Appendix W - Vernon Creek

Associated Environmental

APPENDIX W

Okanagan Basin Water Board
Okanagan Nation Alliance
B.C. Ministry of Forests, Lands and Natural Resource Operations

Vernon Creek




May 2016

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APPENDIX W

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APPENDIX W

1 Introduction

The purpose of this appendix is to provide information to support the application of recommended environmental flow needs (EFN)-setting methods for Vernon Creek following the methods outlined in the accompanying report[1]. This document contains information obtained and collated by Associated Environmental Consultants Inc. (Associated) and will be revised following additional input from Okanagan Nation Alliance. A summary of current available information for Vernon Creek is provided in Table 6-1 in the accompanying report and Table W-1 at the end of this appendix.

Section 5 in the accompanying report provides an overview of two recommended EFN-setting methods for tributaries within the Okanagan Basin, while Section 6 lists the key steps to implement each of the two methods, in both flowchart and text form.

Environmental flows have been previously recommended for lower, middle, and/or upper Vernon Creek by Koshinsky (1972), Halsey (1974), Wildstone Resources Ltd. (1992), Shepherd and Ptolemy (1999), nhc (2001; 2003), ESSA and Solander (2009), and Epp and Neumann (2013-2016) (Table 6-1 in the accompanying report).

2 Relevant Information for Setting Environmental Flow Needs

This section summarizes the information available to support EFN-setting in Vernon Creek. Available information sources for Vernon Creek are included within Table W-1 at the end of this appendix.

2.1 OVERVIEW OF THE WATERSHED

Vernon Creek has a watershed area of approximately 546 km^2. Vernon Creek has three main reaches, defined by Summit (2009) as follows:

1. Upper Vernon Creek between Swalwell (Beaver) Lake and Ellison Lake
2. Middle Vernon Creek between Ellison Lake and Wood Lake
3. Lower Vernon Creek between Kalamalka Lake and Okanagan Lake.

The main tributaries within the Vernon Creek watershed are Oyama Creek (which discharges into Wood Lake), Coldstream Creek (which discharges into Kalamalka Lake), and B.X. Creek (which discharges into lower Vernon Creek) (Summit 2009). Land use activities within the watershed include forestry in the headwater areas and agriculture, industry, and urban and recreational development in the lower portions of the watershed (Summit 2009). In addition, Kalamalka Lake Provincial Park and a Protected Area and Ecological Reserve are located within the eastern portion of the watershed (Summit 2009).

[1] Associated Environmental Consultants Inc. (Associated). 2016. Collaborative Development of Methods to Set Environmental Flow Needs in Okanagan Streams. Working Document, Current Version. Prepared for the Okanagan Basin Water Board, Okanagan Nation Alliance, and B.C. Ministry of Forests, Lands and Natural Resource Operations. May 2016

The Vernon Creek watershed is shown in Figure 1-1 in the accompanying report.

2.2 STREAMFLOWS

2.2.1 Hydrometric Data

There are currently two active Water Survey of Canada (WSC) and one District of Lake Country hydrometric stations within the Vernon Creek watershed:

- **Kalamalka Lake at Vernon Pumphouse** (WSC 08NM143; Regulated; Period of record: 1967-Present)
- **Vernon Creek at Outlet of Kalamalka Lake** (WSC 08NM065; Drainage area: 569 km^2; Regulated; Period of record: 1927-Present)
- **Vernon Creek at Outlet of Swalwell Lake (District of Lake Country; Drainage area: 62.4 km^2; Regulated; Period of record: 2014-Present)**

In addition, historic records are available for the following hydrometric stations within the watershed:

