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Modeling Hydrology for Design of Fish Passage

MODELING HYDROLOGY FOR DESIGN OF FISH PASSAGE

by

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16. ABSTRACT

An estimated 2,400 to 4,000 hydraulic structures are barriers to fish passage in Washington State. Many are culverts inadequately sized for fish passage. Recently, the Washington Department of Fish and Wildlife established statewide guidelines to incorporate fish migration into culvert design by providing two approaches: stream simulation and hydraulic design.

Stream simulation involves designing culverts to be wider than the natural channel under bank-full conditions. The hydraulic design option requires culverts to satisfy minimum depth and maximum hydraulic drop constraints ranging from 0.8 to 1.0 ft and permissible velocities from 2.0 to 6.0 ft/sec depending on salmonid species and culvert length. The permissible velocity criterion is to be met during the fish passage design flow.

A new model is presented for estimating fish passage design flows at ungaged streams in Eastern Washington. The model is founded on two key concepts: a unique definition of fish passage design flow and an area based approach for estimating this flow at ungaged streams.

The fish passage design flow was developed by combining the concepts of allowable fish delay, established to be 3 days, with a consecutive day analysis. This design flow ensures that fish are not delayed for more than 3 consecutive days during a water year.

A fish passage design flow per unit area is assigned to previously delineated subwatersheds in Eastern Washington. Similarity relationships, derived from basin characteristics, relate U.S. Geological Survey (USGS) gaging stations to subwatersheds in Eastern Washington. These relationships form the basis for assigning a value of fish passage design flow per unit area to each subwatershed in Eastern Washington.

The percent standard error for this model was calculated as 36%. This is a significant improvement from the 75% standard error calculated for the model that previously addressed fish passage design flows in Eastern Washington.

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INTRODUCTION

OVERVIEW OF PROBLEM

Many small streams throughout the Pacific Northwest flow through culverts at road crossings. The Washington State Department of Transportation (WSDOT) has traditionally designed such culverts based on the 25-year peak flood discharge and an allowable headwater depth limited to 1.25 times the culvert rise (WSDOT, 1997). The 100-year flood was then checked to ensure that roadway overtopping did not occur. However, as a direct result of the growing concern for the survival and restoration of salmonids in Washington State, additional constraints pertaining to fish passage have recently been added. As a result an estimated 2,400 to 4,000 hydraulic structures are now classified as barriers to fish passage in Washington State alone. Many are culverts improperly designed for the new fish passage requirements (Hall et al., 1999).

The Washington Department of Fish and Wildlife (WDFW) has helped establish design guidelines for water crossing structures. These guidelines are now part of the Washington State Administrative Code (WAC), designated as WAC 220-110-070. The WAC provides two options to meet fish passage criteria in culverts, allowing the designer to choose the method that best fulfills the design requirements: (1) hydraulic design and (2) stream simulation (WAC, 2000). Determining the maximum design flow for the hydraulic design option is the primary focus of this research.

The objective of the hydraulic design option is to ensure that culverts do not impede fish passage by stipulating design requirements such as maximum allowable velocity, minimum depth, and maximum hydraulic drop. The WAC provides precise values for the above parameters corresponding to specific species of salmonid (WAC, 2000). As a result of the velocity constraint, an additional flow requirement, designated as the fish passage design flow, must be implemented. The fish passage design flow is stipulated to be the flow not exceeded more than 10 percent of the time during the months of adult fish migration (WSDOT, 1997; Bates et al., 1999; WDFW, 1993a; WDFW, 1993b).

A complicating factor is that many culverts exist or will be constructed on small tributaries where little or no flow information is available. Historic U.S. Geological Survey (USGS) gages are typically located on larger tributaries where bridges are more appropriate and so provide little guidance on predicting flows on the smaller streams.

The overall intent of this study is to provide a preliminary model for predicting the fish passage design flows on ungaged locations in Eastern Washington (East of the Cascade Mountains). This was addressed by focusing on the following four objectives:

1. Install and monitor stream gages to supplement existing flow records on small tributaries throughout Eastern Washington.
2. Develop improved methods for estimating flows for fish passage at culverts.
3. Prepare a handbook for use by persons needing to know fish passage design flows.
4. Conduct a workshop on the use of handbook.

This report addresses objectives 1, 2, and 3 by providing a preliminary model for predicting the fish passage design flow at ungaged locations in Eastern Washington. This model will be combined with complimentary work developed by John F. Orsborn and the Orsborn Consulting Group. His work will provide additional estimates of fish passage flows other than the high flow design modeled by Washington State University (WSU).

Additional work is warranted to add to the accuracy of the model described herein. This would be accomplished by extending back the flow records of the WSU stream gages so that they may be incorporated into future versions of the model.

Previous methods of predicting flows at ungaged locations typically incorporate the use of regional models and equations developed by regression analysis. To avoid designers and the complication of defining regions and estimating equation parameters, WSU developed a new approach, termed the Contributing HUC6 model. Development of this model involves the three major components outline below:

1. Installation and monitoring of stream gages (for future versions of the model).
2. Define a fish passage design flow.
3. Develop a predictive model for ungaged streams.

OVERVIEW OF MAJOR WORK COMPONENTS

Stream Gaging Stations

Twenty sites were identified in Eastern Washington in regions of critical fish presence for establishment of water level recording stations. A pressure transducer was installed at each of these stations to record stream stage at 15 to 30 minute intervals. Field monitoring of each station involved periodically downloading data and measuring discharge to establish a stage-discharge rating curve so that the recorded depth measurements could be converted into measurements of discharge.

Fish Passage Design Flow

Interpretations of the previously mentioned WAC have led to the development of a design flow criterion based on the premise of allowable fish delay time. The allowable fish delay concept begins by defining the length of a critical fish migration window as one month. Applying the 10% exceedence flow concept to a migration window of one month means that the allowable number of days not passable is 10% of 30 days or 3. This means that for a design flow that is not exceeded more than 10% of the time, the 4th highest flow becomes the design flow.

Combining this concept with allowable fish delay time during the migration window means that fish should not be delayed any more than 3 consecutive days at a time during their migration. Applying this criterion to a water year defines the design flow as the highest flow occurring in each water year that is equaled or exceeded by the previous 3 days. This provides one value for each water year. These annual flows are then averaged, providing a "mean annual fish passage design flow" or "4-day fish passage flow," termed Q_{FP4}.

This procedure was used to define Q_{FP4} for 64 USGS continuous record gages deemed to have a sufficient period of record for analysis. The design flows for each gage were then divided by the corresponding watershed areas to establish a design flow per unit area, Q_{FP4}/A.

Contributing HUC6 Method

The Contributing HUC6 model assigns a discharge per unit area to predefined subwatersheds in Eastern Washington. These subwatersheds were each given a numerical designation based on a 6th Field Hydrologic Unit Code (HUC) and are more commonly referred to by the acronym 6th Field HUC, or HUC6. Larger basins comprised of many 6th Field HUCs all draining to the same point are termed 4th Field HUCs or HUC4s. This study combined the 4th Field HUCs in Eastern Washington into four regions using clustering techniques based on mean annual precipitation, mean elevation, and mean water stress index.

Geographical Information Systems (GIS) techniques were used to evaluate spatial data corresponding to each HUC6, HUC4 and USGS watershed used in the model (ESRI, 1999; Kresch, 2000). The key parameters in this analysis were mean annual precipitation, mean water stress index, and mean elevation.

A similarity matrix was formed to describe the "closeness" of each USGS watershed to each HUC6. The "closeness" measure was calculated as the Euclidean distance of basin characteristics between each USGS watershed and HUC6. This procedure provided a ranking of USGS gages for every HUC6 in the model.

A discharge per unit area, Q_{FP4}/A, was assigned to each HUC6 based on the values of the USGS gages determined to be most similar to the HUC6. Two additional concepts are used to do this, a cutoff criterion and weighting method. The first concept defines a cutoff point for the number of gages to include in the estimation of Q_{FP4}/A for the HUC6. Once the optimum number of gages to include is determined their corresponding values of Q_{FP4}/A are weighted according to their dissimilarity distance and assigned to each HUC6.

OVERVIEW OF DESIGN PROCEDURE

The result of this project is a procedure that can be followed by WSDOT designers to easily size culverts for fish passage. Determining the fish passage design flow at any site, ungaged or gaged, requires the designer to complete the following five steps.

1. Delineate the watershed for the desired location.

2. Find the area of the watershed within each predefined HUC6 using the maps in Appendix E, termed the contributing area.

3. Read value of Q_{FP4}/A, found in Appendix E, corresponding to each HUC6 identified in Step 2.

4. Multiply the contributing area with the corresponding Q_{FP4}/A for that HUC6, providing a total Q_{FP4} for each contributing area.

5. Sum all of the values of Q_{FP4} from Step 4, to yield the design flow at the site.

A complete design example is found at the end of this report in Appendix D. The remainder of this report documents the procedure used to arrive at the proposed approach.

BACKGROUND/REVIEW OF PREVIOUS WORK

CULVERT DESIGN REQUIREMENTS

WAC 220-110-070

WAC 220-110-070 outlines the design limitations for satisfying fish passage requirements of water crossing structures where salmonids are present. Traditional floodwater design is not addressed in the following section but must be met in the final design.

The WAC provides two options to meet fish passage criteria in culverts: stream simulation and hydraulic design (WAC, 2000).

Stream Simulation

To simulate a natural channel inside a culvert, the WAC dictates that the culvert shall be placed on a flat gradient with the bottom of the culvert countersunk a minimum of 20 percent of the rise, measured at the outlet. The width of the culvert at the streambed must be equal to or greater than the average width of the stream at bank-full flow (WAC, 2000).

Hydraulic Design

The hydraulic design option, in contrast, specifies several design criteria (Table 1): a minimum depth, maximum velocity, and hydraulic drop. The minimum depth of water in the culvert must be met using the 2-year 7-day low flow or the 95 percent exceedence flow occurring during months of fish migration. Velocity requirements are to be met during the "high flow" design discharge, defined as the flow that is not exceeded more than 10 percent of the time during the months of adult fish migration, termed the fish passage design flow. The 2-year peak flow may be used when the fish passage design flow is unavailable. The maximum hydraulic drop must be satisfied for all flows between the low and high flow values. Finally, the culvert is to be placed below the natural streambed a depth of at least 20 percent of the rise (WAC, 2000).

Table 1. Fish Passage Design Criteria for Culvert Installation

Criteria[a]	**Adult Trout >150 mm**	**Adult Pink, Chum Salmon**	**Adult Chinook, Coho, Sockeye, Steelhead**
1.) Velocity, Max (ft/sec) Culvert Length (ft)			
a.) 10 - 60	4.0	5.0	6.0
b.) 60 - 100	4.0	4.0	5.0
c.) 100 - 200	3.0	3.0	4.0
d.) greater than 200	2.0	2.0	3.0
2.) Flow Depth Min (ft)	0.8	0.8	1.0
3.) Hydraulic Drop Max (ft)	0.8	0.8	1.0
[a]Table adapted from WAC 220-110-070 (WAC, 2000)			

Design Parameters for Fish Passage

Designing the culvert to meet the passage criteria for a specific species requires the determination of design discharge, the culvert slope, material roughness, and culvert size. Each of these parameters has an influence on the velocity in the culvert, but not all are easily modified to achieve the desired velocity. Ideally the culvert is designed on a grade so that the elevations of the natural channel upstream and downstream match those of the culvert. Placing the culvert on any slope other than that of the stream will require alterations of the natural channel to prevent an excessive hydraulic drop at the culvert entrance or exit. The roughness of the passage area inside the culvert is not uniform as a result of the culvert being countersunk into the streambed. Natural stream material will often act to increase friction compared to that associated with the culvert bottom in an uncountersunk condition, and thus lower velocities inside most culverts (Chang, 1998).

Culvert Design

Once fish passage design criteria are determined, a culvert can be designed for fish passage and to meet the hydraulic requirements of the 25- and 100-year flows. Since traditional design procedures do not account for countersinking, the following steps may be used to determine the required culvert size (Rowland et al., 2001):

1. Design a culvert for the velocity requirements in Table 1 (WAC, 2000).
   - (a) Use natural streambed slope.
   - (b) Determine roughness coefficient for natural streambed and culvert material.
   - (c) Use lowest roughness coefficient, most often the culvert roughness. *Note: using the lowest roughness coefficient is conservative when designing for the fish passage flow since it accounts for the highest velocity condition.*
2. Check the resulting design for the 25-year flood so that the headwater depth does not exceed 1.25 times the culvert diameter (WSDOT, 1997).
3. Check the 100-year peak flood flow, making sure that roadway overtopping does not occur (WSDOT, 1997).
4. Increase the culvert size by 25 percent to account for burying the invert 20 percent of the rise (Norman et al. 1985).

MODELING FLOWS AT UNGAGED STREAMS

Design and evaluation of culverts often requires the estimation of flows at ungaged streams. Predictive models are developed to estimate these flows at ungaged sites by establishing a relationship between watershed attributes and measured flow at gaged sites. This relationship is then used to estimate flows at ungaged sites where only watershed attributes, also referred to as basin characteristics, can be obtained. The following sections discuss seven key aspects of these predictive models:

1. Basin characteristics, outlined in the Basin Characteristics Section, are the physical and climatic attributes obtainable at ungaged and gaged sites from which a relationship to discharge can be developed.

2. Methods of estimating stream flow at ungaged sites from the relationship between basin characteristics and discharge are discussed in the Estimating Streamflow Section.

3. The Regions Section summarizes methods of grouping gaged information into regions for development of predictive models.

4. Measuring hydrologic similarity by evaluating the "Euclidean distance" of basin characteristics is discussed in the Euclidean Distance Section.

5. The Region of Influence Section provides an overview of the "Region of Influence" (ROI) approach to grouping gages.

6. Clustering methods and their uses in the development of regions are reviewed in the Using Cluster Analysis for Establishment of Regions Section.

7. Methods of weighting discharge from gages within a region are discussed in the Discharge Weighting of Gages Section.

Basin Characteristics

Common basin characteristics used in models for estimating flows at ungaged streams are that of precipitation and basin area. Numerous other studies have expanded the list of variables to include such parameters as mean basin elevation, mean annual evaporation, latitude, longitude, basin development factor, basin slope, basin shape, cover, main channel length, max rainfall intensity, and snowfall data. Using all of these variables can become a burden so often the model is simplified by eliminating those parameters that are not significant, (Orsborn and Orsborn, 1997; Lipscomb, 1998; Blakenmore et al., 1997; Sherwood, 1994; Bisese, 1995; Kresch, 1999; Sumioka et al., 1998).

Estimating Streamflow

Regression Techniques

Regression equations have traditionally been used to estimate design flows at ungaged sites. These equations are generally functional relationships developed from basin characteristics at sites with gaged information (Orsborn and Orsborn, 1997; Pope and Tasker, 1999; Adamowski, 2000; Stedinger and Tasker, 1985; Tasker and Stedinger, 1989).

Regression equations used in hydrologic modeling of flood flows most often use power form, Equation 1 (Koch and Smillie, 1986). To develop this equation typically the data are linearized using a Log_{10} transformation, with the parameters determined from least squares regression analysis, Equation 2.

$$Q_T = \alpha \cdot X_1^{\beta_1} \cdot X_2^{\beta_2} \cdot X_3^{\beta_3} \qquad \text{Eqn. 1}$$

$$Log(Q_T) = Log(\alpha) + \beta_1 \cdot Log(X_1) + \beta_2 \cdot Log(X_2) + \beta_3 \cdot Log(X_3) \qquad \text{Eqn. 2}$$

Where Q_T is the desired recurrence flow, α, β_1, β_2, and β_3 are coefficients, and X_1, X_2, and X_3 are basin characteristics such as precipitation and area.

This method typically assigns greatly increased weight to unusually small observations. When the equation is transformed back into the real flow domain, bias may result that was not apparent in the logarithmic form (Paydeym and Nguyen, 1999).

Contributing Area

While most regression equations are left to be applied, Lipscomb (1998) used USGS delineated subbasins to model estimates of mean annual discharge for a region of the Salmon and Clearwater River basins in central Idaho. Previously established regionalized regression equations developed by the USGS for Idaho were used to calculate mean annual flows (Quillian and Hanenberg, 1982). A discharge per unit area was then calculated for each of the subbasins to provide an area-based estimate of discharge (Lipscomb, 1998).

Regions

Boundaries have traditionally been delineated from geographic or administrative considerations (Burn, 1997). Resulting regions may not always contain the entire watershed, potentially leading to a watershed that is spread across two or more regions.

It is more common to delineate regional extents by evaluating similar basin characteristics or hydrologic similarities. The geographic extent of such regions is constrained to coincide with drainage divides, limiting the occurrence of a watershed falling within two or more distinct regions, (Sumioka et al., 1998; Kresch, 1999; Powers and Saunders, 1996; Lipsomb, 1998; Bisese, 1995; Blankenmore et al., 1997). Sumioka et al. (1998) used nine hydrologically defined regions to estimate flood frequency in Washington. The exact same regional delineation was used for the regression analysis providing fish passage design flows in Eastern Washington (Kresch, 1999).

Euclidean Distance

Defining an ROI is performed by grouping gages based on a similarity value. Measuring the Euclidean distance between gaged sites to that of an ungaged site is often used to make this evaluation. Euclidean distance measures the "closeness" of sites by comparing differences in basin characteristics instead of geographical distances (Tasker et al., 1996; Tasker, 1982; Burn, 1997). A matrix is formed for each ungaged site describing the relative closeness to each gaged site under consideration. Those gaged sites having the smallest Euclidean distance are those that most closely match the ungaged site. This matrix can then be ranked to describe the hierarchical closeness of gaged sites, termed the similarity index. The general form of the Euclidean distance formula is (Tasker,1982; Pope, 1999):

$$D_{i,j} = \left[\sum_{i=1}^{P} W_i \left(\frac{X_{i,j} - X_{i,k}}{Stdev(X_i)} \right)^2 \right]^{1/2} \qquad \text{Eqn. 3}$$

where $D_{i,j}$ is the distance between stations j and k, $X_{i,j}$ is the i^{th} hydraulic basin characteristic at station j and p is the total number of basin characteristics.

Dividing the comparative residual, $X_{i,j} - X_{i,k}$, of each basin characteristic by the sample standard deviation of that characteristic is used to normalize the equation for use with several parameters having different magnitudes (Pope and Tasker, 1999; Tasker et al., 1996; Tasker, 1982; Burn, 1990a; Burn, 1990b).

A weighting value, W_i, is also included to reflect the relative importance of each basin characteristic in determining the "closeness" between sites. Burn (1990b) determined the weighting coefficient by evaluating the correlation coefficient between each basin attribute and the 100-year peak flow. A similar procedure was used to estimate attribute weightings in Nebraska, where weightings determined using basin attribute correlation to 2-year and 100-year events were investigated (Provaznik, 1997).

Region of Influence

Recently it has been shown that developing an ROI for each ungaged site of interest is an improvement over geographic regionalization (Provaznik, 1997). In this method gaged sites with similar basin characteristics and/or flow data are used to develop a unique regression equation or other predictive model for each ungaged site under investigation. Thus, a new ROI is created for each ungaged site. The use of a computer program to perform this type of evaluation is highly desirable (Provaznik, 1997; Tasker et al., 1996; Pope and Tasker, 1999). Numerous studies have incorporated this methodology into developing regression based or other predictive models for evaluating flows at ungaged locations (Burn, 1990a; Provaznik and Hotchkiss, 1998; Tasker et al., 1996; Pope and Tasker, 1999; Burn, 1990b; Zrinji and Burn, 1994).

A hierarchical ranking describes the order in which gaged sites will be used to describe an ungaged location. However, the ranking does not define a cutoff for the number of gages to include. Two common methods for doing so are defining a threshold value (Homogeneous Regions and Threshold Values Section) and selecting a homogeneous grouping from distribution analysis (Homogeneous Regions and Distribution Analysis Section).

Homogeneous Regions and Threshold Values

The purpose of a threshold value is to determine the optimum number of gages to include in the ROI. Each gage is assigned a similarity index from the Euclidean distance measure. All of those gages with a distance greater than the threshold value are excluded from the ROI of the ungaged site. Burn (1990a) proposes selection of the threshold value by investigating the correlation between the candidate site and the sites at or near the desired threshold.

The following three methods for defining the threshold value were reported by Burn (1990b), (Note: the user is left to specify the appropriate option):

Formulas	Limits of Application	
Option 1		
$\theta_i = \theta_L$	$NS_i \geq NST$	Eqn. 4
$\theta_i = \theta_L + (\theta_U - \theta_L)\left(\frac{NST - NS_i}{NST}\right)$	$NS_i < NST$	Eqn. 5

Option 2

$$\theta_i = \theta_U \qquad \textit{Constant} \qquad \text{Eqn. 6}$$

Option 3

$$\theta_i = TL_i \qquad \textit{Constant per ROI} \qquad \text{Eqn. 7}$$

where θ_i is the threshold value determined for the ROI of site *i*; θ_U and θ_L are the upper and lower threshold values, respectively; NS_i is the number of stations contained in the ROI of site *i*; and *NST* is the desired number of gages to be included in the ROI.

A trial and error technique was used by Pope and Tasker (1999) to determine the optimum combination of gages to include in a ROI. This method removed one site at a time, using the remaining sites to compute an estimate of discharge. The root mean square error was computed by taking the square root of the mean for the residuals between the estimated and measured discharge at each site. The ROI was also restricted to selection of gages from the hydrologic area in which the ungaged site was located (Pope and Tasker, 1999).

Homogeneous Regions and Distribution Analysis

Defining homogeneous regions can also be accomplished using L-moments (Provaznik, 1997; Adamowski, 2000; Adamowski et al., 1996; Gingras et al., 1994; Hosking, 1993). L-moments, linear functions of probability weighted moments, are useful in calculating parameters of a distribution such as location, scale, skew, and kurtosis (Provaznik, 1997).

Hosking (1993) suggests the use of three tests for use in defining a homogeneous region: discordance, heterogeneity, and goodness-of-fit. The discordance test is used to identify gaged sites within a ROI that are dramatically different from the rest of the sites in the ROI when considered as a whole. Measuring the heterogeneity of a ROI is used to establish a homogeneous grouping of the gaged sites. The final test, goodness-of-fit, is used to determine whether a distribution acceptably matches that of the data in a homogeneous region.

A simpler and more general method for comparing distributions of data can be accomplished with the use of a Rank-Sum test. This straightforward test has the benefit of being nonparametric, meaning that it does not assume a distribution for the data such as normal or lognormal. The Rank-Sum test analyzes a distribution based on the rank assigned to each measured value. Sites having similar distributions of ranks are compared using standard statistical procedures for a normal distribution. The assumption of a normal distribution for the rankings is valid even when the underlying distribution of the data is non-normal (Devore, 2000; Ramsey, 1997).

Using Cluster Analysis for Establishment of Regions

Regions may also be developed using cluster analysis techniques that form a homogeneous grouping or cluster of sites. Each cluster is defined as having homogeneity (similarity) within and heterogeneity (dissimilarity) between other clusters. The final objective of cluster analysis is to assign each site to a specific group of similar sites (Burn, 1997).

Numerous methods of cluster analysis have been developed recently. Milligan and Cooper (1985) evaluated 30 procedures of clustering and provided a ranking of those that performed best. Clusters are generally defined by some similarity measure, which describes a hierarchical closeness of sites. Several methods may be implemented to evaluate the closeness of sites in terms of the similarity measure. Milligan (1981) discusses hierarchical clustering using nearest neighbor, furthest neighbor, group average, and minimum variance techniques.

Clustering methods have been implemented in hydrological studies for the grouping of sites to establish homogenous regions. Lipscomb (1998) established 34 homogeneous clusters by comparing stream order and basin characteristic from 1050 subbasins found in the Clearwater and Salmon River watersheds of central Idaho. Clustering procedures have also been used in the establishment of regions for regression analysis procedures (Tasker et al., 1996; Burn, 1997; Burn, 1989; Burn, 1988).

Discharge Weighting of Gages

Once the ROI has been established for prediction of discharge at an ungaged location, the next necessary step is defining a method of weighting discharge estimates at the gages within the ROI. The three procedures presented in this section, Zrinji and Burn (1994), Burn (1990a), and Burn (1990b), use the similarity index as a measure of the gage's weighting.

Zrinji and Burn (1994) provided the following weighting formula:

$$W_k = \frac{\dfrac{1}{D_{i,k}}}{\displaystyle\sum_{j=1}^{P} \frac{1}{D_{i,j}}} \qquad \text{Eqn. 8}$$

where W_k is the gage weighting factor for site k; $D_{i,k}$ is the similarity index between ungaged site i and gaged site k; and P is the total number of gaged sites in the ROI for site i.

Zrinji and Burn (1994) proposed that the weights applied to the measured discharge at gages within each ROI are inversely proportional to the similarity measure determined for each gage. The inverse of each gage's similarity index is taken so that those gages more closely matching that of the ungaged location are represented by a larger value. Each of these inverses is then divided by the sum of the inverses within a ROI, providing a fractional weighting for each gage.

Burn (1990a) and Burn (1990b) proposed two formulas for weighting gages based on their relative closeness to that of the ungaged site as determined from the similarity index, (Note: the user is left to specify the appropriate option):

$$n_{i,j} = 1 - \left(\frac{D_{i,j}}{TP}\right)^n \qquad \text{Eqn. 9}$$

and

$$n_{i,j} = 1 - \left(\frac{D_{i,j} - \theta_L}{TN - \theta_L} \right)^n \qquad \text{Eqn 10}$$

where $n_{i,j}$ represents the weighting value for gage j corresponding to the ROI for ungaged site i; θ_L is the lower threshold value for inclusion of gages into the ROI; TP and TN dictate gage weighting at the threshold limit; and n provides a decrease in the weighting for gages determined to be most dissimilar (larger similarity index).

PREVIOUS FISH PASSAGE MODELS

WDFW Model for Western Washington

Recent work by the WDFW to develop regression equations for estimating fish passage design flows in Washington, resulted in a model including only the region of Washington west of the Cascade Mountains. No correlation was found for Eastern Washington, leading to the agency's recommendation of using the 2-year peak flow as the design criterion for Eastern Washington. The fish passage design flow was defined as the 10 percent exceedence flow for the critical migration month, January in Western Washington. The 10 percent exceedence flows for these periods were then calculated from the Weibull formula (Powers and Saunders, 1996; Powers, 2000).

Three regions identified as Coastal Lowland, Puget Sound, and Lower Columbia were used to designate hydrologically similar areas. These three regions were then segregated further into lowland, highland, and urban designations for the establishment of regression equations. Gages within each of these regions having drainage areas less than 50 square miles and at least 5 years of record for the month of January were used in the regression model. The regression equations established for each region used combinations of mean annual precipitation, drainage area and precipitation intensity for estimating discharge (Powers and Saunders, 1996; Powers, 2000).

USGS Model for Eastern Washington

The USGS published a design manual for the Washington State Department of Natural Resources (WDNR) providing regression equations for estimating fish passage design flows in Eastern Washington. The manual defines the fish passage design flow as the 10 percent exceedence flow occurring over the 3-month period of highest flows by means of a flow duration analysis (Kresch, 1999).

Sumioka, et al. (1998) attempted to define geographic regions by comparing residuals of actual flood magnitudes with those predicted using an initial regression analysis. The results of this were inconclusive to defining regions, as no meaningful grouping of gages could be established. The regional approach used instead grouped 4th Field HUC boundaries into 9 regions. Kresch (1999) used these same regional boundaries in his model of Eastern Washington, which consisted of 6 separate regions. Separate regression equations were developed for each of these regions using mean annual precipitation and watershed area as the defining variables. A 10-year period of record on unregulated streams having either crest stage or continuous recording stations was used as the criterion for inclusion of gages in the model (Sumioka et al., 1998; Kresch, 1999).

WDFW found this model to be undesirable due to the significantly high standard errors associated with it (Powers, 2000). These high standard errors are the direct result of the limited time allotted for development of this model and the hydrologic heterogeneity of Eastern Washington. These issues prompted WSDOT and WSU to develop a new model for predicting fish passage design flows in Eastern Washington.

GIS BACKGROUND AND TECHNIQUES

Geographic information systems provide a way of analyzing and describing geographic data for use with computer applications. Various types of GIS information are commonly described with the blanket term, spatial data. The purpose of spatial data is to provide a geometric representation of geographic features. These features are referenced to the Earth's surface by means of a coordinate system, projection, and unit of measurement. Numerous combinations of these display options exist, often leading to complications and misrepresentation of data. Various computer applications can convert between these display formats of spatial data.

Spatial data is displayed in ArcView, a GIS analysis program, as themes to represent separate layers on a map. Themes can easily be turned on or off from the display window, allowing for representation of key map features individually or in various combinations. Each feature in a theme has attribute data liked to it, representing information such as location, size, name, etc. (ESRI, 1999).

Several types of spatial data are used to create themes; three of the most common are shapefiles, coverages, and grids. The shapefile format is used for displaying geometric and attribute information of non-topographic data. Coverages allow for the grouping of more than one feature in a topographical format. Common forms of coverages may be grouping of polygons, points, or arcs. Polygons are used in GIS for the representation of specific boundaries, such as the watershed area upstream of a gage site. Points represent a specific location, such as the location of a measuring device or building. Streams and roads are displayed as arcs in spatial data (ESRI, 1999).

Geographic data is often represented in the grid format when detailed information pertaining to specific areas is needed. Grids are composed of numerous cells representing information unique to the geographic location bounded by the extent of the cell. Examples of data that is often displayed in the grid format are precipitation, elevation, and soil type (ESRI, 1999).

A major advantage to using spatial data is the ease in which it can be analyzed to provide key descriptive features of a geographic location. Gridded data can be summarized over a predefined region, such as a polygon. The polygon can then be updated with those attributes determined from the grid. Another useful GIS technique is that of tabulating areas. This can be used to determine the contributing area of one polygon to another. Several other useful procedures may be implemented for analyzing spatial data, one of which is watershed delineation. Watersheds are delineated by performing a series of steps that transform Digital Elevation Maps (DEMs) into flow-accumulation grids. Flow-accumulation grids are then used to disseminate the area upstream of a specific location that contributes flow to that site (ERSI, 1999).

HYDROLOGIC UNIT MAPS

Hydrologic units in the United States are divided into various levels based on geographic area and watershed composition by the USGS. These areas are identified by a unique HUC, varying in length depending on the classification size. The first classification is representative of the water-resources region. The United States is divided into 21 regions based on this level of classification. One field, consisting of two numbers, identifies each of these regions. The next level of classification subdivides each water-resource region into smaller subregions. An additional field is added for the identification of subregions, thus making the length of the subregion HUC two fields or four numbers. The next subdivision is termed an accounting unit. The accounting unit is identified in the same manner as the previous classifications, with the addition of another field. Further classification to the 4^{th} Field HUC is termed the cataloging unit or subbasin (Seaber et al., 1987).

The Interior Columbia Basin Ecosystem Management Project (ICBEMP) performed two additional classifications, watersheds and subwatersheds. Watersheds are the next classification subdivision from that the subbasin, and are thus given an additional field. Watersheds are then subdivided into subwatersheds, which are often referred to as 6^{th} Field HUCs (ICBEMP, 2000).

