WRIA 59 Colville River and Tributaries
Toe-Width Assessment
Final Report

Prepared for
Stevens County
And The
WRIA 59 Water Resource Management Board

Prepared by

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Toe-Width Assessment Report

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ACKNOWLEDGEMENTS

The WRIA 59 Colville River and Tributaries Toe-Width Assessment Project was developed and completed over a six-month period during 2008, under the direction and oversight of the WRIA 59 Water Resource Management Board. EES Consulting, Inc. was contracted by Stevens County to provide project management, conduct and coordinate the toe-width surveys and develop the project report. Local, state, federal, and tribal government representatives provided technical assistance on the project, and the Stevens County Conservation District and the U.S. Forest Service - Colville National Forest provided field equipment for the assessment work. The following individuals listed below provided technical assistance with project development, data collection and assessment work for the project.

WRIA 59 Water Resource Management Board Members:
Sandy Dotts – Washington Department of Fish and Wildlife
Gary Fetter – Cattle Rancher
Jennifer Hickenbottom – U.S.F.S., Colville National Forest
Charlie Kessler – Stevens County Conservation District
Wes McCart – Stevens County Farm Bureau
Jaime Short – Washington Department of Ecology

Additional Assistance:
Brad Caldwell – Washington Department of Ecology, Water Resource Program
Dean Hellie – Stevens County Conservation District
Paul Jurun – Spokane Tribe of Indians, Water Resources Program

Stevens County Staff:
Linda Kiefer – Watershed Planning

EES Consulting, Inc. Staff:
Pete Rittmueller – Project Lead
Nic Truscott – Project Fish Biologist

GLOSSARY

cfs: Unit of measurement for flow rate of fluids; cubic feet per second. One cfs = approximately 449 gallons per minute (gpm).

Control point: The location within a river or stream at which a minimum instream flow set by rule could be monitored.

Egg Incubation: The period of time between fertilization of eggs and emergence of fry, usually about 28 to 40 days for rainbow trout.

Emergence: Term referring to the act of fry leaving the gravel of the redd where they developed for the first time.

Instream flows: Washington Department of Ecology (2007) defines instream flows as "the stream flows needed to protect and preserve instream resources and values, such as fish, wildlife and recreation". Instream flows are most often described and established in a formal legal document, typically an adopted state rule. The term 'instream flow' is used to identify a specific stream flow (typically measured in cubic feet per second, or cfs) at a specific location for a defined time.

Life stage/history: The age and life history period of a fish, as defined for resident trout:

- Incubation: the period between egg fertilization and hatching.
- Alevin: the life stage period between egg hatching and the absorption of the amniotic sac, also known as "swim-up".
- Fry: the life stage period occurring from swim-up to spring the following year.
- Juvenile: immature fish from the first spring to the adult life stage.
- Adult: fish that is believed to be old enough to be reproductively active (typically age 2,3, or 4 and older).
- Mature fish: an adult fish believed to be reproductively active.
- Spawning: the reproductive phase of an adult fish.

Minimum instream flow: Traditionally derived for a given stream location as a low flow rate presumed to support aquatic life, to minimize pollution, or for recreation.

Pool: A part of a stream characterized by low velocity, flat water surface, a downstream hydraulic control, and often deeper water, that is used by fish for resting and cover.

Pool Tailout: A part of a stream between the pool and riffle where velocity increases and the depth decreases; this habitat type is sometimes referred to as a glide.

Preferred Discharge: Described by Swift (1976) as the discharge that provides depths and velocities preferred by spawning steelhead trout (preferred spawning discharge), and the discharges that covers the stream bed for aquatic insects for rearing trout (preferred rearing discharge).

Q (cfs): Symbol used to represent a stream flow rate. The units are typically given in terms of cubic feet per second (cfs).

Rearing: The part of a salmonid life cycle dedicated to feeding and growing.

Riffle: A relatively shallow reach of stream in which the water flows swiftly with the downstream gradient and the water surface is broken into waves by obstructions that are completely or partially submerged.

Run: A portion of a stream with low surface turbulence and constant slope.

Spawning: The act of fish reproduction; in salmonids it involves the female creating a depression in the gravel substrate to deposit her eggs in (called a redd), once the eggs are deposited a male fertilizes the eggs.

Thalweg: A line that follows the deepest part of a channel.

Toe-of-bank: Swift defines the toe-of-bank as the point where the streambed and bank join.

Water Resource Inventory Area (WRIA): One of the 62 geographic areas within Washington State, defined on the basis of surface water resources and codified in Washington Administrative Code (WAC) 173-500.040. **WRIA 59** is the number assigned to the Colville River Watershed.

Watershed: The total land area that drains to any point in a stream; also referred to as a basin, subbasin, or drainage area.

