Creating Safer Cities for Salmon:
A Policy Analysis of the Lower Fraser Watershed

by

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Abstract

Rapid urbanization in the Lower Fraser Watershed (LFW) of British Columbia (BC) directly and indirectly degrades the health of aquatic ecosystems that are home to the ecologically, culturally, socially, and economically significant Pacific Salmon (*Oncorhynchus spp.*). Using the scientific standards of the Salmon-Safe BC urban program as an evaluative framework, this study undertakes a comparative review of government policies and offers a series of recommendations that could facilitate the use of green infrastructure (GI) to mitigate adverse impacts on wild salmon. During consultations with LFW experts, the disparities in policy objectives and requirements were cited as a major barrier to their effective implementation. Addressing these gaps in policy requires development of well-defined statutory foundations and enforcement, and awareness-raising among developers, the public, and politicians to understand GI solutions. This approach can garner the support needed for the use of GI systems to protect wild salmon and ensure long-term watershed health.

Keywords: Green infrastructure; nature-based solutions; salmon habitat protection; rainwater management; sustainable development standards; watershed protection

Dedication

To the wild salmon and waters, we will do better.

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List of Acronyms

BC	British Columbia
BMP	Best Management Practices
CoB	City of Burnaby
CNV	City of North Vancouver
CoS	City of Surrey
CoV	City of Vancouver
CoD	Corporation of Delta
CU	Conservation Unit
DFO	Department of Fisheries and Oceans Canada
DNV	District of North Vancouver
DPA	Development Permit Area
EMA	Environmental Management Act
FBC	Fraser Basin Council
GI	Green Infrastructure
GVRD	Greater Vancouver Sewerage and Drainage District
ILWRMP	Integrated Liquid Waste and Resource Management Plan
ISMP	Integrated Stormwater Management Plan
LFW	Lower Fraser Watershed
LID	Low Impact Development
MOECC	Ministry of the Environment
MV	Metro Vancouver
MAMF	Monitoring and Adaptive Management Framework
NBS	Nature Based Solutions
OCP	Official Community Plan
QEP	Qualified Environmental Professional
RAPA	Riparian Areas Protection Act
RAPR	Riparian Areas Protection Regulation
RGS	Regional Growth Strategy
RCS	Regional Context Statement
SARA	Species at Risk Act
SPEA	Streamside Protection and Enhancement Area
WBM	Water Balance Model
WSA	Water Sustainability Act
WSP	Wild Salmon Policy

Executive Summary

The Fraser River is British Columbia's (BC) longest and most productive salmon spawning watershed that supports Canada's largest salmon fishery (English et al., 2005; Kristensen, Noble, & Patrick, 2013; Nguyen, Young, Hinch, & Cooke, 2016). The Fraser River meanders over 1300 kilometers through the province, draining into the Strait of Georgia after passing through Greater Vancouver Regional District; an area known as the Lower Fraser watershed (LFW) (Nguyen et al., 2016). The LFW is the most densely populated watershed in the province (Kristensen et al., 2013); it has undergone mass urbanization, agricultural development, forest harvesting, and various other land-use changes over the past two centuries that have drastically altered habitat for the salmonid species migrating through, and spawning in the local waterways (Kristensen et al., 2013; Ross et al., 2013).

Historically, hard "grey" infrastructure has been used as the conventional urban development method. The use of grey infrastructure has increased in the LFW's total impervious area (Kokkonen, Grimmond, Christen, Oke, & Järvi, 2018; Kristensen et al., 2013). This approach, in combination with the alteration of the watershed's natural landscape has resulted in an increased volume of surface runoff, disturbance of the existing water balance, and destruction of native vegetation and habitat (Stephens, Gulik, & Maclean, 2003). The cumulative effects from the loss of green spaces, alteration of natural waterways, and frequent elimination of viable habitat in the urban built environment has led to the "urban stream syndrome" wherein these external pressures reduce the overall abundance and diversity of aquatic ecosystems (Canessa & Parris, 2013; Meyer, Paul, & Taulbee, 2005; C. J. Walsh, Roy, et al., 2005). There is a direct and positive correlation between the level of urbanization in a watershed and the concentration of pollutants found in local waterways (C. J. Walsh, Roy, et al., 2005). These pollutants that enter local waterways either via point or non-point source pollution. Point source pollution, largely in the form of untreated sewer discharges and overflows, is typically a significant issue in older cities that have combined sewer systems and is more easily addressed than non-point source pollution (City of Vancouver, 2019; Hatt, Fletcher, Walsh, & Taylor, 2004). However, in cities with updated infrastructure and

separated sewer systems, non-point source pollution is the leading cause of water quality degradation and contamination (Hatt et al., 2004; C. J. Walsh, 2000; C. J. Walsh, Roy, et al., 2005).

Leaching of pollutants from urban impervious surfaces has been directly linked to the increased mortality of salmon spawning and migrating through urban landscapes (Chow et al., 2019; Feist, Buhle, Arnold, Davis, & Scholz, 2011; Feist et al., 2017; McIntyre et al., 2018). For many Indigenous communities in British Columbia, Pacific salmon (*Oncorhynchus* spp.) have immense cultural, spiritual, and economic value (Criddle & Shimizu, 2014; Ettinger et al., 2021; Feist et al., 2017; Gerwing & McDaniels, 2006; Ogston, Gidora, Foy, & Rosenfeld, 2015). Salmon also provide a unique ecological link between terrestrial and aquatic ecosystems along the coast of British Columbia (Gende, Edwards, Willson, & Wipfli, 2002; Hocking & Reynolds, 2011; Janetski, Chaloner, Tiegs, & Lamberti, 2009; Naiman, Bilby, Schindler, & Helfield, 2002; Wagner & Reynolds, 2019). Destruction of salmon habitat from the loss of over 117 streams in the Lower Fraser Valley, compounded by the ongoing contamination of their remaining habitat has been the driving force to alter traditional urban development practices (Durance, Pepin, & Dale, 1997; Stephens & Dupont, 2010).

To address the increased volume of runoff and contaminants draining from urban impervious areas, green infrastructure (GI) or nature-based solutions (NBS)[1] have been deployed. GI can be applied at multiple scales. From site-level solution to a regional scale network, GI solutions works to mimic the pre-development natural hydrological patterns of the landscape to mitigate the impacts of urban development on natural systems (Ahiablame, Engel, & Chaubey, 2013; Pyke et al., 2011; Stephens & Dupont, 2010; Young, Zanders, Lieberknecht, & Fassman-Beck, 2014). Understanding the important role that ecosystems play in human well-being has been a part of Indigenous knowledge systems and beliefs for centuries, but has only been acknowledged by western science in

[1] Although there are numerous and differing definitions of GI and NBS, this paper will use the terms interchangeably. Both will be used to refer to solutions that aim to mimic, protect, or enhance natural systems and the benefits they provide.

the past 30 years (Walters, Janzen, & Maginnis, 2016). The 2005 release of the Millennium Ecosystem Assessment provided a deeper understanding of the importance of ecosystem services and the threats that face them (Millennium Ecosystem Assessment, 2005; Walters et al., 2016).

Within the past two decades, ecosystem services and nature-based solutions have been incorporated to various degrees into policies in Canada (Dhakal & Chevalier, 2017; di Marino & Lapintie, 2018; Hansen et al., 2015; C. M. Johns, 2019). Implementation and uptake of these GI and NBS solutions has been moving at a slow pace which has been attributed to a lack of statutory and regulatory foundations, political will and leadership from both the provincial and federal governments in Canada (Hopkins, Grimm, & York, 2018; C. M. Johns, 2019). Under the *Local Government Act* (2015), local governments in BC have the authority to plan for local land-use through zoning in addition to providing utilities and community services. Similar to the motivations of Conway et al., 2020, my research focuses on how GI and NBS are being incorporated into government policy.

My research addresses current knowledge gaps that exists in BC surrounding the use of GI and NBS in government policy within the Province's most urbanized watershed –Lower Fraser Watershed– by comparing government policy at all four levels of government to the more stringent standards of the Salmon-Safe Urban eco-certification program. Salmon-Safe was brought to Canada in 2011, under the leadership of the Fraser Basin Council and the Pacific Salmon Foundation until it fully transitioned to the Fraser Basin Council in 2018. The Salmon-Safe BC (SSBC) Urban program has seven development standards that focus on managing rainwater, reducing the release of pollutants into the environment, enhancing, and restoring habitat, and conserving water resources. For a development to be certified as Salmon-Safe, it must meet the specific performance requirements under each development standard. The desktop-based policy review was further complimented with expert interviews. These interviews were used to verifiy findings of the analysis while providing essential background insight and understanding of the inner workings behind policy development and implementation. The

interview stage was important for highlighting the current policy gaps and potential ways they could be addressed.

The results of this research reveal that significant efforts to manage rainwater, reduce degradation of salmon habitat, and promote the use of NBS and GI are already being made in the watershed, mostly undertaken by local governments. The alignment between the SSBC program and governmental policy is the highest between rainwater-management-based and riparian area protection policies. However, the research also highlights the many gaps in policy and the significant barriers to implementation that still exist at all levels of government. Therefore, I propose a series of opportunities and recommendations that could be incorporated into both policy frameworks and the SSBC urban program:

<u>Salmon-Safe BC Updates and Opportunities</u>

1. *Add a resiliency component to the development standards to address future risks of climate change*
2. *Explore collaboration and engagement with the local First Nations*
3. *Require the use of educational components that engage the surrounding community to encourage stewardship, awareness, and acceptance*
4. *Expand SSBC influence to residential developments, including single-family homes and small-scale developments*
5. *Consider establishing routine updates to SSBC standards that can directly link to regional planning cycles*

<u>Federal Government Recommendations</u>

1. *Collaborate with lower-level governments to strengthen legislation and regulations to protect wild salmon more effectively from nonpoint-source pollution*

<u>Provincial Government Recommendations</u>

1. *Widen riparian buffer zone requirements in the Riparian Areas Protection Act (RAPA) to a minimum of 30 metres, and require the restoration and enhancement of degraded streamside ecosystems*

2. *Explore the formation of a province-wide enforcement mechanism to provide the same requirements and presence that the provincial government used to hold historically*

Local Government Recommendations

1. *Raise awareness amongst the general public about use of GI and how it relates to watershed health*
2. *Consider updates to the water quality and erosion and sediment control (ESC) standards or develop region-wide agreed upon and scientifically informed erosion and sediment solutions for water quality*
3. *Find ways to link and recognize the benefits between rainwater management, biodiversity conservation, and human health and well-being more explicitly*
4. *Promote and facilitate inter-departmental coordination and joint-government ventures*

All Government Recommendations

1. *Ensure policies across the different levels of government are complimentary and not contradictory*
2. *Strengthen enforcement mechanisms amongst all levels of government to increase compliance*
3. *Expedite the approval of permit applications that focus directly on the use of green infrastructure and nature-based solutions*

Chapter 1. Introduction

The Fraser River is British Columbia's (BC) longest and most productive salmon spawning watershed that supports Canada's largest salmon fishery (English et al., 2005; Kristensen et al., 2013; Nguyen et al., 2016). The Fraser River meanders over 1300 kilometers through the province, draining into the Strait of Georgia after passing through Metro Vancouver; an area known as the Lower Fraser watershed (LFW) (Nguyen et al., 2016). The LFW is the most densely populated watershed in the province (Kristensen et al., 2013); it has undergone mass urbanization, agricultural development, forest harvesting, and various other land-use changes over the past two centuries that have drastically altered habitat for the salmonid species migrating through, and spawning in the local waterways (Kristensen et al., 2013; Ross et al., 2013).

Pacific salmon hold significant cultural, spiritual, ecological, and economic value in British Columbia (Ettinger et al., 2021; Feist et al., 2017; Gerwing & McDaniels, 2006; Norman, 2017; Ogston et al., 2015). Ecologically, salmon are considered to be a sentinel, indicator, and keystone species; this means their health and survival can be used as a proxy and source of information on the current state of aquatic ecosystems and the adjacent terrestrial landscapes (Ettinger et al., 2021; Feist et al., 2017; McIntyre et al., 2018; Stephens & Dupont, 2010). Many terrestrial ecosystems rely on the input of nutrients from wild salmon returning from the marine environment (Hocking & Reynolds, 2011; Schindler et al., 2010; J. C. Walsh, Pendray, et al., 2020), while marine ecosystems rely on the abundance of wild salmon as a vital food source for many marine species – including the endangered Southern Resident Killer Whales (Ford, John K.B., Ellis, Graeme M., Olesiuk, 2005; Hanson et al., 2010; Krahn et al., 2002; Parsons, Balcomb, Ford, & Durban, 2009). Wild salmon have immense value as a key indicator of ecosystem health, the impacts of human-use and development, and the efficacy of nature-based solutions (Ettinger et al., 2021; McIntyre et al., 2018).

Development and urbanization of the Lower Fraser Valley (extending from the Strait of Georgia to the Coquihalla Watershed) has resulted in the loss of over 117

streams and endangered nearly 50% of recorded streams (Durance et al., 1997). Many of the remaining streams have been channelized or diverted, experienced losses of riparian vegetation and water quality, and remain vulnerable to the cumulative effects of impermeable urban development and land-use change (Durance et al., 1997). Significant loss of habitat has contributed to the continued decline of Fraser River salmon populations recorded for the decades leading up to and subsequently after the launch of the Cohen Commission in 2009; when an anticipated return of nine million sockeye resulted in only 600,000 returning females (Ross et al., 2013). Investigation into the continued decline and vulnerability of Fraser River salmon remains ongoing to assess impacts of climate change, fishing pressures, habitat destruction, cumulative effects, and other various environmental or human induced stressors (Peterman, Marmorek, Beckman, & Bradford, 2010; Ross et al., 2013). This decline in wild salmon populations has been credited as the driving force behind provincial action and innovation to more effectively protect the abundance and health of salmon habitat (Porter-Bopp, Brandes, Sandborn, & Brandes, 2011; Stephens & Dupont, 2010).

Human activity, intensive land-use, land conversion, and increasing threats of climate change have significantly altered aquatic salmonid habitat – a factor directly contributing to the decline of salmon in the Pacific Northwest (Bilby & Mollot, 2008). Previous studies have linked mortality of wild salmon directly to contaminants found in urban rainwater run-off (Chow et al., 2019). Recent studies show the harmful impacts of nonpoint-source pollution on salmonid populations more broadly in addition to the chronic, if not lethal impacts on juvenile populations (McIntyre et al., 2018). Rainwater is a primary source of nonpoint-source pollution that drains from urban landscapes into aquatic habitats (Chow et al., 2019). Researchers have deemed the observable mortality in urban stream environments “urban spawner mortality syndrome”, characterized by symptoms that lead to death on a timescale of just a few hours (Feist et al., 2011; McIntyre et al., 2018). In Metro Vancouver, where winters are projected to become even wetter and warmer with climate change (Ek et al., 2018), implementing urban development strategies that can reduce rainwater runoff quantity will become increasingly important for water quality and overall watershed health.

As a strategy for reducing impacts of urban development on salmon populations, green infrastructure (GI) has been used to mitigate urban runoff and provide low-impact development solutions. Green infrastructure, or nature-based solutions have the capacity to retain rainfall where it lands in efforts to reduce overall runoff and storm sewer volume (Dong, Guo, & Zeng, 2017; Salerno, Viviano, & Tartari, 2018). GI systems have also been found to eliminate over 90% of pollutants commonly found in roadway runoff by trapping and degrading pollutants in soils and plant tissues (Demuzere et al., 2014; Hsieh & Davis, 2012). In addition to natural GI, engineered GI systems – often in the form of green roofs, bio-retention cells, and permeable pavements – are capable of retaining 50-70% of annual rainwater runoff when maintained properly (Demuzere et al., 2014). The efficiency of GI systems at reducing runoff volume, preserving water quality, and overall impact on the environment are being realized and encouraged as a means of future development (Nell & Kiparsky, 2015).

Environmental regulators have traditionally relied on taxation and command-and-control regulations to mitigate or remediate impacts of human activities on the environment (Lyon & Maxwell, 2007). However, there is a growing popularity among developers for the use of eco-certifications or voluntary environmental programs to adhere to environmental objectives and regulations (Blackman, 2012; Lyon & Maxwell, 2007; Melo & Wolf, 2005). A well-known green infrastructure certification is the Leadership in Energy and Environmental Design (LEED) from the US Green Building Council and the Canada Green Building Council. The LEED certification has been such a useful tool for regulating the operations of the building industry that in 2010, over 200 jurisdictions in the US either mandated or provided incentives for buildings that were LEED-certified (Cidell & Cope, 2014). However, the LEED certification has a broad application that does not target specific concerns of salmon habitat in BC. Although the benefits of GI systems and eco-certifications are well understood, the implementation and practice of these sustainable development strategies are still in the formative stages.

The Fraser Basin Council (FBC) leads the Salmon-Safe BC (SSBC) urban eco-certification program focusing directly on salmon and watershed protection. SSBC

recognizes progressive, environmentally friendly practices on agricultural and urban lands to help protect Pacific salmon habitat and enhance water quality and ecological function. By adopting SSBC urban standards, developers, landowners, and property managers can help ensure BC's iconic species thrives for future generations. Sites that are applying for certification are assessed for the five key criteria of SSBC core urban standards including stormwater management, water use management, erosion prevention and sediment control, chemical and pesticide reduction, and enhancement of urban ecological function. For development sites that are situated in close proximity to a waterbody or watercourse must also adhere to the performance requirements of SSBC's two context-dependent standards: instream habitat protection and restoration, and riparian, wetland, and locally significant vegetation protection and restoration. There are currently three certified urban sites in Metro Vancouver: Vancouver International Airport (YVR), Mountain Equipment Co-Op (MEC) Headquarters, and MEC Flagship store. The SSBC urban program is also in the process of certifying more developments within Metro Vancouver that range from a single site to a multi-site level certification.

Little is known in BC of how these eco-certification standards, that were developed specifically for the biological needs of the iconic Pacific Salmon, align with Indigenous, federal, provincial, and local government policy and regulations to promote more sustainable development and overall developer compliance. Using the SSBC Urban standards as an evaluative framework, this research has demonstrated the need for holistic approaches to policy development and implementation to effectively integrated GI into standard development practices. GI is still a relatively new term being used in government policies and regulations (C. M. Johns, 2019; C. Johns, Shaheen, & Woodhouse, 2018). My research supports the findings of Hansen et al. (2015) that showed how the concept of "ecosystem services" was becoming more mainstream in the urban planning realm which increases the potential for effective GI implementation. However, similar to Johns (2019) I found that there still exists a level resistance and hesitation from developers, government staff, politicians, and community members to larger-scale or required implementation of GI. Recent legislative changes, increasing environmental regulations and decreasing governmental capacity to enforce them, all

highlight the importance of identifying areas of strengths, weaknesses, and synergies across the different levels of government to promote a more holistic and cohesive approach to urban development management and sensitive habitat protection (Fraser Basin Council, 2015).

There is a need for greater understanding and research on how the development of regions like the LFW and the subsequent stressors impact salmon (Hodgson, Wilson, & Moore, 2020). Although this research does not directly address this knowledge gap, it does provide opportunities for governments to strengthen policy as a precautionary approach to mitigate impacts on salmon and their habitat. However complex, incorporating the cumulative effects from urban development and human activities is an essential step in informing the policy adaptation and decision-making process to better serve salmon populations. To promote effective protection of salmon habitat in BC and reduce impacts of cumulative effects, this research project sought to understand the degree of alignment between current governmental policy and a sustainable development eco-certification.

1.1 Research Questions

This research study aims to further the understanding of sustainable development, habitat protection, and policies enabling GI implementation in the LFW. Focusing on policies and legislation from the federal, provincial, three local First Nations, the regional district, and six detailed municipal case studies, this research addresses three broad questions:

1) How do current government policies, standards, and objectives align with those of the SSBC program standards and objectives?
2) What are the most significant gaps in the current policies that are leaving salmon populations and aquatic habitats vulnerable to urban development impacts?

3) What opportunities exist to better align policies and standards for implementation of more sustainable and holistic urban development in the LFW?

1.2 Purpose and Objectives

The purpose of this research was to identify alignment between the objectives and standards of SSBC certification and government policies and standards at all four levels of government (Indigenous, federal, provincial, local). The findings were used to inform recommendations and present opportunities for governments to enhance existing policies and standards, in addition to providing recommendations to the FBC on how they could strengthen their current SSBC standards. The research also aims to provide an overview of government policy in the region and demonstrate where it works to protect and enhance fish, fish habitat, overall water quality, and outline areas of government efforts that could be strengthened.

The objectives for this research were:

- To identify areas of alignment between government policy and the seven SSBC urban standards
- To determine the degree and nature of any policy alignment with SSBC urban program
- To identify areas where the SSBC urban program could better align or where government policy could be strengthened to better align with Salmon-Safe urban standards
- To provide recommendations to both policy makers and Salmon-Safe to enhance urban standards to ensure the program can be better integrated into the region and provide safer urban development standards focused on the biological needs of salmon.

1.3 Research Scope

The research partnership between the FBC and PWRC was initiated in early 2019. The initial scope of the project was to complete a policy analysis that built upon a previous overarching analysis completed by the FBC. Past research divided municipalities in the Metro Vancouver region based on the degree of alignment with SSBC as either high, medium, or low. Similar classification was used in this study; however, the selected case studies outlined in this report were informed both by the previous FBC research and information from regional watershed management experts. Therefore, this study consisted primarily of a desktop-based policy review that was complimented by several interviews with government and relevant local experts. Analysis was completed for three local First Nations – Musqueam Nation, Squamish Nation, and the Tsleil-Waututh Nation, and acts, policies, guidebooks and best management practices (BMPs) documents from the federal government, provincial government, Metro Vancouver, and six municipalities including: City of Burnaby (CoB), City of North Vancouver (CNV), City of Surrey (CoS), City of Vancouver (CoV), Corporation of Delta (CoD), and the District of North Vancouver (DNV).

Chapter 2. Background Review of Sustainable Urban Development and Riparian Area Protection in the Lower Fraser Watershed

Rapid urbanization of the Lower Fraser Watershed has adversely impacted the natural hydrological patterns of the landscape (Déry, Hernández-Henríquez, Owens, Parkes, & Petticrew, 2012; Durance et al., 1997; Fraser Basin Council, 2009; Kristensen et al., 2013; Peterman et al., 2010; Ross et al., 2013; Stephens, Graham, & Reid, 2002; J. C. Walsh, Connors, et al., 2020). Globally, human development has been concentrated mostly in coastal area with roughly 40% of the world's population living in these regions (Barragán & de Andrés, 2015; Hodgson et al., 2020). Urban development and growth are degrading stream habitats and water quality due to increasing imperviousness of the landscape (Hatt et al., 2004; C. J. Walsh, Fletcher, & Ladson, 2005; C. J. Walsh, Roy, et al., 2005). The density of impervious surfaces in the LFW has increased to over 60% of the total land cover in many Metro Vancouver (MV) municipalities (Metro Vancouver, 2019). Studies have demonstrated the negative impacts on watershed health associated with the increase in impervious cover of 10-20%, as it can increase runoff volume by twofold (Paul & Meyer, 2001). Increasing impervious cover within watersheds is a by-product of past traditional hard "grey" infrastructure approaches to urban development (Kokkonen et al., 2018). Development of these coastal areas has not only altered the natural hydrology, but significantly depleted the abundance of biomass and viable habitat for wildlife (Bartz et al., 2015; Hodgson et al., 2020).

Urban stream syndrome, a term coined to describe watercourses negatively impacted by urbanization, is caused largely by the alterations to the natural hydrological processes in a watershed (Canessa & Parris, 2013; Ettinger et al., 2021; Meyer et al., 2005; C. J. Walsh, Roy, et al., 2005). Alteration of valuable riparian and in-stream habitat has hindered fish passage by impeding or reducing adequate flows of water (Ettinger et al., 2021). Therefore, to effectively protect salmon and their habitat, active efforts must be made to implement sustainable solutions, while preserving what wildlands remain undisturbed (Ettinger et al., 2021; Hatt et al., 2004; Kristensen et al., 2013; Ross et al., 2013; Stephens et al., 2002; J. C. Walsh, Connors, et al., 2020). Leaching of pollutants

from urban impervious surfaces has been directly linked to the increased mortality of salmon spawning and migrating through urban landscapes (Chow et al., 2019; Feist et al., 2011, 2017; McIntyre et al., 2018; Spromberg & Scholz, 2011). The loss of viable habitat compounded with degraded water quality in urbanized watersheds is threatening the long-term health of salmon populations and has already contributed to the decline in population abundance in recent decades (Kristensen et al., 2013; Malick & Cox, 2016; Ogston et al., 2015; Price, English, Rosenberger, Macduffee, & Reynolds, 2017; Ross et al., 2013; J. C. Walsh, Connors, et al., 2020).

2.1 Importance of Wild Pacific Salmon

Pacific salmon are an iconic species in the Pacific Northwest. Wild salmon hold significant cultural, spiritual, ecological, and economic importance in BC (Criddle & Shimizu, 2014; Ettinger et al., 2021; Feist et al., 2017; Gerwing & McDaniels, 2006; Healey, 2009; Hodgson et al., 2020; Ogston et al., 2015; J. C. Walsh, Connors, et al., 2020). Pacific salmon are considered by many as a keystone species in BC due to their significant impact on the structure and composition of streams, lakes, and riparian areas (Hocking & Reynolds, 2011; J. C. Walsh, Pendray, et al., 2020). Recognizing the significant role wild salmon play in terrestrial and aquatic ecosystems through their biological contributions has emphasized the need for implementation of ecosystem-based management approaches and more holistic and sustainable fisheries management (J. C. Walsh, Pendray, et al., 2020). Pacific salmon are a keystone species in BC for many reasons. First, they provide added ecological benefits to terrestrial and aquatic ecosystems that would otherwise not exist. Second, salmon are a significant part of Indigenous cultures, societies, diets, and economies. Third, wild salmon have been used as an ‘indicator’ species because they are sensitive to changes in their environment and can inform scientists of ecological concerns or the efficacy of restoration efforts.

2.1.2 Importance as a Keystone Species

The anadromous nature of salmon provides an influx of unique marine nutrients into terrestrial ecosystems, delivering nutrient subsidies and fertilization to streams and

the adjacent riparian areas (Hocking & Reynolds, 2011; J. C. Walsh, Pendray, et al., 2020). Salmon acquire over 95% of their body mass out at sea (Naiman et al., 2002; Wagner & Reynolds, 2019). In that time, salmon intake heavier forms of nitrogen, carbon, and sulfur (^{15}N, ^{13}C, ^{34}S) (Naiman et al., 2002). A large body of research has focused on the impacts wild salmon and their nutrient subsidies have on terrestrial and freshwater ecosystems after returning from the ocean. Studies have demonstrated the direct linkages between various ecosystem components and the abundance of wild salmon returning from the ocean (Helfield & Naiman, 2006; Hilderbrand et al., 1999; Larkin & Slaney, 1997; Naiman et al., 2002). Research also highlights how declining salmon populations limits the input of marine nutrients, resulting in cascading effects on other trophic levels within the ecosystem (Janetski et al., 2009). In watersheds just south of the LFW, salmon-derived nutrient input of phosphorous and nitrogen into terrestrial and freshwater ecosystems was estimated to be just 7% of its historical amount (Gresh, Lichatowich, & Schoonmaker, 2000; Naiman et al., 2002).

The significant decline of salmon-derived nutrient input has adversely impacted bear, bird, river otter, mink, insect, and riparian flora abundance and size (Gende et al., 2002; Helfield & Naiman, 2006; Hilderbrand et al., 1999; Naiman et al., 2002). Bear populations can be up to 80 times denser in coastal ecosystems with abundant salmon populations, ecosystems which also support greater herbivorous insect populations (Gende et al., 2002; Larkin & Slaney, 1997). A 2019 study demonstrated how salmon biomass has a stronger relationship with the density and diversity of birds than forest composition or watershed size within the central coast of BC (Wagner & Reynolds, 2019).

Overall, wild salmon play a keystone role in coastal ecosystems across BC. They provide a predictable annual input of nutrients which has been shown to increase primary production, support larger populations of consumers, and diversity of understory vegetation (Wagner & Reynolds, 2019). The influence and importance of salmon to coastal ecosystems in BC extends beyond just primary consumers. Salmon provide a nutrient backbone to coastal ecosystems that has been shown to even alter seed

distribution patterns across the landscape (Gende et al., 2002). The profound impact wild salmon populations have on coastal ecosystems supports the pleas from researchers that call for major adjustments to management practices that will preserve the unique and integral keystone role salmon play. In addition to providing vital nutrients for terrestrial and aquatic ecosystems, wild salmon are keystone in the diets and culture of First Nations across BC, playing an important role in Indigenous food security (Garibaldi & Turner, 2004; Nesbitt & Moore, 2016).