- **Ellison Lake near Winfield** (WSC 08NM067; Regulated; Period of record: 1968-1980)
- **Vernon Creek at Inlet to Ellison Lake** (WSC 08NM162; Drainage area: 127 km^2; Regulated; Period of record: 1970-1974)
- **Vernon Creek near Okanagan Centre** (WSC 08NM043; Drainage area: 90.1 km^2; Regulated; Period of record: 1919-1963)
- **Vernon Creek Okanagan Centre Diversion** (WSC 08NM044; Regulated; Period of record: 1919-1963)
- **Vernon Creek below Arda Dam** (WSC 08NM175; Drainage area: 102 km^2; Regulated; Period of record: 1972-1979)
- **Vernon Creek at Outlet of Swalwell Lake** (WSC 08NM022; Drainage area: 62.4 km^2; Regulated; Period of record: 1921-1996)
- **Swalwell Lake near Okanagan Centre** (WSC 08NM062; Regulated; Period of record: 1926-1992)
- **Crooked Lake at the Outlet** (WSC 08NM163; Regulated; Period of record: 1970-1981)
- **Vernon Creek at Outlet of Ellison Lake** (WSC 08NM182; Drainage area: 138 km^2; Regulated; Period of record: 1971-1974)
- **Vernon Creek Above Diversions** (WSC 08NM008; Drainage area: 90.7 km^2; Regulated; Period of record: 1919-1919)
- **Clark Creek near Winfield** (WSC 08NM146; Drainage area: 15.3 km^2; Natural; Period of record: 1968-1982)
- **Vernon Creek at Inlet to Wood Lake** (WSC 08NM009; Drainage area: 151 km^2; Regulated; Period of record: 1919-1987)
- **Winfield Creek at Inlet to Wood Lake** (WSC 08NM181; Regulated; Period of record: 1971-1973)
- **Ribbleworth Creek near Oyama** (WSC 08NM235; Natural; Period of record: 1973-1979)
- **Oyama Lake at the Outlet** (WSC 08NM224; Regulated; Period of record: 1961-1981)
- **Oyama Creek Oyama Diversion** (WSC 08NM028; Regulated; Period of record: 1920-1931)
- **Oyama Creek above Wood Lake Irrigation Intake** (WSC 08NM048; Drainage area: 44 km^2; Regulated; Period of record: 1921-1987)

- **Wood Lake at Inlet to Oyama Canal** (WSC 08NM066; Regulated; Period of record: 1928-1973)
- **Kalamalka Lake at Outlet of Oyama Canal** (WSC 08NM183; Regulated; Period of record: 1971-1979)
- **Vernon Creek at Vernon** (WSC 08NM021; Drainage area: 593 km^2; Regulated; Period of record: 1921-1960)
- **Vernon Creek near the Mouth** (WSC 08NM160; Drainage area: 751 km^2; Regulated; Period of record: 1969-1999)
- **B.X. Creek Below Swan Lake Control Dam** (WSC 08NM123; Drainage area: 120 km^2; Regulated; Period of record: 1959-1978)
- **B.X. Creek Above Swan Lake Control Dam** (WSC 08NM125; Regulated; Period of record: 1959-1979)
- **B.X. Creek Above Vernon Intake** (WSC 08NM020; Drainage area: 55.7 km^2; Regulated; Period of record: 1921-1999)

The Oceola Fish and Game Club also operated five hydrometric stations within the Vernon Creek watershed between 2005 and 2007 (Summit 2009):

- **Ellison / Duck Lake** (Regulated; Period of record: 2004-2007)
- **Middle Vernon Creek at the Remiche Road Bridge Crossing** (Regulated; Period of record: 2004-2007)
- **Vernon Creek at Outflow of Swalwell / Beaver Lake** (Regulated; Period of record: 2004-2005)
- **Vernon Creek downstream of DLC intake** (Regulated; Period of record: 2005-2005)
- **Vernon Creek downstream from old Hiram Walker Spillway** (Regulated; Period of record: 2004-2005)

2.2.2 Naturalized Streamflows

Figure 6-1 in the accompanying report highlights the necessity of producing hydrographs under natural conditions and under actual, licensed, and future proposed water use conditions. nhc (2001; 2003) and Summit (2009) provided naturalized streamflow estimates for Vernon Creek at the outlet of Kalamalka Lake and at the mouth. In addition, as part of the Okanagan Water Supply and Demand Project, net and naturalized flows were modelled for the majority of Okanagan tributaries, including Vernon Creek (Summit 2010). However, DHI (2010) identified that the modelled net streamflows for Vernon Creek (at the outlet of Kalamalka Lake and at the mouth) were significantly higher than naturalized estimates, which is very unlikely. DHI (2010) attributed the overestimation to differences in the operational strategy of Kalamalka Lake between actual operations and those implemented within the model. As a result, for EFN-setting methods within Vernon Creek, it is recommended that net and naturalized streamflows be developed independently of the estimates provided from the Okanagan Water Supply and Demand Project.

