15.7**	N/A	0.2	mg/L	2016-11-28	2016-11-29	
Chromium, total	**0.0014**	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Cobalt, total	**0.00032**	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Copper, total	**0.0036**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Iron, total	**0.68**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Lead, total	**0.0003**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Lithium, total	**0.0009**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Magnesium, total	**5.82**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Manganese, total	**0.0516**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-30	
Molybdenum, total	**0.0011**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Nickel, total	**0.0015**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Phosphorus, total	**0.03**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Potassium, total	**1.94**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Silicon, total	**7.1**	N/A	0.5	mg/L	2016-11-28	2016-11-29	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Sodium, total	**8.15**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Strontium, total	**0.092**	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Sulfur, total	**2**	N/A	1	mg/L	2016-11-28	2016-11-29	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6111767-03) [Water] Sampled: 2016-11-24 10:30, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Titanium, total	**0.021**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Uranium, total	**0.00005**	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Zinc, total	**0.007**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**460**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	
E. coli (MPN)	**150**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	
Sample ID: NA-2 (Balsam Creek) (6111767-04) [Water] Sampled: 2016-11-24 10:50							
Anions							
Nitrate (as N)	**0.565**	N/A	0.010	mg/L	N/A	2016-11-26	
General Parameters							
Alkalinity, Total (as CaCO3)	**6**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Bicarbonate (as CaCO3)	**6**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Calculated Parameters							
Hardness, Total (as CaCO3)	**7.17**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.055**	N/A	0.005	mg/L	N/A	2016-11-29	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Boron, dissolved	**0.006**	N/A	0.004	mg/L	N/A	2016-11-29	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-29	
Calcium, dissolved	**2.1**	N/A	0.2	mg/L	N/A	2016-11-29	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Copper, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	2016-11-29	
Iron, dissolved	**0.023**	N/A	0.010	mg/L	N/A	2016-11-29	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Magnesium, dissolved	**0.44**	N/A	0.01	mg/L	N/A	2016-11-29	
Manganese, dissolved	**0.0013**	N/A	0.0002	mg/L	N/A	2016-11-29	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-29	

SAMPLE ANALYTICAL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111767
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-01

Sample ID: NA-2 (Balsam Creek) (6111767-04) [Water] Sampled: 2016-11-24 10:50, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-29	
Potassium, dissolved	**0.20**	N/A	0.02	mg/L	N/A	2016-11-29	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Silicon, dissolved	**3.6**	N/A	0.5	mg/L	N/A	2016-11-29	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Sodium, dissolved	**1.63**	N/A	0.02	mg/L	N/A	2016-11-29	
Strontium, dissolved	**0.018**	N/A	0.001	mg/L	N/A	2016-11-29	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-11-29	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-29	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-29	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-29	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-29	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Total Metals							
Aluminum, total	**0.113**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Barium, total	**0.005**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Boron, total	**0.008**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-11-28	2016-11-29	
Calcium, total	**2.3**	N/A	0.2	mg/L	2016-11-28	2016-11-29	
Chromium, total	**0.0005**	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Copper, total	**0.0003**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Iron, total	**0.07**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Lead, total	**0.0003**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Magnesium, total	**0.48**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Manganese, total	**0.0029**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-30	
Molybdenum, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Potassium, total	**0.20**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Silicon, total	**3.7**	N/A	0.5	mg/L	2016-11-28	2016-11-29	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6111767
REPORTED 2016-12-01

Sample ID: NA-2 (Balsam Creek) (6111767-04) [Water] Sampled: 2016-11-24 10:50, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Sodium, total	**1.74**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Strontium, total	**0.020**	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Sulfur, total	< 1	N/A	1	mg/L	2016-11-28	2016-11-29	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**3.6**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	
E. coli (MPN)	**3.6**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	

Sample ID: NA-3 (Cattall Brook) (6111767-05) [Water] Sampled: 2016-11-24 11:45

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.974**	N/A	0.010	mg/L	N/A	2016-11-26	
General Parameters							
Alkalinity, Total (as CaCO3)	**39**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Bicarbonate (as CaCO3)	**39**	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-11-27	
Calculated Parameters							
Hardness, Total (as CaCO3)	**45.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.019**	N/A	0.005	mg/L	N/A	2016-11-29	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-11-29	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	2016-11-29	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Boron, dissolved	**0.027**	N/A	0.004	mg/L	N/A	2016-11-29	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-11-29	
Calcium, dissolved	**14.7**	N/A	0.2	mg/L	N/A	2016-11-29	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Cobalt, dissolved	**0.00009**	N/A	0.00005	mg/L	N/A	2016-11-29	
Copper, dissolved	**0.0016**	N/A	0.0002	mg/L	N/A	2016-11-29	
Iron, dissolved	**0.084**	N/A	0.010	mg/L	N/A	2016-11-29	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6111767-05) [Water] Sampled: 2016-11-24 11:45, Continued							
Dissolved Metals, Continued							
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-11-29	
Magnesium, dissolved	**2.16**	N/A	0.01	mg/L	N/A	2016-11-29	
Manganese, dissolved	**0.0283**	N/A	0.0002	mg/L	N/A	2016-11-29	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-29	
Molybdenum, dissolved	**0.0055**	N/A	0.0001	mg/L	N/A	2016-11-29	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-11-29	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-11-29	
Potassium, dissolved	**1.77**	N/A	0.02	mg/L	N/A	2016-11-29	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-11-29	
Silicon, dissolved	**4.8**	N/A	0.5	mg/L	N/A	2016-11-29	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-11-29	
Sodium, dissolved	**8.11**	N/A	0.02	mg/L	N/A	2016-11-29	
Strontium, dissolved	**0.095**	N/A	0.001	mg/L	N/A	2016-11-29	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-11-29	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-11-29	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-11-29	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-11-29	
Uranium, dissolved	**0.00010**	N/A	0.00002	mg/L	N/A	2016-11-29	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-11-29	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-11-29	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-11-29	
Total Metals							
Aluminum, total	**0.149**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Barium, total	**0.014**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Boron, total	**0.032**	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Cadmium, total	**0.00002**	N/A	0.00001	mg/L	2016-11-28	2016-11-29	
Calcium, total	**15.4**	N/A	0.2	mg/L	2016-11-28	2016-11-29	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Cobalt, total	**0.00014**	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Copper, total	**0.0020**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Iron, total	**0.26**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Lead, total	**0.0003**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Lithium, total	**0.0004**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Magnesium, total	**2.27**	N/A	0.01	mg/L	2016-11-28	2016-11-29	
Manganese, total	**0.0380**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-11-29	2016-11-30	
Molybdenum, total	**0.0054**	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-11-28	2016-11-29	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111767
REPORTED 2016-12-01

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6111767-05) [Water] Sampled: 2016-11-24 11:45, Continued							
Total Metals, Continued							
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Potassium, total	**1.77**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-11-28	2016-11-29	
Silicon, total	**4.7**	N/A	0.5	mg/L	2016-11-28	2016-11-29	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-11-28	2016-11-29	
Sodium, total	**8.42**	N/A	0.02	mg/L	2016-11-28	2016-11-29	
Strontium, total	**0.098**	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Sulfur, total	**2**	N/A	1	mg/L	2016-11-28	2016-11-29	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-11-28	2016-11-29	
Titanium, total	**0.007**	N/A	0.005	mg/L	2016-11-28	2016-11-29	
Uranium, total	**0.00011**	N/A	0.00002	mg/L	2016-11-28	2016-11-29	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-11-28	2016-11-29	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-11-28	2016-11-29	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-11-28	2016-11-29	
Microbiological Parameters							
Coliforms, Fecal (MPN)	**73**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	
E. coli (MPN)	**30**	N/A	3.0	MPN/100 mL	N/A	2016-11-25	
Sample ID: Field Blank (6111767-06) [Water] Sampled: 2016-11-24 10:15							
Microbiological Parameters							
Coliforms, Fecal (MPN)	< 3.0	N/A	3.0	MPN/100 mL	N/A	2016-11-25	

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6K1678										
Blank (B6K1678-BLK1)				Prepared: 2016-11-25, Analyzed: 2016-11-25						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6K1678-BLK2)				Prepared: 2016-11-26, Analyzed: 2016-11-26						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6K1678-BS1)				Prepared: 2016-11-25, Analyzed: 2016-11-25						
Nitrate (as N)	4.23	0.010	mg/L	4.00		106	93-108			
LCS (B6K1678-BS2)				Prepared: 2016-11-26, Analyzed: 2016-11-26						
Nitrate (as N)	4.15	0.010	mg/L	4.00		104	93-108			
Dissolved Metals, Batch B6K1861										
Blank (B6K1861-BLK1)				Prepared: 2016-11-29, Analyzed: 2016-11-29						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							

Dissolved Metals, Batch B6K1861, Continued

Blank (B6K1861-BLK1), Continued Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							

Duplicate (B6K1861-DUP1) **Source: 6111767-01** Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.060	0.005	mg/L		0.059			< 1	11	
Antimony, dissolved	< 0.0001	0.0001	mg/L		0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.009	0.005	mg/L		0.009				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.007	0.004	mg/L		0.013				13	
Cadmium, dissolved	< 0.00001	0.00001	mg/L		0.00001				27	
Calcium, dissolved	5.0	0.2	mg/L		5.0			< 1	8	
Chromium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				14	
Cobalt, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				10	
Copper, dissolved	0.0009	0.0002	mg/L		0.0008				28	
Iron, dissolved	0.055	0.010	mg/L		0.056			1	14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0001	0.0001	mg/L		0.0001				14	
Magnesium, dissolved	0.85	0.01	mg/L		0.82			3	6	
Manganese, dissolved	0.0034	0.0002	mg/L		0.0034			< 1	9	
Molybdenum, dissolved	0.0002	0.0001	mg/L		0.0002				19	
Nickel, dissolved	0.0002	0.0002	mg/L		0.0002				21	
Phosphorus, dissolved	< 0.02	0.02	mg/L		< 0.02				14	
Potassium, dissolved	0.64	0.02	mg/L		0.63			1	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	4.2	0.5	mg/L		4.0			3	12	
Silver, dissolved	< 0.00005	0.00005	mg/L		0.00008				20	
Sodium, dissolved	3.31	0.02	mg/L		3.18			4	6	
Strontium, dissolved	0.036	0.001	mg/L		0.035			3	6	
Sulfur, dissolved	< 1	1	mg/L		< 1				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	< 0.00002	0.00002	mg/L		0.00002				14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	< 0.004	0.004	mg/L		0.006				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	

Dissolved Metals, Batch B6K1861, Continued

Reference (B6K1861-SRM1) Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.229	0.005	mg/L	0.233		98	58-142			
Antimony, dissolved	0.0481	0.0001	mg/L	0.0430		112	75-125			
Arsenic, dissolved	0.445	0.0005	mg/L	0.438		102	81-119			
Barium, dissolved	3.33	0.005	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.212	0.0001	mg/L	0.213		99	80-120			
Boron, dissolved	1.63	0.004	mg/L	1.74		93	74-117			
Cadmium, dissolved	0.230	0.00001	mg/L	0.224		103	83-117			
Calcium, dissolved	7.7	0.2	mg/L	7.69		101	76-124			
Chromium, dissolved	0.433	0.0005	mg/L	0.437		99	81-119			
Cobalt, dissolved	0.131	0.00005	mg/L	0.128		103	76-124			
Copper, dissolved	0.865	0.0002	mg/L	0.844		102	84-116			
Iron, dissolved	1.28	0.010	mg/L	1.29		99	74-126			
Lead, dissolved	0.113	0.0001	mg/L	0.112		100	72-128			
Lithium, dissolved	0.105	0.0001	mg/L	0.104		101	60-140			
Magnesium, dissolved	6.97	0.01	mg/L	6.92		101	81-119			
Manganese, dissolved	0.344	0.0002	mg/L	0.345		100	84-116			
Molybdenum, dissolved	0.447	0.0001	mg/L	0.426		105	83-117			
Nickel, dissolved	0.851	0.0002	mg/L	0.840		101	74-126			
Phosphorus, dissolved	0.47	0.02	mg/L	0.495		96	68-132			
Potassium, dissolved	3.23	0.02	mg/L	3.19		101	74-126			
Selenium, dissolved	0.0333	0.0005	mg/L	0.0331		101	70-130			
Sodium, dissolved	18.8	0.02	mg/L	19.1		98	72-128			
Strontium, dissolved	0.884	0.001	mg/L	0.916		97	84-113			
Thallium, dissolved	0.0386	0.00002	mg/L	0.0393		98	57-143			
Uranium, dissolved	0.260	0.00002	mg/L	0.266		98	85-115			
Vanadium, dissolved	0.842	0.001	mg/L	0.869		97	87-113			
Zinc, dissolved	0.897	0.004	mg/L	0.881		102	72-128			

Dissolved Metals, Batch B6K1883

Blank (B6K1883-BLK1) Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Duplicate (B6K1883-DUP1) **Source: 6111767-01** Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				20	

Matrix Spike (B6K1883-MS1) **Source: 6111767-02** Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00027	0.00002	mg/L	0.000250	< 0.00002	107	70-130			

Reference (B6K1883-SRM1) Prepared: 2016-11-29, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00529	0.00002	mg/L	0.00489		108	50-150			

General Parameters, Batch B6K1745

Blank (B6K1745-BLK1) Prepared: 2016-11-27, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6K1745-BLK2) Prepared: 2016-11-27, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							

General Parameters, Batch B6K1745, Continued

Blank (B6K1745-BLK2), Continued Prepared: 2016-11-27, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Blank (B6K1745-BLK3) Prepared: 2016-11-28, Analyzed: 2016-11-28

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6K1745-BS1) Prepared: 2016-11-27, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	100	2	mg/L	100		100	96-108			

LCS (B6K1745-BS3) Prepared: 2016-11-27, Analyzed: 2016-11-27

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	100	2	mg/L	100		100	96-108			

LCS (B6K1745-BS5) Prepared: 2016-11-28, Analyzed: 2016-11-28

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	104	2	mg/L	100		104	96-108			

Microbiological Parameters, Batch B6K1676

Blank (B6K1676-BLK1) Prepared: 2016-11-25, Analyzed: 2016-11-25

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							

Blank (B6K1676-BLK2) Prepared: 2016-11-25, Analyzed: 2016-11-25

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100 mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100 mL							
E. coli (MPN)	< 3.0	3.0	MPN/100 mL							

Duplicate (B6K1676-DUP1) **Source: 6111767-03** Prepared: 2016-11-25, Analyzed: 2016-11-25

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Coliforms, Total (MPN)	4600	3.0	MPN/100 mL		11000			82	102	
Coliforms, Fecal (MPN)	150	3.0	MPN/100 mL		460			102	107	
E. coli (MPN)	93	3.0	MPN/100 mL		150			47	105	

Total Metals, Batch B6K1814

Blank (B6K1814-BLK1) Prepared: 2016-11-28, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							

Total Metals, Batch B6K1814, Continued

Blank (B6K1814-BLK1), Continued Prepared: 2016-11-28, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							

Reference (B6K1814-SRM1) Prepared: 2016-11-28, Analyzed: 2016-11-29

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.308	0.005	mg/L	0.303		102	81-129			
Antimony, total	0.0517	0.0001	mg/L	0.0511		101	88-114			
Arsenic, total	0.119	0.0005	mg/L	0.118		101	88-114			
Barium, total	0.779	0.005	mg/L	0.823		95	72-104			
Beryllium, total	0.0497	0.0001	mg/L	0.0496		100	76-131			
Boron, total	3.62	0.004	mg/L	3.45		105	75-121			
Cadmium, total	0.0485	0.00001	mg/L	0.0495		98	89-111			
Calcium, total	11.5	0.2	mg/L	11.6		100	86-121			
Chromium, total	0.256	0.0005	mg/L	0.250		102	89-114			
Cobalt, total	0.0397	0.00005	mg/L	0.0377		105	91-113			
Copper, total	0.518	0.0002	mg/L	0.486		107	91-115			
Iron, total	0.52	0.01	mg/L	0.488		107	77-124			
Lead, total	0.210	0.0001	mg/L	0.204		103	92-113			
Lithium, total	0.406	0.0001	mg/L	0.403		101	85-115			
Magnesium, total	4.07	0.01	mg/L	3.79		107	78-120			
Manganese, total	0.109	0.0002	mg/L	0.109		100	90-114			
Molybdenum, total	0.198	0.0001	mg/L	0.198		100	90-111			
Nickel, total	0.251	0.0002	mg/L	0.249		101	90-111			
Phosphorus, total	0.23	0.02	mg/L	0.227		103	85-115			
Potassium, total	7.55	0.02	mg/L	7.21		105	84-113			
Selenium, total	0.127	0.0005	mg/L	0.121		105	85-115			
Sodium, total	7.67	0.02	mg/L	7.54		102	82-123			
Strontium, total	0.371	0.001	mg/L	0.375		99	88-112			
Thallium, total	0.0848	0.00002	mg/L	0.0805		105	91-114			
Uranium, total	0.0307	0.00002	mg/L	0.0306		100	85-120			
Vanadium, total	0.390	0.001	mg/L	0.386		101	86-111			
Zinc, total	2.50	0.004	mg/L	2.49		101	85-111			

Total Metals, Batch B6K1927

Blank (B6K1927-BLK1) Prepared: 2016-11-29, Analyzed: 2016-11-30

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	< 0.00002	0.00002	mg/L							

Blank (B6K1927-BLK2) Prepared: 2016-11-29, Analyzed: 2016-11-30

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	< 0.00002	0.00002	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6K1927, Continued										
Matrix Spike (B6K1927-MS1)		**Source: 6111767-01**		Prepared: 2016-11-29, Analyzed: 2016-11-30						
Mercury, total	0.00026	0.00002	mg/L	0.000250	< 0.00002	105	70-130			
Reference (B6K1927-SRM1)				Prepared: 2016-11-29, Analyzed: 2016-11-30						
Mercury, total	0.00526	0.00002	mg/L	0.00489		108	50-150			
Reference (B6K1927-SRM2)				Prepared: 2016-11-29, Analyzed: 2016-11-30						
Mercury, total	0.00503	0.00002	mg/L	0.00489		103	50-150			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6111767
REPORTED 2016-12-01

		6111767-01	6111767-02	6111767-03	6111767-04	6111767-05	6111767-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-11-24	**2016-11-24**	**2016-11-24**	**2016-11-24**	**2016-11-24**	**2016-11-24**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	1.04	0.123	1.03	0.565	0.974	
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	12	2	67	6	39	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	12	2	67	6	39	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	15.9	3.83	60.5	7.17	45.7	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.059	0.161	0.025	0.055	0.019	
	Antimony, dissolved (mg/L)	0.0001	0.0001	0.0002	< 0.0001	0.0001	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Barium, dissolved (mg/L)	0.009	< 0.005	0.011	< 0.005	0.013	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.013	0.006	0.021	0.006	0.027	
	Cadmium, dissolved (mg/L)	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001	
	Calcium, dissolved (mg/L)	5.0	1.3	15.4	2.1	14.7	
	Chromium, dissolved (mg/L)	< 0.0005	0.0007	< 0.0005	< 0.0005	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00014	< 0.00005	0.00009	
	Copper, dissolved (mg/L)	0.0008	0.0004	0.0023	0.0003	0.0016	
	Iron, dissolved (mg/L)	0.056	0.050	0.112	0.023	0.084	
	Lead, dissolved (mg/L)	< 0.0001	0.0002	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0001	< 0.0001	0.0006	< 0.0001	0.0003	
	Magnesium, dissolved (mg/L)	0.82	0.17	5.39	0.44	2.16	
	Manganese, dissolved (mg/L)	0.0034	0.0010	0.0443	0.0013	0.0283	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0002	< 0.0001	0.0011	< 0.0001	0.0055	
	Nickel, dissolved (mg/L)	0.0002	< 0.0002	0.0007	< 0.0002	0.0002	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	0.63	0.10	1.90	0.20	1.77	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	4.0	1.7	6.5	3.6	4.8	
	Silver, dissolved (mg/L)	0.00008	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	3.18	0.68	7.80	1.63	8.11	
	Strontium, dissolved (mg/L)	0.035	0.006	0.090	0.018	0.095	
	Sulfur, dissolved (mg/L)	< 1	< 1	2	< 1	2	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00002	0.00003	0.00004	< 0.00002	0.00010	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	0.006	< 0.004	< 0.004	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6111767
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-01

		6111767-01	6111767-02	6111767-03	6111767-04	6111767-05	6111767-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-11-24	**2016-11-24**	**2016-11-24**	**2016-11-24**	**2016-11-24**	**2016-11-24**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.122	0.188	0.516	0.113	0.149	
	Antimony, total (mg/L)	0.0001	< 0.0001	0.0002	< 0.0001	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0006	< 0.0005	< 0.0005	
	Barium, total (mg/L)	0.010	< 0.005	0.015	0.005	0.014	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.017	0.009	0.026	0.008	0.032	
	Cadmium, total (mg/L)	0.00001	0.00001	0.00002	< 0.00001	0.00002	
	Calcium, total (mg/L)	5.4	1.3	15.7	2.3	15.4	
	Chromium, total (mg/L)	0.0008	0.0008	0.0014	0.0005	0.0008	
	Cobalt, total (mg/L)	0.00017	< 0.00005	0.00032	< 0.00005	0.00014	
	Copper, total (mg/L)	0.0008	0.0004	0.0036	0.0003	0.0020	
	Iron, total (mg/L)	0.13	0.05	0.68	0.07	0.26	
	Lead, total (mg/L)	0.0002	0.0002	0.0003	0.0003	0.0003	
	Lithium, total (mg/L)	0.0002	0.0001	0.0009	< 0.0001	0.0004	
	Magnesium, total (mg/L)	0.89	0.18	5.82	0.48	2.27	
	Manganese, total (mg/L)	0.0071	0.0015	0.0516	0.0029	0.0380	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0003	0.0001	0.0011	< 0.0001	0.0054	
	Nickel, total (mg/L)	0.0002	< 0.0002	0.0015	< 0.0002	0.0003	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.03	< 0.02	< 0.02	
	Potassium, total (mg/L)	0.67	0.09	1.94	0.20	1.77	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	4.2	1.7	7.1	3.7	4.7	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	3.45	0.62	8.15	1.74	8.42	
	Strontium, total (mg/L)	0.038	0.006	0.092	0.020	0.098	
	Sulfur, total (mg/L)	1	< 1	2	< 1	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.021	< 0.005	0.007	
	Uranium, total (mg/L)	< 0.00002	0.00002	0.00005	< 0.00002	0.00011	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.002	< 0.001	< 0.001	
	Zinc, total (mg/L)	0.005	< 0.004	0.007	< 0.004	< 0.004	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0002	< 0.0001	< 0.0001	
Microbiological Parameters	Coliforms, Fecal (MPN) (MPN/100 mL)	9.1	3.6	460	3.6	73	< 3.0
	E. coli (MPN) (MPN/100 mL)	9.1	< 3.0	150	3.6	30	

ANALYTICAL
Caring About Result

* 6 1 1 1 7 6 7 *

CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC# ☐ *PAGE 1 OF 1*

RELINQUISHED BY: Peter deKoning	DATE: 24-Nov-16 TIME: 14:18	RECEIVED BY: WI BS	DATE: 24-Nov-16 TIME: 14:15
PROJECT: 173.191 Blaney, North Alouette, Fraser Rive		PROJECT INFO: Stormwater Monitoring	

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION:
Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

REPORT TO:
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐
EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

INVOICE TO: SAME AS REPORT TO ☐
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

	CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)
1	BL-1 (Anderson Creek)		✓			6	24-Nov-16	11:15				
2	NA-1 (North Alouette River)		✓			6	24-Nov-16	12:15				
3	FR-1 (227 St Creek)		✓			6	24-Nov-16	10:30				
4	NA-2 (Balsam Creek)		✓			6	24-Nov-16	10:50				
5	NA-3 (Cattall Brook)		✓			6	24-Nov-16	~~[illegible]~~				→ 11:45
6	Field Blank		✓			1	24-Nov-16	10:15				
7	Trip Blank		✓			1	24-Nov-16	8:30				

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ *E. coli* ☒	ASBESTOS	Nitrate - N							**HOLD**
BL-1 (Anderson Creek)								✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)								✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)								✓	✓		✓				✓	✓		✓							
NA-2 (Balsam Creek)								✓	✓		✓				✓	✓		✓							
NA-3 (Cattall Brook)								✓	✓		✓				✓	✓		✓							
Field Blank															✓										
Trip Blank																									✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 5.5 ICE: Y ☑ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C):
CUSTODY SEALS INTACT:

ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6120157
PO NUMBER		**RECEIVED / TEMP**	2016-12-02 16:47 / 6°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-09
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

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REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120157
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-09

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120157
REPORTED 2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6120157-01) [Water] Sampled: 2016-12-02 14:00							
Anions							
Nitrate (as N)	**0.697**	N/A	0.010	mg/L	N/A	2016-12-07	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**9**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Bicarbonate (as CaCO3)	**9**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Calculated Parameters							
Hardness, Total (as CaCO3)	**12.6**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.071**	N/A	0.005	mg/L	N/A	2016-12-08	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-08	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Barium, dissolved	**0.007**	N/A	0.005	mg/L	N/A	2016-12-08	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Boron, dissolved	**0.010**	N/A	0.004	mg/L	N/A	2016-12-08	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-12-08	
Calcium, dissolved	**4.0**	N/A	0.2	mg/L	N/A	2016-12-08	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-12-08	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Copper, dissolved	**0.0008**	N/A	0.0002	mg/L	N/A	2016-12-08	
Iron, dissolved	**0.065**	N/A	0.010	mg/L	N/A	2016-12-08	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-08	
Magnesium, dissolved	**0.64**	N/A	0.01	mg/L	N/A	2016-12-08	
Manganese, dissolved	**0.0040**	N/A	0.0002	mg/L	N/A	2016-12-08	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-12-08	
Nickel, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	2016-12-08	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-08	
Potassium, dissolved	**0.53**	N/A	0.02	mg/L	N/A	2016-12-08	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Silicon, dissolved	**2.9**	N/A	0.5	mg/L	N/A	2016-12-08	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Sodium, dissolved	**2.48**	N/A	0.02	mg/L	N/A	2016-12-08	
Strontium, dissolved	**0.027**	N/A	0.001	mg/L	N/A	2016-12-08	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-08	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-08	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120157
REPORTED 2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6120157-01) [Water] Sampled: 2016-12-02 14:00, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	2016-12-08	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-08	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-08	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Total Metals							
Aluminum, total	**0.430**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Barium, total	**0.011**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Boron, total	**0.010**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Cadmium, total	**0.00005**	N/A	0.00001	mg/L	2016-12-07	2016-12-08	
Calcium, total	**4.3**	N/A	0.2	mg/L	2016-12-07	2016-12-08	
Chromium, total	**0.0009**	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Cobalt, total	**0.00021**	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Copper, total	**0.0015**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Iron, total	**0.44**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Lead, total	**0.0004**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Magnesium, total	**0.72**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Manganese, total	**0.0192**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Nickel, total	**0.0005**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Phosphorus, total	**0.03**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Potassium, total	**0.56**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Silicon, total	**3.4**	N/A	0.5	mg/L	2016-12-07	2016-12-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Sodium, total	**2.59**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Strontium, total	**0.029**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-07	2016-12-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Titanium, total	**0.015**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Vanadium, total	**0.001**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Microbiological Parameters							
Coliforms, Fecal	**30**	N/A	2	MPN/100 mL		2016-12-03	

SAMPLE ANALYTICAL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120157
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6120157-01) [Water] Sampled: 2016-12-02 14:00, Continued							
Microbiological Parameters, Continued							
E. coli (MPN)	**23**	N/A	2	MPN/100 mL		2016-12-03	
Sample ID: NA-1 (North Alouette River) (6120157-02) [Water] Sampled: 2016-12-02 15:00							
Anions							
Nitrate (as N)	**0.133**	N/A	0.010	mg/L	N/A	2016-12-07	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**2**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Bicarbonate (as CaCO3)	**2**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Calculated Parameters							
Hardness, Total (as CaCO3)	**4.51**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.159**	N/A	0.005	mg/L	N/A	2016-12-08	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-08	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Boron, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-12-08	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-12-08	
Calcium, dissolved	**1.5**	N/A	0.2	mg/L	N/A	2016-12-08	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Copper, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	2016-12-08	
Iron, dissolved	**0.043**	N/A	0.010	mg/L	N/A	2016-12-08	
Lead, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-08	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Magnesium, dissolved	**0.19**	N/A	0.01	mg/L	N/A	2016-12-08	
Manganese, dissolved	**0.0009**	N/A	0.0002	mg/L	N/A	2016-12-08	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-08	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-12-08	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-08	
Potassium, dissolved	**0.12**	N/A	0.02	mg/L	N/A	2016-12-08	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Silicon, dissolved	**1.7**	N/A	0.5	mg/L	N/A	2016-12-08	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Sodium, dissolved	**0.75**	N/A	0.02	mg/L	N/A	2016-12-08	
Strontium, dissolved	**0.007**	N/A	0.001	mg/L	N/A	2016-12-08	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-08	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-1 (North Alouette River) (6120157-02) [Water] Sampled: 2016-12-02 15:00, Continued							
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-08	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	
Uranium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	2016-12-08	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-08	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-08	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Total Metals							
Aluminum, total	**0.290**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Boron, total	**0.005**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Cadmium, total	**0.00004**	N/A	0.00001	mg/L	2016-12-07	2016-12-08	
Calcium, total	**1.6**	N/A	0.2	mg/L	2016-12-07	2016-12-08	
Chromium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Cobalt, total	**0.00010**	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Copper, total	**0.0011**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Iron, total	**0.16**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Lead, total	**0.0003**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Magnesium, total	**0.23**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Manganese, total	**0.0051**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, total	**0.0001**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Phosphorus, total	**0.02**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Potassium, total	**0.13**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Silicon, total	**1.9**	N/A	0.5	mg/L	2016-12-07	2016-12-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Sodium, total	**0.81**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Strontium, total	**0.008**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-07	2016-12-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Titanium, total	**0.006**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Uranium, total	**0.00002**	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-07	2016-12-08	

Sample ID: NA-1 (North Alouette River) (6120157-02) [Water] Sampled: 2016-12-02 15:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Zinc, total	**0.005**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Microbiological Parameters							
Coliforms, Fecal	**4**	N/A	2	MPN/100 mL		2016-12-03	
E. coli (MPN)	**4**	N/A	2	MPN/100 mL		2016-12-03	

