1.0 INTRODUCTION

1.1 Background

Syilx/Okanagan communities have always recognized and nurtured a strong connection towards siwɬkʷ (water). The importance of water in *Syilx/Okanagan* communities and governance is related through *captikʷl* and the natural laws. *Syilx/Okanagan* governance systems have always sustainably and respectfully managed water (syilx water declaration www.syilx.org).

Implementation of the British Columbia *Water Sustainability Act* (WSA) on February 29, 2016 created the need to develop regulatory environmental flow needs (EFNs). The WSA defines EFNs as the "*the volume and timing of stream flow required for proper functioning of the aquatic ecosystem*". According to Section 15 of the WSA, water managers must consider EFNs in new non-domestic water licensing decisions for surface and groundwater if the aquifer is reasonably likely to be hydraulically connected to a stream. The WSA defines the critical environmental flow threshold ("critical flow") as "*the volume of stream flow below which significant or irreversible harm to the aquatic ecosystem is likely to occur*". Sections 86-88 of the WSA give the province the ability to restrict water withdrawals if streamflow drops below the EFN, or to completely stop withdrawals altogether if flows drop below the critical flow (WSA 2016). The concept of EFNs is not new; however, the consideration of EFNs in water management decisions has recently increased throughout North America, along with greater recognition of the importance of ecological, cultural, and social values of rivers, and an increased demand on water resources.

The Okanagan Valley is an important farming and fruit growing region. Water demand for irrigation and domestic purposes during the naturally dry summer climate competes with the streamflow needs of the aquatic ecosystem. Considerable efforts to define EFNs in the Okanagan have been ongoing since the 1970s. However, EFN development has been hampered by a lack of stream-specific available information to describe an appropriate EFN flow regime (Associated 2016). While various terms have been used to recommend "minimum flows" in Okanagan streams, no previous work has specifically recommended critical flows as defined by the WSA. Koshinsky (1972) first defined minimum flow requirements for Okanagan streams that contained suitable flow regimes to support a fishery, using substrate and stream channel morphology data. Shepherd & Ptolemy (1999) outlined the importance of developing an efficient method for setting EFNs in the Okanagan, based on the compilation of recommendations from previous studies conducted since the 1970s. In 2001, Northwest Hydraulic Consultants (NHC) defined EFNs for 21 tributaries of kłusxənitkʷ (Okanagan Lake) by using the B.C. modified Tennant Method. Their proposed values ranged from 20% of the long-term mean annual discharge (LTMAD) for winter (Oct-March) to 200% in May (NHC 2001). These targets are currently being used to set default EFNs in the Okanagan by provincial fisheries staff. ESSA and Solander (2009) defined instream flow needs (now called EFNs) for the Okanagan Basin Water Board (OBWB) supply and demand project using the B.C. Instream Flow Methodology (BCIFN), which is based on percentile flows. This method did not provide any comparison between flows and fish presence (periodicity) or habitat function, and routinely provided EFNs higher than median flows outside of the freshet period. The more detailed, field-based weighted usable width (WUW) method has previously been used in the Okanagan for water-use planning in Trout Creek (NHC 2005; Water Management Consultants 2005) and Mission Creek (Epp 2008, 2009, 2010; Water Management Consultants 2010).

Previously recommended EFNs have often been considerably higher than possible naturally, particularly in dry years. This project aims to derive science-based EFN flow regimes, and to study the relationship between flows and habitat function more closely. Defining robust and defensible EFNs within the Okanagan Basin is necessary to avoid water allocation conflicts with fish and aquatic ecosystems. The semi-arid climate and hydrology regime of the Okanagan Basin can stress local indigenous fish populations even with their unique coping strategies. High water demand for both agriculture and domestic consumption exacerbates the stress on aquatic species, in particular during the summer when water usage is high and natural streamflow is low. Pressure on water resources in the Okanagan will continue to increase due to a growing population, an increasingly variable flow regime, and a longer growing season due to climate change (Rae 2005).