2.3 FISH AND AQUATIC HABITAT

Vernon Creek provides valuable aquatic habitat for spawning fish. Sensitive Habitat Inventory and Mapping (SHIM) and aquatic habitat assessments have been completed for the lower, middle, and upper portions of Vernon Creek. The studies that summarize aquatic habitat within the watershed are as follows:

- Ecoscape (2006; 2009; 2012a) – SHIM for Upper Vernon Creek
- Ecoscape (2012b) – Aquatic Habitat Index Study on both Kalamalka and Wood Lakes, documenting aquatic habitat and stream morphology.
- EBA Engineering Consultants Ltd. (2004) – SHIM for Lower Vernon Creek
- Geostream Environmental Consulting and Columbia Environmental Consulting (2003) – Biological and Hydrological Assessment of the Middle Vernon Creek watershed, documenting fish habitat, stream morphology, and fish spawning activities
- RDCO (2002) – SHIM for Middle Vernon Creek

Since current (and potentially historic) aquatic habitat information is important for developing an EFN flow regime, it is recommended that up-to-date aquatic habitat information be obtained from publically available databases at the time of investigation.[2]

2.3.1 Current and Historical Fish Species Presence

Fish species found in the Vernon Creek watershed include rainbow trout, kokanee salmon, burbot, northern pikeminnow, sucker (general), prickly sculpin, sculpin (general), and peamouth chub (ESSA and Solander 2009).

Since current (and potentially historic) fish presence information is important for developing an EFN flow regime, it is recommended that up-to-date fish presence information be obtained from publically available databases at the time of investigation.[3]

2.3.2 Fish Periodicity and Habitat Suitability

nhc (2003) provided a fish periodicity chart for Vernon Creek that defines critical timing periods for rainbow trout and kokanee salmon (i.e., Figure 4 in nhc [2003]), including adult migration, spawning, incubation, dry rearing, and par rearing.

Epp and Neumann (2013-2016) provided Weighted Useable Width results for Middle Vernon Creek, and provided essential building blocks for developing Habitat Suitability Index (HSI) curves for Middle Vernon Creek.

In addition, Appendix E in the accompanying report provides information on salmonid species-specific life stage periodicities for the Okanagan Basin, as well as habitat suitability index (HSI) curves for select

[2] Aquatic habitat information, including fish barriers can be obtained from the Government of B.C. Habitat Wizard: http://www.env.gov.bc.ca/habwiz/.
[3] Fish presence information can be obtained from the Government of B.C. Fish Inventory Summary System Database Query: http://www.env.gov.bc.ca/fish/fiss/.

species. The information within nhc (2003), Epp and Neumann (2013-2016), and Appendix E should be used at a minimum to support EFN-setting for Vernon Creek.

2.4 WATER USE AND STORAGE

There are two major water suppliers within the Vernon Creek watershed (Dobson 2008 [included in Summit 2010]):

- Greater Vernon Water (GVW)
- District of Lake Country (DLC)

In addition to multiple private users, Woodsdale Water Utility, Alto Water Utility, and the Okanagan Indian Band also use the sub-basin for water supply purposes (Dobson 2008). The Vernon Golf and Country Club also diverts water from Lower Vernon Creek for irrigation purposes (Dobson 2008).

Substantial information relevant to water use, flow regulation, water management and reservoir operation, water supply, intra- and inter-basin transfers, is available in Dobson (2008), Summit (2010), and Epp and Neumann (2013).

Summit (2010) provides an estimate of actual surface water use within the Vernon Creek watershed for 1996-2006 in Appendix C of the Okanagan Water Supply and Demand Project – Phase 2. The actual mean annual surface water use over 1996-2006 was estimated to be 20,417 ML (which includes water use for the Vernon Creek watershed upstream and downstream of Kalamalka Lake). These water use estimates were subsequently included within the Okanagan Hydrologic Connectivity Model that was used to investigate 'first-in-time, first-in-right' water license legislation within the Okanagan Basin (Summit 2013).