Sample ID: FR-1 (227 St Creek) (6120157-03) [Water] Sampled: 2016-12-02 13:00

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.632**	N/A	0.010	mg/L	N/A	2016-12-07	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**29**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Bicarbonate (as CaCO3)	**29**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Calculated Parameters							
Hardness, Total (as CaCO3)	**27.1**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.044**	N/A	0.005	mg/L	N/A	2016-12-08	
Antimony, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-12-08	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Barium, dissolved	**0.006**	N/A	0.005	mg/L	N/A	2016-12-08	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Boron, dissolved	**0.013**	N/A	0.004	mg/L	N/A	2016-12-08	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-12-08	
Calcium, dissolved	**7.3**	N/A	0.2	mg/L	N/A	2016-12-08	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	2016-12-08	
Copper, dissolved	**0.0024**	N/A	0.0002	mg/L	N/A	2016-12-08	
Iron, dissolved	**0.096**	N/A	0.010	mg/L	N/A	2016-12-08	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Lithium, dissolved	**0.0003**	N/A	0.0001	mg/L	N/A	2016-12-08	
Magnesium, dissolved	**2.17**	N/A	0.01	mg/L	N/A	2016-12-08	
Manganese, dissolved	**0.0221**	N/A	0.0002	mg/L	N/A	2016-12-08	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	2016-12-08	
Nickel, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	2016-12-08	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-08	
Potassium, dissolved	**1.01**	N/A	0.02	mg/L	N/A	2016-12-08	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120157
REPORTED 2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6120157-03) [Water] Sampled: 2016-12-02 13:00, Continued							
Dissolved Metals, Continued							
Silicon, dissolved	**2.9**	N/A	0.5	mg/L	N/A	2016-12-08	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Sodium, dissolved	**3.24**	N/A	0.02	mg/L	N/A	2016-12-08	
Strontium, dissolved	**0.039**	N/A	0.001	mg/L	N/A	2016-12-08	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-08	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-08	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	
Uranium, dissolved	**0.00002**	N/A	0.00002	mg/L	N/A	2016-12-08	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-08	
Zinc, dissolved	**0.007**	N/A	0.004	mg/L	N/A	2016-12-08	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Total Metals							
Aluminum, total	**0.888**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Antimony, total	**0.0003**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Arsenic, total	**0.0008**	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Barium, total	**0.014**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Boron, total	**0.014**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Cadmium, total	**0.00006**	N/A	0.00001	mg/L	2016-12-07	2016-12-08	
Calcium, total	**7.8**	N/A	0.2	mg/L	2016-12-07	2016-12-08	
Chromium, total	**0.0018**	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Cobalt, total	**0.00046**	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Copper, total	**0.0047**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Iron, total	**1.07**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Lead, total	**0.0006**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Lithium, total	**0.0008**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Magnesium, total	**2.59**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Manganese, total	**0.0429**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, total	**0.0005**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Nickel, total	**0.0017**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Phosphorus, total	**0.08**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Potassium, total	**1.17**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Silicon, total	**4.5**	N/A	0.5	mg/L	2016-12-07	2016-12-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Sodium, total	**3.52**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Strontium, total	**0.043**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-07	2016-12-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6120157-03) [Water] Sampled: 2016-12-02 13:00, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Tin, total	**0.0003**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Titanium, total	**0.037**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Zinc, total	**0.013**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Zirconium, total	**0.0003**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Microbiological Parameters							
Coliforms, Fecal	**500**	N/A	2	MPN/100 mL		2016-12-03	
E. coli (MPN)	**500**	N/A	2	MPN/100 mL		2016-12-03	
Sample ID: NA-2 (Balsam Creek) (6120157-04) [Water] Sampled: 2016-12-02 13:30							
Anions							
Nitrate (as N)	**0.518**	N/A	0.010	mg/L	N/A	2016-12-07	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**5**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Bicarbonate (as CaCO3)	**5**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Calculated Parameters							
Hardness, Total (as CaCO3)	**6.94**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.067**	N/A	0.005	mg/L	N/A	2016-12-08	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Boron, dissolved	**0.006**	N/A	0.004	mg/L	N/A	2016-12-08	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-12-08	
Calcium, dissolved	**2.1**	N/A	0.2	mg/L	N/A	2016-12-08	
Chromium, dissolved	**0.0008**	N/A	0.0005	mg/L	N/A	2016-12-08	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Copper, dissolved	**0.0005**	N/A	0.0002	mg/L	N/A	2016-12-08	
Iron, dissolved	**0.026**	N/A	0.010	mg/L	N/A	2016-12-08	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Magnesium, dissolved	**0.42**	N/A	0.01	mg/L	N/A	2016-12-08	
Manganese, dissolved	**0.0017**	N/A	0.0002	mg/L	N/A	2016-12-08	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6120157
REPORTED 2016-12-09

Sample ID: NA-2 (Balsam Creek) (6120157-04) [Water] Sampled: 2016-12-02 13:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Nickel, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-12-08	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-08	
Potassium, dissolved	**0.20**	N/A	0.02	mg/L	N/A	2016-12-08	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Silicon, dissolved	**3.3**	N/A	0.5	mg/L	N/A	2016-12-08	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Sodium, dissolved	**1.54**	N/A	0.02	mg/L	N/A	2016-12-08	
Strontium, dissolved	**0.018**	N/A	0.001	mg/L	N/A	2016-12-08	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-08	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-08	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-08	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-08	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-08	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Total Metals							
Aluminum, total	**0.254**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Barium, total	**0.006**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Boron, total	**0.006**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Cadmium, total	**0.00004**	N/A	0.00001	mg/L	2016-12-07	2016-12-08	
Calcium, total	**2.2**	N/A	0.2	mg/L	2016-12-07	2016-12-08	
Chromium, total	**0.0008**	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Cobalt, total	**0.00011**	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Copper, total	**0.0006**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Iron, total	**0.18**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Lead, total	**0.0002**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Magnesium, total	**0.47**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Manganese, total	**0.0076**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Phosphorus, total	**0.02**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Potassium, total	**0.21**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Silicon, total	**3.5**	N/A	0.5	mg/L	2016-12-07	2016-12-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	

Sample ID: NA-2 (Balsam Creek) (6120157-04) [Water] Sampled: 2016-12-02 13:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Sodium, total	**1.55**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Strontium, total	**0.018**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-07	2016-12-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Titanium, total	**0.009**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Microbiological Parameters							
Coliforms, Fecal	<2	N/A	2	MPN/100 mL		2016-12-03	
E. coli (MPN)	<2	N/A	2	MPN/100 mL		2016-12-03	

Sample ID: NA-3 (Cattall Brook) (6120157-05) [Water] Sampled: 2016-12-02 14:30

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.825**	N/A	0.010	mg/L	N/A	2016-12-07	HT1
General Parameters							
Alkalinity, Total (as CaCO3)	**34**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Bicarbonate (as CaCO3)	**34**	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-06	
Calculated Parameters							
Hardness, Total (as CaCO3)	**44.2**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.028**	N/A	0.005	mg/L	N/A	2016-12-08	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-08	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Barium, dissolved	**0.013**	N/A	0.005	mg/L	N/A	2016-12-08	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Boron, dissolved	**0.029**	N/A	0.004	mg/L	N/A	2016-12-08	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-12-08	
Calcium, dissolved	**14.6**	N/A	0.2	mg/L	N/A	2016-12-08	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Cobalt, dissolved	**0.00013**	N/A	0.00005	mg/L	N/A	2016-12-08	
Copper, dissolved	**0.0016**	N/A	0.0002	mg/L	N/A	2016-12-08	
Iron, dissolved	**0.070**	N/A	0.010	mg/L	N/A	2016-12-08	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6120157-05) [Water] Sampled: 2016-12-02 14:30, Continued							
Dissolved Metals, Continued							
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Lithium, dissolved	**0.0004**	N/A	0.0001	mg/L	N/A	2016-12-08	
Magnesium, dissolved	**1.90**	N/A	0.01	mg/L	N/A	2016-12-08	
Manganese, dissolved	**0.0422**	N/A	0.0002	mg/L	N/A	2016-12-08	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, dissolved	**0.0038**	N/A	0.0001	mg/L	N/A	2016-12-08	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-08	
Potassium, dissolved	**1.74**	N/A	0.02	mg/L	N/A	2016-12-08	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-08	
Silicon, dissolved	**3.9**	N/A	0.5	mg/L	N/A	2016-12-08	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-08	
Sodium, dissolved	**9.45**	N/A	0.02	mg/L	N/A	2016-12-08	
Strontium, dissolved	**0.096**	N/A	0.001	mg/L	N/A	2016-12-08	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-12-08	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-08	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-08	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-08	
Uranium, dissolved	**0.00005**	N/A	0.00002	mg/L	N/A	2016-12-08	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-08	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-08	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-08	
Total Metals							
Aluminum, total	**0.895**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Arsenic, total	**0.0006**	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Barium, total	**0.021**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Boron, total	**0.029**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Cadmium, total	**0.00006**	N/A	0.00001	mg/L	2016-12-07	2016-12-08	
Calcium, total	**15.4**	N/A	0.2	mg/L	2016-12-07	2016-12-08	
Chromium, total	**0.0014**	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Cobalt, total	**0.00043**	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Copper, total	**0.0042**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Iron, total	**0.87**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Lead, total	**0.0005**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Lithium, total	**0.0007**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Magnesium, total	**2.13**	N/A	0.01	mg/L	2016-12-07	2016-12-08	
Manganese, total	**0.0623**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-06	2016-12-06	
Molybdenum, total	**0.0039**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Nickel, total	**0.0010**	N/A	0.0002	mg/L	2016-12-07	2016-12-08	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River
WORK ORDER 6120157
REPORTED 2016-12-09

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6120157-05) [Water] Sampled: 2016-12-02 14:30, Continued							
Total Metals, Continued							
Phosphorus, total	**0.07**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Potassium, total	**1.86**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-07	2016-12-08	
Silicon, total	**4.9**	N/A	0.5	mg/L	2016-12-07	2016-12-08	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-07	2016-12-08	
Sodium, total	**9.78**	N/A	0.02	mg/L	2016-12-07	2016-12-08	
Strontium, total	**0.100**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Sulfur, total	**2**	N/A	1	mg/L	2016-12-07	2016-12-08	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-07	2016-12-08	
Titanium, total	**0.036**	N/A	0.005	mg/L	2016-12-07	2016-12-08	
Uranium, total	**0.00011**	N/A	0.00002	mg/L	2016-12-07	2016-12-08	
Vanadium, total	**0.002**	N/A	0.001	mg/L	2016-12-07	2016-12-08	
Zinc, total	**0.008**	N/A	0.004	mg/L	2016-12-07	2016-12-08	
Zirconium, total	**0.0002**	N/A	0.0001	mg/L	2016-12-07	2016-12-08	
Microbiological Parameters							
Coliforms, Fecal	**30**	N/A	2	MPN/100 mL		2016-12-03	
E. coli (MPN)	**30**	N/A	2	MPN/100 mL		2016-12-03	
Sample ID: Field Blank (6120157-06) [Water] Sampled: 2016-12-02 14:30							
Anions							
Nitrate (as N)	**0.012**	N/A	0.010	mg/L	N/A	2016-12-07	HT1

Sample / Analysis Qualifiers:

HT1	The sample was prepared and/or analyzed past the recommended holding time.

APPENDIX 1: QUALITY CONTROL DATA

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120157
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-09

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6L0306										
Blank (B6L0306-BLK1)				Prepared: 2016-12-06, Analyzed: 2016-12-06						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6L0306-BLK2)				Prepared: 2016-12-07, Analyzed: 2016-12-07						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6L0306-BS1)				Prepared: 2016-12-06, Analyzed: 2016-12-06						
Nitrate (as N)	4.18	0.010	mg/L	4.00		105	93-108			
LCS (B6L0306-BS2)				Prepared: 2016-12-07, Analyzed: 2016-12-07						
Nitrate (as N)	4.14	0.010	mg/L	4.00		103	93-108			
Dissolved Metals, Batch B6L0265										
Blank (B6L0265-BLK1)				Prepared: 2016-12-08, Analyzed: 2016-12-08						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes

Dissolved Metals, Batch B6L0265, Continued

Blank (B6L0265-BLK1), Continued Prepared: 2016-12-08, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							

Matrix Spike (B6L0265-MS1) **Source: 6120157-02** Prepared: 2016-12-08, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Antimony, dissolved	0.398	0.0001	mg/L	0.400	0.0001	99	76-114			
Arsenic, dissolved	0.190	0.0005	mg/L	0.200	< 0.0005	95	81-115			
Barium, dissolved	0.956	0.005	mg/L	1.00	< 0.005	95	80-113			
Beryllium, dissolved	0.0934	0.0001	mg/L	0.100	< 0.0001	93	69-109			
Cadmium, dissolved	0.0962	0.00001	mg/L	0.100	0.00001	96	83-110			
Chromium, dissolved	0.375	0.0005	mg/L	0.400	< 0.0005	94	85-115			
Cobalt, dissolved	0.383	0.00005	mg/L	0.400	< 0.00005	96	86-114			
Copper, dissolved	0.399	0.0002	mg/L	0.400	0.0005	100	82-119			
Iron, dissolved	1.99	0.010	mg/L	2.00	0.043	98	80-116			
Lead, dissolved	0.198	0.0001	mg/L	0.200	0.0001	99	83-112			
Manganese, dissolved	0.372	0.0002	mg/L	0.400	0.0009	93	62-131			
Nickel, dissolved	0.383	0.0002	mg/L	0.400	0.0002	96	81-115			
Selenium, dissolved	0.102	0.0005	mg/L	0.100	< 0.0005	102	79-115			
Silver, dissolved	0.102	0.00005	mg/L	0.100	< 0.00005	102	69-121			
Thallium, dissolved	0.0966	0.00002	mg/L	0.100	< 0.00002	97	84-115			
Vanadium, dissolved	0.361	0.001	mg/L	0.400	< 0.001	90	83-113			
Zinc, dissolved	0.963	0.004	mg/L	1.00	< 0.004	96	82-115			

Reference (B6L0265-SRM1) Prepared: 2016-12-08, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.218	0.005	mg/L	0.233		94	58-142			
Antimony, dissolved	0.0468	0.0001	mg/L	0.0430		109	75-125			
Arsenic, dissolved	0.425	0.0005	mg/L	0.438		97	81-119			
Barium, dissolved	3.28	0.005	mg/L	3.35		98	83-117			
Beryllium, dissolved	0.209	0.0001	mg/L	0.213		98	80-120			
Boron, dissolved	1.67	0.004	mg/L	1.74		96	74-117			
Cadmium, dissolved	0.220	0.00001	mg/L	0.224		98	83-117			
Calcium, dissolved	7.7	0.2	mg/L	7.69		100	76-124			
Chromium, dissolved	0.427	0.0005	mg/L	0.437		98	81-119			
Cobalt, dissolved	0.129	0.00005	mg/L	0.128		100	76-124			
Copper, dissolved	0.846	0.0002	mg/L	0.844		100	84-116			
Iron, dissolved	1.28	0.010	mg/L	1.29		100	74-126			
Lead, dissolved	0.113	0.0001	mg/L	0.112		101	72-128			
Lithium, dissolved	0.103	0.0001	mg/L	0.104		99	60-140			
Magnesium, dissolved	6.86	0.01	mg/L	6.92		99	81-119			
Manganese, dissolved	0.333	0.0002	mg/L	0.345		97	84-116			
Molybdenum, dissolved	0.442	0.0001	mg/L	0.426		104	83-117			
Nickel, dissolved	0.832	0.0002	mg/L	0.840		99	74-126			

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes

Dissolved Metals, Batch B6L0265, Continued

Reference (B6L0265-SRM1), Continued Prepared: 2016-12-08, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Phosphorus, dissolved	0.50	0.02	mg/L	0.495		101	68-132			
Potassium, dissolved	3.10	0.02	mg/L	3.19		97	74-126			
Selenium, dissolved	0.0335	0.0005	mg/L	0.0331		101	70-130			
Sodium, dissolved	18.6	0.02	mg/L	19.1		97	72-128			
Strontium, dissolved	0.855	0.001	mg/L	0.916		93	84-113			
Thallium, dissolved	0.0385	0.00002	mg/L	0.0393		98	57-143			
Uranium, dissolved	0.264	0.00002	mg/L	0.266		99	85-115			
Vanadium, dissolved	0.829	0.001	mg/L	0.869		95	87-113			
Zinc, dissolved	0.853	0.004	mg/L	0.881		97	72-128			

Dissolved Metals, Batch B6L0309

Blank (B6L0309-BLK1) Prepared: 2016-12-06, Analyzed: 2016-12-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	< 0.00002	0.00002	mg/L							

Reference (B6L0309-SRM1) Prepared: 2016-12-06, Analyzed: 2016-12-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, dissolved	0.00485	0.00002	mg/L	0.00489		99	50-150			

General Parameters, Batch B6L0296

Blank (B6L0296-BLK1) Prepared: 2016-12-06, Analyzed: 2016-12-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

LCS (B6L0296-BS1) Prepared: 2016-12-06, Analyzed: 2016-12-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Alkalinity, Total (as CaCO3)	105	2	mg/L	100		105	96-108			

Total Metals, Batch B6L0312

Blank (B6L0312-BLK1) Prepared: 2016-12-06, Analyzed: 2016-12-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	< 0.00002	0.00002	mg/L							

Reference (B6L0312-SRM1) Prepared: 2016-12-06, Analyzed: 2016-12-06

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Mercury, total	0.00463	0.00002	mg/L	0.00489		95	50-150			

Total Metals, Batch B6L0356

Blank (B6L0356-BLK1) Prepared: 2016-12-07, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							

Total Metals, Batch B6L0356, Continued

Blank (B6L0356-BLK1), Continued Prepared: 2016-12-07, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							

Reference (B6L0356-SRM1) Prepared: 2016-12-07, Analyzed: 2016-12-08

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.302	0.005	mg/L	0.303		100	81-129			
Antimony, total	0.0555	0.0001	mg/L	0.0511		109	88-114			
Arsenic, total	0.122	0.0005	mg/L	0.118		103	88-114			
Barium, total	0.813	0.005	mg/L	0.823		99	72-104			
Beryllium, total	0.0508	0.0001	mg/L	0.0496		102	76-131			
Boron, total	3.34	0.004	mg/L	3.45		97	75-121			
Cadmium, total	0.0507	0.00001	mg/L	0.0495		103	89-111			
Calcium, total	11.8	0.2	mg/L	11.6		102	86-121			
Chromium, total	0.255	0.0005	mg/L	0.250		102	89-114			
Cobalt, total	0.0404	0.00005	mg/L	0.0377		107	91-113			
Copper, total	0.523	0.0002	mg/L	0.486		108	91-115			
Iron, total	0.53	0.01	mg/L	0.488		109	77-124			
Lead, total	0.209	0.0001	mg/L	0.204		103	92-113			
Lithium, total	0.404	0.0001	mg/L	0.403		100	85-115			
Magnesium, total	4.03	0.01	mg/L	3.79		106	78-120			
Manganese, total	0.109	0.0002	mg/L	0.109		100	90-114			
Molybdenum, total	0.212	0.0001	mg/L	0.198		107	90-111			
Nickel, total	0.259	0.0002	mg/L	0.249		104	90-111			
Phosphorus, total	0.23	0.02	mg/L	0.227		101	85-115			
Potassium, total	7.69	0.02	mg/L	7.21		107	84-113			
Selenium, total	0.132	0.0005	mg/L	0.121		109	85-115			
Sodium, total	8.02	0.02	mg/L	7.54		106	82-123			
Strontium, total	0.381	0.001	mg/L	0.375		102	88-112			
Thallium, total	0.0832	0.00002	mg/L	0.0805		103	91-114			
Uranium, total	0.0310	0.00002	mg/L	0.0306		101	85-120			
Vanadium, total	0.392	0.001	mg/L	0.386		102	86-111			
Zinc, total	2.59	0.004	mg/L	2.49		104	85-111			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120157
REPORTED 2016-12-09

		6120157-01	6120157-02	6120157-03	6120157-04	6120157-05	6120157-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-12-02	**2016-12-02**	**2016-12-02**	**2016-12-02**	**2016-12-02**	**2016-12-02**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	0.697	0.133	0.632	0.518	0.825	0.012
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	9	2	29	5	34	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	9	2	29	5	34	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	12.6	4.51	27.1	6.94	44.2	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.071	0.159	0.044	0.067	0.028	
	Antimony, dissolved (mg/L)	0.0001	0.0001	0.0002	< 0.0001	0.0001	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Barium, dissolved (mg/L)	0.007	< 0.005	0.006	< 0.005	0.013	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.010	0.005	0.013	0.006	0.029	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	0.00001	< 0.00001	0.00001	
	Calcium, dissolved (mg/L)	4.0	1.5	7.3	2.1	14.6	
	Chromium, dissolved (mg/L)	0.0006	< 0.0005	< 0.0005	0.0008	< 0.0005	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00010	< 0.00005	0.00013	
	Copper, dissolved (mg/L)	0.0008	0.0005	0.0024	0.0005	0.0016	
	Iron, dissolved (mg/L)	0.065	0.043	0.096	0.026	0.070	
	Lead, dissolved (mg/L)	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0001	< 0.0001	0.0003	< 0.0001	0.0004	
	Magnesium, dissolved (mg/L)	0.64	0.19	2.17	0.42	1.90	
	Manganese, dissolved (mg/L)	0.0040	0.0009	0.0221	0.0017	0.0422	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0002	0.0001	0.0005	< 0.0001	0.0038	
	Nickel, dissolved (mg/L)	0.0003	0.0002	0.0005	0.0002	< 0.0002	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	0.53	0.12	1.01	0.20	1.74	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	2.9	1.7	2.9	3.3	3.9	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	2.48	0.75	3.24	1.54	9.45	
	Strontium, dissolved (mg/L)	0.027	0.007	0.039	0.018	0.096	
	Sulfur, dissolved (mg/L)	< 1	< 1	< 1	< 1	2	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	0.00002	0.00002	0.00002	< 0.00002	0.00005	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	0.007	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120157
REPORTED 2016-12-09

		6120157-01	6120157-02	6120157-03	6120157-04	6120157-05	6120157-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-12-02	**2016-12-02**	**2016-12-02**	**2016-12-02**	**2016-12-02**	**2016-12-02**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.430	0.290	0.888	0.254	0.895	
	Antimony, total (mg/L)	0.0001	0.0001	0.0003	< 0.0001	0.0002	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0008	< 0.0005	0.0006	
	Barium, total (mg/L)	0.011	< 0.005	0.014	0.006	0.021	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.010	0.005	0.014	0.006	0.029	
	Cadmium, total (mg/L)	0.00005	0.00004	0.00006	0.00004	0.00006	
	Calcium, total (mg/L)	4.3	1.6	7.8	2.2	15.4	
	Chromium, total (mg/L)	0.0009	< 0.0005	0.0018	0.0008	0.0014	
	Cobalt, total (mg/L)	0.00021	0.00010	0.00046	0.00011	0.00043	
	Copper, total (mg/L)	0.0015	0.0011	0.0047	0.0006	0.0042	
	Iron, total (mg/L)	0.44	0.16	1.07	0.18	0.87	
	Lead, total (mg/L)	0.0004	0.0003	0.0006	0.0002	0.0005	
	Lithium, total (mg/L)	0.0003	0.0001	0.0008	0.0002	0.0007	
	Magnesium, total (mg/L)	0.72	0.23	2.59	0.47	2.13	
	Manganese, total (mg/L)	0.0192	0.0051	0.0429	0.0076	0.0623	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0002	0.0001	0.0005	0.0002	0.0039	
	Nickel, total (mg/L)	0.0005	0.0003	0.0017	0.0003	0.0010	
	Phosphorus, total (mg/L)	0.03	0.02	0.08	0.02	0.07	
	Potassium, total (mg/L)	0.56	0.13	1.17	0.21	1.86	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	3.4	1.9	4.5	3.5	4.9	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	2.59	0.81	3.52	1.55	9.78	
	Strontium, total (mg/L)	0.029	0.008	0.043	0.018	0.100	
	Sulfur, total (mg/L)	< 1	< 1	< 1	< 1	2	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	0.0003	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	0.015	0.006	0.037	0.009	0.036	
	Uranium, total (mg/L)	0.00002	0.00002	0.00004	< 0.00002	0.00011	
	Vanadium, total (mg/L)	0.001	< 0.001	0.002	< 0.001	0.002	
	Zinc, total (mg/L)	0.005	0.005	0.013	< 0.004	0.008	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0003	< 0.0001	0.0002	
Microbiological Parameters	Coliforms, Fecal (MPN/100 mL)	30	4	500	<2	30	
	E. coli (MPN) (MPN/100 mL)	23	4	500	<2	30	

CARO BC COC, Rev 2015-09

ANALYTICAL
Caring About Result

6120157

CHAIN OF CUSTODY RECORD

COC# ☐ *PAGE 1 OF 1*

RELINQUISHED BY: Peter deKoning	DATE: 02-Dec-16 TIME: 1645	RECEIVED BY: JLT w/I	DATE: 02-Dec-16 TIME: 4:47
PROJECT: 173.191 Blaney, North Alouette, Fraser Riv		PROJECT INFO: Stormwater Monitoring	

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION: Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

REPORT TO:
COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley
TEL/FAX: 604-293-3121 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐
EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

COMPANY: Kerr Wood Leidal
ADDRESS: 200-4185A Still Creek Drive
Burnaby, BC, V5C 6G9
CONTACT: Patrick Lilley/Michelle Derer
TEL/FAX: 604-293-3252 604-294-2090
DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ *E. coli* ☒	ASBESTOS	Nitrate - N							HOLD
BL-1 (Anderson Creek)		✓			6	02-Dec-16	14:00												✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)		✓			6	02-Dec-16	15:00												✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)		✓			6	02-Dec-16	13:00												✓	✓		✓				✓	✓		✓							
NA-2 (Balsam Creek)		✓			6	02-Dec-16	13:30												✓	✓		✓				✓	✓		✓							
NA-3 (Cattail Brook)		✓			6	02-Dec-16	14:30												✓	✓		✓				✓	✓		✓							
Field Blank		✓			1	02-Dec-16	14:30																						✓							
Trip Blank		✓			1	02-Dec-16	10:15																													✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved Hg. Alkalinity=SPECIATED alkalinity. Use higher dilution for bacteriological tests pls

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION: ✓
COOLER 1 (°C): 6.0 ICE: Y ☐ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C): ICE: Y ☐ N ☐
CUSTODY SEALS INTACT:

CERTIFICATE OF ANALYSIS

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby) 200 - 4185A Still Creek Dr Burnaby, BC V5C 6G9	**TEL** **FAX**	(604) 294-2088 (604) 294-2090
ATTENTION	Patrick Lilley	**WORK ORDER**	6120837
PO NUMBER		**RECEIVED / TEMP**	2016-12-13 11:00 / 3°C
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-20
PROJECT INFO	Stormwater Monitoring		

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

The results in this report apply to the samples analyzed in accordance with the Chain of Custody or Sample Requisition document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

Work Order Comments:

Authorized By: **Brent Coates, B.Sc.**
Division Manager, Richmond

If you have any questions or concerns, please contact your Account Manager:
Bryan Shaw, Ph.D. (bshaw@caro.ca)

Locations:

#110 4011 Viking Way
Richmond, BC V6V 2K9
Tel: 604-279-1499 Fax: 604-279-1599

#102 3677 Highway 97N
Kelowna, BC V1X 5C3
Tel: 250-765-9646 Fax: 250-765-3893

17225 109 Avenue
Edmonton, AB T5S 1H7
Tel: 780-489-9100 Fax: 780-489-9700

www.caro.ca

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REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120837
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-20

ANALYSIS INFORMATION

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120837
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-20

Analysis Description	Method Reference	Technique	Location
Alkalinity in Water	APHA 2320 B*	Titration with H2SO4	Kelowna
Anions by IC in Water	APHA 4110 B	Ion Chromatography with Chemical Suppression of Eluent Conductivity	Kelowna
Coliforms, Fecal (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Dissolved Metals by ICPMS in Water	APHA 3030 B / APHA 3125 B	0.45 µm Filtration / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond
E. coli (MPN) in Water	APHA 9221	Multiple-Tube Fermentation	Sublet
Hardness (as CaCO3) in Water	APHA 2340 B	Calculation: 2.497 [diss Ca] + 4.118 [diss Mg]	N/A
Hardness (as CaCO3) in Water	APHA 2340 B*	Calculation: 2.497 [total Ca] + 4.118 [total Mg] (Estimated)	N/A
Mercury, dissolved by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Mercury, total by CVAFS in Water	EPA 245.7*	BrCl2 Oxidation / Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Richmond
Total Metals by ICPMS in Water	APHA 3030E* / APHA 3125 B	HNO3+HCl Hot Block Digestion / Inductively Coupled Plasma Mass Spectrometry (ICP-MS)	Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, 22nd Edition, American Public Health Association/American Water Works Association/Water Environment Federation
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
mg/L	Milligrams per litre
MPN/100 mL	Most Probable Number per 100 millilitres

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120837
REPORTED 2016-12-20

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6120837-01) [Water] Sampled: 2016-12-12 15:30							
Anions							
Nitrate (as N)	**0.943**	N/A	0.010	mg/L	N/A	2016-12-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**10**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Bicarbonate (as CaCO3)	**10**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Calculated Parameters							
Hardness, Total (as CaCO3)	**16.0**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.051**	N/A	0.005	mg/L	N/A	2016-12-16	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Barium, dissolved	**0.011**	N/A	0.005	mg/L	N/A	2016-12-16	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Boron, dissolved	**0.009**	N/A	0.004	mg/L	N/A	2016-12-16	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-12-16	
Calcium, dissolved	**4.9**	N/A	0.2	mg/L	N/A	2016-12-16	
Chromium, dissolved	**0.0005**	N/A	0.0005	mg/L	N/A	2016-12-16	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Copper, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	2016-12-16	
Iron, dissolved	**0.037**	N/A	0.010	mg/L	N/A	2016-12-16	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Lithium, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-16	
Magnesium, dissolved	**0.90**	N/A	0.01	mg/L	N/A	2016-12-16	
Manganese, dissolved	**0.0046**	N/A	0.0002	mg/L	N/A	2016-12-16	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-12-16	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-16	
Potassium, dissolved	**0.64**	N/A	0.02	mg/L	N/A	2016-12-16	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Silicon, dissolved	**3.5**	N/A	0.5	mg/L	N/A	2016-12-16	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Sodium, dissolved	**6.14**	N/A	0.02	mg/L	N/A	2016-12-16	
Strontium, dissolved	**0.040**	N/A	0.001	mg/L	N/A	2016-12-16	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-16	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120837
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-20