2.1.3 Importance for Indigenous communities

Coastal First Nations have demonstrated –and continue to in many cases– their ability to sustainably harvest resources through holistic and ecologically sound management strategies (Atlas et al., 2017; Trosper, 2002). Pre-European contact, many First Nations in BC enjoyed the bounty brought back each year in the annual salmon run that was central to their culture, society, ceremonies, survival, and economic activities (Nguyen et al., 2016). Salmon fisheries have been the backbone of Indigenous cultures, diets, and economies for millennia (Atlas et al., 2017; Haggen et al., 2004; Nguyen et al., 2016). Cumulative consumption of salmon in BC was an estimated 46-69 thousand tonnes per year before contact, supporting a population between 200-300 thousand Indigenous peoples (Haggen et al., 2004). However, with the expansion of colonial settlements and outlawing of traditional Indigenous practices for almost one hundred years, Pacific salmon populations were exposed to numerous stressors from overfishing, agriculture, forestry, mining, urban development, and now climate change (Atlas et al., 2017; Ned, Malloway, Hope, Wong, & Silver, 2018; Nguyen et al., 2016). Consumption and harvest of traditional foods for First Nations in BC has declined since the pre-contact era, having adverse effects on physical, emotional, social, and spiritual health of Indigenous peoples (Chan et al., 2011). In 2011, salmon accounted for only 5.3% of the protein consumed by Indigenous peoples living on reserve in BC (Chan et al., 2011).

Harvesting of wild salmon is a constitutionally recognized and protected Aboriginal right that ensures resources for food, social, and ceremonial purposes. Salmon

still remain an important economic resource for First Nations in BC. The annual average return from commercial, recreational, and Aboriginal fisheries is roughly $300 million (Marshall, Litke, & Fresco, 2017). The wild Pacific salmon fishery in BC –Indigenous and non-Indigenous– accounted for an averaged amount of $1,364 (USD) million in output and over 12,000 jobs from 2012 to 2015 (Gislason, Lam, Knapp, & Guettabi, 2017). In addition to the immense value they hold within coastal communities along the coast of BC, wild salmon are also considered to be a keystone, indicator and sentinel species (Criddle & Shimizu, 2014; Déry et al., 2012; Ettinger et al., 2021; Feist et al., 2017).

2.1.4 Importance as an Indicator Species

Coho salmon have been used as a sentinel species to inform researchers and resource managers on the water quality status of freshwater habitats (Ettinger et al., 2021; Feist et al., 2017; Spromberg et al., 2016). The acute lethal response or "mortality syndrome" experienced by these species is triggered by the degraded water quality, mostly due to the input of toxic runoff from urban areas or highways (Chow et al., 2019; Ettinger et al., 2021; Feist et al., 2017; Kristensen et al., 2013; McIntyre et al., 2018; Ross et al., 2013; Scholz et al., 2011; Spromberg et al., 2016; Tian et al., 2021). Previous studies have demonstrated that salmonids are in fact more vulnerable to toxic injury from contaminants including metals, pesticides, and dioxin-like compounds (Ross et al., 2013; Teather & Parrott, 2006).

Anadromous salmon are often considered to be ecologically sensitive to contaminants and fluctuations in water temperatures (Ross et al., 2013). Since 1992, there has been an estimated mortality of 15 million salmon due to high temperatures and/or high river discharges (Macdonald, Morrison, & Patterson, 2012; Ross et al., 2013). Adult Coho salmon that were exposed to untreated stormwater runoff from roads became symptomatic and died within only a few hours (Spromberg et al., 2016). Coho, and other salmon species are sensitive to changes in water quality, temperature, and habitat availability, and are therefore often used as an indicator to determine the success of

restoration projects to combat urban stream syndrome (Feist et al., 2017; Spromberg et al., 2016). In addition to hydrological and habitat restoration efforts, wild Pacific salmon have been seen as an indicator to determine the efficacy of various urban runoff pollution filtration and GI solutions, demonstrating that GI does mitigate mortality syndrome (Chow et al., 2019; Ettinger et al., 2021; Feist et al., 2017; Spromberg et al., 2016).

The importance of wild salmon populations spans along the coast in their cultural significance, ecological impacts, and economic contributions. Governments that have jurisdictional responsibility in the LFW must recognize the cumulative adverse effects urban development had and continues to have on the already declining wild salmon populations of the Fraser River and Burrard Inlet (Marshall et al., 2017). However, this has been a challenge in the past due to jurisdictional overlap and limited regulatory enforcement in the province (Conway, Khan, & Esak, 2020; C. M. Johns, 2019).

2.2 Role of Government Policy

As urban areas continue to expand and grow as projected for the Metro Vancouver region, having an appropriate and effective regulatory system in place is important for the protection of salmon (Metro Vancouver, 2011, 2018b). Within the LFW, the protection of salmon requires involvement from all levels of government. Water policy in Canada has been panned by experts as fragmented, voluntary, and inadequate (Renzetti & Dupont, 2017). Gradual withdrawal of the federal government from water policy related matters has left the provinces and territories to coordinate and manage water resources (Renzetti & Dupont, 2017). Limited national oversight has resulted in a patchwork of different water policies across the country that vary in their level of protection, conservation, and enforcement (Horbulyk, 2017; Brandes & Curran, 2017).

Indigenous peoples in Canada have had their Aboriginal rights recognized constitutionally since the early 1980s. However, the colonial governance system has often failed to consult, include, or respect Indigenous sovereignty and authority over lands and

water resources (Curran, 2019). After decades of legal court battles, social movements, and continued disempowerment, Indigenous perspectives are finally being incorporated into watershed-based models for the equal governance of water resources (Arsenault, Diver, McGregor, Witham, & Bourassa, 2018; Curran, 2019; Simms, Harris, Joe, & Bakker, 2016; Von der Porten & De Loë, 2013). Particularly in BC, the shift away from top-down control has led to the development of co-governance and co-management arrangements that facilitate equitable nation-to-nation partnerships to address water-related issues at a watershed scale (Curran, 2019; Phare, Simms, Brandes, & Miltenberger, 2017b; Von der Porten & De Loë, 2013). Crown[2] and Indigenous watershed governance approaches are often at odds with one another in BC, particularly over the commodification of water, inclusion of cumulative effects, environmental flow needs, and overall water quality and quantity (Curran, 2019). A systematic review done in 2016 found that roughly 38% of Indigenous respondents indicated that their First Nation was currently engaged in disputes over water resources and protection of fish habitat (Centre for Indigenous Environmental Resources Inc., 2016). Nevertheless, the new approach of collaborative watersheds is gaining popularity in BC as a possible means of peaceful conflict resolution and appropriate reconciliation, attempting to 'engage' rather than just 'consult' Indigenous Nations in the decision-making process (Simms et al., 2016). The success of many First Nations in BC to assert their inherent rights and title over land and water resources is essential for sustainable water resource management, and also adds an additional layer of jurisdictional complexity to watershed governance.

The Government of Canada –carried out through the Department of Fisheries and Oceans (DFO)– is responsible for the management of fisheries and therefore any and all development or activities that may impact a stream that contains fish, contained fish, or has the potential to contain fish (depending on the classification of the stream). Applications will require approval from the Minister as stated under the *Fisheries Act*.

[2] For the purposes of this analysis, "Crown" will be used as a general term referring to all colonial governments including local governments, the Provincial Government of British Columbia and the Federal Government of Canada.

The *Fisheries Act* also provides regulations for the prevention of pollution. Federal legislation applicable to water resources is limited as most authority has been downloaded to provinces under the *Canada Act* (1982). Proprietary rights granted to the provinces and territories of Canada has made any national approach or collaboration challenging due to possible infringement of provincial authority and responsibility over natural resources (Mitchell, 2017).

At the provincial level, the Government of British Columbia regulates all matters related to water resource use under the *Water Sustainability Act* (WSA) and any impacts to the environment or riparian areas under the *Environmental Management Act* (EMA) and *Riparian Areas Protection Act* (RAPA). At a regional scale, the MV regional district supplies utilities to the region and provides treatment and management of liquid waste in Greater Vancouver Sewerage and Drainage District (GVSDD). For municipal governments in the LFW, the provincial *Community Charter, Local Government Act,* and *Vancouver Charter* provide the statutory framework for duties and responsibilites. It sets out the broad powers, bylaw enforcement, land-use planning through zoning and management, and other core areas of authority for municipal governments to exercise.

The provincially legislated powers of local governments in BC does not provide a clear definition or role for managing the negative impacts of urban development on the surrounding terrestrial and aquatic environments. All levels of government play an important role as it pertains to the protection of salmon and their habitat from the adverse effects of urban development in the watershed. However, the complexity of the legislative and policy framework has resulted in patchy or limited regulatory enforcement (Conway et al., 2020; Hopkins et al., 2018; C. M. Johns, 2019).

2.3 Gaps in British Columbia's Urban Watershed Management

Jurisdictional responsibility versus authority over the protection and management of water resources in the LFW has been a major barrier to the implementation of GI and sustainable watershed management practices (C. M. Johns, 2019). British Columbia has

been reported as the least prescriptive province, and when it comes to managing watersheds, local governments have significant autonomy over the matter (Stephens & Dupont, 2010). The fragmented policy that exists nation-wide compounded with the increasing pressures from climate change, flooding, drought, and nonpoint source pollution has left water resources vulnerable to degradation from human development. Fragmented regulations and laws have been attributed to the fact that

> the laws governing freshwater management in Canada involve a complex swirl of overlapping jurisdictions, including numerous agencies and departments, and a range of actors including federal, provincial, Aboriginal, and local governments. In essence the Constitution sets out an approach of shared responsibility for water management, but does not specifically articulate overarching responsibility to any one level of government (Brandes & Curran, 2017, p. 48).

Confusion surrounding the management and protection of water resources has been the root cause to many of Canada's water-related failures. Whether it be the failure of the federal government to uphold their fiduciary duty to provide safe and clean drinking water to Indigenous communities across the country, or the significant loss of freshwater habitat in urban areas, increased clarity surrounding responsibility and authority can provide the necessary push for the different levels of government to take action. This is common barrier to effective GI implementation and sustainable urban development strategies stemming from inconsistent policies, lack of clear leadership, responsibility without authority, and limited political will or priority (Hopkins et al., 2018; C. M. Johns, 2019; Winz, Trowsdale, & Brierley, 2014). Although at a federal level, there has been funding incorporated into the national budgets to promote the use of GI, there has been little to no focus on rainwater management or the use of GI for biodiversity protection and enhancement (Conway et al., 2020). Increasing GI implementation in BC would be more easily facilitated by providing a high level policy framework and set of regulatory tools for local governments to utilize (Hansen et al., 2015; C. M. Johns, 2019).

Another challenge in developing effective government policy and regulations is determining the appropriate ecological thresholds for vulnerable species and ecosystems (Hunter, Bean, Lindenmayer, & Wilcove, 2009; Moore et al., 2018). The *Wild Salmon*

Policy created by the federal government aimed to bridge this gap by incorporating robust science-based approaches to salmon management and recovery by introducing the concept of conservation units (CUs). A recent study found that even 12 years after the release of the policy, implementation was still far from complete (Price et al., 2017). The study found that the number of salmon streams assessed was still significantly lower than it should be, the biological status of almost half of the CUs had not been determine, all of which are likely due to the *Wild Salmon Policy* not being given high priority (Price et al., 2017).

There is a direct and observable link between watershed and salmon health. However, there are multiple levels of government that regulate the individual aspects of this issue at various different scales. Local governments have the responsibility of managing their liquid waste, including rainwater, land-use planning, and approval of development permits within municipal borders. The downloading of responsibility of regulating and enforcement to the municipal level in BC runs the risk of producing a patchwork of sustainable development standards, rainwater management requirements, and riparian protection measures that will vary with local government budgets and capacity. A shift in thinking is necessary for development standards and policy in the LFW to recognize the intrinsic and valuable linkages that exist between terrestrial and aquatic ecosystems, and how prioritizing the sustainable management of hydrological and ecological function of the landscape can achieve multiple objectives simultaneously.

2.4 Sustainable Watershed Development and Green Infrastructure/Nature-based Solutions

2.4.1 A Brief History of Green Infrastructure in British Columbia: Linking hydrology, water quality, and salmon populations

Salmon became a major focus of attention in the 1990s after connections were drawn between the notable decline in salmon populations and the ongoing rapid urbanization of the LFW (Stephens & Dupont, 2010). Research during this era began to

uncover the degrading hydrological landscape caused by urban development along the coast of BC. A 'design with nature' approach –partially restoring or mimicking the natural hydrological patterns of the landscape– was catalyzed to manage the volume of untreated urban rainwater runoff contaminating watercourses and threatening sensitive ecosystems and species (Stephens & Dupont, 2010). In 2002, the *Stormwater Planning: A Guidebook for British Columbia* –herein referred to as the Guidebook– was released by a partnership under the BC Ministry of Water, Land, and Air Protection. It is an extensive document that provided an essential foundation for rainwater management planning and sustainable urban development in BC. The Guidebook outlines a set of five guiding principles for the development and implementation of integrated stormwater management:

- Agree that stormwater is a resource
- Design for the complete spectrum of rainfall events
- Act on a priority basis in at-risk drainage catchments
- Plan at four scales – regional, watershed, neighbourhood & site
- Test Solutions and reduce costs by adaptive management

(Stephens et al., 2002)

The Guidebook provided holistic rainwater management strategies and approaches that local governments could utilize to more sustainably manage the hydrology of their watershed to limit pollution, reduce water use demands, and manage flood risks (Stephens et al., 2002). The Partnership that was formed to develop and release the Guidebook then went on to create the *Water Balance Model for British Columbia* (WBM) which would help local governments incorporate rainwater management strategies into land-use planning processes (Stephens et al., 2003). The WBM was the logical link that shifted focus from managing water quality to managing the hydrology of the landscape, which would in turn manage water quality (Stephens et al., 2003). The release of the Guidebook and WBM, set the foundations for the subsequent *Beyond the Guidebook* series which released issues in 2007, 2010, 2015, and with plans for 2021 (Figure 1). In 2008, the province released the *Living Water Smart: British Columbia's Water Plan* that encouraged sustainable and holistic watershed management approaches and plans. The provincial plan stated the government's positions

were to increase awareness and education on ways to foster healthy watersheds, update water laws to include greater ecological and community based components, reduce water use and protect environmental flows, regulate groundwater, adapt to climate change, fast-track green developments in the province, and more (Province of British Columbia, 2008).

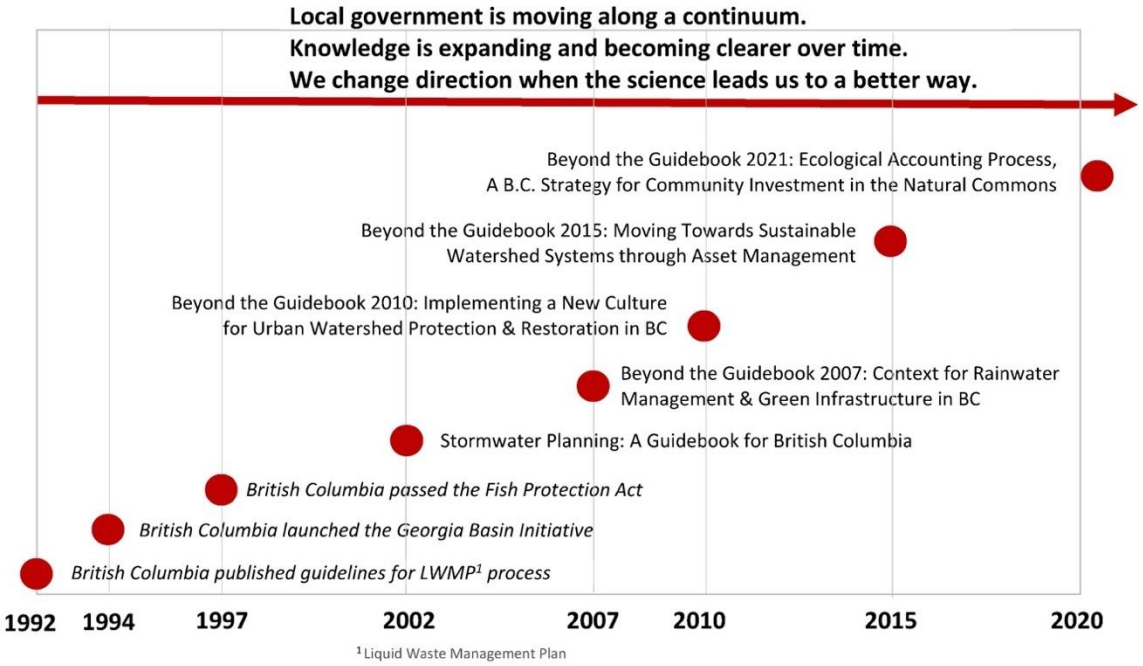

Figure 1. Evolution of the Beyond the Guidebook Series from the Water Sustainability Action Plan BC provided by Kim Stephens, 2021

The *Beyond the Guidebook* series built upon the knowledge and practices created in the 2002 Guidebook, introducing a greater focus on GI, watershed protection and restoration, natural asset management, and ecological accounting for local governments. The evolution of rainwater management in BC took a bottom-up educational approach to implementation versus the more prescriptive nature of rainwater and watershed management seen across the border in Washington state (Stephens & Dupont, 2010). Over the evolution of GI and NBS in BC, salmon have been a driving factor because of increasing threats to their habitat and overall health. Connections have been made in the understanding between hydrological restoration of a watershed and water quality enhancement initiatives, highlighting the intrinsic link between terrestrial and aquatic ecosystems. As climate change continues to threaten the LFW with wetter winters, and

drier summers, GI has become a more popular solution as local governments face massive replacement costs for aging and outdated infrastructure (Ek et al., 2018; Mirza & Ali, 2017; The Partnership for Water Sustainability in BC, 2015).

2.4.2 Nature-Based Solutions to Canada's Infrastructure Deficit

Traditionally, within the urban built environment, greener infrastructure implementation or the planning and management of greenspace has focused predominantly on aesthetic, recreational, or human-health benefits (di Marino & Lapintie, 2018; Hansen et al., 2015; Lennon, 2015). Over time, the perception, understanding, and knowledge of GI has evolved from urban forests and ecosystem services, to engineered, enhanced, and natural GI and NBS (Escobedo, Giannico, Jim, Sanesi, & Lafortezza, 2019; Mell, 2010). GI has a myriad of different definitions, all of which focus primarily on the use of quality natural or semi-natural spaces to provide valuable ecosystem services and support a healthier urban environment (Conway et al., 2020; di Marino & Lapintie, 2018; C. M. Johns, 2019). These GI solutions can range from conventional land protection where wildlands still remain or GI where the urban environment is more established; both methods can filter and slow rainwater runoff to increase water quality and decrease the runoff quantity, all while enhancing urban ecological functions (Hatt et al., 2004; McIntyre et al., 2018).

GI systems in the LFW can be categorized into three types of assets: engineered, enhanced, and natural. Engineered assets are those that fit most effectively into urban environments that have little natural spaces remaining. Engineered assets are comprised of GI solutions that have been human-made to provide similar functions and ecosystem services that natural systems provide, including: green roofs and walls, permeable pavements, and rain barrels (Brooke, O'Neil, & Cairns, 2017; Metro Vancouver, 2018a). Enhanced assets are the natural systems that still remain within the urban built environment that have been "enhanced" to restore some degree of their original capacity to provide ecosystem services, including: rain gardens, bioswales, urban green spaces, rainwater ponds, and any system that performs biomimicry (Brooke et al., 2017; Metro

Vancouver, 2018a). The last type of GI system comes in its semi- or fully original form. These natural assets are systems that exist without human intervention and provide a multitude of valuable ecosystem services, including: wetlands, soils, waterways, waterbodies, forests, and more (Brooke et al., 2017; Metro Vancouver, 2018a). GI systems that can engineer, enhance, or protect natural assets are becoming increasingly popular in BC as municipalities are faced with the ever-growing infrastructure crisis across the country.

Asset management is a practice used by local governments that focuses on long-term sustainable service delivery (Connelly, Markey, & Roseland, 2009; Machado et al., 2014; Mirza & Ali, 2017). Historically, in many municipalities there has been little-to-no focus or emphasis placed on managing natural assets (Brooke et al., 2017). Local governments traditionally prioritized the management of engineered assets throughout their jurisdiction; these assets are now reaching a critical point in their lifespan, forcing local governments to rethink their policies and strategies for the future of sustainable service delivery and asset management (Brooke et al., 2017; Connelly et al., 2009; Mirza & Ali, 2017).

The infrastructure crisis in Canada presents a unique window of opportunity for a paradigm shift that prioritizes the value of natural assets (Connelly et al., 2009). It was estimated in 2016, that the national infrastructure deficit had reached $388 billion with 30% of the assets surveyed being in fair or very poor condition (Mirza & Ali, 2017). The crisis has been forming over the past few decades due to limited quality control, funding, poor maintenance, and lack of detailed asset management strategies and plans (Mirza & Ali, 2017). Now that it is reaching a boiling point, the 2016 national budget responded to this crisis by introducing, for the first time, GI as a possible strategy to ameliorate the situation (Mirza & Ali, 2017).

Addressing this issue at all levels of government presents an opportunity to apply an iterative planning process to asset management, sustainable development and service delivery (Asset Management BC, 2019a; Connelly et al., 2009). Successful incorporation

of natural assets into local government management approaches was pioneered by the Town of Gibsons, BC (Brooke et al., 2017; Machado et al., 2014; The Partnership for Water Sustainability in BC, 2015; Town of Gibsons, 2017). The Town of Gibsons determined that replacing the ecosystem services provided by White Tower Park Pond would cost roughly $3.5 to $4 million for equivalent engineered assets (Sahl et al., 2016; Town of Gibsons, 2017). The sustainable asset management framework that was developed for BC in 2019 highlights the importance of having relevant bottom-up plans, but also how all successful local government asset management plans have the top-down policies to drive leadership and implementation (Asset Management BC, 2019a). Implementing GI systems in addition to preserving and restoring existing natural assets has become a viable solution to help address the looming infrastructure deficit many local governments face in BC due to aging infrastructure and limited funding resources. The appeal of GI solutions extends beyond the benefits of financial appreciation found in many natural assets, but the plethora of co-benefits associated with the systems.

2.4.3 Benefits of Green Infrastructure Solutions

Unlike traditional "grey" infrastructure, GI has the ability to meet multiple policy, planning, sustainability, and development objectives. Grey infrastructure systems are implemented usually for one primary purpose, like collecting stormwater or transporting liquid waste to treatment plants. Whereas GI provides a long list of benefits which are often referred to as "co-benefits", meaning these systems can be implemented for one purpose, but can provide a multitude of environmental, social, and economic services and benefits.

Environmental

Ecosystem services provided by natural systems have become an increasing area of interest for researchers and decision-makers. The Millennium Ecosystem Assessment in 2005 was one of the first large-scale assessments of the Earth's many services that directly or indirectly benefit humans (Millennium Ecosystem Assessment, 2005). The report described ecosystem services in four main categories: supporting, provisioning,

regulation, and cultural (Millennium Ecosystem Assessment, 2005). Since 2005, there has been a significant amount of research conducted on the benefits of GI (Demuzere et al., 2014; Dong et al., 2017; Elmqvist et al., 2015; Jefferson et al., 2017). These range from managing rainwater, filtering contaminants, reducing water demands, enhancing urban biodiversity, increasing pollination, sequestering carbon, and more (Demuzere et al., 2014; Parker & de Baro, 2019). The environmentally related benefits of GI systems are abundant and are further increased with the creation of GI networks that promote connectivity of greenspace and wildlife habitats throughout the urban landscape (Bartz et al., 2015; Conway et al., 2020; Ettinger et al., 2021; Feist et al., 2017). This is just a mere glimpse of the ecological potential of these systems to provide services beyond their intended purposes. Although the concept of ecosystem services has its critiques, it does have the ability to reconnect humans and the natural environment within urban spaces (Schröter et al., 2014; Staddon et al., 2018; Zhou & Rana, 2012).

Social

Urban green spaces have been essential areas for city residents to reconnect with nature. In the 2020, urban green spaces have become increasingly important as a space for people to partake in social gatherings at a safe physical distance (Ugolini et al., 2020). Green spaces, urban trees, parks, and gardens have been shown to improve mental health and well-being (Demuzere et al., 2014; Elmqvist et al., 2015; Parker & de Baro, 2019; Zhou & Rana, 2012). These spaces foster deeper connections to natural space, demonstrating one of the many additional co-benefits of GI systems. For many people, urban greenspaces provide a place for social interaction and enhances overall social cohesion, trust and well-being (Demuzere et al., 2014; Elmqvist et al., 2015; Parker & de Baro, 2019; Zhou & Rana, 2012). GI systems also provided the additional human-health related benefits of purifying air, reducing the urban heat island effect, and facilitating outdoor physical activity (Demuzere et al., 2014; Elmqvist et al., 2015; Parker & de Baro, 2019). Marginalized and underserved communities have been historically overlooked by policymakers and often do not benefit from the implementation of GI (Garcia-Cuerva, Berglund, & Rivers, 2018). However, research has been taking place to underscore the

many benefits strategic watershed scale implementation can have to provide GI and green enhancements to underserved communities (Garcia-Cuerva et al., 2018). Although not all GI systems provide each one of the listed benefits from above, the co-benefits received from just a single rain garden can reach far beyond those of a traditional sewer grate. In addition to providing these immense social benefits, GI systems have been shown to reduce overall costs incurred by local governments, and in some cases have been shown to appreciate in value over time (Mekala, Jones, & MacDonald, 2015; Parker & de Baro, 2019).

Economic

A commonly known benefit of GI systems has been the ability to save energy by improving energy efficiency inside and outside buildings (Staddon et al., 2018). However, the economic benefits are more than just energy efficiency. GI has been shown to increase property value by enhancing overall aesthetic, and is typically more cost-efficient than its grey alternatives (Elmqvist et al., 2015; Garcia-Cuerva et al., 2018; Mekala et al., 2015). Initial upfront costs of GI installation can be higher than those of traditional grey infrastructure. However, traditional systems begin to depreciate after installment, whereas with proper maintenance and care, GI systems can appreciate in value or save operators the significant cost of replacements and repair (C. Johns et al., 2018).

Overall, the benefits of GI implementation extend beyond their initial intended purpose in many cases. These systems have the potential to bring communities together, improve mental health, and reconnect people back with the natural environment. GI provides refuge for urban wildlife, food and shelter for pollinators and insects, and when appropriately linked at a watershed scale, can provide an essential network of habitat corridors for safer wildlife movement throughout the urban landscape. Implementing GI can be an expensive and unfamiliar business investment for many developers and local governments. However, research has shown the added economic values of GI by growing property value, increasing energy efficiency, and reducing the financial burden of

replacement costs associated with grey infrastructure due to shorter lifespans (Mekala et al., 2015; Parker & de Baro, 2019). GI can be resilient to climate change and enhance the overall resilience of urban environments and has therefore been deemed an effective strategy for mitigation and adaption strategies (Asset Management BC, 2019b; Demuzere et al., 2014; Dong et al., 2017; Salerno et al., 2018; Staddon et al., 2018). GI solutions provide a myriad of direct and indirect benefits to people, the local economy, climate, environment, and more. Despite these numerous co-benefits, there still exist many barriers and challenges to large-scale and rapid implementation of GI. This paper will further explore and highlight these gaps in current policies that may be causing barriers to GI implementation.

2.5 Salmon-Safe BC Urban Program Standards

2.5.1 Purpose and Objectives

After its inception in Oregon in 1996, the Salmon-Safe urban program was brought into Canada in 2011 by the Fraser Basin Council (FBC) and Pacific Salmon Foundation. In 2018, the program became fully operational under the FBC. The program spans from BC down to California certifying developments that adopt salmon-friendly development practices. This eco-certification is the only of its kind that links terrestrial land management practices with the protection of watersheds. The program has currently certified three developments in the LFW with more currently in the process of approval. SSBC focuses on development practices that will directly benefit the iconic wild Pacific salmon populations of the area. Focusing their efforts on this keystone and indicator species provides a larger umbrella of protection for the many species that rely directly or indirectly on salmon or share their habitat. As such a culturally, ecologically, and economically important species on the West Coast of Canada, salmon provide an essential link between terrestrial and aquatic ecosystem protection and restoration.

2.5.2 Development Standards and the Evaluative Framework

Similar to other eco-certifications, the SSBC Urban program focuses on five core development management categories with two context-dependent categories for developments occurring within close proximity of a watercourse or waterbody. The seven management categories host a number of specific development standards and performance requirements that are to be met for full certification (Appendix A – Evaluative Framework). The management categories are as follows:

1. Stormwater Management (U.1)
2. Water Use Management (U.2)
3. Erosion and Sediment Control (U.3)
4. Pesticide Reduction and Water Quality Protection in Landscaping (U.4)
5. Enhancement of Urban Ecological Function (U.5)
6. Instream Habitat Protection and Restoration (U.6)
7. Riparian, Wetland, and Locally Significant Vegetation Protection and Restoration (U.7)

More details on the evaluative framework specifics can be found in Appendix A – Evaluative Framework.

2.5.3 The Role of Green Infrastructure in the Salmon-Safe BC Urban Program

The SSBC urban eco-certification focuses on the direct link between terrestrial and aquatic ecosystems with a primary focus on wild Pacific salmon. For developers to obtain certification, all seven SSBC standards must be met. Developers can do this by managing rainwater onsite, reducing the use of water, controlling erosion pre-, during, and post-construction, reduce pesticide use, enhance, and restore urban habitats, and protect and restore streams, riparian, and wetland areas when applicable. GI plays an essential role in helping developers meet the SSBC urban standards. The details laid out in Appendix A – Evaluative Framework, outlines the types of GI that can be used to achieve the level of performance required for certification.