RESEARCH APPROACH/PROCEDURES

To meet the objectives of this study and develop the Contributing HUC6 Model, three focus areas were identified. These areas are summarized in the following sections:

1. The WSU Gaging Stations Section describes the selection and installation stream gaging sites throughout Eastern Washington.

2. The concepts and methods used for defining the fish passage design flow at gaged sites are discussed in the Fish Passage Design Flow Section.

3. The Contributing HUC6 Method Section outlines the techniques employed to predict this discharge at ungaged sites.

WSU GAGING STATIONS

A limited number of USGS continuous record water level monitoring stations exist on small streams in Eastern Washington. Figure 1 illustrates the locations of USGS continuous record gaging stations having drainage areas less than or equal to 50 mi^2.

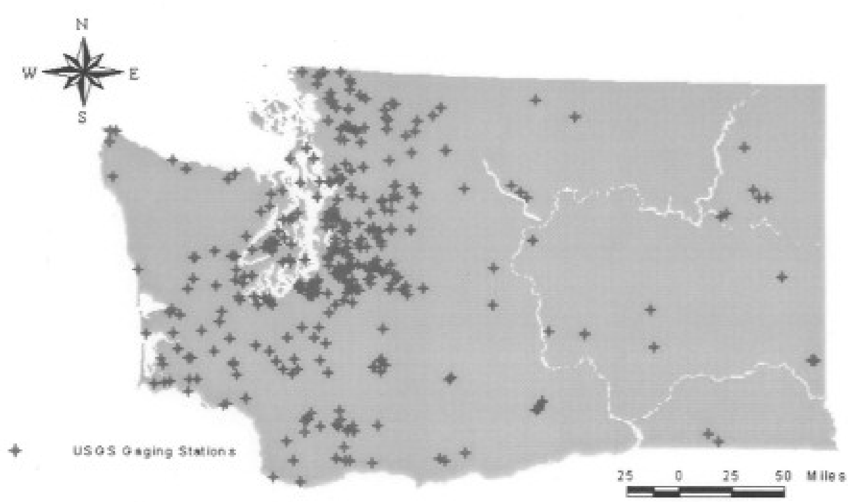

Figure 1. USGS Gages on Streams under 50 mi^2

To address this lack of monitoring stations, WSU identified numerous small streams throughout Eastern Washington in regions of known fish presence as potential gaging sites. Twenty of these streams, identified in Figure 2 and Tables 2 and 3, were selected as gaging sites based on their location and size. Each of these gaging stations is located at or near a road crossing structure. This was done to provide a controlled cross-section, stable instrument mounting, ease of access, in addition to furnishing a direct measurement at a culvert or bridge for the purpose of future evaluation of the structure.

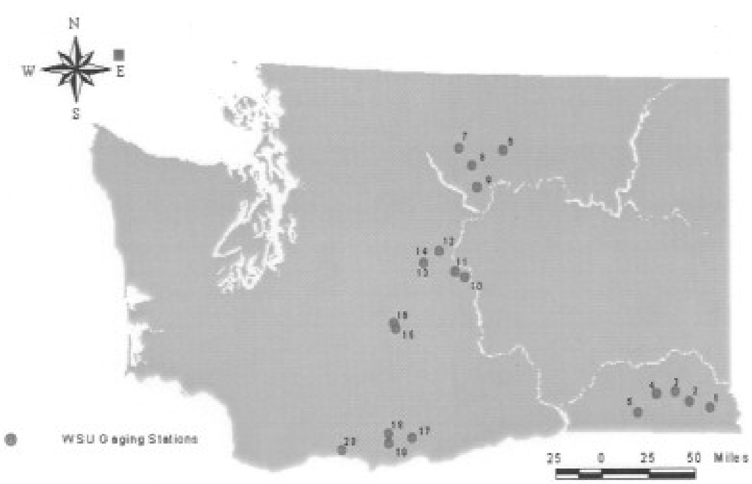

Figure 2. Locations of WSU Gaging Stations

Table 2. Locations of WSU Gaging Stations

Map Id	Stream Name	Long (HMS)	Lat (HMS)	County	Road Name
1	S. Fork Asotin Creek	117:16:48	46:13:32	Asotin	S. Fork Asotin Creek Rd.
2	Pahata Creek	117:31:08	46:16:33	Garfield	Forest Road 040
3	Tumalum Creek	117:41:02	46:21:33	Columbia	Tucannon Rd.
4	Patit Creek	117:53:45	46:20:17	Columbia	Range Grade Rd.
5	S. Fork Coppei Creek	118:06:27	46:10:44	Walla Walla	S. Fork Coppei Creek Rd.
6	Loup Loup Creek	119:44:46	48:21:59	Okanogan	HWY 20
7	Little Bridge Creek	120:17:06	48:22:46	Okanogan	NFDR 44
8	Libby Creek	120:07:01	48:13:50	Okanogan	HWY 153
9	Black Canyon Creek	120:03:04	48:02:57	Okanogan	Hwy 153
10	Colockum Creek	120:09:18	47:17:35	Chelan	Colockum Rd.
11	Stemilt Creek	120:16:48	47:19:44	Chelan	Stemilt Creek Rd
12	Mission Creek	120:28:26	47:30:14	Chelan	Mission Creek Rd
13	Upper Peshastin Creek	120:39:11	47:23:48	Chelan	Forest Road 7320
14	Lower Peshastin Creek	120:39:14	47:24:04	Chelan	Forest Road 7320
15	Nile Creek	120:57:00	46:50:18	Yakima	Nille Rd
16	Rock Creek	120:58:48	46:52:52	Yakima	HWY 410
17	Butler Creek	120:42:18	45:54:53	Klickitat	HWY 97
18	Bowman Creek	120:58:41	45:56:10	Klickitat	Garrison Rd.
19	Mill Creek	120:57:47	45:51:34	Klickitat	State HWY 142
20	Buck Creek	121:30:58	45:46:57	Klickitat	Big Buck Creek Rd

Table 3. Site Data for WSU Gaging Stations

Map Id	Stream Name	Area (mi2)	Gage El. (ft.)	Precipitation (mm)
1	S. Fork Asotin Creek	36.6	2346	597
2	Pahata Creek	9.4	3960	1155
3	Tumalum Creek	15.8	1975	832
4	Patit Creek	50.1	1877	817
5	S. Fork Coppei Creek	12.5	1791	825
6	Loup Loup Creek	44.2	2119	509
7	Little Bridge Creek	24.3	2136	756
8	Libby Creek	41.7	1391	776
9	Black Canyon Creek	11.3	1982	680
10	Colockum Creek	35.1	1332	539
11	Stemilt Creek	24.6	1739	657
12	Mission Creek	80.8	876	579
13	Upper Peshastin Creek	19.4	2579	832
14	Lower Peshastin Creek	36.4	2585	817
15	Nile Creek	31.7	2021	1025
16	Rock Creek	17.4	2169	1054
17	Butler Creek	11.6	2165	589
18	Bowman Creek	13.4	2320	818
19	Mill Creek	28.6	1614	732
20	Buck Creek	13.8	364	1057

Each station consists of a water level logger enclosed in a PVC pipe with a screw down cap. A hasp is attached to the cap so that the instrument can be locked within the pipe. A portion of galvanized pipe is used to further protect the sensor residing in the lower portion of the pipe on streams thought to have significant bedload. A typical gaging station installed by WSU is shown in Figure 3.

A water level logger (Figure 4) is used to record the height of the water at 15- to 30-minute time intervals, helping to identify rapidly rising and falling water levels following storm events. The water level logger consists of two major components: (1) a submersible pressure transducer and (2) a data logger. Two styles of pressure transducers were used. The majority of pressure transducers installed were capable of measuring depths ranging from 0 to 3 feet. Several of the gaging sites required a higher depth range and thus pressure transducers with depth capacity from 0 to 15 feet were installed. The error associated with each of these units is 0.02% of the transducer's maximum measuring depth. The data logger has the capability of recording up to 6000 data reading before rewriting over previously recorded information. Field monitoring of each gaging station consists of downloading these readings to a laptop computer. Additionally, the accuracy of each water level logger is evaluated by comparing the field-measured readings with those measured by the instrument. Prior to leaving each site the newly recorded data is evaluated for erroneous recordings in order to identify long-term problems with the unit (Global Water, 1999).

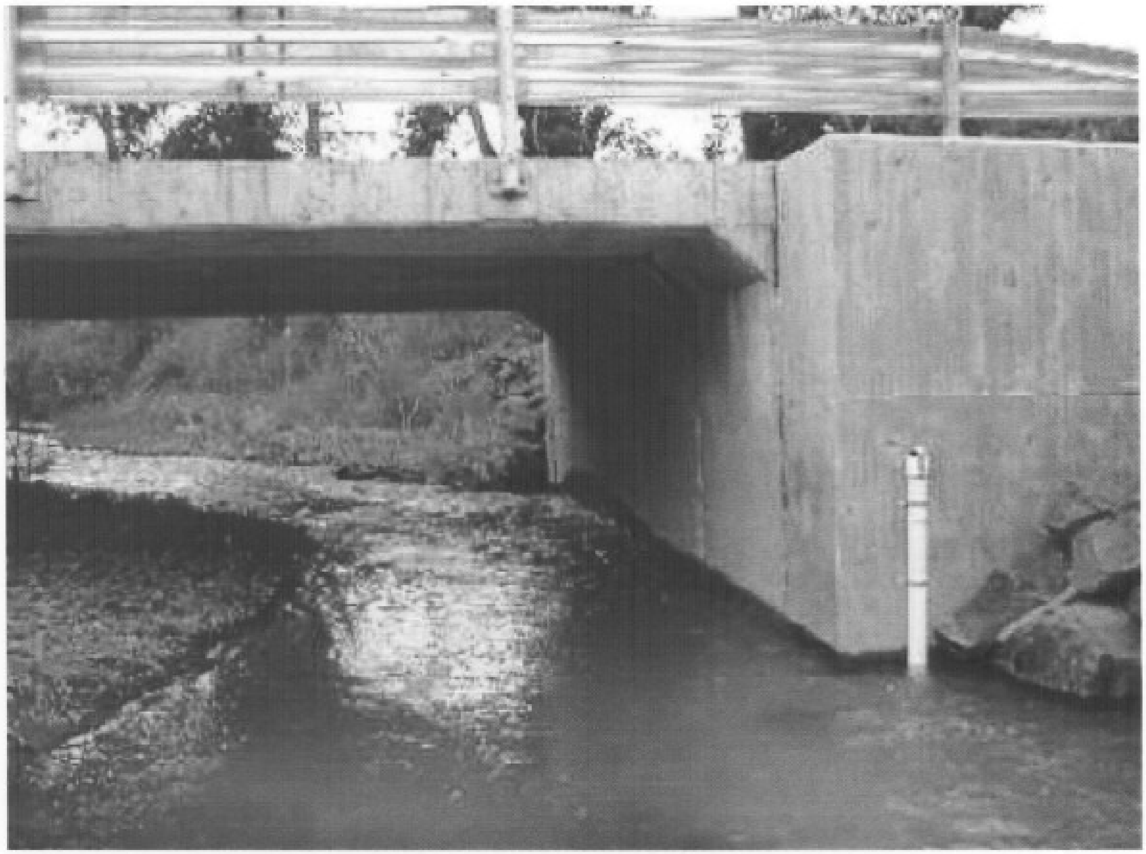

Figure 3. Typical Gage: S.F. Coppei Creek

Figure 4. Water Level Logger

Several times throughout the year, velocity profiles are taken near the stream gage using a Pygmy meter (Figure 5). This is done by stretching a tape across the stream and taking velocity measurements along the targeted cross-section, as shown in Figure 6. The total discharge is determined by summing the incremental discharge calculated for the area surrounding each velocity reading. The measured values of stream height and discharge are used to establish a rating curve, relating depth to discharge. This rating curve can then be used to yield a discharge value for any recorded stage of the stream.

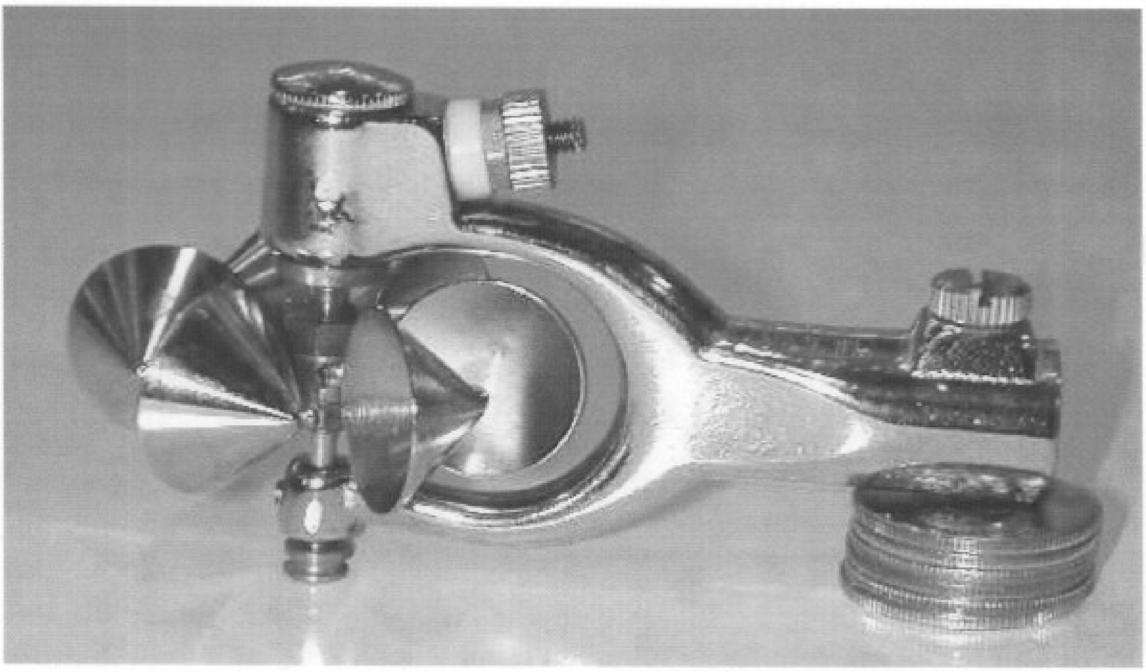

Figure 5. Velocity Measuring Instrument: Pygmy meter (Note: quarter-size coin shown for scale)

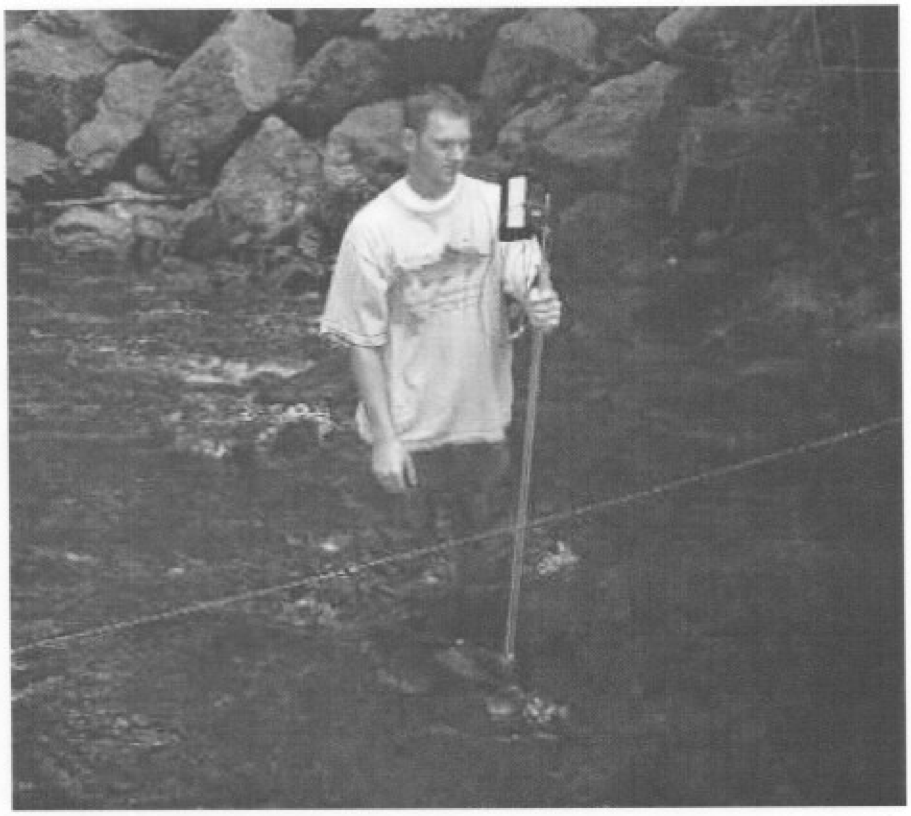

Figure 6. Measuring Velocity at Buck Creek

FISH PASSAGE DESIGN FLOW

WSU has taken a new approach to defining fish passage design flow, incorporating the concept of allowable fish delay. The allowable fish delay concept is based on the premise of defining the length of the migration window to be one month, much less than commonly occurs (WDFW, 1993a; WDFW 1993b). A one month critical migration window was chosen following numerous discussions with WDFW (Powers, 2000). Applying the 10% exceedence flow concept to a migration window of one month means that the allowable number of days not passable is 10% of 30 days or 3. This means that for a design flow that is not exceeded more than 10% of the time, the 4th highest flow becomes the design flow.

Applying this concept to allowable fish delay time during the migration window means that fish should not be delayed any more than 3 days at a time during their natural migration. Ranking of daily flows is not reasonable in this approach since fish delay under this concept is defined on a consecutive day basis. Applying this concept to a water year defines the design flow as the highest flow occurring in each water year that is equaled or exceeded by the previous 3 consecutive days.

A MathCAD worksheet was used to perform this computation for all of the USGS gages used in the model (MathSoft, 1998). This worksheet investigated each water year with a 4-day moving window. Every time the 4th day was equal to or less than the previous 3 days a value was recorded. An example of this "moving window" is presented below for a 19-day section taken from USGS gage 14107000, located on the Klickitat River. The moving window is designated by the outlined area, the flow record highlighted in yellow meets the design criterion of being equal to or exceeded by the previous three days, which are designated in a red font. This procedure is performed for a continuous string of flow values arranged by water year for the period of record at a gage. The maximum of these flows is then designated as the design flow for that water year. This provides one value for each water year. These annual flows are then averaged, providing a "mean annual fish passage design flow" or "4-day fish passage flow," termed Q_{FP4}.

Table 4. Moving Window and Designation of Q_{FP4} (USGS gage 14107000 on the Klickitat River)

	WY 1950	WY 1950	WY 1950	WY 1950	WY 1950	WY 1950	WY 1950	WY 1950
2-Oct	97	97	97	97	97	97	97	97
3-Oct	97	97	97	97	97	97	97	97
4-Oct	97	97	97	97	97	97	97	97
5-Oct	124	124	124	124	124	124	124	124
6-Oct	129	129	129	129	129	129	129	129
7-Oct	118	118	118	118	118	118	118	118
8-Oct	113	113	113	113	113	113	113	113
9-Oct	113	113	113	113	113	113	113	113
10-Oct	141	141	141	141	141	141	141	141
11-Oct	124	124	124	124	124	124	124	124
12-Oct	132	132	132	132	132	132	132	132
13-Oct	124	124	124	124	124	124	124	124
14-Oct	121	121	121	121	121	121	121	121
15-Oct	118	118	118	118	118	118	118	118
16-Oct	121	121	121	121	121	121	121	121
17-Oct	118	118	118	118	118	118	118	118
18-Oct	116	116	116	116	116	116	116	116
19-Oct	110	110	110	110	110	110	110	110
20-Oct	113	113	113	113	113	113	113	113

This procedure was used to define Q_{FP4} for 64 USGS continuous record gages based on the 79 continuous record gages chosen previously by Kresch (1999). The USGS provided delineated watersheds sufficient for analysis using GIS techniques for many of these gages (Kresch, 2000). Fifteen of the gages used by Kresch were discarded from this model due to insufficient watershed boundary delineations or complications involving continuous water years.

The design flow for each gage was then divided by the corresponding watershed drainage area to establish a design flow per unit area, Q_{FP4}/A. This normalized design flow from each gage was later used for comparison to ungaged sites.

CONTRIBUTING HUC6 METHOD

The Contributing HUC6 model assigns a discharge per unit area to predefined subwatersheds in Eastern Washington. These subwatersheds are each given a numerical designation based on a 6^{th} Field HUC and are more commonly referred to by the acronym 6^{th} Field HUC, or HUC6. The HUC6s found in Eastern Washington range in size from 3 to 287 mi^2 with a mean of 33 mi^2.

Geographical Information Systems and Data Types

GIS techniques were used to analyze spatial data corresponding to these HUC6s and the USGS gages used in the model (USGS, 2000). The spatial data obtained from the ICBEMP included: (1) spatial boundaries of Hydrologic Units, (2) digital elevation maps, (3) water stress index, and (4) mean annual precipitation (ICBEMP, 2000). Boundaries of USGS watersheds used in the model were obtained from the USGS (Kresch, 2000). This information was analyzed in ArcView GIS to determine mean annual precipitation, mean elevation, and mean water stress index for USGS watersheds and HUCs (ESRI, 1999).

Hydrologic Unit Boundaries

Hydrologic units in the United States are divided into various levels based on geographic area and watershed composition by the USGS. These areas are identified by a unique HUC, varying in length depending on the classification size. Central to the development of this model is the use of previously delineated 4^{th} Field and 6^{th} Field HUCs (Seaber et al., 1982; ICBEMP, 2000).

Basin Attribute Data

The relationship between USGS gaging stations and 6[th] Field HUCs was established by evaluating three forms of spatial data: elevation, precipitation, and water stress index. Each of these data sources was represented as a grid in ArcView. The mean characteristic value corresponding to each attribute was calculated for each 4[th] Field HUC, 6[th] Field HUC, and USGS watershed.

The elevation grid, Figure 7, was provided by ICBEMP (2000) at a 500-meter scale with attribute units in meters. Digital USGS 7.5 minute quadrangles, provided at a smaller scale, were also evaluated for use in the model. The 7.5 minute grids were not used since the benefit of more detailed information was outweighed by the time required to compile and analyze them.

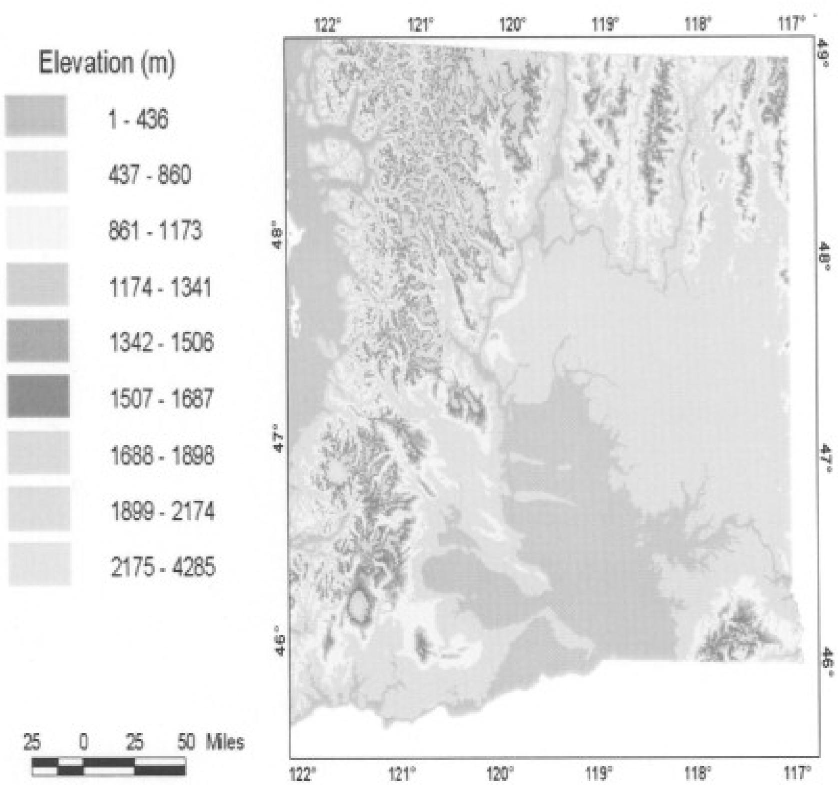

Figure 7. Elevation Grid for Eastern Washington (ICBEMP, 2000)

Precipitation data, Figure 8, was obtained from ICBEMP (2000) at a 500-meter scale with attribute units of millimeters. This data came from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) originally developed by the Spatial Climate Analysis Service and the Oregon Climate Service located at Oregon State University and, representing mean annual precipitation from 1961-1990.

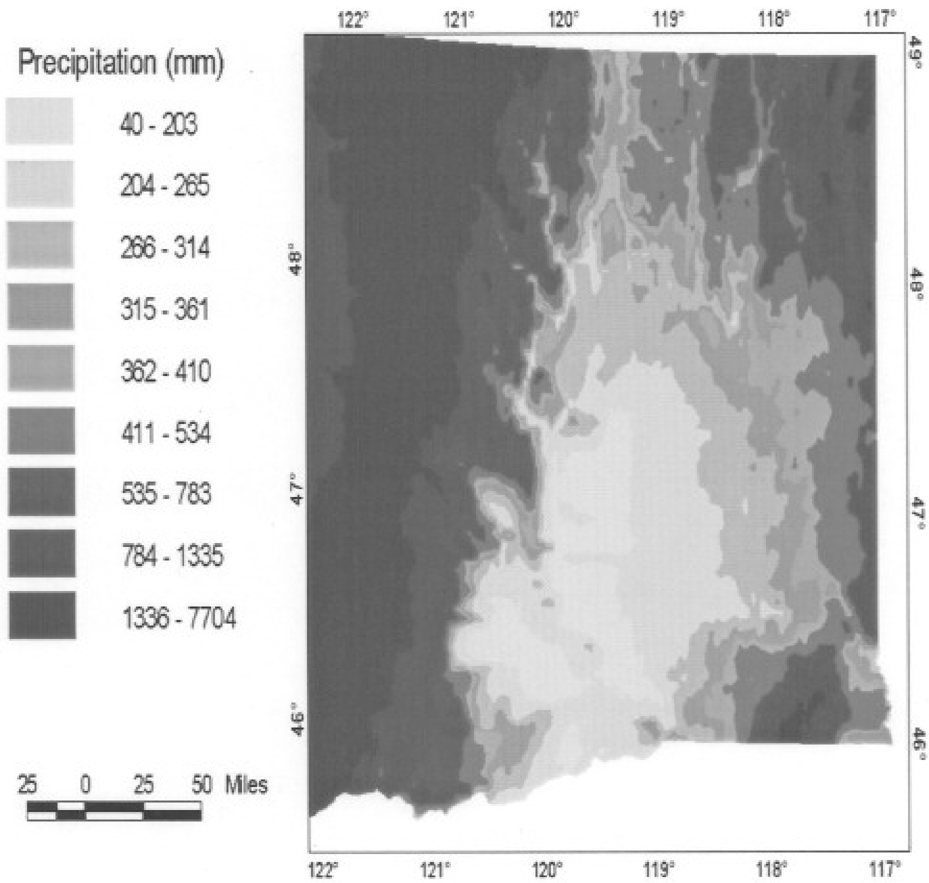

Figure 8. Precipitation Grid for Eastern Washington (ICBEMP, 2000)

The water stress index, Figure 9, obtained from ICBEMP (2000) is provided at a 2-km scale with attribute units in percent. This data defines the total annual evapotranspiration as a percentage of the total annual precipitation. The data was provided for three years to represent a wet, dry, and average year. The average year data was used in this model. The percentage values range from 1 to 100, with lower values signifying excess water at a site and higher values representing the opposite.

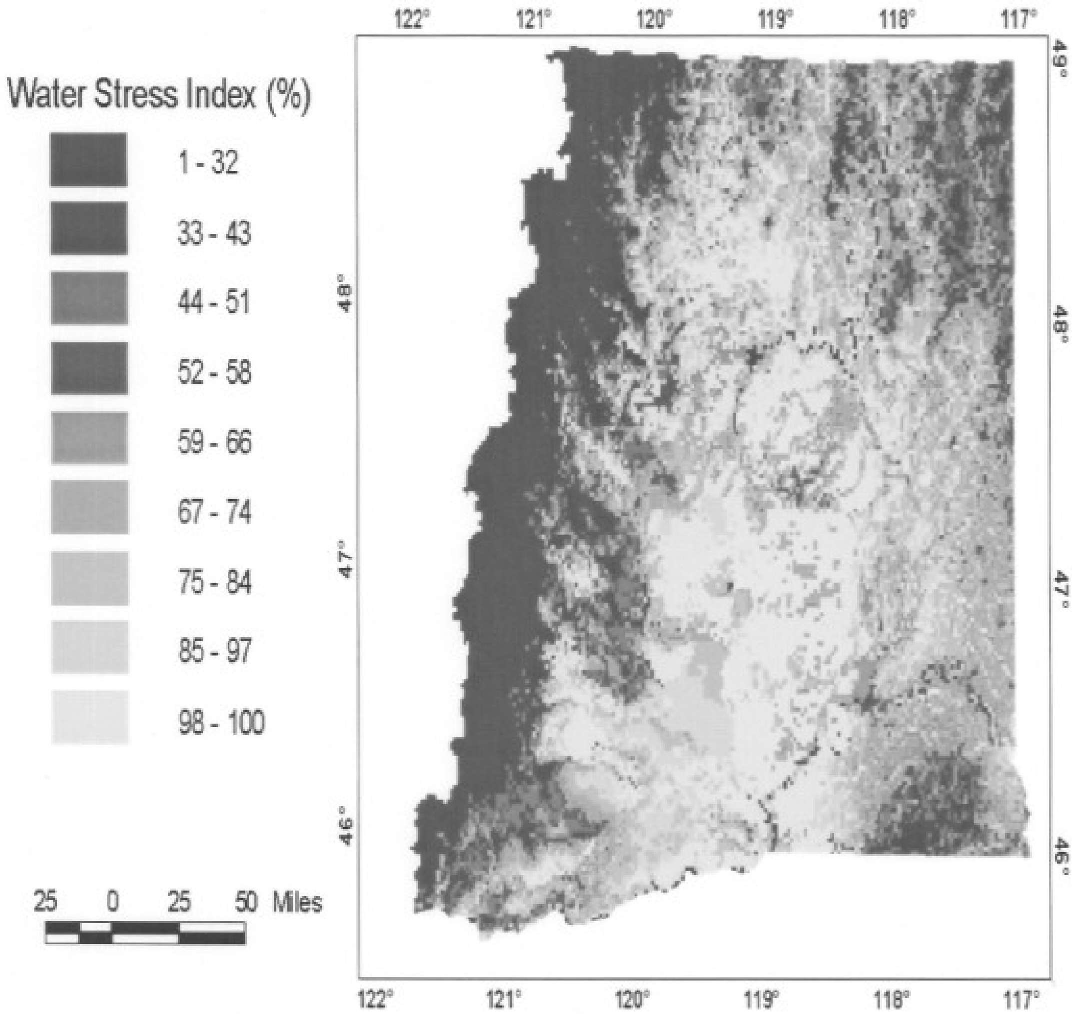

Figure 9. Water Stress Index Grid for Eastern Washington (ICBEMP, 2000)

Region Delineation

Initial simulations of the model did not separate Eastern Washington into regions based on hydrologic similarities. These simulations demonstrated the need for separate regions of Eastern Washington to be established. Regional delineation for estimation of design flows in Washington has often consisted of grouping 4th Field HUCs based on hydrologic similarity (Sumioka et al., 1998; Kresch, 1999; Powers and Saunders, 1998). Four regions in Eastern Washington were defined based on mean annual precipitation, mean elevation, and mean water stress index as basin characteristics for these 4th field HUCs. A statistical software package, SPSS, was used to define four unique clusters in Eastern Washington using the procedure outlined below (SPSS, 1999).