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: BL-1 (Anderson Creek) (6120837-01) [Water] Sampled: 2016-12-12 15:30, Continued							
Dissolved Metals, Continued							
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-16	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-16	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Total Metals							
Aluminum, total	**0.105**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Barium, total	**0.011**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Boron, total	**0.013**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-12-14	2016-12-15	
Calcium, total	**4.9**	N/A	0.2	mg/L	2016-12-14	2016-12-15	
Chromium, total	**0.0006**	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Cobalt, total	**0.00007**	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Copper, total	**0.0008**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Iron, total	**0.10**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Lithium, total	**0.0002**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Magnesium, total	**0.91**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Manganese, total	**0.0070**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Nickel, total	**0.0002**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Potassium, total	**0.63**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Silicon, total	**3.5**	N/A	0.5	mg/L	2016-12-14	2016-12-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Sodium, total	**6.15**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Strontium, total	**0.040**	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-14	2016-12-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Zinc, total	**0.004**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Microbiological Parameters							
Coliforms, Fecal	<2	N/A	2	MPN/100 mL		2016-12-13	

REPORTED TO	Kerr Wood Leidal Associates Ltd. (Burnaby)	**WORK ORDER**	6120837
PROJECT	173.191 Blaney, North Alouettem, Fraser River	**REPORTED**	2016-12-20

Sample ID: BL-1 (Anderson Creek) (6120837-01) [Water] Sampled: 2016-12-12 15:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Microbiological Parameters, Continued							
E. coli (MPN)	<2	N/A	2	MPN/100 mL		2016-12-13	

Sample ID: NA-1 (North Alouette River) (6120837-02) [Water] Sampled: 2016-12-12 16:30

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.237**	N/A	0.010	mg/L	N/A	2016-12-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**4**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Bicarbonate (as CaCO3)	**4**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Calculated Parameters							
Hardness, Total (as CaCO3)	**5.25**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.072**	N/A	0.005	mg/L	N/A	2016-12-16	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Boron, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-12-16	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-12-16	
Calcium, dissolved	**1.6**	N/A	0.2	mg/L	N/A	2016-12-16	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Copper, dissolved	**0.0004**	N/A	0.0002	mg/L	N/A	2016-12-16	
Iron, dissolved	**0.025**	N/A	0.010	mg/L	N/A	2016-12-16	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Magnesium, dissolved	**0.27**	N/A	0.01	mg/L	N/A	2016-12-16	
Manganese, dissolved	**0.0014**	N/A	0.0002	mg/L	N/A	2016-12-16	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-16	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-16	
Potassium, dissolved	**0.14**	N/A	0.02	mg/L	N/A	2016-12-16	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Silicon, dissolved	**2.5**	N/A	0.5	mg/L	N/A	2016-12-16	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Sodium, dissolved	**1.24**	N/A	0.02	mg/L	N/A	2016-12-16	
Strontium, dissolved	**0.010**	N/A	0.001	mg/L	N/A	2016-12-16	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-16	

Sample ID: NA-1 (North Alouette River) (6120837-02) [Water] Sampled: 2016-12-12 16:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-16	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-16	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Total Metals							
Aluminum, total	**0.089**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Boron, total	**0.008**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-12-14	2016-12-15	
Calcium, total	**1.9**	N/A	0.2	mg/L	2016-12-14	2016-12-15	
Chromium, total	**0.0007**	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Copper, total	**0.0005**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Iron, total	**0.04**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Lead, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Lithium, total	**0.0001**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Magnesium, total	**0.31**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Manganese, total	**0.0019**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, total	**0.0002**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Potassium, total	**0.16**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Silicon, total	**2.6**	N/A	0.5	mg/L	2016-12-14	2016-12-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Sodium, total	**1.41**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Strontium, total	**0.011**	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-14	2016-12-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-14	2016-12-15	

Sample ID: NA-1 (North Alouette River) (6120837-02) [Water] Sampled: 2016-12-12 16:30, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Total Metals, Continued							
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Microbiological Parameters							
Coliforms, Fecal	<2	N/A	2	MPN/100 mL		2016-12-13	
E. coli (MPN)	<2	N/A	2	MPN/100 mL		2016-12-13	

Sample ID: FR-1 (227 St Creek) (6120837-03) [Water] Sampled: 2016-12-12 14:45

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Anions							
Nitrate (as N)	**0.867**	N/A	0.010	mg/L	N/A	2016-12-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**44**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Bicarbonate (as CaCO3)	**44**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Calculated Parameters							
Hardness, Total (as CaCO3)	**47.5**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.026**	N/A	0.005	mg/L	N/A	2016-12-16	
Antimony, dissolved	**0.0001**	N/A	0.0001	mg/L	N/A	2016-12-16	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Barium, dissolved	**0.015**	N/A	0.005	mg/L	N/A	2016-12-16	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Boron, dissolved	**0.016**	N/A	0.004	mg/L	N/A	2016-12-16	
Cadmium, dissolved	**0.00002**	N/A	0.00001	mg/L	N/A	2016-12-16	
Calcium, dissolved	**12.0**	N/A	0.2	mg/L	N/A	2016-12-16	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-12-16	
Cobalt, dissolved	**0.00015**	N/A	0.00005	mg/L	N/A	2016-12-16	
Copper, dissolved	**0.0023**	N/A	0.0002	mg/L	N/A	2016-12-16	
Iron, dissolved	**0.120**	N/A	0.010	mg/L	N/A	2016-12-16	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Lithium, dissolved	**0.0005**	N/A	0.0001	mg/L	N/A	2016-12-16	
Magnesium, dissolved	**4.27**	N/A	0.01	mg/L	N/A	2016-12-16	
Manganese, dissolved	**0.0450**	N/A	0.0002	mg/L	N/A	2016-12-16	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, dissolved	**0.0008**	N/A	0.0001	mg/L	N/A	2016-12-16	
Nickel, dissolved	**0.0006**	N/A	0.0002	mg/L	N/A	2016-12-16	
Phosphorus, dissolved	**0.02**	N/A	0.02	mg/L	N/A	2016-12-16	
Potassium, dissolved	**1.76**	N/A	0.02	mg/L	N/A	2016-12-16	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6120837-03) [Water] Sampled: 2016-12-12 14:45, Continued							
Dissolved Metals, Continued							
Silicon, dissolved	**4.2**	N/A	0.5	mg/L	N/A	2016-12-16	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Sodium, dissolved	**38.3**	N/A	0.02	mg/L	N/A	2016-12-16	
Strontium, dissolved	**0.082**	N/A	0.001	mg/L	N/A	2016-12-16	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-16	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	
Uranium, dissolved	**0.00003**	N/A	0.00002	mg/L	N/A	2016-12-16	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-16	
Zinc, dissolved	**0.008**	N/A	0.004	mg/L	N/A	2016-12-16	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Total Metals							
Aluminum, total	**0.480**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Antimony, total	**0.0002**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Arsenic, total	**0.0005**	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Barium, total	**0.018**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Boron, total	**0.019**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Cadmium, total	**0.00003**	N/A	0.00001	mg/L	2016-12-14	2016-12-15	
Calcium, total	**13.7**	N/A	0.2	mg/L	2016-12-14	2016-12-15	
Chromium, total	**0.0013**	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Cobalt, total	**0.00032**	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Copper, total	**0.0037**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Iron, total	**0.63**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Lead, total	**0.0004**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Lithium, total	**0.0008**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Magnesium, total	**4.53**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Manganese, total	**0.0574**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, total	**0.0008**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Nickel, total	**0.0012**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Phosphorus, total	**0.04**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Potassium, total	**1.95**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Silicon, total	**4.7**	N/A	0.5	mg/L	2016-12-14	2016-12-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Sodium, total	**40.6**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Strontium, total	**0.083**	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Sulfur, total	**2**	N/A	1	mg/L	2016-12-14	2016-12-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120837
REPORTED 2016-12-20

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: FR-1 (227 St Creek) (6120837-03) [Water] Sampled: 2016-12-12 14:45, Continued							
Total Metals, Continued							
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Titanium, total	**0.018**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Uranium, total	**0.00004**	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Vanadium, total	**0.001**	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Zinc, total	**0.012**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Zirconium, total	**0.0003**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Microbiological Parameters							
Coliforms, Fecal	**170**	N/A	2	MPN/100 mL		2016-12-13	
E. coli (MPN)	**170**	N/A	2	MPN/100 mL		2016-12-13	
Sample ID: NA-2 (Balsam Creek) (6120837-04) [Water] Sampled: 2016-12-12 15:00							
Anions							
Nitrate (as N)	**0.595**	N/A	0.010	mg/L	N/A	2016-12-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**4**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Bicarbonate (as CaCO3)	**4**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Calculated Parameters							
Hardness, Total (as CaCO3)	**6.93**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.053**	N/A	0.005	mg/L	N/A	2016-12-16	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Barium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Boron, dissolved	**0.005**	N/A	0.004	mg/L	N/A	2016-12-16	
Cadmium, dissolved	< 0.00001	N/A	0.00001	mg/L	N/A	2016-12-16	
Calcium, dissolved	**2.0**	N/A	0.2	mg/L	N/A	2016-12-16	
Chromium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Cobalt, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Copper, dissolved	**0.0002**	N/A	0.0002	mg/L	N/A	2016-12-16	
Iron, dissolved	**0.013**	N/A	0.010	mg/L	N/A	2016-12-16	
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Lithium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Magnesium, dissolved	**0.46**	N/A	0.01	mg/L	N/A	2016-12-16	
Manganese, dissolved	**0.0014**	N/A	0.0002	mg/L	N/A	2016-12-16	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	

Sample ID: NA-2 (Balsam Creek) (6120837-04) [Water] Sampled: 2016-12-12 15:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Molybdenum, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Nickel, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-16	
Potassium, dissolved	**0.16**	N/A	0.02	mg/L	N/A	2016-12-16	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Silicon, dissolved	**3.2**	N/A	0.5	mg/L	N/A	2016-12-16	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Sodium, dissolved	**1.87**	N/A	0.02	mg/L	N/A	2016-12-16	
Strontium, dissolved	**0.019**	N/A	0.001	mg/L	N/A	2016-12-16	
Sulfur, dissolved	< 1	N/A	1	mg/L	N/A	2016-12-16	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	
Uranium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-16	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-16	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Total Metals							
Aluminum, total	**0.104**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Antimony, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Barium, total	< 0.005	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Boron, total	**0.007**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Cadmium, total	< 0.00001	N/A	0.00001	mg/L	2016-12-14	2016-12-15	
Calcium, total	**2.4**	N/A	0.2	mg/L	2016-12-14	2016-12-15	
Chromium, total	**0.0007**	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Cobalt, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Copper, total	**0.0004**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Iron, total	**0.06**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Lithium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Magnesium, total	**0.50**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Manganese, total	**0.0029**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Nickel, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Potassium, total	**0.19**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Silicon, total	**3.4**	N/A	0.5	mg/L	2016-12-14	2016-12-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-2 (Balsam Creek) (6120837-04) [Water] Sampled: 2016-12-12 15:00, Continued							
Total Metals, Continued							
Sodium, total	**2.11**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Strontium, total	**0.020**	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Sulfur, total	< 1	N/A	1	mg/L	2016-12-14	2016-12-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Uranium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Microbiological Parameters							
Coliforms, Fecal	<2	N/A	2	MPN/100 mL		2016-12-13	
E. coli (MPN)	<2	N/A	2	MPN/100 mL		2016-12-13	
Sample ID: NA-3 (Cattall Brook) (6120837-05) [Water] Sampled: 2016-12-12 16:00							
Anions							
Nitrate (as N)	**1.01**	N/A	0.010	mg/L	N/A	2016-12-15	
General Parameters							
Alkalinity, Total (as CaCO3)	**33**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Phenolphthalein (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Bicarbonate (as CaCO3)	**33**	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Carbonate (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Alkalinity, Hydroxide (as CaCO3)	< 1	N/A	2	mg/L	N/A	2016-12-14	
Calculated Parameters							
Hardness, Total (as CaCO3)	**44.7**	N/A	0.50	mg/L	N/A	N/A	
Dissolved Metals							
Aluminum, dissolved	**0.020**	N/A	0.005	mg/L	N/A	2016-12-16	
Antimony, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Arsenic, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Barium, dissolved	**0.016**	N/A	0.005	mg/L	N/A	2016-12-16	
Beryllium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Bismuth, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Boron, dissolved	**0.021**	N/A	0.004	mg/L	N/A	2016-12-16	
Cadmium, dissolved	**0.00001**	N/A	0.00001	mg/L	N/A	2016-12-16	
Calcium, dissolved	**13.9**	N/A	0.2	mg/L	N/A	2016-12-16	
Chromium, dissolved	**0.0006**	N/A	0.0005	mg/L	N/A	2016-12-16	
Cobalt, dissolved	**0.00010**	N/A	0.00005	mg/L	N/A	2016-12-16	
Copper, dissolved	**0.0015**	N/A	0.0002	mg/L	N/A	2016-12-16	
Iron, dissolved	**0.066**	N/A	0.010	mg/L	N/A	2016-12-16	

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120837
REPORTED 2016-12-20

Sample ID: NA-3 (Cattall Brook) (6120837-05) [Water] Sampled: 2016-12-12 16:00, Continued

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Dissolved Metals, Continued							
Lead, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Lithium, dissolved	**0.0002**	N/A	0.0001	mg/L	N/A	2016-12-16	
Magnesium, dissolved	**2.44**	N/A	0.01	mg/L	N/A	2016-12-16	
Manganese, dissolved	**0.0328**	N/A	0.0002	mg/L	N/A	2016-12-16	
Mercury, dissolved	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, dissolved	**0.0050**	N/A	0.0001	mg/L	N/A	2016-12-16	
Nickel, dissolved	**0.0003**	N/A	0.0002	mg/L	N/A	2016-12-16	
Phosphorus, dissolved	< 0.02	N/A	0.02	mg/L	N/A	2016-12-16	
Potassium, dissolved	**2.01**	N/A	0.02	mg/L	N/A	2016-12-16	
Selenium, dissolved	< 0.0005	N/A	0.0005	mg/L	N/A	2016-12-16	
Silicon, dissolved	**4.2**	N/A	0.5	mg/L	N/A	2016-12-16	
Silver, dissolved	< 0.00005	N/A	0.00005	mg/L	N/A	2016-12-16	
Sodium, dissolved	**14.5**	N/A	0.02	mg/L	N/A	2016-12-16	
Strontium, dissolved	**0.103**	N/A	0.001	mg/L	N/A	2016-12-16	
Sulfur, dissolved	**2**	N/A	1	mg/L	N/A	2016-12-16	
Tellurium, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Thallium, dissolved	< 0.00002	N/A	0.00002	mg/L	N/A	2016-12-16	
Thorium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Tin, dissolved	< 0.0002	N/A	0.0002	mg/L	N/A	2016-12-16	
Titanium, dissolved	< 0.005	N/A	0.005	mg/L	N/A	2016-12-16	
Uranium, dissolved	**0.00007**	N/A	0.00002	mg/L	N/A	2016-12-16	
Vanadium, dissolved	< 0.001	N/A	0.001	mg/L	N/A	2016-12-16	
Zinc, dissolved	< 0.004	N/A	0.004	mg/L	N/A	2016-12-16	
Zirconium, dissolved	< 0.0001	N/A	0.0001	mg/L	N/A	2016-12-16	
Total Metals							
Aluminum, total	**0.135**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Antimony, total	**0.0001**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Arsenic, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Barium, total	**0.019**	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Beryllium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Bismuth, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Boron, total	**0.024**	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Cadmium, total	**0.00001**	N/A	0.00001	mg/L	2016-12-14	2016-12-15	
Calcium, total	**16.6**	N/A	0.2	mg/L	2016-12-14	2016-12-15	
Chromium, total	**0.0009**	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Cobalt, total	**0.00014**	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Copper, total	**0.0021**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Iron, total	**0.20**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Lead, total	**0.0001**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Lithium, total	**0.0003**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Magnesium, total	**2.65**	N/A	0.01	mg/L	2016-12-14	2016-12-15	
Manganese, total	**0.0392**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Mercury, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-14	
Molybdenum, total	**0.0054**	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Nickel, total	**0.0003**	N/A	0.0002	mg/L	2016-12-14	2016-12-15	

SAMPLE ANALYTICAL DATA

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120837
REPORTED 2016-12-20

Analyte	Result / *Recovery*	Standard / Guideline	MRL / *Limits*	Units	Prepared	Analyzed	Notes
Sample ID: NA-3 (Cattall Brook) (6120837-05) [Water] Sampled: 2016-12-12 16:00, Continued							
Total Metals, Continued							
Phosphorus, total	< 0.02	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Potassium, total	**2.22**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Selenium, total	< 0.0005	N/A	0.0005	mg/L	2016-12-14	2016-12-15	
Silicon, total	**4.3**	N/A	0.5	mg/L	2016-12-14	2016-12-15	
Silver, total	< 0.00005	N/A	0.00005	mg/L	2016-12-14	2016-12-15	
Sodium, total	**16.3**	N/A	0.02	mg/L	2016-12-14	2016-12-15	
Strontium, total	**0.107**	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Sulfur, total	**3**	N/A	1	mg/L	2016-12-14	2016-12-15	
Tellurium, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Thallium, total	< 0.00002	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Thorium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Tin, total	< 0.0002	N/A	0.0002	mg/L	2016-12-14	2016-12-15	
Titanium, total	< 0.005	N/A	0.005	mg/L	2016-12-14	2016-12-15	
Uranium, total	**0.00009**	N/A	0.00002	mg/L	2016-12-14	2016-12-15	
Vanadium, total	< 0.001	N/A	0.001	mg/L	2016-12-14	2016-12-15	
Zinc, total	< 0.004	N/A	0.004	mg/L	2016-12-14	2016-12-15	
Zirconium, total	< 0.0001	N/A	0.0001	mg/L	2016-12-14	2016-12-15	
Microbiological Parameters							
Coliforms, Fecal	**170**	N/A	2	MPN/100 mL		2016-12-13	
E. coli (MPN)	**170**	N/A	2	MPN/100 mL		2016-12-13	
Sample ID: Field Blank (6120837-06) [Water] Sampled: 2016-12-12 14:40							
Microbiological Parameters							
E. coli (MPN)	<2	N/A	2	MPN/100 mL		2016-12-13	

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method's precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method's accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Anions, Batch B6L0837										
Blank (B6L0837-BLK1)				Prepared: 2016-12-15, Analyzed: 2016-12-15						
Nitrate (as N)	< 0.010	0.010	mg/L							
Blank (B6L0837-BLK2)				Prepared: 2016-12-15, Analyzed: 2016-12-15						
Nitrate (as N)	< 0.010	0.010	mg/L							
LCS (B6L0837-BS1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Nitrate (as N)	4.03	0.010	mg/L	4.00		101	93-108			
LCS (B6L0837-BS2)				Prepared: 2016-12-15, Analyzed: 2016-12-15						
Nitrate (as N)	4.09	0.010	mg/L	4.00		102	93-108			
LCS (B6L0837-BS3)				Prepared: 2016-12-15, Analyzed: 2016-12-15						
Nitrate (as N)	4.01	0.010	mg/L	4.00		100	93-108			
Dissolved Metals, Batch B6L0832										
Blank (B6L0832-BLK1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Mercury, dissolved	< 0.00002	0.00002	mg/L							
Reference (B6L0832-SRM1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Mercury, dissolved	0.00521	0.00002	mg/L	0.00489		106	50-150			
Dissolved Metals, Batch B6L0939										
Blank (B6L0939-BLK1)				Prepared: 2016-12-16, Analyzed: 2016-12-16						
Aluminum, dissolved	< 0.005	0.005	mg/L							
Antimony, dissolved	< 0.0001	0.0001	mg/L							
Arsenic, dissolved	< 0.0005	0.0005	mg/L							
Barium, dissolved	< 0.005	0.005	mg/L							
Beryllium, dissolved	< 0.0001	0.0001	mg/L							
Bismuth, dissolved	< 0.0001	0.0001	mg/L							
Boron, dissolved	< 0.004	0.004	mg/L							

Dissolved Metals, Batch B6L0939, Continued

Blank (B6L0939-BLK1), Continued Prepared: 2016-12-16, Analyzed: 2016-12-16

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Cadmium, dissolved	< 0.00001	0.00001	mg/L							
Calcium, dissolved	< 0.2	0.2	mg/L							
Chromium, dissolved	< 0.0005	0.0005	mg/L							
Cobalt, dissolved	< 0.00005	0.00005	mg/L							
Copper, dissolved	< 0.0002	0.0002	mg/L							
Iron, dissolved	< 0.010	0.010	mg/L							
Lead, dissolved	< 0.0001	0.0001	mg/L							
Lithium, dissolved	< 0.0001	0.0001	mg/L							
Magnesium, dissolved	< 0.01	0.01	mg/L							
Manganese, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.0001	0.0001	mg/L							
Nickel, dissolved	< 0.0002	0.0002	mg/L							
Phosphorus, dissolved	< 0.02	0.02	mg/L							
Potassium, dissolved	< 0.02	0.02	mg/L							
Selenium, dissolved	< 0.0005	0.0005	mg/L							
Silicon, dissolved	< 0.5	0.5	mg/L							
Silver, dissolved	< 0.00005	0.00005	mg/L							
Sodium, dissolved	< 0.02	0.02	mg/L							
Strontium, dissolved	< 0.001	0.001	mg/L							
Sulfur, dissolved	< 1	1	mg/L							
Tellurium, dissolved	< 0.0002	0.0002	mg/L							
Thallium, dissolved	< 0.00002	0.00002	mg/L							
Thorium, dissolved	< 0.0001	0.0001	mg/L							
Tin, dissolved	< 0.0002	0.0002	mg/L							
Titanium, dissolved	< 0.005	0.005	mg/L							
Uranium, dissolved	< 0.00002	0.00002	mg/L							
Vanadium, dissolved	< 0.001	0.001	mg/L							
Zinc, dissolved	< 0.004	0.004	mg/L							
Zirconium, dissolved	< 0.0001	0.0001	mg/L							

Duplicate (B6L0939-DUP1) **Source: 6120837-03** Prepared: 2016-12-16, Analyzed: 2016-12-16

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, dissolved	0.027	0.005	mg/L		0.026			6	11	
Antimony, dissolved	0.0001	0.0001	mg/L		0.0001				44	
Arsenic, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				8	
Barium, dissolved	0.015	0.005	mg/L		0.015				7	
Beryllium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				14	
Bismuth, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, dissolved	0.017	0.004	mg/L		0.016				13	
Cadmium, dissolved	0.00003	0.00001	mg/L		0.00002				27	
Calcium, dissolved	12.6	0.2	mg/L		12.0			5	8	
Chromium, dissolved	0.0007	0.0005	mg/L		0.0006				14	
Cobalt, dissolved	0.00015	0.00005	mg/L		0.00015				10	
Copper, dissolved	0.0025	0.0002	mg/L		0.0023			7	28	
Iron, dissolved	0.126	0.010	mg/L		0.120			4	14	
Lead, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				26	
Lithium, dissolved	0.0005	0.0001	mg/L		0.0005			4	14	
Magnesium, dissolved	4.48	0.01	mg/L		4.27			5	6	
Manganese, dissolved	0.0469	0.0002	mg/L		0.0450			4	9	
Molybdenum, dissolved	0.0008	0.0001	mg/L		0.0008			1	19	
Nickel, dissolved	0.0007	0.0002	mg/L		0.0006				21	
Phosphorus, dissolved	0.04	0.02	mg/L		0.02				14	
Potassium, dissolved	1.84	0.02	mg/L		1.76			5	8	
Selenium, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				36	
Silicon, dissolved	4.4	0.5	mg/L		4.2			5	12	
Silver, dissolved	< 0.00005	0.00005	mg/L		< 0.00005				20	
Sodium, dissolved	40.0	0.02	mg/L		38.3			4	6	
Strontium, dissolved	0.084	0.001	mg/L		0.082			3	6	

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Dissolved Metals, Batch B6L0939, Continued										
Duplicate (B6L0939-DUP1), Continued	**Source: 6120837-03**			Prepared: 2016-12-16, Analyzed: 2016-12-16						
Sulfur, dissolved	1	1	mg/L		< 1				26	
Tellurium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, dissolved	< 0.00002	0.00002	mg/L		< 0.00002				13	
Thorium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				30	
Tin, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				6	
Titanium, dissolved	< 0.005	0.005	mg/L		< 0.005				20	
Uranium, dissolved	0.00003	0.00002	mg/L		0.00003				14	
Vanadium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Zinc, dissolved	0.008	0.004	mg/L		0.008				11	
Zirconium, dissolved	< 0.0001	0.0001	mg/L		< 0.0001				36	
Reference (B6L0939-SRM1)				Prepared: 2016-12-16, Analyzed: 2016-12-16						
Aluminum, dissolved	0.241	0.005	mg/L	0.233		103	58-142			
Antimony, dissolved	0.0466	0.0001	mg/L	0.0430		108	75-125			
Arsenic, dissolved	0.476	0.0005	mg/L	0.438		109	81-119			
Barium, dissolved	3.50	0.005	mg/L	3.35		105	83-117			
Beryllium, dissolved	0.195	0.0001	mg/L	0.213		92	80-120			
Boron, dissolved	1.66	0.004	mg/L	1.74		95	74-117			
Cadmium, dissolved	0.238	0.00001	mg/L	0.224		106	83-117			
Calcium, dissolved	7.1	0.2	mg/L	7.69		92	76-124			
Chromium, dissolved	0.471	0.0005	mg/L	0.437		108	81-119			
Cobalt, dissolved	0.138	0.00005	mg/L	0.128		108	76-124			
Copper, dissolved	0.923	0.0002	mg/L	0.844		109	84-116			
Iron, dissolved	1.37	0.010	mg/L	1.29		106	74-126			
Lead, dissolved	0.103	0.0001	mg/L	0.112		92	72-128			
Lithium, dissolved	0.0917	0.0001	mg/L	0.104		88	60-140			
Magnesium, dissolved	7.25	0.01	mg/L	6.92		105	81-119			
Manganese, dissolved	0.362	0.0002	mg/L	0.345		105	84-116			
Molybdenum, dissolved	0.436	0.0001	mg/L	0.426		102	83-117			
Nickel, dissolved	0.901	0.0002	mg/L	0.840		107	74-126			
Phosphorus, dissolved	0.50	0.02	mg/L	0.495		101	68-132			
Potassium, dissolved	3.19	0.02	mg/L	3.19		100	74-126			
Selenium, dissolved	0.0330	0.0005	mg/L	0.0331		100	70-130			
Sodium, dissolved	18.9	0.02	mg/L	19.1		99	72-128			
Strontium, dissolved	0.942	0.001	mg/L	0.916		103	84-113			
Thallium, dissolved	0.0357	0.00002	mg/L	0.0393		91	57-143			
Uranium, dissolved	0.242	0.00002	mg/L	0.266		91	85-115			
Vanadium, dissolved	0.904	0.001	mg/L	0.869		104	87-113			
Zinc, dissolved	0.955	0.004	mg/L	0.881		108	72-128			
General Parameters, Batch B6L0830										
Blank (B6L0830-BLK1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							
Blank (B6L0830-BLK2)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Alkalinity, Total (as CaCO3)	< 1	2	mg/L							
Alkalinity, Phenolphthalein (as CaCO3)	< 1	2	mg/L							
Alkalinity, Bicarbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Carbonate (as CaCO3)	< 1	2	mg/L							
Alkalinity, Hydroxide (as CaCO3)	< 1	2	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
General Parameters, Batch B6L0830, Continued										
LCS (B6L0830-BS1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Alkalinity, Total (as CaCO3)	104	2	mg/L	100		104	92-106			
LCS (B6L0830-BS2)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Alkalinity, Total (as CaCO3)	103	2	mg/L	100		103	92-106			
Total Metals, Batch B6L0834										
Blank (B6L0834-BLK1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Mercury, total	< 0.00002	0.00002	mg/L							
Reference (B6L0834-SRM1)				Prepared: 2016-12-14, Analyzed: 2016-12-14						
Mercury, total	0.00485	0.00002	mg/L	0.00489		99	50-150			
Total Metals, Batch B6L0858										
Blank (B6L0858-BLK1)				Prepared: 2016-12-14, Analyzed: 2016-12-15						
Aluminum, total	< 0.005	0.005	mg/L							
Antimony, total	< 0.0001	0.0001	mg/L							
Arsenic, total	< 0.0005	0.0005	mg/L							
Barium, total	< 0.005	0.005	mg/L							
Beryllium, total	< 0.0001	0.0001	mg/L							
Bismuth, total	< 0.0001	0.0001	mg/L							
Boron, total	< 0.004	0.004	mg/L							
Cadmium, total	< 0.00001	0.00001	mg/L							
Calcium, total	< 0.2	0.2	mg/L							
Chromium, total	< 0.0005	0.0005	mg/L							
Cobalt, total	< 0.00005	0.00005	mg/L							
Copper, total	< 0.0002	0.0002	mg/L							
Iron, total	< 0.01	0.01	mg/L							
Lead, total	< 0.0001	0.0001	mg/L							
Lithium, total	< 0.0001	0.0001	mg/L							
Magnesium, total	< 0.01	0.01	mg/L							
Manganese, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.0001	0.0001	mg/L							
Nickel, total	< 0.0002	0.0002	mg/L							
Phosphorus, total	< 0.02	0.02	mg/L							
Potassium, total	< 0.02	0.02	mg/L							
Selenium, total	< 0.0005	0.0005	mg/L							
Silicon, total	< 0.5	0.5	mg/L							
Silver, total	< 0.00005	0.00005	mg/L							
Sodium, total	< 0.02	0.02	mg/L							
Strontium, total	< 0.001	0.001	mg/L							
Sulfur, total	< 1	1	mg/L							
Tellurium, total	< 0.0002	0.0002	mg/L							
Thallium, total	< 0.00002	0.00002	mg/L							
Thorium, total	< 0.0001	0.0001	mg/L							
Tin, total	< 0.0002	0.0002	mg/L							
Titanium, total	< 0.005	0.005	mg/L							
Uranium, total	< 0.00002	0.00002	mg/L							
Vanadium, total	< 0.001	0.001	mg/L							
Zinc, total	< 0.004	0.004	mg/L							
Zirconium, total	< 0.0001	0.0001	mg/L							
Duplicate (B6L0858-DUP1)		**Source: 6120837-03**		Prepared: 2016-12-14, Analyzed: 2016-12-15						
Aluminum, total	0.480	0.005	mg/L		0.480			< 1	29	
Antimony, total	0.0002	0.0001	mg/L		0.0002				31	

