

3.2 Equesis Creek

Equesis Creek is a tributary to Okanagan Lake, flowing from the west side of the Okanagan Basin into the northwest arm of Okanagan Lake south of Vernon, B.C. over a total length of 27 km (Wildstone Resources Ltd. 1997). The Equesis Creek watershed is approximately 204 km² (Associated 2016) and has several lakes in its headwaters including Pinaus Lake, which had an outlet dam built in 1922 to control downstream flows. A summary of creek characteristics is found in Table 3-4 and additional stream-specific data is provided in Appendix B2.

In the lower reaches, Equesis Creek flows over an alluvial fan that has merged with the Naswhito Creek fan. Water losses and gains across the fan are unknown. The lower reaches of Equesis Creek (downstream of Westside Road) flow through agricultural fields and bank modifications, bank erosion from unrestricted livestock access, and riparian clearing were identified during habitat surveys for this project. Severe downcutting of the streambed and associated bank erosion was observed in the lower 2 km. Further, extensive flooding and sediment deposition during the 2017 and 2018 freshets resulted in dredging work near the mouth. The lower reaches of Equesis Creek have some impairment due to channelization, but have medium to good quality riparian vegetation (Eyjolfson & Dunn 2016). The reach upstream of Westside Road shows moderate development impacts and areas of erosion, with some unscreened water intakes (Eyjolfson & Dunn 2016). The intermediate and upper reaches of Equesis Creek mostly traverse forested lands with some agricultural use.

Equesis Creek is an important spawning and rearing area for fluvial and adfluvial Rainbow, and an important producer of Kokanee (Wightman & Taylor 1978). The entire length of Equesis Creek is of suitable gradient for spawning (Anonymous 1969), and it was ranked #3 for fisheries production capacity in tributaries to Okanagan Lake (Wightman & Taylor 1978). Several irrigation weirs were documented as barriers to fish passage in previous reports (Anonymous 1969; Wightman & Taylor 1978). Habitat surveys for this project revealed that several of them have either been removed, altered or deteriorated to a point where they have become passable. The irrigation weir immediately below Westside Road has become partially passable and Kokanee were documented to spawn in the reaches upstream (Louis 2012). The largest of the barriers, an irrigation dam located 4.8 km from the mouth (Eyjolfson & Dunn 2016), was identified to block Kokanee and Rainbow adult migrations. However, this dam was impacted by high flows during the 2018 freshet and is now partially passable (Louis pers. comm. 2019). Annual Kokanee spawner enumerations generally find the majority of spawning activity occurs below Westside road. Annual spawner reports make note of a higher proportion of large-bodied Kokanee in Equesis Creek than adjacent Naswhito and Whiteman Creeks during some years (Louis 2016). Rainbow spawning activity likely extends much further upstream.

A total of three glide and three riffle transects were established in Equesis Creek in August of 2016 (Figure B2-3, Appendix B2). All transects were located downstream of the irrigation dam fish barrier 4.8 km from the mouth and mostly within the documented Kokanee spawning reaches below Westside Road. One paired glide riffle transect was situated upstream of Westside Road. The lowermost transects (1 and 2) near the mouth had to be moved following the 2017 freshet due to extensive channel changes at the original locations.

Equesis Creek has relatively high flows during the non-freshet period due to flow augmentation from storage in Pinaus Lake (Associated 2019). The Okanagan Indian Band holds several storage licences on Pinaus Lake that are managed for downstream irrigation users and releases are also jointly managed with FLNRORD to supplement natural streamflows for fish when needed (Dobson 2008). There are no active

WSC hydrometric stations on Equis Creek though historical data exists. Three hydrometric stations were installed in 2016 to collect hydrometric data for this project (Figure B2-3, Appendix B2). The station near the mouth had to be moved further upstream post-2017 freshet due to extensive flooding and sediment deposition in the area. A real-time station installed just downstream of Westside Road continues to operate presently. A third station was installed upstream of Westside Road. At present, there are 67 points of diversion within the watershed and two pending water licence applications (Associated 2019); however, the actual volume extracted is unknown. A conservation licence is in place but is very small (0.002 m³/s) (Associated 2019). Equis Creek is 'flow sensitive' during summer and winter when naturalized flows are below 20% LTMAD (Table 3-5).