SSBC offers various types of GI systems that can be used to accomplish the required performance metrics for management of water resources onsite and encourages a 'design with nature' type approach that will restore, improve, and protect urban wildlife habitats. GI systems like rain gardens, green roofs, bioswales, and green walls can help developers meet multiple SSBC objectives. All SSBC urban standards offer nature-based solutions for developers to limit their impacts on salmon, their habitat, and the environment more broadly.

Chapter 3. Methods

Starting in February 2020, I served as a research intern with the Pacific Water Research Centre (PWRC) and the FBC partnership to explore government policy frameworks and management of local watersheds during the urban development process. My research process was broken down into eight main stages, beginning with a brief literature review, followed by the policy review of the four levels of government, an expert interview phase, and ended with a synthesis of all the findings over the course of the year (Figure 2).

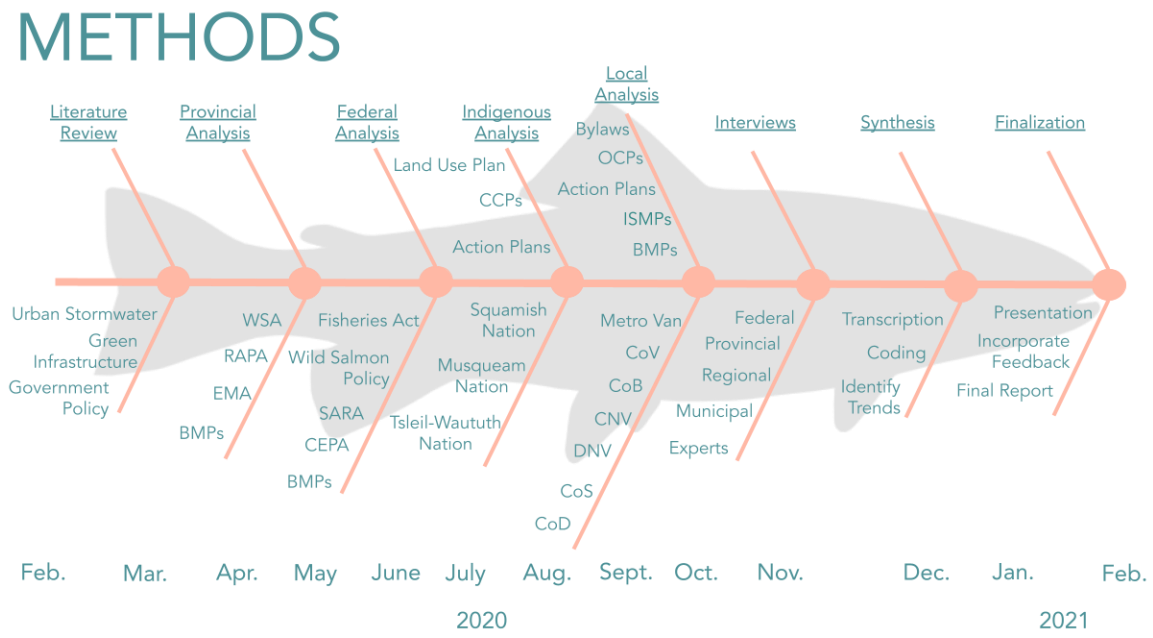

Figure 2 Overview of the methodological approach used in this policy alignment research project.

3.1 Background Review

A brief background review was completed during the first stage of this project to gather all relevant documents and academic papers related to the region and watershed protection for salmon populations. It provided a greater understanding of the challenges the study region is facing in balancing urban development and the protection of wild salmon populations and local waterways. The background review was also integral for developing the process for applying the evaluative framework and overall structure of the analysis completed.

3.2 Data Collection

This policy analysis took place in stages starting with the collection of documents from the provincial level government, followed by the federal and Indigenous governments, and ended at the local government level. I collected 265 policy documents from government websites or from communications with government staff. Using the findings of previous research conducted for the FBC by UBC students, a list of eleven municipalities were selected. Due to time constraints and expert input, those municipalities were then altered to a shorter list of six. From all levels of government, a combination of legislation, policy statements, regulations, guidelines, and strategies were collected (Table 1). All documents were downloaded into Mendeley referencing software to be annotated. The local government level review occupied the largest portion of the research timeline due to the sheer volume of community plans, guidelines, development standards, and action plans; over 400 local government documents were searched and 238 were used for further analysis.

Table 1 Types of documents collected from each level of government

Federal Governments	Indigenous Government	Provincial Government	Regional District	Municipal Government
Fisheries Act and Regulations	Strategic Plans	Water Sustainability Act and Regulations	Regional Growth Strategy	Official Community Plans
Canadian Environmental Protection Act	Comprehensive Community Plans	Riparian Areas Protection Act and Regulations	Ecological Health Framework	Local Area Plans/Neighbourhood Concept Plans
Species at Risk Act	Bylaws	Environmental Management Act	Regional Parks Management Plans	Development Permit Areas and Guidelines
Wild Salmon Policy	Land Use Plans	Stormwater Planning: A guidebook for BC	Integrated Liquid Waste and Resource Management Plan	Bylaws
Land Development Guidelines	Action Plans	Develop with Care Guidelines	Monitoring and Adaptive Management Framework for Stormwater	Biodiversity/Ecology Strategies and Action Plans
		Beyond the Guidebook	Guidebooks and Resource Guides	Integrated Stormwater Management Plans

3.3 Interviews

For the interview process, I used a semi-structured approach to conduct expert interviews with participants from the BC Ministry of the Environment and Climate Change Strategy (MOECC), the Federal Department of Fisheries and Oceans, the Water Sustainability Action Plan for BC and other watershed experts, members from Metro Vancouver, Corporation of Delta, City of North Vancouver, City of Vancouver, City of Surrey, and District of North Vancouver. The interviews took place between August and December 2020 and asked a series of 10 to 13 policy-related questions to all local government participants. Similar questions were used in the federal, expert, and provincial level interviews to identify overall trends in the region and any potential gaps in jurisdiction and policy that may have been present. The interview questions and

methodology were approved by the Office of Research Ethics at Simon Fraser University before they were conducted, and all necessary steps were taken to protect participant information and anonymity, if requested.

The interview process was an essential stage in the research process as it provided insights on the current and future policy directions as well as clarification on how the different policy documents are operationalized, individually, and collectively. All the significant policy trends recognized through the desk-top analysis were verified and discussed with experts. Interview participants played a vital role in highlighting policy gaps, policy implementation, and provided insights as to what steps are needed for the watershed to be more sustainably managed long-term. All interviews were conducted over Zoom and recorded to be transcribed and analyzed. Transcriptions of each interview were then coded using NVivo for trends in answers. A detailed list of the questions asked during the interview process can be found in Appendix B – Expert Interview Questions.

3.4 Data Analysis

The five core and two context-dependent SSBC urban standards were used as an evaluative framework to determine the degree of alignment with the selected policy documents. The SSBC standards are divided into the seven habitat-related management categories. Under each category there are detailed standards for development and specific performance requirements to satisfy each standard. For certification, all standards and their subsequent performance requirements should be met by developers. Therefore, this study used the management categories as the general objectives for policy to align with, the standards were used as indicators throughout the document, and the performance requirements provided more details to determine the degree of alignment (high, medium, or low). Building off similar concepts used by Baynham and Stevens (2014) and Berry (2016), I ranked alignment with the evaluative framework as high, medium, or low. This study was not looking at the implementation of policies, but rather focusing on the goals and objectives of the policies and the binding legal language used. I used a similar approach by noting any time there was a mention of an indicator keyword or phrases

from one of the seven standards (Baynham & Stevens, 2014; Berry, 2016). Based on the language used, I would then rank the policy or section as high, medium, or low. Keywords and phrases were derived from the performance requirements outlined in Appendix A – Evaluative Framework, for a total of 111 which can be found in Appendix C – Keywords and Phrases. If a document did not contain any of the keywords or phrases or have relevant context using the keywords and phrases, it was excluded from analysis.

Only certain policy documents were tracked at a policy or standard level to maintain a consistent analysis across jurisdictions and policy documents; the other documents were analyzed and presented as a whole. Documents were therefore divided into two categories: detailed alignment and scoping alignment (Table 2). The "detailed alignment" documents analyzed government documents and identified the number of policies that demonstrated alignment, and to what degree that alignment was per policy and "scoping alignment" documents were analyzed for the overarching objectives and goals that were shared with SSBC.

Table 2 Categories for the level of detail used for data analysis of government documents

Detailed Alignment	Scoping Alignment
Federal and Provincial Acts	Action Plans
Federal and Provincial Regulations	Strategies
Official Community Plans	Integrated Stormwater Management Plans
Design Guidelines or Criteria	Adaptation Plans
Development Permit Areas	Resource Management and Conservation Plans
Local Area Plans/Neighbourhood Concept Plans/Community Plans	
Bylaws	

Once all documents were imported into the referencing software, a set of key search terms were used to identify pertinent sections of policies in each document. Afterwards, a scan of the entire document was completed to ensure no policies were

missed in the overview. All policies that demonstrated alignment were then annotated with the specific standard and performance requirement from SSBC that shared similar objectives and/or standards. The degree to which a given policy aligned was determined based on the language used and similarity to the requirements and objectives for each of the seven SSBC urban standards (Table 3).

Table 3 Examples of policy that demonstrate the three degrees of alignment.

Degree of Alignment	Policy Example	Justification	Indicators
Low	"Promote water conservation" (City of Burnaby, 2014)	The policy or objective promotes similar concepts without any prescriptive measures.	Demonstrated similar ideas and objectives, but at a much broader scale, lacking specificity.
Medium	"Exploring opportunities to improve local ecology, such as improving stormwater management and increasing the number, size, and health of street trees" (City of Vancouver, 2018)	The policy encourages the opportunistic use of salmon-friendly development standards.	Use of language: • "May" • "Explore" • "Consider" • "Voluntary" • "Efforts should be made" • "Should" • "Encourage" without any specific actions or details
High	"Facilitate the maintenance of fish passage in all streams and restore habitat and connectivity in riparian areas of the District" (District of North Vancouver, 2018)	The policy requires or strongly encourages the use of salmon-friendly development standards, sometimes providing prescriptive methods to apply.	Demonstrated nearly the same objective and/or standard. Use of language: • "Improve" • "Shall" • "Must" • "Require" • "Facilitate" • "Calls for" • "Implement" • "Support" or "Promote" implementation of

After annotating all documents, the number of policies for each of the "detailed alignment" documents were added into an Excel spreadsheet to track overall trends in alignment. After adding up the number of policies that showed alignment at each degree (high, medium, or low), the degree of alignment category with the highest score was used as the overall alignment with a given SSBC urban standard when represented at the document level and any alignment matrix. For those documents that had a tied score between high, medium, or low alignment, the higher degree of alignment was selected.

For "scoping alignment" documents, I applied a similar approach, however, the document received a high, medium, or low for a specific standard if it had any objective, goal, action item, recommendation, or vision mentioned that demonstrated alignment. Therefore, some of the "scoping alignment" documents received a score of high alignment for a given standard even if it only had a single portion that demonstrated high alignment with that certain SSBC urban standard.

3.5 Limitations

The main limitations of this research project can be broken up into two main categories: incomplete information/government staff and the volume/type of documents.

3.5.1 Incomplete Information and Access to Government Staff

My research relied heavily on the information available for public access on government websites. All levels of government have within them multiple departments and committees that all have individual projects and/or related documents. For the federal government search, it was difficult to navigate between the different branches of government that were involved in the enforcement of different pieces of legislation or regulations. To combat this limitation, I reached out to experts from the federal government, as well as those working in partnership with the government to confirm whether or not I had collected the right documents to represent their actions. I also relied on the acts and other pieces of legislation summarized in similar academic studies,

previous REM student projects, and lower-level government policy framework explanations. I was only able to contact a member from the DFO, who did provide valuable insight, but was not able to answer some of the more general questions regarding high-level policy documents and implementation phases.

For the provincial government, I took the same approach, but was able to contact more staff from the different departments to guide me in the direction of missing information. Additionally, as it pertains to my research, provincial regulations and legislation are more applicable and relevant to urban development and protection of salmon habitat. Therefore, local government staff, which I had the most communication with, were highly familiar with applicable provincial legislation and regulations. I was only able to conduct one interview with a member from the MOECC to discuss the liquid waste management aspect of the LFW. Unfortunately, I was not able to contact anyone from the riparian areas protection division to discuss the RAPA and regulations. The provincial election that was called in the latter half of 2020 also hindered the interview process as staff are unable to speak to the public during the election period, and it remains that way until they receive their updated mandate and objectives once the elected government is established in office.

For the local governments, there were a few documents that would have been highly relevant to my research that were either "being reviewed and updated" or were unavailable on the public website. Reaching out to government staff to confirm the documents I had gathered as well as requesting any I had missed helped to ameliorate the situation. However, there were some cases where staff were unresponsive and/or sent the documents after my analysis had already been completed. None of these missing documents I received after my main analysis were highly influential documents (e.g., two ISMPs that were not yet published).

3.5.2 Volume and Type of Documents

Understanding the legal weight of various different planning and legislative documents took the insight provided by local experts, government staff, and other academic studies. What is stated on paper versus what is implemented in practice in some cases were two different actions. This is what the expert interview stage was for; to help me better understand what legal weight each document, guideline, action plan, etc. held at the government level. Additionally, understanding the stage of implementation and level of enforcement various policy documents had was a limiting factor in my research. To overcome this challenge, I divided the types of documents into two levels of analysis to avoid double counting or over-weighting certain planning documents.

Nevertheless, there still remained a challenge in appropriately representing the local level government alignment due to the varying size of municipalities included in the case studies. The City of Surrey has a total population that is roughly five times larger than the Corporation of Delta. I mitigated impacts of this limitation by representing alignment for some of the analysis in the form of a proportion of all the planning documents available for that municipality to avoid scenarios where smaller municipalities were poorly represented due to capacity and volume of relevant policy documents. In addition, the inclusion of the City of Vancouver, which was recommended by regional experts and the FBC, proved difficult as Vancouver falls under the provincial *Vancouver Charter* unlike the other case studies which the *Community Charter* applies. This only impacted the analysis because the City of Vancouver does not have an Official Community Plan (OCP) which made it challenging to have a comparable policy document. Overall, as this research was not meant to be a ranking exercise for the various case studies, I included the City of Vancouver to demonstrate a more regional analysis which can identify more general strengths and weaknesses. However, future research may consider selected case studies that could be more easily compared.

Chapter 4. Policy Analysis

The protection of fish and fish habitat, primarily salmon, is a complex jurisdictional and logistical matter in the LFW. Overlapping of jurisdictions was noted during the interview process as a common justification for either inaction or avoiding responsibility. At a superficial level, it would appear that there are numerous levels of policy and stringent regulations that would ensure the protection of salmon habitat and local waterways. However, confusion frequently exists about what role each level of the government plays in each stage of the development process. Additionally, the management of wild salmon has an added layer of complexity due to their anadromous life-history and international migration pathways. Therefore, a cohesive approach needs to be applied across the region to protect not only habitat, but the waters draining into them.

4.1 First Nations Government

The LFW has been sustainably stewarded by the First Peoples since time immemorial. For many local First Nations, water holds immense socio-cultural and spiritual value (Norman & Bakker, 2017). The sustainable co-existence the Indigenous communities in the LFW have had with aquatic resources and wild salmon populations was abruptly disrupted with the first contact of European colonizers (Rosenau & Angelo, 2007). The annual salmon harvest plays an integral role for many First Nations' cultural, spiritual, societal, and economic activities (Nguyen et al., 2016). After contact, European settlers began exploiting many of the resources throughout the LFW which has resulted in the loss of over 117 salmon-bearing streams (Durance et al., 1997). Despite being directly and negatively impacted by the loss and decline of water resources and wild salmon populations, First Nations were systematically excluded from most governance practices that impacted their lands and waters (Norman & Bakker, 2017).

However, there has been a recent resurgence of First Nations' inclusion in the decision-making process in BC (Phare, Simms, Brandes, & Miltenberger, 2017a; Simms

et al., 2016; Von der Porten & De Loë, 2013). According to colonial governance systems, First Nations hold constitutional rights which must be acknowledged and respected in any planning process involving their communities (Constitution, 1982). However, due to the complex nature of water governance in Canada and past dismissal of Aboriginal rights and title, there is still a long way to go to ensure that First Nations are effectively and appropriately incorporated into the decision-making process.

This policy analysis was purely a desk-based exercise that only reviewed policies and practices that were documented and available for public access. Therefore, it is essential to note that a large portion of knowledge and practice is kept within the community and has not been included in this work. For a more appropriate representation of Indigenous government alignment with SSBC, a dedicated and Indigenous-led research project would be required. For this study's purposes, documents that covered both reserve lands and traditional territory planning, and management were reviewed including comprehensive community plans, bylaws, and strategic action plans.

4.2 Federal Government

In the LFW, and across Canada, the Government of Canada's Department of Fisheries and Oceans oversees the conservation of fish and fish habitat which includes the prevention of pollution and proper management of fisheries. The primary federal legislations that are relevant for water management in the LFW include the *Fisheries Act*, the *Canadian Environmental Protection Act*, *Species at Risk Act*, and the *Wild Salmon Policy*. In addition, DFO released a set of guidelines titled the *Land Development Guidelines for the Protection of Aquatic Ecosystems* in 1992 and is a commonly referenced and used document in stream and riparian related development in British Columbia. Overall, the federal government provides the over-arching regulatory framework to set a precedent for provinces and local governments to meet when developing their own acts, regulations, and bylaws.

4.3 Provincial Government

At the provincial level, the Government of British Columbia regulates all surface and groundwater as well as the riparian habitat adjacent to provincial watercourses. As it relates to SSBC and water management in the LFW, the Province has enacted policy to manage surface and groundwaters as well as overall watershed management (*Water Sustainability Act*), riparian area protection and management (*Riparian Areas Protection Act*), general environmental protection regulations (*Environmental Management Act*), and standards for safe development (*BC Building Code)*. The Province also delegates authority to local governments under the *Local Government Act*, *Community Charter*, and *Vancouver Charter* which help in understanding the responsibilities local governments have in managing local waters, rainwater, and wild salmon populations. Under the *Environmental Management Act*, the province mandated the development of an Integrated Liquid Waste and Resource Management Plan (ILWRMP) which was completed by the regional district of Metro Vancouver. Local governments are to ensure that all liquid waste is properly managed – often in the form of an Integrated Stormwater Management Plan– and meets the water quality parameters outlined in the Approved and Working Water Quality Guidelines to protect people, the environment, and aquatic species. Last, the province provides considerable guidance in managing rainwater through the inter-governmental agency *the Watershed Sustainability Action Plan BC* which has helped produce the *Stormwater Planning: A Guidebook for BC* – one of the most in-depth and BC specific rainwater management guidance documents – and the *Beyond the Guidebook Series* from 2007-2020 which has produced numerous guidance documents, toolkits, and seminars for local governments to better and more sustainably manage the hydrology of their local watersheds.

4.4 Metro Vancouver

Under the *EMA* and the *Greater Vancouver Sewerage & Drainage District Act*, Metro Vancouver and the GVSDD operate and manage water resources across the region, delivering drinking water, regulating industrial discharge, collecting, and treating liquid

waste, and providing guidance for the implementation of required actions in the region. The Integrated Liquid Waste and Resource Management Plan was created by MV and approved by the Minister in 2011; it outlines the responsibilities of all member municipalities to sustainably manage, recycle, and when necessary, discharge liquid waste. Under the ILWRMP, municipalities were to create and implement an Integrated Stormwater Management Plan (ISMP). MV also provides regional direction for development in the *Metro Vancouver 2040: Shaping Our Future* which is the *Regional Growth Strategy* (RGS). The RGS is a planning document that requires all member municipalities to integrate into their OCPs and/or general planning process in the form of a regional context statement (RCS) to demonstrate how municipal actions and bylaws are aligning with the RGS.

4.5 Municipal Governments

Each municipality within MV is required to develop and implement an ISMP which will reduce non-point source and point source pollution. MV has provided municipalities with the *Monitoring and Adaptive Management Framework (MAMF)* to adhere to the provincial requirements under the *EMA*. Additionally, member municipalities are required to update local bylaws to require on-site stormwater management. Municipalities in the region also have the ability to implement rainwater management strategies and best management practices into local planning documents; this is often in the form of an OCP, a *Local Area Plan (LAP)* or *Neighbourhood Concept Plan (NCP)*, and/or design guidelines and criteria for urban development. Municipalities also have the power to protect ecosystems and direct land-use by implementing Development Permit Areas (DPAs) that can require specific development standards and practices.

Chapter 5. Results

The findings of the study are organized below based on the level of government. All findings represent the data collected from both "detailed" and "scoping" policy documents. Alignment identified with the four levels of government varied with each SSBC urban standard. An overview of the more general alignment can be seen in Figure 3, which only demonstrates alignment with Crown governments to avoid misrepresenting alignment with First Nations governments. The general trends showed that policy in the LFW had greatest focus on rainwater management (U.1), and a limited focus on water use management (U.2) and pesticide use reduction (U.4)

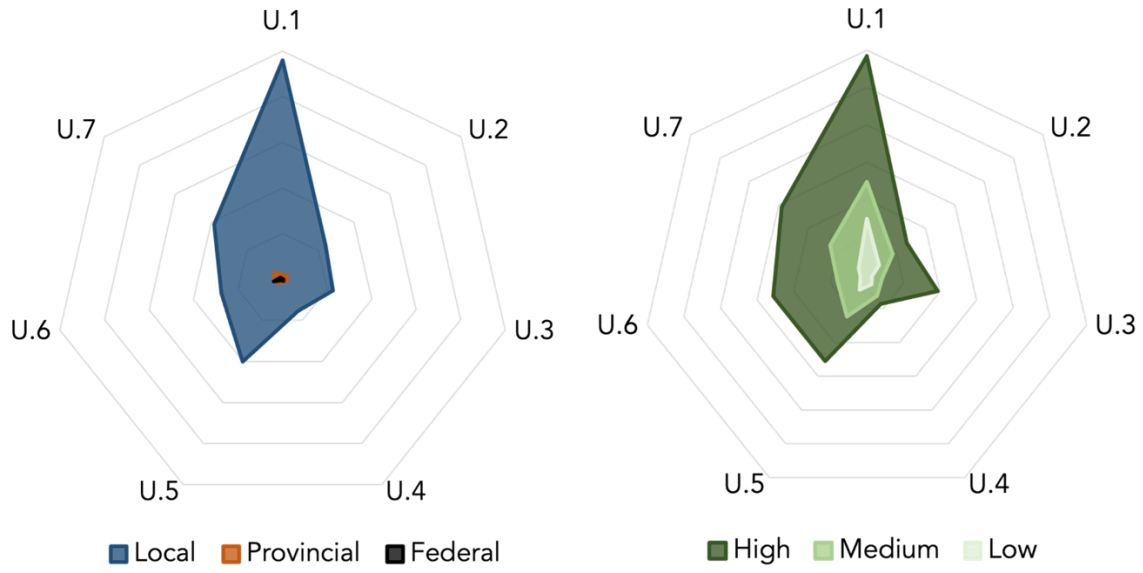

Figure 3 Radar charts showing the distribution of alignment from all Crown government analysis. The left showing alignment for each level of government. The right showing the combined total for all three levels broken down by degree of alignment identified.

5.1 First Nations Government

The LFW is home to numerous First Nations; however, for this policy analysis, only the Musqueam Nation, Squamish Nation, and Tsleil-Waututh Nation were reviewed. This review process was primarily a desk-based exercise, which has major limitations in its ability to fully understand and assess the actual practices, objectives, and principles used by the local Indigenous governments. A total of five main policy documents were

reviewed that varied both spatially and temporally in terms of their planning scales. The documents were a collection of Comprehensive Community Plans which highlight directions and policies for the community: Land-Use Plans, which focused on both on and off reserve lands planning and Strategic Plans, which provided long-term strategic direction for the community as a whole.

5.1.1 Musqueam Nation

The Musqueam Nation's Comprehensive Community Plan from 2018 had notable mention of habitat protection and restoration, with an emphasis on promoting indigenous species over invasive species. The Land-Use Plan published by the Musqueam Nation in 2014 is specifically for on-reserve lands (IR-2, IR-3, and IR-4) and demonstrated high alignment with standards U.5, U.6, and U.7, all of which promote significant riparian zone preservation and the protection of important ecological areas from development. The Land-Use Plan also demonstrated medium alignment with U.1 and discouraged the alteration of natural drainage patterns during development and landscaping. Even from this brief paper review of the Musqueam Nation's policies and practices surrounding land development, it is apparent there is high alignment with SSBC urban standards, though a more in-depth review is necessary to fully understand the alignment between SSBC and the Musqueam Nation.

5.1.2 Squamish Nation

The Squamish Nation published their Strategic Visions for 2020-2023 online. This Strategic Vision aimed to revitalize Squamish lands and waters to be healthy and prioritized the development of marine use policies and environmental management plans. Overall, there was medium alignment with standards U.5, U.6, and U.7 which aim to preserve aquatic and terrestrial ecosystems. A more in-depth review is necessary to fully understand the alignment between SSBC and the Squamish Nation.

5.1.3 Tsleil-Waututh Nation

The Tsleil-Waututh Nation have been actively pursuing the implementation of Green Infrastructure systems on reserve which is supported in their Land Use Plan and the Burrard Inlet Action Plan. The Land Use Plan (2018-2118) showed high alignment with standards U.1, U.5, U.6, and U.7 as it had the objectives to implement stormwater stewardship, increase wildlife corridors, enhance fish habitat, increase water quality and quantity, and limit development within Environmentally Sensitive Areas. The Land Use Plan provides a guide for the development and use of reserve lands for the next 100 years (Tsleil-Waututh Nation, 2018). The Burrard Inlet Action Plan (2017) is large scale action plan to restore the health of the Inlet. The Tsleil-Waututh Nation has the objectives to promote stormwater management onsite, monitor and reduce nonpoint source pollution, and increase water quality overall. The Burrard Inlet Action Plan showed high alignment with the U.1 standard which aims to mitigate impacts from stormwater runoff and nonpoint source pollution (Tsleil-Waututh Nation and Kerr Wood Leidal, 2017). Although there was high alignment with the available documents from the Tsleil-Waututh Nation, a more in-depth review is necessary to fully understand alignment with SSBC.

5.2 Federal Government

The Federal Government of Canada plays a significant role in the protection and management of fisheries across the country as carried out by the Department of Fisheries and Oceans Canada. The federal level government provides an important policy framework that outlines the actions necessary and minimum standards for the protection of fish and fish habitat. Alignment with the SSBC urban standards was found to be primarily with the overarching objectives to limit negative impacts on wildlife species, including local salmon populations (Figure 4). Alignment was identified in the *Fisheries Act* and *Regulations*, the *Wild Salmon Policy* (WSP), the *Species at Risk Act* (SARA), and the 1992 *Land and Development Guidelines for the Protection of Aquatic Habitat* provided by the DFO. The most highly aligning document was the *Land and Development Guidelines* as they provide detailed and science-based approaches for land

development that works to reduce any harmful or disruptive impacts on nearby aquatic species and their habitat.

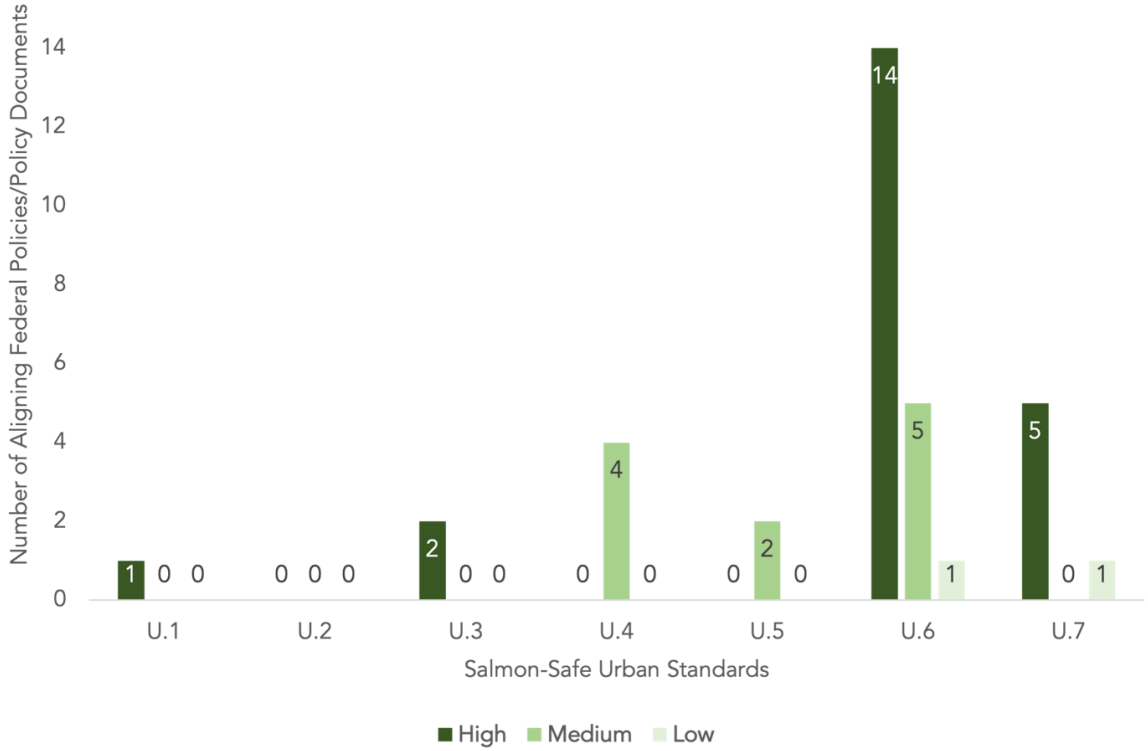

Figure 4 Total alignment between federal policies/policy documents and the Salmon-Safe Urban standards and objectives. In-stream habitat protection and restoration (U.6) was the highest aligning standard.