Total Metals, Batch B6L0858, Continued

Duplicate (B6L0858-DUP1), Continued **Source: 6120837-03** Prepared: 2016-12-14, Analyzed: 2016-12-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Arsenic, total	0.0005	0.0005	mg/L		0.0005				15	
Barium, total	0.018	0.005	mg/L		0.018				9	
Beryllium, total	< 0.0001	0.0001	mg/L		< 0.0001				16	
Bismuth, total	< 0.0001	0.0001	mg/L		< 0.0001				20	
Boron, total	0.015	0.004	mg/L		0.019				29	
Cadmium, total	0.00002	0.00001	mg/L		0.00003				33	
Calcium, total	13.8	0.2	mg/L		13.7			< 1	12	
Chromium, total	0.0013	0.0005	mg/L		0.0013				12	
Cobalt, total	0.00034	0.00005	mg/L		0.00032			7	13	
Copper, total	0.0038	0.0002	mg/L		0.0037			2	37	
Iron, total	0.63	0.01	mg/L		0.63			< 1	18	
Lead, total	0.0004	0.0001	mg/L		0.0004				23	
Lithium, total	0.0008	0.0001	mg/L		0.0008			5	19	
Magnesium, total	4.59	0.01	mg/L		4.53			1	10	
Manganese, total	0.0571	0.0002	mg/L		0.0574			< 1	13	
Molybdenum, total	0.0008	0.0001	mg/L		0.0008			< 1	20	
Nickel, total	0.0012	0.0002	mg/L		0.0012			2	28	
Phosphorus, total	0.05	0.02	mg/L		0.04				24	
Potassium, total	1.98	0.02	mg/L		1.95			1	13	
Selenium, total	< 0.0005	0.0005	mg/L		< 0.0005				24	
Silicon, total	4.8	0.5	mg/L		4.7			1	11	
Silver, total	< 0.00005	0.00005	mg/L		0.00005				18	
Sodium, total	40.7	0.02	mg/L		40.6			< 1	10	
Strontium, total	0.084	0.001	mg/L		0.083			2	9	
Sulfur, total	1	1	mg/L		2				24	
Tellurium, total	< 0.0002	0.0002	mg/L		< 0.0002				20	
Thallium, total	< 0.00002	0.00002	mg/L		< 0.00002				24	
Thorium, total	< 0.0001	0.0001	mg/L		< 0.0001				18	
Tin, total	< 0.0002	0.0002	mg/L		< 0.0002				18	
Titanium, total	0.017	0.005	mg/L		0.018				32	
Uranium, total	0.00004	0.00002	mg/L		0.00004				14	
Vanadium, total	0.001	0.001	mg/L		0.001				17	
Zinc, total	0.013	0.004	mg/L		0.012				8	
Zirconium, total	0.0002	0.0001	mg/L		0.0003				60	

Reference (B6L0858-SRM1) Prepared: 2016-12-14, Analyzed: 2016-12-15

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Aluminum, total	0.309	0.005	mg/L	0.303		102	81-129			
Antimony, total	0.0485	0.0001	mg/L	0.0511		95	88-114			
Arsenic, total	0.123	0.0005	mg/L	0.118		104	88-114			
Barium, total	0.797	0.005	mg/L	0.823		97	72-104			
Beryllium, total	0.0491	0.0001	mg/L	0.0496		99	76-131			
Boron, total	3.28	0.004	mg/L	3.45		95	75-121			
Cadmium, total	0.0502	0.00001	mg/L	0.0495		101	89-111			
Calcium, total	11.2	0.2	mg/L	11.6		97	86-121			
Chromium, total	0.256	0.0005	mg/L	0.250		103	89-114			
Cobalt, total	0.0395	0.00005	mg/L	0.0377		105	91-113			
Copper, total	0.530	0.0002	mg/L	0.486		109	91-115			
Iron, total	0.52	0.01	mg/L	0.488		106	77-124			
Lead, total	0.202	0.0001	mg/L	0.204		99	92-113			
Lithium, total	0.373	0.0001	mg/L	0.403		93	85-115			
Magnesium, total	3.97	0.01	mg/L	3.79		105	78-120			
Manganese, total	0.112	0.0002	mg/L	0.109		102	90-114			
Molybdenum, total	0.203	0.0001	mg/L	0.198		102	90-111			
Nickel, total	0.262	0.0002	mg/L	0.249		105	90-111			
Phosphorus, total	0.21	0.02	mg/L	0.227		91	85-115			
Potassium, total	7.56	0.02	mg/L	7.21		105	84-113			
Selenium, total	0.128	0.0005	mg/L	0.121		106	85-115			

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Notes
Total Metals, Batch B6L0858, Continued										
Reference (B6L0858-SRM1), Continued				Prepared: 2016-12-14, Analyzed: 2016-12-15						
Sodium, total	7.88	0.02	mg/L	7.54		105	82-123			
Strontium, total	0.374	0.001	mg/L	0.375		100	88-112			
Thallium, total	0.0815	0.00002	mg/L	0.0805		101	91-114			
Uranium, total	0.0297	0.00002	mg/L	0.0306		97	85-120			
Vanadium, total	0.389	0.001	mg/L	0.386		101	86-111			
Zinc, total	2.58	0.004	mg/L	2.49		104	85-111			

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120837
REPORTED 2016-12-20

		6120837-01	6120837-02	6120837-03	6120837-04	6120837-05	6120837-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-12-12	**2016-12-12**	**2016-12-12**	**2016-12-12**	**2016-12-12**	**2016-12-12**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Anions	Nitrate (as N) (mg/L)	0.943	0.237	0.867	0.595	1.01	
General Parameters	Alkalinity, Total (as CaCO3) (mg/L)	10	4	44	4	33	
	Alkalinity, Phenolphthalein (as CaCO3) (mg/	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	10	4	44	4	33	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	< 1	< 1	< 1	< 1	< 1	
Calculated Parameters	Hardness, Total (as CaCO3) (mg/L)	16.0	5.25	47.5	6.93	44.7	
Dissolved Metals	Aluminum, dissolved (mg/L)	0.051	0.072	0.026	0.053	0.020	
	Antimony, dissolved (mg/L)	< 0.0001	< 0.0001	0.0001	< 0.0001	< 0.0001	
	Arsenic, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Barium, dissolved (mg/L)	0.011	< 0.005	0.015	< 0.005	0.016	
	Beryllium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, dissolved (mg/L)	0.009	0.005	0.016	0.005	0.021	
	Cadmium, dissolved (mg/L)	< 0.00001	< 0.00001	0.00002	< 0.00001	0.00001	
	Calcium, dissolved (mg/L)	4.9	1.6	12.0	2.0	13.9	
	Chromium, dissolved (mg/L)	0.0005	< 0.0005	0.0006	< 0.0005	0.0006	
	Cobalt, dissolved (mg/L)	< 0.00005	< 0.00005	0.00015	< 0.00005	0.00010	
	Copper, dissolved (mg/L)	0.0006	0.0004	0.0023	0.0002	0.0015	
	Iron, dissolved (mg/L)	0.037	0.025	0.120	0.013	0.066	
	Lead, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Lithium, dissolved (mg/L)	0.0001	< 0.0001	0.0005	< 0.0001	0.0002	
	Magnesium, dissolved (mg/L)	0.90	0.27	4.27	0.46	2.44	
	Manganese, dissolved (mg/L)	0.0046	0.0014	0.0450	0.0014	0.0328	
	Mercury, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, dissolved (mg/L)	0.0002	0.0001	0.0008	< 0.0001	0.0050	
	Nickel, dissolved (mg/L)	< 0.0002	< 0.0002	0.0006	< 0.0002	0.0003	
	Phosphorus, dissolved (mg/L)	< 0.02	< 0.02	0.02	< 0.02	< 0.02	
	Potassium, dissolved (mg/L)	0.64	0.14	1.76	0.16	2.01	
	Selenium, dissolved (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, dissolved (mg/L)	3.5	2.5	4.2	3.2	4.2	
	Silver, dissolved (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, dissolved (mg/L)	6.14	1.24	38.3	1.87	14.5	
	Strontium, dissolved (mg/L)	0.040	0.010	0.082	0.019	0.103	
	Sulfur, dissolved (mg/L)	< 1	< 1	< 1	< 1	2	
	Tellurium, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, dissolved (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, dissolved (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, dissolved (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	
	Uranium, dissolved (mg/L)	< 0.00002	< 0.00002	0.00003	< 0.00002	0.00007	
	Vanadium, dissolved (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	
	Zinc, dissolved (mg/L)	< 0.004	< 0.004	0.008	< 0.004	< 0.004	
	Zirconium, dissolved (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	

APPENDIX 2: ANALYTICAL SUMMARY

REPORTED TO Kerr Wood Leidal Associates Ltd. (Burnaby)
PROJECT 173.191 Blaney, North Alouettem, Fraser River

WORK ORDER 6120837
REPORTED 2016-12-20

		6120837-01	6120837-02	6120837-03	6120837-04	6120837-05	6120837-06
		Water	**Water**	**Water**	**Water**	**Water**	**Water**
		2016-12-12	**2016-12-12**	**2016-12-12**	**2016-12-12**	**2016-12-12**	**2016-12-12**
		BL-1 (Anderson Creek)	**NA-1 (North Alouette River)**	**FR-1 (227 St Creek)**	**NA-2 (Balsam Creek)**	**NA-3 (Cattall Brook)**	**Field Blank**
Total Metals	Aluminum, total (mg/L)	0.105	0.089	0.480	0.104	0.135	
	Antimony, total (mg/L)	< 0.0001	< 0.0001	0.0002	< 0.0001	0.0001	
	Arsenic, total (mg/L)	< 0.0005	< 0.0005	0.0005	< 0.0005	< 0.0005	
	Barium, total (mg/L)	0.011	< 0.005	0.018	< 0.005	0.019	
	Beryllium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Bismuth, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Boron, total (mg/L)	0.013	0.008	0.019	0.007	0.024	
	Cadmium, total (mg/L)	< 0.00001	< 0.00001	0.00003	< 0.00001	0.00001	
	Calcium, total (mg/L)	4.9	1.9	13.7	2.4	16.6	
	Chromium, total (mg/L)	0.0006	0.0007	0.0013	0.0007	0.0009	
	Cobalt, total (mg/L)	0.00007	< 0.00005	0.00032	< 0.00005	0.00014	
	Copper, total (mg/L)	0.0008	0.0005	0.0037	0.0004	0.0021	
	Iron, total (mg/L)	0.10	0.04	0.63	0.06	0.20	
	Lead, total (mg/L)	< 0.0001	< 0.0001	0.0004	0.0001	0.0001	
	Lithium, total (mg/L)	0.0002	0.0001	0.0008	< 0.0001	0.0003	
	Magnesium, total (mg/L)	0.91	0.31	4.53	0.50	2.65	
	Manganese, total (mg/L)	0.0070	0.0019	0.0574	0.0029	0.0392	
	Mercury, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Molybdenum, total (mg/L)	0.0002	0.0002	0.0008	< 0.0001	0.0054	
	Nickel, total (mg/L)	0.0002	< 0.0002	0.0012	< 0.0002	0.0003	
	Phosphorus, total (mg/L)	< 0.02	< 0.02	0.04	< 0.02	< 0.02	
	Potassium, total (mg/L)	0.63	0.16	1.95	0.19	2.22	
	Selenium, total (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	
	Silicon, total (mg/L)	3.5	2.6	4.7	3.4	4.3	
	Silver, total (mg/L)	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	
	Sodium, total (mg/L)	6.15	1.41	40.6	2.11	16.3	
	Strontium, total (mg/L)	0.040	0.011	0.083	0.020	0.107	
	Sulfur, total (mg/L)	< 1	< 1	2	< 1	3	
	Tellurium, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Thallium, total (mg/L)	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	
	Thorium, total (mg/L)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	
	Tin, total (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	
	Titanium, total (mg/L)	< 0.005	< 0.005	0.018	< 0.005	< 0.005	
	Uranium, total (mg/L)	< 0.00002	< 0.00002	0.00004	< 0.00002	0.00009	
	Vanadium, total (mg/L)	< 0.001	< 0.001	0.001	< 0.001	< 0.001	
	Zinc, total (mg/L)	0.004	< 0.004	0.012	< 0.004	< 0.004	
	Zirconium, total (mg/L)	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001	
Microbiological Parameters	Coliforms, Fecal (MPN/100 mL)	<2	<2	170	<2	170	
	E. coli (MPN) (MPN/100 mL)	<2	<2	170	<2	170	<2

CARO
ANALYTICAL
Caring About Result

6120837

X9
C3
H7

CARO BC COC, Rev 2015-09

CHAIN OF CUSTODY RECORD

COC# ☐ PAGE 1 OF 1

RELINQUISHED BY: Peter deKoning	DATE: ~~12~~ 13-Dec-16 TIME: 9:00	RECEIVED BY: NOVEX HM	DATE: 12-Dec-16 TIME: 11:00 12/13
PROJECT: 173.191 Blaney, North Alouette, Fraser Riv		PROJECT INFO: Stormwater Monitoring	

REPORT TO:

COMPANY:	Kerr Wood Leidal	COMPANY:	Kerr Wood Leidal
ADDRESS:	200-4185A Still Creek Drive Burnaby, BC, V5C 6G9	ADDRESS:	200-4185A Still Creek Drive Burnaby, BC, V5C 6G9
CONTACT:	Patrick Lilley	CONTACT:	Patrick Lilley/Michelle Derer
TEL/FAX:	604-293-3121 604-294-2090	TEL/FAX:	604-293-3252 604-294-2090

DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
DATA FORMAT: EXCEL ☐ WATERTRAX ☐ ESdat ☐ EQuIS ☐ BC EMS ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: pdekoning@kwl.ca
EMAIL 3: *Please send PDF by email as well

DELIVERY METHOD: EMAIL ☒ MAIL ☐ OTHER* ☐
EMAIL 1: plilley@kwl.ca
EMAIL 2: mderer@kwl.ca
EMAIL 3: pdekoning@kwl.ca
PO #: 173.191

TURNAROUND TIME REQUESTED:
Routine: (5-7 Days) ☒
Rush: 1 Day* ☐ 2 Day* ☐ 3 Day* ☐
Other*
***Contact Lab To Confirm. Surcharge May Apply**

REGULATORY APPLICATION: Regs on Report? ☒
Canadian Drinking Water Quality Guidelines ☐
BC Drinking Water Protection Act / Reg. ☐
BC CSR ☐ AB TIER 1 ☐ CCME ☒ OTHER* ☒
AL ☐ PL ☐ RL ☐ CL ☐ IL ☐ AW ☐ IW ☐ LW ☐

** NEW ** If you would like to sign up for ClientConnect and/or EnviroChain, CARO's online service offerings, check here: ☐

SAMPLED BY: Peter deKoning

6120837

ANALYSES REQUESTED:

CLIENT SAMPLE ID:	MATRIX: DRINKING WATER	OTHER WATER	SOIL	OTHER	# CONTAINERS	SAMPLING: DATE DD-MMM-YY	TIME HH:MM	COMMENTS: CHLORINATED	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX ☐ VPH ☐ PHC F1 ☐	VOC ☐ VPH ☐	EPH ☐ PHC F2-F4 ☐	PAH ☐ L/HEPH ☐	PHENOLS Chlorinated ☐ Non-Chlor. ☐	PCB ☐ GLYCOLS ☐ HAA ☐	PESTICIDES ☐ ACID HERBICIDES ☐	METALS - WATER TOTAL Hg ☒	METALS - WATER DISSOLVED Hg ☒	METALS - SOIL (SALM) ☐ inc. pH ☐	pH ☐ EC ☐ ALK ☒	TSS ☐ VSS ☐ TDS ☐	BOD ☐ COD ☐	TOG ☐ MOG ☐	FECAL COLIFORMS ☒ HPC ☐	TOTAL COLIFORMS ☐ *E. coli* ☒	ASBESTOS	Nitrate - N							**HOLD**
BL-1 (Anderson Creek)		✓			6	12-Dec-16	15:30												✓	✓		✓				✓	✓		✓							
NA-1 (North Alouette River)		✓			6	12-Dec-16	16:30												✓	✓		✓				✓	✓		✓							
FR-1 (227 St Creek)		✓			6	12-Dec-16	14:45												✓	✓		✓				✓	✓		✓							
NA-2 (Balsam Creek)		✓			6	12-Dec-16	15:00												✓	✓		✓				✓	✓		✓							
NA-3 (Cattall Brook)		✓			6	12-Dec-16	16:00												✓	✓		✓				✓	✓		✓							
Field Blank		✓			1	12-Dec-16	14:40																				✓									
Trip Blank		✓			1	12-Dec-16	12:40																													✓

SHIPPING INSTRUCTIONS: Return Cooler(s) ☐
Supplies Needed:
**Other Instructions for Regulatory Application:
Include BC WQ Guidelines for Aquatic Life

SAMPLE RETENTION INSTRUCTIONS (Discarded 30 days after Report unless otherwise specified):
60 Days ☐ 90 Days ☐ Longer Date (Surcharges will Apply):

*** OTHER INSTRUCTIONS:**
Total and dissolvedmetals, mercury, and bacteriological samples have been preserved. Dissolved metals and mercury have been filtered. Metals analysis should LOW level ICPMS package. Add total and dissolved

PAYMENT:
CHEQUE ☐
CREDIT ☐
DEBIT ☐
CASH ☐
INVOICE ☐

SAMPLE RECEIPT CONDITION:
COOLER 1 (°C): 2.6 ICE: Y ☑ N ☐
COOLER 2 (°C): ICE: Y ☐ N ☐
COOLER 3 (°C):
CUSTODY SEALS INTACT: NA ☐ Y ☐ N ☐

Appendix E

Initial Stakeholder Consultation

Appendix E - Initial Stakeholder Consultation

Stakeholder	Date	Consultation	Discussion	KWL Representatives	People Present	Actions
Alouette River Management Society, Alouette Valley Association	17-Nov-16	Meeting	Phase 1 input on environmental inventory, key concerns	Patrick Lilley, Luke Warkentin	Greta Borick-Cunningham (Executive Dir., ARMS), Doug Stanger (Treasurer, ARMS), Terri Dumas (AVA), Dian Murrell (AVA), Erica Messam (Engineering Technologist, City of Maple Ridge)	Received WQ reports, fry release data, spawner survey data, received list of other stakeholders to contact, initiated further input from AVA membership, directed to N. Alouette Flood report, rain gauges, incorporated into env. Inventory, followed up with other stakeholders
Alouette Field Naturalists	21-Nov-16	Phone call	ISMP overview, discussed bird list	Luke Warkentin	Michael Sather	Luke to send contact info, Michael to send bird list
DFO	06-Dec-16	Phone call	Fisheries values, threats, past enhancement, potential enhancement	Luke Warkentin	Maurice Coulter-Boisvert	Received info and incorporated into env. inventory
Alouette Field Naturalists	09-Dec-16	Email	Received bird list	Luke Warkentin	Michael Sather	incorporated into env. inventory
Alouette Valley Association	05-Dec-16	Email	Received input from AVA members on Env. Inv. Questions	Luke Warkentin	Dian Murrell, Terri Dumas	incorporated into env. inventory
Metro Vancouver Parks	09-Nov-16	Email	Received reports and references	Luke Warkentin	Janice Jarvis	incorporated into env. inventory, need to set meeting date
Metro Vancouver Parks	08-Mar-17	Scanning reports from library	Scanned reports on Blaney Bog, Codd Island Wetland in Metro Van Parks East office	Luke Warkentin	Chris Kimmel	acquired 13 reports/resources for inventory, incorporated into inventory

KERR WOOD LEIDAL
consulting engineers

Greater Vancouver
200 - 4185A Still Creek Drive
Burnaby, BC V5C 6G9
T 604 294 2088
F 604 294 2090

Meeting Minutes

MEETING DATE: November 17, 2016

LOCATION: Alouette River Management Society
24959 Alouette Road, Maple Ridge

RE: **NORTH ALOUETTE, BLANEY, AND FRASER WATERSHEDS ISMP**
173.188

ATTENDEES:
Greta Borick-Cunninham, Executive Director, Alouette River Management Society
Terri Dumas, Alouette Valley Association
Dian Murrell, Alouette Valley Association
Luke Warkentin, Jr. Biologist, KWL
Patrick Lilley, Sr. Biologist, KWL
Erica Messam, Engineering Technologist, City of Maple Ridge
Doug Stanger, Treasurer, ARMS

DISTRIBUTION: All attendees

CONTACTS:

Luke Warkentin, B.I.T.
Junior Biologist
lwarkentin@kwl.ca
O: 604 293 3136
C: 778 628 0286

Patrick Lilley, R.P.Bio.
Senior Biologist
plilley@kwl.ca
O: 604 293 3121
C: 604 812 2578

Item	Discussion	Action
1	Introduction (round-table) and ISMP overview: 1. Information gathering and analysis 2. Building the watershed vision 3. Develop the watershed plan 4. Monitoring and adaptive management plan and project reporting	
2	Identify stewardship priorities and top concerns to be addressed: • E.g., development issues, stormwater runoff, flooding, water quality, etc.	See note below

Item	Discussion	Action
3	Information gathering - existing reports, data, notes, anecdotes on: • Fish populations (spawner counts, escapement, communities, sampling) • Fish habitat (mapping, restoration, enhancement) • Hatchery enhancement (hatchery records, data) • Riparian and terrestrial habitat • Water quality and benthic invertebrates • Blaney Bog, Codd Island Wetland, other specific areas • Wildlife and species at risk	• Get hatchery release data from ARMS • Get spawner survey data from ARMS • Get links to AVA rain gauges • Get link to AVA report page • Pitt Meadows Rain gauges
4	Fish specific: • Main constraints on fish productivity • Barriers to fish passage	
5	Additional stakeholders to solicit for input • Ross Davies, KEEPS • Hammond Neighbours Association • City of Pitt Meadows • Aqualini • Timberline Ranch • Dyking Authority • Katzie First Nation - Debbie Miller, Chief treaty Negotiator and Susan Miller, Chief • Malcolm Knapp Research Forest – Cheryl Power, Chief Forester and Paul Lawson, Director	
6	Other input (roundtable) • Importance of education in the plan	
7	Wrap up and next steps	

NOTES (Numbers refer to agenda items)

1. Introduction
2. Identify stewardship priorities and top concerns to be addressed:
    a. Flooding of North Alouette River
        i. Extreme in 2007
        ii. Potential causes: upland development, filling in lowland (raising elevation of entire lots)
        iii. Happens about once every five years, sometimes more often
        iv. Each flood has unique situations – tides, snow, rain, debris jams
    b. Log jams in North Alouette River
        i. Tend to accumulate regularly, from trees upstream that are washed from banks and logging and then travel downstream; some beaver activity in lower reaches too
        ii. Apparently land-owners own part of channel bottom, and so are responsible for clearing
            1. Some landowners don't want to remove/aren't able/don't want to pay
            2. Some precedent for City paying for half of removal costs
            3. City doesn't want to take responsibility
            4. Unclear whose responsibility
            5. Can exacerbate/cause flooding
            6. Risk to landowner bridges, some are only access to homes, some are not properly designed
            7. Trees are likely coming from upstream of Balsam Ck confluence in heavily forested section
        iii. Problem stretch is along 132 Ave between 224th and equestrian centre (check with AVA on this)
    c. Gravel accumulation in North Alouette
        i. Possible source is erosion of bank in reach upstream of Balsam Ck confluence (by Greg Moore Trail)
    d. Filling land: raising level of entire lot:
        i. Changes flood conditions
        ii. Changes hydrology
        iii. Sediment used: contaminated? Possible leaching to river
    e. Choke points in North Alouette River
    f. Water Removal
        i. By cranberry farmers, some illegal (2009) affects fish populations
        ii. By Pitt Meadows residents

   g. Changes to downstream conditions in Pitt Meadows
      i. Filling land, dykes, filling in ditches, channels
   h. Development:
      i. Companies need to monitor and maintain stormwater mitigation measures
      ii. Rezoning land prior to development is where the money is made
      iii. Construction mitigation measures (ESC)
   i. Education

3. Information and Data
   a. Hydrotechnical model
   b. Two river gauges operated by AVA
   c. One gauge in Pitt Meadows
   d. Connector Creeks are not mapped correctly/flow changes direction depending on situations
      i. Usually flor north to south, except for during big releases from Alouette Dam, when the can switch
   e. Spawner surveys for North Alouette
   f. Chum returns at South Alouette gate
   g. AVA reports
   h. City of Maple Ridge development setbacks (apparently conservative)
   i. Soil Deposit Bylaw
   j. Maple Ridge Planning Department website with applications
   k. Cattell Brook west of 132 (seemed to disappear in field): filled in in past
   l. Paradise Ck (couldn't find in field): runs through backyard, very small channel but does flood over 232 St
   m. Portrait Homes – UBC – Stormwater study (likely KWL grad student/Co-op)
   n. North Alouette Choke Point report (AVA)

Appendix E - Initial Stakeholder Consultation

Survey Responses

Postal Code	Q1. Have you experienced flooding in your neighbourhood?	Q2. Are you aware of how natural features are important for drainage?	Q3. Your impression of watershed health (rural areas)	Q4. Your impression of watershed health (suburban areas)	Q5. Your impression of watershed health (urban areas)	Q6. How important is health of watersheds to you?	Q7. What level of investment drainage improvements would you support?
V4R 0A9	no	no	seems fine to me	128 near 224th seems fine	good	Minor importance	Moderate investment
V2X 5P9	Yes in the basement 220 and lougheed area comes up in the sani main no Stromboli's in area people are pumping into sani main and sani main is 55 + old and it is AC pipe it has happen 3 times in 20 years	Yes	They are getting over tax need to do more to slow water down and clean water before it goes into the streams	Not good they are not getting cleaned or inspected	They are under sized and old not getting cleaned or inspected	Minor importance	Significant investment
V2W 1C2	No	Yes	They are excellent.	Good	They seem fine.	Minor importance	Minor investment
V4R 0G1	The intersection/bridge at 224th & 132nd. It has happened several times per year during the last few years. It never used to occur so frequently.	Yes	I feel watershed health is not being taken into enough consideration. There has been a large amount of development in Silver Valley, particularly in the RockRidge area, where too many homes have been built too close together and not enough grass, tress, etc. has been maintained. Additionally, construction (including road construction on 232) has been causing more soil (and who knows what else) run-off into the North Alouette River.	Answer same as above (not sure which area is considered rural vs. suburban) I feel watershed health is not being taken into enough consideration. There has been a large amount of development in Silver Valley, particularly in the RockRidge area, where too many homes have been built too close together and not enough grass, tress, etc. has been maintained. Additionally, construction (including road construction on 232) has been causing more soil (and who knows what else) run-off into the North Alouette River.	Answer same as above (not sure which area is considered rural vs. suburban) I feel watershed health is not being taken into enough consideration. There has been a large amount of development in Silver Valley, particularly in the RockRidge area, where too many homes have been built too close together and not enough grass, tress, etc. has been maintained. Additionally, construction (including road construction on 232) has been causing more soil (and who knows what else) run-off into the North Alouette River.	Moderate importance	Moderate investment
V2X 2L2	Yes.After heavy rains. 3 to 4 times a year	yes	They have been fine up to this point.	I am not sure exactly where you are describing. More accurate descriptions would help. As a long time resident we know that the soil along the Fraser has a high amount of clay which has and will continue to create a slippage. There is poor drainage to the west of the Town Center. Water floods the basement of some homes and there are no storm drains.	This area seems to function pretty well.	Need more information before commenting	Need more information before commenting
V2X 4J4	No	yes, very aware. That is why we need to preserve them!	Nature takes care of the water when it comes. I have lived here a long time and never seen a problem. If there is standing water, all it takes is a little patience and it will be absorbed by the earth and trees, which need it.	It seems to be very good.	It is perfect. And since you do not provide adequate space on this form for comments, I want to say that we should not be trying to have "ongoing urbanization" - that is the main problem here. There is too much development and not enough natural spaces left that would offset any water issues. It's time Maple Ridge put a cap on development, or we will end up with an ugly city that is simply urban sprawl (like Langley) and not the beautiful green city we are on the verge of losing.	Need more information before commenting	Minor investment

Appendix E - Initial Stakeholder Consultation

Postal Code	Q1. Have you experienced flooding in your neighbourhood?	Q2. Are you aware of how natural features are important for drainage?	Q3. Your impression of watershed health (rural areas)	Q4. Your impression of watershed health (suburban areas)	Q5. Your impression of watershed health (urban areas)	Q6. How important is health of watersheds to you?	Q7. What level of investment drainage improvements would you support?
V4R 2P7	Yes we have experienced it, and so have the majority of our neighbours on the north side of 136th immediately at the back of our properties. 22579 136th ave, Maple Ridge. Almost anytime it rains as majority of our perimeter drainage goes to the back of the property where there's a ditch, but the ditch is completely clogged in in desperate need of cleaning. Over the past year the ditch has started to now flood our property almost every time it rains.	No	I don't have an opinion as I'm unsure what this is referring to.	I don't have an opinion as I'm unsure what this is referring to.	I don't have an opinion as I'm unsure what this is referring to.	Need more information before commenting	Need more information before commenting
V4R 0A8	I have seen it in the neighbourhood on 132 Av at or near 224 St. It occurs with heavy rainfall. Two or three times a year commonly with spring runoff but more volatile now with Climate Change.	Yes	I cannot say, other than that the city is more and more encroaching upon them, and that isn't good for drainage and watershed health.	Not improving because of the increased housing and pavement uphill from the lower lands especially floodplains in this area. Near where I live, the North Allouette needs dredging because of increased gravel deposits.	I cannot say.	Significant importance	Significant investment
V2W 2C2	No	Yes	Fairly healthy except were development has been allowed in the upstream areas.	Fair but could be greatly improved. Would require the city or developers to invest in monitoring flows to determine what actually runoff from storms are and what is the water quality of this runoff.	Poor. Old infrastructure that does not address runoff rates or water quality. Recent downtown improvements could have integrated modern runoff facilities and did not. Not seeing the green infrastructure that should be required with new developments- a rooftop patio with a tree does not cut it.	Significant importance	Moderate investment
V2W 0A2	Yes. On October 28/19 approx. during a heavy downpour the storm water drain at 10596 245 St. backed up causing considerable damage to my basement suite with eight inches of water. Cause was the outlet pipe for the catch basin located at the end of the SRT Field was clogged by overgrowth due to lack of maintenance.	Yes.	No comment.	Generally poor considering the amount of flooding of streets in the last year. Examples are: Seniors Centre on 224th.and the 225th. & Haney Bypass intersection.	Very poor.See 4. above.	Significant importance	Significant investment
V2X 4A4	During heavy rains we regularly get water pooling in our large yard (next to ALR). We are north of 123 Avenue on 208 St.	Absolutely. They are also important for human physical and mental health, supporting biodiversity, and moderating climate change effects.	The forested areas appear to be doing well. I have concerns about the rural areas. I'm not sure that enough is being done to protect these natural features from the effects of urbanization and contamination from farming and other rural land uses.	There are many examples of streams that are paved over (at best with culverts) and non-existant set-backs. Very poor practice. By contrast, an area that was recently developed fairly close to me retained and protected the natural stream and streamside vegetation. It is a joy to walk through and I'm sure the developer(s) still received ample return on their investment.	Much much more needs to be done to restore the watershed health within the Town Centre and along major traffic corridors. This is absolutely essential in order to grow sustainably and mitigate the effects of climate change. At the same time, the community as a whole will enjoy the many interrelated benefits offered by this approach, from better air quality to more options for active transportation ("green" corridors supporting safe pedestrian and cycling modes of transportation).	Significant importance	Significant investment
V4R 1R8	No, i have not experienced flooding in my neighbourhood.	Yes. I am extremely aware of the importance of the natural features such as urban trees, forests, stream and wetlands and their importance on drainage and watershed health.	We need to retain more forests and riparian areas along rivers and creeks to encourage more natural drainage. Keeping streamside setbacks of 30 metres is a very good start but should be increased to 50m. Use more bioswales and other natural remediation measures in new developments.	Again, the more trees kept, grassed areas and less asphalt, the better. We need to think about using new technologies of pervious pavements and move away from using so much impervious surfaces to channel and move stormwater out of our systems.	As above.	Significant importance	Significant investment