Table 3-4: Equis Creek description

Drainage Area	203.5 km ²
Median elevation	1173 m
WSC station	There are no active WSC stations in the Equis drainage area. Historic records are available from: 08NM176 – Ewer Creek near the Mouth (1971-1986) 08NM024 – Equis Creek near Vernon (1921-1926) 08NM161 – Equis Creek near the Mouth (1969-1982)
ONA station	08NM707 – Equis Hydromet 1a at Victoria Road (2017-2018) 08NM161-HDS – Equis Hydromet 2 at Westside Road (2017-present) 08NM585 – Equis Hydromet 3 at Bonneau Road (2016-2017)
LTMAD	0.700 m ³ /s (Associated 2019)
Fish species expected	Rainbow, Kokanee, Prickly Sculpin, and Yellow Perch (ESSA & Solander 2009)
Land use	Forestry, agriculture. Lower reach flows through Okanagan Indian Reserve No. 1 (Associated 2016)

Naturalized, residual and maximum licensed flow data were provided by Associated (2019), with an estimated data quality rating of B for naturalized flows (data error between 10% and 25%), and a rating of D for residual and maximum licensed flows (data error greater than 50%). The naturalized LTMAD and summer low flow estimates were considered relatively low for the watershed and channel size. Estimated maximum licensed flows indicate that the stream would be dry from late July to mid-September if licensed withdrawal and storage volumes were maximized (Figure 3-4).

Okanagan Tennant EFNs for Equis Creek were developed in accordance with the methods outlined in Section 2.2. Fish periodicity and flow standards described in Table 2-2 to Table 2-6 were used. Weekly Okanagan Tennant EFNs were set to the lower of the naturalized flow or flow standard. However, flows in Equis Creek are augmented by releases from Pinaus Lake and residual flows are typically greater than flow standards during the non-freshet period. Local fish populations have adapted to this flow augmentation and therefore, final EFN setting in Equis Creek was based on residual rather than naturalized flows. Accordingly, WUW information from the study transects was used to adjust the Okanagan Tennant EFNs. A summary of the recommended EFNs is provided in Table 3-5, including the median EFN and the range of weekly EFNs, with weekly details in Figure 3-3, 3-4 and Appendix B2 and naturalized flow sensitives in Table 3-5. The recommended EFNs are intended to maintain current levels of fish production in Equis Creek by protecting flow conditions that local populations have become adapted to. Critical flows were calculated as described in Section 2.4. Further information regarding EFN and critical flow setting in Equis Creek is provided at the end of this section.

Table 3-5: Flow sensitivities in Equis Creek

Species & life stage	1-in-2 yr 30-day summer low flow		1-in-2 yr 30-day winter low flow	
	Flow (m ³ /s)	% LTMAD	Flow (m ³ /s)	% LTMAD
Rainbow rearing	0.059	8%		
Insect production				
Kokanee spawning				
Rainbow overwintering			0.046	7%
Kokanee egg incubation				

Source: Associated (2019)

Table 3-6: EFN summary table for Equis Creek

Species & life stage	Time period	Okanagan Tennant EFN		WUW EFN (m ³ /s)	Recommended EFN (m ³ /s)				Critical flow	
		Median (m ³ /s)	% LTMAD		Median	% LTMAD	Min	Max	Flow (m ³ /s)	% LTMAD
Rainbow rearing & insect production ^a	April 1 – Oct 31	0.140	20%	0.17	0.170	24%	0.163	0.505	0.035	5%
Rainbow spawning	May 20 – Jul 10	1.18	168%	1.100	1.10	157%	0.706	3.39	0.380	54%
Kokanee spawning	Sep 10 – Oct 10	0.132	19%	0.177	0.177	25%	0.170	0.198	0.070	10%
Rainbow overwintering	Nov 1 – March 31	0.121	17%	n/a	0.137	20%	0.134	0.173	0.035	5%

^a while EFNs apply to the entire period, median values are presented for the summer low flow period from Jul 15-Sept 30.