Accordingly, OBWB, the Okanagan Nation Alliance (ONA), and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) implemented an EFN-setting project for the Okanagan. The EFN Phase I report (Associated 2016) developed and recommended methods for determining the EFNs of Okanagan streams, and provided information for customized EFN-setting plans for 18 specific tributaries in the Okanagan Basin. The development of methods began in late 2015 by the consulting team from Associated Environmental Consultants (Associated), and was supplemented with input by technical experts within the project team (OBWB, ONA, and FLNRORD), as well as other external experts. Implementation of the methods and development of EFN flow regimes and critical flows for 18 Okanagan streams is described in this report (Phase II). EFN development has been a collaborative process; contributions from steering committee members and contributors to this report and/or support in collecting the data are described inTable 1-1.

Table 1-1: Contributors to this report

Name	Organization	Contribution
Elinor McGrath	ONA Fisheries	Study design and implementation; WUW analysis; reporting; Technical Advisory committee
Joe Enns	ONA Fisheries, past employee	Study design and implementation; Technical Advisory committee
Natasha Neumann	FLNRORD, formerly OBWB consultant	Hydrologist, QA/QC of Aquarius data; percentile flow analysis; Technical Advisory committee
Rich McCleary	FLNRORD – Stewardship	Steering committee and flow sensitivity assessments
Ron Ptolemy	Ministry of Environment and Climate Change Strategy	Technical Advisory committee and EFN setting guidance
Ryan Whitehouse	FLNRORD – Ecosystems	SEFA analysis, Technical Advisory committee
Molly Teather	ONA Fisheries, now at FLNRORD	Field data collection; reporting
Samantha Davis	ONA Fisheries	Report drafting and critical flow analysis
Adam O'Dell	ONA Fisheries, now at DFO	WUW analysis
Karilyn Alex	ONA Fisheries	Report review and Tennant analysis
Field technicians	ONA Fisheries and the Nations member Bands	Field data collection and guidance

1.2 Objectives

The goal of the Okanagan EFN Project was to produce defensible, transparent and robust EFN values for Okanagan streams. The scope was limited to providing technical recommendations. The specific objectives of Phase II of the EFN project were to;

1. accumulate and assess previously collected data from parallel studies that may be applicable to the study;
2. establish hydrometric stations, where applicable, to gather adequate hydrometric data to inform the EFN development;
3. determine the level of field intensity required and delineate study sites to be sampled for the streams chosen;
4. collect field data on fish habitat characteristics over a range of flows;
5. apply the "Okanagan Tennant Method" outlined in Phase I to set recommended EFNs for all 18 tributaries;
6. apply the "Okanagan WUW Method" outlined in Phase I to set recommended EFNs for ten of the 18 tributaries; and
7. recommend critical flows for each species and life-stage of concern in all 18 tributaries.

1.3 Study Area

The Okanagan Basin is a transboundary basin, spanning the Canada-U.S. border. The watershed runs from north to south, starting near Vernon, B.C. (Figure 1-1) and crossing the border at Osoyoos, B.C. The Okanagan River flows into the nx̌ʷəntkʷitkʷ (Columbia River) at Brewster, Washington State. The Canadian portion of the Okanagan Basin spans 8,000 km^2, and is long and narrow and deeply incised in the interior plateau of southern B.C. (Merritt et al. 2006). Elevation ranges from 270 meters above sea level in the southern valley to 2100 meters above sea level on the plateaus (Merritt et al. 2006). The main tributaries generally originate from elevations around 1500 meters, and drop steeply through narrow valleys before crossing alluvial fans and entering kłusxənitkʷ (Okanagan Lake) or q̓awsitkʷ (Okanagan River).