Appendix E - Initial Stakeholder Consultation

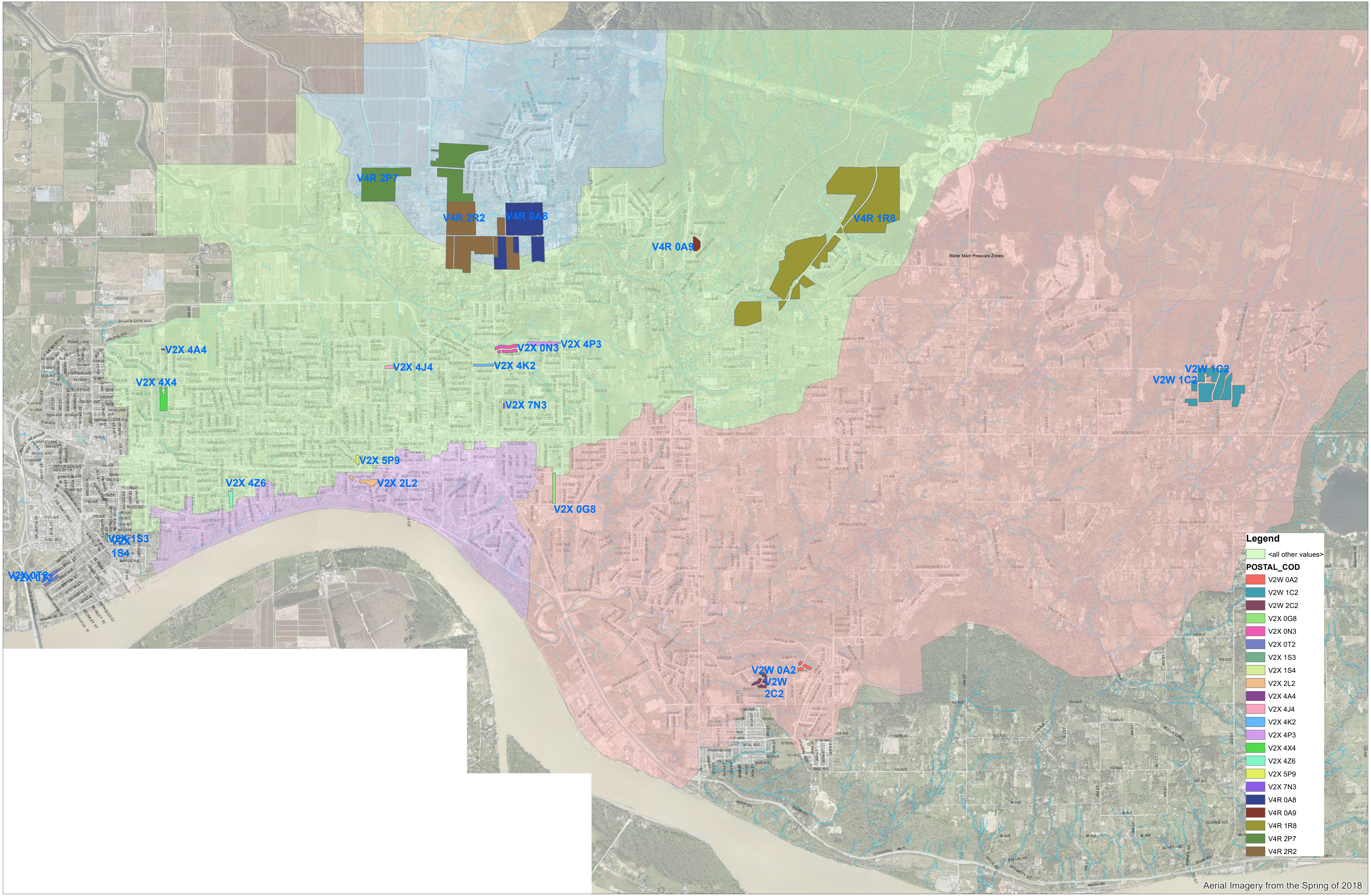
Postal Code	Q1. Have you experienced flooding in your neighbourhood?	Q2. Are you aware of how natural features are important for drainage?	Q3. Your impression of watershed health (rural areas)	Q4. Your impression of watershed health (suburban areas)	Q5. Your impression of watershed health (urban areas)	Q6. How important is health of watersheds to you?	Q7. What level of investment drainage improvements would you support?
V2X 0N3	Yes, during a major rainfall last August/September, our road (228th north of Abernathy) turned into a waterway, with water shooting *out* of the storm drains as they were overwhelmed.	Yes.	The green spaces and waterways in maple ridge are a jewel, but continued further development appears to be greatly encroaching on them, with negative impacts, like increased and extreme waterflows, more debris, less shading, etc. even the required 15-30 m buffer from major waterways for new development appears very loosely enforced, and developments above watersheds tend to raise the water table below them from additional runoff.	Getting worse with more development, see my comment above to #3.	Much worse, as it's more developed, with little green space to absorb rainfall, etc. With increasing effects of climate change, we need to be able to handle storms dropping an inordinate amount of rainfall in a short period of time.	Significant importance	Significant investment
V2X 4X4	No flooding/pooling of water during heavy rains	Absolutely	I am very concerned. The development of housing in the East has been peeling away the protective layer of the forests and I don't see it slowing down. I'd like to know that the rural areas are going to be protected from development.	Even worse in the East/Albion areas. I'm a (home) insurance broker and the incidence of basements flooding has increased disproportionately in recent years in these areas. The more pavement, the less absorption. Very basic common sense.	The existing drains may be at capacity already as evidenced by the street flooding earlier this year. Although some of it was caused by blocked drains, there were still several blocks 'underwater' as the systems couldn't remove the volume of water. I'd like to know that the systems are going to be upgraded or maintained to prevent collapse.	Significant importance	Moderate investment
V2X 7N3						Significant importance	Significant investment
V2X 1S3	My backyard is wet most of every winter. The back boundary has a footing for the fence, which prevents drainage. Muddy	Yes. Silly question	NA	NA	In Hammond, it's not very complete	Significant importance	Significant investment
V2X 4Z6	The house I live in has flooded 4 times over the years because the city storm drain system doesn't reach all the way up 212st	Yes			I live 2 blocks from the hospital and half the houses on our end the street do not have storm drains or connections	Significant importance	Significant investment
V2X 4P3	No	Somewhat	None	Seems fine	None	Significant importance	Significant investment
V4R 0A	yes, flooding in neighbourhood twice per year, most years, usually spring and fall, about 4 times/year.....in N. Alouette river area.	yes, very aware	very poor drainage "improvement" at corner of 232 St and 132 Ave............all the runoff from silver valley hill and it's silt directed to N. Alouette (salmon bearing river). Too much development and can't handle it.	see above	big flood at Sr. Ctr., so obvious that there are problems	Significant importance	Moderate investment
V2X 1S4	Not personally, but it's always a concern for nearby Lower Hammond. We were also horrified to learn the Katzie First Nation Reserve is located on the WRONG side of the dikes, that due to the politics of the day, the dikes go AROUND the outside edge of the reserve and leave their whole reserve extremely vulnerable to flooding. This needs to be rectified ASAP.	YES!! We need more of them!! Nature has spent millennia perfecting the earth's water storage (eg. glaciers) and drainage system and we are destroying it and having to deal with the consequences. Keep the green we have and let it do its job. Add more green. It improves mental health as well as helping with the water cycle.	Forested areas = good, most rural areas = not bad, depending on how much concrete/pavement/building there is.	Not so good - many of the ditches and waterways are covered over and are damaged during construction of roads & new development. NEW developments will be better equipped to deal with drainage and work with/around existing watershed elements, but older developments destroyed everything. We need to do restoration in these areas.	Terrible - look at all the damage done when there was a flash flood. Too much concrete & pavement. Not enough green spaces and permeable surfaces.	Significant importance	Significant investment

Appendix E - Initial Stakeholder Consultation

Postal Code	Q1. Have you experienced flooding in your neighbourhood?	Q2. Are you aware of how natural features are important for drainage?	Q3. Your impression of watershed health (rural areas)	Q4. Your impression of watershed health (suburban areas)	Q5. Your impression of watershed health (urban areas)	Q6. How important is health of watersheds to you?	Q7. What level of investment drainage improvements would you support?
V4R 2R2	Yes. Occurs along the North Alouette River. The nature of the flooding has changed dramatically over time. In the 70- 80s spring freshet caused the Fraser floodwaters to back up and 224 north of 132 flooded almost every year. This was predictable and occurred slowly enough that residents for the most part could take precautions. After the development of Silver Valley, unquestioned deposition of fill, construction of the cranberry dykes , and raising of 224, the type of flooding changed . Now spring freshet rarely causes a problem(and there doesn't seem to be enough snow on the local mountains to have much effect). Almost every year there is flooding corresponds to weather events. These are usually severe, rapid onset and unpredictable.	Yes, as a resident of Alouette Valley, I see this first hand.	Can only speak to the neighbourhood I know. I believe that the overall watershed may be in good health due to its remoteness and size. The lower reaches however seem to be suffering .	The water quality seems to be deteriorating in the lower reaches of the North Alouette. Since the development of Silver Valley there has been increased siltation and gravel deposition. The connector creeks by MREC used to support spawning salmon, now they have silted in and are pretty much seasonal creeks. The gravel bars between 232 and 224 have built up to the point that fry can be stranded in extended dry periods.	Do not know	Significant importance	Significant investment
V4R 2R2	Yes. North Alouette River, during heavy rains. Happening more and more frequently as years go on.	Yes and very concerned about the way development is occurring in the area. Trees taken down and properties clear cut with out proper consideration to how this affects run off to lower areas. Vegetarian disturbed taking away the opportunity for natural draining, fill brought in to raise development areas, and hard surfaces put in that give no natural drainage. The rivers are being polluted and salmon are being put at risk. Environmental engineers hired by developers ignoring problems to save money.	The way the area is being developed puts severe pressure on the natural environment and is destroying the forests and watersheds.	Development is reaching into the suburban areas and being indiscriminately done at the risk of destroying our natural streams and waterways. There is no thought to the future of our waterways or of the damage that is being done.	The areas within the Town centre are being destroyed, trees taken down and waterways and natural areas are being ripped up, large amounts of fill being brought in to build up area and drainage from developments going directly into the rivers bringing large amounts of sediment and pollutants which will decimate what few salmon and water life left, and waterways are turning stagnant. Water levels in streams and rivers are very low due to gravel build up and stream diversion. Areas that should have been for left for conservation are developed. In this day of the concerns over the environment, it is disgusting that an area of natural waterways and beauty is being destroyed. There was once a Official Community Plan that was put into place at great cost that has been ignored. There were awards given to the first development in the Silver Valley area for the installation of rain gardens and the concern over the waterways. Since then environment protection has been ignored.	Significant importance	Significant investment

Appendix E - Initial Stakeholder Consultation

Postal Code	Q1. Have you experienced flooding in your neighbourhood?	Q2. Are you aware of how natural features are important for drainage?	Q3. Your impression of watershed health (rural areas)	Q4. Your impression of watershed health (suburban areas)	Q5. Your impression of watershed health (urban areas)	Q6. How important is health of watersheds to you?	Q7. What level of investment drainage improvements would you support?
V2X 0G8	No	Yes. The odd urban tree makes no difference, which is why the tree bylaw is so ridiculous - forest and parks where there is a a decent amount of vegetation on the other hand do make an impact. I would like to see an increase in planting and parks around any new development - paid for by the developer. Case in point - the sports filed at Arthur Peake has plenty of room around the edges to plant trees that would also assist the residents in screening from the light and noise at night from the field. Instead we have a poorly planted grass verge with terrible drainage in winter.	Generally OK, though building on the flood plain of any significant river/stream ought to be automatically prohibited, not only for the health of the watershed but also because when the river floods (which it will) taxpayers are indirectly on the hook for some of the bailout costs. We could just avoid it altogether and not allow any further construction on flood plains.	I think they are probably OK, though again I remain concerned about building close to streams. The construction that has happened around Cotttonwood, and now continuing close by with development at the end of 232 St seems likely to put more pressure on feeder streams to Kanaka Creek. I am also concerned that these natural watersheds/drainage are also wildlife corridors, or rather were. We should be encouraging developers to enhance some of the existing natural features and ensure separation for wildlife. Sadly we have already encroached too far within the urban and suburban areas, but we can at least, if the will is there, prevent future destruction and erosion in the name of "growth" (which everyone but me seems to think is a good and necessary thing!)	OK - it rains a lot, we get wet. We need to halt the rate of urbanization and say "enough is enough". Maple Ridge is no longer open for developers other than on existing Brownfield sites.	Significant importance	Minor investment
V2X 0T2	No	Yes. Stream side buffers are important to reduce the amount of flooding after minor rain events.	Excessive stream side development is degrading the natural flood control.	Excessive stream side development is degrading the natural flood control. Many stream banks can no longer retain enough water to prevent significant siltation and downstream flooding.	Our storm water is directed into the streams and rivers, instead of treatment. Too many people are unaware, or just oblivious, to the consequences of dumping into the storm system. (The Hoy Creek fish kill is a tragic example of this ignorance.)	Significant importance	Moderate investment
V2X 4K2	Yes, mainly on the street. 124th and 227thst	Yes	We need to do better to protect our watershed	I feel that it is a bit better due to a more natural setting which is better equipped to handle water	Needs improvement	Significant importance	Need more information before commenting



Aerial Imagery from the Spring of 2018

Appendix F

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F. Hydrologic and Hydraulic Modelling

F.1 Introduction

The PCSWMM software was used for developing the Blaney, North Alouette and Fraser River hydraulic and hydrologic watershed model. The drainage system, as shown in Figures 1-2A & 1-2B, includes:

- 17 km of pipes;
- 304 manholes;
- Diversion structures; and
- North Alouette tributaries, Cattell Brook & and Blaney tributaries.

This Appendix outlines the development of the detailed hydrologic and hydraulic model of the North Alouette, Blaney and Fraser River watersheds. The section includes:

- descriptions of the detailed hydrologic and hydraulic model development using the GIS data received the city as a base; and
- calibration and verification of the hydrologic model to ensure accurate predictions of watershed rainfall-runoff response.

The completed hydrologic/hydraulic model was used to assess the drainage system under different design event conditions. The results of these analyses are presented in Appendix G.

F.2 Rainfall and Flow Monitoring Data Collection

Rainfall Data

Rainfall data for calibration was collected from two rain gauge locations, a low elevation gauge at the Golden Ears Elementary School (Metro Vancouver DM62) and a higher elevation gauge at the UBC Research Forest site (AES 1103332). The period of record available for the Golden Ears Elementary gauge is from 2013 to present and the UBC Research Forest gauge is from 1961 to 2016. See Figure 1-2A & 1-2B for the rainfall station locations.

Flow Monitoring

North Alouette Flow Monitoring

KWL obtained the North Alouette River flow data from the Water Survey of Canada (WSC) 08MH006 gauge at 232nd St. It was ahydrometric station operated by Water Survey of Canada. The gauge records 5-minute discharge data from 2011 to present, hourly data from 1969 to present and daily data from 1911 to present. The gauge record is to assumed datum with a conversion factor of +11.118 m to convert to Geodetic Survey of Canada (GSC) datum. Table F-1 shows the coordinates of the station location.

Appendix F - Hydrologic and Hydraulic Modelling

Anderson & Blaney Creek Flow Monitoring

Table F-1 summarizes monitoring data collected by KWL at nearby monitoring sites and the monitoring period for each. The locations of the stations are shown on Figure 1-2A & Figure 1-2B.

Table F-1: Flow Monitoring Site Summary

Monitoring Station	Location	Active Period
North Alouette River at 232 St. Hydrometric Station (Water Survey of Canada)	49°14'33"N, 122°34'48"W	1911 to present
Anderson Creek Hydrometric Station (KWL)	49°15'24.99"N, 122°35'4.49"W	September 2016 to September 2018
Fraser River Tributary Hydrometric Station (KWL)	49°12'33.06"N, 122°35'40.33"W	September 2016 to August 2018
Balsam Creek Hydrometric Station (KWL)	49°14'44.06"N, 122°35'36.98"W	November 2016 to May 2018
Cattell Brook Hydrometric Station (KWL)	49°14'37.32"N, 122°34'32.66"W	November 2016 to May 2018

F.3 TIA & EIA Estimates

The impervious coverage for the total impervious area (TIA) and effective impervious area (EIA) at the flow monitoring gauges are shown in Table F-2.

Table F-2: TIA and EIA Estimates for Catchment at Gauge Location

Location	TIA[1]	EIA
North Alouette at 232nd St.	1%	0.3%
Anderson Creek Hydrometric Station	15%	No Data
Fraser River Tributary Hydrometric Station	52%	No Data
Balsam Creek Hydrometric Station	22%	No Data
Cattell Brooke Hydrometric Station	21%	No Data

1. The total impervious area (TIA) for the existing conditions was estimated using assigned percent impervious in the model based on zoning and air photo information.

EIA is the impervious coverage in the watershed that effectively contributes runoff directly to the storm drainage system. A significant summer rainfall event, on July 23 - 27, 2015 was selected to estimate EIA for the North Alouette gauge because this event meets the conditions of an antecedent dry period, rainfall length, and total rain amount, which are ideal for EIA calculation. EIA was not estimated for the hydrometric stations shaded in the table above due to insufficient dry antecedent data during the active recording period. EIA was estimated using a formula that separates a recorded flow hydrograph into groundwater/interflow and runoff components using a maximum rate of increase of interflow parameter. Hourly rainfall data from the Golden Ears Elementary and UBC Research Forest were used for this analysis as the most representative gauges for the watershed. The flow record data from the North

Appendix F - Hydrologic and Hydraulic Modelling

Alouette River at 232nd St. gauge was used for the EIA analysis. The EIA is estimated to be 0.3% in the watershed upstream of this gauge which is slightly lower than the already-low TIA of 1%. The EIA is lower than the TIA because the majority of flow recorded at this gauge is coming from mostly undeveloped land and most of the residential lots within the watershed are serviced with LID's and detention ponds.

F.4 PCSWMM Model Development

Model Catchments

The Blaney, North Alouette and Fraser River subcatchments were modelled by individual lots in urban and suburban areas based on cadastral data from the City of Maple Ridge and with large manually delineated catchments in undeveloped areas.

In the hydraulic model, only pipes that were 400 mm diameter and larger were included. Usually, to assign lot subcatchments to the drainage network an automated process in the modelling software links subcatcatchments to the nearest downstream node. with pipes smaller than 400mm not included in the model there were areas in the model where subcatchments would be mis assigned so another approach had to be used to ensure subcatchments were not assigned to wrong nodes (i.e. nodes uphill of subcatchments). To assign subcatchments to their proper nodes and preserve proper drainage areas sucatchment-node connections were manually assigned by reviewing mapping of the whole drainage network.

Because the GIS databases received from the City of Maple Ridge did not have a right-of-way (ROW) layer, the ROW subcatchments had to be created so they could be imported into the model. The ROW's were split up using the voronoi polygons method based on the manholes included in the model. The split ROW segments were assigned outlet nodes in a similar fashion as the lot catchment assignment.

In total the model includes 2,971 legal sub-catchments and 573 small right-of-way sub-catchments. Catchments were assigned the following attributes:

- slopes, using digital elevation mapping (DEM) information,
- existing land use impervious area, by using a combination of the City's land use information for legal catchments and 2015 aerial imagery,
- impervious area for future land use scenarios, using the City's OCP Zoning and community plans, and
- infiltration and groundwater parameters based on soils mapping.

These catchments are shown in Figure 2-2.

Appendix F - Hydrologic and Hydraulic Modelling

Design Storms

The drainage system analysis required the creation of three sets of design storms for the various scenarios that were modelled. The drainage system analysis was performed using design storms from the short duration design storm provided in the City of Maple Ridge Design Criteria Manual. The design storms were developed from Golden Ears Elementary (DM62), Haney UBC RF Admin (AES 1103332), and Katzie Pump Stations (DM44).

- the 10-year, 100-year, and 200-year return period events Modified AES Short Storm (30th percentile distribution) for the 1 to 2 hours durations;
- the 10-year, 100-year, and 200-year return period events AES Long Storm (50th percentile distribution) for the 6 hours to 12 hours durations;
- the 10-year, 100-year, and 200-year return period events SCS Type 1A for 24 hours duration.

The rainfall amounts for each of the design storms are presented in the table below.

Table F-3: Design Storms for Drainage System Analysis (un-factored for elevation)

Duration	2-year Total Rainfall (mm)	5-year Total Rainfall (mm)	10-year Total Rainfall (mm)	100-year Total Rainfall (mm)
UBC RF Admin				
1-hour	12.7	16.5	19.0	26.8
2-hour	19.4	23.0	25.4	32.8
6-hour	38.4	45.0	49.2	62.4
12-hour	57.6	70.8	78.0	104.4
24-hour	86.4	108.0	122.4	168.0
Golden Ears Elementary School (DM62) & Katzie Pumpstation (DM44)				
1-hour	14.5	21.9	26.9	42.3
2-hour	20.3	27.4	32.0	46.7
6-hour	38.6	49.3	56.4	78.6
12-hour	56.4	78.8	93.6	140.1
24-hour	76.2	110.3	132.9	203.7

- The stormwater storage facility analysis was performed using design storms listed below:
    - the 2-year, 5-year return period events with 3-day to 5-day durations; and
    - the 5-year, 10-year, 25-year, 50-year and 100-year return period events with 30-day duration.

The design events were selected from historical rainfall events recorded at DM45 rain gauge as per the City's Design Criteria Manual. The rainfall amounts for each of the design storms are presented in Table F-4.

Appendix F - Hydrologic and Hydraulic Modelling

Table F-4: Design Storms for Drainage System Analysis (un-factored for elevation)

Duration	Storm Event	Return Period	Total Rainfall (mm)
3 Day Event	March 8, 2007 – March 11, 2007	2-year to 5-year	144
	March 21, 2001 – March 24, 2007	2-year to 5-year	147
30 Day Event	September 4, 1996	Up to a 100-Year (including 5-, 10-, and 25-Year)	189
	October 15, 2003	Up to a 50-Year (including 5-, 10- and 25-year)	382
	September 16, 2004	Up to a 25-Year (including 5- and 10-year)	123

All events were modelled using saturated soil conditions typical of winter conditions.

Groundwater and Soil Parameters

The groundwater routine in PCSWMM was used to better estimate the groundwater and interflow portions of the runoff hydrograph. Infiltration rates, soil depths, and soil hydraulic conductivity were all input based on previously used and typical values. Figure 2-2 shows the surficial geology (Geological Survey of Canada, 1976) of the Blaney, North Alouette and Fraser River watersheds that was used to determine soil parameters.

Percentage Impervious

As a starting point for calibration, typical impervious percentages were assigned based on the City's design criteria manual (Sept, 2015) completed in the region, as shown in Table F-5. The modified impervious values after visual inspection of aerial imagery can be seen in Table F-6.

Table F-5: Base Impervious Values

Land Use	Base % Impervious
Suburban Residential*	**20%**
Low Density Residential	**40%**
Medium Density Residential	**65%**
High Density Residential	**78%**
Commercial / Industrial	**90%**
Institutional	**80%**
Parks / Grasslands	**20%**
Cultivated Fields (Agricultural)	**30%**
Woodlands / Forested	**5%**
Rights of Way**	**80%**

*Lots 0.5 ha or larger
**KWL added land use
Source: *City of Maple Ridge Design Criteria Manual*, Sept 2015

Appendix F - Hydrologic and Hydraulic Modelling

The existing impervious percentage for all lots was determined from the GIS data received from the City, and then applying the typical impervious values as a base. Percent impervious values were then checked for accuracy by overlaying 2015 aerial imagery, and if needed the impervious percentages were manually adjusted in areas with a large mismatch. Adjustments were mostly made to agricultural lots and the single-family residential lots. There was impervious percentage adjustment on agricultural lands because agricultural lots had a wide variety of structures on them or no structures at all. Low density residential lots were also commonly adjusted because of varying size of lot and size of structures. Due to the number of low-density residential lots adjusted were made at a neighbourhood level based on aerial imagery comparisons. Suburban residential lots (Low Density lots 0.5ha or larger) also had a variety of structures but because of the small number of lots in this class they were adjusted individually as required. The range of final impervious values can be seen in Table F-6 below and the overall existing impervious are of each watershed can be seen in Table 7-1 in the main text.

Table F-6: Modified Impervious Values

Land Use	Base % Impervious
Suburban Residential*	**10 - 20%**
Low Density Residential	**20 - 60%**
Medium Density Residential	**65 - 70%**
High Density Residential	**78%**
Commercial / Industrial	**90%**
Institutional	**80%**
Parks / Grasslands	**0 - 20%**
Cultivated Fields (Agricultural)	**0 - 30%**
Woodlands / Forested	**0 - 5%**
Rights of Way**	**80%**

*Lots 0.5 ha or larger
**KWL added land use

Model Network

The model includes all detention facilities, creeks and storm sewer pipes larger than 400 mm in diameter as per the City's GIS databases, with the exception of smaller pipes that were required downstream of the modelled detention ponds and culverts within the Blaney, North Alouette and Fraser River watershed. Nodes in the model consist of manholes, outfalls, and culvert ends. Missing or inaccurate information in the database was corrected with the use of available as-built drawings and field inspection notes.

Figure 1-2B represents the Blaney Creek and North Alouette Creek drainage system and Figure 1-2A represents the Fraser River drainage system.

Appendix F - Hydrologic and Hydraulic Modelling

Assumptions

Data received from the City of Maple Ridge was checked for any missing elements and for quality. Missing data was compiled and given to the KWL survey team who filled in as much of the missing data as they could in the field within the confines of the project budget. Any further missing data was assumed in both PCSWMM and GIS.

Manhole Data

Manhole invert data was assumed in two ways:

1) If a manhole with missing invert data was between upstream and downstream manholes with a known inverts, PCSWMM could calculate the missing invert based on a slope calculation between the two known inverts.
2) If there were 2 or more manholes connected in series with missing invert data, inverts were set so the slope of the furthest upstream conduit was preserved.

Missing manhole RIM elevations were assumed using 2015 LiDAR information. These processes were not able fill all the data gaps and some manual interpolation was performed. All assumptions and interpolations are documented in the model.

Pipe & Culvert Inverts

Any pipes with missing inlet or outlet invert data were assumed to have the same invert as the manhole or node they were connected to.
Culvert inverts that were not able to be surveyed due to time or due to compliance with CN rail private lands were assumed with LiDAR and further interpolation if needed. Culvert that had assumed data were assigned a generic name in the model and were not assessed for the capital plan. All assumptions and interpolation is documented in the model.

Channels

Cross sections for the North Alouette channel were created from surveyed data received from the City, and all other creek cross sections were derived from 2015 LiDAR data. Cross sections for man-made drainage channels were also derived from 2015 LiDAR. Small roadside ditch channels were modelled as trapezoidal channels and the dimensions were established from field observations.

Conduit Roughness

Pipe and culvert roughness values were assigned based on typical values associated with the conduit material. Natural and man-made channel roughness values were based on the substrate of the channel, the amount of vegetation in the channel and the channel sinuosity. Because all channels were not visited in the field, roughness values for unsurveyed channels were globally assigned based type (i.e. ditch, creek or river) and reaches were adjusted by analysing data recorded in the field. Collected field data including photos, notes and drawings made for more accurate roughness assumptions by revealing how vegetated a channel is and/or its substrate composition.

Appendix F - Hydrologic and Hydraulic Modelling

Boundary Conditions

The hydrologic and hydraulic mode was developed specifically for the purpose of pipe and culvert conveyance capacity and detention pond effectiveness, therefore a boundary condition was not applied in the assessment and design scenarios. However, boundary conditions were applied to the developed model to establish their effective extent on drainage infrastructure under an existing Pitt River (that is driven by the Fraser River level) level of 2.1m and a future level with climate change at 3.1m. It was determined that these boundary conditions do no effect storm sewers or detention facilities but do effect water levels at culverts in the Blaney and North Alouette floodplains. To fully understand how incoming flow and boundary condition effect water levels at culverts and bridges a floodplain study would have to be undertaken that includes a 2-dimensional model or a model that incorporates overland flow and storage.

F.5 Calibration & Validation

Flow Monitoring Gauges

Flow monitoring gauges marked in Figure 1-2A & 1-2B were used to validate the model using the gauge's preliminary and published discharge values. Calibration and validation events were chosen by selecting the largest rainfall events with fewest data gaps that also occurred within the recording period of the installed flow monitoring gauges. Selected rainfall events were modelled in PCSWMM and the resulting flows were compared to the recorded data at the locations highlighted in Table F-1.

Limitations

Due to the limited amount of recorded data at the flow monitoring gauges on Balsam, Anderson, Cattell, and Fraser River creeks only one calibration and one validation event could be performed. Furthermore, because Blaney and the North Alouette watersheds rainfall data comes from the Haney UBC rain gauge operated by Environment Canada which only offered data at daily intervals; rainfall data used for calibration consisted of scaled 5-minute rainfall data from the GVRD gauge DM62. Scaled data had to be used to capture peak flow events in the calibration process which require a smaller time step than daily. Rainfall at gauge DM62 was scaled based on a total monthly rainfall comparison between the Haney UBC gauge and DM62, the results of the comparison can be seen in Figure F-1. As seen in Figure F-1 there is a monthly rainfall correlation (R^2=0.94) at a scaling factor of 1.27. Therefore, to simulate a 5-minute event within the Haney UBC catchment a factor of 1.27 was applied to rainfall from DM62 at every 5-minute time step. After applying this scaling factor to DM62 and comparing the scaled monthly rainfall of DM62 to UBC month rainfall from 2007 – 2017 the average difference in rainfall volume was -3.7%.