1.0 INTRODUCTION

There are 62 designated major watersheds or Water Resource Inventory Areas (WRIAs) in Washington State. The Colville River Watershed has been identified as the 59th watershed, or 'WRIA 59'.

The Colville River Watershed, located in northeast Washington State encompasses approximately 1007 square miles within Stevens County. The headwaters are near Loon Lake and Springdale in the south end of the watershed. The Colville River empties into Lake Roosevelt at the north end of the watershed near the city of Kettle Falls.

The WRIA 59 Water Resource Management Board (WRIA 59 Board), organized in 1999 under the Washington State Watershed Planning Act (Chapter 90.82 RCW), is examining instream flow needs and future water supply options in the Colville River Watershed, as priority actions outlined in the WRIA 59 Watershed Plan (Version 2.0, Golder, 2007) and the WRIA 59 Colville River Watershed Detailed Implementation Plan (Golder, 2006.)

In preparation for the WRIA 59 Board's task of determining minimum instream flows, EES Consulting, Inc (EESC) was contracted by Stevens County to lead the instream flow assessment project using the Toe-Width Method. The assessment results will help the WRIA 59 Board to develop instream flow recommendations for the development of an instream flow rule and water resource management plan for the Colville River Watershed.

The WRIA 59 Toe-width Instream Flow Assessment Project was designed to characterize relationships between stream flow and fish habitat in the Colville River and selected priority tributaries within the Colville River Watershed (WRIA 59) using the Toe-Width Method (Swift 1976, 1979).

2.0 PURPOSE

The purpose of this study was to provide the WRIA 59 Water Resource Management Board (WRIA 59 Board) with data to help set instream flows for the Colville River and selected tributaries.

3.0 TOE-WIDTH METHOD

The analysis discussed in this report utilizes the Toe-Width Method to calculate preferred discharges for rainbow trout rearing in 19 WRIA 59 streams: Chewelah, North Fork Chewelah, Sheep, Grouse, Mill, Huckleberry, Blue, Stensgar, Haller, Gold, Cottonwood, Sherwood, Bulldog, Waitts, Deer, and Stranger Creeks, as well as the Colville and Little Pend Oreille Rivers. Swift (1976) originally developed this method to estimate preferred discharges for steelhead trout rearing and spawning. Swift measured several independent variables (drainage area, mean altitude of basin, reach altitude, reach slope, and average width of stream at toe of

bank) and correlated them to preferred rearing and spawning discharges. Initial results showed that the average width of the stream at the toe of its bank had the best correlation to preferred discharges. Equations were subsequently developed that allowed for the calculation of preferred discharges for steelhead trout rearing and spawning.

Although species specific equations for rainbow trout have not been developed, the preferred discharges for rainbow trout rearing can be calculated using the steelhead trout rearing coefficients. Steelhead and rainbow trout are technically the same species; the difference between the two being that steelhead are anadromous (go to the ocean), while rainbow remain in fresh water their entire lives. The rearing habits and habitats of steelhead and rainbow are similar (Quinn, 2005), thus the use of Swift's rearing equations are readily transferable. The steelhead rearing equation estimates the discharge that covers the streambed. The preferred discharge is related to the minimum flow required to provide the maximum habitat availability to the benthic aquatic invertebrates that rearing rainbow trout primarily feed on.

Using Swift's equations to calculate preferred flows for spawning rainbow trout is not always appropriate. Spawning rainbow are usually much smaller than spawning steelhead. This size discrepancy precludes the use of Swift's equations for spawning rainbow in most streams. Occasionally, in large lakes or reservoirs where rainbow grow quite large, Swift's spawning equation is appropriate. Per the approval and guidance provided by the Washington State Department of Fish and Wildlife and Washington State Department of Ecology's Instream Flow Specialists, preferred spawning discharges were not calculated in this assessment because the rainbow trout present in WRIA 59 streams are generally much smaller than steelhead.

The Toe-Width method does not assess the effect of different flows on available habitat; rather, it suggests a single preferred flow for the species and life-stage in question. Rainbow trout rear year-round, as juveniles and adults. This assessment presents flows preferred by rearing rainbow trout. The calculated preferred rearing discharges presented in this report are not exact; it is important to remember that the calculated discharge is part of a range of flows (due to the variance in Swift's equation). Local hydrology, seasonal weather variation, life history information and other background information should all be considered carefully before setting minimum instream flows in the streams assessed in this report.

Field Methods

Methods for determining the toe-width follow Swift's methods (1976):

1. A tape, measuring in tenths of feet, is strung across the streambed at points well above the bottom of the bank. For consistency, the zero-end of the tape is always placed on the left bank, looking downstream.
2. Significant breaks in slope across the transect are surveyed along the tape using a stadia rod and auto-level.
3. The toe of bank is identified for both banks whenever possible. The toe of bank is defined as the point where the stream bed and bank meet. In some instances only one toe of bank is identified.
4. The toe-width is calculated as the horizontal distance from the lowest toe of bank (when both toes are identified) to a point of the same elevation on the opposite bank using

interpolation (Figure 1). In instances when only one toe of bank is identified, the horizontal distance from the identified toe to the same elevation on the opposite bank was used as the toe-width.