A hierarchical cluster analysis procedure was used in SPSS to group the 4th Field HUCS into four homogeneous regions. The hierarchical clustering algorithm is used to identify homogeneous groups of HUC4s using basin characteristics. The basin characteristics are used to calculate similarity measures between each HUC4. These similarity measures are then used to combine the HUC4s into homogeneous groupings, or clusters. The clusters are formed by first designating each single HUC4 as a cluster. The clustering algorithm then evaluates the similarity measure of each cluster and combines those that are determined to be alike. This procedure is continued until all of the HUC4s are combined into one cluster or region, or until a user-defined number of clusters is reached. The order in which the HUC4s are combined into clusters is shown in the dendrogram provided for the final analysis, Figure 10 (SPSS, 1999).

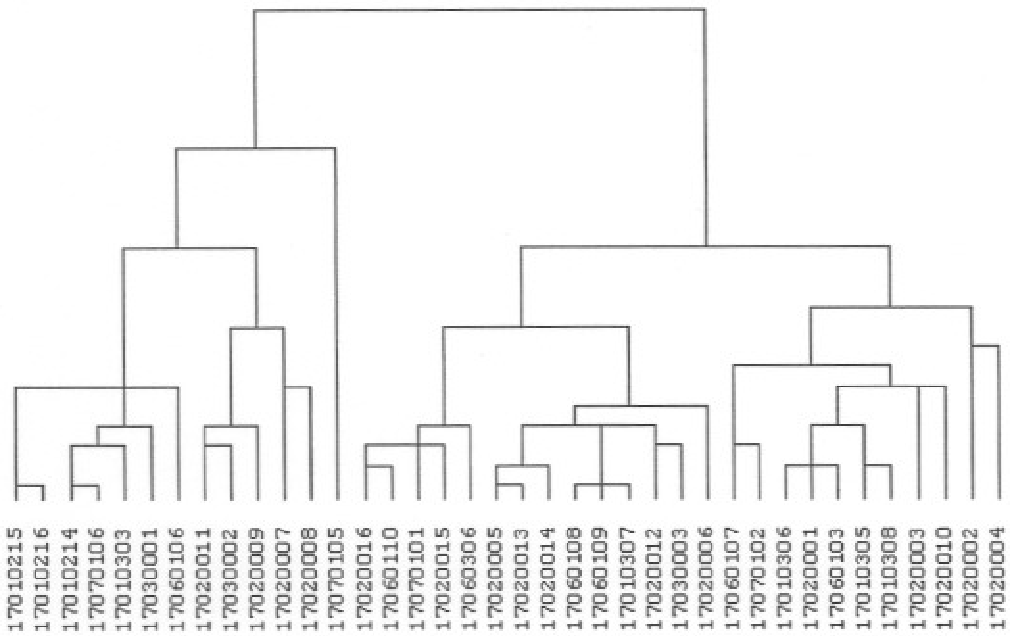

Figure 10. Dendrogram Showing Cluster Formation of 4th Field HUCs.

This procedure allowed for specification of several aspects in the clustering algorithm and output data. The similarity measure used was a measure of the Euclidean distance between basin characteristics of each HUC4. The magnitude of each basin characteristic was not the same and thus had to be normalized to allow equal weighting of each attribute. SPSS provides several options for normalizing variables prior to calculation of the Euclidean distance. The method used in this simulation normalized each basin attribute to a range of zero to one, thus giving each basin characteristic the same range in magnitudes. SPSS allows the user to specify the desired number of clusters or a range of cluster sizes in the output file; a range of two to eight clusters was used in this analysis. Table 5 illustrates the cluster memberships for each 4th Field HUC. The 4th Field HUCs are labeled for each row, with their corresponding cluster membership labeled in the next columns. The final cluster number for each analysis is labeled at the top of each column (SPSS, 1999). The highlighted column shows the membership designation of each 4th Field HUC into one of the four separate regions or clusters used in this final analysis.

Table 5. Cluster Membership by 4th Field HUC: Highlighted column represents final cluster membership chosen

HUC4	8 Clusters	7 Clusters	6 Clusters	5 Clusters	4 Clusters	3 Clusters	2 Clusters
17010214	1	1	1	1	1	1	1
17010215	1	1	1	1	1	1	1
17010216	1	1	1	1	1	1	1
17010303	1	1	1	1	1	1	1
17010305	2	2	2	2	2	2	2
17010306	2	2	2	2	2	2	2
17010307	3	3	3	3	2	2	2
17010308	2	2	2	2	2	2	2
17020001	2	2	2	2	2	2	2
17020002	4	4	4	2	2	2	2
17020003	2	2	2	2	2	2	2
17020004	4	4	4	2	2	2	2
17020005	3	3	3	3	2	2	2
17020006	3	3	3	3	2	2	2
17020007	5	5	5	4	3	1	1
17020008	5	5	5	4	3	1	1
17020009	6	6	5	4	3	1	1
17020010	2	2	2	2	2	2	2
17020011	6	6	5	4	3	1	1
17020012	3	3	3	3	2	2	2
17020013	3	3	3	3	2	2	2
17020014	3	3	3	3	2	2	2
17020015	7	3	3	3	2	2	2
17020016	7	3	3	3	2	2	2
17030001	1	1	1	1	1	1	1
17030002	6	6	5	4	3	1	1
17030003	3	3	3	3	2	2	2
17060103	2	2	2	2	2	2	2
17060106	1	1	1	1	1	1	1
17060107	2	2	2	2	2	2	2
17060108	3	3	3	3	2	2	2
17060109	3	3	3	3	2	2	2
17060110	7	3	3	3	2	2	2
17060306	7	3	3	3	2	2	2
17070101	7	3	3	3	2	2	2
17070102	2	2	2	2	2	2	2
17070105	8	7	6	5	4	3	1
17070106	1	1	1	1	1	1	1

Several simulations were performed using combinations of other basin attributes such as the minimum and maximum of the same descriptive variables for each 4th Field HUC. Each combination was compared to map developed using GIS techniques showing the distribution of Q_{FP4}/A by USGS gages. The simulation that best represented the distribution of Q_{FP4}/A analyzed mean elevation, mean annual precipitation, and mean water stress index for each of the 4th Field HUCs, combining them into four clusters or regions. The final regional delineation and the measured values of Q_{FP4}/A for each USGS gages are shown in Figure 11.

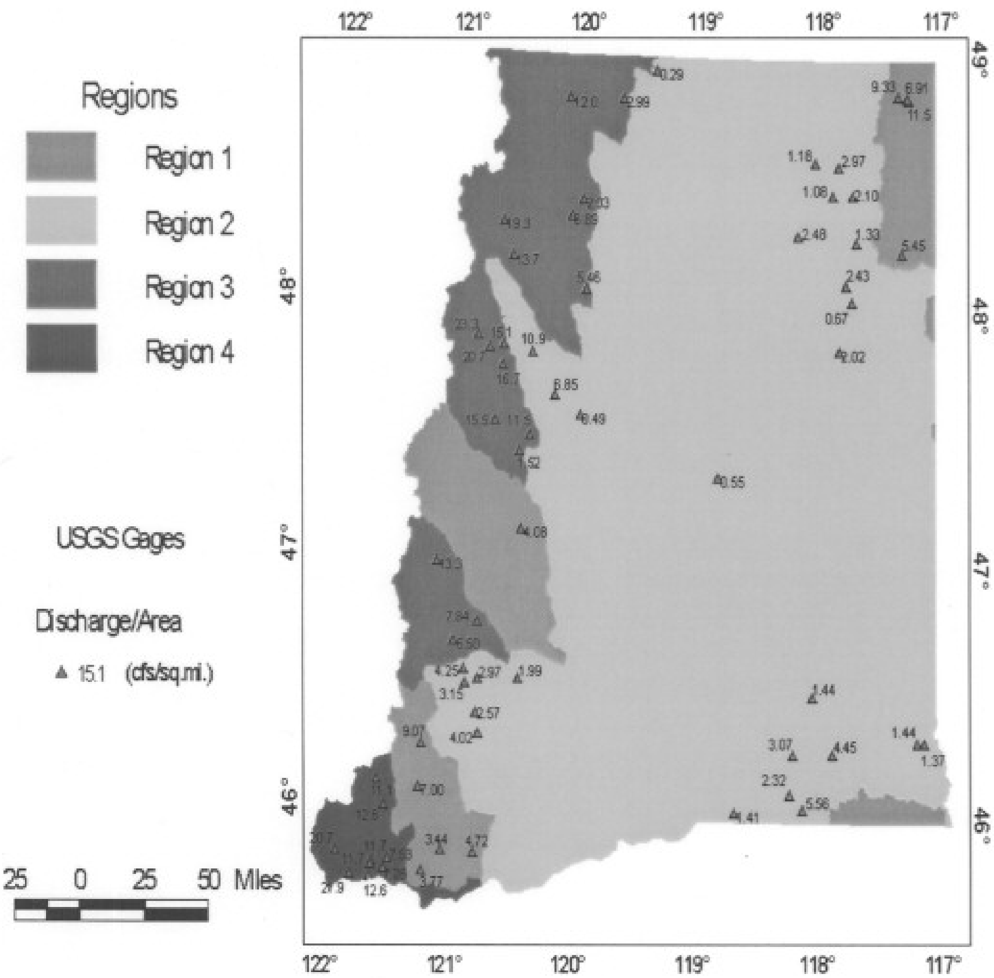

Figure 11. Regional Map Developed from Cluster Analysis

Comparing HUC6s and USGS Watersheds

The next step in the model was to find the USGS watersheds that most closely matched each HUC6 based on similarity between basin characteristics previously defined for each 6th Field HUC. To explain this procedure, consider one HUC6 and all of USGS gages in one of the previously defined regions. A similarity matrix was formed describing the Euclidean "distance" (Equation 3) between the HUC6 and all of the USGS gages within the region. The USGS gages having the smallest distance values are those that most closely match the HUC6 by basin characteristics. This procedure was then repeated for every HUC6 by region, providing a hierarchical ranking of USGS gages for every HUC6 in the model.

Discharge at HUC6s

A discharge per unit area, Q_{FP4}/A, is assigned to each HUC6 based on the values of the USGS gages determined to be most similar to the HUC6. Two additional concepts are used to do this, a region of influence and gage weighting formula.

Region of Influence

Each HUC6 is given an ROI, consisting of those gages that most closely match it termed the similarity matrix. The ROI is determined by selecting all of those gages having a similarity index less than or equal to a specified threshold limit. An addition criterion is also used, that of specifying the minimum number of gages to include in the ROI.

The minimum number of gages included in each ROI was set to two for each region. This was done so that each HUC6 would be estimated by no less than two gages, thus reducing the chance for over or under prediction based on one gage. The threshold value was determined for each of the four regions by trial and error techniques aimed at providing the smallest percent standard error by region. This procedure allows for the number of gaged sites used in the estimation of discharge for each HUC6 to be a function of the unique similarity matrix determined for each HUC6.

This method stems from the procedures outlined by Burn (1990a) and Pope and Tasker (1999) described previously. Additional methods for defining the ROI of each HUC6 were evaluated, but were discarded due to poor results.

Gage Weighting

Once the optimum number of gages for each ROI is determined, the corresponding values of Q_{FP4}/A are weighted according to their dissimilarity index and assigned to each HUC6. The weighting procedure used in this model employs Equation 8, proposed by Zrinji and Burn (1994). This method uses the previously determined similarity index of each gage within a HUC6's ROI as a measure of the discharge weighting applied to that gage.

Trial and Error

A discharge per unit area was assigned to each HUC6 based on the ROI developed for that HUC6. Since the ROI is a function of the threshold value for each region, a trial and error analysis was used to establish the ROI at each HUC6 (MathSoft, 1998). The objective of this procedure was to minimize the percent standard error for each region. Once the standard error was minimized, the values of Q_{FP4}/A assigned to each HUC6 in that simulation were recorded as the final design values.

Design Procedure

The result of this project is a procedure that can be followed by WSDOT designers to easily size culverts for fish passage. Determining the fish passage design flow at any site, ungaged or gaged, requires the designer to complete the following 5 steps.

1. Delineate the watershed for the desired location.

2. Find the area of the watershed within each predefined HUC6 using the maps in Appendix E, termed the contributing area.

3. Read value of Q_{FP4}/A, found in Appendix E, corresponding to each HUC6 identified in Step 2.

4. Multiply the contributing area with the corresponding Q_{FP4}/A for that HUC6, providing a total Q_{FP4} for each contributing area.

5. Sum all of the values of Q_{FP4} from Step 4, to yield the design flow at the site.

FINDINGS/DISCUSSION

MEASURING ACCURACY

Three comparative methods were used to assess the accuracy of the Contributing HUC6 model: (1) standard error (2) coefficient of determination (3) graphical analysis.

Comparison of Standard Error

Powers and Saunders (1998) provide the following formula for measuring the percent standard error of a model, *SE%*:

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(\ln(Qm_i) - \ln(Qe_i)\right)^2 \qquad \text{Eqn. 11}$$

$$SE\% = 100\left(e^{MSE} - 1\right)^{\frac{1}{2}} \qquad \text{Eqn. 12}$$

where e is 2.3026, the base of the natural logarithm; Qm_i and Qe_i are the measured and estimated discharges, respectively; n is the number of gages in a region; and *MSE* is the mean square error expressed in natural log units.

To assess the success of the model it is compared against recently published work by the USGS (Kresch, 1999). As previously stated, a larger gage sampling was used by the USGS, consisting of both crest-stage stations and continuous-record stations. The Contributing HUC6 model used a selection of the continuous-record gages chosen by Kresch (1999).

To adequately compare the USGS model to the Contributing HUC6 model only those gages common to both were compared in Table 6. Discharge was estimated for each of the 64 gages for comparison to measured values. The USGS study provided a table listing the measured fish passage design flow, watershed area, precipitation, and regression region for each of the gages. The fish passage design flow was estimated for each gage using the appropriate regression equation and attribute information.

The percent standard error for each method was calculated by grouping the gages according to the six regions defined in the USGS regression model (Kresch, 1999). Regions 4 and 5 were combined due to the limited number of gages comprising each region individually. The models were additionally evaluated independent of regions, thus grouping all 64 gages together. The results of these analyses are displayed in Table 6.

Table 6. Percent Standard Error of Models: Common Gages using USGS Regions

	Total	**Region 1[a]**	**Region 2[a]**	**Region 3[a]**	**Regions 4 & 5[a]**	**Region 6[a]**
WSU	36	44	39	17	39	27
USGS	75	52	80	33	275	32

Notes: [a]Regions represent those used by Kresch (1999)

Table 6 shows that the WSU model is a better predictor of measured flows than the USGS approach. Each case evaluated in Table 6 illustrates that the WSU model had lower percent standard errors than the USGS regression equation approach.

The combination of regions 4 and 5 predicted very poorly for the USGS approach, having a percent standard error of 275.1. A number of gages in this combined region predicted design flows a full order of magnitude different from the measured value when using the USGS regression approach. Prediction errors of this magnitude explain the high percent standard error calculated for this region.

An additional comparison is provided in Table 7, comparing the total number of gages used in each model. The results published by Kresch (1999), including all of the gages used in his analysis are provided in Table 7. The gages used by WSU in development of the Contributing HUC6 model are provided as they correspond to the USGS regions. The WSU model again provides smaller percent standard errors than does the USGS regression approach, consistent with Table 6.

Table 7. Percent Standard Error of Models: All Gages using USGS Regions

	Total	Region 1[a]	Region 2[a]	Region 3[a]	Regions 4[a]	Region 5[a]	Region 6[a]
WSU[c]	36	44	39	17	---[b]	25	27
USGS[d]	---[b]	97	47	112	112	100	43

Notes: [a]Regions represent those used by Kresch (1999)
[b]Insufficient data
[c]Only those gages used in WSU model
[d]Published values including all gages used by Kresch (1999)

Comparison of Coefficient of Determination

Another commonly used measure to evaluate the accuracy of a model is the coefficient of determination, R^2. The coefficient of determination is the square of the Pearson's correlation; measuring how closely estimated values correspond to measured values. Values of R^2 range from 0 to 1 with 0 being no correlation and 1 being a perfect match to measured values.

Table 8. R^2 for Models: Common Gages using USGS Regions

	Total	Region 1[a]	Region 2[a]	Region 3[a]	Regions 4 & 5[a]	Region 6[a]
WSU	0.951	0.966	0.966	0.894	0.878	0.84
USGS	0.876	0.881	0.892	0.816	0.0004	0.84

Notes: [a]Regions represent those used by Kresch (1999)

Analyzing Table 8, it is again evident that the WSU model performed best, with values of R^2 ranging from 0.84 – 0.96 as opposed to 0.0004 – 0.892. It is necessary to point out the region that predicted extremely poor for the USGS model, R^2 of 0.0004, was due to vast differences in the predicted and measured flows.

Graphical Analysis

Graphical analysis presents another means of representing prediction error. The distribution of discharge prediction errors is displayed below using Q-Q plots. The measured discharge is on the plotted Y-axis and the predicted discharge on the X-axis. The model is deemed to fit well if the data plotted falls near a 45 degree line, meaning that the discharge predicted and discharge observed have similar values. Q-Q plots are provided below to demonstrate the error in each model over a range of flows.

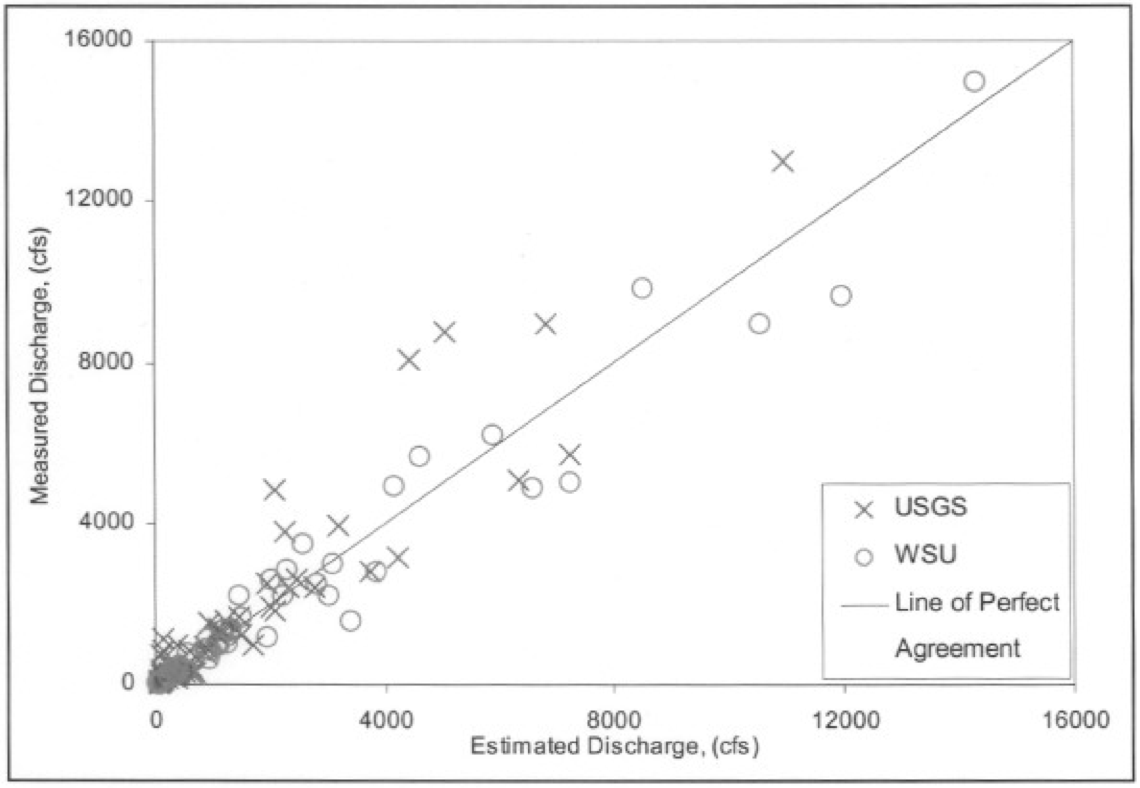

Figure 12. Plot of Measured vs. Estimated Flows: All Common Gages

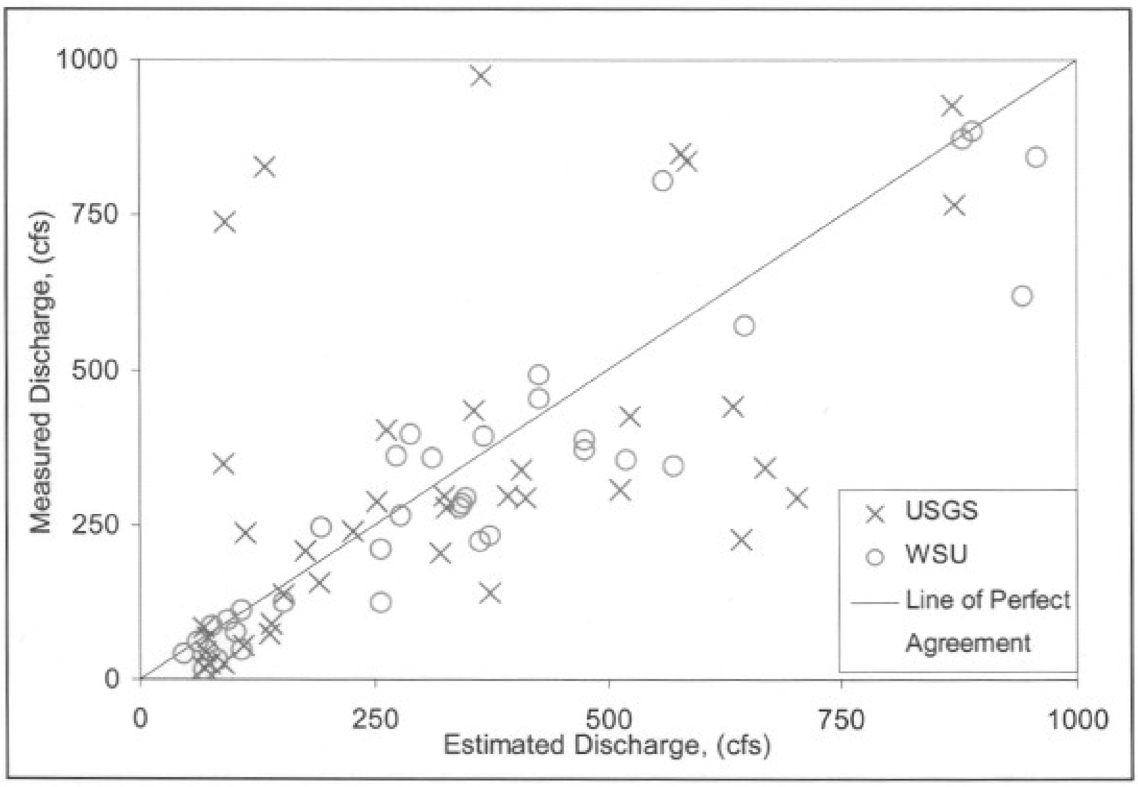

Figure 13. Plot of Measured vs. Estimated Flows: Discharge less than 1000 cfs

The entire range of flows, represented in Figure 12, illustrates that on average the WSU model predicts closer to the 45° line than the USGS model. This is further explained by referencing the R^2 values of each model when all gages are included. The WSU model measured an R^2 of 0.95 as compared to 0.88 for the USGS model, meaning that the measured and predicted values are closer in the WSU model.

Figure 13 illustrates the predicted vs. measured flows for gages having discharge less than 1000 cfs in magnitude. This is of significant importance since the focus of both models was to predict flows on small streams and thus a lower range of flows. The USGS model displays a broad scattering of flows, many deviating dramatically from the 45° line. The WSU model experiences some scatter from the 45° line, but not near the extreme as is shown for the USGS model.

MAGNITUDE OF FLOWS

The vagueness of WAC 220-110-070 in defining the fish passage design flow for use in culvert design has led to numerous interpretations and thus differing magnitudes of fish passage design flow for the same location. The method proposed by Kresch (1999) defines the fish passage design flow in terms of an exceedence probability. The method proposed in this study bases fish passage on yet another measure, the consecutive day criterion. The WAC also specifies the use of the 2-year peak flow for high flow culvert design when the fish passage design flow cannot be obtained. Each of these potential design flows was calculated for the 64 USGS gaging stations used in this study and are compared in Table 9.

Table 9. Comparison of Design Flows

Gage	USGS[a]	WSU	2-Year[b]		Gage	USGS[a]	WSU	2-Year[b]
12396000	349	372	525		12483800	279	285	412
12396900	738	806	1010		12488500	975	1049	1460
12397500	827	843	989		12489500	4810	4999	5930
12398000	1120	1325	1260		12492500	1540	1554	2390
12407500	24	32	44		12500500	298	293	380
12407520	84	88	119		12501000	74	78	96
12407700	158	125	165		12502000	306	353	538
12408300	293	277	301		12502500	294	345	421
12408420	45	40	41		12506000	424	491	696
12408500	241	246	298		12506500	142	210	241
12409000	1240	1184	1140		13334500	227	225	338
12409500	402	397	390		13334700	204	232	413
12433200	207	362	373		13344500	442	620	1510
12439300	18	17	54		14013500	68	94	324
12442000	340	388	523		14016000	89	112	548
12447390	236	265	368		14016500	289	454	862
12449500	8060	8961	11200		14017000	836	1109	2700
12449600	137	126	113		14017500	926	1035	3520
12449950	8770	9669	11800		14107000	1310	1369	1840
12451000	5690	6191	9600		14110000	2530	2519	3180
12451500	850	886	1270		14112000	296	394	1070
12452800	1940	2213	2680		14112500	766	965	3260
12453000	2600	2871	3380		14113000	3930	4889	7840
12454000	3150	3490	4640		14121300	342	358	699
12455000	5080	5652	7040		14121500	971	873	1590
12456500	2410	2597	3140		14123000	1820	2213	2760
12457000	8950	9851	11600		14123500	2410	2809	4600
12458000	2800	2999	4420		14124500	1200	1338	2780
12461400	54	61	181		14125000	1400	1369	2520
12462500	13000	14942	17500		14125500	1590	1686	3300
12463000	27	49	490		14127000	1660	2238	5240
12465000	433	572	814		14128500	3800	4916	13800

Ref: [a]Kresch (1999)
[b]Sumioka et al. (1998)

The 2-year peak flow is predominately higher than either measure of fish passage design flow. On average, the method proposed by WSU calculates a slightly higher value for the fish passage design flow than does method used in the USGS study. The key principle to be taken from Table 8 is that even though the methods of calculating fish passage design flow are vastly different between the WSU and USGS, the values of design flow associated with each gage are not. The 2-year peak flow is higher in most instances than either fish passage flow, thus making it less desirable for culvert design.

LIMITATIONS OF MODEL

The most significant factor limiting this model is the number of gaging stations used in the analysis. The fish passage design flow is defined in terms of daily flows, thus excluding the use of gaging stations that record only peak discharge. Kresch (1999) limited the number of continuous record gaging stations used to 79. Additionally the USGS study used regression techniques to estimate flows at crest-stage gaging stations, providing another 88 gages to the model. The WSU model uses only 64 of the continuous record gages used by Kresch (1999). Implementing any of the following procedures could have increased the number of gages in used in this model:

1. Correlating flows at continuous record gages to crest-stage stations.
2. Delineating the missing watersheds used by Kresch (1999) using GIS techniques.
3. Using continuous record gaging stations not deemed to have a sufficient period of record by Kresch (1999).

Implementation of any or all of these procedures would have introduced an additional source of uncertainty to the model and thus only those gages meeting the previously specified criteria were used.

A second factor limiting the use of the model is the size of the 6th Field HUCs and assumption of homogeneity within each 6th Field HUC. The model assigns a discharge per unit area to each 6th Field HUC, assuming homogeneity of Q_{FP4}/A throughout the 6th Field HUC. This assumption was made to aid in the application of the model for designers.

OTHER METHODS INVESTIGATED

Several other methods were investigated at various steps during the development of this model. One such step was defining a measure of homogeneity for inclusion of gages into a region of influence. Rank-Sum and L-moment models for establishing a homogeneous grouping of gages were given serious consideration for this step. The standard errors associated with the Rank-Sum model were higher than that calculated using the threshold criterion used in the final model. The Rank-Sum model was discarded for this reason. L-moment is commonly used to measure homogeneity within groups. Time constraints prevented sufficient testing of L-moment procedures.

CONCLUSIONS/RECOMMENDATIONS

The purpose of this research was to develop a method for predicting fish passage design flows at small-ungaged streams in Eastern Washington. This model meets this objective by establishing a new technique for measuring the fish passage design flow at gaged locations and simple method for estimating this flow at ungaged catchments.

SUMMARY OF DESIGN FLOW

The new approach taken by WSU to define fish passage design flow combines the concept of allowable fish delay with a migration window one month in length. This approach represents a hydrological interpretation of the high flow design discharge specified in the WAC and should not be interpreted as method derived from fisheries biology. This technique insures that fish will not be delayed any more than three days at a time during their natural migration spanning a given water year.

The concept of establishing the months of adult fish migration is central to defining the fish passage design flow outlined in the WAC. Migration times vary from stream to stream and from species to species, making establishment of a uniform window difficult if not impossible. The 4-day fish passage flow addresses this issue by focusing on the worst possible month occurring in each water year, negating the need to establish a migration window for each design.

SUMMARY OF CONTRIBUTING HUC6 MODEL

A major objective of this research was to develop a method for predicting design flows at ungaged catchments that required little estimation of basin characteristics by the designer. The Contributing HUC6 model has achieved this by incorporating key basin parameters internally into the model, leaving catchment area the only parameter for the designer to estimate. This provides for quick and accurate analysis of design flows at ungaged sites without the complications associated with measuring numerous basin attributes.

APPLICATIONS OF MODEL

Recent concerns regarding the ability of fish to successfully negotiate culverts are of increasing concern in many fish bearing streams. This model will aid in the design of new, and the retrofit of existing culverts to ensure adequate passage for migrating species.