The challenge of calibrating to storms that have been scaled up from gauge DM62 is that local intensities and storm durations, occurring at or close to the Haney UBC gauge that would have been recorded, may be missing in the scaled data because of the difference in distance and elevation of the two gauges. Inversely, local intensities and storm durations occurring at or close to DM62 were scaled up and included in Blaney and North Alouette watershed calibrations which may not have actually occurred. This scaling error can be seen in some of the following calibrations graphs.

Appendix F - Hydrologic and Hydraulic Modelling

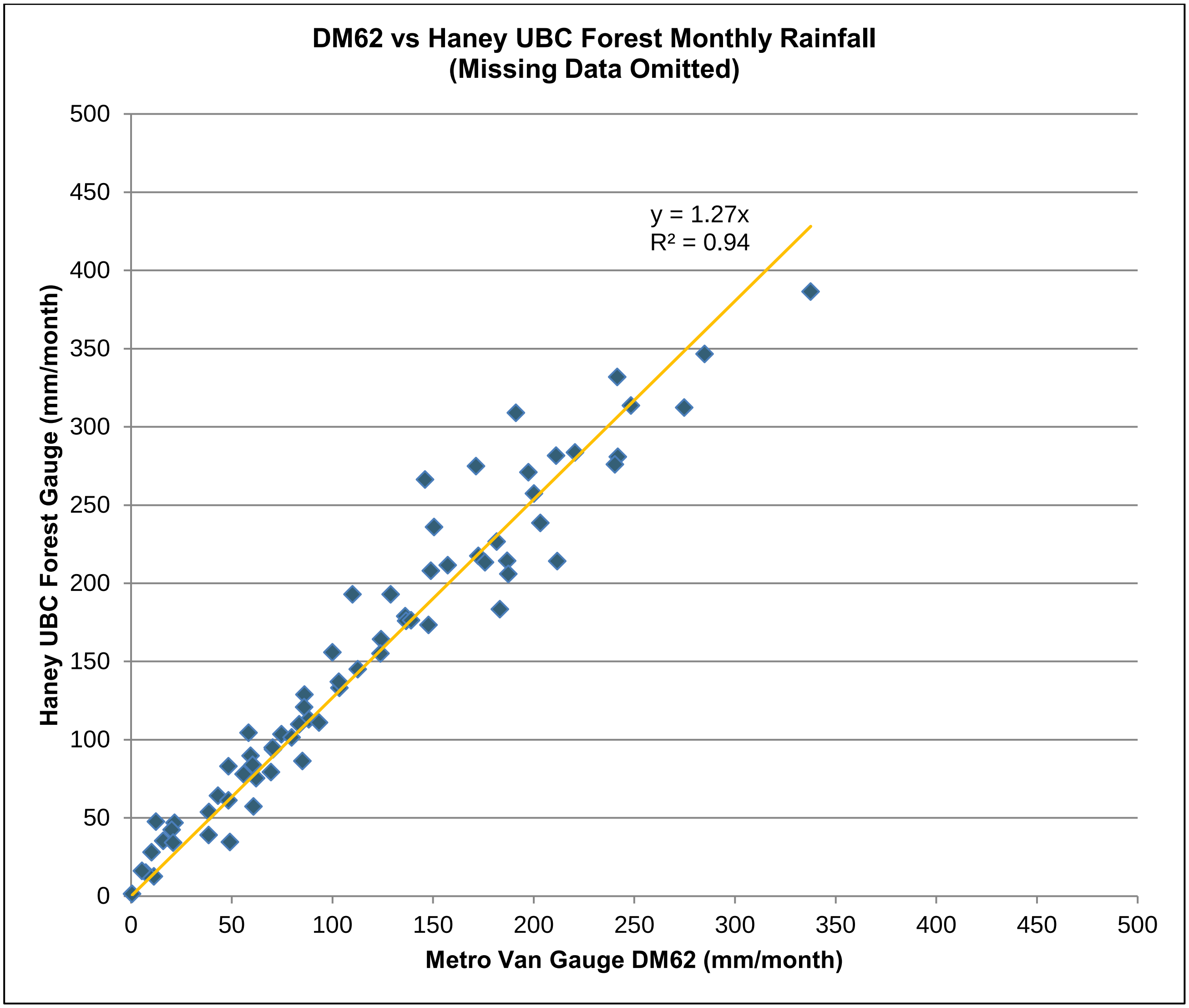

Figure F-1: DM62 vs Haney UBC Forest Monthly Rainfall Scatter Plot

Appendix F - Hydrologic and Hydraulic Modelling

Calibration and Validation

Ideally, the calibration/validation process includes two calibration storms, one dry initial condition to calibrate the imperviousness of the watershed and one wet initial condition to calibrate the groundwater response and a third independent validation storm. Once calibrated, it is important to validate the hydrologic/hydraulic model against events that were not used in the calibration process. This serves as an independent check on the assumptions made during the calibration. This validation process was possible on the North Alouette because of its long period of record. However, due to the short record of recorded flows in Balsam, Anderson, Cattell and the Fraser River tributary and the lack of large storm events, an independent validation run was only performed for the North Alouette River catchment.

Calibrated parameters were applied to the monitoring stations respective watershed. If a watershed didn’t not have a monitoring station such as the Blaney Creek watershed, land in the uncalibrated watershed was assigned appropriate calibrated parameters from adjacent land with similar characteristics.

Re-Calibration

Due to a installation problem in Anderson Creek and a lack of measured flows in Cattell Brooke that is required to develop a stage flow relationship re-calibration in those watersheds had to be performed approximately 2-years after the first calibration was undertaken. It was found that Anderson Creek was calibrated to a stage flow relationship that was under predicting flow above a certain stage and Cattell Brooke was calibrated to a stage flow relationship that was over estimating flow by at high stages by approximately 30 to 40%. The calibrated flows seen in Figures F-3 and F-4 are the re-calibrated comparisons and Figure F-2, F-5,F-6 and F-7 are the comparisons from the original calibration as there were no issues found in those stations.

A summary of validated peak flows and volumes can be seen in Table F-7.

The calibration at the five stations is described in the following subsections.

Balsam Creek

The December 3-6, 2016 storm was smaller than a 2-year 2-hour storm and was used as a wet calibration event The modelled volume is approximately 3% more than the recorded data and the modelled peak flow is approximately 13% higher than the recorded peak. Figure F-2 shows the calibration.

The peak flow proved difficult to emulate in this model because of the possibility of source controls in the catchment affecting the runoff peak and the possible rainfall discrepancy discussed above. On-lot source controls in the catchment could reduce the peak flows and slowly release the volume detained creating a “wider”, “lower” peak flow spike. There was no data received that included information on source controls in the Balsam catchment and therefore none have been included in the model.

Appendix F - Hydrologic and Hydraulic Modelling

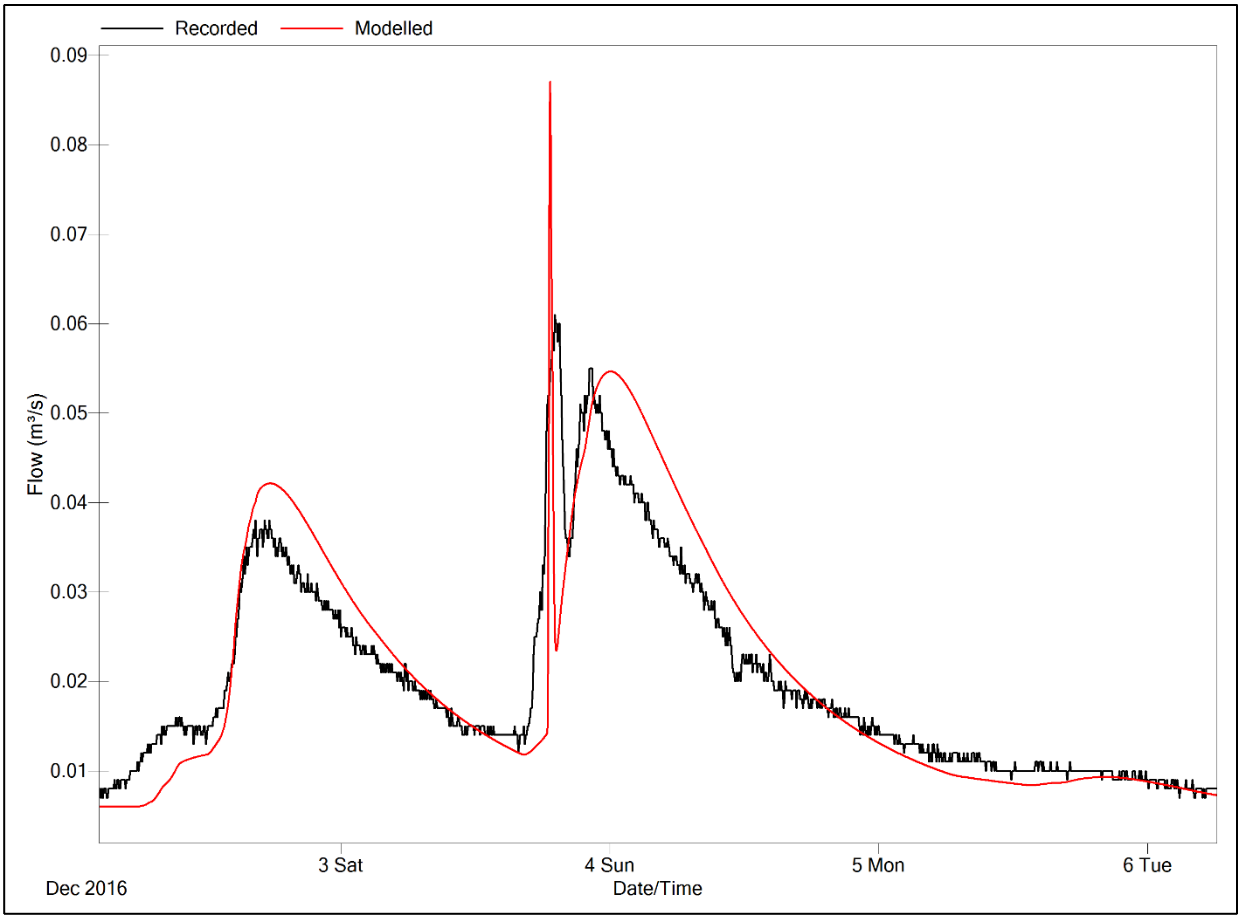

Figure F-2: Balsam Creek Calibration

Appendix F - Hydrologic and Hydraulic Modelling

Anderson Creek

The December 2–3, 2016 storm event was used for the wet calibration run in Anderson creek. The difference in timing of the second peak in the Anderson Creek calibration could not be eliminated and could possibly be a result of using the DM62 rain gauge outside of the catchment where the timing of rainfall could have been slightly different.

The large flow discrepancy in the second peak in Figure F-3 is the result of the installation issue in Anderson Creek. The rainfall was included in Figure F-3 so the issue is emphasized; the second rainfall event starting at approximately 3PM on December 3rd is significantly larger than the first but the monitoring in Anderson estimates approximately the same flow for both events. As mentioned above the high flows at this station bypass the sensor and therefore the station estimates all large rainfall event flows “peak” at approximately 0.18 m³/s. To attempt to rectify this high flow estimation error at this station the calibration attempted to preserve the rising limb and the receding limb flow and did not focus on matching the peak flows under large rainfall events.

The flow monitoring station along Anderson Creek is also located in a pool at the bottom of a steep section of creek and there is some surging of water occurs at the gauge which causes the jagged appearance of the recorded hydrograph.

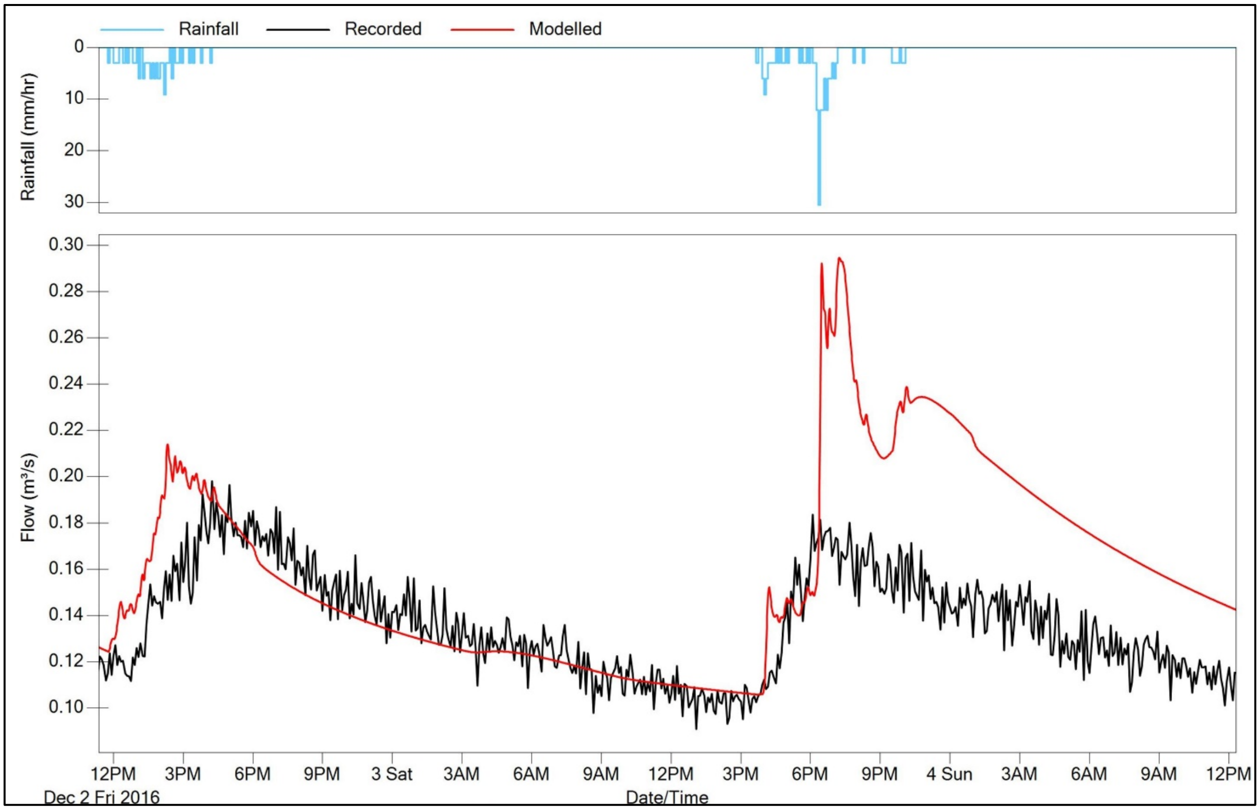

Figure F-3: Anderson Creek Calibration

Appendix F - Hydrologic and Hydraulic Modelling

Cattell Brook

The December 2-5, 2016 event was used for the wet calibration in Cattell Brook and was a 2-year 2-hour storm. The modelled peak flow is ~5% higher than recorded during in both the modelled storms and the overall volume is within 2%. Figure F-4 shows the calibration.

To account for groundwater flow in Cattell Brook, groundwater discharge from catchments to the east of 232nd Street had to be connected to the Cattell system. Runoff from those catchments did not flow into Cattell Brook and flowed south/north in the ditch along the east side of 232nd Street.

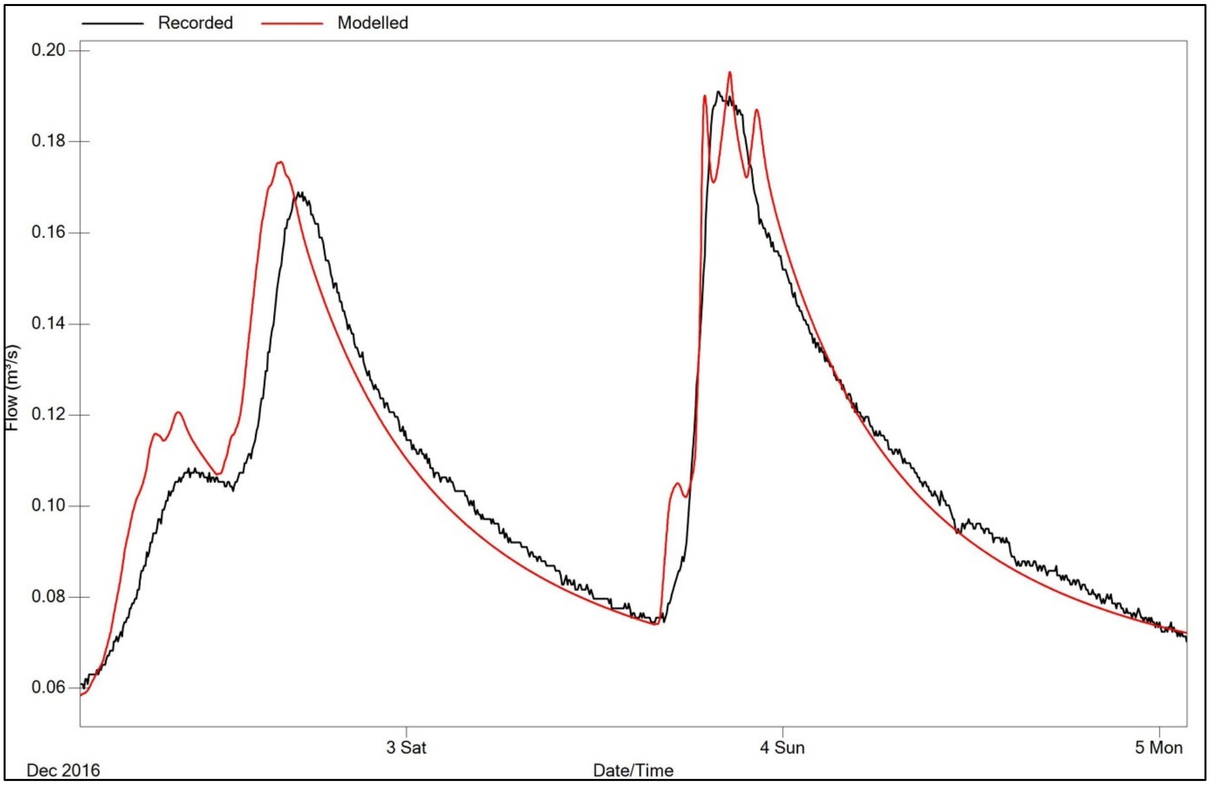

Figure F-4: Cattell Brooke Calibration

Appendix F - Hydrologic and Hydraulic Modelling

Fraser River Tributary

Flows recorded in a tributary creek in Fraser River catchment at 227th Street was used to calibrate the higher density developed areas. A 2-year 1-hour storm event recorded in September 2016 was used for the calibration. The calibrated peak flow is approximately 20% higher than the recorded peak flow, and the modelled volume is within 5% of the recorded volume. The first calibration attempt in this catchment resulted in much higher peak flow than recorded; to bring down peak flow without reducing volume a combination of impervious redirection (impervious runoff flows onto pervious ground) and impervious reduction (reducing impervious area) was attempted. Impervious redirection was only applied to single family residential lots where disconnected roof leaders are possible. The peak could not be reduced to match the recorded peak without unrealistic impervious area reductions or without affecting the rest of the hydrograph. This calibration will result in conservative peak flow estimates.

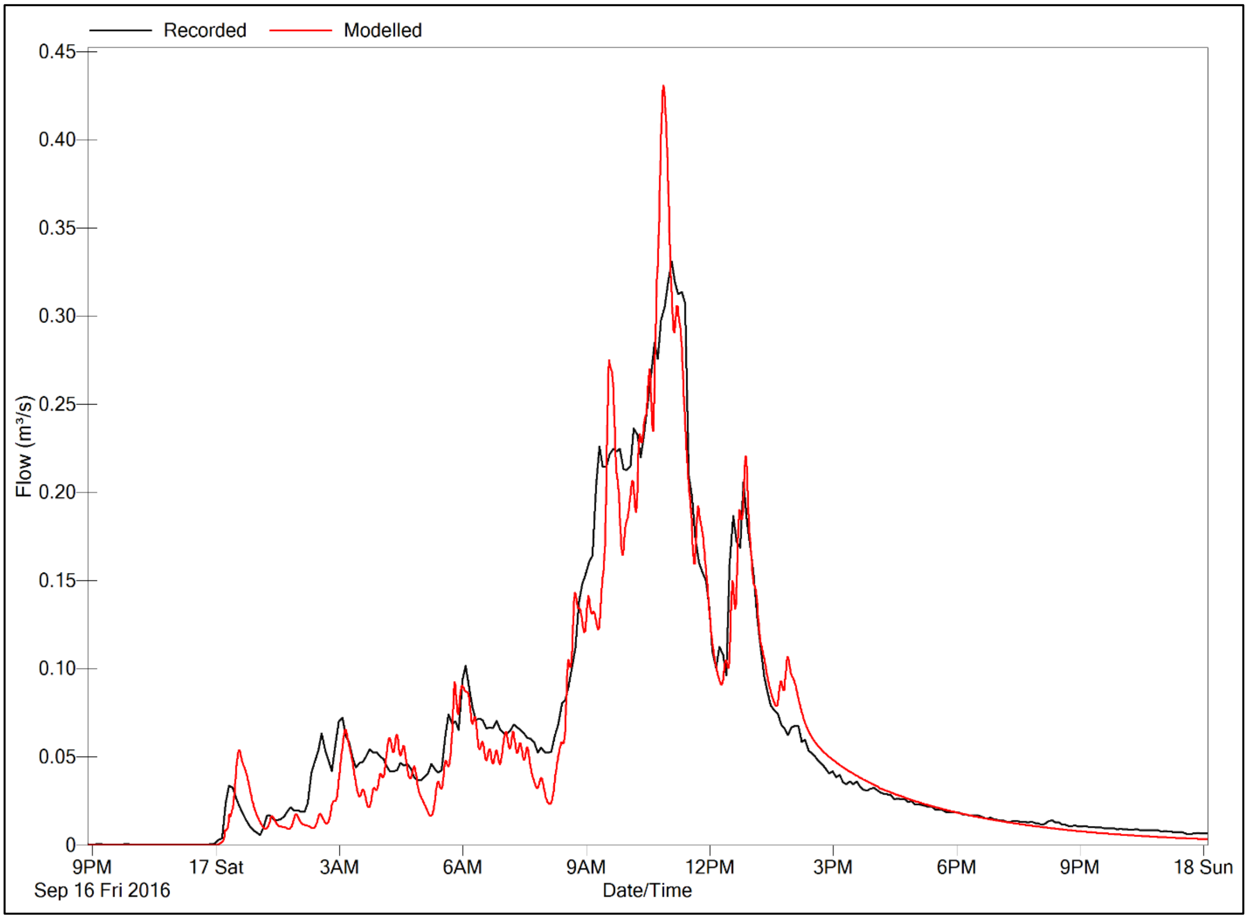

Figure F-5: Fraser River Tributaries Calibration

Appendix F - Hydrologic and Hydraulic Modelling

North Alouette River

Because there was a much longer period of record for the North Alouette River both a dry and wet initial condition calibration could be undertaken. A continuous simulation of the period from October 1 to November 8, 2014 was used to calibrate the model upstream of the North Alouette River gauge. This period contained both wet and dry initial condition events and is shown in Figure F-6. The modelled flow peaks are within 10%, and the modelled volume is 5%.

After the calibration was completed, the March 20-22, 2015 event was a 2-year 2-hour storm used to validate the North Alouette River portion of the model (Figure F-7). The modelled peak flow and volume are both within 12% of recorded. The recorded volume and peak may not exactly match the rainfall volume because the rain gauge used was outside of the catchment as described in the previous subsection. However, as a model primarily used for sizing storm sewers, the validated model flows are conservative and acceptable.

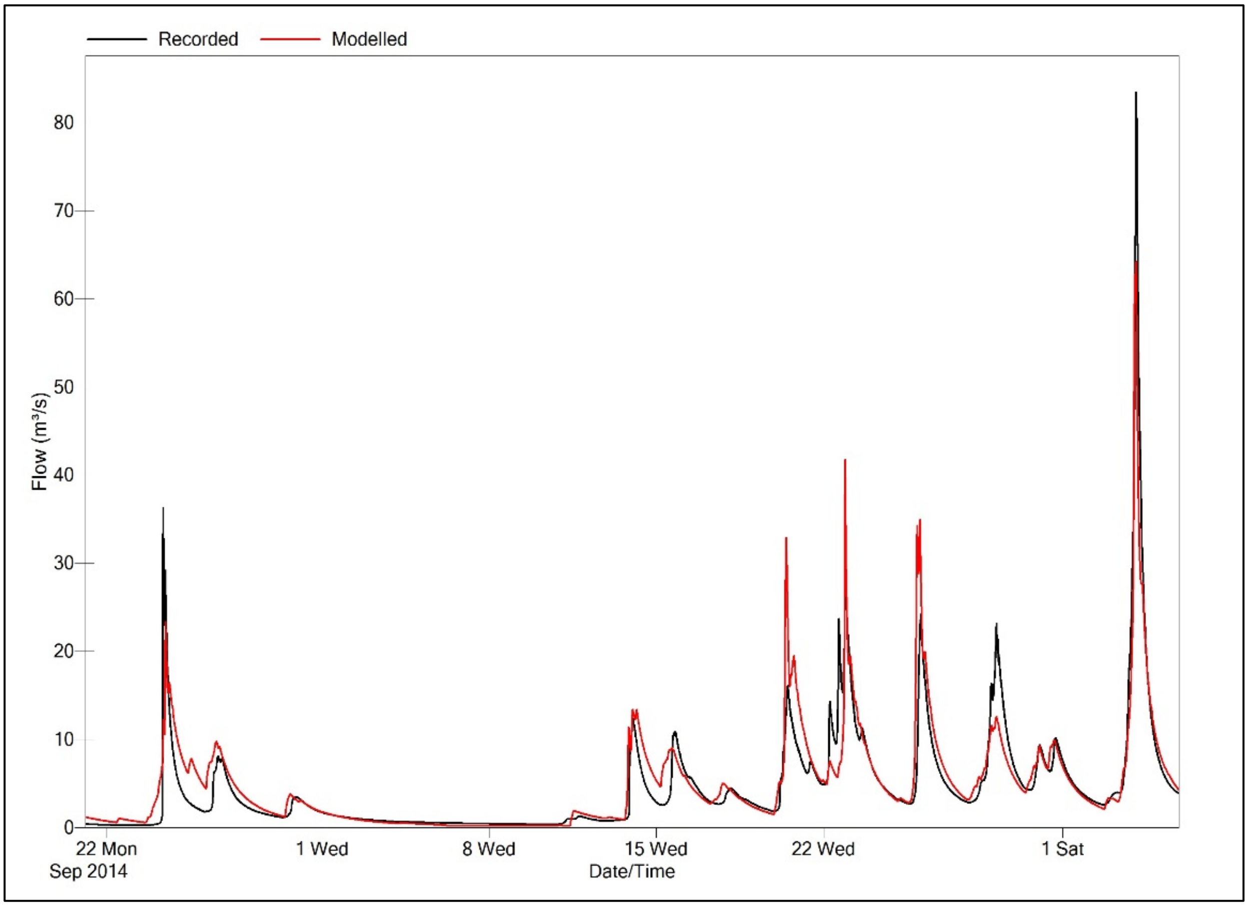

Figure F-6: North Alouette Continuous Calibration

Appendix F - Hydrologic and Hydraulic Modelling

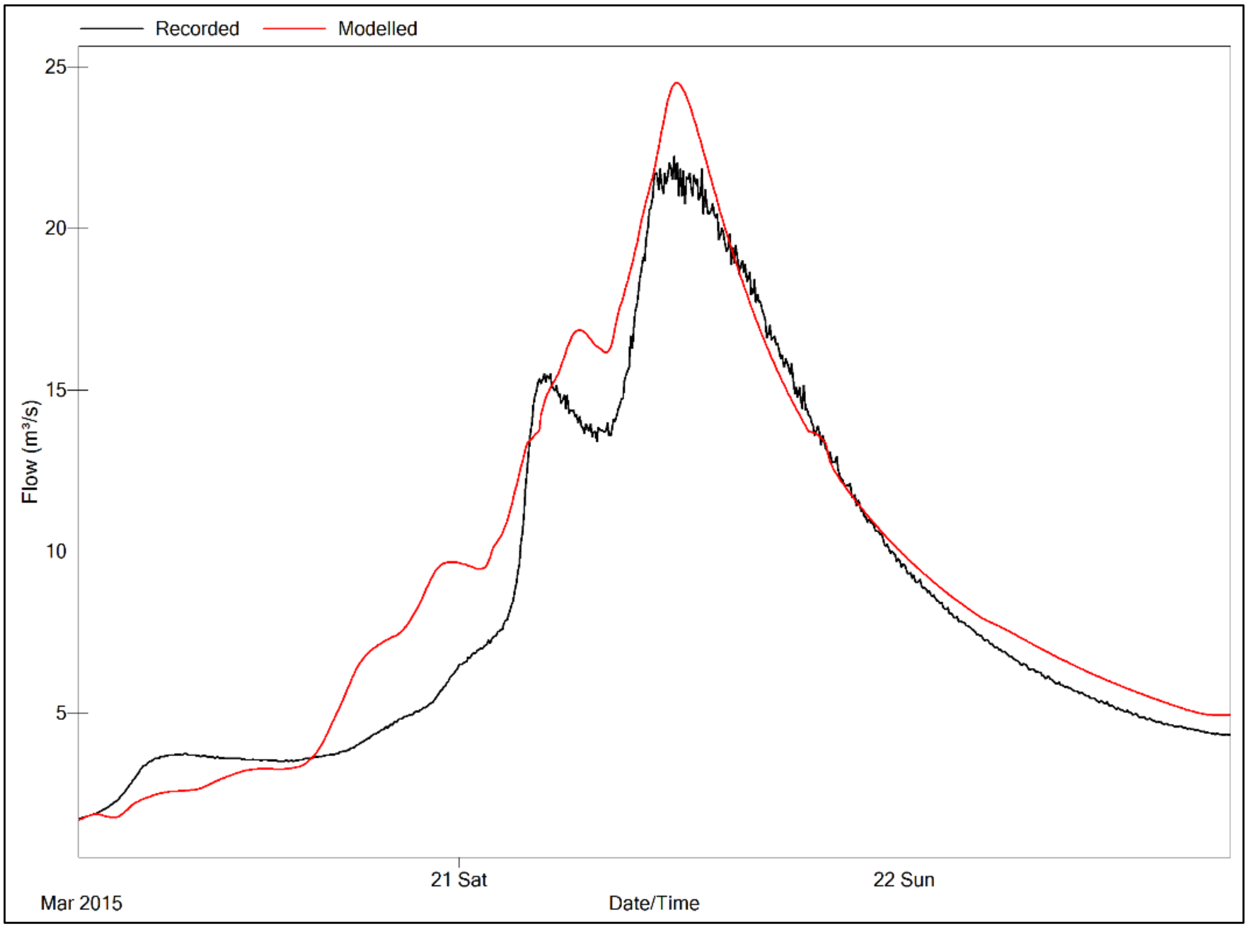

Figure F-7: North Alouette Validation

Appendix F - Hydrologic and Hydraulic Modelling

Table F-7: Validation Summary

Creek / Monitoring Station	Flow (m^3/s)		Peak Flow Difference	Volume (m^3)		Volume Difference
	Recorded	Calibrated		Recorded	Calibrated	
North Alouette River at 232 St. Hydrometric Station (Water Survey of Canada)	22.23	24.50	10%	2,248,000	2,525,000	12%
Anderson Creek Hydrometric Station (KWL)	0.20	0.29	49%	30,510	35,570	17%
Fraser River Tributary Hydrometric Station (KWL)	0.35	0.43	20%	5,923	5,670	-4%
Balsam Creek Hydrometric Station (KWL)	0.08	0.09	13%	7,724	7,990	3%
Cattell Brooke Hydrometric Station (KWL)	0.19	0.20	2%	24,330	24,280	0%
The shaded station has an installation issue which under predicts flow at certain stages which is the reason for the large peak flow discrepancy						

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consulting engineers

Appendix G

Drainage Assessment

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G. Drainage Assessment

G.1 Introduction

This section summarizes the hydrotechnical assessments for the:

- storm sewer systems (diameter 400 mm or larger);
- culverts along the main watercourses and tributaries; and
- existing detention facilities.