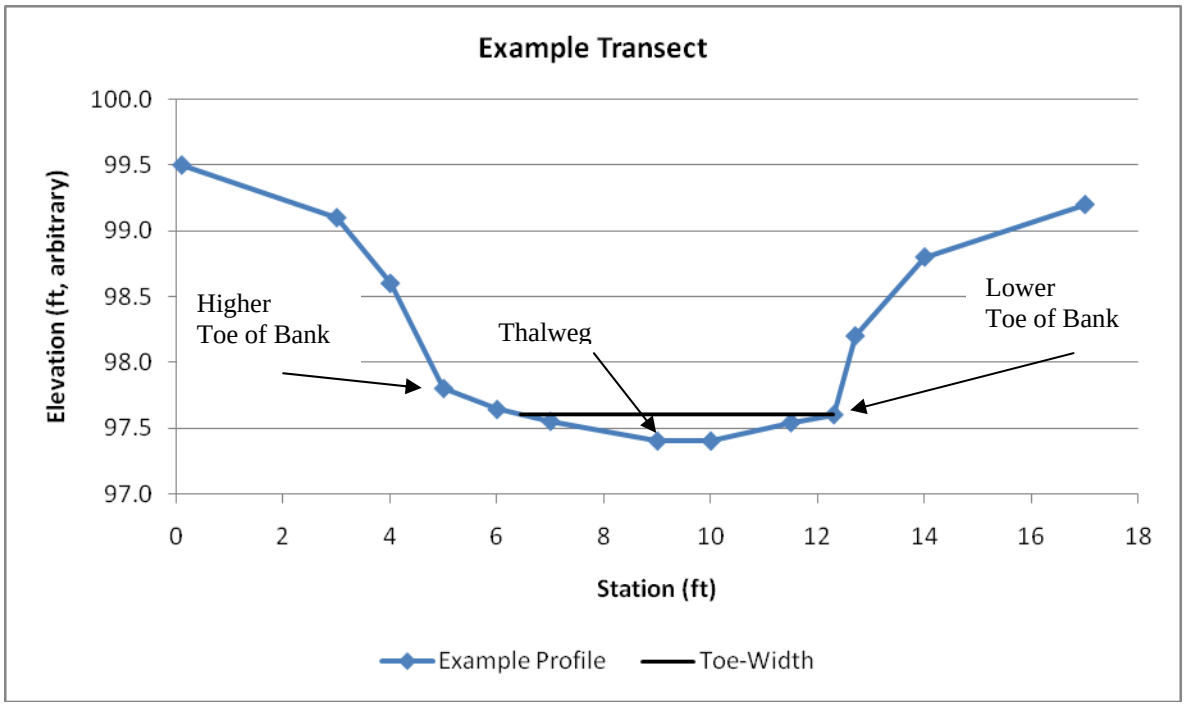

Figure 1. Example of Toe-Width Interpolation

In certain instances Swift's method for determining toe-width is inappropriate. This method does not allow for identifying toe-width when the thalweg (deepest part of the channel) and the lower toe of bank coincide. When one toe is also the thalweg, the other (higher) toe of bank is used as the elevation from which a horizontal line is drawn from. An example of a situation where the lower toe of bank cannot be identified is illustrated in Figure 2. It is impossible to measure toe-width, using Swift's criteria, from the lowest toe of bank in this example transect; therefore, the higher toe of bank is used to determine toe-width.

Although the toe-width method appears clear that the toe-width is a horizontal measurement from the lowest toe of bank it also is clear that it should include the gravel bars. "*The width of gravel bars, if present, is included, and the lower toe of the two banks is used if a toe is found on both sides of the channel" (*Swift, 1976 pg. 39). After initial review by and discussions with state resource agencies, EESC revised toe widths on several transects to include gravel bars in the toe width measurement. See Appendix B, Public Comments for additional details on this issue