SUMMARY OF GAGING STATIONS

Throughout Eastern Washington there exists a limited number of continuous recording stations on small catchments. Continuous recording stations are essential for establishing low and high flows pertaining to the fish passage design criterion of the WAC. One of the primary objectives of this project addressed this issue by installing and monitoring 20 stream gages on small catchments in Eastern Washington. The site selection for each gaging station was determined by evaluating areas of known fish presence. Each gage was additionally installed at or near a road crossing structure to provide for a controlled cross-section and accommodate the possibility of replacement of the structure by providing an accurate measurement of discharge at the site.

The WSU gages were not used in the Contributing HUC6 model for two major reasons. The first reason is the need for a sufficient period of record for analysis. Seaber et al. (1982), Kresch (1999), Sumioka et al. (1998), and many others state that optimal period of record for statistical analysis is 10 years. Due to the length of this project the period of record recorded at each gage to date is less than one year and at the conclusion of this work will only be one and half years.

RECOMMENDATIONS FOR FUTURE RESEARCH

Continued monitoring of the continuous recording stations installed by WSU is essential for development of future regional models within Washington State. Several reasons supporting the continued monitoring of these gages are provided below.

The focus of this research was to address the issue of passage for adult fish in culverts during high flow conditions. The WAC governing design of water crossing structures outlines additional requirements pertaining to juvenile migration in culverts during low flow conditions. Continuous recording stations, providing mean daily flows, are needed to perform low flow analysis. The limited number of continuous record gages in Eastern Washington begs for the continued monitoring of the WSU gaging stations, allowing for improved prediction of both low and high design flows at small streams for juvenile and adult fish passage. Additional reasons supporting the continuation of these gaging stations are:

1. The development of a sufficient period of record for analysis.

2. Monitoring of sites for potential replacement of road crossing structure located at or near gaging stations.

Further studies should be performed addressing the issue of juvenile passage in culverts. Neglecting to focus on juvenile fish survival could lead to disastrous outcomes, such as continued decline or extinction of a species. The need to address the issue of juvenile passage during low flows is obvious and should be implemented immediately.

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NOTATION

Notation	Description
Q_{FP4}	Mean annual fish passage design flow or 4-day fish passage flow.
Q_{FP4}/A	Discharge per unit area.
HUC	Hydrologic unit code.
HUC6	6th hydrologic unit code.
HUC4	4th hydrologic unit code.
Q_T	Desired recurrence flow.
$\alpha, \beta_1, \beta_2, \beta_3$	Coefficients of Q_T.
X_1, X_2, X_3	Basin characteristics of Q_T such as precipitation and area.
D_{ij}	Distance between stations *j* and *k*.
X_{ij}	i^{th} hydraulic basin characteristic at station *j*.
p	Total number of basin characteristics.
W_i	Weighting value.
θ_i	Threshold value determined for the ROI of site *i*.
θ_U, θ_L	Upper and lower threshold values, respectively.
NS_i	Number of stations contained in the ROI of site *i*.
NST	Desired number of gages to be included in the ROI.
W_k	Gage weighting factor for site *k*.
$D_{i,k}$	Similarity index between ungaged site *i* and gaged site *k*.
P	Total number of gaged sites in the ROI for site *i*.
n_{ij}	Weighting value for gage *j* corresponding to the ROI for ungaged site *i*.

θ_L	Lower threshold value for inclusion of gages into the ROI.
TP, TN	Dictate gage weighting at the threshold limit.
n	Provides a decrease in the weighting for gages determined to be most dissimilar (larger similarity index).
e	Base of natural logarithm, 2.3026.
Qm_i, Qe_i	Measured and estimated discharges, respectively.
n	Number of gages in a region.
MSE	Mean square error expressed in natural log units.

APPENDIX A

WSU GAGING STATIONS

WSU GAGING STATIONS

DESCRIPTION OF WSU GAGING STATIONS

This section describes the locations, instrumentation, and basin characteristics the twenty WSU gaging stations installed throughout Eastern Washington. A limited number of USGS continuous record water level monitoring stations exist on small streams in Eastern Washington. Figure A.1 illustrates the locations of USGS continuous record gaging stations having drainage areas less than or equal to 50 mi^2.

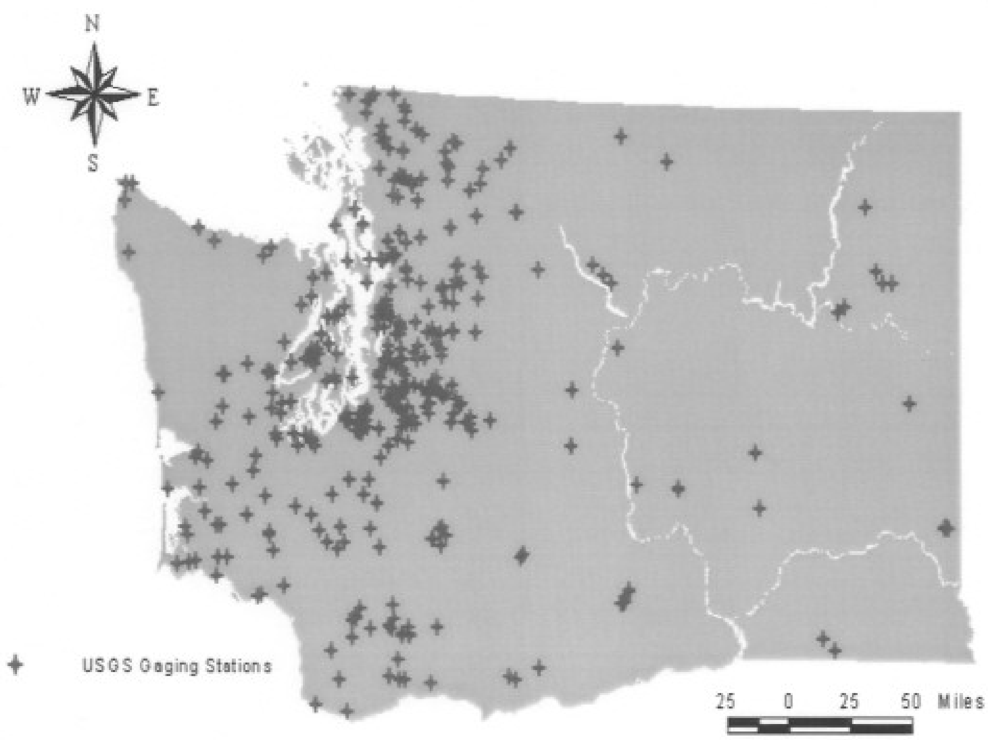


Figure A.1. USGS Gages on Streams under 50 mi^2

To address this lack of monitoring stations, WSU identified numerous small streams throughout Eastern Washington in regions of known fish presence as potential gaging sites. Twenty of these streams, identified in Figure A.2 and Tables A.1 and A.2, were selected as gaging sites based on their location and size. Each of these gaging stations is located at or near a road crossing structure. This was done to provide a controlled cross-section, stable instrument mounting, ease of access, in addition to furnishing a direct measurement at a culvert or bridge for the purpose of future evaluation of the structure.

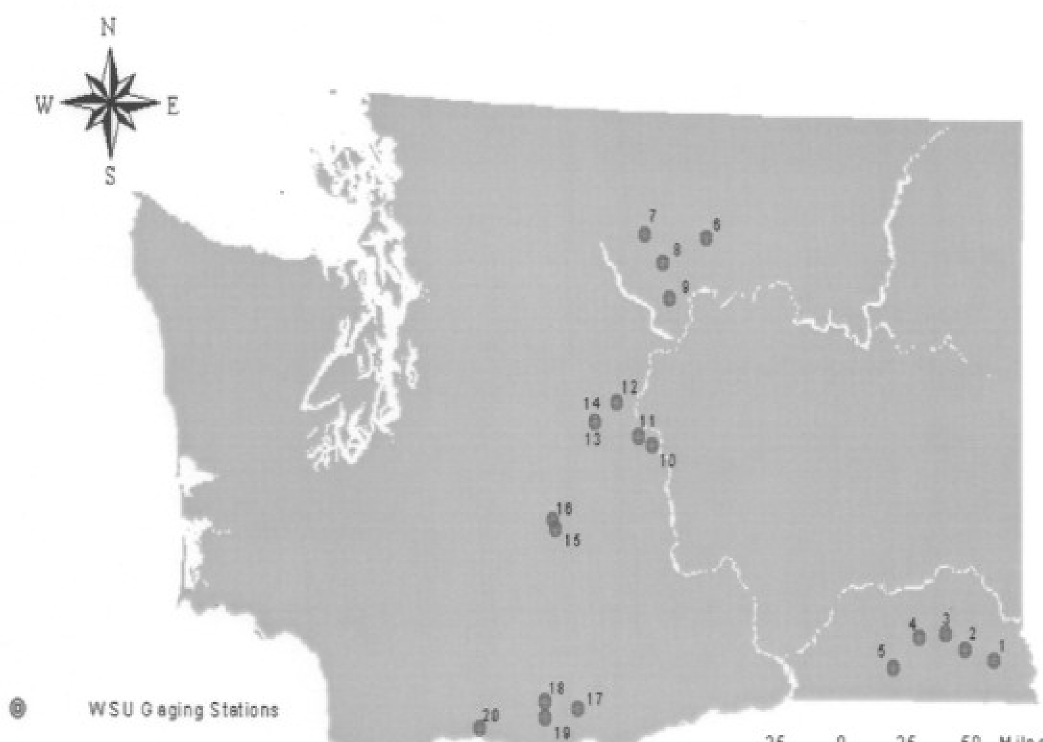


Figure A.2. Locations of WSU Gaging Stations

Table A.1. Locations of WSU Gaging Stations

Map Id	Stream Name	Long (HMS)	Lat (HMS)	County	Road Name
1	S. Fork Asotin Creek	117:16:48	46:13:32	Asotin	S. Fork Asotin Creek Rd.
2	Pahata Creek	117:31:08	46:16:33	Garfield	Forest Road 040
3	Tumalum Creek	117:41:02	46:21:33	Columbia	Tucannon Rd.
4	Patit Creek	117:53:45	46:20:17	Columbia	Range Grade Rd.
5	S. Fork Coppei Creek	118:06:27	46:10:44	Walla Walla	S. Fork Coppei Creek Rd.
6	Loup Loup Creek	119:44:46	48:21:59	Okanogan	HWY 20
7	Little Bridge Creek	120:17:06	48:22:46	Okanogan	NFDR 44
8	Libby Creek	120:07:01	48:13:50	Okanogan	HWY 153
9	Black Canyon Creek	120:03:04	48:02:57	Okanogan	Hwy 153
10	Colockum Creek	120:09:18	47:17:35	Chelan	Colockum Rd.
11	Stemilt Creek	120:16:48	47:19:44	Chelan	Stemilt Creek Rd
12	Mission Creek	120:28:26	47:30:14	Chelan	Mission Creek Rd
13	Upper Peshastin Creek	120:39:11	47:23:48	Chelan	Forest Road 7320
14	Lower Peshastin Creek	120:39:14	47:24:04	Chelan	Forest Road 7320
15	Nile Creek	120:57:00	46:50:18	Yakima	Nille Rd
16	Rock Creek	120:58:48	46:52:52	Yakima	HWY 410
17	Butler Creek	120:42:18	45:54:53	Klickitat	HWY 97
18	Bowman Creek	120:58:41	45:56:10	Klickitat	Garrison Rd.
19	Mill Creek	120:57:47	45:51:34	Klickitat	State HWY 142
20	Buck Creek	121:30:58	45:46:57	Klickitat	Big Buck Creek Rd

Table A.2. Site Data for WSU Gaging Stations

Map Id	Stream Name	Area (mi2)	Gage El. (ft.)	Precipitation (mm)
1	S. Fork Asotin Creek	36.6	2346	597
2	Pahata Creek	9.4	3960	1155
3	Tumalum Creek	15.8	1975	832
4	Patit Creek	50.1	1877	817
5	S. Fork Coppei Creek	12.5	1791	825
6	Loup Loup Creek	44.2	2119	509
7	Little Bridge Creek	24.3	2136	756
8	Libby Creek	41.7	1391	776
9	Black Canyon Creek	11.3	1982	680
10	Colockum Creek	35.1	1332	539
11	Stemilt Creek	24.6	1739	657
12	Mission Creek	80.8	876	579
13	Upper Peshastin Creek	19.4	2579	832
14	Lower Peshastin Creek	36.4	2585	817
15	Nile Creek	31.7	2021	1025
16	Rock Creek	17.4	2169	1054
17	Butler Creek	11.6	2165	589
18	Bowman Creek	13.4	2320	818
19	Mill Creek	28.6	1614	732
20	Buck Creek	13.8	364	1057

Each station consists of a water level logger enclosed in a PVC pipe with a screw down cap. A hasp is attached to the cap so that the instrument can be locked within the pipe. A portion of galvanized pipe is used to further protect the sensor residing in the lower portion of the pipe on streams thought to have significant bedload. A typical gaging station installed by WSU is shown in Figure A.3.

A water level logger (Figure A.4) is used to record the height of the water at 15- to 30-minute time intervals, helping to identify rapidly rising and falling water levels following storm events. The water level logger consists of 2 major components: (1) a submersible pressure transducer and (2) a data logger. Two styles of pressure transducers were used. The majority of pressure transducers installed were capable of measuring depths ranging from 0 to 3 feet. Several of the gaging sites required a higher depth range and thus pressure transducers with depth capacity from 0 to 15 feet were installed. The error associated with each of these units is 0.02% of the transducers maximum measuring depth. The data logger has the capability of recording up to 6000 data reading before re-writing over previously recorded information. Field monitoring of each gaging station consists of downloading these readings to a laptop computer. Additionally, the accuracy of each water level logger is evaluated by comparing the field-measured readings with those measured by the instrument. Prior to leaving each site the newly recorded data is evaluated for erroneous recordings in order to identify long-term problems with the unit (Global Water, 1999).

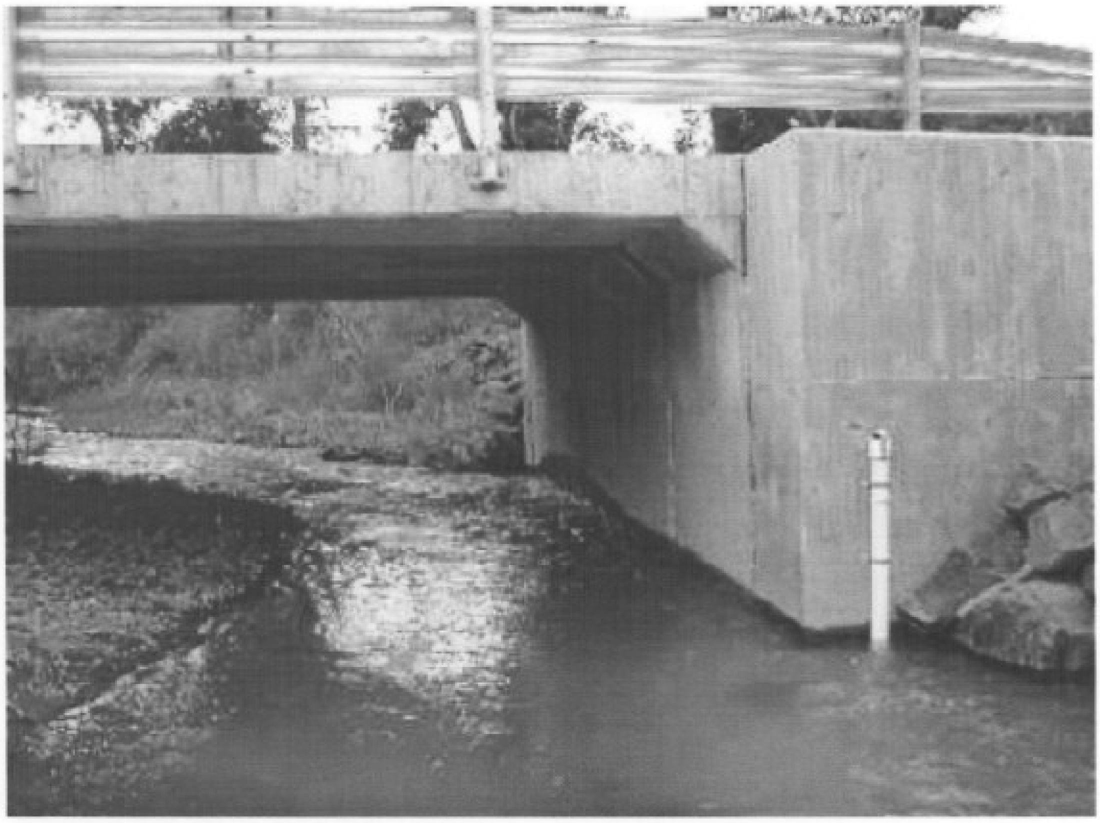


Figure A.3. Typical Gage: S.F. Coppei Creek

Figure A.4. Water Level Logger

Several times throughout the year, velocity profiles are taken near the stream gage using a Pygmy meter (Figure A.5). This is done by stretching a tape across the stream and taking velocity measurements along the targeted cross-section, as shown in Figure A.6. The total discharge is determined by summing the incremental discharge calculated for the area surrounding each velocity reading. The measured values of stream height and discharge are used to establish a rating curve, relating depth to discharge. This rating curve can then be used to yield a discharge value for any recorded stage of the stream.

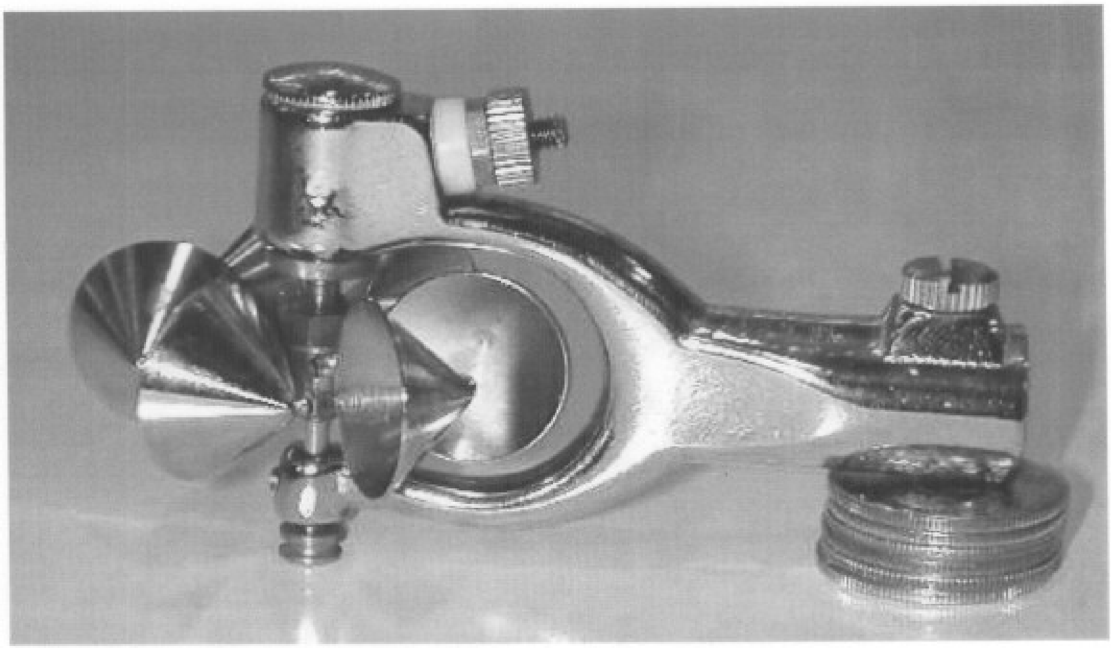


Figure A.5. Velocity Measuring Instrument: Pygmy meter (Note: quarter-size coin shown for scale)

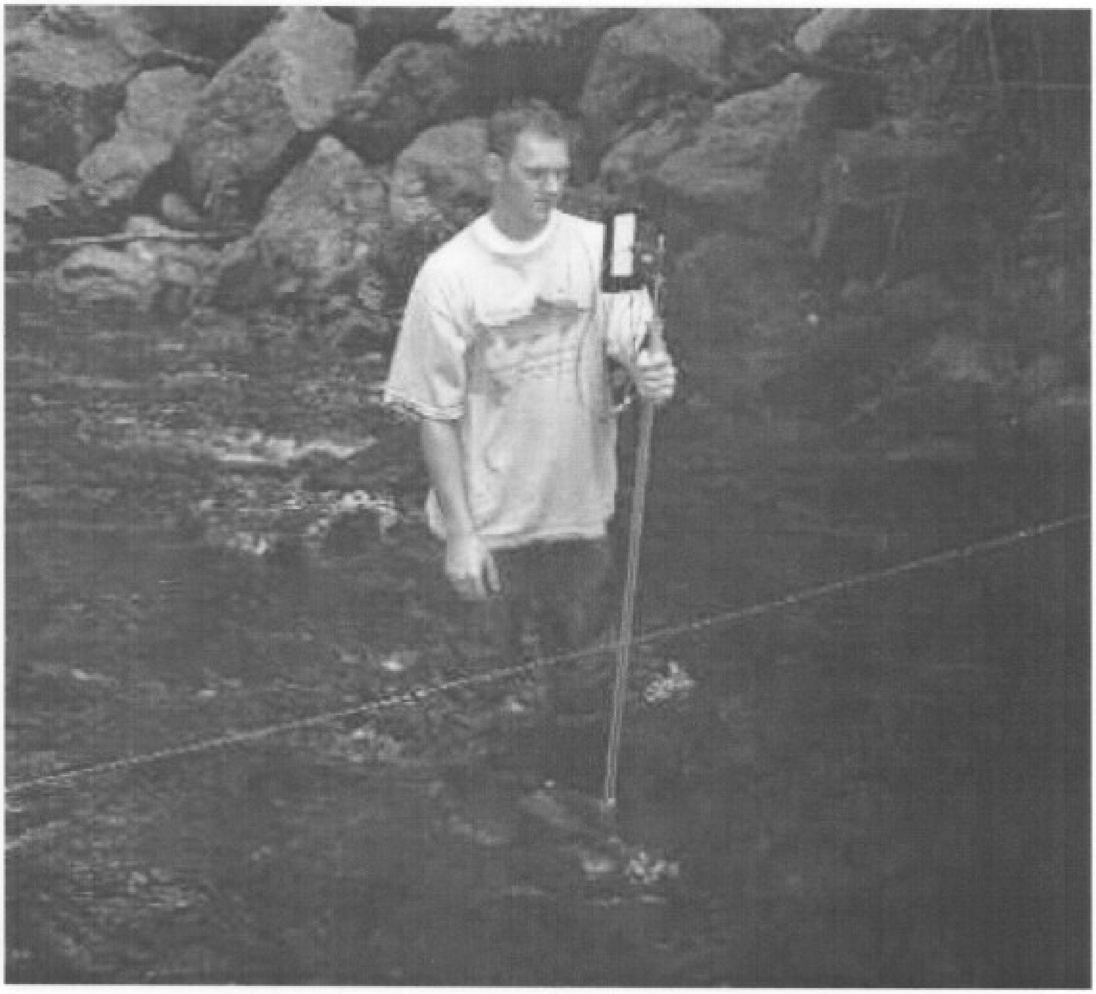


Figure A.6. Measuring Velocity at Buck Creek

WSU GAGING STATION PROFILES

This section provides a photo and profile of the twenty WSU gaging stations installed throughout Eastern Washington.

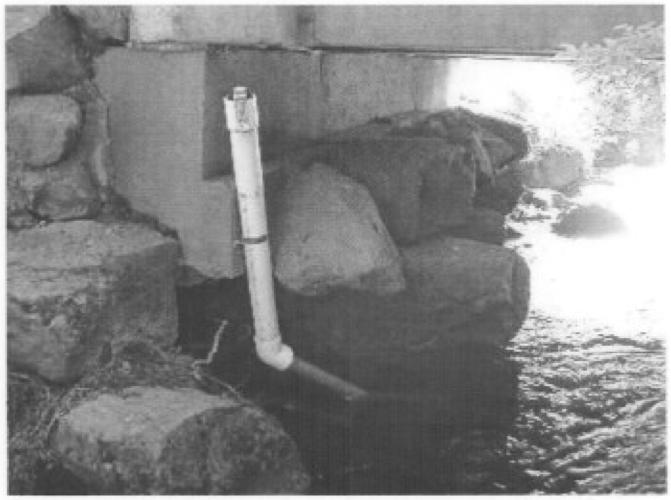
Black Canyon Creek

Longitude: **120:03:04**
Latitude: **48:02:57**
Road: **Black Canyon Rd.**
County: **Okanogan**
Washington DeLorme Gazetteer Page: **99**
Tributary of: **Methow River → Columbia River**
Drainage Area: **11.3 mi^2**
Gage Elevation: **1982 ft**
Mean Annual Precipitation: **680 mm**
Mean Water Stress Index: **39 %**

Comments:

Installed in bank upstream of culvert past Snow Park. PVC pipe is supported by roots, rocks and rebar. Ice dam occurred downstream of gage during winter months. The ice dam influenced the stage readings recorded at the gage over a period of time during winter.

Bowman Creek

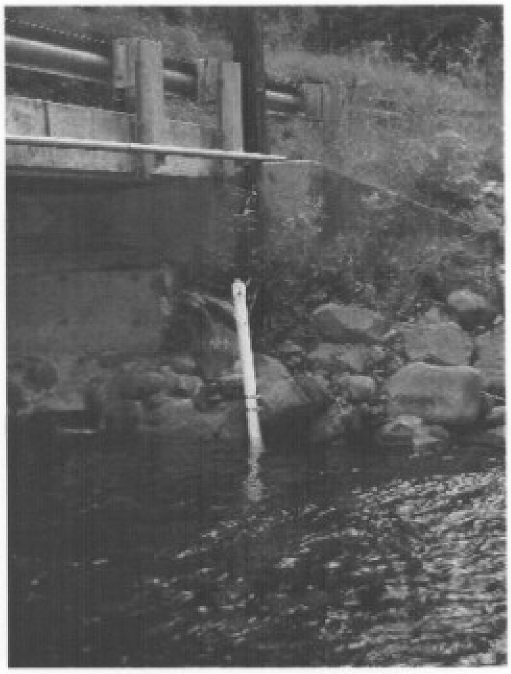


Longitude: ***120:58:41***
Latitude: ***45:56:10***
Road: ***Garrison Rd.***
County: ***Klickitat***
Washington DeLorme Gazetteer Page: ***26***
Tributary of: ***Canyon Creek → Little Klickitat River → Klickitat River → Columbia River***
Drainage Area: ***13.4 mi²***
Gage Elevation: ***2320 ft***
Mean Annual Precipitation: ***818 mm***
Mean Water Stress Index: ***56 %***

Comments:

Installed under bridge at upstream end with boulders protecting gage. Gage location iced over during winter months.

Buck Creek

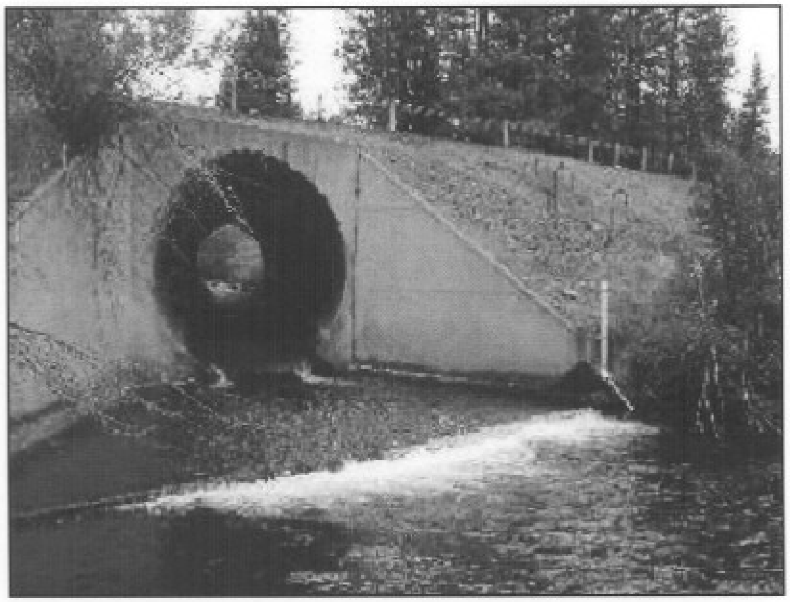


Longitude: ***121:30:58***
Latitude: ***45:51:34***
Road: ***Big Buck Creek Rd.***
County: ***Klickitat***
Washington DeLorme Gazetteer Page: ***24***
Tributary of: ***White Salmon River → Columbia River***
Drainage Area: ***13.8 mi²***
Gage Elevation: ***364 ft***
Mean Annual Precipitation: ***1057 mm***
Mean Water Stress Index: ***37 %***

Comments:

Installed at downstream end of bridge on boulder that has been cemented to bridge abutment. Gage was replaced on 11/11/00 due to malfunction.

Butler Creek

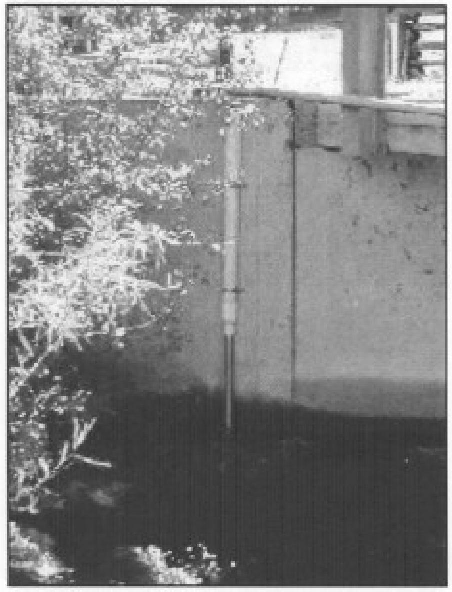


Longitude: **120:42:18**
Latitude: **45:54:53**
Road: **HWY 97**
County: **Klickitat**
Washington DeLorme Gazetteer Page: **26**
Tributary of: **Little Klickitat River → Klickitat River → Columbia River**
Drainage Area: **11.6 mi^2**
Gage Elevation: **2165 ft**
Mean Annual Precipitation: **589 mm**
Mean Water Stress Index: **68 %**

Comments:

Installed at downstream of CMP on end of concrete wingwall. The USGS previously gaged this stream, at or very close to this location.

Colockum Creek



Longitude: ***120:16:48***
Latitude: ***47:19:44***
Road: **Colockum Rd.**
County: **Chelan**
Washington DeLorme Gazetteer Page: ***67***
Tributary of: **Columbia River**
Drainage Area: ***35.1 mi²***
Gage Elevation: ***1332 ft***
Mean Annual Precipitation: ***539 mm***
Mean Water Stress Index: ***64 %***

Comments:

Installed at downstream end of bridge. This gage was replaced on 7/1/00 due to malfunction. Local landowners informed WSU that Colockum Creek might run dry during summer months partially due to irrigation practices.

Libby Creek

Longitude: **120:07:01**
Latitude: **48:13:50**
Road: **HWY 53**
County: **Okanogan**
Washington DeLorme Gazetteer Page: **99**
Tributary of: **Methow River → Columbia River**
Drainage Area: **41.7 mi^2**
Gage Elevation: **1391 ft**
Mean Annual Precipitation: **776 mm**
Mean Water Stress Index: **39 %**

Comments:

Gage installed at downstream end of bridge with Galvanized pipe extended into water for added protection. This is a deceivingly fast stream. An unknown agency began monitoring the same location some time after installation of the WSU stream gage. Gage malfunctioned during battery replacement on 2/24/00 and was replaced. No data was lost. Gage location iced over during winter months.