5.2.1 Fisheries Act

The purpose of the *Fisheries Act*, aside from providing a framework for the proper management of fisheries, is to offers ways to conserve and protect fish and fish habitat which includes the prevention of pollution. As it is related to fish, fish habitat, and threats of pollution, the SSBC urban standards provide a sustainable framework for urban development to meet objectives as set in the *Fisheries Act*.

Overall, alignment with the SSBC urban standards is seen in the preservation of fish and fish habitat by promoting sustainable development projects whereby no developer shall conduct works that will impact or harm fish or fish habitat (Fisheries Act, 1985). If impacts on fish or fish habitat are to be expected and work is still authorized, mitigation measures that must be tested and studied, and must be carried out and then

reported to the Minister. Whether impacts are from the direct impact on fish habitat by interfering with fish passage or fish streams/streambanks, or through the introduction of deleterious substances into fish waters, mitigation and/or compensation is necessary if the act is authorized to continue. In addition, there is a duty to notify an inspector, fishery officer, fishery guardian, or authority prescribed by the regulations of fish death, the harmful alteration, disruption, or destruction of fish habitat, or the introduction of deleterious substances deposited into water frequented by fish. Therefore, the alignment that was noted in the *Fisheries Act* was with the U.4, and context-dependant standard U.6.

5.2.2 Wild Salmon Policy

The *Wild Salmon Policy* (WSP) was released by the Department of Fisheries and Oceans in 2005. The WSP is intended to guide future decision making involving the conservation of wild Pacific salmon and their habitat in BC and the Yukon. Watershed-based fish sustainability planning (WFSP) was introduced as a new approach in this policy to manage fish stocks and fish habitat more sustainably in BC. WFSP included ensuring adequate food supply, migration pathways, and spawning grounds that fish rely on directly or indirectly. Overall, the policy aligns generally with the objectives of SSBC to preserve salmon and salmon habitat by mitigating the adverse impacts from urban development.

5.2.3 Canadian Environmental Protection Act

The *Canadian Environmental Protection Act* is an important Federal Act that regulates pollution from land-based sources to protect marine environments from adverse impacts. There was no direct alignment with SSBC urban program standards identified in this federal legislation. However, it was important to include as it provides regulations for land-based pollution that lower-level governments must adhere to.

5.2.4 Species at Risk Act

The *Species at Risk Act*, although not highly aligned to the SSBC urban standards, is an important Federal Act providing stringent protection measures and regulations to prevent wildlife species from becoming extinct. The Act does this by providing recovery and management plans, as well as prohibiting the harm or killing of a listed wildlife species and the damage or destruction of a listed species habitat. Fraser River sockeye experience external threats to their physical health and habitat in the form of agricultural development, forestry, industrial discharge, municipal waste discharge, and the non-point source impacts from urbanized landscapes. Those populations migrating through the mouth of the Fraser River pass through the most urbanized watershed in the Province. Overall alignment with the SARA was found to be to a medium degree with only two aligning policies. However, there could be more direct and high alignment within the specific recovery actions and plans to be carried out for listed populations within the LFW.

5.2.5 Land Development Guidelines for the Protection of Aquatic Habitat

The Land Development Guidelines for the Protection of Aquatic Habitat were released by DFO in 1992 and provide a set of detailed guidelines for safe and sustainable land development activities. The guidelines follow the principle of "no net loss of the productive capacity of fish habitat" and offers six main objectives to achieve this:

1. Provision and protection of leave strips adjacent to watercourses.
2. Control of soil erosion and sediment in runoff water.
3. Control of rates of water runoff to minimize impacts on watercourses.
4. Control of instream work, construction and diversions on watercourses.
5. Maintenance of fish passage in watercourses. for all salmonid life stages.
6. Prevention of the discharge of deleterious substances to watercourses.

(Department of Fisheries and Oceans, 1992)

These guidelines highly align with SSBC as they promote on-site rainwater control and treatment, erosion and sediment control measures, safe instream works, and

riparian area protection and restoration. The guidelines did align, but to a lesser degree, with the U.4 standard by promoting the use of on-site treatment to avoid the discharge of any deleterious substances into a watercourse. However, discharge guidelines were mainly referencing the control of rainwater runoff and sedimentation. Overall alignment with SSBC was found to be high for four out of the seven standards and further details can be found in Appendix D – Federal and Provincial Alignment Details.

5.3 Provincial Government

In Canada, the provincial governments have a long list of jurisdictional responsibilities as set out in the Constitution and other Federal legislation. For this policy analysis, it is important to outline the responsibilities of the province and how it relates to SSBC's urban objectives and standards. In the federal *Constitution Act (1867)*, provinces are granted the authority to govern property rights, municipalities, local works, and any provincial civil services (Constitution Act, 1867). In addition, under the *Constitution Act, 1982* the provinces were allocated the power of indirect taxation over provincial natural resources (Constitution Act, 1982). As it relates to the SSBC urban program, the provincial government has the overarching authority over natural resources and land use. However, the *Local Government Act*, *Community Charter*, and *Vancouver Charter* outline the downloaded responsibilities that have been taken on by local governments; most relevant is the municipal jurisdiction and authority over urban development (Local Government Act, 2015; Vancouver Charter, 1953). Although the provincial government does have policies, legislation, and standards that align with SSBC, most alignment was found at the local government level, where the regulation of development takes place.

The most highly aligned areas of provincial policy were found in the stream-related sections of the *Water Sustainability Act*, the *Riparian Areas Protection Act*, and provincial best management practices documents and guidebooks (Figure 5). Below is an outline of all the aligned policies and legislation with a short description and, where applicable, a more detailed breakdown of sections that showed alignment with each of the seven standards.

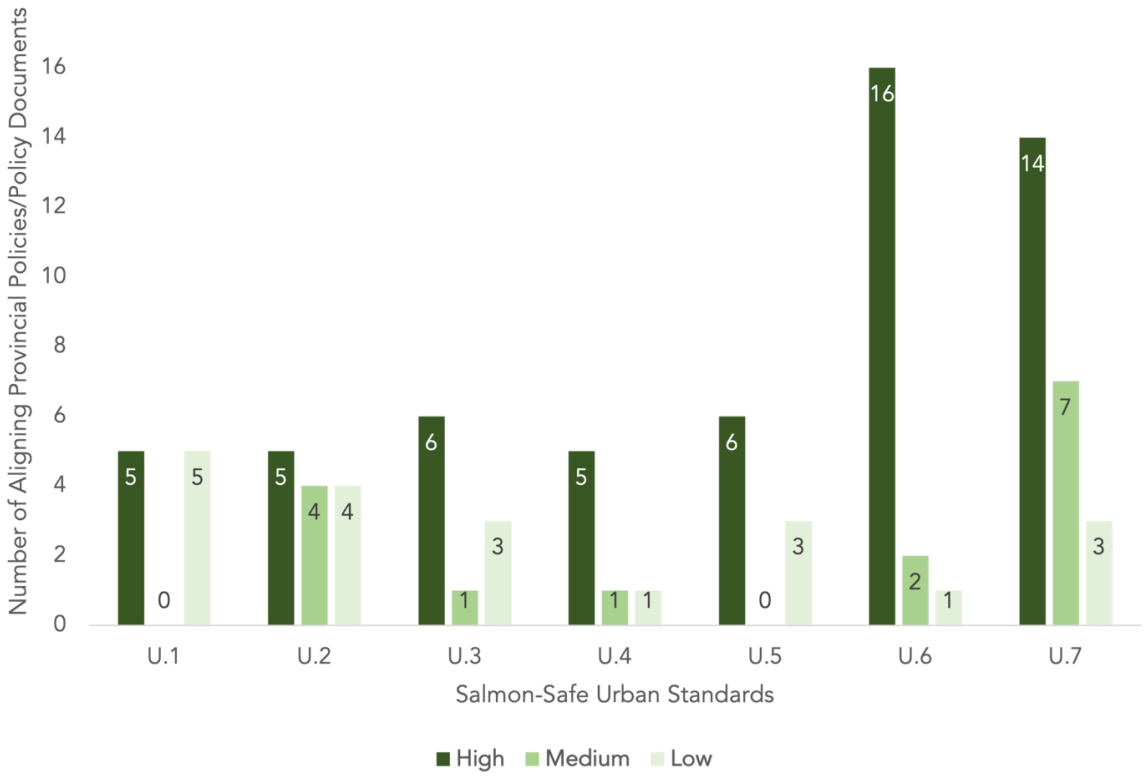

Figure 5 Total alignment between provincial policies/policy documents and the Salmon-Safe Urban standards. The highest aligning standards were related to stream and riparian protection (U.6 and U.7).

5.3.1 Water Sustainability Act

In 2016, the *Water Sustainability Act* replaced the *Water Act* of 1909 and introduced groundwater regulations, consideration of environmental flows in new water license applications, and created regulatory authority that linked land-use and watershed outcomes (Mettler, 2017). Although there were initial regulations set in place when the WSA was first called into force, there are still many areas of regulations that remain undeveloped (Mettler, 2017). The WSA was seen as a transformative act that would improve the way governments, stakeholders, and local water users would work together to govern and manage water more sustainably (Brandes & O'Riordan, 2014; Farthing-Nichol, 2019; Fraser Basin Council, 2015; Phare et al., 2017a; Simms et al., 2016). The opportunities presented in the WSA were especially transformative for collaborative governance of water in BC between Indigenous and non-Indigenous government relations in government-to-government relationships. (Fraser Basin Council, 2015; Phare et al., 2017a; Simms et al., 2016). However, any large-scale collaboration is still in its infancy

and will require the development of more detailed provincial regulations to facilitate the development of watershed objectives and water sustainability plans. Although the WSA has presented opportunities for collaboration, a report by the Centre for Indigenous Environmental Resources found that the process by which the Act was formed inadequately incorporated and engaged Indigenous Nations and failed to formally recognize Aboriginal Title and Rights established under the *Canadian Constitution* (1982) (Centre for Indigenous Environmental Resources Inc., 2016).

The SSBC urban program commonly certifies developments at a site or neighbourhood scale. The WSA takes a much larger-scale approach by providing direction for management at a watershed scale rather than site level. However, the language of the WSA offers the potential tools necessary for local governments to more effectively manage urban watersheds and increase overall watershed health (Mettler, 2017). Eleven sections within the WSA showed alignment with SSBC; these were primarily focusing on the protection of streams and fish populations, mitigation measures for potential impacts on streams, developing objectives and plans for overall watershed health, and the provisioning of water quality and quantity.

5.3.2 Water Sustainability Regulations

In 2016 when the WSA came into force, the *Water Sustainability Regulation* were released, which presented an initial set of regulations. The government plans to take a phased approach to development of regulations, outlined on by the Government of British Columbia in 2016, related to:

- Water Objectives
- Water Sustainability Plans
- Measuring and reporting
- Licence reviews
- Designated areas
- Dedicated agricultural water; and
- Alternative governance approaches.

From the regulations that are currently in effect, six were identified to have alignment with SSBC urban standards and objectives. The common areas of alignment were seen in regulations that promoted the protection of water quality and aquatic ecosystems, provided direction on required mitigation measures and/or compensatory measures when impacting sensitive streams. Overall, the greatest alignment identified from the regulations is with U.6 and U.7, the context-dependent urban certification standards, as these provincial regulations only apply to sites containing a sensitive stream(s).

5.3.3 Riparian Areas Protection Act

The *Riparian Areas Protection Act* is meant to provide legal protection for riparian areas against human developments. The RAPA is not applicable in agricultural development, where 'human disturbance' is already present in the form of a pre-existing structure, or development as defined within the regulations. The RAPA may not apply to 'Industrial Developments' where the *Water Sustainability Act* and *Fisheries Act* are applied. However, it does become relevant for any development occurring within 30 metres of a watercourse, which is defined as the riparian area. The Act provides a range of 'setbacks' –ranging from 5 m to 30 m–that any new development would need to adhere to in order to ensure limited impacts on the *Streamside Enhancement and Protection Area* (SPEA). Local governments have the ability form locally specific bylaws and zoning regulations that can *'meet or exceed'* the RAPA, in which case requirements for the RAPA may be altered. The power granted to local governments to create their own SPEA bylaws or development permit areas is common within the LFW and identified in four of the municipalities researched.

The Riparian Areas Regulation (RAR) was changed to the Riparian Areas Protection Regulation (RAPR) in November 2019. Amendments to the RAR required that local governments protect riparian areas during the development of any residential, commercial, or industrial sites by utilizing a science-based assessment approach of the

proposed activities that will be carried out by a Qualified Environmental Professional (QEP). Amendments were made to specify the training requirements and provide added rigor to the application of the regulatory standards. The RAPR aims to protect and enhance the ecological integrity of riparian areas by promoting:

- large course woody debris (CWD)
- increasing channel migration capacity
- temperature moderation by vegetative cover
- stream bank stabilization
- nutrients and organic matter to freely enter streams
- buffer riparian areas from over sedimentation and run-off pollution

5.3.4 Environmental Management Act

The *Environmental Management Act* may require the use of a waste management plan for a region. MV has created the Integrated Liquid Waste and Resource Management Plan to help municipalities adhere to the provincial requirements. There is no direct alignment with SSBC, but it is an important Act that provides the regulatory framework for liquid waste management in the region.

5.3.5 Local Government Act

Regional growth strategies are strategic plans "that directs long-term planning for regional district and municipal official community plans" (Ministry of Municipal Affairs, 2019). In accordance with section 43 of the *WSA*, water objectives can be made for a "watershed, stream, aquifer, or other specified area or environmental feature or matter in order to sustain" water quality and quantity for users and aquatic ecosystems. Water objectives and subsequent regulations made under section 43 of the *WSA* should be considered in the RGS and community plans under the *Local Government Act*. The RGS should promote "human settlement that is socially, economically, and environmentally healthy and that makes efficient use of public facilities and services, land and other resources" (Local Government Act, 2015). If a region has a RGS in place, OCPs must

include RCSs to show how community plans align with regional aspirations; in the **Error! Reference source not found.** section of this report, the OCPs are all outlined and analyzed to highlight key areas of alignment.

Overall, understanding the legislation under the *Local Government Act* and the prescribed OCPs and RGS allows for a greater understanding of SSBC alignment with municipalities and the power that local level governments have over development, rainwater management, and riparian area and stream protection.

5.3.6 Best Management Practices Guidebooks and the Water Sustainability Action Plan

The Province of British Columbia offers a set of *Best Management Practices* which can be used as a set of methods to avoid harming natural resources and, in the case of riparian areas, fish and fish habitat. Best management practices are based on science and field testing to provide reliable methods for developers to complete projects while acting "as environmental stewards" (Ministry of the Environment and Climate Change Strategy, 2020). The Province also offers a number of documents that offer guidance on instream works, riparian protection, and rainwater management during development, including:

- Stream Stewardship: A Guide for Planners and Developers (2012)
- Develop with Care (2014)
- A Guidebook for British Columbia: Stormwater Planning (2002)
- Environmental Planning and Development at the Site Level (2004)
- Standards and Best Practices for Instream Works (2004)
- Beyond the Guidebook Series (2007, 2010, 2015)

Guidance documents provided by the Province were found to have the highest level of alignment with all of the SSBC urban standards. Many of the guidebooks provided a science-based approach to holistic watershed management that echoed many of the same principles and objectives that guide SSBC urban developments. Further

details on alignment data can be found in Appendix D – Federal and Provincial Alignment Details.

5.4 Local Governments

The Local Governments stage of this policy analysis explored six municipal governments, and one regional district. Overall trends that were found across the region showed the highest degree of alignment, meaning the standards with the highest number of aligning policies/policy documents at all degrees of alignment, were linked to standards U.1, U.5, and U.7 (Figure 6). The lowest alignment, meaning the standard that had the lowest number of aligning policies/policy documents was standard U.4 (Figure 6).

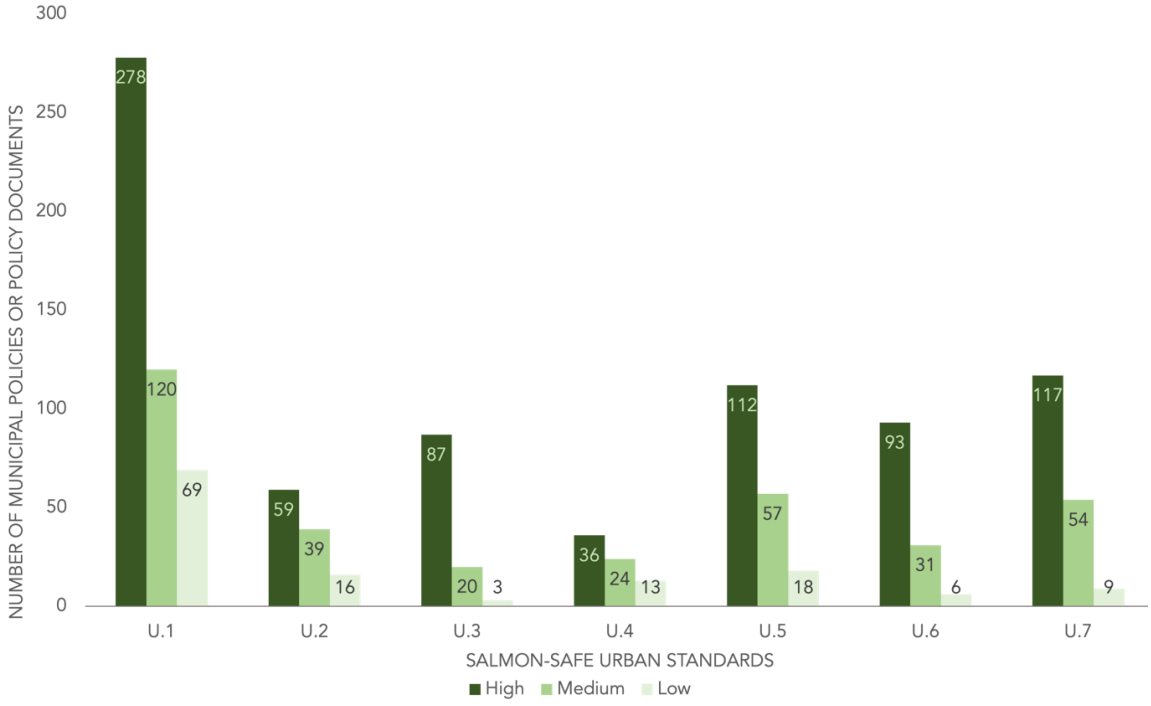

Figure 6 Total alignment between municipal policies/policy documents and the Salmon-Safe Urban standards and objectives. Standard U.1 was found to be the most highly aligning standard with over 270 highly aligning policies identified.

The most commonly identified themes identified between aligning policies and SSBC urban standards were often requirements or initiatives to implement on-site rainwater management that could serve multiple functions while enhancing the urban ecosystem function. Riparian area protection, restoration, and enhancement were all

commonly mentioned policies across all municipalities in addition to a regional emphasis on connecting greenspaces to establish habitat corridors and connectivity. Holistic rainwater management and sustainable urban development would likely implement measures similar SSBC urban standards for construction and site maintenance. However, it was found that many municipal bylaws, policies, and action plans failed to integrate all aspects of SSBC's urban program into their development requirements. Standard U.4, which promotes sustainable landscaping to mitigate negative impacts on water quality through the proper management of pesticide use and chemical application, and U.2, which promotes water use conservation on site, demonstrated the lowest alignment overall across municipalities. Although all municipalities did have mention of IPM practices and approaches, they were rarely included in development standards and requirements. Similar gaps were found with the U.2 standard, where some municipalities had dedicated water conservation strategies, but these all focused on drinking water – which in MV means all water– and indoor water use rather than outdoor usage. Watering restrictions, rainwater harvest and re-use, and the encouragement of native, drought resistant plants were the most commonly aligning policies with the U.2 standard.

The same trends can be seen more generally in the breakdown of alignment between SSBC urban standards and municipal OCPs as well as the RGS. The proportion of alignment with each of the SSBC urban standards varied across the region, but similar to the total alignment, OCPs more often aligned with standards U.1, U.5, and the context-dependent standards (Figure 7).

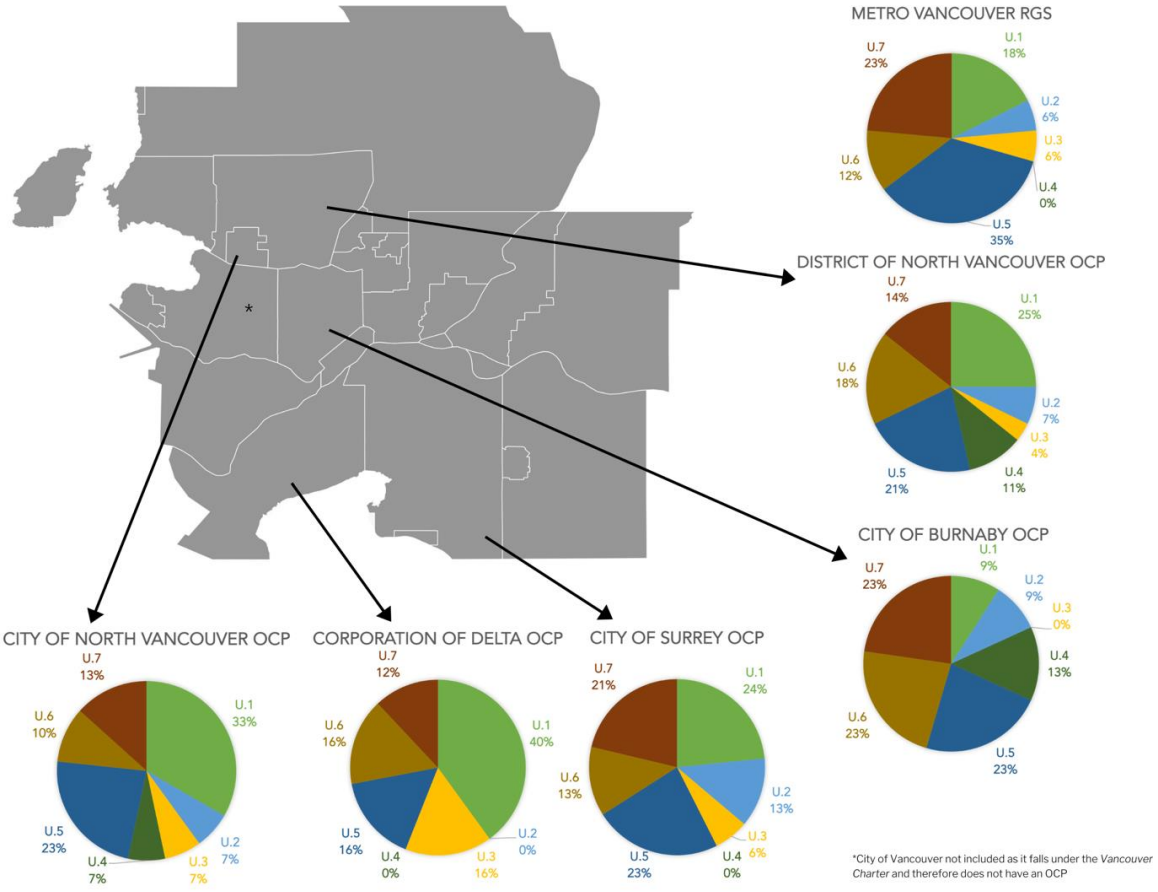

Figure 7 Map of Metro Vancouver with the proportion each Salmon-Safe urban standard was found to align with all Official Community Plans and the Regional Growth Strategy policies. City of Vancouver not included as it falls under the Vancouver Charter with no OCP.

5.4.1 Metro Vancouver

Metro Vancouver is the regional authority within the Lower Fraser Watershed and comprises a partnership between 21 Municipalities, one Electoral Area, and one Treaty First Nation. As a regional body, MV plans urban growth and expansion under the RGS to focus development in the Lower Fraser Watershed to within the Urban Containment Boundary. MV also provides affordable housing, monitors air quality, and manages the 23 regional parks, 3 park reserves, 5 greenways, one conservation reserve, and 2 conservancy areas in the region. This policy review identified numerous policies, frameworks, guidelines, and management plans published by MV that demonstrated high alignment with the objectives of SSBC, promoting the long-term health and sustainability

of both terrestrial and aquatic environments in the region. All the analyzed plans and strategies are to be complimentary to one another and should be utilized and applied by municipalities in conjunction with other regional district policy documents.

The RGS, *Metro Vancouver 2040: Shaping Our Future* was adopted by the Greater Vancouver Regional District Board in 2011, updated in 2020, and is currently under review to expand the strategy to 2050. The RGS is guided by MV's overall Sustainability Framework that has been foundational for regional planning and growth since 2002. The RGS focuses more specifically on land use policies and the provisioning of regional services including transportation, regional infrastructure, and community services (Metro Vancouver, 2011). As one of the most important planning documents in the region, the RGS demonstrated numerous points of high alignment with SSBC objectives. The RGS presents five main goals, of which Goal 3: *Protect the Environment and Respond to Climate Change Impacts* showed the greatest alignment. Goal 3 outlined 4 strategies that would achieve the overall goal with the highest aligning strategies and policies identified in strategy 3.2 *Protect and enhance natural features and their connectivity*. Alignment was noted for RGS objectives to restore, enhance, connect, and protect riparian, instream, and terrestrial habitat and implement municipal plans that incorporate ISMPs and water resource conservation strategies (Figure 8).

The most highly aligned management document created by MV was the MAMF, developed to aid member municipalities meet the requirements as mandated by the province in the *Environmental Management Act*. MV adopted the *Integrated Liquid Waste and Resource Management Plan* (ILWRMP) in 2010 and is currently in the process of providing updates to the plan. As the MAMF was only implemented in 2015, the first cycle of water quality monitoring has been or is nearing completion, as the MAMF requires that member municipalities perform water quality monitoring on a five-year cycle. Additionally, the District provides three notable and highly aligning guidance documents for municipalities, homeowners, and developers to use to better manage stormwater in order to help meet the requirements of the MAMF and ILWRMP.

MV also manages all the regional parks, and therefore has policies and guidance documents that promote habitat enhancement, restoration, and connection across the region. As MV is a utility and not a regulatory body, alignment with some of the SSBC urban standards was limited across all policy documents. Overall, MV provides regional direction for urban development and growth to mitigate impacts on sensitive ecosystems, restore degraded habitats, reduce the quantity of rainwater runoff, and improve the connectivity between greenspaces, which all share similar objectives with the SSBC urban standards.

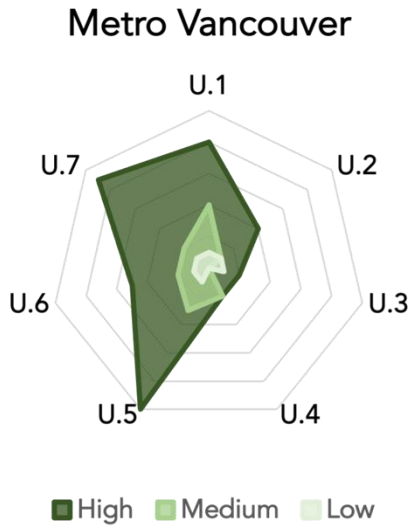

Figure 8 Radar distribution of alignment identified with Metro Vancouver's policy documents

5.4.2 City of Burnaby

The City of Burnaby is home to over 250,000 residents, situated between two of the region's largest municipalities – City of Vancouver and City of Surrey (Statistics Canada, 2017). Burnaby demonstrated alignment with SSBC at each level of interest (Appendix E – Local Government Alignment Details). Overall, the most highly aligned documents were found in the Burnaby's Integrated Stormwater Management Plans. The Still Creek ISMP, "From Pipe Dreams to Healthy Streams: A vision for the Still Creek Watershed" was the most highly aligned document from the municipality; it demonstrated policy actions, recommendations, and plans for the watershed that highly aligned with all the seven SSBC urban standards.

As part of Burnaby's municipal Zoning Bylaw, a Streamside Protection and Enhancement Area which meets the requirements of the RAPR. With efforts from the municipality to control stormwater through their Total Stormwater Management Policy, ISMPs, and design criteria, Burnaby shares many similar objectives with the first urban standard, U.1.

The Total Stormwater Management Policy was adapted from Burnaby's ISMPs to be applied on a broader citywide scale. The policy recommends stormwater BMPs or requires stormwater management up to 5-year frequency storm standard for water quality enhancement depending on the classification of the watershed being developed. The proposed BMPs were in high alignment with those recommended by SSBC. Additionally, both the Design Criteria Manual and the Town Centre Standards were in high alignment with SSBC urban standard U.1. The criteria outlined in these guidance documents requires that developers comply with all federal, provincial, and regional stormwater management requirements and that all construction in Burnaby shall utilize ESC measures to protect water quality and maintain these measures until 95% of the construction work has been completed.