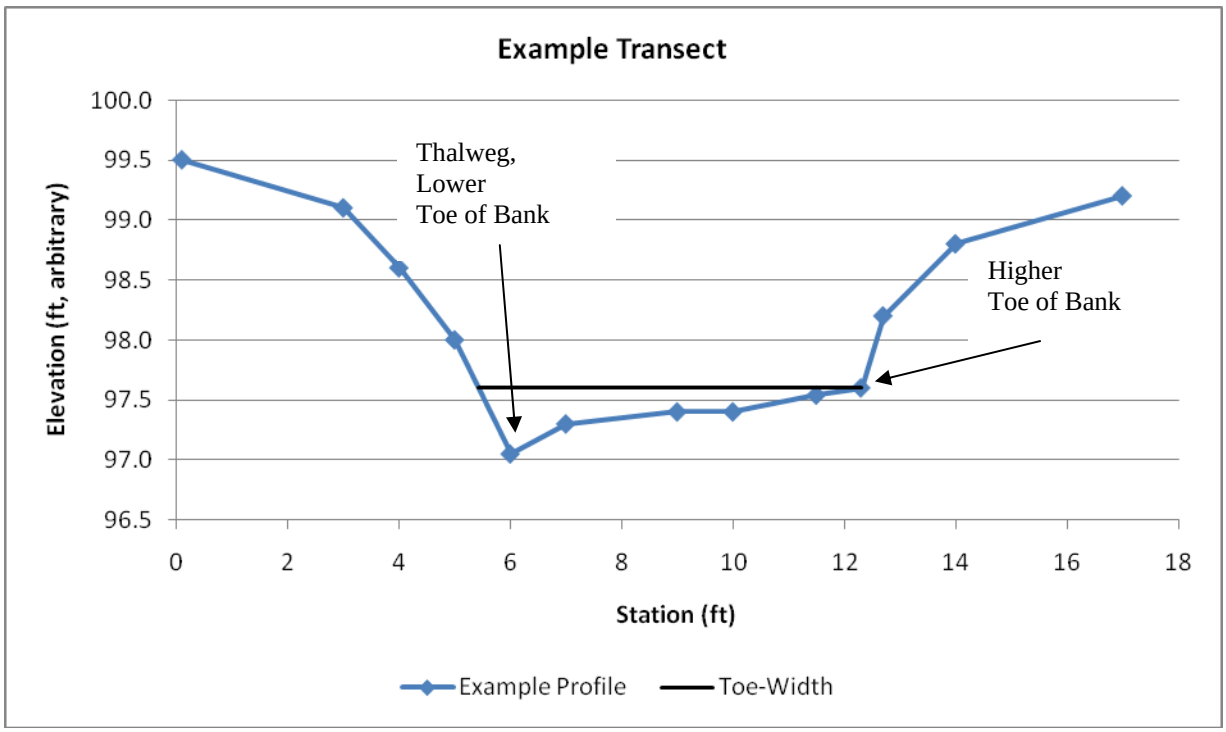

Figure 2. Example of Thalweg and Toe of Bank Coinciding

Calculations

The toe-width measurements for each stream site are averaged and then used to calculate the estimated preferred discharges for rainbow trout rearing. The equation and coefficients used for these calculations are shown in Table 1 (Swift, 1976).

Table 1
Swift's Equation and Coefficients Used to Estimate Preferred Discharges (cfs) for Rainbow Trout Rearing

Swift's Equation: $Y = \mathbf{a}(TW)^{\mathbf{b}} \pm \mathbf{SE}$			
Preferred Discharge (cfs)	Constant (**a**)	Constant (**b**)	**SE**
Rainbow Trout Rearing	0.164	1.42	56

Y = preferred discharge (cfs)
a = regression constant determined by Swift
TW = distance (ft)
b = regression constant determined by Swift
SE = standard error expressed as percentage of Y

4.0 WRIA 59 TOE-WIDTH ASSESSMENT

A Quality Assurance Project Plan (QAPP) was developed specifically to provide quality control procedures and guidance in both data collection and analysis phases of the WRIA 59 Toe-Width Assessment Project. The QAPP was approved and signed by the Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (WDOE), Stevens County

Board of Commissioners, WRIA 59 Board Chairmen, and EES Consulting (EESC) prior to commencement of the fieldwork.

4.1 PRE-SITE SELECTION FIELD WORK

On August 27, 2008, Linda Kiefer, Stevens County met and consulted with representatives Sandy Dotts, Washington State Department of Fish and Wildlife (WDFW), and Jaime Short, Department of Ecology (Ecology) on the transect sites for each of the proposed reach study areas for the Toe-Width Project. Transect sites were visited and approved by WDFW and Ecology, (with the exception of Blue, Waitts, Sherwood, and Gold creeks), consistent with agency guidelines (WDFW and WDOE 2004). On selected tributaries, previous site visits by the agencies provided validation of necessary riffle/pool locations for the Toe-Width Project. Those tributaries were covered in the 8/27/08 consultation with Stevens County.

During the pre-site consultation, the group agreed that transect sites on the four smaller tributaries of Blue, Waitts, Sherwood, and Gold creeks should be selected within the reach areas of the 2006 stream flow monitoring sites for those tributaries. Per the WRIA 59 Board's request, stream width data would be collected for verification of the actual widths of those streams, in consideration of toe-width methodology guidelines outlined by WDFW (Sandy Dotts, WDFW, personal communication, 2008), and for review and consideration during the development of the final minimum instream flow recommendations. Stream sites were selected within the direct vicinity of control points selected by the WRIA 59 Board, where stream gauges have been installed for monitoring instream flows.