Little Bridge Creek

Longitude: **120:17:06**
Latitude: **48:22:46**
Road: **National Forest Development Road 44**
County: **Okanogan**
Washington DeLorme Gazetteer Page: **99**
Tributary of: **Twisp River→ Methow River → Columbia River**
Drainage Area: **24.3 mi^2**
Gage Elevation: **2136 ft**
Mean Annual Precipitation: **756 mm**
Mean Water Stress Index: **36 %**

Comments:

A hole was dug into the bank through which PVC and Galvanized pipe are braced against roots and rocks. Water cuts under bank at this location, providing a protective site for the instrument. Flow through culvert just upstream of gage was identified to be supercritical over the entire length. The stream iced over at gage location during cold winter months.

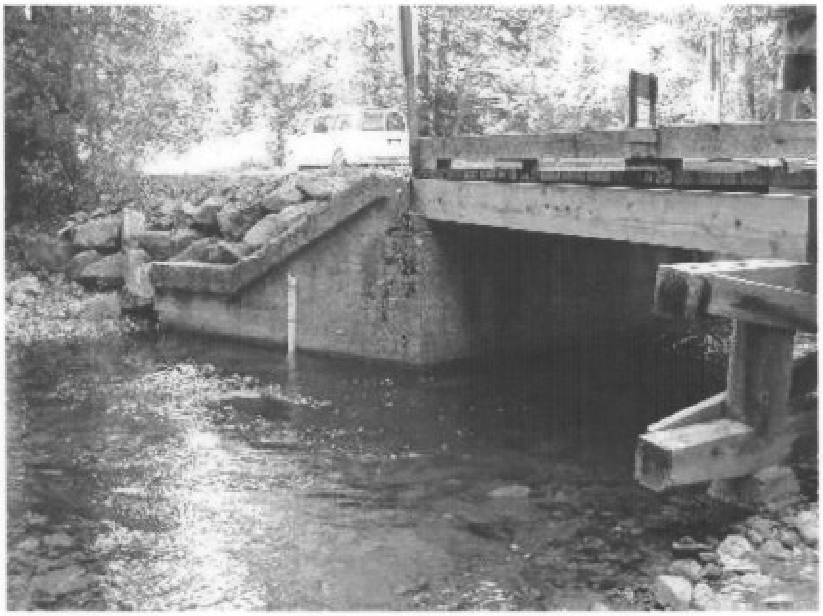
Loup Loup Creek

Longitude: **119:44:46**
Latitude: **48:21:59**
Road: **HWY 20**
County: **Okanogan**
Washington DeLorme Gazetteer Page: **100**
Tributary of: **Summit Creek → Okanogan River → Columbia River**
Drainage Area: **44.2 mi^2**
Gage Elevation: **2119 ft**
Mean Annual Precipitation: **509 mm**
Mean Water Stress Index: **76 %**

Comments:

Gage was installed to concrete at downstream end of culvert. Fish have been sited several times at this stream. Photo was taken prior to installation of gage.

Lower Peshastin Creek



Longitude: ***120:39:11***
Latitude: ***47:23:49***
Road: ***Forest Road** 7320*
County: ***Chelan***
Washington DeLorme Gazetteer Page: ***66***
Tributary of: ***Wenatchee River → Columbia River***
Drainage Area: ***36.4 mi^2***
Gage Elevation: ***2585 ft***
Mean Annual Precipitation: ***817 mm***
Mean Water Stress Index: ***40 %***

Comments:

Gage installed at downstream end of bridge. Large scour hole under bridge provides great fish habitat. Road is not plowed beyond the bridge during winter so area beyond can be used as a snow park.

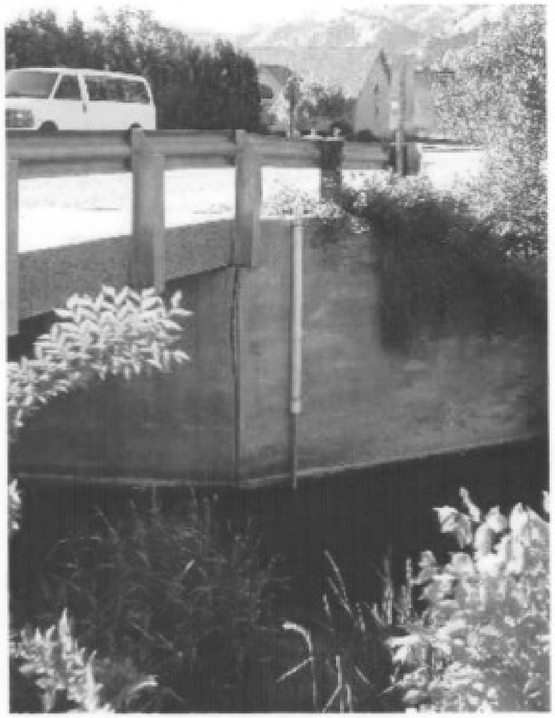
Mill Creek

Longitude: ***120:57:47***
Latitude: ***45:51:34***
Road: ***HWY 142***
County: ***Klickitat***
Washington DeLorme Gazetteer Page: ***26***
Tributary of: ***Little Klickitat River → Klickitat River → Columbia River***
Drainage Area: ***28.6 mi^2***
Gage Elevation: ***2585 ft***
Mean Annual Precipitation: ***732 mm***
Mean Water Stress Index: ***63 %***

Comments:

Gage installed at downstream end of culvert. This is the location of a discontinued USGS gaging station. Resident trout have been seen consistently in this area of the creek.

Mission Creek

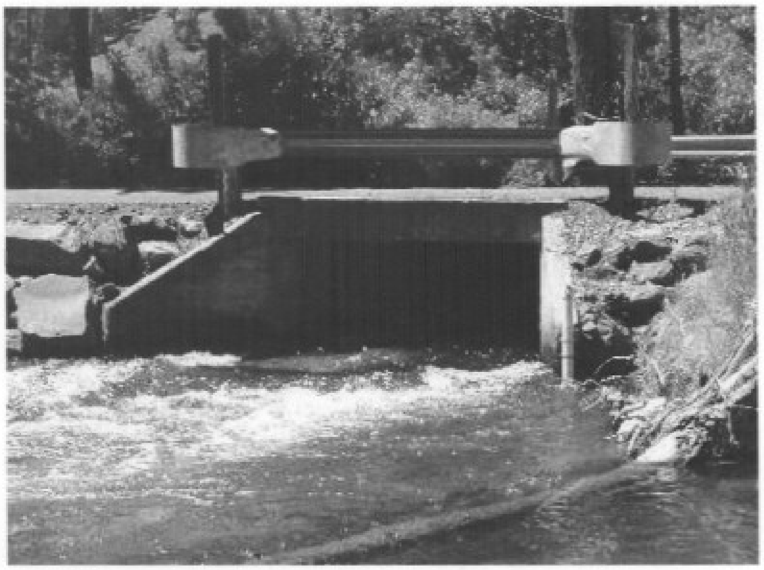


Longitude: ***120:28:26***
Latitude: ***47:30:14***
Road: ***Mission Creek Rd.***
County: ***Chelan***
Washington DeLorme Gazetteer Page: ***83***
Tributary of: ***Wenatchee River → Columbia River***
Drainage Area: ***80.8 mi^2***
Gage Elevation: ***876 ft***
Mean Annual Precipitation: ***579 mm***
Mean Water Stress Index: ***60 %***

Comments:

Gage installed at downstream end of bridge. Location is within residential area of Cashmere with much automobile and pedestrian traffic. No evidence of vandalism or interference of the gage has been witnessed.

Nile Creek



Longitude: ***120:57:00***
Latitude: ***46:50:18***
Road: ***Nile Rd.***
County: ***Yakima***
Washington DeLorme Gazetteer Page: ***50***
Tributary of: ***Naches River → Yakima River → Columbia River***
Drainage Area: ***31.7 mi²***
Gage Elevation: ***2021 ft***
Mean Annual Precipitation: ***1025 mm***
Mean Water Stress Index: ***25 %***

Comments:

Installed at downstream end of concrete box culvert. Local landowner informed WSU that the culvert is scheduled for replacement. There is an extremely large scour pool at downstream end of culvert. The gage was replaced on 7/3/00 due to malfunction as a result of vandalism.

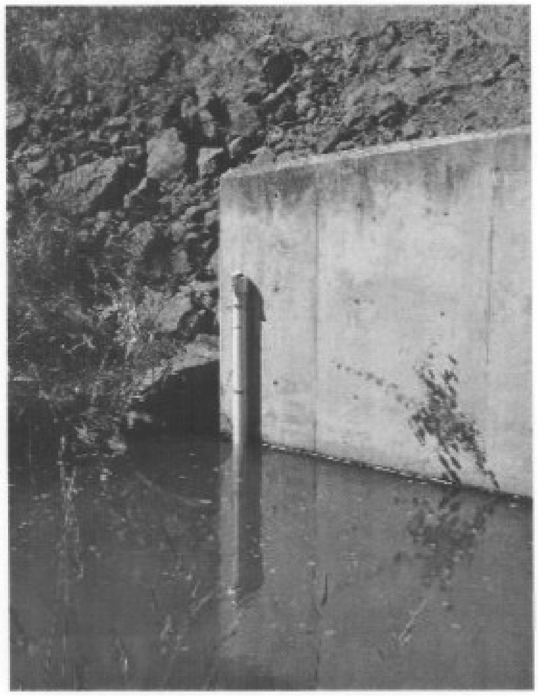
Pahata Creek

Longitude: **117:31:08**
Latitude: **46:16:33**
Road: **Forest Road 040**
County: **Garfield**
Washington DeLorme Gazetteer Page: **42**
Tributary of: **Tucannon River → Snake River → Columbia River**
Drainage Area: **9.4 mi^2**
Gage Elevation: **3960 ft**
Mean Annual Precipitation: **1155 mm**
Mean Water Stress Index: **51 %**

Comments:

Installed to CMP near location of stream re-habilitation site. Log check dams were installed downstream of the culvert prior to installation of WSU gage. Rainbow trout and brook trout have been identified on several occasions. During winter months the stream froze over.

Patit Creek



Longitude: **117:53:46**
Latitude: **46:20:17**
Road: **Range Grade Rd.**
County: **Columbia**
Washington DeLorme Gazetteer Page: **42**
Tributary of: **Touchet River → Walla Walla River → Columbia River**
Drainage Area: **50.1 mi^2**
Gage Elevation: **1877 ft**
Mean Annual Precipitation: **817 mm**
Mean Water Stress Index: **59 %**

Comments:

Gage installed to concrete at downstream end of bridge. The gage was installed in a large scour pool with calm water for safe placement. The creek ran dry during late summer months and into winter.

Rock Creek

Longitude: ***120:58:48***
Latitude: ***46:52:52***
Road: ***HWY 410***
County: ***Yakima***
Washington DeLorme Gazetteer Page: ***50***
Tributary of: ***Naches River → Yakima River → Columbia River***
Drainage Area: ***17.4 mi²***
Gage Elevation: ***2169 ft***
Mean Annual Precipitation: ***1054 mm***
Mean Water Stress Index: ***21 %***

Comments:

Installed at downstream end of concrete box culvert. Poor design of culvert at upstream end with water flowing into diversion headwall. Next culvert upstream has large cottonwood tree growing on top of it. This gage was replaced on 11/11/00, when malfunction occurred due to changing battery in cold weather. No data was lost during the replacement of this gage.

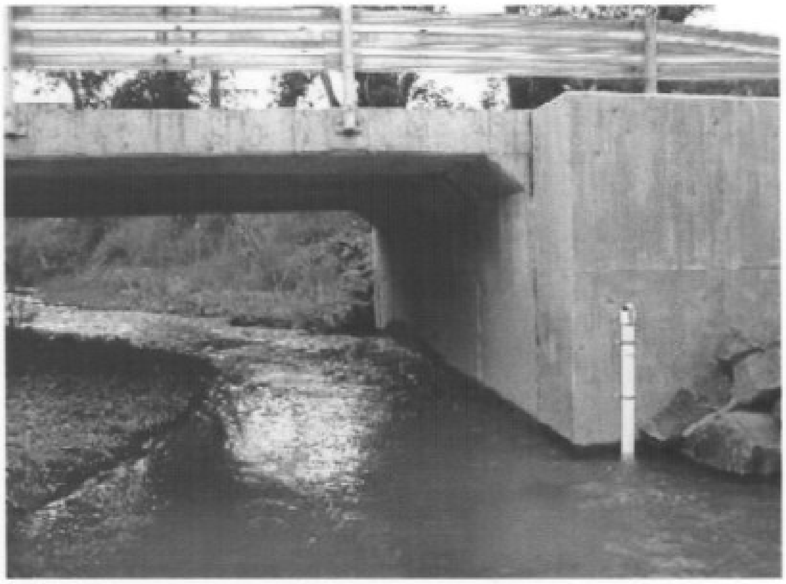
South Fork Asotin Creek

Longitude: **117:16:48**
Latitude: **46:13:32**
Road: **South Fork Asotin Creek Rd.**
County: **Asotin**
Washington DeLorme Gazetteer Page: **43**
Tributary of: **Asotin Creek → Snake River → Columbia River**
Drainage Area: **36.6 mi^2**
Gage Elevation: **2346 ft**
Mean Annual Precipitation: **597 mm**
Mean Water Stress Index: **53 %**

Comments:

Installed to boulder under bridge near location of stream re-habilitation site. This is a step-pool type stream bounded by trees and pasture in areas. Stream re-habilitation efforts have been taken to improve the riverine habitat upstream of the gage site. The gage malfunctioned during cold weather battery replacement on 11/12/00. The gage was replaced on a following trip. Gage location iced over during winter months.

S. Fork Coppei Creek

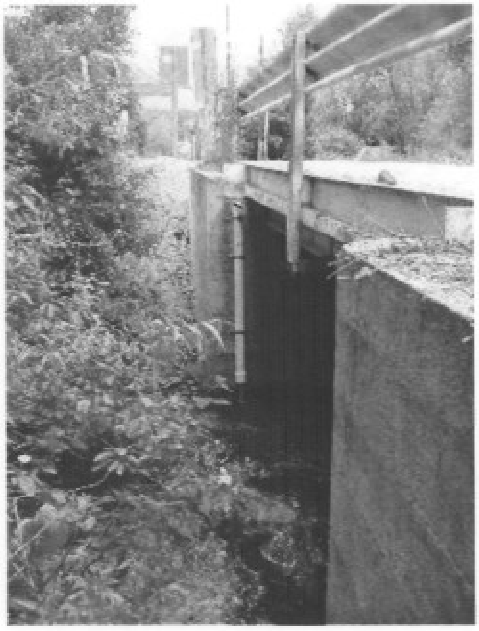


Longitude: **118:06:27**
Latitude: **46:10:44**
Road: **S. Fork Coppei Creek Rd.**
County: **Walla Walla**
Washington DeLorme Gazetteer Page: **41**
Tributary of: **Touchet River → Walla Walla River → Columbia River**
Drainage Area: **12.5 mi^2**
Gage Elevation: **1791 ft**
Mean Annual Precipitation: **825 mm**
Mean Water Stress Index: **51 %**

Comments:

Installed to concrete at downstream end of bridge. Extreme rain event occurred during one discharge measurement. Notable rise in stage height occurred during this event.

Stemilt Creek



Longitude: **120:09:18**
Latitude: **47:17:35**
Road: **Stemilt Creek Rd.**
County: **Chelan**
Washington DeLorme Gazetteer Page: **67**
Tributary of: **Columbia River**
Drainage Area: **24.6 mi^2**
Gage Elevation: **1739 ft**
Mean Annual Precipitation: **657 mm**
Mean Water Stress Index: **51 %**

Comments:

Gage installed at upstream end of bridge. Trout were identified on several occasions. The stream ran dry with the exception of water in some large pools, leaving fish stranded. Local landowners identified this occurrence as the result of new irrigation practices by a separate landowner. They claimed this caused the creek to go dry for over a month. Gage location iced over during cold winter months.

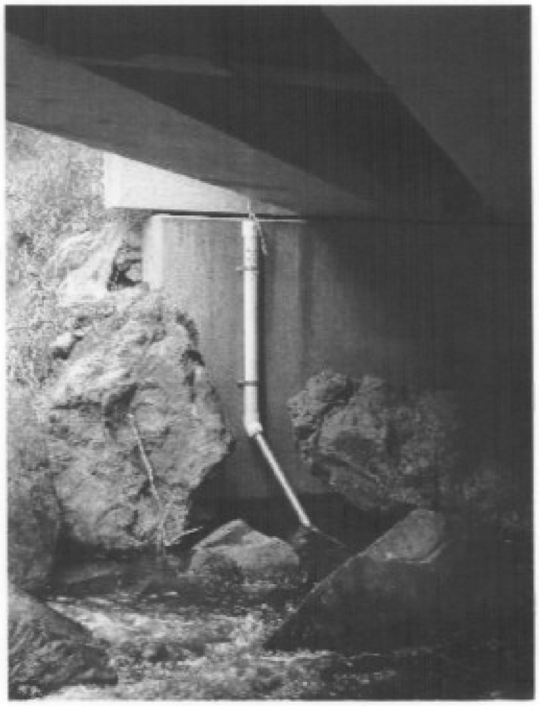
Tumalum Creek

Longitude: **117:41:02**
Latitude: **46:21:33**
Road: **Tucannon Rd.**
County: **Columbia**
Washington DeLorme Gazetteer Page: **42**
Tributary of: **Tucannon River → Snake River → Columbia River**
Drainage Area: **15.8 mi^2**
Gage Elevation: **1975 ft**
Mean Annual Precipitation: **832 mm**
Mean Water Stress Index: **50 %**

Comments:

Installed to concrete at downstream end of culvert. Very close to Tucannon River potentially providing habitat for juvenile salmonids. Changes were noted in downstream reach of stream, which in turn affected the recording of stage height a minor amount.

Upper Peshastin Creek



Longitude: ***120:39:29***
Latitude: ***47:23:23***
Road: ***Forest Road 7320***
County: ***Chelan***
Washington DeLorme Gazetteer Page: ***66***
Tributary of: ***Wenatchee River → Columbia River***
Drainage Area: ***19.4 mi²***
Gage Elevation: ***2579 m***
Mean Annual Precipitation: ***832 mm***
Mean Water Stress Index: ***40 %***

Comments:

Gage installed under bridge at upstream end and is protected by large boulders. Gage location iced over during winter months. Road is inaccessible during times of heavy snow and must be hiked from lower bridge about 0.4 miles away.

APPENDIX B

GIS DATA

GIS DATA

Appendix B describes the type of data used in the development of the Contributing HUC6 model. Descriptions include spatial data representing HUC boundaries and basin characteristics, such as mean annual precipitation, mean basin elevation, and mean water stress index.

HYDROLOGIC UNIT MAPS

Central to the development of this model is the use of previously delineated hydrologic unit maps (Seaber et. al, 1982; ICBEMP, 2000).

Hydrologic units in the United States are divided into various levels based on geographic area and watershed composition by the USGS. These areas are identified by a unique HUC, varying in length depending on the classification size. The first classification is representative of the water-resources region. The United States is divided into 21 regions based on this level of classification. One field, consisting of two numbers, identifies each of these regions. The next level of classification subdivides each water-resource region into smaller sub-regions. An additional field is added for the identification of sub-regions, thus making the length of the sub-region HUC two fields or four numbers. The next subdivision is termed an accounting unit. The accounting unit is identified in the same manner as the previous classifications, with the addition of another field. Further classification to the 4th Field HUC is termed the cataloging unit or subbasin (Seaber et al, 1987). Figure B.1 maps the 4th Field HUCs found in Eastern Washington.

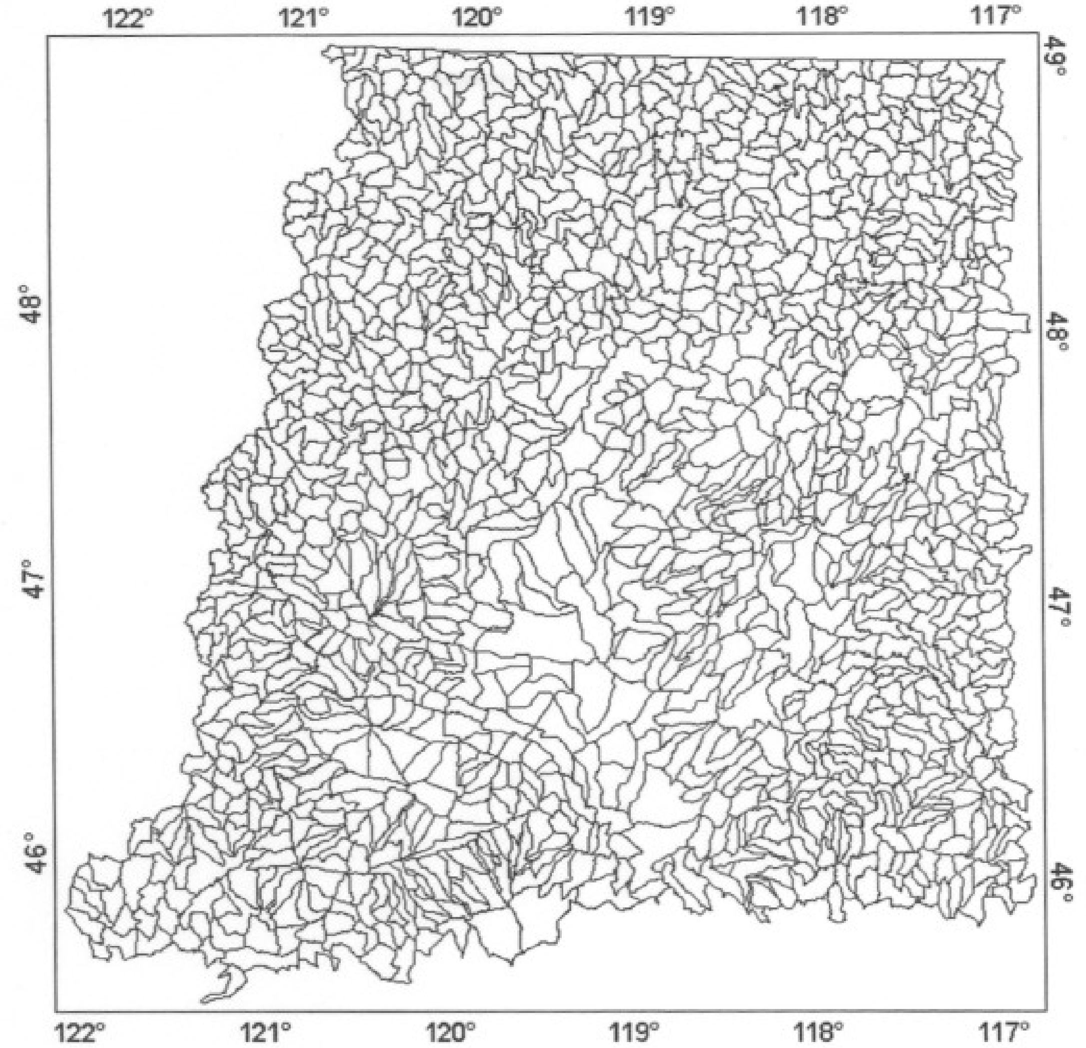


Figure B.2. 6th Field HUCs in Eastern Washington

Basin Attribute Data

The relationship between USGS gauging stations and 6th Field HUCs was established by evaluating three forms of spatial data: elevation, precipitation, and water stress index. Each of these data sources was represented as a grid in ArcView. The mean characteristic value corresponding to each attribute was calculated for each 4th Field HUC, 6th Field HUC, and USGS watershed.

The elevation grid, Figure B.3, was provided by ICBEMP (2000) at a 500-meter scale with attribute units in meters. Digital USGS 7.5 minute quadrangles, provided at a smaller scale, were also evaluated for use in the model. The USGS grids were not used since the benefit of more detailed information, was outweighed by the time required to compile and analyze them.

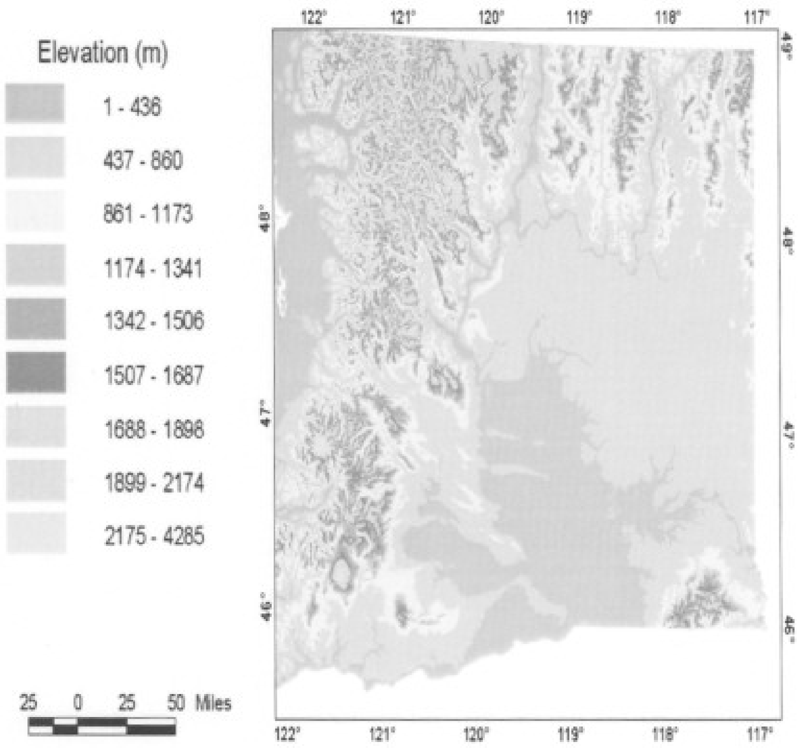


Figure B.3. Elevation Grid for Eastern Washington

Precipitation data, Figure B.4, was obtained from ICBEMP (2000) at a 500-meter scale with attribute units of millimeters. This data came from the PRISM model originally developed by Oregon State University and the Oregon Climate Service, representing mean annual precipitation from 1961-1990.

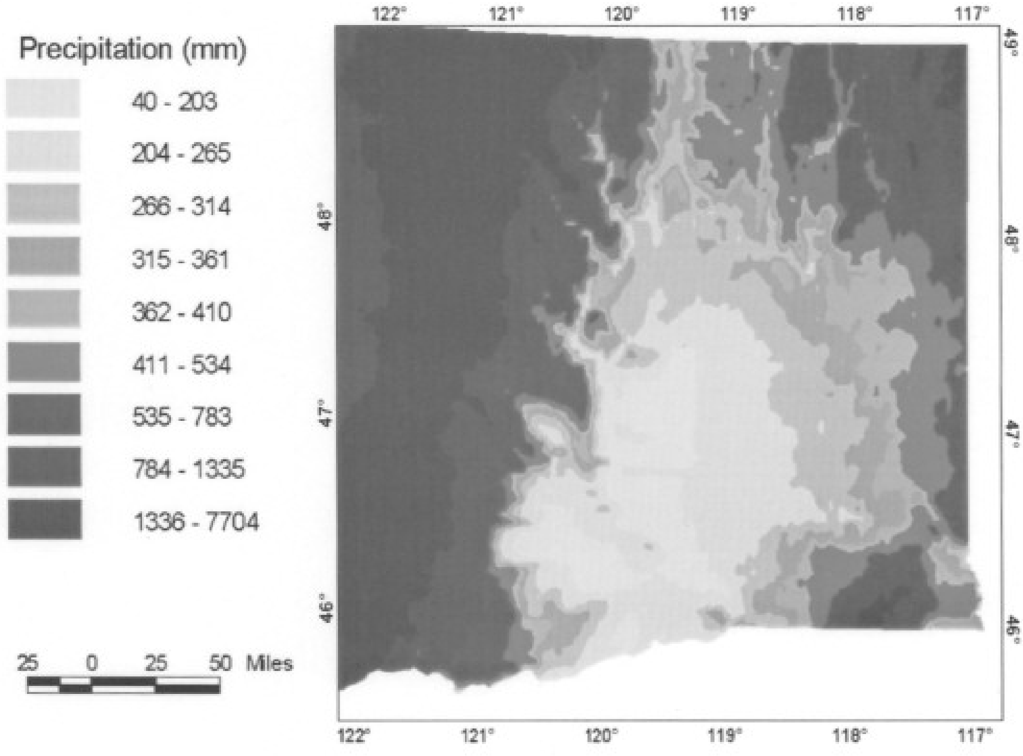


Figure B.4. Precipitation Grid for Eastern Washington

The water stress index, Figure B.5, obtained from ICBEMP (2000) is provided at a 2-km scale with attribute units in percent. This data defines the total annual evapotranspiration as a percentage of the total annual precipitation. The data was provided for three years to represent a wet, dry, and average year. The average year data was used in this model. The percentage values range from 1 to 100, with lower values signifying excess water at a site and higher values representing the opposite.

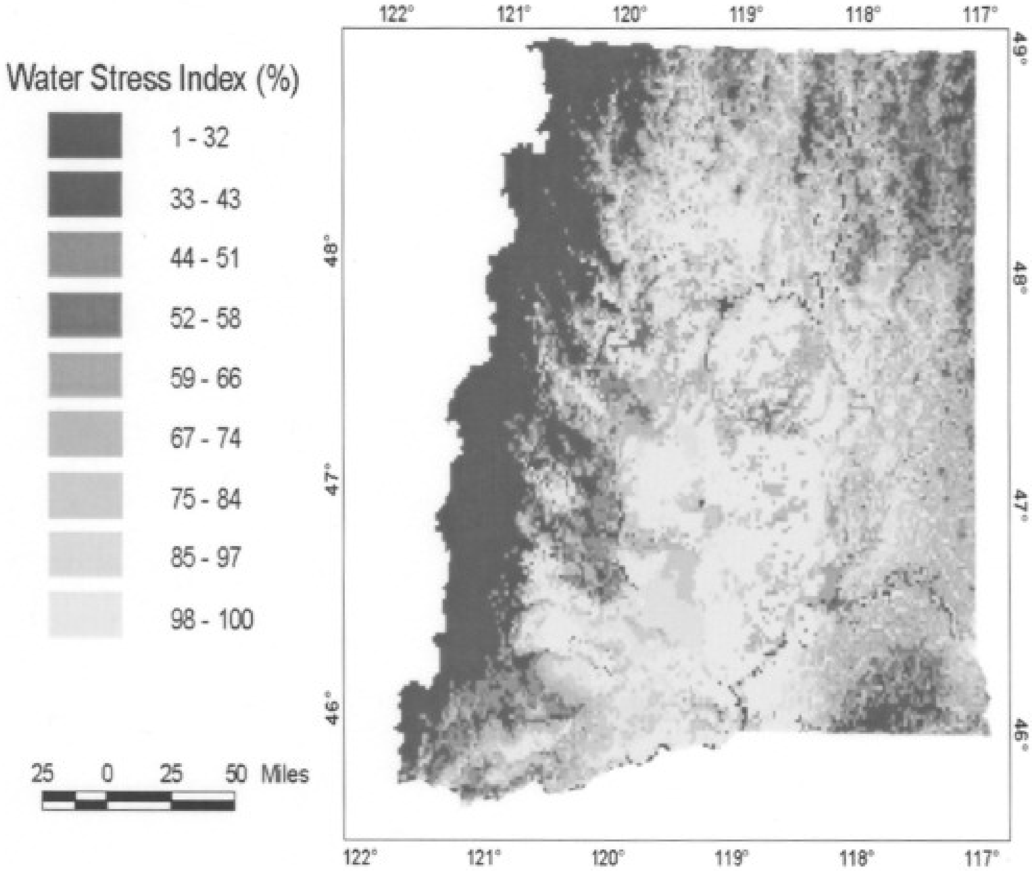


Figure B.5. Water Stress Index Grid for Eastern Washington

APPENDIX C

USGS GAGING STATIONS

USGS GAGING STATIONS

Appendix C describes the years of record, basin characteristics, and measured fish passage design flows for the USGS gages used in the Contributing HUC model.