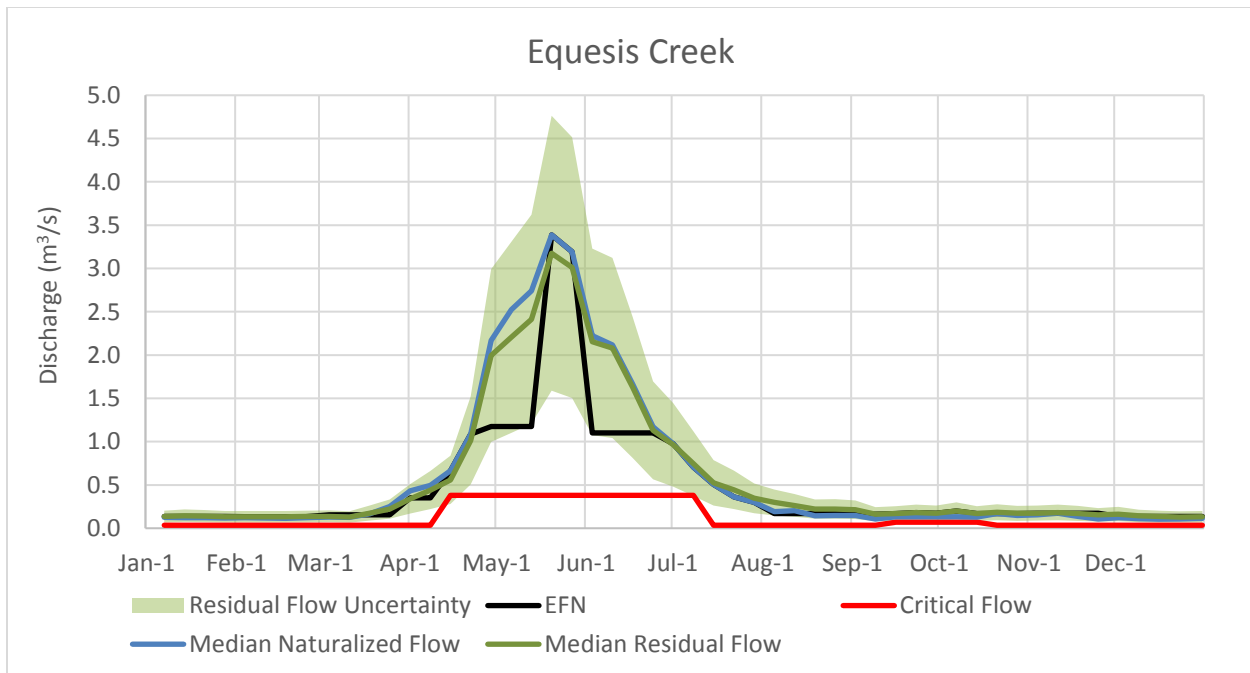


Figure 3-3: Weekly EFN, critical flow and streamflows in Equis Creek

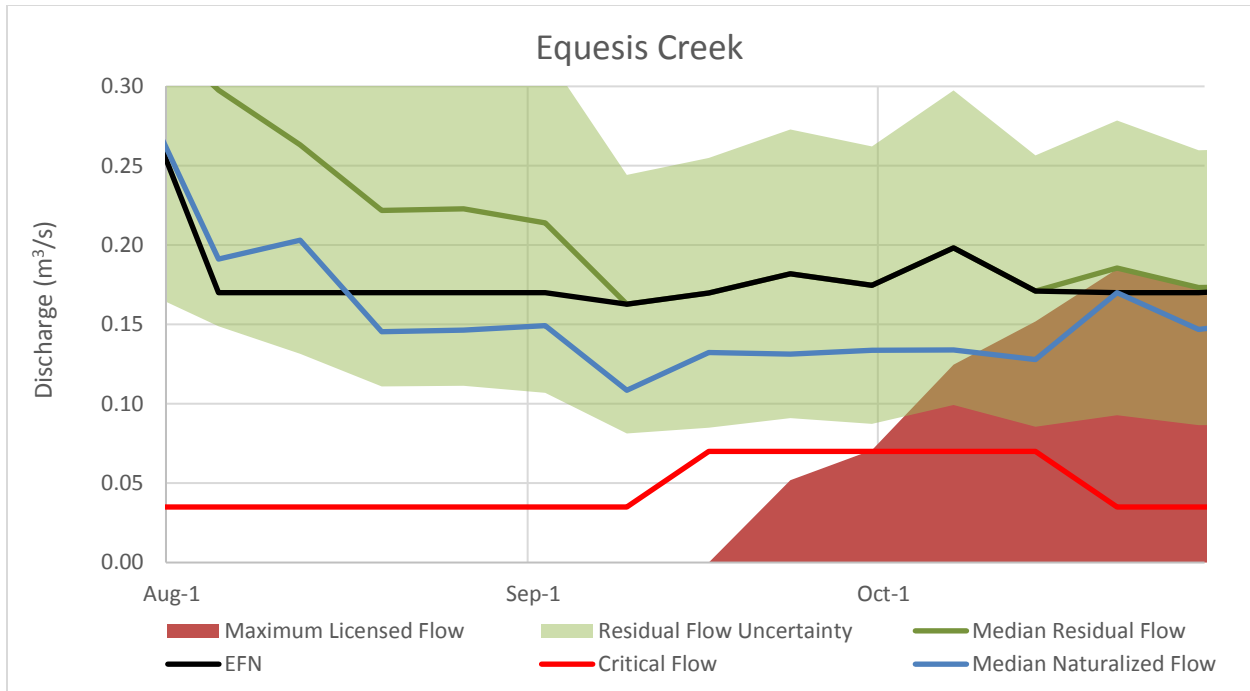


Figure 3-4: Weekly EFN, critical flow and streamflows during the summer and fall period in Equesis Creek

Rainbow parr rearing

Due to consistently high streamflows in Equesis Creek during the study period, no low flow WUW measurements could be obtained. Therefore, the low flow portion of the WUW curve has greater uncertainty than in other streams, as indicated by the wider confidence bands (Figure B2-11, Appendix B2). The recommended EFN for Rainbow Parr rearing is $0.170 \text{ m}^3/\text{s}$ (24% LTMAD). While naturalized flows indicate a slightly lower Okanagan Tennant EFN ($\sim 0.140 \text{ m}^3/\text{s}$, Table 3-6), fish populations in the creek have adapted to an augmented residual flow regime and any reductions would lead to losses in productivity, as indicated by the rapid decline of the WUW curve. The recommended EFN maintains approximately 45% of maximum Rainbow parr rearing WUW (Figure B2-11, Appendix B2) and 25% of insect production WUW (Figure B2-12, Appendix B2). It is near the lowest of the weekly residual flow estimates provided by Associated (2019), confirming that the recommended EFN is generally achievable under residual flow conditions. Further, residual flows recorded at the hydrometric stations from 2016-2018 were greater than $0.2 \text{ m}^3/\text{s}$ (Figures B2-4 to B2-6, Appendix B2), indicating that the recommended EFN can be met with relative certainty under current water use and release