4.2 FIELD DATA COLLECTION

Final Transect Selection

Twenty stream sites were selected by the WRIA 59 Board in conjunction with stakeholders for toe-width analysis (Figure 3). Three to five cross-sections (transects) were selected and surveyed for analysis at each stream site. Cross-sections were placed at pool tailouts or riffles, where depth was consistent and the toe of bank was identifiable. Pool tailouts and riffles are often the primary producers of food for aquatic organisms; they also allow for easy identification of the toe of bank and therefore are given top priority as transect locations. More than three transects were selected for streams with varying widths, to adequately represent the variation of that specific stream. WRIA 59 Board members and field technicians from the Stevens County Conservation District who were familiar with the streams assisted in the selection of cross-section location.

The Toe-width data collection work took place on September 16 – 17, 2008. Two field teams were established, with a minimum of three field technicians on each team. The twenty stream sites selected for the toe-width assessment project were split between the two teams. For consistency measures, EESC provided technical expertise and oversight on each team, utilizing guidance from the approved Quality Assurance Project Plan (QAPP) that had been developed

specifically for this project. The field teams and streams assessed by each team are shown in Table 2.

Table 2
Field Measurement Schedule

Stream site	Date	Field Team
Lower Watershed		
Lower Colville River	9/16/08	1(a)
Little Pend Oreille River	9/17/08	1(b)
Mill Creek	9/16/08	1(a)
Stensgar Creek	9/17/08	1(b)
Haller Creek	9/17/08	1(b)
Stranger Creek	9/16/08	1(a)
Gold Creek	9/17/08	1(b)
Middle Watershed		
Upper Colville River	9/16/08	1(a)
Chewelah Creek	9/16/08	2(a)
North Fork Chewelah Creek	9/16/08	2(a)
Sherwood Creek	9/16/08	2(a)
Blue Creek	9/17/08	1(b)
Thomason Creek	9/17/08	1(b)
Upper Watershed		
Deer Creek	9/17/08	2(b)
Grouse Creek	9/17/08	2(b)
Huckleberry Creek	9/17/08	1(b)
Sheep Creek	9/17/08	2(b)
Cottonwood Creek	9/16/08	2(a)
Bulldog Creek	9/17/08	2(b)
Waitts Creek	9/17/08	2(b)

Field Team 1(a) – 9/16/08:
Brad Caldwell, WDOE
Jaime Short, WDOE
Dean Hellie, SCCD
Pete Rittmueller, EESC

Field Team 1(b) – 9/17/08:
Charlie Kessler, SCCD
Gary Fetter, Rancher
Pete Rittmueller, EESC

Field Team 2(a) – 9/16/08:
Paul Jurun, Spokane Tribe
Wes McCart, SCFB
Linda Kiefer, Stevens County
Nic Truscott, EESC

Field Team 2(b) – 9/17/08:
Paul Jurun, Spokane Tribe
Linda Kiefer, Stevens County
Nic Truscott, EESC