Table C.1. USGS Gages Used in Contributing HUC6 Model

Station ID	Station Name
12396000	Calispell Creek near Dalkena, WA
12396900	Sullivan Creek above Outlet Creek near Metaline Falls, WA
12397500	Sullivan Creek near Metaline Falls, WA
12398000	Sullivan Creek at Metaline Falls, WA
12407500	Sheep Creek at Springdale, WA
12407520	Deer Creek near Valley, WA
12407700	Chewelah Creek at Chewelah, WA
12408300	Little Pend Oreille River near Colville, WA
12408420	Haller Creek near Arden, WA
12408500	Mill Creek near Colville, WA
12409000	Colville River at Kettle Falls, WA
12409500	Hall Creek at Inchelium, WA
12433200	Chamokane Creek below falls near Long Lake, WA
12439300	Tonasket Creek at Oroville, WA
12442000	Toats Coulee Creek near Loomis, WA
12447390	Andrews Creek near Mazama, WA
12449500	Methow River at Twisp, WA
12449600	Beaver Creek below South Fork, near Twisp, WA
12449950	Methow River near Pateros, WA
12451000	Stehekin River at Stehekin, WA
12451500	Railroad Creek at Lucerne, WA
12452800	Entiat River near Ardenvoir, WA
12453000	Entiat River at Entiat, WA
12454000	White River near Plain, WA
12455000	Wenatchee River below Wenatchee Lake, WA
12456500	Chiwawa River near Plain, WA
12457000	Wenatchee River at Plain, WA
12458000	Icicle Creek above Snow Creek near Leavenworth, WA
12461400	Mission Creek above Sand Creek near Cashmere, WA
12462500	Wenatchee River at Monitor, WA

Table C.1. USGS Gages Used in Contributing HUC6 Model

Station ID	Station Name
12463000	Douglas Creek near Alstown, WA
12465000	Crab Creek at Irby, WA
12483800	Naneum Creek near Ellensburg, WA
12488500	American River near Nile, WA
12489500	Naches River at Oak Flat near Nile, WA
12492500	Tieton River at Canal Headworks near Naches, WA
12500500	North Fork Ahtanum Creek near Tampico, WA
12501000	South Fork Ahtanum Creek at Conrad Ranch near Tampico, WA
12502000	Ahtanum Creek at The Narrows near Tampico, WA
12502500	Ahtanum Creek at Union Gap, WA
12506000	Toppenish Creek near Fort Simcoe, WA
12506500	Simcoe Creek below Spring Creek near Fort Simcoe, WA
13334500	Asotin Creek near Asotin, WA
13334700	Asotin Creek below Kearney Gulch near Asotin, WA
13344500	Tucannon River near Starbuck, WA
14013500	Blue Creek near Walla Walla, WA
14016000	Dry Creek near Walla Walla, WA
14016500	East Fork Touchet River near Dayton, WA
14017000	Touchet River at Bolles, WA
14017500	Touchet River near Touchet, WA
14107000	Klickitat River above West Fork near Glenwood, WA
14110000	Klickitat River near Glenwood, WA
14112000	Little Klickitat River near Goldendale, WA
14112500	Little Klickitat River near Wahkiacus, WA
14113000	Klickitat River near Pitt, WA
14121300	White Salmon River below Cascades Creek near Trout Lake, WA
14121500	Trout Lake Creek near Trout Lake, WA
14123000	White Salmon River at Husum, WA
14123500	White Salmon River near Underwood, WA
14124500	Little White Salmon River at Willard, WA
14125000	Little White Salmon River above Lapham Creek, Willard, WA
14125500	Little White Salmon River near Cook, WA
14127000	Wind River above Trout Creek near Carson, WA
14128500	Wind River near Carson, WA

Table C.2. USGS Gage Record and Design Flows

		Design Flows	
Station ID	Period of Record (Water Year)	Q_{FP4}: cfs	2-Year: cfs[a]
12396000	(1951-73)	372	525
12396900	(1960-72, 1995-99)	806	1010
12397500	(1914-24)	843	989
12398000	(1955-68, 1995-99)	1325	1260
12407500	(1954-72)	32	44
12407520	(1960-72)	88	119
12407700	(1958-74)	125	165
12408300	(1959-75)	277	301
12408420	(1960-70)	40	41
12408500	(1941-72, 1978-86)	246	298
12409000	(1924-31, 1933-99)	1184	1140
12409500	(1914-15, 1917-22, 1972)	397	390
12433200	(1972-78, 1988-99)	362	373
12439300	(1968-91)	17	54
12442000	(1921, 1958-69)	388	523
12447390	(1969-99)	265	368
12449500	(1921-29, 1934-62, 1992-99)	8961	11200
12449600	(1961-78)	126	113
12449950	(1960-99)	9669	11800
12451000	(1912-15, 192-99)	6191	9600
12451500	(1912, 1928-57)	886	1270
12452800	(1958-99)	2213	2680
12453000	(1912-25, 1952-58)	2871	3380
12454000	(1955-83)	3490	4640
12455000	(1933-58)	5652	7040
12456500	(1914, 1937-49, 1955-57, 1992-99)	2597	3140
12457000	(1911-29, 1932-79, 1990-99)	9851	11600
12458000	(1937-71, 1994-99)	2999	4420
12461400	(1960-71)	61	181
12462500	(1963-99)	14942	17500
12463000	(1950-55, 1964-68)	49	490
12465000	(1943-99)	572	814
12483800	(1958-71, 1973-78)	285	412
12488500	(1940-99)	1049	1460
12489500	(1905-13)	4999	5930
12492500	(1908-15, 1920-25, 1928-78)	1554	2390
12500500	(1911-15, 1932-78)	293	380
12501000	(1932-78)	78	96

Table C.2. USGS Gage Record and Design Flows

		Design Flows	
Station ID	**Period of Record (Water Year)**	Q_{FP4}**: cfs**	**2-Year: cfs[a]**
12502000	(1909-1913, 1961-68)	353	538
12502500	(1961-99)	345	421
12506000	(1910-23)	491	696
12506500	(1910-23)	210	241
13334500	(1929-59)	225	338
13334700	(1960-82, 1990-95)	232	413
13344500	(1915-17, 1929-31, 1959-90, 1995-99)	620	1510
14013500	(1940-71)	94	324
14016000	(1950-67)	112	548
14016500	(1945-51, 1957-68)	454	862
14017000	(1926-29, 1952-76, 1978-89)	1109	2700
14017500	(1942-55)	1035	3520
14107000	(1945-77, 1992-99)	1369	1840
14110000	(1911-1956, 1958-71)	2519	3180
14112000	(1911, 1947-70)	394	1070
14112500	(1946-48, 1951-81)	965	3260
14113000	(1910-11, 1929-99)	4889	7840
14121300	(1958-78)	358	699
14121500	(1960-68)	873	1590
14123000	(1910-19, 1930-41, 1958-61)	2213	2760
14123500	(1916-30, 1936-99)	2809	4600
14124500	(1946-61)	1338	2780
14125000	(1950-63)	1369	2520
14125500	(1957-77)	1686	3300
14127000	(1945-69)	2238	5240
14128500	(1935-77)	4916	13800

[a]Values published by Kresch (1999)

Table C.3. USGS Gage Basin Attributes

Station ID	Precipitation P (in) (USGS)[a]	P (in) (WSU)	Elevation E (ft) (USGS)[a]	E (ft) (WSU)	Water Stress Index WSI (%) (WSU)	Area Area: (mi²)
12396000	38	37	3650	3633	46.6	68.3
12396900	45	37	4760	3651	42.3	70.2
12397500	37	59	4900	4678	42.4	122
12398000	37	57	4660	4572	43.7	142
12407500	18	25	2390	2654	61.5	48.2
12407520	20	24	3160	3132	57.2	36
12407700	22	37	3160	3283	55.3	94.1
12408300	29	38	3475	3444	53.7	132
12408420	20	28	2570	2943	68.8	37
12408500	26	38	3510	3529	56.8	83
12409000	21	30	3000	2883	62.8	1007
12409500	20	20	3650	3836	70.9	160
12433200	20	18	2380	2423	75.8	179
12439300	15	16	3280	3454	60.6	60.1
12442000	29	28	5520	5475	42.5	130
12447390	35	50	6300	6404	24.4	22.1
12449500	35	38	5180	5025	32.7	1301
12449600	24	28	5090	5005	51.7	62
12449950	32	35	4780	4656	40.1	1772
12451000	99	70	5130	5011	19.5	321
12451500	52	50	4930	5496	18.4	64.8
12452800	59	40	5230	4987	22.1	203
12453000	45	34	4390	4257	33.1	419
12454000	108	70	4590	4724	20.3	150
12455000	100	68	4720	4285	21.6	273
12456500	78	46	4440	4473	23.9	172
12457000	69	57	4540	4222	24.4	591
12458000	88	64	5260	5071	16.6	193
12461400	25	24	3400	3403	55.2	39.8
12462500	60	47	3890	3998	31.5	1301
12463000	11	13	2800	2736	75.3	99.9
12465000	13	13	2200	2153	86.7	1042
12483800	25	31	4830	4854	37.2	69.8
12488500	74	56	4860	4827	19.9	78.9
12489500	45	47	4100	4331	21.6	638
12492500	57	53	4740	4595	22.0	239
12500500	53	38	4700	4658	28.3	68.9
12501000	54	36	4820	4296	30.5	24.8

Table C.3. USGS Gage Basin Attributes

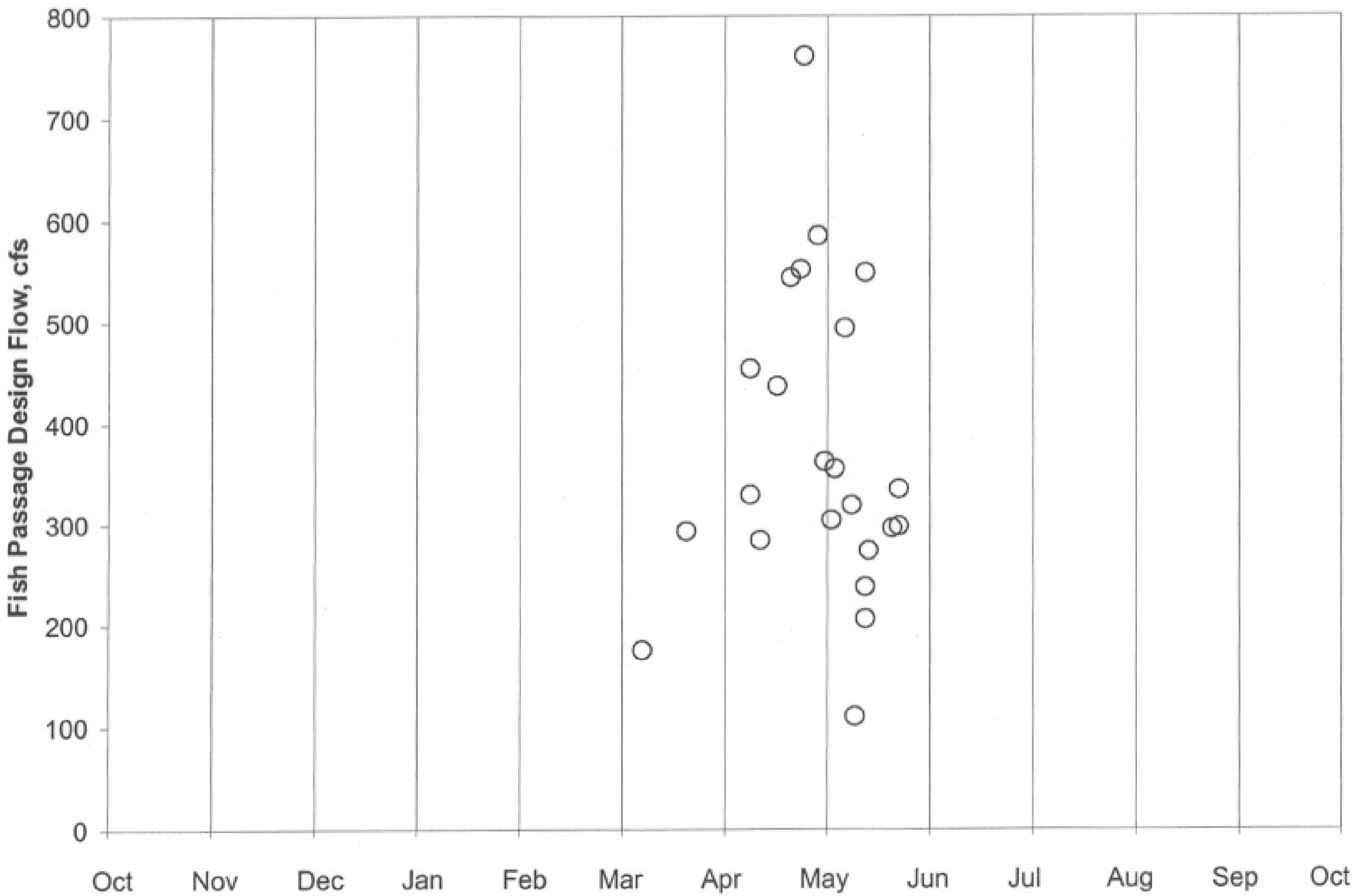
Station ID	Precipitation P (in) (USGS)[a]	Precipitation P (in) (WSU)	Elevation E (ft) (USGS)[a]	Elevation E (ft) (WSU)	Water Stress Index WSI (%) (WSU)	Area Area: (mi²)
12502000	49	34	3870	4123	30.5	119
12502500	38	27	3200	3346	45.1	173
12506000	29	28	3550	3524	35.4	122
12506500	39	25	2990	3019	34.5	81.5
13334500	22	27	3760	3854	51.0	156
13334700	24	26	3550	3711	54.9	170
13344500	23	28	3000	2937	61.2	431
14013500	36	35	3140	3020	42.8	17
14016000	29	27	2360	2264	57.9	48.4
14016500	30	44	3750	3756	46.7	102
14017000	25	31	2950	2857	56.3	361
14017500	20	23	2200	2091	71.0	733
14107000	58	50	4690	4674	26.3	151
14110000	56	49	4520	4530	27.0	360
14112000	25	21	3160	3103	82.5	83.5
14112500	25	25	2600	2537	74.6	280
14113000	36	35	3140	3044	50.8	1297
14121300	106	80	----[b]	5105	----[b]	32.4
14121500	82	84	----[b]	3547	----[b]	69.3
14123000	71	63	----[b]	3317	----[b]	294
14123500	66	57	----[b]	2972	----[b]	386
14124500	70	69	----[b]	2942	----[b]	114
14125000	70	67	----[b]	2948	----[b]	117
14125500	70	63	----[b]	2778	----[b]	134
14127000	103	100	----[b]	2629	----[b]	108
14128500	99	89	----[b]	2363	----[b]	225

[a]Values published by Williams and Pearson (1985)
[b]No data

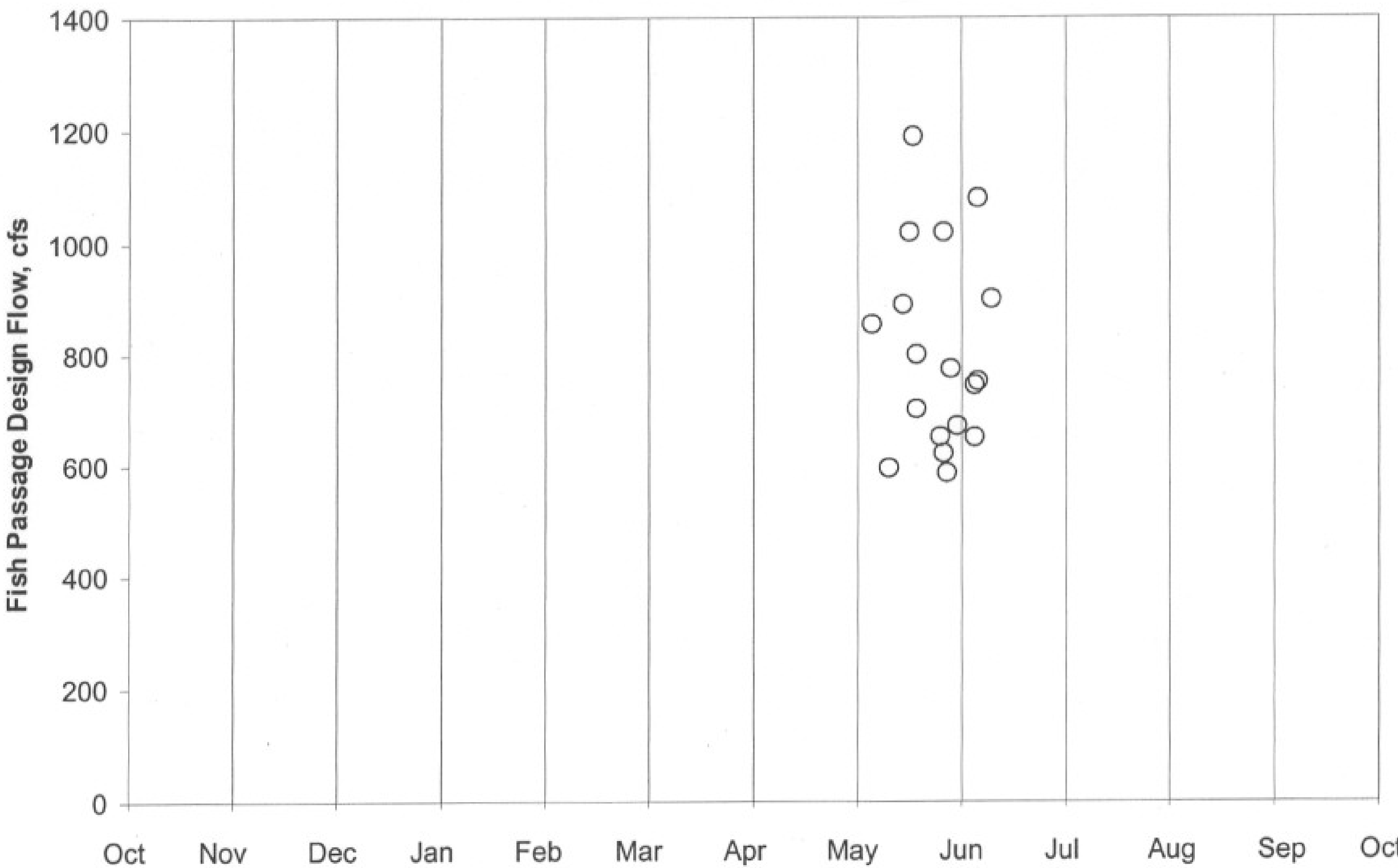
Q_{FP4} TIMING CHARTS FOR USGS GAGES

This section provides charts showing the timing in which Q_{FP4} occurs for each USGS gage used in the Contributing HUC model.

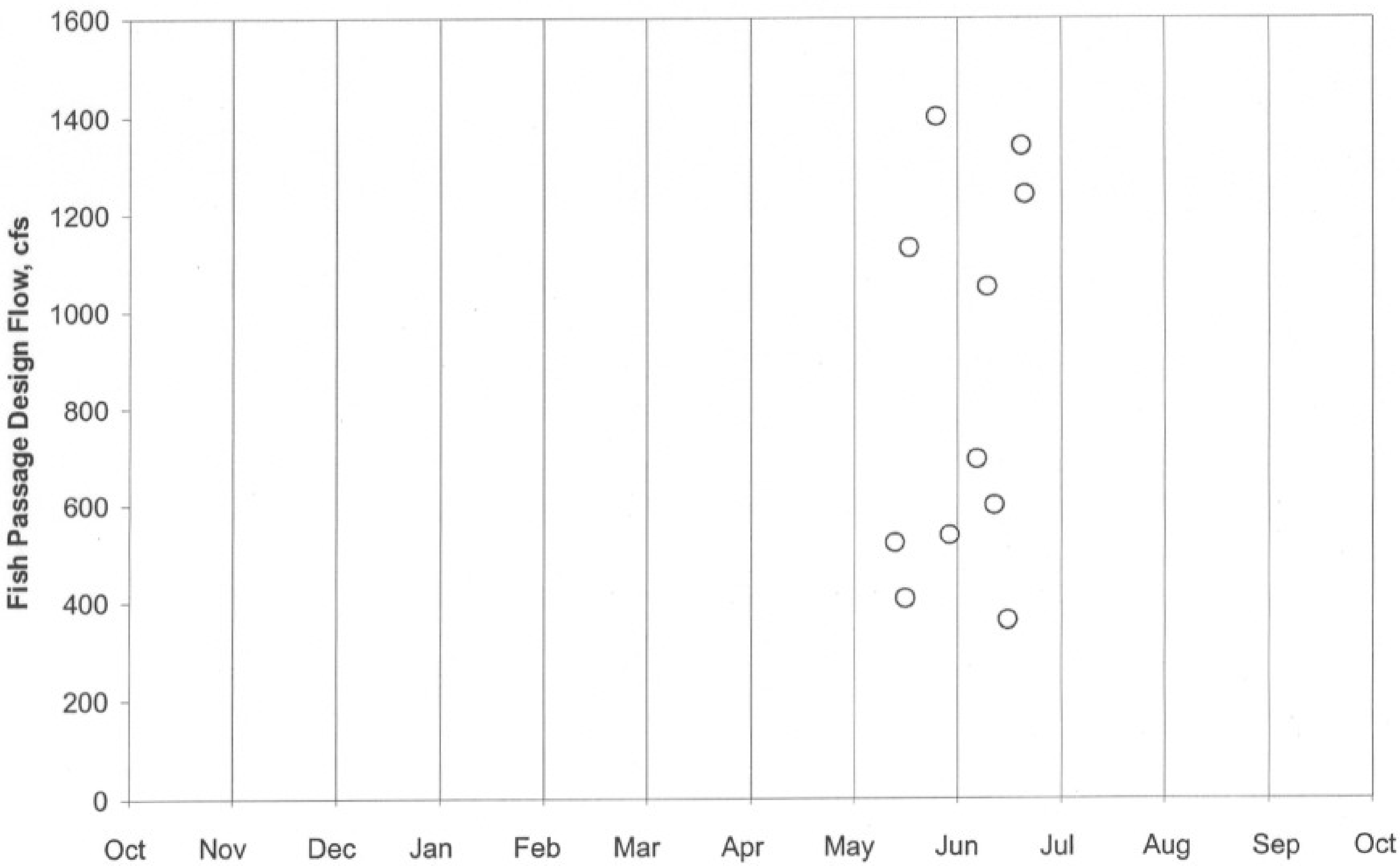
USGS Gage: 12396000
Calispell Creek near Dalkena, WA

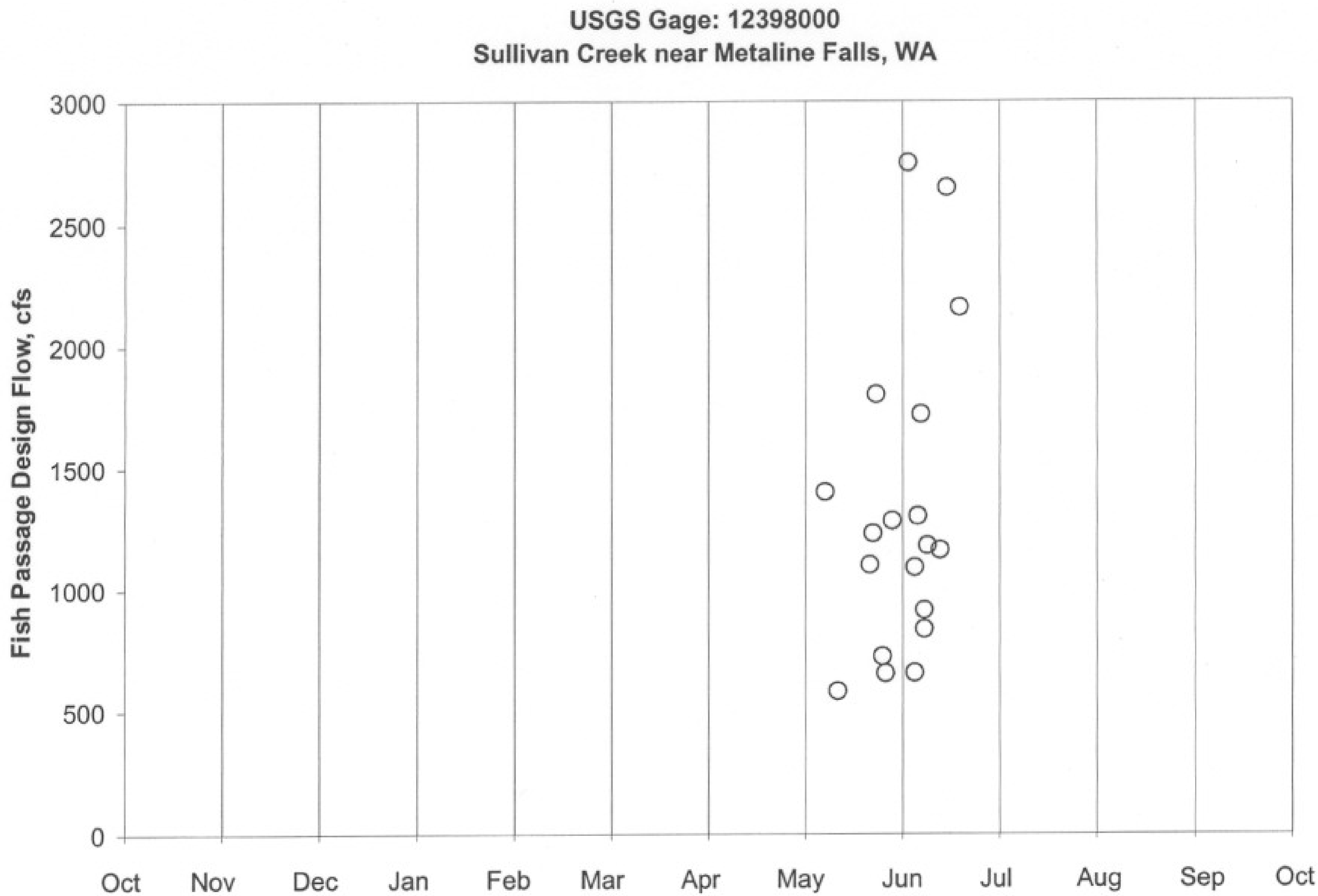


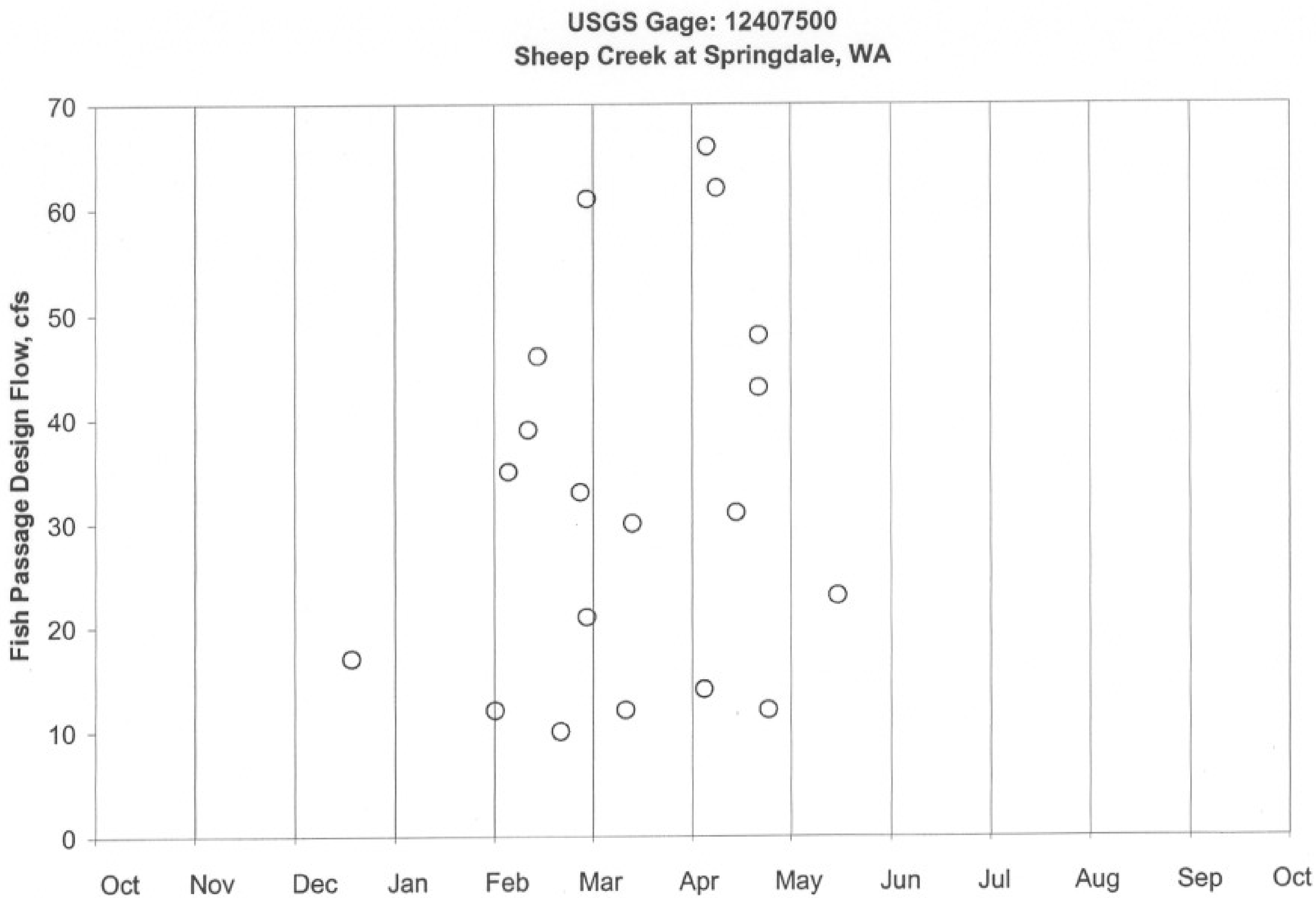
USGS Gage: 12396900
Sullivan Creek above Outlet Creek near Metaline Falls, WA