The study area covers a diverse set of ecosystems from three broad types including basins, plateaus and mountains and has been classified based on the British Columbia Ecoregion Classification System (DeMarchi 2011). The main valley is split near t̓iwcən (Skaha Lake) into the Northern Okanogan Basin and Southern Okanogan Basin Ecosections. The watersheds on the east side of the Okanagan valley originate in the Northern Okanagan Highland Ecosection. On the west side of valley, and north of Trout Creek, headwaters lie within the Western Okanagan Upland Ecosection, whereas those watersheds south of Trout Creek originate within the Okanagan Range Ecosection.

The Okanagan Basin has a semi-arid continental climate, consisting of a dry and hot summer with colder winters. Annual precipitation shows a bimodal distribution: there is a winter peak driven by storms from the Pacific Ocean, and another caused by convective summer storms (Merritt et al. 2006). The hydrological regime is snowmelt-dominated, with about three quarters of the annual runoff occurring from April to July (NHC 2001), and low flows occurring from late summer to winter. Flow in most tributaries is regulated for water storage or flood control purposes.

The Okanagan Basin is currently the most northern and upstream extent that is accessible by anadromous salmon populations in the Columbia River system. According to Traditional Ecological Knowledge (TEK), the Okanagan Basin once supported Pacific salmon species including (Rae 2005):

- sćwin – Sockeye Salmon (*Oncorhynchus nerka*) – currently present;
- ntitiyx – spring Chinook Salmon (*Oncorhynchus tshawytscha*) – currently present;
- sk'lwist – summer Chinook Salmon (*Oncorhynchus tshawytscha*) – currently present;
- qʷəyqʷəyʕaćaʔ – Steelhead (*Oncorhynchus mykiss*) – currently present; and
- kisúʔ – Coho Salmon (*Oncorhynchus kisutch*) – extirpated but low numbers have been returning.

The Basin also supports native non-anadromous salmonid species including (Rae 2005):

- kəkni – Kokanee Salmon (*Oncorhynchus nerka*) – currently present;
- xʷuminaʔ – Rainbow Trout (*Oncrorhynchus mykiss*) – currently present;
- miməlt – Whitefish –currently present;
  - Mountain Whitefish (*Prosopium williamsoni*) and
  - Pygmy Whitefish (*Prosopium coulterii*).

In addition, there have been 14 native non-salmonid species recorded and at least 14 non-native fish species introduced and observed in the Okanagan watershed (Rae 2005; Basok 2000; NPCC 2004). Several native species are listed as threatened or endangered in Canada and the United States (COSEWIC 2008; FWS 2008).

The fish species of primary interest in this report include salmonids that use the tributaries for spawning and rearing. Many of these species are culturally important to the Okanagan Nation. Species assessed in the South Okanagan included Kokanee, Rainbow, Sockeye, Steelhead, and Chinook. The Okanagan Lake Dam at the outlet of Okanagan Lake was the final migration barrier for anadromous salmonids until summer 2019, therefore, only non-anadromous species (Kokanee and Rainbow) were assessed in the north Okanagan for the purpose of this report; however, the data collected can be used to develop EFNs for other anadromous salmonid species that traditionally accessed and may once again occupy that portion of the watershed.

According to TEK, "the river channel, used to be rich in fish; Steelhead, Coho, Sockeye and King (Chinook) Salmon" (Ernst & Vedan 2000). *captikwł* (traditional legends) teach us that the natural laws of the Okanagan Basin included anadromous salmon when coyote brought them to the head of Okanagan Lake (ONA 2020). Fish passage was impeded as early as 1910 with changes to the outlet of Okanagan Lake, and in 1914 with a log weir at the site of nˤaylintən (McIntyre Dam area) (Ernst 1999). Subsequently, dams on the Okanagan River were constructed at the outlets of Okanagan Lake (Penticton Dam), Skaha Lake (Okanagan Falls Dam), Vaseux Lake (McIntyre Dam), and Osoyoos Lake (Zosel Dam in the U.S., does not impede passage) and anadromous fish populations declined drastically. As permanent fish passage was re-established at McIntyre Dam in 2009 and at Skaha Lake Control Dam at sx̌ʷəx̌ʷnikʷ (Okanagan Falls) in 2014, anadromous salmon have re-established themselves back into their territory up to the Okanagan Lake outlet dam (in Penticton). Fish passage into Okanagan Lake was established in 2019 but for the purposes of this report, EFNs for anadromous salmon were not included in tributary streams of Okanagan Lake.