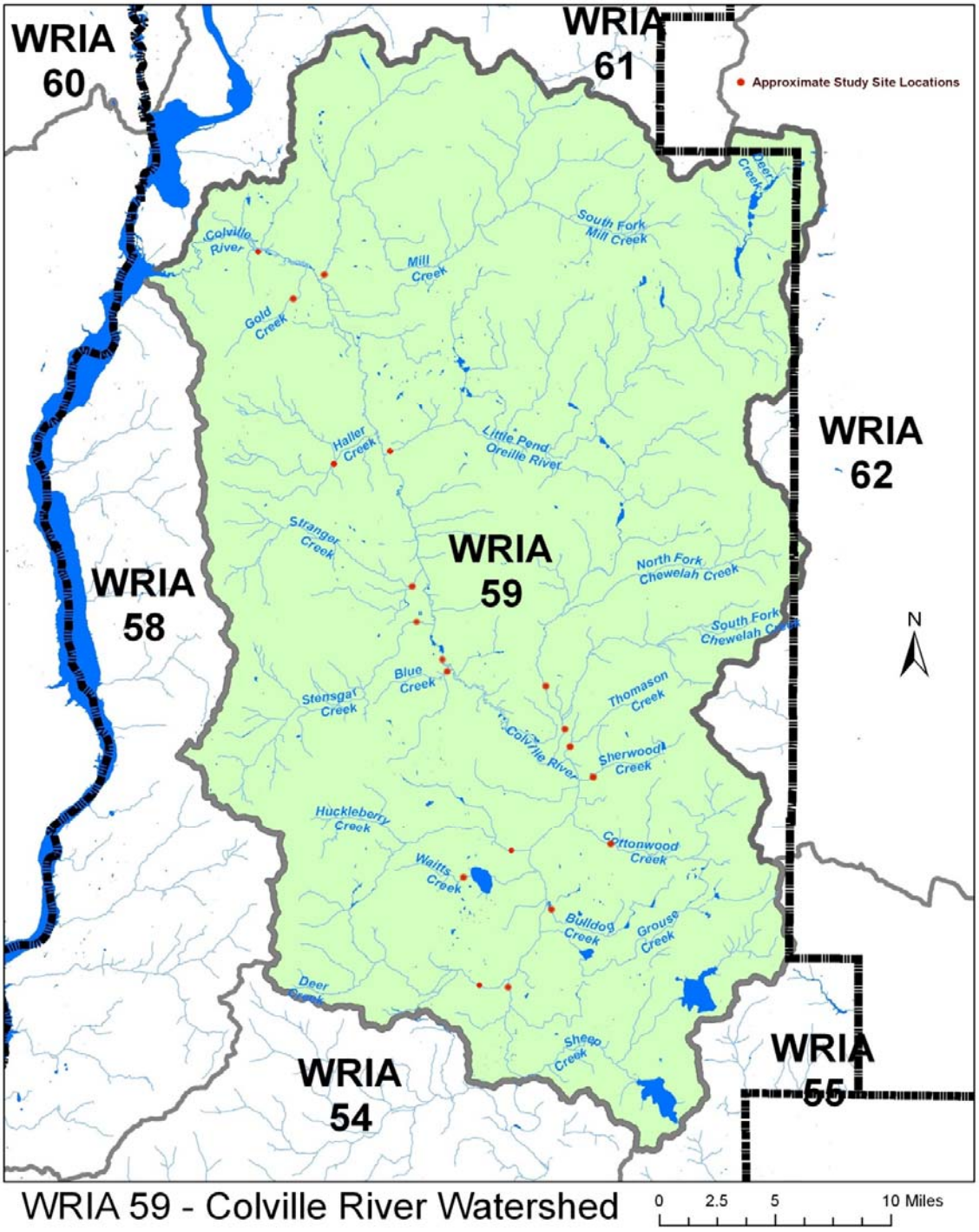

Figure 3. Approximate Stream site Locations (figure from Stevens County)

Data Collection

The WRIA 59 Toe-Width Assessment study plan called for 19 streams to be surveyed at 20 different stream sites. All stream sites were surveyed with the exception of the Thomason Creek site. Too much reed canary grass was growing in and around the channel to definitively identify

the toe of the bank, and no pools or riffles were found at or near the control point or future gauge location.

Toe-width measurements at each cross-section and the average toe-width for each stream site are presented below (Table 3).

Table 3
Toe Width Measurements (in feet)

Stream site	Transect-1	Transect-2	Transect-3	Transect-4	Transect-5	Average
Lower Watershed						
Lower Colville River	51.15	42.33	56.04	54.39		50.98
Little Pend Oreille River	23.22	24.53	22.66	27.30		24.43
Mill Creek	15.33	18.81	20.45	22.76		19.34
Stensgar Creek	8.93	4.54	6.51	6.01		6.50
Haller Creek	4.15	6.36	4.28	8.57		5.84
Stranger Creek	4.97	4.65	*	*		4.81
Gold Creek	6.96	4.18	7.35	2.86		5.34
Middle Watershed						
Upper Colville River	39.48	32.05	26.47	26.81		31.20
Chewelah Creek	9.15	13.95	13.73			12.28
North Fork Chewelah Creek	29.35	13.69	14.81	10.23	15.13	16.64
Sherwood Creek	4.99	4.23	5.33	5.21		4.94
Blue Creek	4.10	4.14	3.44			3.89
Thomason Creek						**
Upper Watershed						
Deer Creek	10.37	12.43	13.48	13.42		12.43
Grouse Creek	15.50	9.00	14.50	12.88		12.97
Huckleberry Creek	10.96	9.59	12.53			11.03
Sheep Creek	8.49	8.16	9.98			8.88
Cottonwood Creek	7.28	8.33	8.96			8.19
Bulldog Creek	8.91	7.00	6.69			7.53
Waitts Creek	4.12	4.84	4.66			4.54

* see discussion in results section for Stranger Creek below
** see discussion in results section for Thomason Creek below

5.0 RESULTS

The results of using the average toe-width from each stream site in Swift's equation for preferred rearing discharge are presented in Table 4. Cross-sectional profiles and on-site photos of each transect are presented in Appendix A.