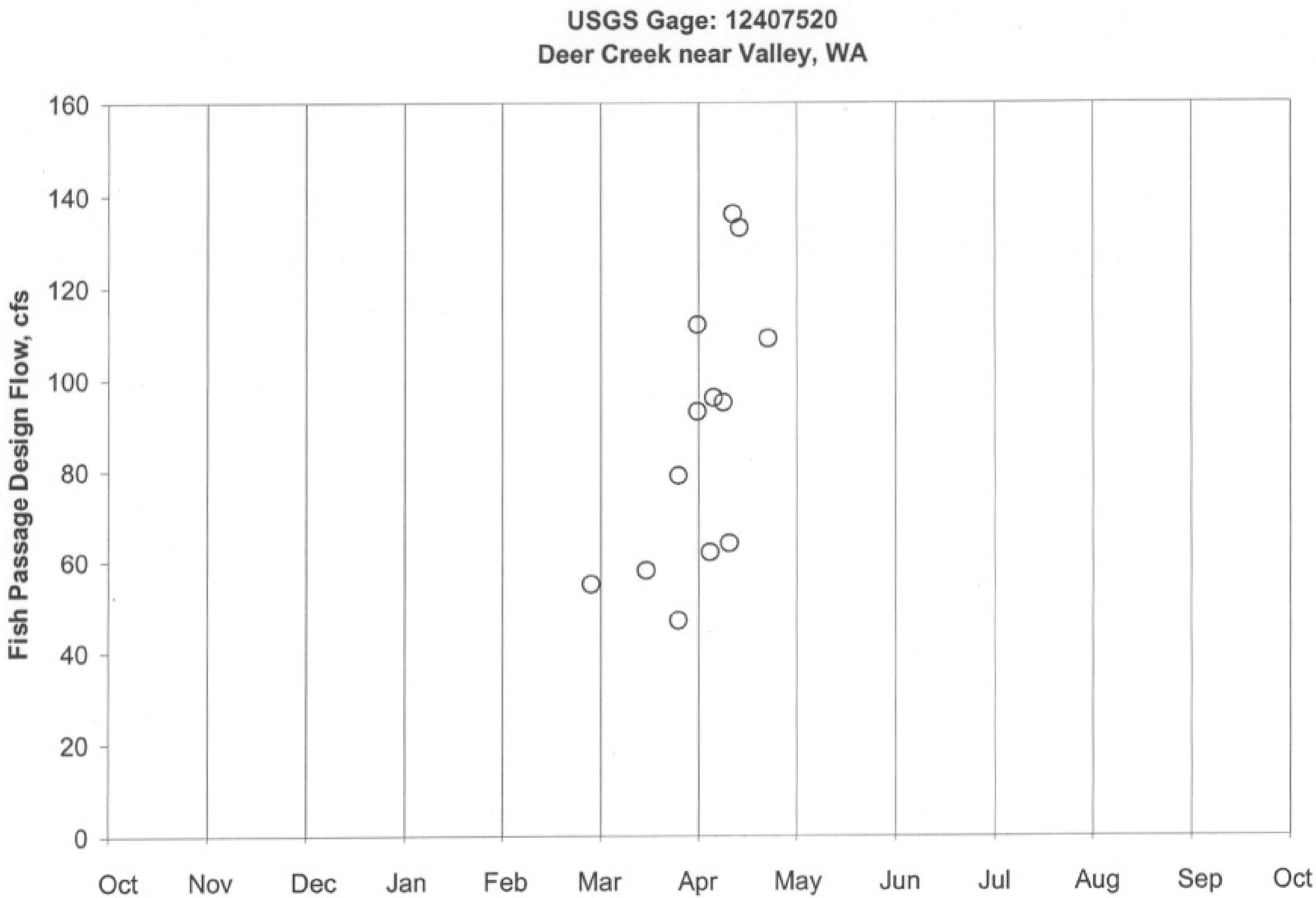


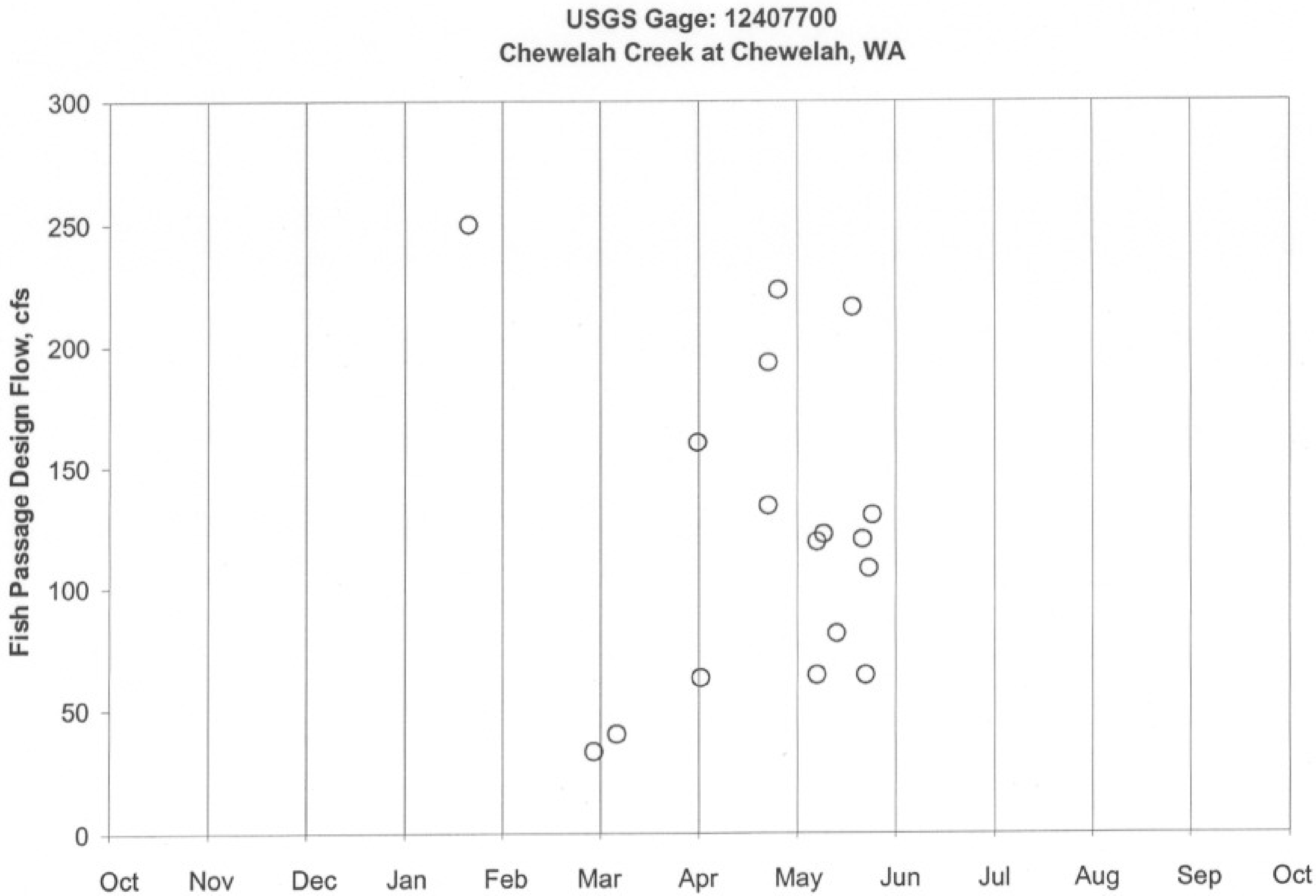
USGS Gage: 12397500
Sullivan Creek near Metaline Falls, WA

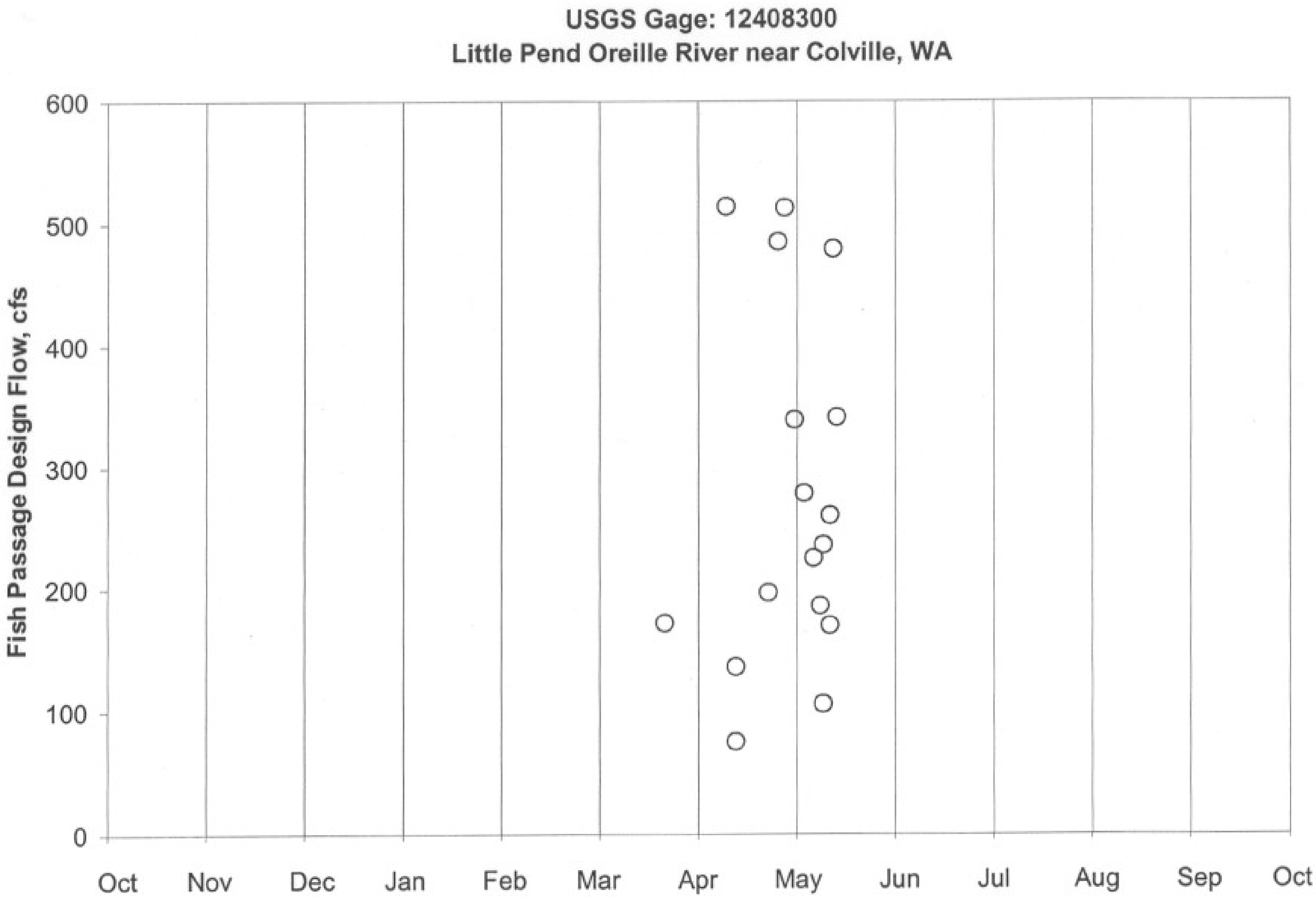



USGS Gage: 12398000
Sullivan Creek near Metaline Falls, WA
Fish Passage Design Flow, cfs
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

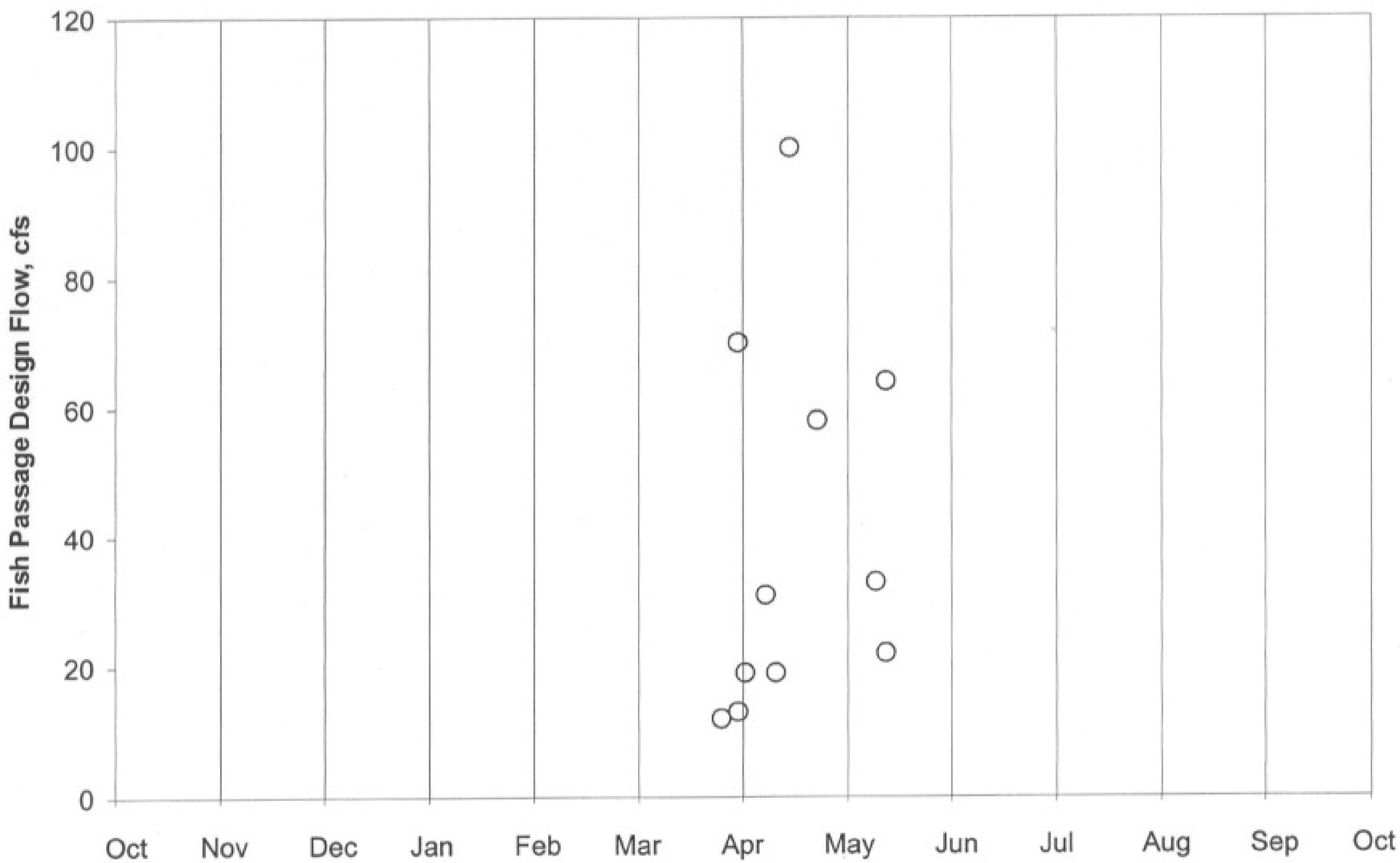

USGS Gage: 12407500
Sheep Creek at Springdale, WA
Fish Passage Design Flow, cfs
70
60
50
40
30
20
10
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

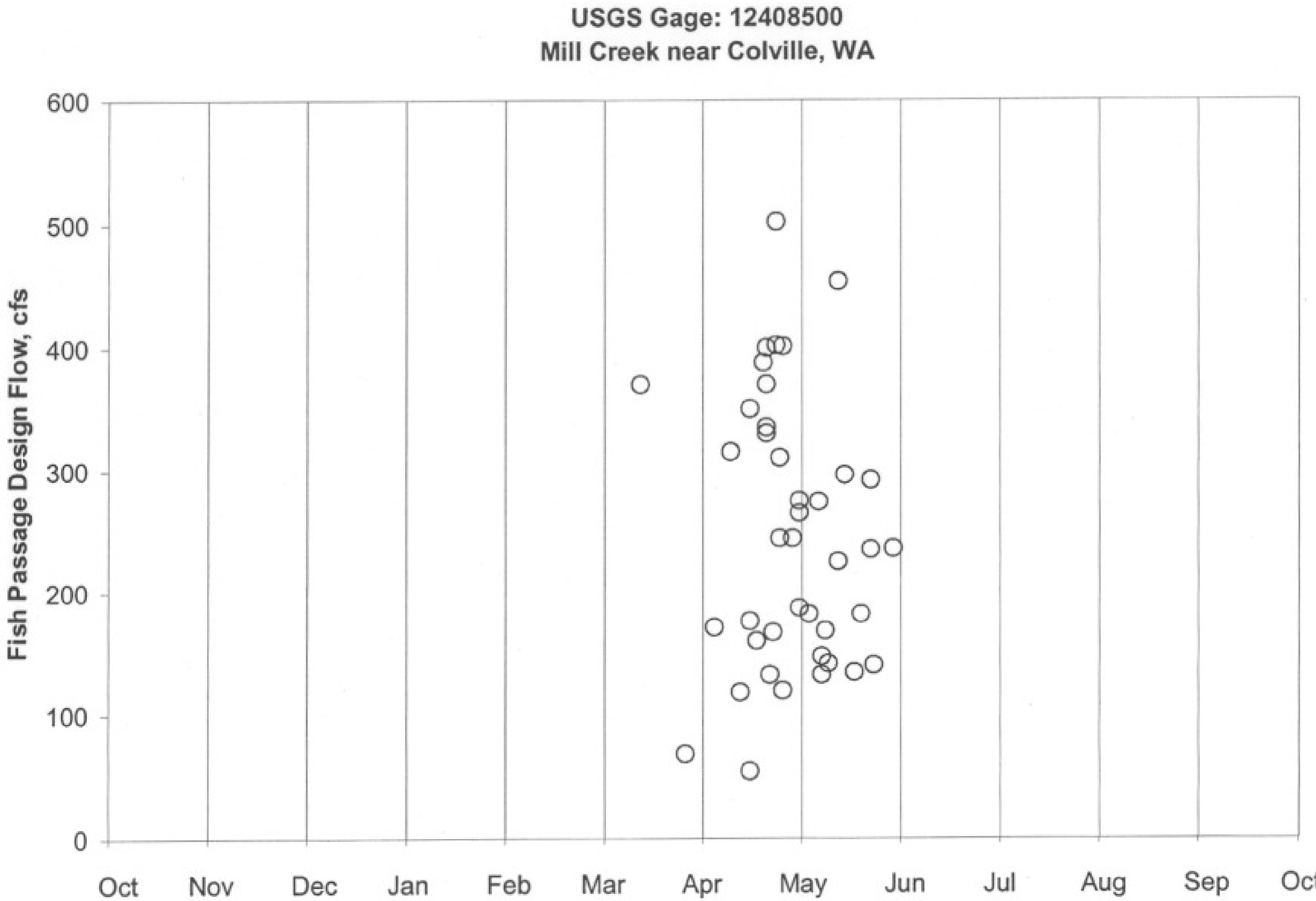

USGS Gage: 12407520
Deer Creek near Valley, WA
Fish Passage Design Flow, cfs
0
20
40
60
80
100
120
140
160
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct


USGS Gage: 12407700
Chewelah Creek at Chewelah, WA
Fish Passage Design Flow, cfs
0
50
100
150
200
250
300
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

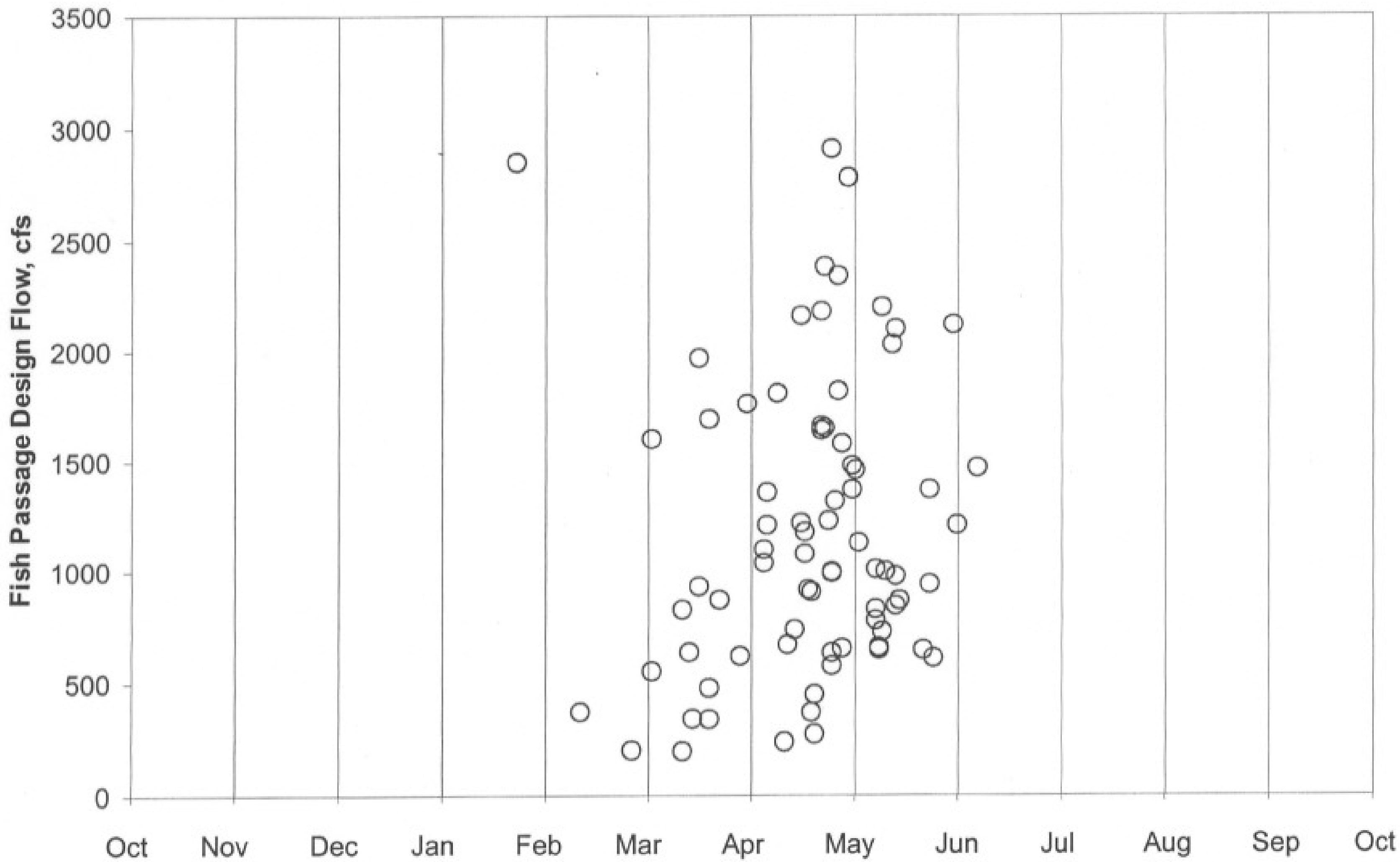

USGS Gage: 12408300
Little Pend Oreille River near Colville, WA
Fish Passage Design Flow, cfs
0
100
200
300
400
500
600
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

USGS Gage: 12408420
Haller Creek at Arden, WA

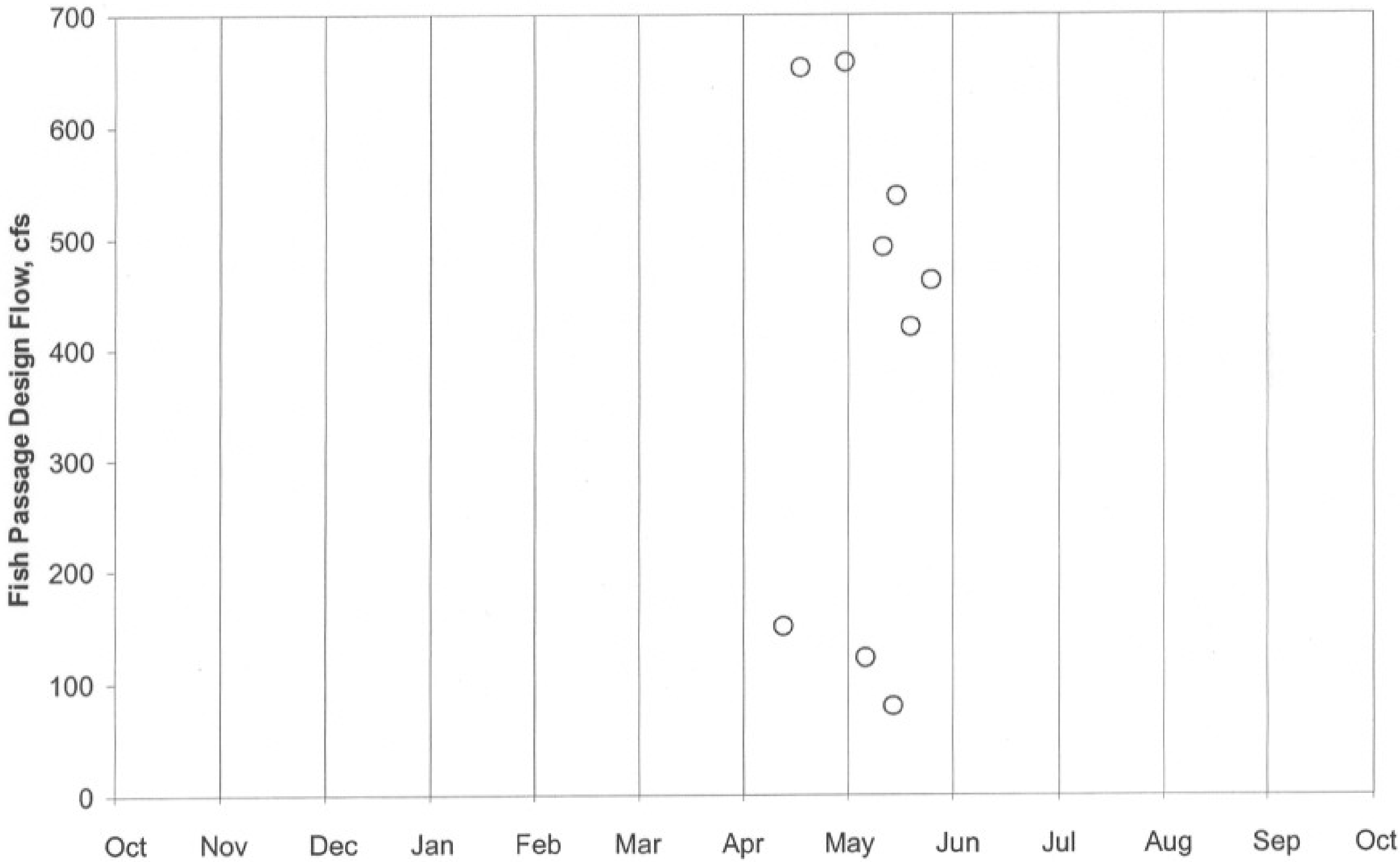


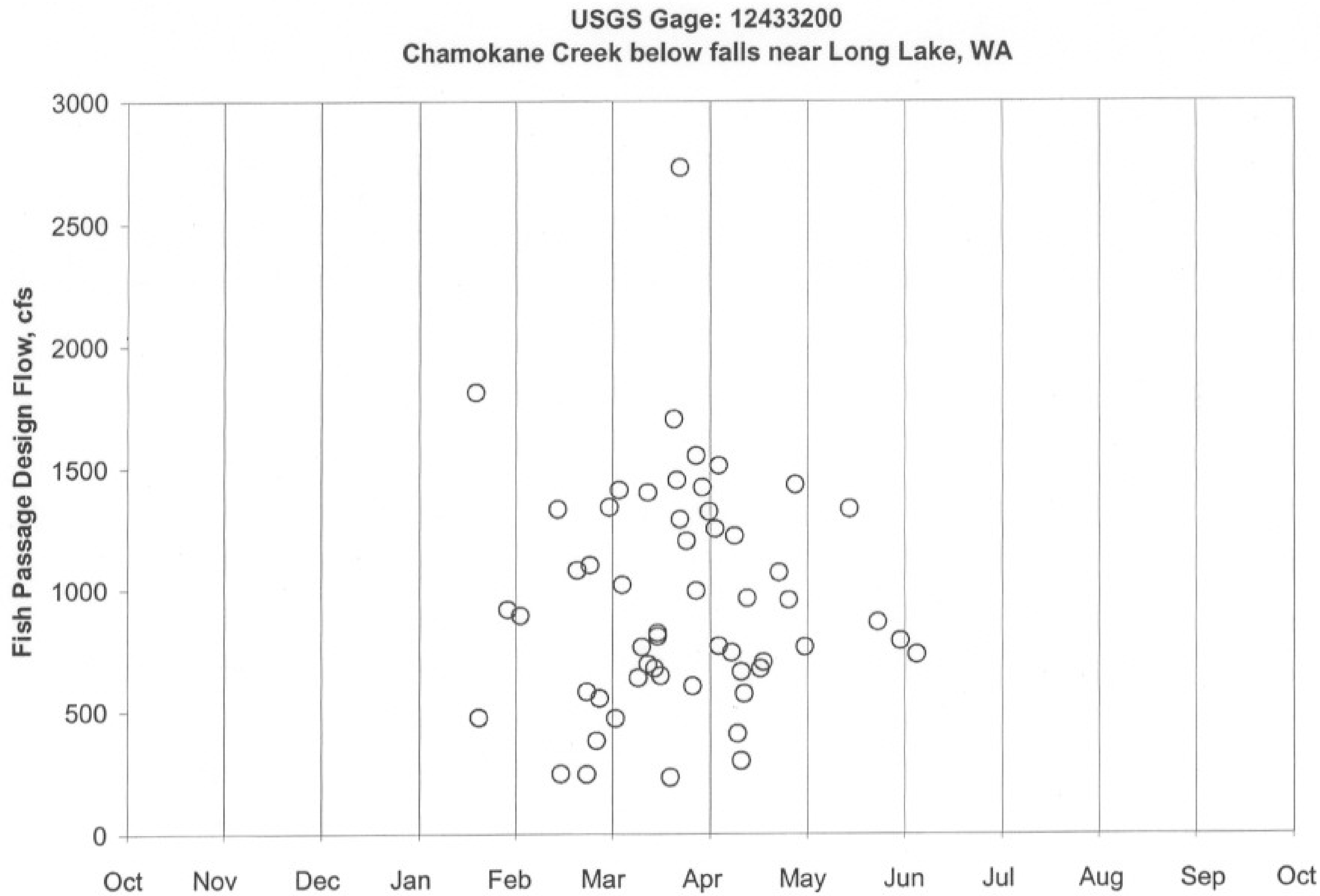

USGS Gage: 12408500
Mill Creek near Colville, WA
Fish Passage Design Flow, cfs
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