2.4.1 Storage Reservoirs

Vernon Creek is strongly influenced by developed storage throughout the watershed. DLC operates the following reservoirs within the watershed (Summit 2009):

- Crooked Lake
- Swalwell Lake
- Oyama Lake
- Dammer Lake

The storage reservoirs capture snowmelt runoff and water is released into Vernon Creek to augment natural low summer, fall, and winter flows (Dobson 2008). Crooked, Swalwell, and Dammer Lake are connected and operate together to control streamflows within Upper and Middle Vernon Creek. In addition, Greater Vernon Water operates the King Edward Reservoir within the Coldstream Creek watershed (Appendix F).

The B.C. Ministry of Environment (MOE) regulates water levels within Kalamalka Lake and Wood Lake by a dam at the outlet of Kalamalka Lake. Note that the two lakes are connected by a canal at Oyama and are considered a single water body (Summit 2009). MOE manages the water levels in Kalamalka and Wood

Lakes by a dam at the outlet of Kalamalka Lake. In addition, releases from Kalamalka Lake (i.e., into Lower Vernon Creek) is managed to maintain a minimum fishery flow release of 0.035 m^3/s (Dobson 2008).

Epp and Neumann (2016) report that a temporary flow control structure (sandbags) has been installed on Middle Vernon Creek since 2003 in an attempt to increase storage in Ellison Lake and augment streamflows during kokanee salmon spawning periods in September and October.

2.4.2 Water Licences and Major Points of Diversion

There are 617 current water extraction licences and three active applications within the entire Vernon Creek watershed. Since knowledge of current water licences is critical in developing EFN flow regimes, it is recommended that up-to-date water licence information be obtained at the time of investigation.[4]

DLC operate one intake on Middle Vernon Creek approximately 7 km upstream from Ellison Lake, and a second on Wood Lake, approximately 2 km upstream from Kalamalka Lake. In addition, GVW has an intake on Kalamalka Lake that diverts water for use within the Lower Vernon Creek sub-basin and surrounding areas (i.e., City of Vernon).

2.4.3 Interbasin Transfers

There are no direct diversions of water to or from the Vernon Creek watershed; however, water is distributed throughout the Vernon Creek watershed.

2.5 GROUNDWATER AND SURFACE WATER INTERACTION

Summit (2009) reports that there is likely no net loss / gain of streamflow to or from groundwater (Section 3.6 of Summit 2009). In addition, Epp and Neumann (2013-2016) include estimates of groundwater and surface water interactions in the annual water balance for Middle Vernon Creek.

2.6 TRADITIONAL KNOWLEDGE

The current version of this document does not include presentation of any Okanagan Nation Traditional Knowledge. However it is anticipated that a future revision will include such information, as well as potentially other technical information held by the Okanagan Nation Alliance Fisheries Department.

[4] Water Licence Information can be obtained from the Government of B.C. Water Licences Query: http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input.

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Table W-1 Summary of relevant information for setting environmental flow needs within Vernon Creek watershed

Information Source	Fish and Aquatic Habitat											Streamflow				Water Management															
	Current Fish Species Presence	Historic Fish Species Presence	Fish Periodicity Tables	Aquatic Habitat	Channel Characteristics	Channel Cross-Sections	Channel Velocity/Depth Measurements	Habitat Suitability Index	Fish Barriers (Natural/Man-made)	EFN Investigations / Recommended Fish Flows	Other Relevant Information	Streamflow Measurements	Water Quality / Temperature	Streamflow Estimates	Other Relevant Information	History of Water Management	Water License Points-of-Diversion Mapping	Water License Information	Water License – Conservation Storage/Flows	Water Purveyor Intakes	Groundwater Wells Mapping	Groundwater Information	Water Use Information (Actual/Estimated)	Return Flow Information	Land Use and Associated Water Supply Source	Interbasin/Intrabasin Transfers	Flow Regulation	Reservoir Flow Release Patterns	Reservoir Minimum Flow Releases	Other Relevant Information
Online Resources																															
B.C. Habitat Wizard (http://www.env.gov.bc.ca/habwiz/)	✓								✓																						
B.C. Ministry of Forests, Lands, and Natural Resource Operations – Dam Safety Program (http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/). Contact: Mike Noseworthy, Dam Safety Officer (Penticton).																											✓				
B.C. Orchard Museum (https://kelownamuseums.ca/museums/the-bc-orchard-industry-museum/)																✓															
B.C. Water Licences Query (http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input)																		✓													
B.C. Water Resources Atlas (http://www.env.gov.bc.ca/wsd/data_searches/wrbc/)												✓	✓				✓			✓	✓	✓					✓				
B.C. Water Use Reporting Center (http://www.obwb.ca/tools/bc-water-use-reporting-centre/)												✓											✓								
B.C. Water Well Application (https://a100.gov.bc.ca/pub/wells/public/)																						✓									
DataBC (http://www.data.gov.bc.ca/)												✓	✓				✓	✓		✓	✓	✓					✓				
District of Lake Country (http://www.okanaganway.ca/municipal/). Contact: Director of Engineering and Environmental Services												✓	✓			✓				✓			✓				✓	✓	✓	✓	
Fisheries Inventory Summary System (http://www.env.gov.bc.ca/fish/fiss/)	✓			✓																											
Okanagan Historical Society Reports (https://open.library.ubc.ca/#/collections/ohs)																✓															
Regional District of North Okanagan (water master plan) (http://www.rdno.ca/index.php/services/engineering/water/greater-vernon-water)													✓	✓									✓		✓		✓				
Regional District of North Okanagan (http://www.rdno.ca/index.php/services/engineering/water/greater-vernon-water). Contact: Manager – Greater Vernon Water																✓				✓			✓			✓	✓	✓	✓	✓	
Water Survey of Canada (https://www.ec.gc.ca/rhc-wsc/)												✓																			
Literature Resources																															