Table 4 Toe-Width Results for Rainbow Rearing			
Stream site	Average TW (ft)	Preferred Discharge (cfs)	GPS Coordinates (Approximate Stream Site Location)
Lower Watershed			
Lower Colville River	50.98	43.59	48° 35.11' N, 117° 59.09' W
Little Pend Oreille River	24.43	15.34	48° 27.56' N, 117° 52.95' W
Mill Creek	19.34	11.01	48° 34.20' N, 117° 56.43' W
Stensgar Creek	6.50	2.34	48° 20.99' N, 117° 51.24' W
Haller Creek	5.84	2.01	48° 28.13' N, 117° 54.04' W
Stranger Creek	4.81	1.53	48° 22.18' N, 117° 51.33' W
Gold Creek	5.34	1.77	48° 33.96' N, 117° 58.11' W
Middle Watershed			
Upper Colville River	31.20	21.70	48° 19.19' N, 117° 49.17' W
Chewelah Creek	12.28	5.77	48° 15.98' N, 117° 43.38' W
North Fork Chewelah Creek	16.64	8.89	48° 17.96' N, 117° 43.74' W
Sherwood Creek	4.94	1.58	48° 15.09' N, 117° 41.14' W
Blue Creek	3.89	1.13	48° 19.15' N, 117° 49.23' W
Thomason Creek	N/A		None Taken
Upper Watershed			
Deer Creek	12.43	5.87	48° 07.18' N, 117° 48.07' W
Grouse Creek	12.97	6.24	48° 07.38' N, 117° 41.53' W
Huckleberry Creek	11.03	4.96	48° 12.17' N, 117° 45.83' W
Sheep Creek	8.88	3.64	48° 06.72' N, 117° 47.76' W
Cottonwood Creek	8.19	3.25	48° 12.35' N, 117° 39.84' W
Bulldog Creek	7.53	2.88	48° 09.80' N, 117° 43.50' W
Waitts Creek	4.54	1.41	48° 11.16' N, 117° 48.08' W

Lower Watershed

Lower Colville River

This site had the largest toe-width of all the sites surveyed. The average toe-width at this site was 50.98 ft which correlates to a preferred rearing discharge of 43.59 cfs. The higher toe of bank was used to calculate toe-width at all transects on the lower Colville River site. The lower toes of bank were near the thalwegs and using that elevation to determine toe-width would not have been representative of the river at that location (see Appendix A for plots of cross-sections).

Little Pend Oreille River

The toe-widths ranged from 22.66 – 27.30 ft, with an average of 24.43 ft. The preferred rearing discharge was calculated at 15.34 cfs. The higher toe of bank was used to determine toe-width on transect number four at this location.

Mill Creek
Toe-widths averaged 19.34 ft, ranging from 15.33 – 22.76 ft. The lower toes of bank at transect numbers one, two and four were near the thalweg elevation, so the higher toe of bank was used to determine toe-width at that location. The calculated preferred rearing discharge for Mill Creek is 11.01 cfs.

Stensgar Creek
Four transects with toe-widths ranging from 4.54 – 8.93 ft were measured at the stream site. The average of the measured toe-widths at Stensgar Creek was 6.50 ft, relating to a 2.34 cfs discharge for rainbow trout rearing. The higher toe of bank was used to calculate toe-width at transect numbers two and three.

Haller Creek
Toe-widths at Haller Creek sites varied from 4.15 – 8.57 ft, and averaging 5.84 ft. The preferred rearing discharge calculated for Haller Creek is 2.01 cfs.

Stranger Creek
Toe-widths at the Stranger Creek stream site averaged 4.81 ft. Only two transects were surveyed at the stream site due to a lack of acceptable transects. After surveying both transects at the stream site, Washington Department of Ecology and EES Consulting staff traveled upstream about a mile to another site, where rough estimates of toe-width were made. The rough estimates of toe-width ranged from 4.2 – 5.1 ft; it was deemed reasonable to use only two transects to represent this site. The estimated preferred rearing discharge for rainbow trout in Stranger Creek is 1.53 cfs.

Gold Creek
Four transects were surveyed, with toe-widths ranging from 2.86 – 7.35 ft, and averaging 5.34 ft. The preferred rearing discharge for Gold Creek was calculated to be 1.77 cfs. The higher toe of bank was used to calculate toe-width at transects one, two and three.

Middle Watershed
Upper Colville River
This site had an average toe-width at 31.20 ft, corresponding to a rearing discharge of 21.70 cfs. It was necessary to use the higher toe of bank on transect numbers one and two at this site.

Chewelah Creek
Toe-widths ranged from 9.15 – 13.95 ft, with an average of 12.28 ft. A flow of 5.77 cfs is the preferred discharge for rainbow to rear in. The higher toe of bank was used to determine toe-width at transect number three.

North Fork Chewelah Creek
North Fork Chewelah Creek toe-widths varied considerably. Five different cross-sections were selected to ensure that the variation present in the stream was represented. Measured toe-widths varied from 10.23 – 29.35 ft, averaging 16.64 ft, corresponding to a rearing discharge of 8.89 cfs. Identifying the toe of bank at this stream site was difficult due to dense vegetation on the banks, and gently sloping banks in some locations. The higher toe of bank was used to determine toe

width at transect number three, and the original toe-width measurements were extended at transects one, two and four to include gravel bars present at the transects.