Eighteen Okanagan streams were included in this project (Figure 1-1) and were chosen in collaboration between FLNRORD, OBWB and ONA. Resource limitations necessitated a ranking process to prioritize watersheds for field investigations. The following criteria were used in the ranking process:

- **Fish habitat value** – fish habitat value was determined from information contained in the stream-specific appendices of the Phase I report (Associated 2016) as well as other literature resources and traditional and local knowledge of the project partners.
- **Current Water Use Pressure** – water use pressure was determined by calculating the proportion of licensed water use to discharge on an annual basis as well as seasonally during the summer baseflow period. LTMAD values used for the calculations were taken from Summit (2009) and from Ministry of Environment (MOE; Ptolemy 2019). Estimated summer baseflows were provided by FLNRORD (2016) and estimated annual use and licensed baseflow use were contained in Associated (2016) and (Dobson 2008), respectively. Updated estimates of LTMAD and summer baseflows were later provided by Associated (2019); however, the data was not yet available at the time of the prioritization exercise.
- **Future Water Demand** – since EFNs are considered in the review of future water licence applications, those watersheds with potential for further allocation were prioritized. The number of pending licence applications (indicating high future demand) as well as any licensing restrictions (indicating that no or limited further licences would be granted) were considered. Only Equesis Creek, Shorts Creek and Vaseux Creek had no licensing restrictions on file.

Further considerations included the presence or absence of operating Water Survey of Canada (WSC) stations as well as existing Water Use Plans or Operating Plans (Table 1-2). Watersheds with Water Use Plans or Operating Plans in place were not ranked and were considered low priority for field investigations as they had previously gone through an extensive planning process; however, Mission Creek was included regardless in the Okanagan WUW Analysis due to its very high fisheries value. Lower Vernon Creek was initially included as one of the key tributaries; but was later omitted due to the complexity of its flow regime and water management, which complicated naturalized streamflow development. This report organizes the tributaries based on the EFN setting method used, then from North to South.