In addition to all the outlined documents in, ten area plans and Simon Fraser University's OCP were analyzed for alignment. Similar to the rest of the municipality's documents, the standard with the most highly aligning policies was U.1 as there was notable focus on stormwater management at a neighbourhood or town centre scale (Figure 9). Burnaby is still lacking a holistic policy that can be used for developers to achieve a fully SSBC urban development. Based on the high alignment identified with Burnaby's various action plans and strategies, SSBC could be easily integrated into the region to help developers meet and exceed the municipal requirements. Overall, the City of Burnaby demonstrated high alignment with 64% of the 139 policies/policy documents that demonstrated alignment with SSBC urban standards ranked as high.

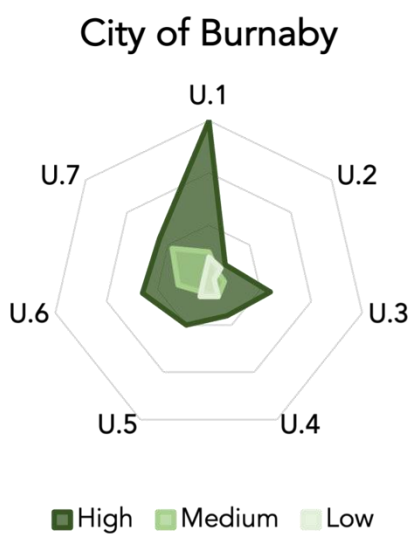

Figure 9 Radar distribution chart of alignment identified within the City of Burnaby's policy documents

5.4.3 Corporation of Delta

The Corporation of Delta is the smallest municipality (by population) analyzed for this policy review. Delta had many highly aligning policies and plans with each of the SSBC urban standards. Delta's OCP had many policies that highly aligned with the objectives of SSBC urban standards U.1, U.3, U.5, U.6, and U.7 (Figure 10). The municipal boundaries include the Pacific Coast of Canada's most significant bird habitat, found on the shores of Boundary Bay. These lands have been designated as an important bird and biodiversity area (Corporation of Delta, 2018). Delta also hosts a large portion of the Lower Mainland's agricultural lands. Balancing the use of lands for agricultural purposes, biodiversity preservation, and urban development presents a unique set of challenges for the municipality. However, the Corporation of Delta has produced numerous policies, bylaws, DPAs, ISMPs, and guidelines to work toward a sustainable balance of land-use objectives. One of the major jurisdictional challenges for Delta, as identified during interviews, was the level of the water table, and the diking system that surrounds the municipality. All matters that impact groundwater, or the dikes must be referred to and approved by the Province. Therefore, Delta is often in communication back-and-forth with the Province during the urban development process. Overall, Delta had high alignment with all of the SSBC urban standards. However, it was noted in each

of the municipal ISMPs and during interviews that Delta lacks an Erosion and Sediment Control Bylaw which can make enforcement of any standards more challenging. Although bylaws tend to be retroactive in nature, they were also noted to have a significant impact on developer behaviour in other municipalities. Overall, Delta is making notable efforts to sustainably develop municipal lands as is seen from the alignment identified in, which could allow for easy implementation of SSBC to exceed municipal requirements and guidelines for developers.

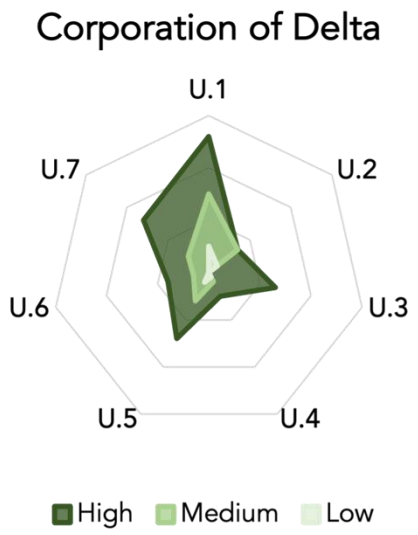

Figure 10 Radar distribution chart of alignment identified within the Corporation of Delta's policy documents

The Corporation of Delta's OCP was adopted by council in 1985 and has been periodically updated to incorporate the changing needs of the community, economy, and local environment. The OCP has six main goals: liveable, complete, green, planned, prosperous, and involved. As of 2005, roughly 46% of Delta was planned and used for agricultural purposes, with 10% allotted for single-family residential uses, and 9% industry and commercial usage. The Corporation of Delta is anticipated to grow to up to 121,000 by 2041 from the almost 111,000 current residents (Statistics Canada, 2017). With that anticipated growth, Delta has outlined a number of policies that work to preserve the natural landscape and internationally recognized wildlife habitat and refuge of the municipality. Section 10 of the OCP is where most of the alignment was identified

with SSBC, with the most common themes were promoting ‘naturescaping’ and stormwater management, habitat connectivity and preservation, stream and riparian area protection and the use of BMPs for protecting fish and aquatic life, and enhancement and restoration of wildlife habitat and riparian areas.

The OCP also has a specifically designated Streamside Protection and Enhancement Development Permit Area, which similar to the other SPEAs in the region, had high alignment with U.6 and U.7. Applications are required for any development occurring within 30 metres from the top of the bank of a watercourse. The SPEA DPA requires that all developers are to conduct a survey by a QEP to assess the current terrestrial and aquatic environmental features, fish presence, and any other stream and riparian ecosystem features. It also requires developers to plant vegetation within the setback area to ensure that fish habitat is protected, restored, and enhanced, while mitigating impacts of stormwater runoff and erosion and sedimentation. In addition, a complete erosion and sediment control plan is required for any development. The guidelines were in high alignment with the performance requirements of U.6, U.7, and in medium alignment with U.1 and U.3. Additionally, all six of Delta’s DPAs demonstrated alignment with SSBC urban standard U.1 to manage stormwater runoff onsite. In addition, Delta also uses the SPEA DPA to meet the requirements of the RAPR, but also promotes a unique policy of a required net-benefit to riparian areas, which is in high alignment with standards U.6 and U.7. For all developments, Delta has created a Green Growth Index to promote sustainable development.

Delta’s Green Growth Index is a holistic checklist for developers to use to assess the sustainability of their planned developments. The checklist has criteria for onsite stormwater management, habitat conservation, sustainable landscaping, ESC, and water conservation during construction. The checklist demonstrated high alignment with all five core SSBC urban standards. Similar to the items required in the Green Growth Index, Delta’s ISMPs promote a holistic and sustainable approach to watershed management and urban development.

Delta has four urban watersheds that each have an individual ISMP. The Boundary/Shaw Creek and Cougar Creek ISMPs were both joint ventures with the City of Surrey. All four ISMP documents provided a holistic set of recommendations to the municipality for ways to increase watershed health and overall resilience. It was recommended in all of the ISMPs for Delta to develop a unique ESC Bylaw or enforcement mechanism to reduce sedimentation and risk of erosion in local waterways. Overall, the Corporation of Delta demonstrated high alignment with the objectives and standards of SSBC with 65% of the 137 identified policies/policy documents that demonstrated some degree of alignment with the urban standards were ranked as high alignment.

5.4.4 City of North Vancouver

The City of North Vancouver (CNV) is geographically the smallest municipality analyzed in this policy review. The CNV demonstrated high alignment with SSBC urban standards in its OCP and DPAs requirements. Overall, the CNV had the greatest alignment with U.1 promoting and requiring onsite rainwater management which was represented across multiple policies and policy documents. CNV also demonstrated high alignment with standards U.3 and U.7 which was reflected in their erosion and sediment control efforts to mitigate streamside erosion and enhance protection of riparian areas (Figure 11). The CNV is currently in the process of updating the *Stream and Drainage System Protection Bylaw* to provide some improvements to the water quality criteria, predominately for development and sediment control as the bylaw is over 15 years old. In sum, the CNV demonstrated strong alignment with the SSBC urban standards.

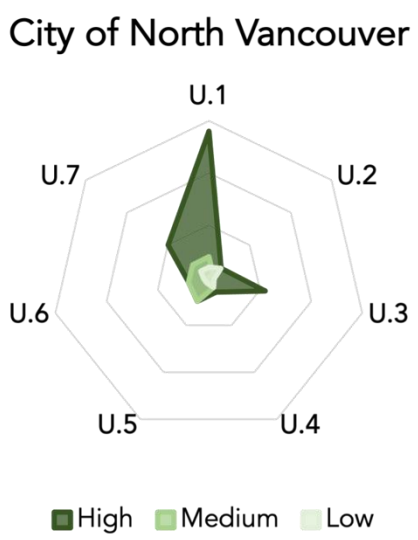

Figure 11 Radar distribution chart of alignment identified within the City of North Vancouver's policy documents

The CNV's OCP was adopted by council in 2015. The OCP uses ten guiding principles to guide the development of goals and objectives. These goals and objectives will ultimately support and implement the community vision which aims to be sustainable, diverse, vibrant, and resilient to climate change by 2031. Similar to most municipalities in the LFW, the CNV is anticipated to grow in the coming years, to 62,000 people by 2031 (City of North Vancouver, 2014). The Community Directions of the OCP are split into eight chapters that provide goals with specific objectives in order to implement the plan and achieve the overall vision for the City. Alignment with SSBC was found primarily in Chapter 4: *Natural Environment, Energy & Climate* and Chapter 8: *Municipal Services & Infrastructure*. The number of aligning objectives can be seen in Appendix E, which highlights the greatest alignment with the stormwater management standards and enhancement of ecological urban function. The themes that were most commonly identified to align throughout the document were promoting the enhancement of ecosystem health, increasing permeable green space through redevelopment, improving the quality and quantity of stormwater discharge, increasing habitat connectivity, restoring and enhancing habitat and riparian areas, and improving local water quality overall.

The City's Stream and Drainage System Protection Bylaw (2003) also promoted water quality improvement and protection by prohibiting the fouling, obstruction, or impediment of a watercourse or drainage system. The City of North Vancouver also promotes an Open Stream Policy that requires all streams to be fish-passable and open, only to be covered where crossed by highways (City of North Vancouver, 2003). Efforts to restore watershed health were also echoed throughout the City's ISMP.

The primary goal of the City of North Vancouver's ISMP is to improve the health of the watershed by identifying opportunities for effective stormwater management (City of North Vancouver, 2014). The ISMP outlines nine objectives which aim to increase base flows, fish populations, riparian areas, social connections, reconciliation, natural assets, and institutional alignment. The first three objectives showed high alignment with SSBC urban standards U.1, U.6, and U.7. The City of North Vancouver demonstrated high alignment overall, with 67% of the 96 identified aligning policies/policy documents were found to be highly aligning.

5.4.5 City of Surrey

"PlanSurrey 2013", the City of Surrey's OCP was adopted in 2013 to guide development for 30 years. The plan is guided by 9 building blocks (greener, complete, compact, connected, resilient, safer, inclusive, healthier, beautiful) with the most relevant to SSBC being a "Greener" Surrey. A "Greener" Surrey will connect natural ecosystems, riparian areas, and other natural environments, reduce urban stormwater runoff and recycle water, and develop green neighbourhoods that promote low-impact rainwater management systems that protect fish habitat. As one of the Province's fastest growing municipalities, the City of Surrey is anticipated to grow to 685,250 by 2031 and sustainable development is a primary theme communicated throughout the OCP. The greatest alignment with stormwater management, enhancement of ecological function, and riparian area protection and restoration standards (U.1, U.5, U.7) (Figure 12). The most commonly identified themes that aligned with SSBC throughout the OCP were

promoting habitat connectivity, improving local water quality, protecting and restoring riparian and wetland areas, and managing invasive species.

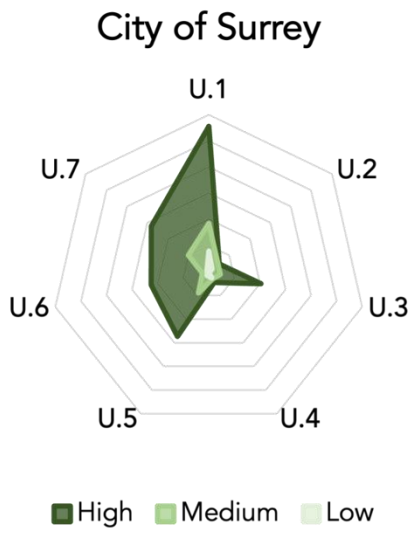

Figure 12 Radar distribution chart of alignment identified within the City of Surrey's policy documents

The City of Surrey's *Stormwater Drainage Regulations and Charges Bylaw* requires all newly created parcels to be constructed with on-site stormwater management facilities as prescribed in the applicable ISMP, or NCP. The bylaw also prohibits the fouling, obstruction, or impediment of and watercourse. Stormwater management was also a common theme throughout Surrey's 36 LAPs and NCPs that were analyzed, with over 51 highly aligning policies with standard U.1 (Appendix E – Local Government Alignment Details). Onsite stormwater management has been implemented in Surrey for decades and the City was noted by an external watershed expert to "live and breathe" stormwater management. Surrey also implemented an ESC bylaw in 2006 to manage discharge of sediment laden water into receiving water bodies. During the interview process, a Surrey staff explained that although bylaws are retroactive in nature, the implementation of the ESC bylaw did influence developer behaviour overall in the City. Surrey has also developed over twenty ISMPs for their urban watersheds. 20 ISMPs were reviewed for the City of Surrey, and all 20 showed high to medium alignment with every

SSBC urban standard, promoting holistic watershed management overall and sustainable urban development.

The Sustainable Development Checklist aims to promote sustainable land use and building design. The checklist has three main focus areas of sustainability: community well-being, respect for the natural environment, and efficient use of resources and money to operate. The checklist takes place in two distinct stages; the first stage is for Land Use Development Applications and the second stage is for Building Permit Applications. Currently, only the first stage of the checklist is available for the Land Development Application. Section 4 of the checklist *Ecology and Stewardship* demonstrated high alignment with SSBC urban standards U.1, U.3, U.5, U.6, and U.7 as it promoted the use of low impact development (LID) standards which included numerous rainwater management design considerations, erosion and sediment control measures, preservation, enhancement, or compensation for surrounding ecosystems, green infrastructure network connections, and riparian area protection and promotion of the *Biodiversity Conservation Strategy*.

Surrey's Biodiversity Conservation Strategy offers numerous recommendations at a site level for the management of aquatic and riparian habitats that demonstrated significant alignment with the context specific (U.6 and U.7) objectives and standards of SSBC (Figure 12). In addition, the strategy also offers policy recommendations to effectively implement the goals and vision of the strategy, many of which highly align with SSBC. The main themes identified in the strategy were to promote habitat connectivity and restoration, stormwater management, riparian protection and restoration, and the mitigation of light pollution.

Overall, Surrey was the highest aligning municipality with over 460 policies/policy documents showing some degree of alignment with the SSBC urban standards. As was alluded to during the interview process that took place before the Surrey analysis with a local watershed expert, Surrey has made significant efforts in rainwater management in the City, which is demonstrated by the 111 highly aligning

policies/policy documents identified with U.1 through this analysis (Figure 12). Roughly 71% of the aligning policies/policy documents identified from the City of Surrey demonstrated high alignment with SSBC urban standards.

5.4.6 City of Vancouver

The City of Vancouver is the largest municipality (by population) included in this review. Vancouver is a unique municipality as its governing powers are outlined in the *Vancouver Charter* rather than the *Community Charter* that applies to the other five municipalities. Therefore, the City of Vancouver did not have an OCP for a uniform comparison across all six municipalities. In addition, Vancouver is unique as it is one of the only municipalities to have historically buried or removed many of the natural streams in the municipality. It was noted during the interview process that this adds an extra layer of challenge to the implementation of GI in the CoV. Not having a visual reminder of the receiving water bodies in a neighbourhood was said to be a main reason people are more disconnected from that natural environment, and therefore do not see the purpose or urgency for LID approaches. A scenario analysis of Vancouver that opportunistically applied rainwater management with new developments and rezoning applications found that it would take over 200 years before the entire city would have its rainwater managed for volume and pollution (Expert Interview Participant, Personal Communications, November 6th, 2020). Currently, the City aims to manage 40% of impervious surfaces using GI by 2050.

The Rain City Strategy was adopted by Council as the City of Vancouver's integrated rainwater management plan (IRMP). This document offers a holistic approach to rainwater management, recognizing the important role each sector and the general public plays in mitigating urban runoff contamination in nearby waterbodies and watercourses. The plan is broken into eight chapters that provide an overview of the City's operations, goals, targets, and actions plans for how those targets can be achieved. Through both the interview process and comparison to other municipal ISMPs, the Rain City Strategy offers some highly ambitious goals for managing rainwater. The Streets and

Public Spaces implementation programs demonstrated the highest alignment with SSBC urban objectives, and to a degree, standards, outlining the City's plans to promote the use of Green Rainwater Infrastructure, permeable pavements, assess opportunities to increase the use of non-potable water, and adopt a more holistic sediment and erosion control program. Overall, the City of Vancouver demonstrated high alignment with SSBC urban objectives and standards across all five core urban standards but largely with U.1, U.2, and U.5 (Figure 13).

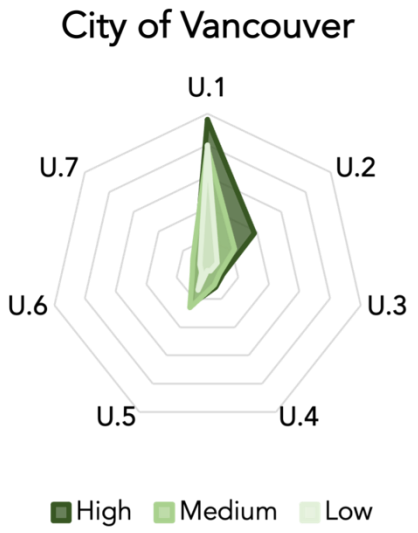

Figure 13 Radar distribution chart of alignment identified within the City of Vancouver's policy documents

At a neighbourhood scale, Vancouver has 23 area plans that showed alignment with SSBC urban objectives (Appendix E – Local Government Alignment Details). The most common area of alignment was with standard U.1 to manage rainwater, which was identified to mostly a medium degree of alignment with 37 policies (Figure 13). Overall, the City of Vancouver had a relatively even split between the percentage of policies that were high, medium, or low alignment, with 41% of the 239 policies/policy documents that demonstrated alignment being ranked as high.

5.4.7 District of North Vancouver

The District of North Vancouver is the least urbanized municipality with roughly 40% of the District being covered by impervious surfaces (Metro Vancouver, 2019). The District still has active salmon bearing streams within its municipal boarders and this is translated into their policies/policy documents overall. The District's OCP demonstrated high alignment with six of the seven SSBC urban standards. The greatest alignment between SSBC urban standards and the District was identified in U.1; 30% of all the identified policies/policy documents indicated alignment with U.1 (Figure 14). The Districts *Development and Servicing Bylaw* outlined the requirements for onsite stormwater management for new developments and redevelopments. Section 9.0 *On-Site Drainage Management and Sediment and Erosion Control* states that developers must comply with the stormwater management guidelines that are outlined in Schedule A of the Bylaw. Schedule A states that drainage management that protects or replicates the natural water balance and mimics the balance of pre-development hydrological conditions it considered to be best management practice by the District and any disruption of the natural water balance due to urban and suburban development is to be avoided. In addition, Section 9.0 also states that developers must also comply with all on-site sediment and erosion control measures. The bylaw outlines the four goals the District prescribes should be achieved with drainage design to preserve, enhance, and integrate natural capital and habitat, maintain water balance, and promote stewardship of the local environment. Environmental protection measures are also outlined in the District's *Environmental Protection and Preservation Bylaw*.

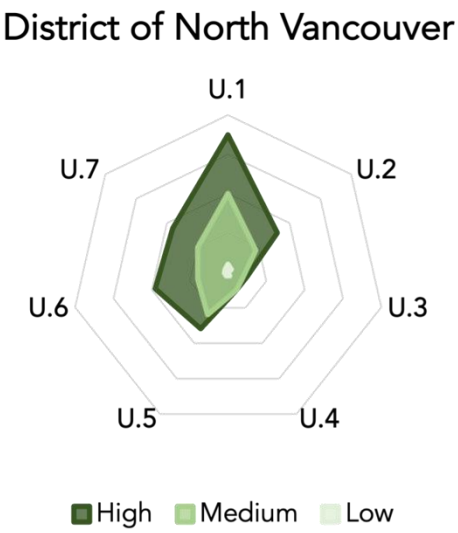

Figure 14 Radar distribution chart of alignment identified within the District of North Vancouver's policy documents

The *Environmental Protection and Preservation Bylaw* was enacted to preserve and protect the District's natural setting and ecosystems both aquatic and terrestrial. The bylaw did not contain many requirements that were in high alignment with SSBC. However, alignment within this bylaw was primarily for the preservation of aquatic ecosystems and the protection of these systems from erosion and sedimentation. The DNV's DPAs had significant alignment with the context-dependent standards U.6 and U.7 that require setbacks from sensitive ecosystems and no-net-loss of the habitat and function (Figure 14). Overall, the District demonstrated high alignment with SSBC as 60% of the 189 policies/policy documents that were identified to show alignment were ranked as high.

Chapter 6. Discussion

Within the LFW, Indigenous, federal, provincial, regional, and municipal government policy can be applied to the urban development process. The various government policies at each level, overlapping jurisdictions, and transboundary water resources have created a patchwork of urban development requirements. In many cases, this patchwork of policies and protection has left the local salmon populations and water resources vulnerable, and sometimes threatened (Hopkins et al., 2018). Findings of this research support the need for higher-level regulatory mechanisms within the LFW to increase GI implementation and compliance with any pre-existing regulations (Hansen et al., 2015; C. M. Johns, 2019). Without higher level enforcement and top-down mechanisms, BC has taken a bottom-up education based approach due to the lacking prescriptive direction from the provincial government (Stephens & Dupont, 2010). In the LFW there are an abundance of action plans and government strategies to address biodiversity loss, ecosystem protection, and rainwater management (Figure 15). However, there was found to be a limited number of enforcement mechanisms within the documents analyzed, further supporting the need for greater regulatory tools and enforcement mechanisms (Figure 15).

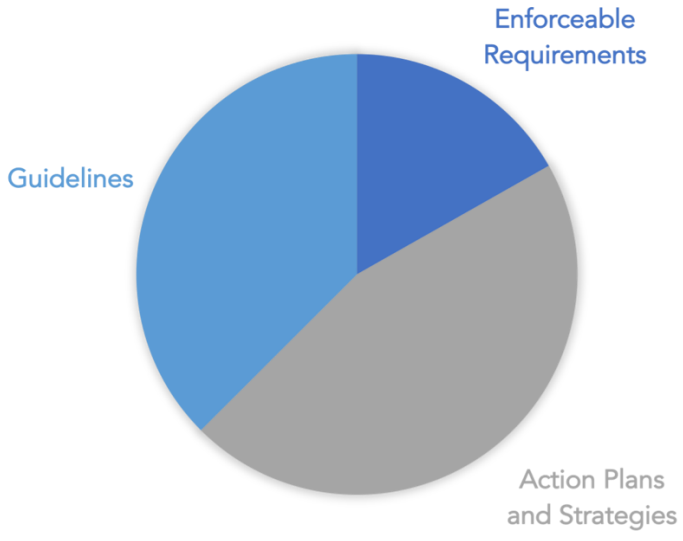

Figure 15 Proportion of the different kinds of government policy documents analyzed that demonstrated areas of alignment

Having a limited statutory and regulatory foundation for the use of GI in Canada has resulted in a slower implementation in comparison to the US (C. M. Johns, 2019). The expert interview process was integral in providing a deeper understanding of how policy implementation works at each level of government, while highlighting the challenges and gaps the participants have personally noted or experienced. Questions asked during the interview process encouraged participants to expand on the application of current policies, the underlying motivations and objectives guiding policy development and implementation, as well as verify and clarify trends that had been observed throughout this policy analysis. This section will provide a brief overview of trends and how each of the seven urban standards align across the region will identify areas of strong and weak alignment for future considerations and then highlight some of the common barriers identified during the interview process and desktop review.

6.1 Stormwater Management – U.1

Stormwater, or rainwater, has become a major contributor of non-point source (NPS) pollution in the LFW. There has been progress in addressing NPS pollution in BC since the release of *Stormwater Planning: A Guidebook for BC* in 2002. Over the past decade, there has been a change in the language used to describe stormwater management. What was previously referred to primarily as stormwater management has shifted to rainwater management. The reason for this shift in terminology stems from efforts to view rainwater as a resource and implement management solutions that extend beyond only storm events (Water Sustainability Action Plan for British Columbia, 2007). Nevertheless, local water ways are still being inundated with untreated urban rainwater runoff laced with heavy metals, pesticides, and other contaminants that are harmful and/or lethal for local salmon populations. Impervious surfaces cover a total of 20% of MV's land base and 50% of the Urban Containment Boundary (Metro Vancouver, 2019). A 2001 study of urban streams found that increasing imperviousness to 10 to 20% of a catchment can increase runoff twofold and negatively impact streams by overshooting the aquatic ecosystems threshold for degradation (Paul & Meyer, 2001).

Review of Provincial level policy found that the most highly aligning policies came in the form of guidance documents and recommended BMPs (Figure 15). With the lack of province-wide enforcement, focus on stormwater management has become the responsibility of local municipalities to implement and study on a watershed-by-watershed basis. This is demonstrated in the proportion of alignment with U.1 that was identified within local government policies and policy documents (Figure 16). Interviews with experts highlighted that there is no "silver bullet" when it comes to stormwater management; it often takes a suite of GI approaches and policy tools. This policy analysis found at a municipal level, 37% of all the identified policies/policy documents to show alignment with SSBC were in alignment with the U.1 stormwater management standard. In total, 278 municipal policies/policy documents were found to demonstrate high levels of alignment. With the implementation of the ILWRMP, it has become a main focus for member municipalities to ensure their policy frameworks respond accordingly to ensure compliance with the MAMF and overall provincial regulations. Significant efforts are also being made my local First Nations to implement stormwater BMPs to mitigate contaminated runoff and work to improve water quality overall. Although there still exist many barriers to effective implementation of stormwater management practices across the LFW, in relation to SSBC, it is the most advanced and mentioned theme.

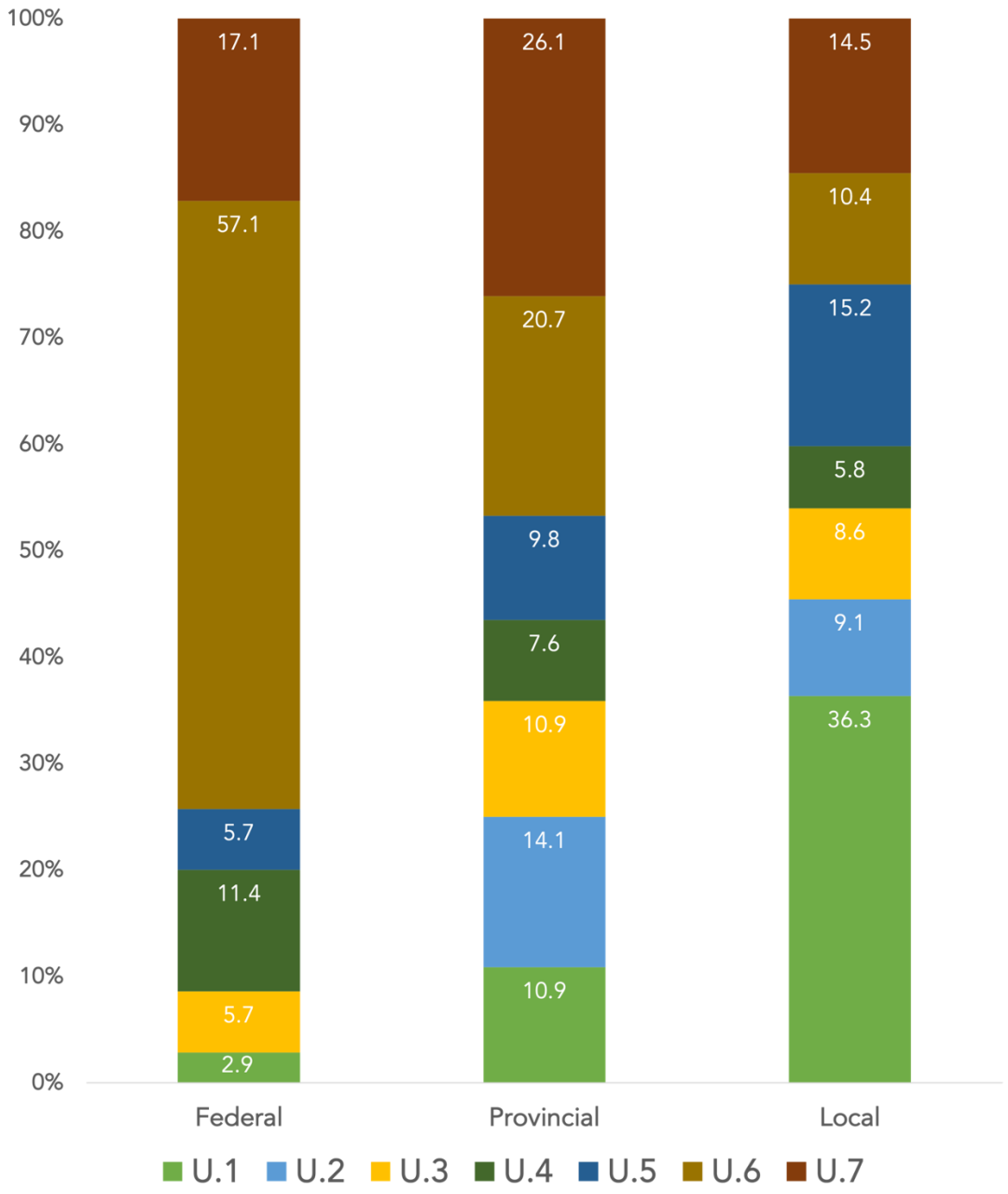

Figure 16 Proportion of all identified alignment (high, medium, and low) with each of the seven urban standards for three levels of government.