Sherwood Creek
Four transects were surveyed at the stream site. The difference between the widest toe-width and the narrowest toe-width was only 1.10 ft, ranging from 4.23 – 5.33 ft and averaging 4.94 ft. The preferred rearing discharge calculated for Sherwood Creek is 1.58 cfs.

Blue Creek
Three transects were surveyed at this stream site. The measured toe-widths were 4.10, 4.14, and 3.44 ft resulting in an average of 3.89 ft, the second lowest of all the stream sites measured. A 3.89 ft toe-width average corresponds to a 1.13 cfs rearing flow.

Thomason Creek
No transects were surveyed at the Thomason Creek site. Abundant reed canary grass and a lack of acceptable cross-section locations precluded measurements.

Upper Watershed
Deer Creek
Toe-widths averaged 12.43 ft; the four measured toe-widths ranged from 10.37 – 13.48 ft. The equation for preferred rearing discharge gives a value of 5.87 cfs for a toe-width average of 12.43 ft.

Grouse Creek
Four transects were surveyed at this stream site. The toe-widths for transects varied by 6.50 ft (9.00,14.50,12.88 respectively), while transect number one had the highest toe-width of 15.50 ft, resulting in an average toe-width of 12.97 ft. The preferred rearing discharge estimated using the average toe-width is 6.24 cfs. The toe-width for transects three and four were extended to include the gravel bars present at these transects.

Huckleberry Creek
Measured toe-widths at this site averaged 11.03 ft, resulting in an estimated preferred rearing discharge of 4.96 cfs. The higher toe of bank was used to determine toe-width on transect numbers two and three because the lower toe and thalweg coincided.

Sheep Creek
Toe-widths were consistent, ranging from 8.49 – 9.98 ft, with an average of 8.88 ft. Three transects were surveyed at this stream site. Riparian vegetation was scarce at this site, and the banks were undercut over large portions of the stream. Care was taken to ensure that identification of the toe of bank was accurate. Swift's equation results in a preferred rearing discharge of 3.64 cfs.

Cottonwood Creek
Toe-widths were consistent, differing by only 1.68 ft. The measured toe-widths ranged from 7.28 – 8.96 ft with an average of 8.19 ft. Using Swift's equation to predict the preferred rearing discharge for rainbow trout gives a value of 3.25 cfs.

Bulldog Creek

The measured toe-widths ranged from 6.69 – 8.91 ft and averaged 7.53 ft. Three transects were surveyed. The estimated preferred rearing discharge for Bulldog Creek is 2.88 cfs.

Waitts Creek

Three transects were surveyed at the site. Waitts Creek was channelized, resulting in consistent toe-width measurements with a difference of only 0.72 ft. The toe-widths at this stream site ranged from 4.12 – 4.84 ft with an average of 4.54 ft, corresponding to a preferred rearing discharge of 1.41 cfs.

6.0 WRIA 59 TOE-WIDTH SUMMARY AND CONCLUSIONS

Results of the WRIA 59 toe-width assessment are summarized in Table 5.

Table 5
Toe-Width Results Summary for Rainbow Trout Rearing

Stream site	Average TW (ft)	Preferred Discharge (cfs)
Lower Watershed		
Lower Colville River	50.98	43.59
Little Pend Oreille River	24.43	15.34
Mill Creek	19.34	11.01
Stensgar Creek	6.50	2.34
Haller Creek	5.84	2.01
Stranger Creek	4.81	1.53
Gold Creek	5.34	1.77
Middle Watershed		
Upper Colville River	31.20	21.70
Chewelah Creek	12.28	5.77
North Fork Chewelah Creek	16.64	8.89
Sherwood Creek	4.94	1.58
Blue Creek	3.89	1.13
Thomason Creek	N/A	
Upper Watershed		
Deer Creek	12.43	5.87
Grouse Creek	12.97	6.24
Huckleberry Creek	11.03	4.96
Sheep Creek	8.88	3.64
Cottonwood Creek	8.19	3.25
Bulldog Creek	7.53	2.88
Waitts Creek	4.54	1.41

Rainbow Trout Life History – Rainbow trout in the Colville River basin spawn from February through June (Table 6). Fertilized eggs will remain in the gravel for approximately 28 to 40 days before hatching, and another two weeks before emerging from the gravel (HDR, 2007). Rearing takes place year-round, making instream flows for rearing crucial to rainbow trout success.

Table 6 WRIA 59 Rainbow Trout Life History												
Life Stage	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Spawning												
Egg Incubation												
Emergence												
Rearing												

Source: HDR, WRIA 59 Instream Flow Study Report, 2007.

Stream sites measured in this assessment were in the direct vicinity of control points selected by the WRIA 59 Board; as such the information from this report is directly applicable to setting instream flow requirements at each stream site.

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