Information Source	Fish and Aquatic Habitat											Streamflow				Water Management															
	Current Fish Species Presence	Historic Fish Species Presence	Fish Periodicity Tables	Aquatic Habitat	Channel Characteristics	Channel Cross-Sections	Channel Velocity/Depth Measurements	Habitat Suitability Index	Fish Barriers (Natural/Man-made)	EFN Investigations / Recommended Fish Flows	Other Relevant Information	Streamflow Measurements	Water Quality / Temperature	Streamflow Estimates	Other Relevant Information	History of Water Management	Water License Points-of-Diversion Mapping	Water License Information	Water License – Conservation Storage/Flows	Water Purveyor Intakes	Groundwater Wells Mapping	Groundwater Information	Water Use Information (Actual/Estimated)	Return Flow Information	Land Use and Associated Water Supply Source	Interbasin/Intrabasin Transfers	Flow Regulation	Reservoir Flow Release Patterns	Reservoir Minimum Flow Releases	Other Relevant Information
Epp, P., and N. Neumann. 2016. Middle Vernon Creek Action Plan Year Four Summary: 2015 Hydrology, Water Balance & Weighted Usable Widths for Kokanee Spawning in Middle & Upper Vernon Creeks. Prepared for Okanagan Nation Alliance Fisheries Department and B.C. Ministry of Forests, Land and Natural Resource Operations.																															
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Ecoscape Environmental Consultants Ltd. 2012. Kalamalka Lake and Wood Lake Aquatic Habitat Index. Prepared for the Okanagan Collaborative Conservation Program, December 2012.	✓			✓							✓														✓						
Ecoscape Environmental Consultants Ltd. 2012. Upper Vernon Creek modified SHIM and Landslide assessment.				✓	✓	✓	✓	✓	✓						✓																✓
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Information Source	Fish and Aquatic Habitat											Streamflow				Water Management															
	Current Fish Species Presence	Historic Fish Species Presence	Fish Periodicity Tables	Aquatic Habitat	Channel Characteristics	Channel Cross-Sections	Channel Velocity/Depth Measurements	Habitat Suitability Index	Fish Barriers (Natural/Man-made)	EFN Investigations / Recommended Fish Flows	Other Relevant Information	Streamflow Measurements	Water Quality / Temperature	Streamflow Estimates	Other Relevant Information	History of Water Management	Water License Points-of-Diversion Mapping	Water License Information	Water License – Conservation Storage/Flows	Water Purveyor Intakes	Groundwater Wells Mapping	Groundwater Information	Water Use Information (Actual/Estimated)	Return Flow Information	Land Use and Associated Water Supply Source	Interbasin/Intrabasin Transfers	Flow Regulation	Reservoir Flow Release Patterns	Reservoir Minimum Flow Releases	Other Relevant Information
describing monthly water extraction, water use, and net and natural streamflow for all major tributaries in the Okanagan Basin.																															
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Information Source	Fish and Aquatic Habitat											Streamflow				Water Management															
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