The storm sewer pipe network was organized into two groups; the major and minor systems. All storm sewer pipes were considered minor unless pipe sections were found to have no overland flow path (pipes under private property). All culverts were also considered part of the major system. The assessments did not include pipe condition or age. The pipes were assessed for existing and future land use and climate conditions.

G.2 Urban Storm Sewers

Results from modeling the watershed's pipe network highlighted a number of areas where pipes are undersized and surcharging. The storm sewer assessment does not include culverts as they were assessed separately (see Section B.3).

Storm Sewer Assessment Criteria

Minor System

The drainage system was assessed to determine its ability to convey the minor flow, generated by the 10-year return period rainfall event. The following three criteria were used to determine whether each sewer is undersized:

1. modelled instantaneous peak flow is larger than pipe capacity under free-flowing conditions, and
2. pipe surcharged for longer than 15 minutes, and
3. water surcharged higher than 0.3 m above the crown of the pipe.

All of the above criteria must be exceeded for pipe to be considered undersized. The surcharge allowed in the above criteria was incorporated to avoid flagging pipes that are likely adequate for the design flow with only minor surcharging. It also eliminates minor model instabilities as a reason for flagging a pipe.

Major System

The major system is the conveyance system that carries large storms, greater than the 10-year event and up to the 100-year event. Road surfaces and creeks make up most of the major system in this watershed. Additionally, underground sewers have been designated as part of the major system when they are between sections of creeks. This is to ensure that major flows in the creeks have a major flow route and do not cause damage to adjacent properties.

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Some additional checks were carried out on the drainage network and its interaction with the surface grades to confirm the adequacy of the existing major flow system. The first check was to confirm that all pipes crossing private property or located in between residential lots have associated easements. It is standard industry practice to construct an overland swale that parallels the pipe in the easement, usually directly above the pipe. These swales are part of the major system and exist to ensure that large flows would not be directed towards lots adjacent to the easement. The existence of these swales was not field-verified, but they are assumed to be in place in locations with easements.

The interactions between contours, the road network, and the pipe network were reviewed to flag location that may not have an overland flow path (sag in the road or dead-end/cul-de-sac). No such locations were found. However, there were 2 locations (pipe ID NAa065NAa064 and NAa116NAa101) in the Silver Valley area that had storm sewers with an insufficient overland flow path, therefore those sections of pipe and the pipes downstream to an outfall were designated as part of the major system.

The following criteria was used to determine whether each segment of storm sewer pipe designated as the major system is undersized:

- modelled 100-year event instantaneous peak flow is larger than pipe capacity under free-flowing conditions, and,
- Surcharging greater than 15 minutes.

Modelling Scenarios & Storm Sewer Assessment Results

To assess the conveyance capacity for the pipes in the study two land use conditions were applied under three different climate conditions. The four modelled scenarios that incorporate these land use conditions and climate conditions are described in the section below.

The minor event (10-year) results are shown in Figure G-1 to Figure G-4 and in Table G-1 to Table G-4. The major event (100-year) results are shown in Figure G-5 to Figure G-7 and in Table G-5 to Table G-7.

1) Existing Land Use without Climate Change Condition

The existing land use models were built to include the benefits of detention being provided by all existing detention facilities according to the information in their respective as-built drawings. Figure G-1 schematically shows the minor pipes that exceeded the three criteria described above, under the existing land use conditions and under a current IDF 10-year rainfall event. Table G-1 lists the pipes that exceeded the minor system criteria. In total, 20 pipes of the 240total minor system pipes are identified as undersized. The major system in the existing conditions model was assessed under a current IDF 100-year rainfall event with the same criteria as the minor system (i.e., at least 30cm of surcharging for at least 15 minutes); the undersized pipes for the major system are listed in Table G-5 and area also shown in Figure G-5. In total, 9 pipes of the 39 total major system pipes are identified as undersized.

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2) Future Land Use without Climate Change Condition

To estimate future conditions in the model future impervious area was assumed as stated in Appendix A The same rainfall events used in the existing conditions models were used in the future land use conditions model to determine the effect of land use change alone on the storm sewer system capacity; the 10-year to assess the minor system and the 100-year to asses the major system. Undersized pipes in the minor system are shown schematically in Figure G-2 and listed in Table G-2. One additional minor system pipe is identified as undersized. Undersized pipes in the major system are shown schematically in Figure G-6 and listed in Table G-6. One additional major system pipe is identified as undersized.

3) Future Land Use with Year 2050 Climate Change Condition

To estimate future conditions in approximately the year 2050, the future land use was used, and the design storm rainfall volumes were increased by 10% above current IDF values. Undersized minor system pipes are shown schematically in Figure G-3 and listed in Table G-3. The undersized major system pipes are shown in Figure G-7 and listed in Table G-7. The increased rainfall in the simulated Year 2050 future climate change condition is estimated to cause 6 additional pipes to be undersized in the minor system and 6 additional pipes in the major system.

4) Future Land Use with Year 2080 Climate Change Conditions

To estimate future conditions in approximately the year 2080, the design storms were increased by 20% above current IDF values. Undersized minor system pipes are shown schematically in Figure G-4 and listed in Table G-3. The increased rainfall in the simulated Year 2080 future climate change condition is estimated to cause 6 more minor pipes in addition to those flagged in the Year 2050 assessment to be undersized. No major pipes in addition to those flagged in the Year 2050 assessment are found to be undersized under the Year 2080 future conditions.

Table G-1: Minor Storm Sewers Undersized for Existing Land Use and Climate

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 10-year Peak Flow (Existing) (m^3/s)
In1041	450	0.010	0.174
FRb431FRb410	450	0.140	0.533
FRb411FRb431	450	0.140	0.500
FRb410FRb285	450	0.300	0.551
FRB354FRB127	600	0.360	0.690
FRB348FRB350	450	0.150	0.260
FRB297FRB293	450	0.220	0.234
FRB295FRB294	400	0.170	0.511
FRB294FRB293	450	0.270	0.612
FRB293FRB289	500	0.290	0.899
FRB291FRB289	450	0.080	0.335
FRb289CB3744	600	0.520	0.774

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Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 10-year Peak Flow (Existing) (m^3/s)
FRB285FRB284	375	0.150	0.632
FRB283FRB282	525	0.520	0.574
FRB282FRB281	525	0.420	0.616
FRB281FRB280	600	0.160	1.107
FRB280FRB279	450	0.510	0.929
FRb280	450	0.470	0.492
FRb157FRb283	525	0.320	0.661
FRB128FRB354	525	0.290	0.693

Table G-2: Minor Storm Sewers Undersized for Future Land Use without Climate Change

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 10-Year Peak Flow (Future) (m^3/s)
FRB139FRB136	450	0.500	0.638

Table G-3: Minor Storm Sewers Undersized for Future Land Use and Year 2050 Climate

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 10-Year Peak Flow (2050 Future) (m^3/s)
FRB233FRB232	600	1.130	1.160
FRB232FRB118	600	0.900	1.231
FRb229In359	750	0.890	1.331
FRB136FRB135	450	0.700	1.195
FRB135FRB102	750	2.620	3.491
FRB130FRB129	525	0.310	0.322

Table G-4: Minor Storm Sewers Undersized for Future Land Use and Year 2080 Climate

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 10-Year Peak Flow (2080 Future) (m^3/s)
NAa148NAa153	0.525	0.37	0.575
NAa109NAa110	0.45	0.45	0.578
FRB311FRB283	0.375	0.16	0.167
FRB247FRB088	0.45	0.26	0.417
FRB239FRB238	0.525	0.26	0.388
FRB235FRB234	0.45	0.81	0.959

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Table G-5: Major Storm Sewers Undersized for Existing Land Use and Climate

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 100-Year Peak Flow (Existing) (m^3/s)
FRB072FRB355	525	0.390	1.325
FRB331FRB330	675	0.760	1.577
FRb356FRb331	675	0.340	1.546
FRB357FRB072	525	0.560	1.294
FRB358FRB357	525	0.280	1.262
NAa003NAa002	450	0.490	0.521
NAa064NAa116	300	0.230	0.754
NAa066NAa065	250	0.110	0.503
NAa116NAa101	300	0.340	0.800

Table G-6: Major Storm Sewers Undersized for Future Land Use without Climate Change

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 100-Year Peak Flow (Future) (m^3/s)
SAd008SAd005	525	0.390	1.325

Table G-7: Major Storm Sewers Undersized for Future Land Use and Year 2050 Climate

Conduit ID	Existing Diameter (mm)	Existing Pipe Capacity (m^3/s)	Inst. 100-Year Peak Flow (2050) (m^3/s)
FRb355FRb356	0.525	1.64	1.655
NAa002In1203	0.45	0.58	0.611
NAa099NAa098	0.75	1.64	1.726
SAd009SAd009	0.45	0.94	0.955
SAd012SAd009	0.45	0.76	0.854
SAd014SAd013	0.45	0.78	0.883

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G.3 Culvert Assessment

Culvert Assessment Criteria

The City's Design Criteria[1] for culverts (and bridges) states:

> *Culverts located in natural watercourses or culverts crossing all roads shall be designed to convey the major flow or greater.*
>
> *Driveway culverts that form part of the minor system shall have capacity for the runoff from the 1:25-year storm for urban areas and 1:10 or 1:5-year storm for rural areas with the design headwater not to exceed the top of the culvert*
>
> *Culverts and channels under bridges for arterial and collector roads are to be designed to clear the 1 to 200-year flood level plus 0.6m freeboard.*

The assessment criteria used to identify undersized culverts is as follows:

- **Major Culverts**
  - Culverts that cross arterial and collector roads - 200-year peak flow is required to be conveyed without surcharging above the culvert crown (i.e., zero freeboard);
  - Culverts along creeks and streams - 100-year peak flow is required to be conveyed; and
- **Minor Culverts**
  - Culverts under driveways - 10-year peak flow is required to be conveyed.

In lowlands or flat areas, where backwatering from downstream constrictions may fully submerge a culvert, the assessment criteria used the hydraulic grade line (HGL) slope from upstream to downstream end of a culvert instead of its amount of surcharging as an indication of whether a culvert was undersized. A threshold of 1% maximum HGL slope was used.

Boundary Conditions

All culverts were assessed in modelling scenarios under low Pitt River conditions due to backwatering that normally results in the North Alouette floodplain when the Pitt River water level is high. When the Pitt River is at its annual highest water level, a number of culverts in the North Alouette floodplain are submerged, which makes it difficult to assess the culvert capacity. Lowering the boundary condition enables a better conveyance and surcharging assessment inline with the City's design criteria.

To properly assess water levels and surcharging at the culverts within the North Alouette floodplain, a detailed floodplain study needs to be undertaken that includes a 2-dimensional model or a model that take into account overland flows and storage.

---

[1] City of Maple Ridge Design Criteria Manual, 2015

Appendix G – Drainage Assessment

Modelling Scenarios & Culvert Assessment Results

The same four modelled scenarios combining land use and climate, as were used for the storm sewer assessment, were used to assess the conveyance capacity for the culverts in the study area.

1) Existing Land Use without Climate Change Conditions

The culvert results under the existing land use scenario are presented in Table G-8 and Figure G-8. In summary, there are 19 culverts identified as undersized and are listed below. In addition to the undersized culverts that fail the above mentioned criteria, there are culverts that surcharge but have minimal losses (HGL% less than 1) and some culverts that have surcharging caused by backwatering either in the channel cause by attenuation or due to a downstream constriction. These culverts are not listed but it is important to note that surcharging at culverts not listed here are the result of either downstream backwatering conditions.

As seen in Table G-8, there are 9 culverts assessed under the 10-Year rainfall event that were identified as undersized and in Table G-9 there are 6 culverts identified as undersized under a 100–Year rainfall event. The undersized 10-Year minor culverts can be seen spatially in Figure G-3 and the 100-Year major undersized culverts can be seen in Figure G-4.

2) Future Land Use without Climate Change Condition

Culverts under a future land use scenario without climate change were assessed but there were no additional undersized culverts identified.

3) Future Land Use with Year 2050 Climate Change Condition

Culverts under a future land use scenario and rainfall event with the estimated effect of climate change in Year 2050 were assessed and it was found that 2 culverts (1 100-Year and 1 200-Year) in addition to the exiting land use scenario were undersized. These 2 culverts are listed in Table G-10 and Table G-11, and can be seen in Figure G-4.

4) Future Land Use with Year 2080 Climate Change Conditions

Culverts under a future land use scenario and rainfall event with the estimated effect of climate change in 2080 were assessed and it was found that 2 culverts in addition to the exiting and future 2050 conditions scenario were undersized. Those 2 culverts are listed in Table G-12 and Table G-13 and can be seen spatially in Figure G-4.

Table G-8: 10-Year Culverts Undersized for Existing Land Use and Climate

Location	Name / Road Crossing	Size (mm)	Design Flow (m^3/s)	Surcharging at Inlet	Head Loss (m)	HGL (%)
224th St.	In2696In2695	600	0.929	Yes	0.95	1.9

Note:
1) All culverts were assessed but only culvert that do not meet the assessment criteria are listed.

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Table G-9: 100-Year Culverts Undersized for Existing Land Use and Climate

Location	Name / Road Crossing	Size (mm)	Design Flow (m^3/s)	Surcharging at Inlet	Head Loss (m)	HGL (%)
Blaney Creek	In1760In1761 @ 144th Ave.	675	3.526	Yes	1.72	3.4
Balsam Creek	In1276In1272 @ 233rd St.	820	1.041	Yes	0.86	1.7
Anderson Creek	In1756In1757 @ 141st Ave.	900	1.787	Yes	1.45	2.9
	In1758In1759 @ 232nd St.	1050	2.102	Yes	1.26	2.5
Fraser River Catchment	In1115In1116 @ End of Best St.	1200	4.335	Yes	0.9	1.8
	In322In321 @ Haney Bypass	1200	3.769	Yes	0.53	1.1

Table G-10: 100-Year Culverts Undersized for Future Land Use and Year 2050 Climate

Location	Name / Road Crossing	Size (mm)	Design Flow (m^3/s)	Surcharging at Inlet	Head Loss (m)	HGL (%)
Fraser River Catchment	In2559In2558 @ Haney Bypass	1800	6.153	Yes	0.75	1.5

Note:
1) All culverts were assessed but only culvert that do not meet the assessment criteria are listed.

Table G-11: 200-Year Culverts Undersized for Future Land Use and Year 2050 Climate

Location	Name / Road Crossing	Size (mm)	Design Flow (m^3/s)	Surcharging at Inlet	Head Loss (m)	HGL (%)
Balsam Creek	In2512In2511 @ Balsam St.	1100	2.019	Yes	1.11	2.2

Table G-12: 100-Year Culverts Undersized for Future Land Use and Year 2080 Climate

Location	Name / Road Crossing	Size (mm)	Design Flow (m^3/s)	Surcharging at Inlet	Head Loss (m)	HGL (%)
North Alouette Tributary	In1691In1692 @ 224th St.	450	0.507	Yes	0.56	1.1

Note:
1) All culverts were assessed but only culvert that do not meet the assessment criteria are listed.

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Table G-13: 200-Year Culverts Undersized for Future Land Use and Year 2080 Climate

Location	Name / Road Crossing	Size (mm)	Design Flow (m^3/s)	Surcharging at Inlet	Head Loss (m)	HGL (%)
Cattell Brooke	In1709In1710 @ 136th Ave.	900 (x2)	2.576	Yes	0.57	1.1

Note:
1) All culverts were assessed but only culvert that do not meet the assessment criteria are listed.

G.4 Detention Reporting

A total of 9 existing detention facilities were included in the modelling to determine if these facilities are operating as intended. Design release rates were missing for all ponds in the study area so detention was performance was assessed solely by the ponds ability to detain the volumes produced from the three-day 2/5-Year rainfall events and the volumes from the 1-month 10/25-, 50 and 100-year rainfall events, with their existing control structures to their design water levels. The performance of the detention facilities was simulated for the existing and future land use scenario; an estimated effect of climate change was added to the rainfall in conjunction with the future land use conditions. Each detention facilities used volume is reported in every event as a percentage as well as water levels. Also under every event, each facilities water level was compared to its estimate water levels which were provided within record drawings received from the City.

Volume Assumptions

To estimate detention pond volume, storage curves were developed for the PCSWMM model by examining as-built drawings received from the City. Most as-built drawings had the information necessary to develop storage curves for their respective pond, but if a drawing did not have sufficient information storage curves had to be assumed with a combination of as-built drawings and pond area measurements completed with the aid of orthophotos and contours. Best St. & Blaney Rd. ponds were the only ponds where a storage curve and total volume had to be assumed due to the lack of data on their respective as-built drawings.

Design Storms

The 1-hour to 24-hour duration AES storms used for the storm sewer and culvert assessments were not used for the detention assessment. The City's Design Criteria requires detention to be assessed with the listed 3-day (2/5-Year) and 1-month events (10/25-, 50-, and 100-Year). Typically detention facilities take longer to drain then storm sewers so longer storms were are modelled to estimate the likely initial water levels in the detention facilities prior to the large return period rainfall events occurring. These longer model runs called "Continuous Simulations", give a better representation of detention facility performance than short duration (less than 24 hr) design storms.

Appendix G – Drainage Assessment

Detention Modelling Scenarios

The same four modelled land use scenarios that were used for the storm sewer assessment, were used to assess the detention facilities in the study area. Rainfall events used to estimate detention facility water levels and volumes were retrieved from the City's Design Criteria.

The detention assessment results for the 2/5-year, 10/25-year, 50-year, and 100-year design storms are shown in Figure G-5 to Figure G-8.

Existing Land Use without Climate Change Condition

To estimate water levels and volumes under existing conditions, existing land use was used in combination with the 3-day and 1-month design storms retrieved from the City's design criteria. The results of the existing land use scenario model are presented in Table G-14 and spatially in Figure G-5. The detention facility simulations estimated that 7 facilities exceeded their design water levels, and 1 facility had water levels exceed its banks.

Future Land Use without Climate Change Condition

For this scenario land use in the model was changed to represent future build out with the same design storms used in the existing conditions scenario. There are no additional detention facilities that exceed their design water levels in the future scenario with no climate change but there are 2 additional facilities that have water levels exceed their banks under a 100-Year event. The additional facilities with all the other facilities can be seen in Table G-15 and seen spatially in Figure G-6.

Future Land Use with Year 2050 Climate Change Condition

To estimate future conditions in approximately the year 2050, the future land use was used, and the retrieved design storms were increased by 10%. Under this scenario, there are 2 additional water levels that exceed their estimated design level under the 100-year event and 1 facility that had water levels exceed its banks. The additional facilities with all the other facilities can be seen in Table G-16 and seen spatially in Figure G-7.

Future Land Use with Year 2050 Climate Change Condition

To estimate future conditions in approximately the year 2080, the future land use was used and the retrieved design storms were increased by 20%. Under this scenario there is only one additional facility has its water levels exceed its banks. The additional facility along with all other facilities in the future 2080 scenario can be seen in Table G-17 and seen spatially in Figure G-8.

Detention Results Summary

The detention facility results in are summarized in Table G-14 to Table G-17 and a summary of each facility with recommendations is provided in Table 13-1 of the main text. Figure G-5 to Figure G-8 summarize the same results spatially.

With no release rate established for each detention facility it would be difficult to identify which facility is not performing as intended. The main text provides a more qualitative assessment of the facilities based on data that was available in the hydraulic model (Table G-14 to Table G-17); water levels, percent volume used and land use / storm events. The assessment and recommendations below are capacity-based assessments, to determine a better overall performance (i.e., capacity and ability to detain and attenuate) each facility would require a target release rate.

Under existing conditions and all events most facilities operate within their designed capacity, the exception being the Silver Valley Walkway facility. The future conditions without climate change scenario results in 2 more facilities exceeding their design capacity but only under 100-year events. The future climate change conditions result in 2 more facilities exceeding their design capacity and a number of facilities see high water levels under 100-year events. Detailed studies were recommended for facilities that have limited / exceeded estimated volume and high water levels under large 100-year events. Under these large events surface flow is expected throughout the drainage system including at these facilities and a detailed detention study would identify how surface flow in the large events would affect detention facilities and how facilities that exceed their design capacity affect adjacent infrastructure and property.

Design Storm Effects on Detention Assessment Results

It should be noted that these ponds were assessed with recorded storms in Maple Ridge provided in the City's 2015 Design Criteria Manual under Section 6.2, and since these ponds were assessed with recorded storm events, max water level and volumes do not always increase with larger return periods as it would with synthetic design storms. These lower water levels and volumes with larger return periods can be seen when comparing the water level results and volume results for the 10/25 year and 50-year return periods. The reason for this appears to be the difference in intensity. The 10/25-year month of storms has a smaller overall rainfall volume than the 50-year month but has shorter higher intensity storms peaking at 29 mm/hr. Whereas the 50-year month of storms has larger overall rainfall volume than the 10/25-year month but longer lower intensity storms peaking at 12 mm/hr.

Table G-14: Detention Assessment Existing Land Use

Pond	Orifice Diameter (mm)	Orifice Invert Elev. (m)	Design Peak Water Level (m)	Modelled Peak Water Level (m)				Modelled Pond Volume Used (%)			
				2 - 5yr	10 -25yr	50yr	100yr	2 - 5yr	10 -25yr	50yr	100yr
Best St.	1200 (culvert)	1.53	n/a	1.95	2.71	2.19	2.96	33	78	46	97
Telsoky Bioinfiltration	100	29.40	30.60	30.62	30.68	30.63	30.72	75	78	74	80
	450	30.60									
229 Loop	100	22.65	24.00	23.74	24.00	23.93	24.08	72	93	87	98
	450	23.90									
134 Loop	100	12.54	13.90	13.94	14.00	13.95	14.12	77	82	78	93
	450	13.90									
Blaney Rd.	100	74.06	75.70	75.71	75.79	75.71	75.82	81	86	81	88
	450	75.70									
Silver Valley Walkway	100	55.94	57.50	57.70	57.70	57.70	57.70	100	100	100	100
	400	57.50									
Parkside Biofiltration	100 (pipe)	35.10	36.60	36.23	36.28	36.22	36.38	65	69	64	78
	300 (pipe)	36.00									
Docksteader East	100	23.50	26.00	26.04	25.86	26.04	25.93	86	79	86	82
	450	26.00									
Docksteader West	100	23.50	26.00	26.04	23.79	26.04	25.72	85	4	85	71
	450	26.00									

Notes:

1. Water level exceeded max water level as per as-built drawings by **less** than 10cm
2. Water level exceeded max water level as per as-built drawings by **more** than 10cm
3. Limited Volume Remaining
4. Total Volume Exceeded

Table G-15: Detention Assessment Future Land Use

Pond	Orifice Diameter (mm)	Orifice Invert Elev. (m)	Design Peak Water Level (m)	Modelled Peak Water Level (m)				Modelled Pond Volume Used (%)			
				2 - 5yr	10 -25yr	50yr	100yr	2 - 5yr	10 -25yr	50yr	100yr
Best St.	1200 (culvert)	1.53	n/a	2.25	2.79	2.24	3.00	49	84	48	100
Telsoky Bioinfiltration	100	29.40	30.60	30.63	30.68	30.63	30.70	75	78	74	80
	450	30.60									
229 Loop	100	22.65	24.00	23.86	24.03	23.94	24.10	81	95	88	100
	450	23.90									
134 Loop	100	12.54	13.90	13.95	14.05	13.96	14.17	78	87	79	97
	450	13.90									
Blaney Rd.	100	74.06	75.70	75.73	75.79	75.72	75.82	82	86	82	88
	450	75.70									
Silver Valley Walkway	100	55.94	57.50	57.70	57.70	57.70	57.70	100	100	100	100
	400	57.50									
Parkside Biofiltration	100 (pipe)	35.10	36.60	36.24	36.35	36.22	36.46	65	75	64	86
	300 (pipe)	36.00									
Docksteader East	100	23.50	26.00	26.04	25.87	26.04	25.93	86	79	86	82
	450	26.00									
Docksteader West	100	23.50	26.00	26.04	23.96	26.04	25.81	85	7	85	75
	450	26.00									

Notes:

1. Water level exceeded max water level as per as-built drawings by **less** than 10cm
2. Water level exceeded max water level as per as-built drawings by **more** than 10cm
3. Limited Volume Remaining
4. Total Volume Exceeded

Table G-16: Detention Assessment Future 2050 Land Use

Pond	Orifice Diameter (mm)	Orifice Invert Elev. (m)	Design Peak Water Level (m)	Modelled Peak Water Level (m)				Modelled Pond Volume Used (%)			
				2 - 5yr	10 -25yr	50yr	100yr	2 - 5yr	10 -25yr	50yr	100yr
Best St.	1200 (culvert)	1.53	n/a	2.31	2.89	2.30	3.00	53	92	52	100
Telsoky Bioinfiltration	100	29.40	30.60	30.64	30.70	30.63	30.73	75	79	75	81
	450	30.60									
229 Loop	100	22.65	24.00	23.95	24.05	23.95	24.10	88	96	89	100
	450	23.90									
134 Loop	100	12.54	13.90	13.98	14.10	13.98	14.20	91	91	80	100
	450	13.90									
Blaney Rd.	100	74.06	75.70	75.74	75.80	75.73	75.83	82	87	82	89
	450	75.70									
Silver Valley Walkway	100	55.94	57.50	57.70	57.70	57.70	57.70	100	100	100	100
	400	57.50									
Parkside Biofiltration	100 (pipe)	35.10	36.60	36.25	36.38	36.24	36.53	67	78	65	92
	300 (pipe)	36.00									
Docksteader East	100	23.50	26.00	26.05	25.91	26.05	26.05	86	81	86	86
	450	26.00									
Docksteader West	100	23.50	26.00	26.05	24.67	26.04	26.04	85	27	85	85
	450	26.00									

Notes:

1. Water level exceeded max water level as per as-built drawings by **less** than 10cm
2. Water level exceeded max water level as per as-built drawings by **more** than 10cm
3. Limited Volume Remaining
4. Total Volume Exceeded

Table G-17: Detention Assessment Future 2080 Land Use

Pond	Orifice Diameter (mm)	Orifice Invert Elev. (m)	Design Peak Water Level (m)	Modelled Peak Water Level (m)				Modelled Pond Volume Used (%)			
				2 - 5yr	10 -25yr	50yr	100yr	2 - 5yr	10 -25yr	50yr	100yr
Best St.	1200 (culvert)	1.53	n/a	2.37	2.98	2.35	3.00	56	99	55	100
Telsoky Bioinfiltration	100	29.40	30.60	30.64	30.71	30.64	30.75	75	80	75	82
	450	30.60									
229 Loop	100	22.65	24.00	23.96	24.09	23.96	24.10	89	99	89	100
	450	23.90									
134 Loop	100	12.54	13.90	13.99	14.15	13.99	14.20	81	96	81	100
	450	13.90									
Blaney Rd.	100	74.06	75.70	75.74	75.81	75.73	75.84	83	87	82	90
	450	75.70									
Silver Valley Walkway	100	55.94	57.50	57.70	57.70	57.70	57.70	100	100	100	100
	400	57.50									
Parkside Biofiltration	100 (pipe)	35.10	36.60	36.27	36.42	36.25	36.60	68	82	67	100
	300 (pipe)	36.00									
Docksteader East	100	23.50	26.00	26.06	25.92	26.05	26.14	87	81	86	90
	450	26.00									
Docksteader West	100	23.50	26.00	26.05	25.19	26.05	26.14	85	49	85	89
	450	26.00									

Notes:

1. Water level exceeded max water level as per as-built drawings by **less** than 10cm
2. Water level exceeded max water level as per as-built drawings by **more** than 10cm
3. Limited Volume Remaining
4. Total Volume Exceeded