operations. Historically, the lowest residual median weekly flows at the WSC hydrometric station 08NM161 (1969-1982) was slightly below the recommended EFN at $0.124 \text{ m}^3/\text{s}$, but discharge was generally above $\sim 0.2 \text{ m}^3/\text{s}$ (Figure B2-7, Appendix B2). Photos of habitat conditions in Equesis Creek at the recommended EFN flows are provided in Plate 3-3.

Historic EFN recommendations for Rainbow rearing in Equesis Creek have ranged from $0.075 \text{ m}^3/\text{s}$ (11% LTMAD) (Shepherd & Ptolemy 1999) to $0.75 \text{ m}^3/\text{s}$ (ESSA & Solander 2009) but were not based on field observations. WUW curves indicate that a flow of $0.075 \text{ m}^3/\text{s}$ would provide <20% of maximum parr rearing WUW. Koshinsky (1972) recommended a minimum incubation flow of $0.17\text{-}0.23 \text{ m}^3/\text{s}$, which is similar to the recommended EFN.

The recommended critical flow for Rainbow parr rearing is 0.035 m³/s (5% LTMAD, Table 3-6). While riffle analysis indicates that 60% of maximum wetted width is maintained at flows of approximately 0.107 m³/s (15% LTMAD; Table B2-2, Appendix B2), no measurements were collected below 0.21 m³/s and there is considerable uncertainty in this estimate. Further measurements at low flows should be obtained to confirm the critical flow recommendation.

Water temperatures in Equis Creek recorded at the ONA hydrometric stations were generally favorable to Rainbow rearing (maximum 16°C recorded in mid-July), which was likely aided by the relatively high streamflows throughout the summer period (Figures B2-8 to B2-10, Appendix B2).