The CoS and CoV both had significant alignment with the U.1 (rainwater management) and there were two contributing factors explained during the interview process. The CoS was involved in numerous legal disputes over water use and pollution between the urban centres and the agricultural sector in the mid-1900s. Interviews with experts suggested that these cases spurred on the rainwater management action that the

CoS has prioritized ever since with the help of some long-serving and dedicated champion municipal staff (Expert Interview Participant, Personal Communications, October 9th, 2020). The CoV on the other hand has been combating the side-effects of their aging combined sewer system which has resulted in the discharging of nearly 33 billion litres of untreated wastewater and rainwater into the ocean in 2018 (City of Vancouver, 2019). The CoV has been actively working to address this issue by separating the sewer system since the 1970s and has successfully completed roughly 54% or the mainline sewer pipes (City of Vancouver, 2019). Vancouver still has a long way to go to fully address the combined sewer overflow (CSO) problem but has made it a priority in their IRMP to continue their efforts. The historical context of these two municipalities provides a better understanding of the trends in alignment identified, especially with the U.1 standard.

6.2 Water Use Management – U.2

MV is often faced with challenges of high water demand during the summer months due to naturally occurring droughts. With climate change, these water stresses are only anticipated to worsen as summers become hotter and drier. The U.2, water use management SSBC urban standard promotes sustainable and reduced use of water resources for site operations and construction. As water use and distribution is primarily a regional district authority and utility, there is limited over-arching regulation or direction provided by the Province or Federal governments.

This policy analysis found that at a municipal level, there are some efforts being made to address water use and demand during and post the urban development process. Of the 1261 identified policies demonstrating alignment with SSBC to any degree, 9% were focused primarily on water use and aligned with U.2 standards and objectives. The most common policies aligning with U.2 were those promoting the use of drought tolerant, native plants for landscaping purposes.

6.3 Erosion and Sediment Control – U.3

Similar to the first two standards, erosion and sediment control is primarily a municipal government matter. However, like U.1, the sedimentation of watercourses does concern both the Federal government to protect fish and fish habitat, and the Provincial government to reduce water contamination and protect sensitive streams and environmental flows. At a federal level, the DFO provides the *Land Development Guidelines* which outline steps that can be taken to mitigate streambank erosion and the discharge of sediment-laden waters into nearby fish bearing streams. Within the LFW, the most commonly used parameter for limiting sediment discharge is taken directly from the 1992 *Land Development Guidelines* that prescribes no more than 25mg/L TSS in the dry months and 75mg/L TSS in wet months. Additionally, the province provides direction in their many guidance documents that outline stormwater management approaches, they also outline measures for effective erosion and sediment control.

At a municipal level, three of the selected municipalities have some form of ESC bylaw. The other three municipalities either have bulletins or guidelines. Overall, 9% of the 1261 identified policies/policy documents, that demonstrate some degree of alignment with SSBC, aligned with U.3 –with 87 of the 110 policies or policy documents aligning to a high degree. However, there still lacks a regionally accepted standard for ESC which causes challenges for enforcement and confusion amongst developers moving between municipalities trying to adhere to differing regulations.

6.4 Pesticide Use Reduction and Water Quality Protection in Landscaping – U.4

The most common alignment identified with the U.4 standard and its performance requirements came in the form of Integrated Pest Management (IPM) policies and bylaws at the municipal level. At a federal level, pesticides are regulated for the protection of human health and the environment under the *Pest Control Products Act* (Health Canada, 2009). The *Pest Control Products Act* provides a science-based evaluation of acceptable pesticides to be used in Canada, while promoting sustainable pest management. The Act itself, at a federal level did not demonstrate high levels of alignment. However, it

provides the legislative framework to better understand the use of pesticides and herbicides in Canada. Additionally, the *Fisheries Act*, although not directly referencing pesticides, prohibits the discharging of any deleterious substances and provides regulations to control pollution of aquatic environments.

At the provincial level, the Government of British Columbia enacted the *Integrated Pest Management Act* in 2003 to transition from the *Pesticide Control Act*. The *IPM* Act established classes of pesticides that range from domestic and commercial use to permit-restricted and restricted pesticides. The varying classes of pesticides works to restrict or limit the use of pesticide products that have the risk of unreasonable adverse effects on human health and the environment (Integrated Pest Management Act, 2015). As seen in, most of the alignment identified with U.4 was occurring at the higher levels of government, as they provided a more province-wide control of potentially harmful and deleterious substances.

At the municipal level, four of the six municipalities had dedicated pesticide control bylaws; the other municipalities had some form of Integrated Pest Management Program or Policy. U.4 was the lowest aligning standard with only 6% of all the identified policies/policy documents, to demonstrate some degree of alignment with SSBC, aligned with U.4. The most common policies and programs were promoting IPM principles and prohibiting the use of pesticides for any cosmetic purpose.

6.5 Enhancement of Urban Ecological Function – U.5

The enhancement of urban ecological function is predominantly carried out on a site-level. Therefore, most alignment with the U.5 standard was at the municipal level. The most common policies that aligned with U.5 were found in the OCPs, the RGS, and municipal biodiversity and conservation strategies and action plans. The U.5 standard is often not a main focus within local government policies, as the benefits are often implied through stormwater management BMPs. Many municipal policies focused on restoring and enhancing habitat and greenspace connectivity/wildlife corridors. There were some

policies that promoted the enhancement of urban ecological function at a site level through plantings and habitat restoration for urban wildlife species, birds, and pollinators. Overall, 15% of the 1261 policies/policy documents, that demonstrated some degree of alignment with SSBC, aligned with U.5, with 112 of those ranking as high alignment.

The lack of alignment identified with this urban standard highlights the missed opportunity for many local governments to emphasize the linkages and co-benefits that come from implementing GI systems. Although habitat connectivity was commonly referenced in many municipal and regional biodiversity and conservation strategies, there was not a clear line drawn between the benefits of rainwater management systems from GI and biodiversity protection and enhancement of urban ecological function. Updating policy to reflect the co-benefits that GI systems provide could provide an educational tool and policy mechanism for local governments to achieve multiple objectives through the implementation of a single development standard requirement (using GI).

6.6 Instream Habitat Protection and Restoration – U.6

Instream works and protection of fish and fish habitat are often the main sources of jurisdictional confusion and overlap. Any stream that contains, has contained, has the potential to contain, or is directly influencing a stream that does contain fish requires permits and approval from the DFO. Fisheries management within the LFW is often concerning Fraser River salmon populations, which experience significant threat due to human activity. At the Federal level, the *Fisheries Act* provides the policy framework for lower-level governments to abide by when planning works in or near a stream. Additionally, the DFO provided the *Land Development Guidelines* in 1992 which provide highly detailed steps and precautions that are to be taken to ensure the safety of fish during any stages of development.

At a Provincial level, the *Water Sustainability Act* introduced the “sensitive stream” designation as an added layer of protection for vulnerable fish populations at risk. As well, the *Riparian Areas Protection Act,* although concerning the riparian area,

does demonstrate alignment with U.6. At a local government level, the most commonly aligning policies with U.6 were those promoting open streams, prohibiting the disturbance, alteration, impediment of a stream or discharge of deleterious substances into a stream. Four of the municipal governments had established *Streamside Protection and Enhancement Areas (SPEA)* which ultimately protect streams from any disturbance by establishing a 30-metre riparian buffer. Overall, 10% of the 1261 policies/policy documents, that demonstrated some degree of alignment with SSBC, aligned with standard U.6, of which, 93 were ranked as highly aligning.

There is also a notable trend between the local government policies related to standards U.6 and U.7. Municipalities that still have natural streams running throughout their jurisdiction have the policies to reflect that (DNV, CNV, CoD, CoS, and CoB). This further supports the concept which was noted during the interview process that the loss of streams in the CoV has not leant itself well to the implementation of GI. Constituents of the CoV do not have a direct visual or physical connection to the buried and diverted streams that run beneath their properties and roadways. This disconnection that exists due to the destruction of streams has only amplified the water quality issues in the area as people do not directly see the pollution, degradation, or habitat loss because it was likely done before they lived there. Lack of natural streams and creeks in the CoV was reported as a challenge to garner public support for certain protection and restoration initiatives, but also from government staff and developers that do not see the interconnectedness that exists among the landscape and how development can negatively impact even the invisible streams as they drain into the ocean.

6.7 Riparian, Wetland and Locally Significant Vegetation Protection and Restoration – U.7

Similar to the jurisdictional overlap seen in the U.6 standard for stream protection and management, riparian areas also exhibit that same inter-governmental involvement. At the Federal level, if the stream in question is a fish-bearing stream, *Fisheries Act* approval will likely be required for any development occurring within or near the

determined buffer zone. However, it is primarily the Province that provides the most regulation and legislation surrounding riparian areas. Riparian zones are highly sensitive ecosystems, prone to erosion and degradation from human activity. The *Riparian Areas Protection Act* and *Regulations* provide the minimum required measures necessary for development occurring within the *Streamside Protection and Enhancement Area*. The SPEA ranges from 10 to 30 metres depending on the class of the stream, based predominately on fish presence, to buffer human activity from the sensitive stream ecosystem.

Municipal governments do have the authority to implement their own local bylaws or DPAs to protect riparian areas as long as the regulations and implemented measures meet or exceed those of the RAPR. U.7 was tied with U.5 as the second most commonly aligning standard. 14% of the 1261 identified policies/policy documents, that demonstrated some degree of alignment with SSBC, aligned with U.7, of which 117 were ranked as highly aligning. The most common policy recommendation throughout municipal ISMPs called for widening of the riparian areas to better protect these sensitive ecosystems from development.

6.8 Gaps in Policy Facilitating Effective GI Implementation

Based on the policy analysis and expert interviews, there still exist many barriers to effective and rapid implementation of GI systems and initiatives. It was noted by one participant that similar hesitations existed during the initial stages of incorporating energy efficient standards into urban developments, as it was costly and unfamiliar to many developers. However, now energy efficiency in urban developments is common practice and much more accessible for developers than it once was. Throughout the expert interviews, it was commonly noted that rainwater management in BC is lacking province-wide enforcement mechanism, further supporting the findings of Johns (2019). Additionally, that there is often confusion about what the standards are applicable for rainwater discharge, and how to effectively meet them.

During the interview process, it was mentioned by four participants how the provincial government used to play a significant role in the management and regional discussions surrounding GI and rainwater management, but after the 2008 financial crisis, the province took a step back from the collaborating table. It was suggested that civil servants were no longer allowed to travel to meetings or attend workshops in the post-2008 economic climate. The gradual retreat of provincial involvement in rainwater and urban watershed health management left a gap where there once was central authority providing guidance and clarity regarding the expectations and consequences for non-compliance. The wavering top-down enforcement compounded with the fact that most of the development in the LFW took place before resource managers fully understood the adverse side-effects of large-scale imperviousness has resulted in a limited watershed scale implementation of sustainable development strategies within the past two decades.

Uncertainty associated with the implementation of GI systems as a solution to address degraded water quality, loss of biodiversity and salmon habitat, and many other co-benefits in-part stems from the incomplete biological response data (Ettinger et al., 2021; Jefferson et al., 2017). In an interview with local government staff, there was enthusiasm expressed for this research as it could add to the much-needed business cases to support the efficacy and importance of GI systems in the LFW. The urgency that associated with many environmental crises does not often facilitate a lengthy research and trial process for GI systems (Ettinger et al., 2021). Although the use of eco-certifications like SSBC are valuable in their contributions to bettering watershed health and salmon habitat protection, opportunistic use of GI will not address the large scale hydrological issues the LFW faces (Ettinger et al., 2021).

Regionally, GI implementation is often done opportunistically when rezoning occurs or new developments are being put in place; even then, GI or nature-based approaches have not traditionally been required, and in some cases are still not required in each municipality. Hard, grey infrastructure systems have been common practice in urban development but are now being phased out due to their short lifespans, unreliable nature, and expensive replacement fees. Work to mitigate impacts of urban development

are done opportunistically as one interview participant pointed out the use of GI and NBS are the exception rather than the rule; there is good work being done, but it is not uniformly being done.

One interview participant highlighted the varying degrees of familiarity and understanding of GI systems across the region. Some developers have been required to utilize onsite GI for stormwater management for decades, whereas in other municipalities, the knowledge base is limited, and implementation is still in its infancy. This participant also emphasized the importance of GI and rainwater management systems being integrated during the initial stages of planning. They highlighted the need for a culture shift around water management, that rainwater management must be incorporated into all stages of the process, especially the initial planning phase. The landscaping stage of the planning process is often an afterthought because it is the last step. Therefore, it must be an entire system change that can rethink how GI is integrated in the process.

Disconnect with GI application is that the landscaping of urban developments is often the last step in the development process and in some cases gets completed haphazardly or is ignored because it tends to be an afterthought. To change this situation, it can be argued that there must be an overall paradigm shift to keep urban GI at the forefront and put it higher on the priority list for new and re-developments (Burch, 2010; Hatt et al., 2004; C. M. Johns, 2019; Tayouga & Gagné, 2016; Winz et al., 2014). An expert interview participant highlighted the immense importance of designing with nature; they explained the misguided and ineffective efforts of focusing solely on pollution and water quality treatment, when understanding and developing in harmony with the natural hydrology of the watershed can address many of the common issues we see today. Moreover, there needs to be an increased emphasis on public and developer education. Educating people and developers on the underlying water quality and habitat degradation problems, the innovative and sustainable solutions to address them, and the benefits of sustainable design solutions can help with regional uptake and acceptance overall (Tayouga & Gagné, 2016). An interview participant underscored how watershed

management requires everyone to do their part. They emphasized the importance of educating current and new generations on GI to increase familiarity and comfort with the system operation and design. The participant noted current hesitations to adopt GI systems amongst developers and politicians which is limiting GI becoming more common or standard practice. Overcoming these challenges and hesitations will require a combination of top-down direction and support with bottom-up action and change.

This research project sought to identify areas of alignment between the SSBC urban program standards and objectives for sustainable development with those used by governments at all four levels in the LFW. The results are encouraging, as there already exists a high degree of synergy between the SSBC urban standards and government development requirements, standards, and objectives. However, there is a major gap in which few government policies are able to promote the principles of all five core (or including the context-dependant standards) urban standards to provide a holistic approach to urban development. This often results in a plethora of local government guidelines, provincial regulations, and municipal bylaws providing differing requirements for a sustainable development process.

Protection of salmon and their habitat from the adverse impacts of urban development is a challenging task that requires an all-of-government response. Findings from this research highlight the variable involvement and guidance provided from the higher levels of government in Canada, which is a common barrier for other local governments in North America (Hopkins et al., 2018; Shandas, Matsler, Caughman, & Harris, 2020; Tayouga & Gagné, 2016). This complex, and partially redundant, jurisdictional web of protection was noted to be the main source of confusion and frustration at a local government level; riparian areas were noted to be one of the main areas of jurisdictional overlap and uncertainty. As one expert noted, the province must provide more clarity on direct regulatory obligations which have compliance initiatives in place to enforce them. The participant highlighted the fundamental problem stems from a confusing set of regulatory obligations, the monitoring of those requirements, and what the consequences for non-compliance or non-action are for those avoiding regulations.

The province plays an essential role in providing that universal approach which could be more effective with firm and clear enforcement for municipalities to follow. Understanding the role each level of government plays is integral for effective policy implementation and sustainable resource management and as one expert stated: "Unless all the players understand their role, then you have weak links" (Expert Interview Participant, October 9th, 2020).

93% of interview participants stated that current development patterns in the LFW are unsustainable for the long-term health of the watershed. However, 100% of the participants responded that GI is one of the most effective tools for managing the negative impacts on watershed health from stormwater, and GI should therefore be used as a development standard going forward in combination with other strategies. As one expert noted:

> Water sustainability will be achieved by implementing green infrastructure policies and practices. Designing with nature is key to protecting and/or restoring hydrology by capturing rain where it falls and maintaining natural water balance pathways. When communities take action through the land development process to protect and/or restore hydrology, potential problems are eliminated at the source and water quality benefits" (Expert Interview Participant, Personal Communications, October 9th, 2020).

As there was no cohesive use of policy tools and elements across the region, some local governments have non-enforceable guidelines or limited bylaw requirements. Through the interview process it was suggested that the most effective policy tools for promoting holistic sustainable development were a mix of zoning bylaws, regulations, and top-down guidance and authority. Currently, there does not exist a dedicated body for rainwater management at the provincial level and interviews highlighted the limited capacity for enforcement of the existing top-down regulatory tools. A participant noted the challenges that exist in addressing nonpoint source pollution and how ISMPs and the AMF are the only tools currently being used in MV. Rainwater management is resource intensive, with close to 100 watersheds with ISMPs in MV, it can be challenging for enforcement and monitoring.

Even at the local government level, the interview process proved challenging as multiple departments were required to answer questions related to sustainable urban development. Of course, inter-departmental involvement in the urban development process is necessary; however, it did highlight the many moving parts within local governments that may not be in synergy with the actions and objectives of their neighbouring departments. Similar silos were identified in research by Zeemering (2016), Johns (2019), Ettinger et al., (2021), Hopkins et al., (2018). Emphasizing and prioritizing inter-departmental collaboration and communication is an essential step in ensuring sustainable watershed development.

Moreover, there still exist a multitude of gaps in current policy that limit the effective implementation of GI in the LFW. These stem from the lack of public acceptance and understanding, limited developer education and familiarity, fragmented regulatory approaches and lack of statutory foundations, siloed departmental work, and the budgetary constraints that municipal governments experience annually (Burgess, 2013; Ettinger et al., 2021; Hopkins et al., 2018; C. M. Johns, 2019; Shandas et al., 2020; Tayouga & Gagné, 2016). However, problems associated with urban runoff and habitat loss were not created overnight, it was done one problem at a time and will need to be fixed one problem at a time (Expert Interview Participant, Personal Communications, October 9th, 2020).

There exists a window of opportunity for action by all levels of government, researchers are linking the benefits of GI, habitat protection, water quality, and "people are finally connecting the dots between people, land, and salmon. We're all a part of the same ecosystem and should develop our urban areas accordingly" (Expert Interview Participant, Personal Communications, October 9th, 2020). This research is timely as it falls within the 5-year window of the *International Year of the Salmon* (IYS), an initiative which is inspiring research and facilitating dialogue and solutions to protect wild salmon. The IYS is "working to enable projects that will achieve the following outcomes that, in total, represent the conditions necessary for salmon and people to be resilient in the face of a changing climate" (International Year of the Salmon, 2018). IYS has seven

objectives which aim to increase understanding, awareness, and knowledge; encourage collaboration and data-sharing; support conservation and restoration strategies; and further efforts to help manage salmon in a changing environment (International Year of the Salmon, 2018). Finding opportunities such as the IYS can advance government efforts and initiatives that protect salmon and salmon habitat, including the use and implementation of GI solutions.

Additionally, GI and NBS have played an essential role in providing safe spaces for public to physically distance outside during the COVID-19 pandemic (Ugolini et al., 2020). The co-benefits that have been realized from existing GI across the LFW were essential during the pandemic for providing outdoor space, cleaning and filtering air, and lowering urban heat. GI also has an important role to play in post-pandemic recovery plans and the rebuilding of the BC economy (Paehlke, 2020). Researchers have been calling on governments to form 'green' recovery plans to rebuild economies in the post-pandemic environment (Helm, 2020; Paehlke, 2020; Taherzadeh, 2020). Recovering from the COVID-19 pandemic offers a turning point and unique opportunity for governments to focus on sustainable development and economic recovery plans that prioritize the environment and 'green' growth sector (Paehlke, 2020; Taherzadeh, 2020).

Not only can GI provide greater resilience to climate change, but it can also help address climate change while providing numerous co-benefits (Demuzere et al., 2014; Dong et al., 2017; Salerno et al., 2018; Staddon et al., 2018). The federal *Canadian Net-Zero Emissions Accountability Act* introduced in November 2020 highlights greater opporutnitiy for the role of GI to be realized in fighting cliamte change and meeting internationally agreed upon targets to limit warming. Moreover, as BC, Canada, and the rest of the world begin recovering from the adverse impacts of the COVID-19 pandemic, the numerous direct and indirect (co-benefits) benefits from GI can help policy-makers meet multiple objectives like increasing resiliency to climate change, providing safer urban wildlife habitat, offering more green space for physical distancing, filtering air, and providing sustainable water resources management.

Chapter 7. Conclusions and Recommendations

Urban development of the LFW has resulted in an increase impervious surfaces, loss of natural habitat, and introduction of harmful contaminants into local waterways. Green Infrastructure (GI) systems, like those promoted by SSBC, offer a proven and effective way to mitigate these unwanted impacts to better protect salmon and watershed health more generally. However, implementation of GI systems in the LFW is still in its infancy.

7.1 Conclusions

Overall, there was high alignment between government policies and the SSBC urban standards. However, the alignment was inconsistent across the different levels of government, regionally, and within the local government operations themselves. There were few enforceable policies that shared the same objectives and/or standards with all five (or seven) SSBC urban standards. Although not a direct objective of this study, the background literature review presented several barriers to GI implementation that were further supported during the expert interview process. In sum, the interview process identified seven major gaps in current policy and enforcement that created barriers to GI implementation and salmon and salmon habitat protection:

1. Limited understanding among the general public of GI systems and their many benefits. The lack of educational awareness has presented a challenge for governments to gain support from local taxpayers to explore more sustainable and holistic opportunities.
2. Lack of consolidated policy enforcement and statutory foundations to implement GI at larger scales or at a more rapid pace.
3. Disjointed policy frameworks surrounding the protection of salmon habitat and management of rainwater by local governments. Having four different levels of government operating simultaneously creates redundancy, but also confusion as to who is responsible for which part of the development process.

4. Siloed government approaches. At all levels of government (not including Indigenous), there are notable silos. Answers to interview questions required the input from multiple different government staff who, in some cases, were unaware of the objectives and/or works of neighbouring departments.
5. Limited funding and enforcement capacity at the local government level. 2016 was the first year GI initiatives were included in the federal budget in Canada. Implementation of GI has been occurring at a slow pace. This lackadaisical approach, compounded with the urgent need to upgrade infrastructure and address the national infrastructure crisis has left many local governments with significant responsibility and limited resources to address it.
6. Uncertainty associated with GI systems. In addition to raising awareness amongst the general public and providing more informative educational opportunities, the same approach needs to be applied to government staff as well. All departments need to be on the same page, sharing the same objectives when it comes to sustainable urban development. The uncertainty associated with the performance of different GI systems should not remain a barrier with the abundance of research and examples across the LFW.
7. There is a missed opportunity to highlight and achieve multiple objectives with one GI system. The co-benefits of GI are plentiful and well researched. Governments should take advantage of the many co-benefits of GI to achieve multiple government objectives rather than focusing on rainwater and biodiversity in silo.

This research provides an overview and deeper understanding of sustainable urban development objectives and standards within the LFW. Highlighting the alignment between the SSBC urban standards and government policy has exposed the areas where there is much needed improvement. Holistic policies that aim to incorporate all SSBC urban standards should be considered to ensure development practices in the LFW are

applying a precautionary approach to aid in salmon population recovery and habitat protection and restoration.

7.2 Opportunities and Recommendations

7.2.1 Salmon-Safe BC Updates and Opportunities

The SSBC urban development certification program is a highly robust and science-based approach to urban development. Through the interview process, literature review, and policy analysis a set of four general opportunities were found:

1. *Add a resiliency component to the development standards to address risks of climate change*

Climate change is anticipated to exacerbate the adverse impacts of urban development on watershed health we already see today, particularly the prospect of more extreme rainfall events and related urban flooding. Therefore, incorporating elements of resiliency and adaptive management are essential to ensure the long-term viability and performance of SSBC certified developments.

2. *Explore collaboration and engagement with the local First Nations*

The limited opportunity to identify alignment with Indigenous governments during this study highlighted the importance of finding ways to represent the intrinsic value and cultural importance Pacific Salmon have more effectively, in order to better serve their communities and protect salmon in the LFW.

3. *Require the use of educational components that engage the surrounding community to encourage stewardship, awareness, and acceptance*

Many municipalities promoted or required the use of informational signs as part of sustainable developments to engage with the public. It is equally important to also include an education component to developments that could increase public awareness and acceptance of GI systems across the urban landscape.

4. *Expanding SSBC influence to residential developments, including single-family homes and small-scale developments*

Although residential development in the form of single-family dwellings is anticipated to decrease into the future, it currently makes up roughly 29% of the region's development (Metro Vancouver, 2018b). Financial cost of certification is a major barrier for many homeowners seeking more sustainable development options. SSBC could collaborate with local governments to help inform development standards and/or provide guidance documents and educational opportunities for homeowners to create safer properties for salmon. Adequately addressing the imperviousness found within residential developments is a potential opportunity for the SSBC urban program to have a greater impact on watershed health in the MV region.

5. *Consider establishing routine updates to SSBC standards that can directly link to regional planning cycles*

As the SSBC team starts the process to revise existing Salmon-Safe standards, a regular cyclical approach should be considered. Currently, many action plans, *OCPs* and the *RGS* are updated on cycles that range roughly from 5 to 10 years. SSBC should consider linking their updating process to these existing cycles to incorporate emerging scientific findings as well as aligning with new policy formulation. This approach will better integrate the use of SSBC standards and certification in the LFW.

7.2.2 Policy Updates and Opportunities

Throughout the jurisdictional desktop review and expert interview process, a number of gaps in the current policies were found. The interview participants emphasized the barriers to broad-scale and faster implementation of GI that exist due to gaps in policy and enforcement across the LFW. This set of six recommendations can be used by policy and decision-makers to adapt their current practices and develop more robust and holistic policy:

Federal Government Recommendations

1. *Collaborate with lower-level governments to strengthen legislation and regulations to protect wild salmon more effectively from nonpoint-source pollution*

Presently, Canada does not have any nation-wide vision or legislation regulating the management of water resources. Providing stricter regulations around the discharge of deleterious substances to protect fish and fish habitat (carried out under the *Fisheries Act*) can establish a statutory framework necessary for provincial accountability and compliance.

Provincial Government Recommendations

1. *Widen riparian buffer zone requirements in the RAPA to a minimum of 30 metres, and require the restoration and enhancement of degraded streamside ecosystems*

The required riparian buffer ranges from 10 to 30 metres. Still, it was recommended in many of the municipal ISMPs that a widening of the riparian protection zone be implemented to more effectively protect the remaining sensitive ecosystems. The SSBC program requires development impacts to mitigated to the best extent operationally feasible within 60 metres (double the RAPR requirements). Additionally, similar to the requirements of SSBC, active efforts should be made to restore degraded riparian areas in order to increase water and overall habitat quality.

2. *Explore the formation of a province-wide enforcement mechanism to provide the same requirements and presence that the provincial government used to hold*

The threat of non-compliance for rainwater management is limited across the region. Enforcement is lacking and challenging due to the limited government capacity at all levels. However, it could also be an opportunity to collaborate and form a province-wide enforcement mechanism to increase compliance with set regulations specific to rainwater management and water quality protection.

Local Government Recommendations

1. *Raise awareness amongst the general public about GI and watershed health*

To increase acceptance of taxpayers and promote local stewardship, use the implementation of GI systems in the region to proactively engage with the public and create educational and recreational opportunities. Finding ways to engage constituents in the GI will safeguard sustainable development practices from the fluctuating motivations linked to short-term political cycles.

2. *Consider updates to the water ESC standards or develop region-wide agreed upon and scientifically informed erosion and sediment solutions for water quality*

Currently for some of the municipalities reviewed, the 1992 recommended standard from the DFO is still being used (i.e., 25mg/L to 75 mg/L). If a set parameter for ESC is not regionally appropriate, promote increased knowledge exchange for local governments to be able to implement more effective ESC-based solutions. As all waters eventually drain into the same body (e.g.., the Fraser river or Burrard Inlet), it is important to enforce a uniform and scientifically relevant standard for water quality.

3. *Find ways to link and recognize the benefits between rainwater management, biodiversity conservation, and human health and well-being more explicitly*

The co-benefits that exist within a single rain garden are numerous (management of water quality and quantity, wildlife habitat, pollution reduction, groundwater recharge, aesthetic values, community health and well-being, improved air quality, and reduction of the urban heat island effect). Explicitly linking the benefits of GI can ultimately work to achieve multiple government objectives with one approach. Explore ways to integrate co-benefit into the current momentum of policy changes and federal/provincial funding available for municipal asset management (including natural assets) to address the national infrastructure crisis.

4. *Promote and facilitate inter-departmental coordination and joint-government ventures*

Many local governments are working towards the same objectives overall. However, it often is requiring the expertise of multiple different internal departments. Therefore, enhancing internal and external communication, fostering municipal partnerships, and aiming for a more regional management approach can mitigate redundancy, increase efficiency, and provide more robust watershed level protection.