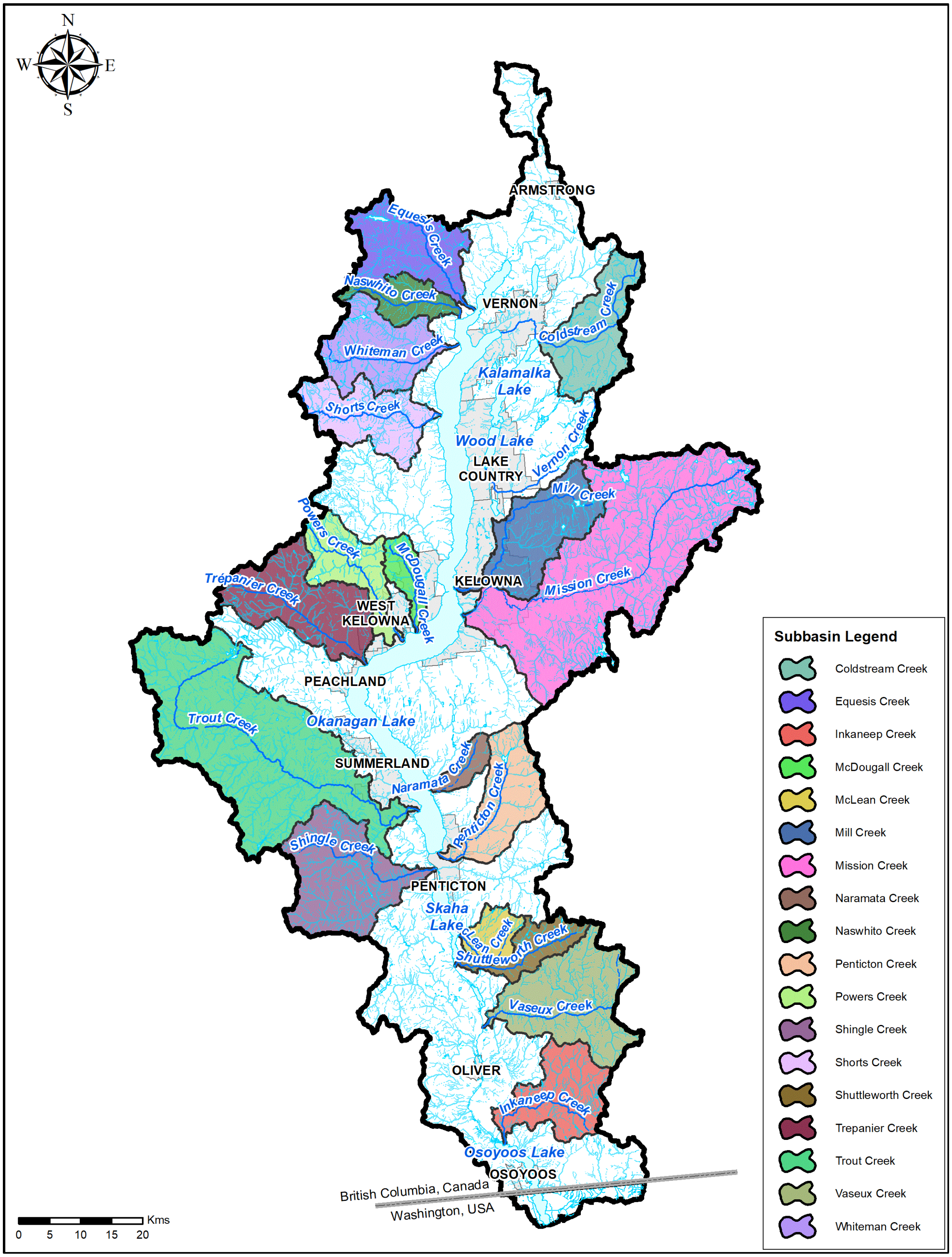

Figure 1-1: Map of the 18 study streams (Associated 2016)

Table 1-2: Criteria used for fieldwork prioritization and methods selection for EFN setting in 18 Okanagan streams

Stream	Active Water Use Plan / Operating Plan	Operating WSC hydrometric station	Fish/Fish Habitat Value	Water Use Pressure	Pending Water Licence Applications	EFN Setting Method
Coldstream Creek	No	Yes	Very High	High	4	Tennant & WUW
Equesis Creek	No	No	Very High	High	1	Tennant & WUW
Naswhito Creek	No	No	Medium	High	0	Tennant & WUW
Whiteman Creek	No	Yes	High	Low	0	Tennant & WUW
Mission Creek	Yes	Yes	a	a	a	Tennant & WUW
McDougall Creek	No	No	Medium	High	5	Tennant & WUW
Shingle Creek (upper and lower)	No	Yes	Very High	High	3	Tennant & WUW
Shuttleworth Creek	No	No	Medium	High	2	Tennant & WUW
Vaseux Creek	No	Yes	Very High	Low	0	Tennant & WUW
Inkaneep Creek	No	Yes	Very High	High	0	Tennant & WUW
Shorts Creek	No	No	Medium	Low	0	Tennant
Mill Creek	No	No	High	High	1	Tennant
Powers Creek	No	No	b	b	b	Tennant
Trepanier Creek	Yes	No	a	a	a	Tennant
Naramata Creek	No	No	Medium	High	0	Tennant
Trout Creek	Yes	No	a	a	a	Tennant
Penticton Creek	No	No	Low	Medium	0	Tennant
McLean Creek	No	No	High	N/A	1	Tennant

a not assessed due to existing Water Use Plan or Operating Plan in place

b not assessed

N/A insufficient data available to support estimate