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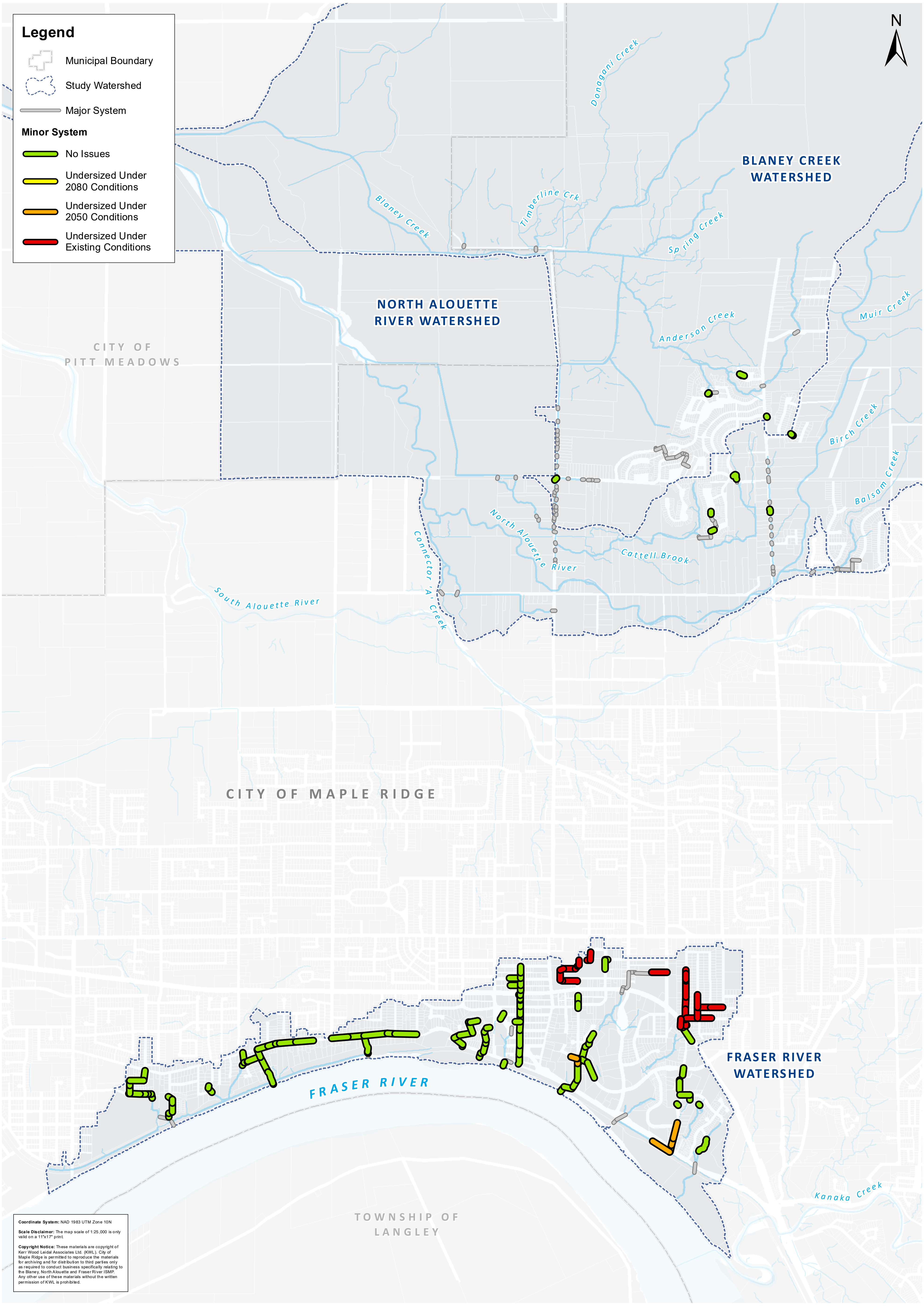


Legend

Municipal Boundary

Study Watershed

Major System

Minor System

🟩 No Issues

🟨 Undersized Under 2080 Conditions

🟧 Undersized Under 2050 Conditions

🟥 Undersized Under Existing Conditions

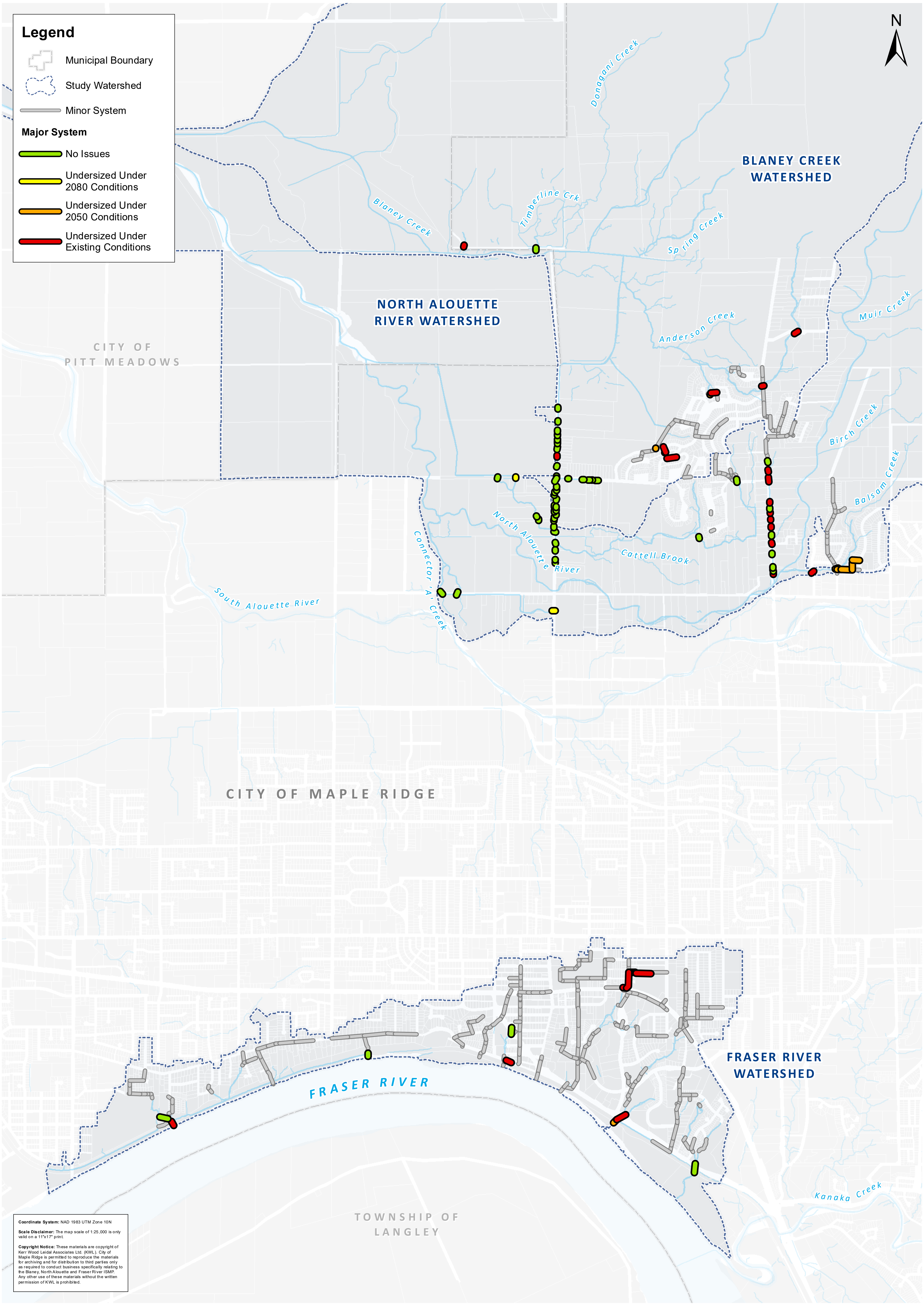
Coordinate System: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:25,000 is only valid on a 11"x17" print.

Project No.	173-188
Date	March 2020
Scale 1:25,000	0 100 200 400 (m)

Minor Storm Sewer Capacity Assessment

Figure G-1



Coordinate System: NAD 1983 UTM Zone 10N

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Project No. 173-188

Date March 2020

Scale 0 100 200 400 (m)
1:25,000

Major Storm Sewer Capacity Assessment

Figure G-2

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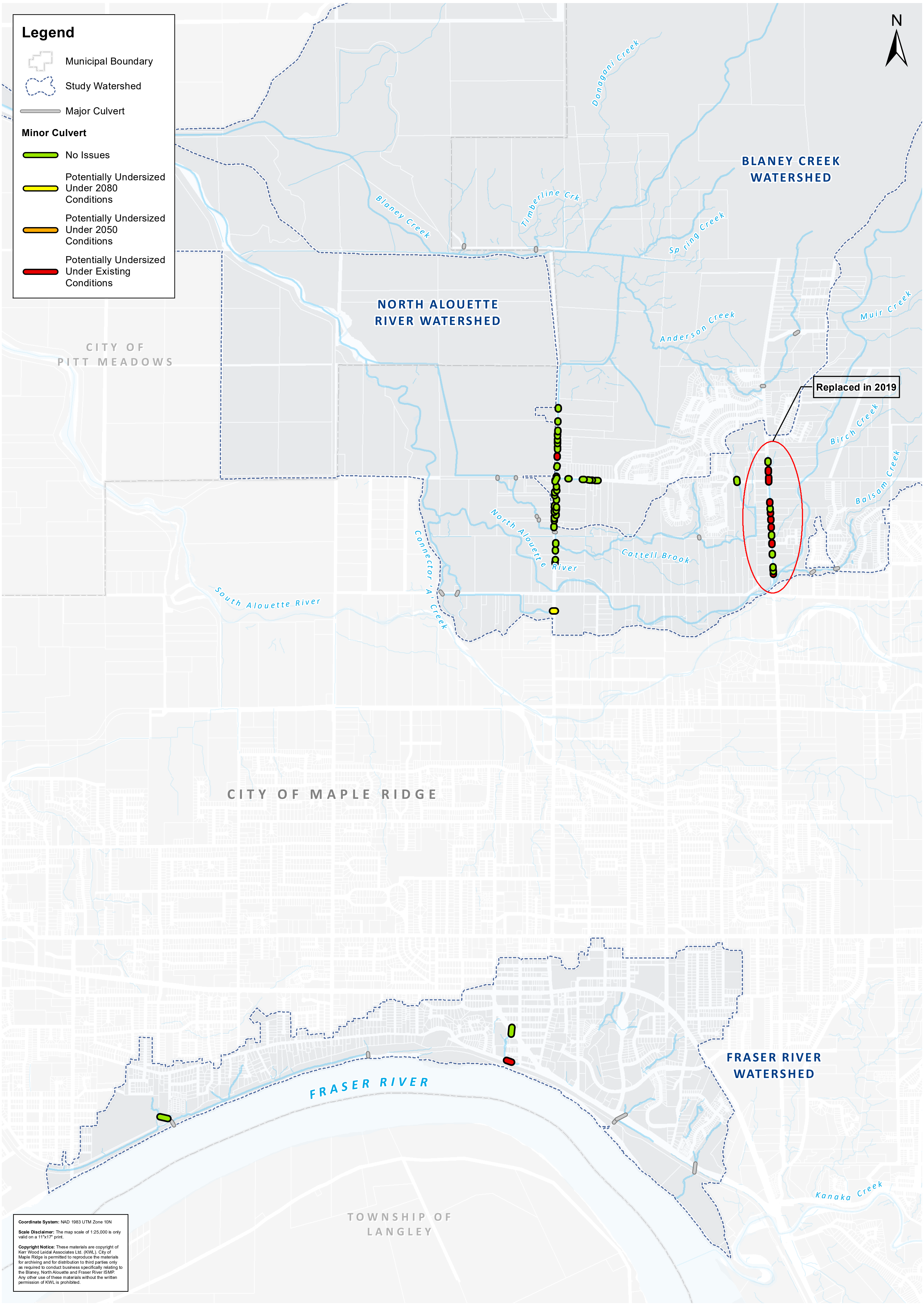

Coordinate System: NAD 1983 UTM Zone 10N

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Project No.	173-188
Date	August 2020
Scale 1:25,000	0 100 200 400 (m)

Minor Culvert Assessment

Figure G-3

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\Draft_Final\173188_FigB-4_MajorCulvertAssessment.mxd Date Saved: 8/17/2020 2:27:33 PM | Author: BWhitehouse

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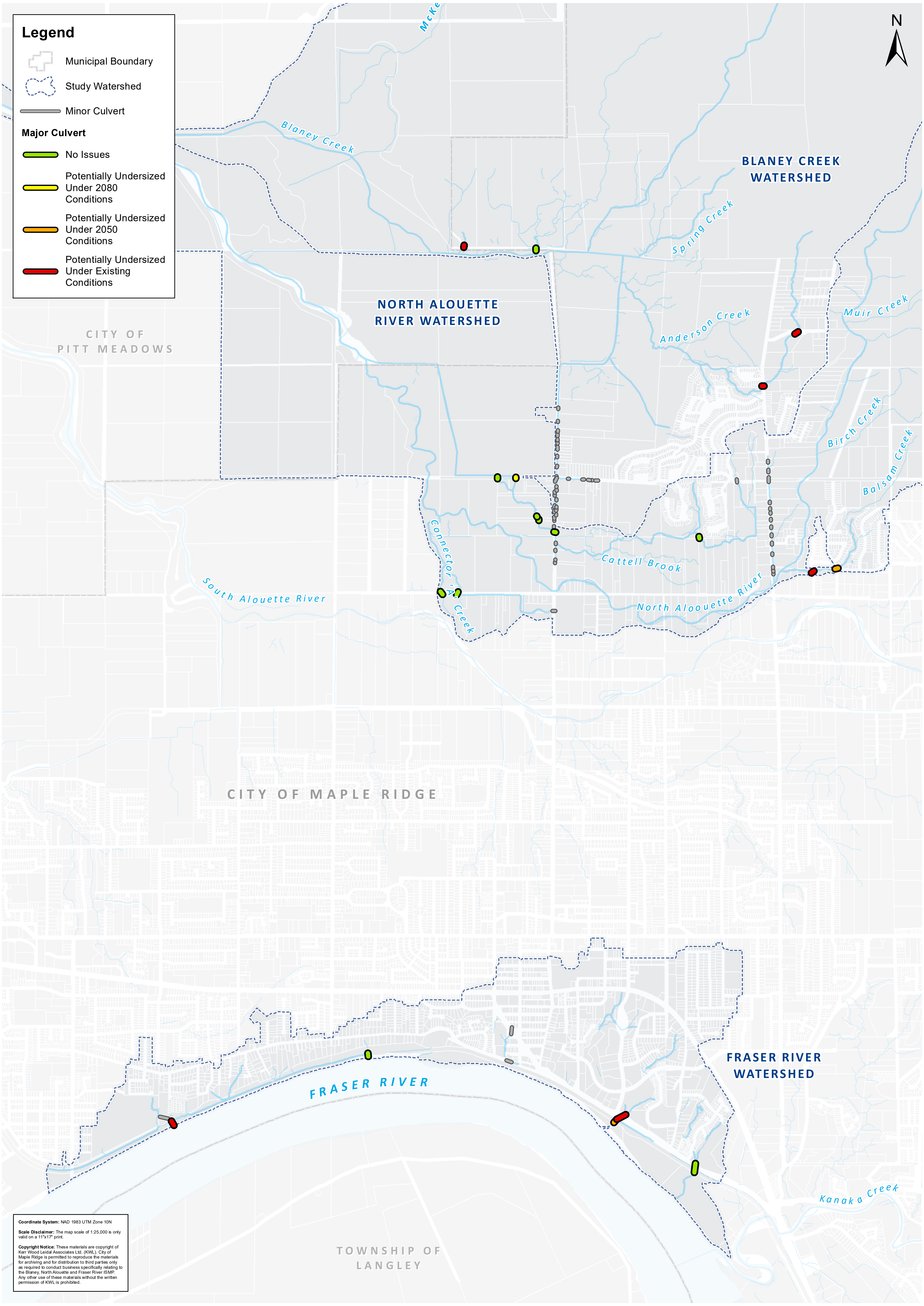

Coordinate System: NAD 1983 UTM Zone 10N

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Project No. 173-188

Date August 2020

Scale 0 100 200 400 (m)
1:25,000

Major Culvert Assessment

Figure G-4

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\Draft_Final\173188_FigB-5_ExistingDetentionAssessment.mxd Date Saved: 3/4/2020 12:38:12 PM | Author: TSoh

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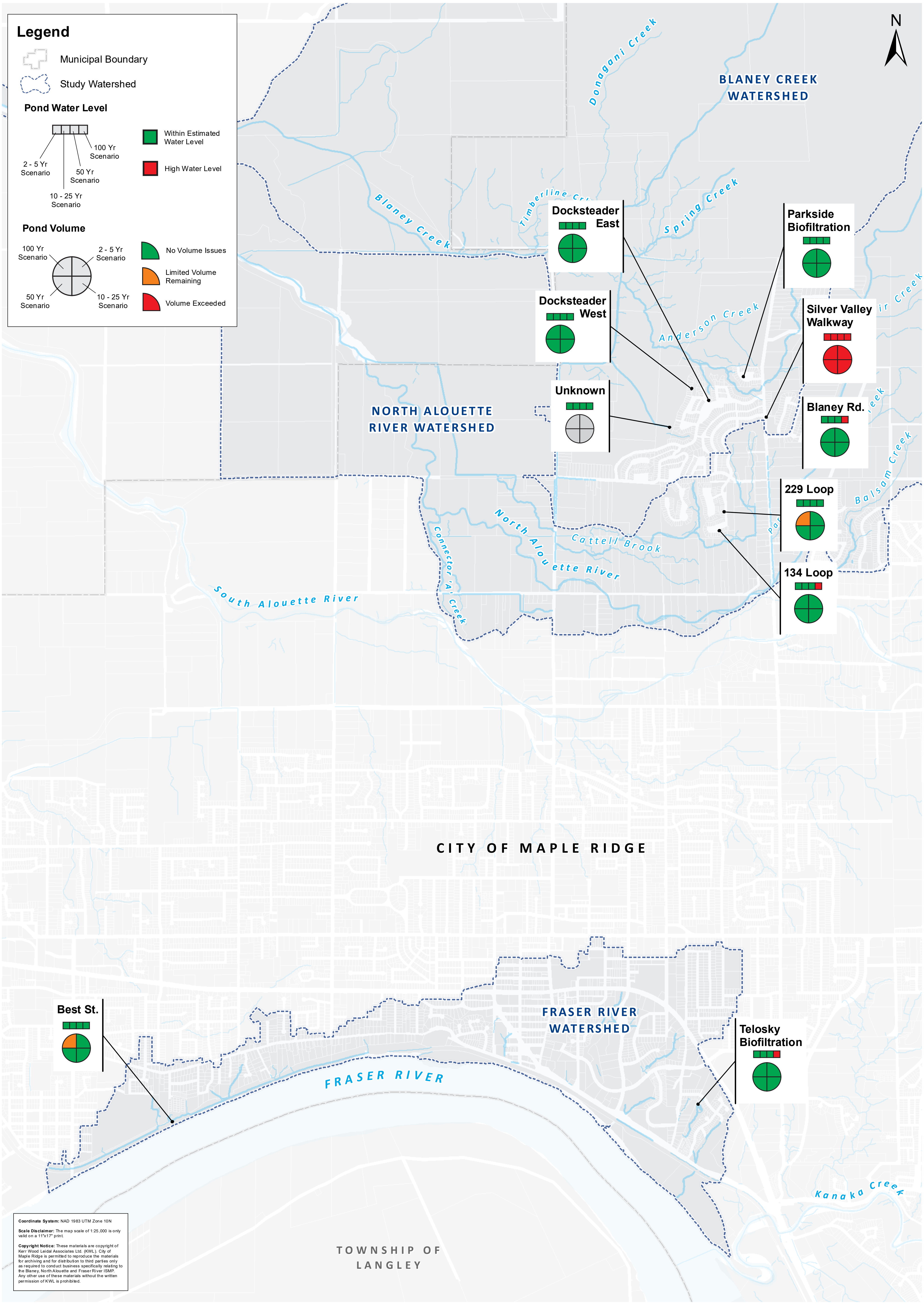

Coordinate System: NAD 1983 UTM Zone 10N

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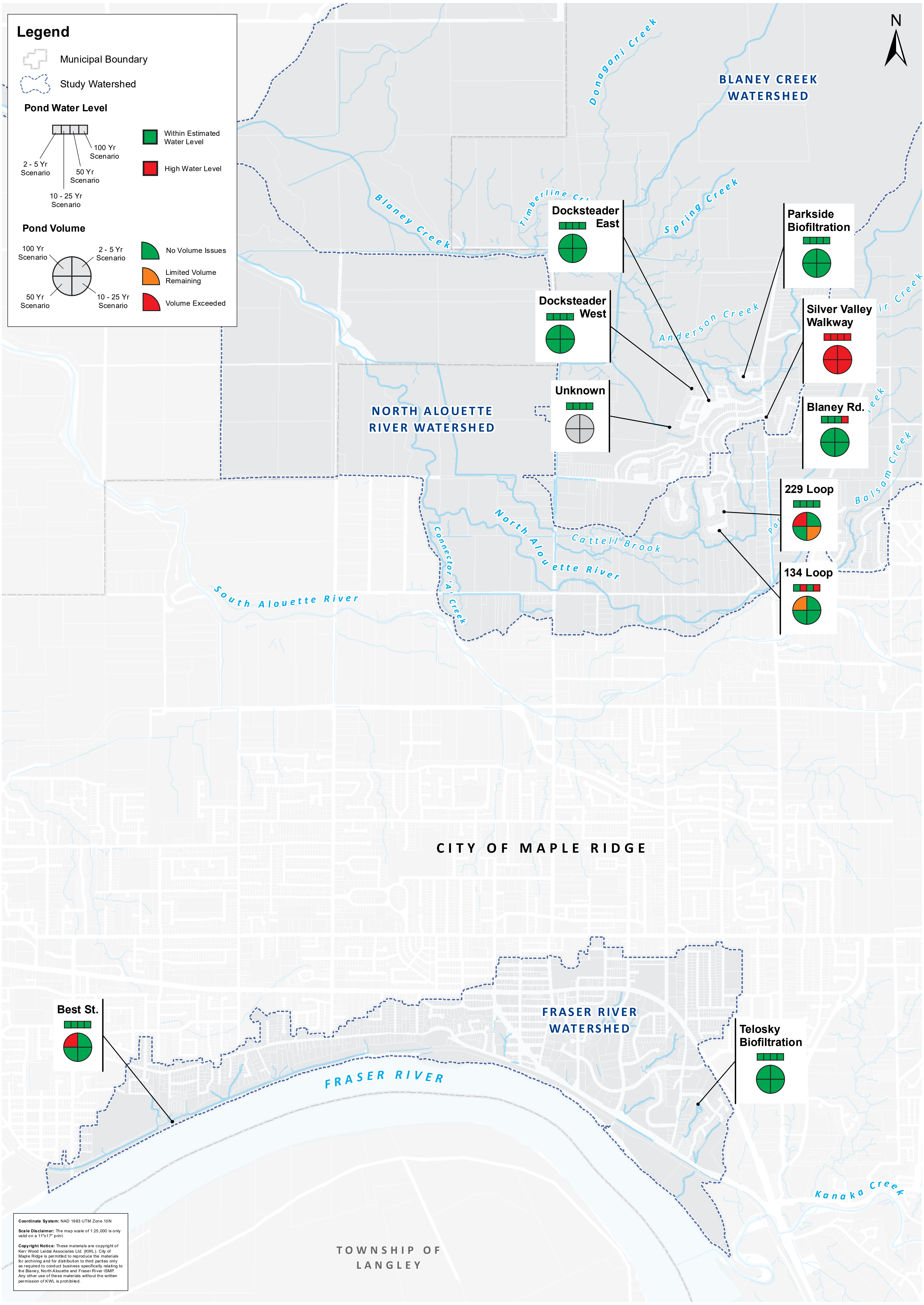
Project No. 173-188

Date March 2020

Scale 0 100 200 400 (m)
1:25,000

Existing Land Use Detention Results

Figure G-5



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Project No. 173-188
Date March 2020
Scale 0 100 200 400 (m)
1:25,000

Future Land Use Detention Results

Figure G-6

Path: Z:\0000-0999\0100-0199\173-188\430-GIS\MXD-Rp\Draft_Final\173188_FigB-7_Fut2050DetentionAssessment.mxd Date Saved: 3/4/2020 12:01:43 PM | Author: TSoh

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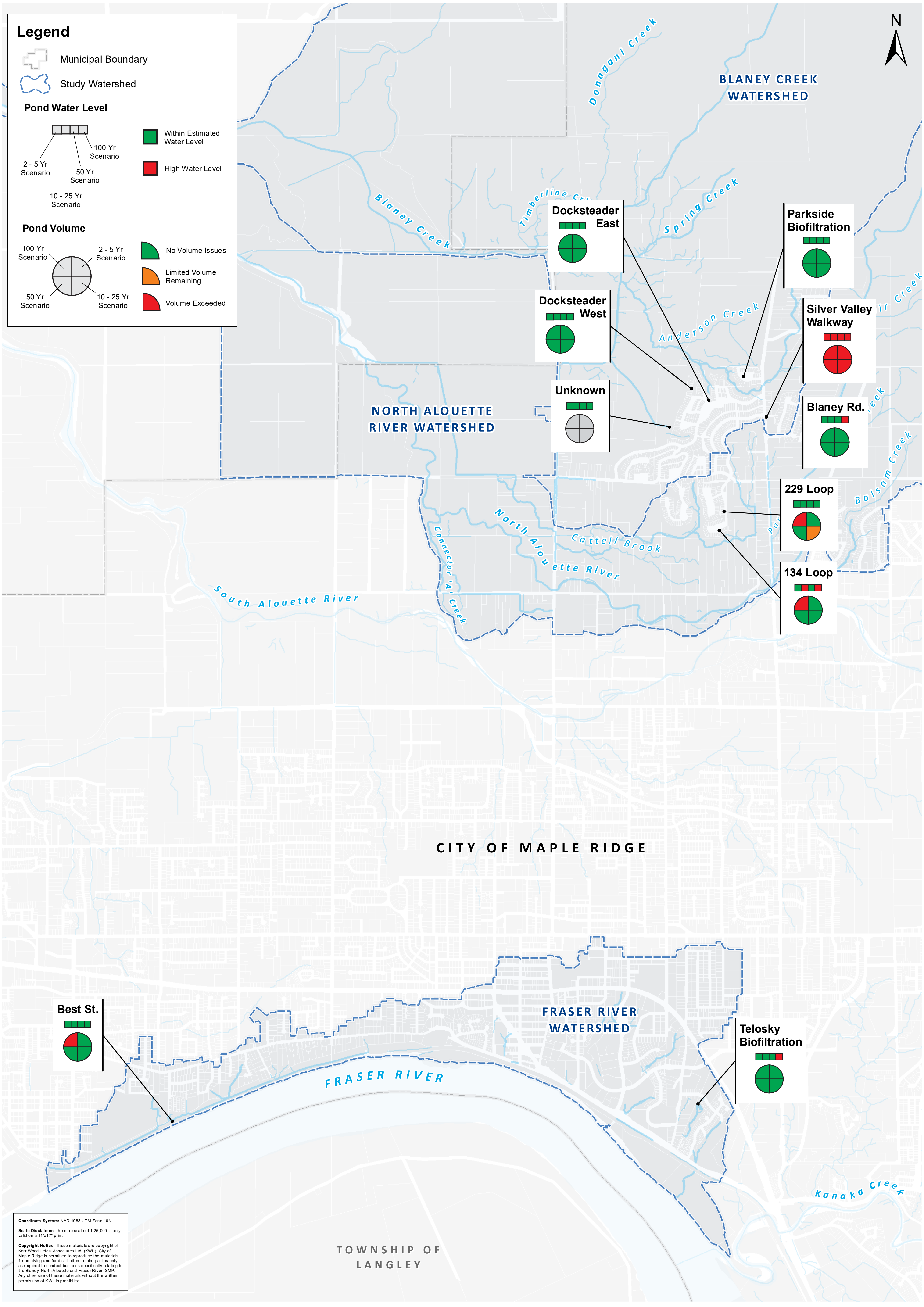

Coordinate System: NAD 1983 UTM Zone 10N

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Project No. 173-188

Date March 2020

Scale 0 100 200 400 (m)
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Future 2050 Land Use Detention Results

Figure G-7

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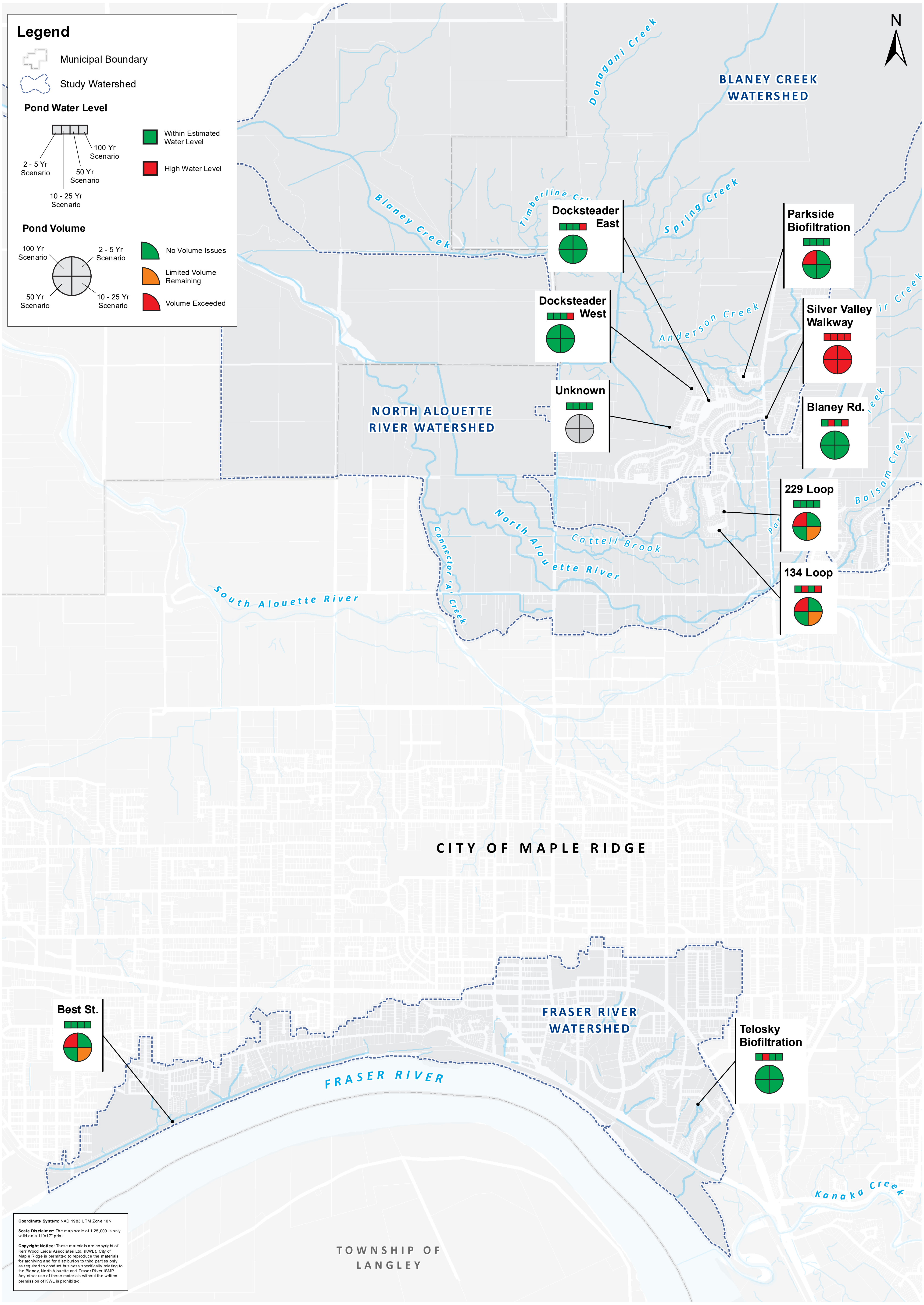

Coordinate System: NAD 1983 UTM Zone 10N

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Project No. 173-188

Date March 2020

Scale 0 100 200 400 (m)
1:25,000

Future 2080 Land Use Detention Results

Figure G-8