General Recommendations

1. *Ensure policy across the different levels of government are complimentary and not contradictory*

Every interview highlighted the contradicting policies that exist across the various levels of government. Requiring multiple permits from different departments, or conflicting standards from the DFO versus the province can lead to significant backlog and confusion in the process.

2. *Strengthen enforcement mechanisms at all levels of government to increase compliance*

Similar to the provincial recommendation, efforts need to be made by all levels of government to increase monitoring and enforcement. Bylaw officers need to understand the standards they are to enforce, as do provincial and federal officers. Increasing enforcement mechanisms across all levels of government will likely increase overall compliance.

3. *Expedite the approval of permit applications that focus directly on the use of green infrastructure and nature-based solutions*

Part of the *Living Water Smart* plan for BC emphasized the provincial government's objective to expedite permits in the approval process that promote sustainable solutions. However, based on interview responses, it seems there is a significant backlog for permits

requested by the province. Hopefully, in future, there can be increased capacity for all levels of government to expedite GI permits to encourage and incentivize their usage.

4. *Update outdated guidance documents or development and restoration standards to reflect current science and ecological understanding*

Five out of the six municipalities analyzed in this study referenced the *Land Development Guidelines for the Protection of Aquatic Habitat* for BMPs. These guidelines were published by the Habitat Division of the DFO in 1992. There has been significant development in our collective understanding of development impacts, water quality, erosion and sediment control, and more in the past 29 years. It is pertinent that developers are referencing the most up-to-date and ecologically relevant standards to help protect wild salmon.

7.3 Future Research

There are significant opportunities for future research to expand off the findings of this study. The first is a deeper analysis that provides the appropriate attention and respect to Indigenous communities and their governance systems. This is essential to gain a full understanding of the alignment with SSBC and use of sustainable development standards more broadly. Incorporating Indigenous perspectives, knowledges, and expertise into the urban development process is necessary for meaningful reconciliation in the LFW. An Indigenous-led research project can provide insight on ways and opportunities for Indigenous communities to participate in the urban development process more actively on their unceded lands. The FBC is currently collaborating and engaging with local First Nations to identify ways the SSBC urban program can better serve their communities. A research project focused primarily on this topic could aid in the FBC's efforts and appropriately represent and engage with local Indigenous governments.

Additionally, the present analysis is limited in its ability to linguistically analyze the collected documents. Future research could conduct a more thorough analysis to uncover how the different policy documents are weighted in terms of their enforcement capacity and potential. Many of the documents analyzed may have just been paying lip

service to the protection of salmon habitat or promotion of GI solutions, so further research could help to distinguish the role these policies actually play in the LFW (Hansen et al., 2015). This area of research would require the support and involvement of all levels of government and a more dedicated component of communication to understand current and future policies.

Future researchers should take advantage of the current momentum that exists in the GI field of study. The IYS provides a unique opportunity for researchers to address some of the elements this research was unable to address, questions at various geographic scales including: What are the policies and practices being used in other watersheds across the province or nation-wide? Are there international examples of holistic policies and development standards that incorporate multiple ecosystem elements?

Researchers should also direct efforts towards better understanding the role developers play in protecting salmon and salmon habitat. The FBC could expand this study to explore the alignment between developer objectives and the SSBC urban program; this could also identify potential barriers and possible solutions to address them. Finally, public perception and understanding of the water quality issue and loss of salmon habitat plays an essential role in policy development and implementation of solutions. Research that can work to uncover the values held by public within the LFW could help all levels of government create solutions that can appropriately respond and educate.

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Appendix A – Evaluative Framework

Table A.1 Evaluative Framework (Salmon-Safe BC Urban Standards) used for analyzing policy documents divided into the seven habitat-related management categories. Greyed out boxes indicate no specific performance requirements.

Management Category	Standard	Performance Requirement
Stormwater Management – U.1	**U.1.1** Existing site improvements related to stormwater management have been inventoried	**1.** Information on existing stormwater infrastructure has been collected from record drawings, site mapping or field visits, including locations of stormwater conveyance channels, pipes, catch basins, outlets and low-impact development stormwater facilities. **2.** Impervious and semi-pervious (gravel or pavers) surfaces are mapped. **3.** Site topography mapped to show drainage area assessment of major stormwater catchments and receiving stormwater drains or streams. **4.** Areas suitable for low impact development stormwater facilities based in part on soil infiltration capacity have been mapped.
	U.1.2 An offsite drainage analysis has been conducted	**1.** Influence from offsite sources on water quality or drainage onto site are mapped and characterized as impervious or pervious.
	U.1.3 Site layout responds to site conditions in a way that conserves contiguous existing vegetation, minimizes impervious or semi-pervious areas, eliminates effective (or connected) impervious area and minimizes stormwater runoff.	**1.** Non-invasive vegetation and soils are left undisturbed to the greatest extent operationally feasible. Disturbed locations are selected over undisturbed locations during site planning and building. Locally significant vegetation left undisturbed and connected to the greatest extent possible. **2.** Lots and buildings are clustered to reduce building footprints. Minimizing soil excavation and compaction and vegetation disturbance; minimize impervious surfaces. **3.** Roadway alignment to limit encroachment on

Management Category	Standard	Performance Requirement
		natural resources. Parking area only to meet minimum code required.
	U.1.4 Stormwater management planning results in clear benefits to water quality and flow control. Stormwater management planning generally follows a hierarchy that prioritizes total onsite treatment and infiltration as follows: i. total on-site treatment & infiltration with vegetated facilities, green roof and permeable pavements, ii. total on-site infiltration with a combination of vegetated & pervious facilities (Level i) with outflow to subsurface infiltration facilities (i.e. drywell), iii. Combination of on-site infiltration (Level ii) and treatment/detention with vegetated facilities prior to outfall, iv. on-site treatment/detention use vegetated facilities, green roof, permeable paving prior to outfall, v. combination of on-site treatment/detention using vegetated facilities with additional treatment/detention using	**1.** evaluate which of i through vi from the options of stormwater hierarchy are needed. **2.** Project aims to treat and infiltrate stormwater onsite. **3.** Project runoff meets predevelopment surface water hydrology conditions (e.g., for peak flows, temp, volume, and duration). **4.** Existing drainage patterns are maintained unless there are existing problems such as flooding, channelization or improperly functioning stormwater infrastructure. **5.** Project design minimizes contaminant loading of downstream receiving waters, especially for dissolved metals, sediment, nutrients and water temperature. **6.** Low impact development used to intercept stormwater at point of origin to minimize need for centralized stormwater management facilities.

Management Category	Standard	Performance Requirement
	filters/vaults, vi. treatment using filters and detention using vaults (only after evaluation of Levels i through v above)	
	U.1.5 Parking and roadway design deliberately minimizes the footprint of impervious area and associated stormwater runoff.	**1.** site design minimizes impervious surfaces where allowed by code and public safety is not compromised. **2.** permeable paving where possible. **3.** roadbeds and utility lines to minimize impact on subsurface waterflow. **4.** stormwater runoff is managed per U.1.7.
	U.1.6 Building design deliberately minimizes the footprint of impervious area and associated stormwater runoff.	**1.** impervious rooftop and building footprints minimized. **2.** rooftop runoff treated onsite and dispersed or infiltrated rather than concentrated during treatment. **3.** building materials selected to minimize pollutants in runoff.
	U.1.7 Stormwater facility design results in water quality and flow control benefits that meet predevelopment hydrology planning goals established in U.1.4.	**1.** stormwater facilities designed for peak flow events. **2.** use things like rain gardens, vegetated swales; vegetated filter strips; infiltration trenches, roof rainwater collection cisterns and vegetated rooftops **3.** Reduce contaminants with constructed wetlands, wet ponds, extended detention basins, biofiltration swales and filter strips, and filtration by sand and other media. **4.** measures must be put in place to slow runoff originating from all primary drainage areas on the project site through conventional infiltration, detention or other means. **5.** for existing sites, analysis to retrofit existing stormwater drainage systems to manage runoff per the above performance requirements in U.1.7 and U.1.8 below.

Management Category	Standard	Performance Requirement
	U.1.8 Stormwater facilities and infiltration features are fully integrated with habitat-based site features.	**1.** stormwater facilities are designed with native and adapted vegetation to fluctuating water conditions. **2.** stormwater facilities will not trap fish at any time and have screens to avoid entry of fish. **3.** Stormwater facilities incorporate habitat features such as logs, snags, and varying pool depths, integrate with the surrounding habitat and vegetation, and support connectivity between nearby habitats. **4.** space used to manage stormwater is protected from future development by a perpetual conservation easement through an existing local agency or land trust, is protected by local buffer zoning regulations, or is owned and/or protected in perpetuity by the managing authority.
	U.1.9 Construction practices avoid or reduce short- and long-term negative stormwater impacts resulting from construction.	**1.** Construction will limit runoff and sediment loading. Construction-phase stormwater management plan is used on site. **2.** Vegetation disturbance, soil excavation and compaction are avoided or minimized. **3.** LID facilities are fully protected from soil compaction and receiving sediment during construction.
	U.1.10 The appropriate managing authority within the development has adopted a long-term stormwater management plan as a concise written document to formalize the existing low impact development practices.	**1.** plan provides post-construction maintenance plan to ensure everything works. **2.** plan guides the design and construction of any future improvements, infill development, or new phases of development so that they comply with SS. **3.** the plan, as a whole, or its elements therein have been adopted into the development's guiding documentation that formalizes the appropriate managing authority's responsibility

Management Category	Standard	Performance Requirement
		to implement and enforce all aspects of the plan on both private and common property managed for the public good.
Water Use Management – U.2	**U.2.1** An existing site water infrastructure inventory as it relates to water use and disposal has been completed.	**1.** availability of public water sources has been investigated to aid in avoiding the use of surface water rights. Existing sanitary/wastewater infrastructure has been mapped. **2.** local jurisdictional code as it relates to reuse of graywater and treated wastewater has been reviewed and documented for reference during later stages of planning and design.
	U.2.2 Surface water withdrawals are avoided, and alternative water resources used, to the greatest extent operationally feasible. To the extent operationally feasible and as permissible by building codes and other regulations, reduction, reuse, treatment and recycling, and treatment and reclamation are incorporated into water use according to the following hierarchy: 1) Reduction, 2) Reuse, 3) Treatment and recycling, 4) Treatment and Reclamation, 5) Potable use.	**1.** document evaluation of each of the options in the water use management hierarchy.
	U.2.3 Opportunities for stormwater harvest, water reuse and wastewater reclamation under municipal code have been investigated during the site inventory and assessment and are employed to the	

Management Category	Standard	Performance Requirement
	greatest extent operationally feasible.	
	U.2.4 Sanitary systems connect to public infrastructure rather than onsite treatment and discharge to the greatest extent operationally feasible. Where onsite treatment is necessary, sanitary systems are sited outside of wetland and riparian buffers areas defined in U.7.4 and U.7.5, in such a way to avoid contaminant risk to surface water and groundwater resources. Sanitary systems are in full compliance with all standards applied to such systems by state and local jurisdictions.	
	U.2.5 Landscape vegetation has been selected and located appropriate to site conditions to limit water demand.	**1.** Drought tolerant plants that require minimal, if any, irrigation. No invasive species. **2.** Open lawn is minimized or has drought tolerant alternative seed mixes. **3.** Construction details specify the use of suitable compost and mulch during installation to reduce irrigation needs. **4.** Existing developments are assessed to see where the above can be done.
	U.2.6 Water conservation practices are used during site maintenance.	**1.** Modern drip irrigation, automated soil moisture sensors and other water conserving techniques are part of the irrigation plan. **2.** stormwater reuse and grey water reuse systems, are used to code. **3.** for existing developments, the above is retrofitted as best as possible.

Management Category	Standard	Performance Requirement
	U.2.7 Equipment cleaning occurs off site or sufficiently away from riparian and wetland resources or their buffers to avoid accidental runoff, contamination or other impacts on water and natural resources.	
	U.2.8 No surface water withdrawals are made in association with site construction activities.	
	U.2.9 The appropriate managing authority within the development has adopted a water conservation plan as a short-written document and formalizes the existing conservation practices, as detailed in Appendix G	**1.** plan of who is responsible for what, when. Adaptive management triggers actions that respond to changes in performance. Water conservation plan shall include a drought management plan that details how significant reductions will be achieved during a drought. **2.** plan has been adopted into the development's guiding documentation.
Erosion Prevention and Sediment Control – U.3	**U.3.1** Soil characteristics have been mapped	**1.** soil characteristics have been mapped, including soil type, presence of hydric soils, infiltration rates and erosion factors and more. **2.** Areas of unstable soil or existing erosion and sedimentation problem areas have been mapped (slumps, failures, steep slopes, and unstable soils). **3.** onsite soil tests or geotechnical bores are available to the project team early on.
	U.3.2 Site development responds to site conditions in a way that minimizes ground disturbance, erosion and sediment transport	**1.** Disturbed sites are prioritized for development, otherwise, soil disturbance is limited (excavation and grading, etc.). **2.** Erosion prevention is emphasized over sediment control. **3.** Clumping of utilities close together to minimize disturbance. **4.** Trails are distant

Management Category	Standard	Performance Requirement
		from riparian areas, wetlands, and steep slopes to avoid being a source of sediment, chemical pollution or bank instability.
	U.3.3 Soil is protected from erosion and generation of sediment that could enter surface water bodies.	**1.** Limit bare soils. Erosion control blankets, mulch and/or tackifiers are used to prevent erosion. **2.** Site improvements, including buildings, roads, bridges or other features are protected by BMPs as necessary to prevent erosion. **3.** Permanent erosion control features, in the form of site grading, flow control and landscaping, are strategically placed to prevent turbid stormwater from leaving the site.
	U.3.4 Construction practices limit soil erosion and eliminate potential sediment inputs into surface waters to the greatest extent operationally feasible. Visible or measurable sediment or pollutants do not exit the site or enter the public right of way. Measures to prevent erosion and control sedimentation are installed according to plans, monitored and maintained regularly, and left in place until the site is stabilized. Please refer to Standard U.1.9 for additional guidance on meeting this standard. All new plans meet or exceed current state requirements for site pollution control during construction.	

Management Category	Standard	Performance Requirement
	U.3.5 Long-term erosion and sediment control provisions should be addressed in the plans required in Section U.7 and in Section U.1 by providing standards that protect soil from erosion and prevent transport of sediment into streams or offsite stormwater.	
Pesticide Reduction and Water Quality Protection in Landscaping – U.4	**U.4.1** High risk areas, where chemical use and storage should be avoided, have been identified and mapped (e.g., areas with surface water connection to stream, wetland or other sensitive water body; areas on steep slopes or unstable soils). Potential locations for temporary storage of chemicals during construction have been identified	
	U.4.2 Areas identified for chemical storage during construction staging are mapped and located outside of high-risk areas identified in U.4.1.	
	U.4.3 Landscape plans require minimal chemical and nutrient use, if any. Areas that may require chemical use are planted outside of wetland and riparian buffer zones and are placed in such a way to minimize risk of chemicals leaving the site.	

Management Category	Standard	Performance Requirement
	U.4.4 Designated dog run, or livestock areas are outside of required wetland and riparian buffers. Animal areas are located sufficiently away from aquatic zones. The site layout locates these areas to minimize the risk of animal waste leaving the site. Public education programs, signage and pickup stations promote proper waste disposal.	
	U.4.5 Sanitary system designs connect to public infrastructure rather than onsite treatment and discharge to the greatest extent operationally feasible. Where on- site treatment is necessary, sanitary systems result in no impact to aquatic resources and buffers defined in U.7.4 and U.7.5 and avoid contaminant risk to surface water and ground- water resources. Sanitary systems are in full compliance with all standards applied to such systems by state and local jurisdictions	
	U.4.6 Landscape vegetation includes either native plants or hardy non-native plants requiring minimal chemical application, if any	**1.** Only resilient plants to be used. None that require any chemicals from the Salmon-Safe High Risk Pesticide List unless absolutely necessary. **2.** For existing developments, do the same landscaping as in 1.

Management Category	Standard	Performance Requirement
	U.4.7 The staging area for the project is located outside of any designated riparian, wetland, or other buffer for storage and maintenance of equipment, vehicles, chemicals, or other materials that could reasonably pose a risk to sensitive aquatic habitats.	
	U.4.8 An equipment and vehicle cleaning, fueling and maintenance plan is used during construction to limit the import and export of invasive plant seeds, petroleum, or other toxic substances to and from the site.	
	U.4.9 Use of herbicides, pesticides, or other chemicals is expressly avoided to the greatest extent operationally feasible, especially within riparian and wetland buffer areas.	**1.** Mechanical removal of plants over chemical. **2.** No herbicide or pesticide in Salmon-Safe High Risk Pesticide List to be used.
	U.4.10 The appropriate managing authority for the development shall prepare and implement an integrated pest management (IPM) plan and nutrient management plan consistent with Salmon-Safe standards as detailed in Appendix D	**1.** Plans are prepared with aid from professionals trained in IPM plans. **2.** plans have been incorporated into the development's guiding documentation and will be implemented and enforced on both private and common property. **3.** Contractor landscaping will follow the IPM and nutrient management plans, documentation must be provided to demonstrate their plans meet standards. The IPM record keeping system shall include notes on pest monitoring, all IPM methods used and evaluation of effectiveness.

Management Category	Standard	Performance Requirement
Enhancement of Urban Ecological Function – U.5	**U.5.1** Provide landscape scale mapping and analysis of habitat patches and corridors within the local region (sites, buildings, roofs, open space and site) as a tool for maximizing the connectivity between habitats at multiple sites and to larger core habitat zones beyond the immediate project area.	
	U.5.2 Conduct a survey of existing species of birds, mammals, insects and invertebrate composition within the region and onsite to aid in setting goals for successful establishment (e.g., types, numbers, distribution) of key indicator species E	
	U.5.3 Work with local jurisdictions and other property owners in the region to create synergies with adjacent properties to provide larger parcels (two or more buildings with similar habitat functions adjacent) or corridors (more expansive and connected terrestrial and canopy coverage in right-of-way and through sites).	
	U.5.4 Using the analysis conducted in the previous standards, develop site strategies for creation and retention of habitat and landscape patches that provide for food, forage and refuge for a diversity of species, including key	**1**. Creation of pollinator pathways of vegetation along roadways and through sites to attract bees, butterflies and other species of interest. Salmon-Safe, **2**. Usage of street tree, shrub and groundcover species that provide biological diversity and consistent food, forage and refuge for a range of urban

Management Category	Standard	Performance Requirement
	indicators of ecosystem health.	species, **3**. Extension of street planters and larger bulb-outs at corners to maximize street landscape coverage and diversity and incorporation of stormwater facilities to provide intermittent water, mud and nesting materials, **4**. Reduction of turf areas and strategic integration of large patches of green roof with specific habitat elements into designs, such as woody debris, gravel/cobble and other elements typically not found in urban settings
	U.5.5 Ensure that building materials, lighting and facades do not endanger or pose a threat to wildlife. Use netting or screening to reflect glare on windows and prevent bird kills. Consider various types of living walls and infrastructure that increase the habitat value of the site. Hazardous or toxic building and landscape materials that pose a threat to wildlife should be avoided.	
	U.5.6 Improve the existing environmental condition of sites prior to and during construction through restoration and retrofitting. Look at opportunities for temporary improvements to vacant or underutilized sites with low-cost plantings that have the potential to provide habitat value.	
	U.5.7 Utilize maintenance strategies that maximize the conservation of beneficial species, reduce intrusion of invasive species and	**1.** include such activities as leaving some vegetation over winter rather than cutting back, reducing pruning and slowing planting to provide dense refuge. **2.** Use appropriate

Management Category	Standard	Performance Requirement
	provide beneficial habitat elements of food, forage and refuge.	composts to amend soils, maintain healthy vegetation and support beneficial soil microorganisms.
Instream Habitat Protection and Restoration – U.6	**U.6.1** A physical instream inventory has been completed that adequately characterizes factors contributing to habitat quality conditions for salmonids and other sensitive species.	**1.** map of watershed. **2.** Existing watershed-specific restoration or recovery plans and local salmonid recovery programs collected and objectives incorporated into this development plan. **3.** physical and biotic watershed conditions investigated. Physical and chemical impairments to water quality within the system noted, including 202(d) or (TMDL). Biological impairments such as non-native fish are noted. **4.** onsite stream channel deficiencies identified. Bank stability and channel incision characterised. Onsite 100-year floodplain and channel migration zones mapped. **5.** onsite stream crossings inventoried and evaluated to determine priorities for fish and wildlife passage and flood conveyance.
	U.6.2 A biological instream inventory has been completed that characterizes riparian and aquatic habitat conditions on site and investigates the likelihood that fish may be able to access the site and characterizes aquatic habitat conditions.	**1.** Watershed system assessed for fish presence (if data available) and stream types classified as 1) fish bearing, 2) potentially fish bearing, 3) non-fish bearing with a defined channel connected to fish-bearing or potential fish-bearing stream, or 4) none of the above. **2.** Fish survey conducted. **3.** All steams with connection or presence of fish are mapped.
	U.6.3 The site plan details locations for instream enhancement, barrier removal or other rehabilitation based on the results of the site inventory (per Standard U.6.1).	

Management Category	Standard	Performance Requirement
	U.6.4 The site plan avoids impacts to instream areas identified in the inventory to the greatest extent operationally feasible during development.	**1.** buildings and site improvements placed outside floodplain and channel migration zone**. 2.** Utility lines on stream crossings placed on bridge crossings in serviceable locations, rather than buried.
	U.6.5 When avoidance is not possible, the site plan minimizes impacts on instream habitat.	**1.** site plan protects existing channels from new impacts or disconnection of off-channel wetlands and ponds. **2.** number of stream crossings reduced. Placement of crossings is accompanied by rehabilitation or riparian habitat and reduction of water quality impacts where applicable.
	U.6.6 Where impacts on streams are unavoidable, impacts are mitigated by site improvements that offset physical and biological impacts on streams to the greatest extent operationally feasible.	
	U.6.7 Overall, stream bank conditions are acceptable on site. Key deficiencies identified in Performance Requirement U.6.1 (iii) have been addressed and resolved.	**1.** incised or eroded stream banks have been stabilized using bioengineering methods. **2.** stream banks are stabilized with native vegetation. **3.** channel manipulation only allowed for habitat restoration, if necessary, bioengineering is chosen.
	U.6.8 Overall, channel and instream habitat is functioning on the property. Key deficiencies identified in Performance Requirement U.6.1 (iii) have been addressed and resolved.	**1.** stream has intact channel and floodplain, existing off-channel habitats remain connected and no large wood has been removed unnecessarily. **2.** habitat improvement projects use large woody debris from salvage or sustainable harvest. **3.** habitat improvement projects incorporate large wood and rock features in a

Management Category	Standard	Performance Requirement
		gynomorphically appropriate manner in accordance with natural and historical conditions.
	U.6.9 Key issues with regard to barriers and man-made features identified in Standard U.6.1 have been addressed and resolved	**1.** unnatural barriers to fish and wildlife, water, sediment and large woody debris movement have been removed or plans are in place for removal. **2.** existing levees have been removed/moved, floodplains restored, and no new levees proposed. **3.** artificial ponds located in stream channels are removed or reconstructed as needed for fish passage and habitat and to maintain ideal stream conditions. **4.** stream crossings avoid obstructions and encumbrances to fish, wildlife, large wood and sediment passage.
	U.6.10 Fish and wildlife exclusion/protection measures are in place during construction near water bodies. For work below the ordinary high-water line where fish may be harmed or entrapped during construction, work area isolation barriers such as cofferdams, silt curtains or other devices are used at all times and Applicant has coordinated with agencies to perform in-water work only when permitted. During in-water construction, a fisheries biologist or other qualified specialist is available on site in the event of accidental fish entrapment.	

Management Category	Standard	Performance Requirement
	U.6.11 If instream habitat features have been installed, the appropriate managing authority within the development has adopted a post-construction inspection and maintenance plan (O&M) to ensure that instream habitat features are working as designed	**1.** plan lists activities to perform, provides a schedule for completion and identifies responsible parties. Adaptive management triggers actions that respond to change in performance. **2.** plan is adopted into development's guiding documentation.
Riparian, Wetland and Locally Significant Vegetation Protection and Restoration – U.7	**U.7.1** A riparian inventory has been conducted by a biologist, ecologist, wetland scientist or other qualified professional that characterizes riparian habitat conditions on site	**1.** Local and watershed riparian habitat extent, quality and conditions have been inventoried for species, percent cover, shrub layer, herbaceous layer. **2.** Riparian areas onsite identified and mapped and identified by width of existing buffer and stream length of riparian vegetation free from intrusions. Invasive noted and at risk areas noted and mapped. **3.** local terrestrial riparian species characterized. **4.** site inventory of local terrestrial riparian species, game trails or other signs of use by wildlife and mapped.
	U.7.2 A wetland inventory has been conducted by a wetland scientist or other qualified professional that adequately characterizes wetland habitat conditions on site and in the local geographical area. Existing onsite wetlands are identified, classified and mapped. Classification of existing wetlands includes types of impacts and whether the wetland historically or currently provides fish habitat.	**1.** local and watershed wetland habitats characterized by type, condition, and quality. **2.** onsite wetland areas identified and mapped, 100ft of wetlands are characterized by vegetative composition, land use characteristics and topography. **3.** wetland hydroperiods have been estimated and hydrologic pathways have been determined. Existing wetland functions and deficits are characterized. Damaged, exposed or at-risk areas identified and mapped to identify areas in need of restoration. **4.** local wetland species characterized. **5.** site inventory and

Management Category	Standard	Performance Requirement
		survey done during growing and breeding season.
	U.7.3 Patches of locally significant vegetation and sensitive habitats that are not associated with riparian and wetland areas have been inventoried and mapped by a qualified biologist or in consultation with a local or state fish and wildlife agency. Tree species, diameter at breast height distribution, canopy cover, understory conditions and limits of contiguous canopy cover are noted.	
	U.7.4 Riparian habitat across the site is maintained, restored and unimpeded by structures or improvements and is contiguously connected to riparian habitat in adjoining parcels	**1.** limited development near riparian areas, impacts minimized within 200ft of a stream or river channel migration zone or within the riparian protection areas. **2.** degraded riparian areas identified in need of restoration. **3.** connectivity between riparian, wetland and upland habitats maximized. **4.** 100-year floodplain areas are avoided and not filled.

Management Category	Standard	Performance Requirement
	U.7.5 Impacts to wetlands are avoided to the greatest extent feasible. If wetland impacts cannot be avoided, they are, in order of preference, protected, restored or recreated. The site plan strives to provide off-channel salmonid habitat, improved water quality, additional floodplain storage and/or other habitat benefits associated with proper wetland function	**1.** degraded wetlands identified are restored or new wetlands created**. 2.** existing wetlands avoided and protected from development. **3.** development near wetlands is avoided. Impacts to wetland functions affecting water quality, water quantity, floodplain condition and contiguous habitat connectivity shall be minimized within 100 ft of a wetland. **4.** degraded existing wetland buffers are restored by revegetation or removal of existing detrimental structures or impervious surfaces. **5.** wetland habitats and their buffers are spatially connected by locally appropriate contiguous native vegetation.
	U.7.6 Riparian zones and their buffers specified in Performance Requirement U.7.4 (i) are operating in a properly functioning condition	**1.** riparian zones are dominated by native vegetation and invasive removed. **2.** riparian buffers adequately infiltrate or filter site sheet flow runoff. **3.** riparian buffers are protected in perpetuity by conservation easements through an existing local agency or land trust.
	U.7.7 Wetlands and their buffers specified in Performance Requirement U.7.5 (iii) are operating in a properly functioning condition	**1.** wetlands are gynomorphically and hydrologically similar to natural, well-functioning reference wetlands of similar types in the vicinity. **2.** wetland habitats are dominated by native vegetation that provides wetland functions of bank stability, infiltration, nutrient absorption and habitat value for wildlife. **3.** wetland buffers are designed to adequately infiltrate and/or filter site sheet flow based on steepness, substrate and degree of vegetation coverage. **4.** wetlands, their buffers and connecting habitats are protected in perpetuity by conservation easements through an existing local agency/land trust.

Management Category	Standard	Performance Requirement
	U.7.8 Sensitive natural resources are protected during construction	**1.** intensive construction activities with the potential to disturb sensitive wildlife occur outside the height of the terrestrial breeding season. **2.** a tree protection plan has developed with the aid of a certified arborist for use during construction. Plan must adhere to: i) project work limits are clearly defined by a temporary construction fence, to protect tree drip lines and vegetation not-to-be disturbed. ii) riparian areas, wetland areas, identified locally significant vegetation and their corresponding buffers are marked and protected from construction encroachment through the use of construction fence and signage. iii) pre-construction meetings are held on-site so that contractors understand project work limits and other construction restrictions, iv) where necessary, disturbed native plants, woody substrate and soils are salvaged and reused on site.
	U.7.9 The appropriate managing authority within the development has adopted a post-construction inspection and maintenance plan to ensure that riparian and wetland features are in a properly functioning condition and invasive species are controlled	**1.** plan lists activities to perform, provides an activity schedule and identified responsible parties. Adaptive management triggers actions that respond to changes in performance. **2.** the plan as a whole or its elements therein, have been adopted into the development's agreements or other guiding documentation that formalizes the appropriate managing authority's responsibility.