Rainbow spawning

The recommended EFN for Rainbow Spawning is 1.10 m³/s (157% LTMAD), which is just below the Okanagan Tennant flow standard (168% LTMAD) and below the median weekly naturalized flows during the Rainbow spawning period (Figure B2-13, Appendix B2). This EFN maintains high WUW (> 90% of maximum) while also maintaining approximately 90% of Rainbow parr rearing WUW. Photos of habitat conditions in Equis Creek at the recommended EFN flows are provided in Plate 3-4.

The recommended critical flow for Rainbow spawning is 0.380 m³/s (54% LTMAD, Table B2-2, Appendix B2) based on the passage depth criterion (Table 2-7).

Kokanee spawning

The recommended EFN for Kokanee spawning is 0.177 m³/s (25% LTMAD; Table 3-6), which is equivalent to the median estimated residual flows during the Kokanee spawning period (Associated 2019). While naturalized flows are slightly lower during the same period (~0.132 m³/s, 19% LTMAD), fish populations in Equis Creek have adapted to the augmented flow regime and any reductions may result in losses in productivity, as indicated by the rapid decline of the WUW curve (Figure B2-14, Appendix B2). The recommended EFN maintains approximately 70% of Kokanee spawning WUW. Safe riffle passage conditions for Kokanee are achieved at 0.095 m³/s (14% LTMAD, Table B2-2, Appendix B2), though higher flows or channel modifications may be needed to facilitate access during some years if gravel aggradation occurs at the mouth. The recommended EFN is expected to provide sufficient flows for safe riffle passage during most years. Photos of habitat conditions in Equis Creek at the recommended EFN flows are provided in Plate 3-3.

Historic EFN recommendations for Kokanee spawning in Equis Creek have ranged from 0.09 m³/s (13% LTMAD; Dobson 1990b) to 0.9 m³/s (ESSA & Solander 2009). The recommended EFN is similar to that by Shepherd & Ptolemy (1999) who recommended an EFN of 0.15 m³/s but lower than that of Koshinsky (1972) who recommended 0.23-0.28 m³/s.

The recommended critical flow for Kokanee spawning is 0.070 m³/s (10% LTMAD, Table B2-3, Appendix B2) based on the LTMAD criterion (Table 2-7). While riffle analysis indicates that safe riffle passage is maintained at flows of 0.095 m³/s (14% LTMAD; Table B2-2, Appendix B2), no measurements were collected below 0.21 m³/s and there is considerable uncertainty in this estimate. Further measurements at low flows should be obtained to confirm the critical flow recommendation.

Recently observed residual flows during the Kokanee spawning period are typically greater than those estimated by Associated (2019). Daily flows during the Kokanee spawning period recorded at the hydrometric station near Westside Road (08NM161HDS) from 2016 to 2018 ranged from 0.25 to 0.51 m³/s

(Figure B2-5, Appendix B2). Noticeably lower flows were recorded at the hydrometric station near the mouth in 2017 (approximately 0.2 m³/s) throughout the irrigation season, followed by a sudden increase in mid-October (Figure B2-4, Appendix B2). The reaches below Westside Road may have flows below the EFN during the summer and the Kokanee spawning period due to irrigation water withdrawals during some years. Historical median weekly residual flows from the WSC 08NM161 hydrometric station (1969-1982, also near Westside Road) ranged from 0.19 to 0.25 m³/s. Kokanee spawning EFNs are likely to be met during most years with continued supplementation from Pinaus Lake. Maintaining spawning flows in the 0.25-0.5 m³/s range, when possible, would maximize Kokanee spawning habitat capacity (WUW increase from 70% to 100%) and should be encouraged to maximize production from this creek.

Plate 3-3: Equis Creek habitat conditions at flows near the recommended Rainbow parr rearing (0.170 m³/s) EFN and Kokanee spawning EFN (0.177 m³/s)



Glide 2 at 0.172 m³/s (25% LTMAD)



Glide 2a at 0.200 m³/s (29% LTMAD)



Riffle 2 at 0.172 m³/s (25% LTMAD)



Riffle 2a at 0.200 m³/s (29% LTMAD)

Plate 3-4: Equis Creek habitat conditions at flows near the recommended Rainbow spawning (1.10 m³/s) EFN



Glide 2a at 1.14 m³/s (163% LTMAD)



Glide 1a at 1.30 m³/s (186% LTMAD)