Appendix B – Expert Interview Questions

1. How do you view the current state of urban watersheds in British Columbia (BC)?
    - Are current urban development patterns and strategies sustainable or unsustainable for the long-term health of urban watersheds?
2. Does your (level of government) currently have any incentives, policies, regulations, or guiding principles on the use of green infrastructure?
    - If yes, can you elaborate on what these incentives, policies, regulations, etc. might be?
    - If no, what role do you think the municipality plays in promoting green infrastructure?
3. Are there requirements for on-site stormwater management for development/redevelopment/rezoning?
4. Do you think green infrastructure could be a useful tool for reducing nonpoint-source pollution and contaminated runoff running into the local waterways?
    - Has the (level of government) had any successful examples of this?
5. Do you think green infrastructure systems should be used as a standard for urban development?
6. What role do you think the (level of government) should play in the protection of wild salmon and their habitat in urban watersheds?
7. Do you think eco-certifications could be a useful tool for providing uniform standards and regulations for salmon-friendly urban development across the Lower Fraser Watershed?
8. What standards for water quality and stormwater management treatment does your (level of government) currently use?
9. What do you believe is the most effective policy tool in achieving healthy watersheds (e.g., Bylaw enforcement, building guidelines or recommended standards, Provincial regulations)?
10. What role do the municipal ISMPs play in regulating development in the municipality?

11. Does your municipality currently use the standards provided by any third-party entity such as LEEDs, Salmon-Safe, or other eco-certifications for sustainable urban developments?
12. Do you think there are gaps between the various levels of government regarding the jurisdiction over water management?
    - If yes, what do you think those gaps are?
    - If no, why?
13. Does the (level of government) have plans for any future collaborations or initiatives for rainwater management (e.g., Indigenous partnerships, joint municipal ventures, etc.)?

Appendix C – Keywords and Phrases

U.1	permeable pervious impervious impermeable rainwater stormwater water quality pollution hard landscaping soft landscaping drainage infiltration low impact development green infrastructure nature-based solutions building footprint paving onsite treatment onsite detention green roof rain runoff

U.2	water use water conservation reduction reuse recycling reclamation potable use water capture water harvest wastewater greywater groundwater surface water drought tolerant irrigation soil erosion sediment sedimentation ESC bank stability ground disturbance
U.3	soil erosion erode sediment sedimentation ESC bank stability ground disturbance

U.4	chemical use chemical storage pesticide pest fertilizer herbicide IPM nutrient use animal waste dog waste livestock waste sanitary system contamination hardy native toxic substances leak invasive
U.5	habitat wildlife corridor connectivity greenspace greenfield pollinator bird-friendly vegetation shrub diversity ecological nesting light pollution hazardous building materials habitat enhancement

U.6	biological inventory site inventory biotic watershed conditions physical watershed conditions stream channel streambank floodplain river fish passage spawning fish-bearing restoration instream habitat offset woody debris hydrology barriers to fish and wildlife
U.7	riparian wetland bog fen swamp marsh terrestrial vegetation set-back buffer zone easement protection preservation conservation

Appendix D – Federal and Provincial Alignment Details

Provincial Water Sustainability Act and Regulations

U.1 – Stormwater Management

Water Sustainability Act

Stormwater runoff at a Provincial level is managed and regulated under the *Environmental Management Act.* Therefore, any alignment that was identified with the WSA was primarily with the context specific standards as they provide actions and objectives for the protection of watercourses and waterbodies. The relevant sections for stormwater management are:

- Section **43** – Water Objectives (low)
- Section **46** – Prohibition on introducing foreign matter into stream (low)
- Section **65** – Order designating area for planning process (low)

Alignment with the above sections of the WSA are primarily in reference to the protection of streams and waterbodies from the introduction of any deleterious substances. As stormwater runoff is considered to be a major source of non-point source pollution, there was alignment identified with Section 46 of the Act that directly prohibited the introduction of foreign matter into streams. This alignment was low as neither the Act, nor regulations provide specifications on managing stormwater or urban runoff from any sources. The alignment identified in Section 43 of the Act was in relation to the use of water objectives, which can be utilized at a local or regional government level. Although there is no direct and all alignment was to a low degree with SSBC, both the water objectives in Section 43 and the Water Sustainability Plans in Section 65 offer opportunities for SSBC to become a more widely adopted program to mitigate urban runoff contamination.

U.2 – Water Use Management

Water Sustainability Act

Water use management and water conservation efforts are primarily under the jurisdiction of regional bodies, and in the case of the LFW, Metro Vancouver. Therefore, provincial legislation does not provide much direction or regulation in conserving water at a site level. However, where there is alignment with U.2 is primarily in the form of ensuring

adequate stream flow by avoiding surface water withdrawals and demonstrating that any water that is diverted must be for beneficial use.

- Section **15** – Environmental Flow Needs (medium)
- Section **16** – Mitigation Measures (low)
- Section **30** – Beneficial Use (high)
- Section **43** – Water Objectives (low)
- Section **88** – Fish population protection orders (low)
- Section **127** – Regulations respecting licensing, diversion and use of water and related matters (medium)
- Section **128** – Regulations respecting sensitive streams (low)

Water Sustainability Regulations

Sections of the *Water Sustainability Regulations* that showed alignment with standard U.2 were both promoting and ensuring that there was adequate water supply, and that water conservation measures were taken when operating around streams and sensitive streams.

- Section **18** – Applications respecting sensitive streams (medium)
- Section **20** – Mitigation Measures (medium)

U.3 – Erosion Prevention and Sediment Control

Water Sustainability Act

- Section **43** – Water Objectives (low)
- Section **46** – Prohibition on introducing foreign matter into stream (medium)
- Section **65** – Order designating area for planning process (low)

Water Sustainability Regulations

Section **18** of the Regulations may require that applications working around sensitive streams provide information on what impacts from erosion and sedimentation are likely to occur during construction.

- Section **18** – Applications respecting sensitive streams (low)

U.4 – Pesticide Reduction and Water Quality Protection in Landscaping

Water Sustainability Act

- Section **43** – Water Objectives (low)
- Section **46** – Prohibition on introducing foreign matter into stream (medium)
- Section **65** – Order designating area for planning process (low)

U.5 – Enhancement of Urban Ecological Function

Water Sustainability Act

- Section **17** – Sensitive Streams Mitigation (low)
- Section **65** – Order designating area for planning process (low)
- Section **88** – Fish population protection orders (low)

U.6 – Instream Habitat Protection and Restoration

Water Sustainability Act

- Section **15** – Environmental Flow Needs (high)
- Section **16** – Mitigation Measures (high)
- Section **17** – Sensitive Streams Mitigation (high)
- Section **43** – Water Objectives (medium)
- Section **65** – Order designating area for planning process (low)
- Section **88** – Fish population protection orders (high)
- Section **128** – Regulations respecting sensitive streams (high)

Water Sustainability Regulations

- Section **18** – Application respecting sensitive streams (high)
- Section **19** – Mitigation requirements (high)
- Section **20** – Mitigation measures (high)
- Section **21** – Compensatory mitigation measures (high)
- Section **43** – Protection of Water Quality (medium)
- Section **44** – Protection of aquatic ecosystem (high)

U.7 – Riparian, Wetland, and Locally Significant Vegetation Protection and Restoration

Water Sustainability Act

- Section **17** – Sensitive Streams Mitigation (medium)
- Section **43** – Water Objectives (low)
- Section **65** – Order designating area for planning process (low)
- Section **128** – Regulations respecting sensitive streams (medium)

Water Sustainability Regulations

- Section **18** – Application respecting sensitive streams (medium)
- Section **20** – Mitigation measures (medium)
- Section **21** – Compensatory mitigation measures (low)
- Section **43** – Protection of Water Quality (medium)
- Section **44** – Protection of aquatic ecosystem (high)

Federal Government	Document Type	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Fisheries Act	Act											2					5		1			
Fisheries Regulations	Regulations																6	1		2		
Measures to Protect Fish and Fish Hab	Guiding Practices							1				1					1			1		
Species at Risk Act	Act														2			2				
Wild Salmon Policy	Policy																					
Land Development Guidelines	Guidelines																					

Figure D.1 Federal Government Alignment Data

Provincial Government	Document Type	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Water Sustainability Act	Act			3	1	2	4		1	2		1	1			3	5	1	1		2	2
Water Sustainability Act Regulations	Regulations					2				1							5	1		1	3	1
Riparian Areas Protection Act	Act																			1	1	
Riparian Areas Protection Regulation	Regulations																			6	1	
Environmental Management Act	Act																					
Develop with Care	Guidebook																					
Beyond the Guidebook Series	Guidebook																					
Standards and BMPs for Instream Works	Guidebook																					
Environmental Planning and Development at the Site level	Guidebook																					
Stream Stewardship: A guide for Planners and Developers	Guidebook																					
A Guidebook for BC: Stormwater Planning	Guidebook																					

Figure D.2 Provincial Government Alignment Data

Appendix E – Local Government Alignment Details

Local Government	Document	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Corporation of Delta	Delta's Birds & Biodiversity Conservation Strategy														1							
	Green Growth Index	1			1			1			1			1				1			1	
	Delta Total	1	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	1	0	0	1	0
City of Burnaby	Sediment Control Notes							1												1		
	Sediment Control System							1														
	Design Criteria Manual	1						1										1				
	Total Stormwater Management Guide for Developing Near Streams	1							1													
			1					1									1				1	
	Building Information: Streams and Ravines	1						1												1		
	Integrated Pest Management										1											
	Town Centre Standards	1				1																
	Environmentally Sensitive Area Strategy	1							1					1			1			1		
	A Plan for Burnaby's Green Future	1			1							1		1				1			1	
	Burnaby Total	7	1	0	1	1	0	5	2	0	1	1	0	3	0	0	2	2	0	3	2	0
City of North Vancouver	Parks and Greenways Strategic Plan	1																				
	Integrated Pest Management Policy										1											
	Climate Change Adaptation Plan	1					1							1						1		
	City of North Vancouver Total	2	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0
City of Surrey	Sustainable Development Checklist	1						1						1						1		
	Design Criteria Manual	1							1													
	Environmental Guidelines	1			1			1			1			1			1					
	Sustainability Charter 2.0	1				1						1		1								
	Biodiversity Conservation Strategy	1												1			1			1		
	Surrey Total	5	0	0	1	1	0	2	1	0	1	1	0	4	0	0	2	0	0	2	0	0
City of Vancouver	Biodiversity Strategy		1			1								1				1		1		
	Climate Change Adaptation Strategy		1				1									1						
	Urban Forest Strategy	1										1		1								
	Water Conservation Action Plan				1																	
	Erosion and Sediment Control	1						1														
	Small and Large Lot Rainwater Management Bulletin	1				1		1														
	Water Wise Landscape Guidelines	1			1				1		1				1							
	Bird Friendly Landscape Design Guidelines		1											1				1			1	
	Integrated Pest Management (IPM) Policy										1											
	Sustainable Large Developments	1			1				1						1							
	Policy Statements	14	12	1	5	4	1	0	0	0	0	0	0	1	4	0	0	0	1	0	0	1
	Vancouver Total	19	15	1	8	6	2	2	2	0	2	1	0	4	6	1	0	2	1	1	1	1
District of North Vancouver	The Natural Step Framework Policy								1			1			1			1			1	
	EcoSmart Concrete		1																			
	Sediment and Erosion Control and Tree Protection Residential Construction							1														
	Climate Change Adaptation Strategy	1			1									1								
	Parks and Open Space Strategic Plan	1										1		1			1			1		
	Pest Management											1										
	District of North Vancouver Total	2	1	0	1	0	0	1	1	0	0	3	0	2	1	0	1	1	0	1	1	0
Metro Vancouver	Integrated Liquid Waste and Resource Management Plan	1			1						1											
	Regional Parks Natural Resource Management Framework	1												1			1			1		
	Drinking Water Management Plan				1																	
	A Homeowner's Guide to Stormwater Management	1																				
	Connecting the Dots: Regional Green Infrastructure Network Resource Guide	1												1						1		
	Sustainability Framework		1												1							
	Monitoring and Adaptive Management Framework	1				1		1			1			1			1			1		
	Region-wide Baseline for On-site Stormwater Management	1																				
	Stormwater Source Control Design Guidelines	1			1			1				1		1			1			1		
	Ecological Health Framework		1											1						1		
	Sustainable Infrastructure and Buildings Policy		1				1					1										
	Metro Vancouver Total	7	3	0	3	1	1	2	0	0	2	2	0	6	1	0	4	0	0	5	0	0

Figure E.1 Local Government Policies and Plans Alignment Data

Local Government	Document	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Corporation of Delta	OCP	7	2	1				4						3		1	4			3		
City of Burnaby	OCP	1		1			2				2		1	2	2	1	2	2	1	2	2	1
City of North Vancouver	OCP	6	3	1			2	1		1	1		1	3	3	1	1	1	1	2	1	1
City of Surrey	OCP	10	1		2	3	1	2	1					6	5		3	3		4	5	1
District of North Vancouver	OCP	5	1	1	1		1	1			1	1	1	2	3	1	3	1	1	3		1
Metro Vancouver	RGS	1	1	1	1					1				4	2		1	1		3	1	

Figure E.2 Local Government Growth Strategies (OCP and RGS) Data

Municipality	Policy Statement	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
City of Vancouver	Vancouver Community College King Edward Campus		1			1																
	Pearson Dogwood		1																			
	Oakridge Centre	2			2																	
	Oakridge Transit Centre and Adjacent Sites	2		1																		
	Under Granville Bridge Neighbourhood Commercial Centre		1			1																
	New St. Paul's Hospital and Health Campus	2			1									1								
	Southeast False Creek		1			1	1								1							
	Arbutus Centre	2																				
	Langara College		1			1																
	Heather Lands	4			1										1							
	East Fraserlands		2												1				1			1
	Little Mountain		1																			
	Langara Gardens	2	4		1										1							
	total	14	12	1	5	4	1	0	0	0	0	0	0	1	4	0	0	0	1	0	0	1
Municipality	Official Development Plan	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
City of Vancouver	Southeast False Creek	1	1		3										1							
	East Fraser Lands	3	2	1	1									1	1	1				1		1
	total	4	3	1	4	0	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1

Figure E.3 City of Vancouver Official Development Plans and Zoning Policy Statements Data

Municipality	ISMP	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
City of Vancouver	Rain City Strategy	1			1			1						1					1			
City of Burnaby	Eagle Creek ISMP	1						1						1			1			1		
	Still Creek ISMP	1			1			1			1			1			1			1		
	Stoney Creek ISMP	1															1			1		
	Bryne Creek ISMP	1						1					1								1	
	Brunette Basin Watershed Plan	1						1						1			1			1		
		5	0	0	1	0	0	4	0	0	1	0	1	3	0	0	4	0	0	4	1	0
City of Delta	North Delta Ravines	1						1			1			1			1			1		
	Boundary/Shaw Creek	1			1			1				1		1			1			1		
	Tsawwassen Area Cougar Creek	1			1			1			1			1			1			1		
		4	0	0	2	0	0	4	0	0	2	1	0	4	0	0	4	0	0	4	0	0
City of Surrey	Anderson Creek	1			1			1			1			1			1			1		
	Bon Accord- North Slope East	1						1						1			1			1		
	Boundary Shaw Creek	1			1			1				1		1			1			1		
	Bridge-North Slope	1						1			1			1			1			1		
	Clayton	1					1	1					1	1			1			1		
	Cloverdale McLellan	1						1				1		1			1			1		
	Cruikshank and Grenville	1						1						1			1			1		
	Elgin, Barabar, and Anderson Creek	1					1	1				1		1			1			1		
	Erickson Creek	1						1				1		1			1			1		
	Fergus Creek	1						1			1			1			1			1		
	Fleetwood Greenway North Creek	1						1					1	1			1			1		
	Latimer Creek Watershed	1						1					1	1			1			1		
	Little Campbell River	1				1		1					1	1			1			1		
	Lower Bear Creek	1						1						1			1			1		
	Ocean Bluff-Chantrell Creek	1						1						1			1			1		
	Old Logging Ditch and Burrow's Ditch	1						1						1			1			1		
	Quibble Creek	1						1						1			1			1		
	Sam Hill Watershed	1						1					1	1			1			1		
	South Westminister Upper Serpentine	1						1			1			1			1			1		
		20	0	0	2	1	2	20	0	0	4	4	5	20	0	0	20	0	0	20	0	0
City of North Vancouver	ISMP	1															1			1		

Figure E.4 Local Government ISMPs Alignment Data

Municipality	Policy/Policy Documer	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Corporation of Delta	OCP	7	2	1	0	0	0	4	0	0	0	0	0	3	0	1	0	0	0	3	0	0
	DPAs	6	5	1	1	4	1	3	0	0	1	0	1	5	1	0	3	2	0	8	3	0
	LAPs	6	2	2	2	3	1	0	0	0	0	0	0	1	4	1	0	0	0	1	1	0
	Bylaws	2	6	1	1	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0
	Policies and Plans	1	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	1	0	0	1	0
	ISMPs	4	0	0	2	0	0	4	0	0	2	1	0	4	0	0	4	0	0	4	0	0
	CoD total	26	15	5	7	7	2	13	0	0	5	2	1	14	6	2	8	3	0	16	5	0
City of Burnaby	OCP	1	0	1	0	0	2	0	0	0	2	0	1	2	2	1	2	2	1	2	2	1
	LAPs	16	4	2	2	1	1	2	1	0	4	2	0	3	1	3	4	2	0	2	4	0
	Bylaws	1	0	1	0	0	0	1	0	1	0	1	2	0	0	0	1	0	0	1	0	0
	Policies and Plans	7	1	0	1	1	0	5	2	0	1	1	0	2	0	0	2	2	0	3	2	0
	ISMPs	5	0	0	1	0	0	4	0	0	1	0	1	3	0	0	4	0	0	4	1	0
	CoB total	30	5	4	4	2	3	12	3	1	8	4	4	10	3	4	13	6	1	12	9	1
City of North Vancouver	OCP	6	3	1			2	1		1	1		1	3	3	1	1	1	1	2	1	1
	DPAs	11	1	0	2	1	0	3	0	0	1	1	0	1	2	0	2	1	0	6	2	1
	Bylaws	8	0	1	1	0	0	7	0	0	0	1	1	0	0	0	0	2	0	0	1	0
	Policies and Plans	2	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0
	ISMPs	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
	CNV Total	28	4	2	3	1	3	11	0	1	3	2	2	5	5	1	4	4	1	10	4	2
City of Surrey	OCP	10	1	0	2	3	1	2	1	0	0	0	0	6	5	0	3	3	0	4	5	1
	DPAs	19	3	1	1	1	0	7	0	0	1	0	0	13	2	0	7	1	0	10	1	0
	LAPs	51	31	14	4	3	0	7	6	0	1	0	0	12	11	3	12	1	1	19	14	1
	Bylaws	6	2	1	0	0	0	3	1	0	2	1	0	0	0	0	1	0	0	1	0	0
	Policies and Plans	5	0	0	1	1	0	2	1	0	1	1	0	4	0	0	2	0	0	2	0	0
	ISMPs	20	0	0	2	1	2	20	0	0	4	4	5	20	0	0	20	0	0	20	0	0
	CoS Total	111	37	16	10	9	3	41	9	0	9	6	5	55	18	3	45	5	1	56	20	2
City of Vancouver	District Schedules	3	13	34	0	4	0	0	0	1	0	1	0	2	2	1	0	1	0	0	1	0
	ODPs	4	3	1	4	0	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	1
	LAPs	16	4	2	2	1	1	2	1	0	4	2	0	3	1	3	4	2	0	2	4	0
	Bylaws	5	4	2	4	0	1	0	1	0	0	1	0	1	2	1	0	0	0	1	0	1
	Policies and Plans	19	15	1	8	6	2	2	2	0	2	1	0	4	6	1	0	2	1	1	1	1
	ISMPs	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0
	CoV Total	48	39	40	19	11	4	5	4	1	6	5	0	12	13	7	4	5	2	5	6	3
District of North Vancouver	OCP	5	1	1	1	0	1	1	0	0	1	1	1	2	3	1	3	1	1	3	0	1
	DPAs	5	9	0	5	4	0	0	2	0	0	0	0	9	6	0	6	4	0	8	8	0
	LAPs	18	8	0	7	5	0	0	0	0	2	1	0	3	2	0	5	0	0	4	0	0
	Bylaws	5	1	1	2	0	0	3	1	0	2	0	0	0	0	0	4	2	0	2	1	0
	Policies and Plans	2	1	0	1	0	0	1	1	0	0	3	0	2	1	0	1	1	0	1	1	0
	DNV Total	35	20	2	16	9	1	5	4	0	5	5	1	16	12	1	19	8	1	18	10	1
	Municipal Totals	278	120	69	59	39	16	87	20	3	36	24	13	112	57	18	93	31	6	117	54	9
Metro Vancouver	Plans and Policies	7	3	0	3	1	1	2	0	0	2	2	0	6	1	0	4	0	0	5	0	0
	Electoral Area A Zoning Bylaw	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	RGS	1	1	1	1	0	0	0	0	1	0	0	0	4	2	0	1	1		3	1	0
	OCP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1
	MV Total	8	4	1	4	1	1	2	0	1	2	2	0	10	3	1	5	2	1	9	2	1
	LOCAL GOVERNMENT TOTAL	286	124	70	63	40	17	89	20	4	38	26	13	122	60	19	98	33	7	126	56	10

Figure E.5 Local Government Alignment Summary Chart Data

Municipality	LAP/NCP	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
City of Vancouver	ARKS Community Vision		3			2	1															
	Arbutus Neighbourood Policy Plan			1																		
	Downtown Eastside Community Plan	1	2												2							
	Dunbar Community Vision			1																		
	Cambie Corridor Plan	4	3	1	2	1						1		1	3							
	False Creek Flats Area Plan		1	2										1		1						
	Grandview Boundary Mixed Employment Area Plan			1																		
	Grandview-Woodland Community Plan		4			1									3			1				
	Hastings-Sunrise Community Vision		1	1									1						1			
	Kensington-Cedar Cottage Community Vision		2																			
	Kingsway and Knight Neighbourhood Centre		2	1																		
	Marpole Community Vision		5												4							
	Mount Pleasant Community Plan	1	1	1																		
	Norquay Village Neighbourhood Centre Plan			1																		
	Norquay Village Public Realm Plan		2			1																
	Northeast False Creek Plan	1	3		1	5								2	1					1		
	Renfrew-Collingwood Vision		2				1														2	
	Riley Park/South Cambie Community Vision		3			1	1											1				
	Southlands Plan														1			1			3	
	Sunset Community Vision Highlights		1				1															
	Victoria-Fraserview/Killarney Vision						1															
	West End Community Plan	2	1																			
	West Point Grey Community Vision		1				1															
	Total - CoV	9	37	10	3	11	6	0	0	0	0	1	1	4	14	1	0	3	1	1	5	0
City of Burnaby	Brentwood Town Centre Development Plan	3				1					1											
	Byrne Road and Marine Way Development Plan	2																				
	Cariboo Community Plan		1						1						1							
	Edmonds Town Centre Plan											1				1						
	Holdom Station Area Guide Plan	3	1	1			1				1						2	1		1	2	
	Lake City Business Centre Guide Plan		1	1	1							1		2								
	Lougheed Town Centre Plan	2									1					1						
	Metrotown Downtown Plan	1			1									1								
	New Haven Land Use Framework Plan	1	1															1		1		
	Oaklalla Adopted Plan	1																				
	Simon Fraser University OCP	3						2			1					1	2				2	
	Total - CoB	16	4	2	2	1	1	2	1	0	4	2	0	3	1	3	4	2	0	2	4	0
Corporation of Delta	North Detla Area Plan	4	1	1	2	3								1	2							
	Tsawwassen Area Plan														1							
	Riverside Area Plan														1						1	
	Ladner Area Plan	2	1	1			1									1				1		
	Total - CoD	6	2	2	2	3	1	0	0	0	0	0	0	1	4	1	0	0	0	1	1	0
District of North Vancouver	Edgemont Village Centre		1			1						1			1							
	Lynn Valley Town Centre	4	4			1					1						1			1		
	Lions Gate Public Realm Strategy		1												1							
	Lower Lynn Town Centre	6	1		3	1											1			1		
	Maplewood Village Centre	3			1	1								3			2			1		
	Lower Capilano Marine Village Centre	5	1		3	1					1						1			1		
	Total - DNV	18	8	0	7	5	0	0	0	0	2	1	0	3	2	0	5	0	0	4	0	0
City of Surrey	Abbey Ridge LAP	1						1													1	
	Aloha Estates		1																			
	Campbell Heights LAP	1				1		1						2	1		2			2		
	Central Newton Cultural Commercial District Guidelines	1																				
	Cloverdale Town Centre	2	1	1												1				1		
	Crescent Beach Land Use Plan			2															1			1	
	Douglas Neighbourhood Concept Plan	1	1						1								1			1	1	
	East Clayton NCP Extension West of 188	1																				
	East Clayton NCP	3	2																		1	
	East Clayton OTA Land Use Concept Plan	1																				
	East Newton Business Park Neighbourhood Concept Plan		1																			
	East Newton North NCP	1	2	1				1	1												1	
	East Newton South NCP	1	1	1		1																
	Grandview Heights Area 1 NCP	4	1						1							1	1	1			1	
	Grandview Heights General LUP	3												2							2	
	Grandview Heights NCP	1	3																			
	Highway 99 Corridor LAP				1									2			1			1		
	Newton Town Centre Plan	3	1		1				1						1					1	1	
	North Cloverdale East Neighbourhood Concept Plan		1																		1	
	North cloverdale West NCP																				1	
	North Grandview Heights NCP	7	4	1				1						2			3			4	1	
	Orchard Grove NCP	4	1		1						1				1							
	Redwood Heights NCP	3	2	1		1		1						2	3		4			6		
	Rosemary Heights Business Parkland Live Work Area NCP	1		3											1						2	
	Rosemary Heights Central NCP		1					1												1		
	Rosemary Heights West NCP	1						1												1		
	South Newton NCP																				1	
	South Prot Kells General LUP	2													1							
	South Westminster Heights NCP		1						1						3							
	Sunnyside Heights NCP	6												1		1						
	Surrey City Centre Plan	3	2		1									1						1		
	West Clayton NCP		1																			
	West Cloverdale North NCP			1																		
	West Cloverdale South NCP		1	1					1													
	West Newton North NCP		2	1																		
	West Newton South NCP		1	1																		
	Total - CoS	51	31	14	4	3	0	7	6	0	1	0	0	12	11	3	12	1	1	19	14	1

Figure E.6 Local Government Neighbourhood Plans/Local Area Plans/Neighbourhood Concept Plans/Town Centre Plans Data

Local Government	Bylaw	U.1			U.2			U.3			U.4			U.5			U.6			U.7		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Corporation of Delta	Subdivision and Development Standards Bylaw No. 7162	2	3					1														
	Waterways Protection Bylaw No. 1615																1					
	Zoning Bylaw No. 7600		2	1	1							1										
	Pesticide Use Control Bylaw No, 6788										1											
	Storm Sewer Regulation and Connection Charge Bylaw No. 57867		1																			
		2	6	1	1	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0
City of Burnaby	Zoning Bylaw No. Watercourse Bylaw No. 9044	1						1		1		1	1				1			1		
	Pesticide Use Control Bylaw No. 12465												1									
		1	0	1	0	0	0	1	0	1	0	1	2	0	0	0	1	0	0	1	0	0
City of North Vancouver	Zoning Bylaw No. 6700																					
	Stream and Drainage System Protection Bylaw No. 7541	4			1			7				1	1					2			1	
	Subdivision and Development Control Bylaw No. 8014	4																				
		8	0	1	1	0	0	7	0	0	0	1	1	0	0	0	0	2	0	0	1	0
City of Surrey	Subdivision and Development Bylaw No. 8830		1																			
	Zoning Bylaw No. 12000	1																		1		
	Building Bylaw No. 17850	1																				
	Stormwater Drainage Regulations and Charges Bylaw No. 16610	2						1			2						1					
	Erosion and Sediment Control Bylaw No. 16138	2	1	1				2	1													
	Pesticide Use Bylaw No. 17160											1										
		6	2	1	0	0	0	3	1	0	2	1	0	0	0	0	1	0	0	1	0	0
City of Vancouver	Zoning Bylaw	1	1																			
	Sewer and Watercourse Bylaw No. 8093			1					1			1										
	Water Works Bylaw No. 4848						1															
	Southeast False Creek	1	1		3										1							
	East Fraser Lands	3	2	1	1									1	1	1				1		1
		5	4	2	4	0	1	0	1	0	0	1	0	1	2	1	0	0	0	1	0	1
District of North Vancouver	Construction Bylaw No. 8271							1														
	Development Servicing Bylaw No. 8145	5	1		2			2			1						1	1		1	1	
	Environmental Protection and Preservation Bylaw No. 6515			1					1								3	1		1		
	Pesticide Control Use Bylaw No. 7686										1											
		5	1	1	2	0	0	3	1	0	2	0	0	0	0	0	4	2	0	2	1	0
Metro Vancouver	Electoral Area A Zoning Bylaw																			1		

Figure E.7 Local Government Bylaw Alignment Data