USGS Gage: 12409000
Colvile River at Kettle Falls, WA

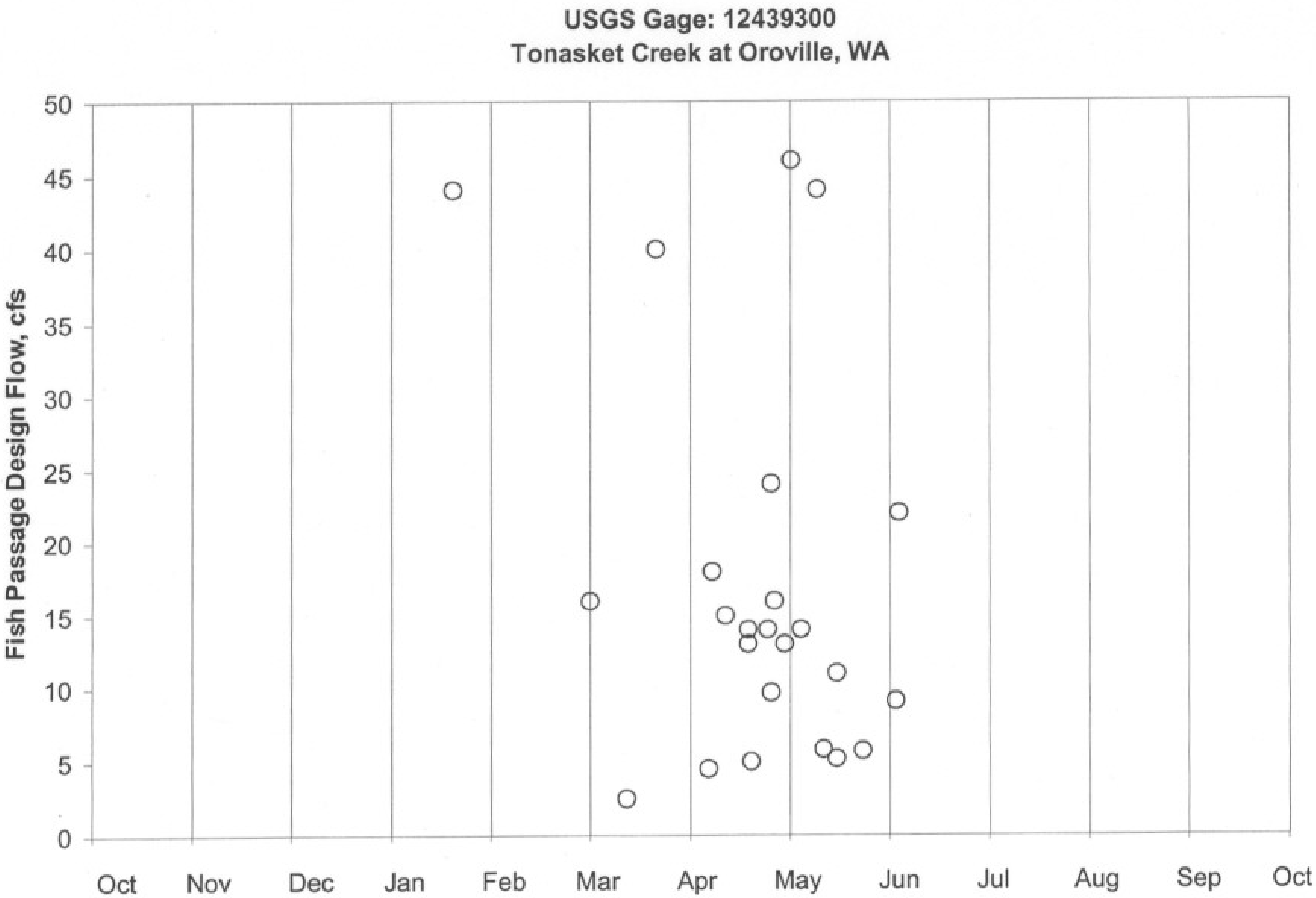


USGS Gage: 12409500
Hall Creek at Inchelium, WA

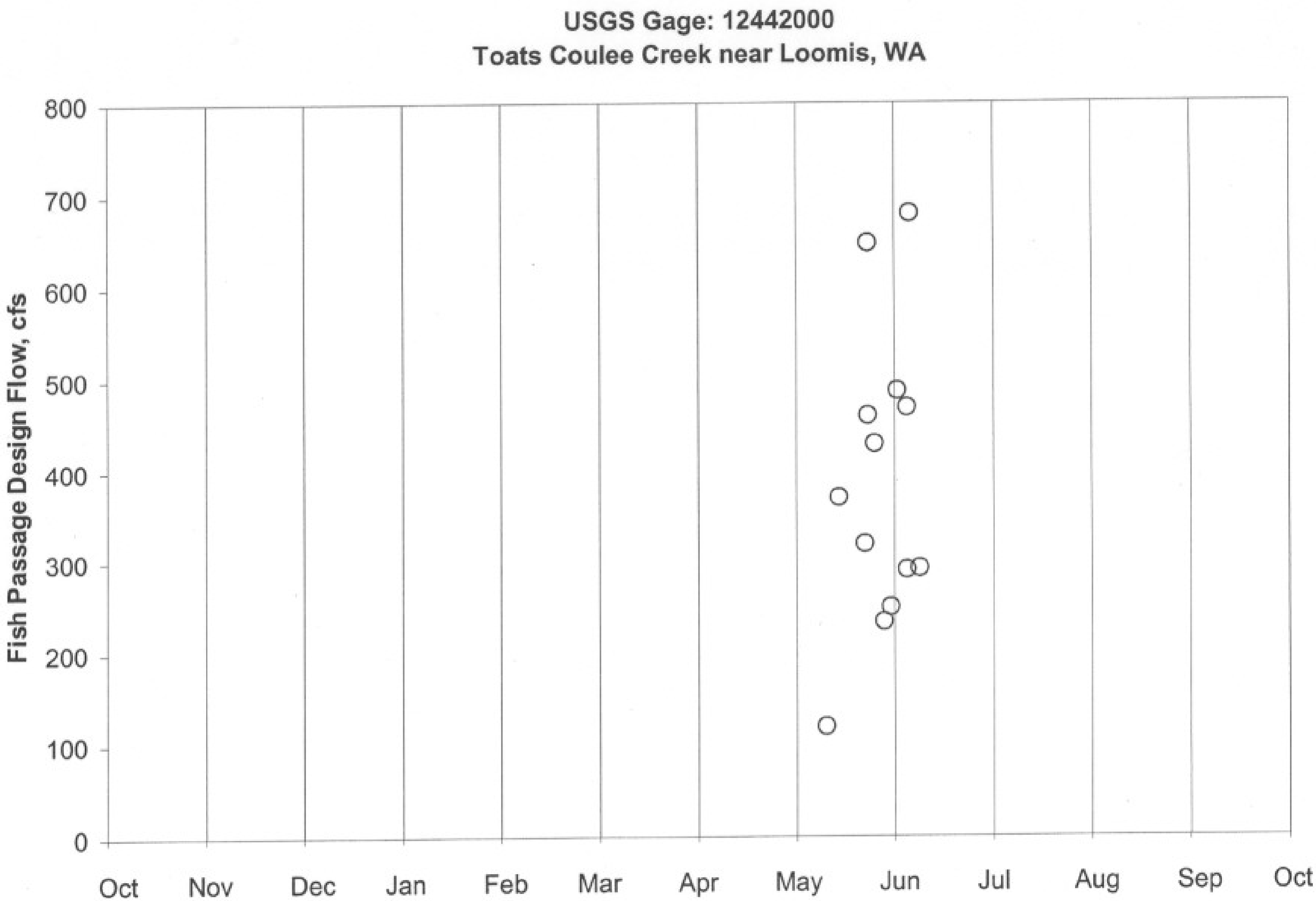




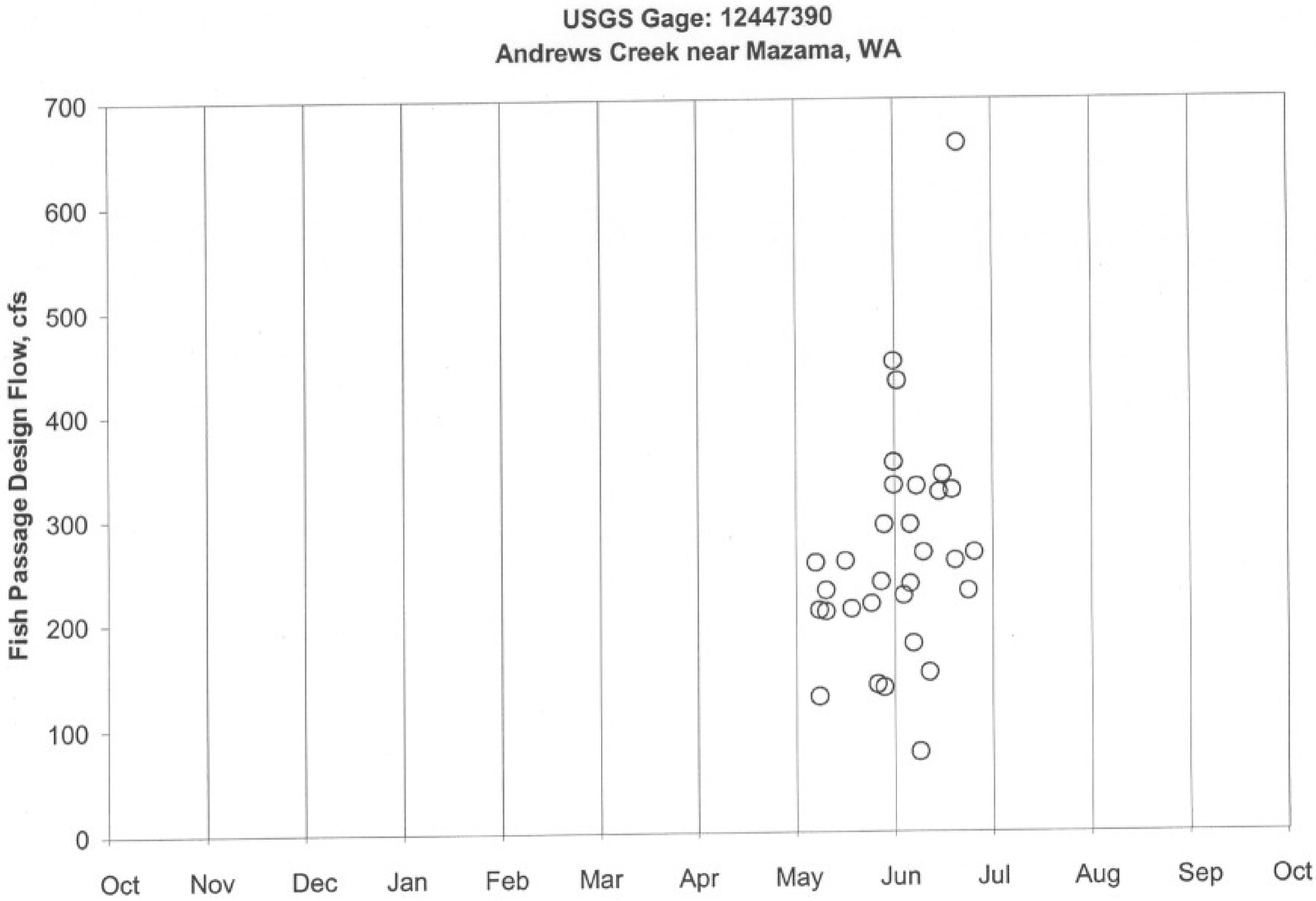
USGS Gage: 12433200
Chamokane Creek below falls near Long Lake, WA
Fish Passage Design Flow, cfs
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

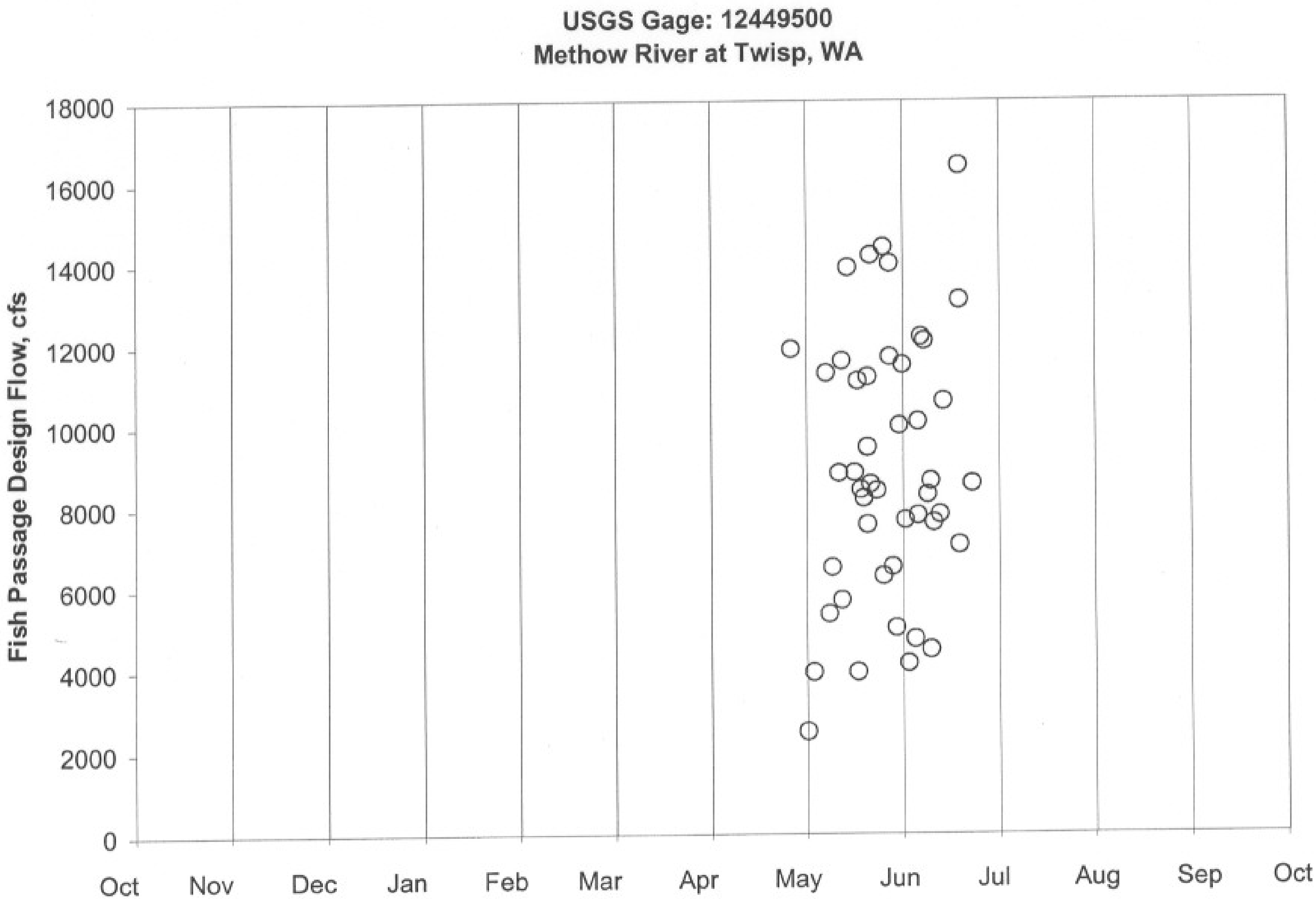


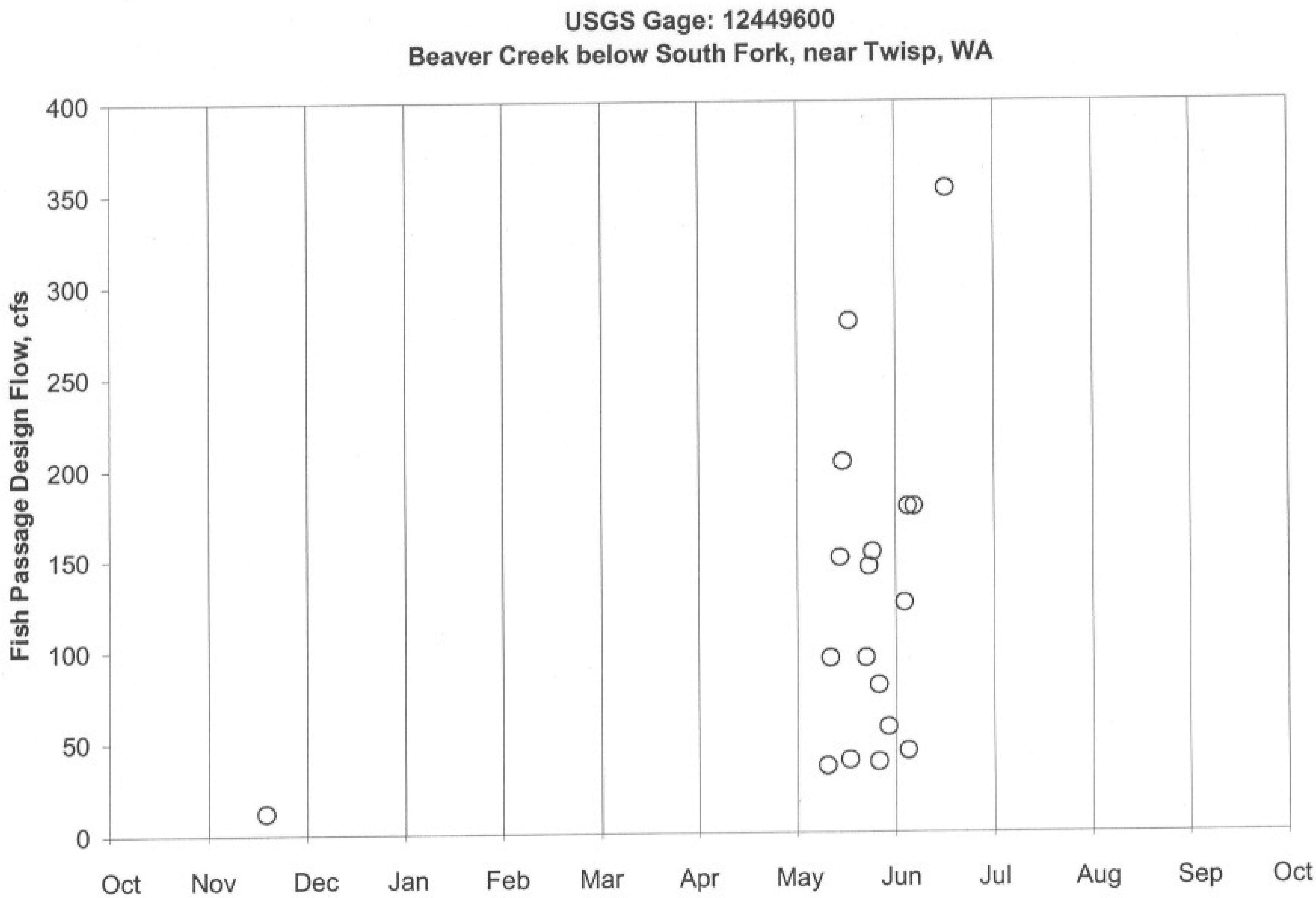
USGS Gage: 12439300
Tonasket Creek at Oroville, WA
Fish Passage Design Flow, cfs
50
45
40
35
30
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct



USGS Gage: 12442000
Toats Coulee Creek near Loomis, WA
Fish Passage Design Flow, cfs
800
700
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

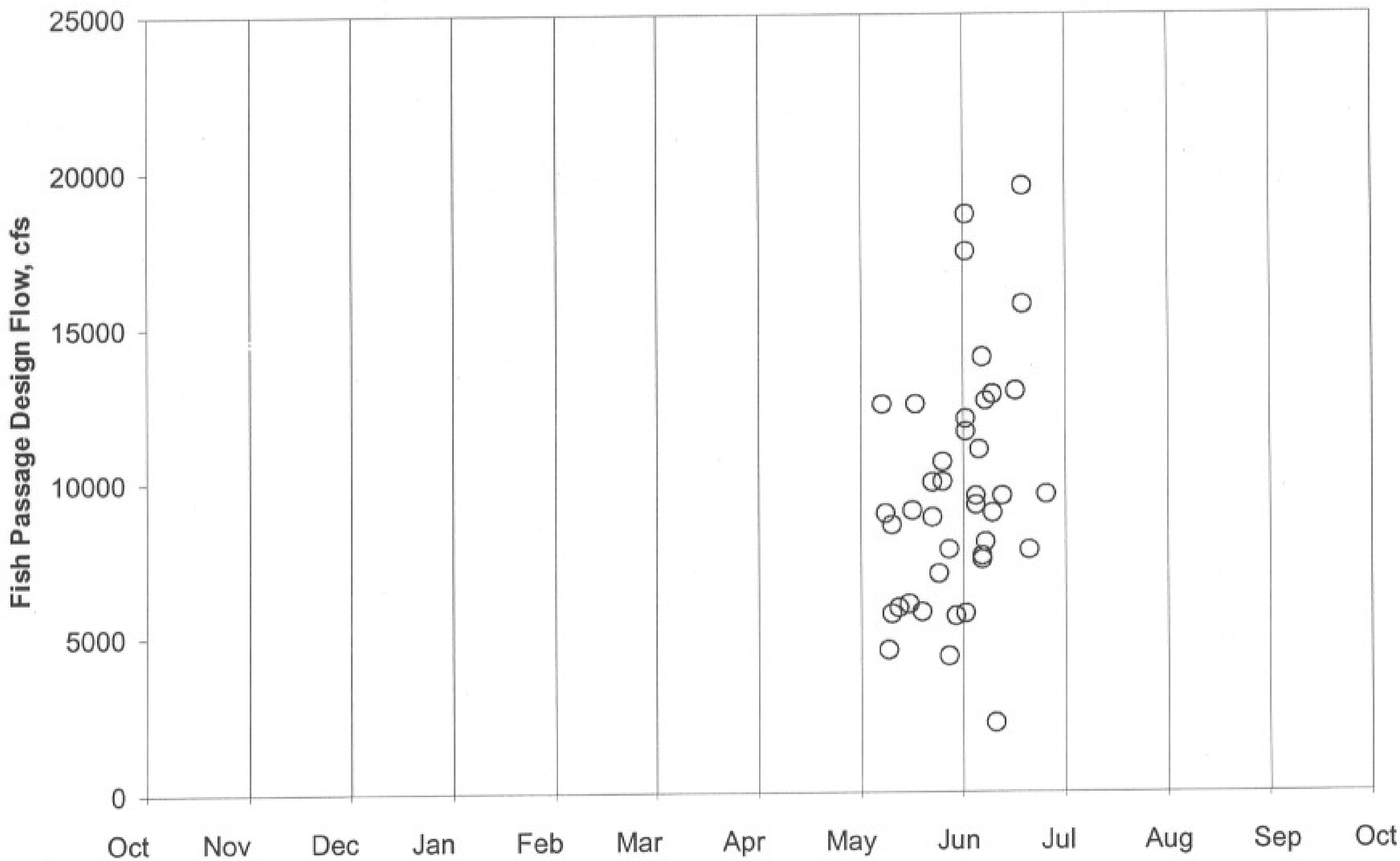

USGS Gage: 12447390
Andrews Creek near Mazama, WA
Fish Passage Design Flow, cfs
700
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

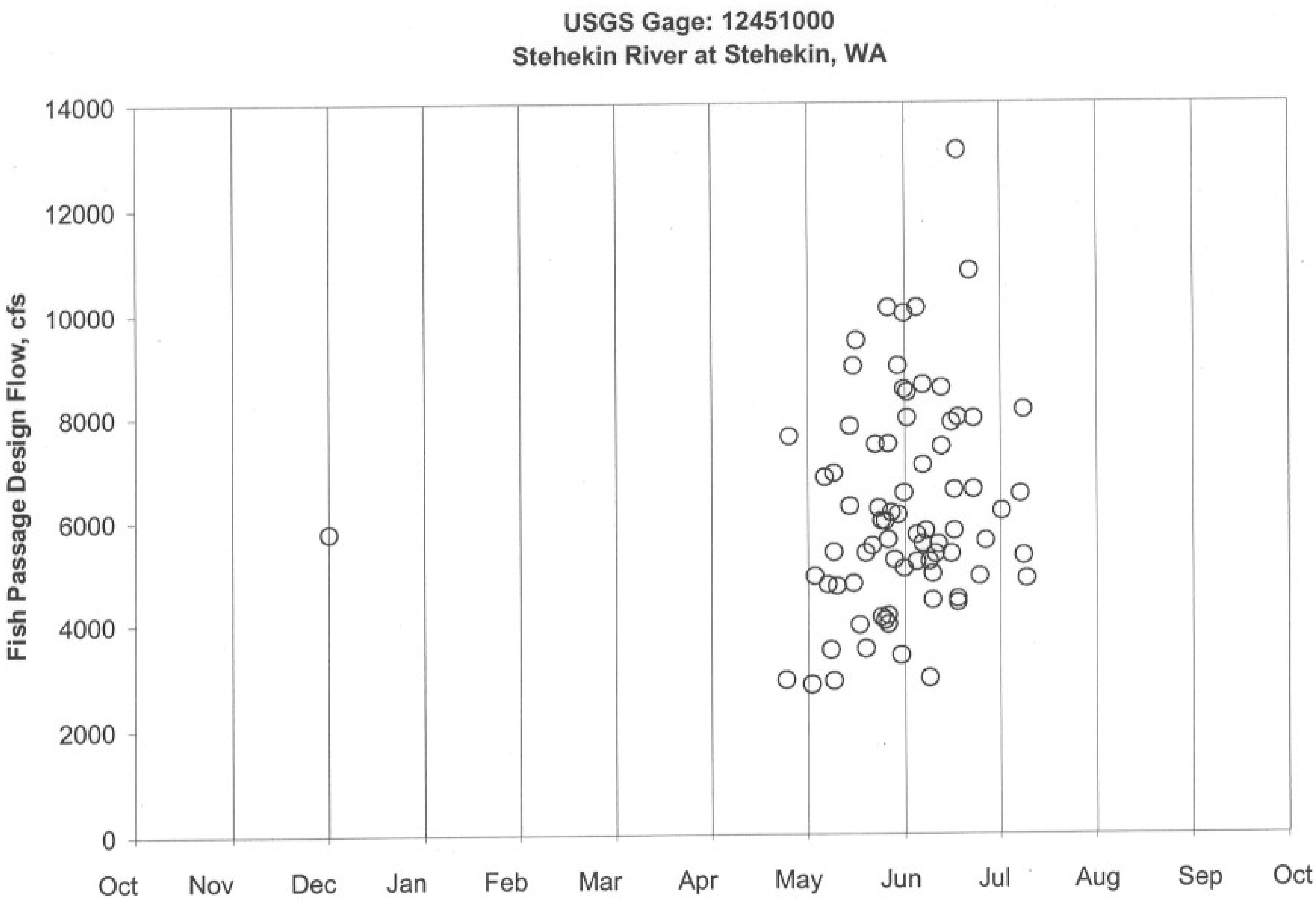

USGS Gage: 12449500
Methow River at Twisp, WA
Fish Passage Design Flow, cfs
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct



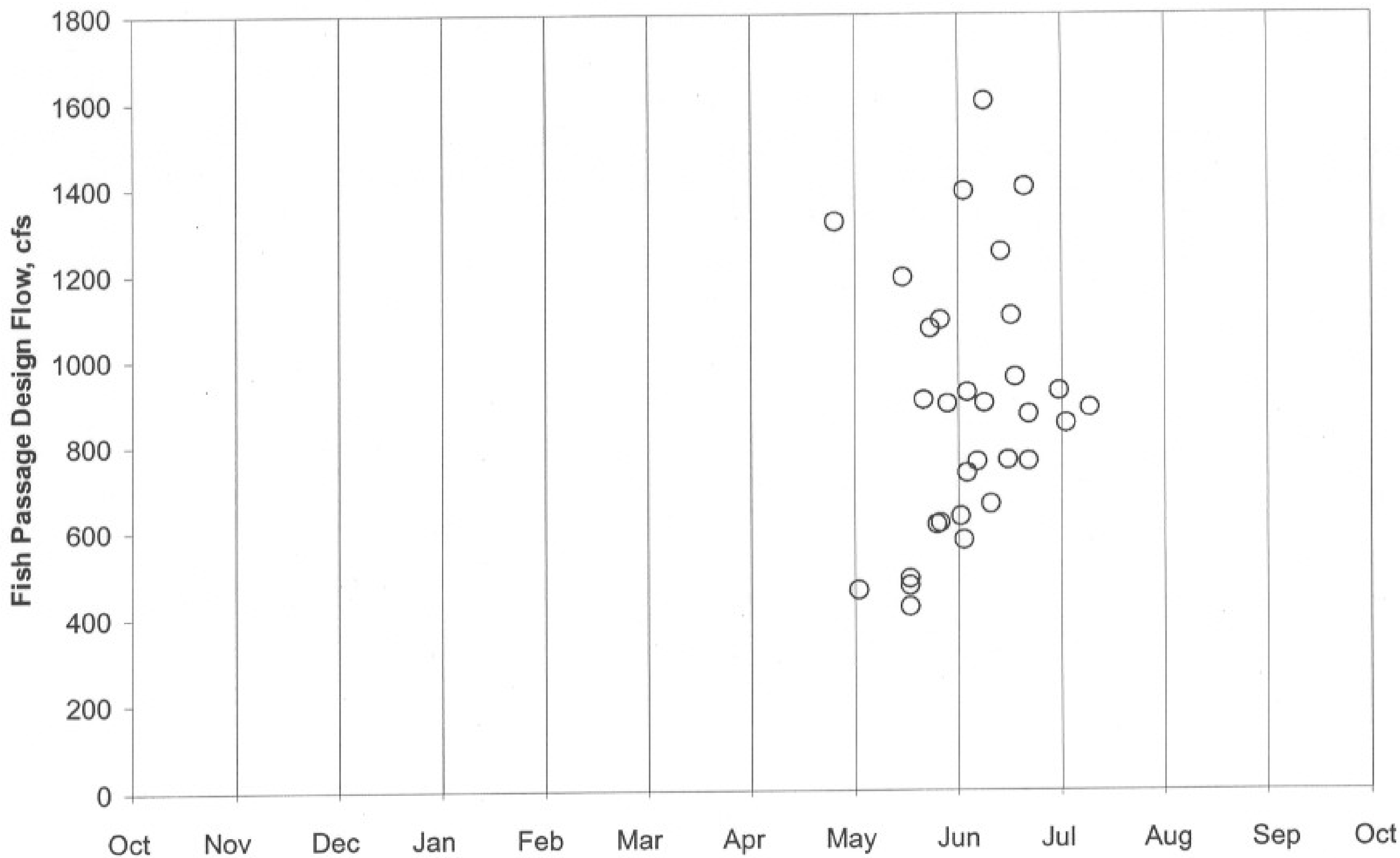
USGS Gage: 12449600
Beaver Creek below South Fork, near Twisp, WA
Fish Passage Design Flow, cfs
400
350
300
250
200
150
100
50
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

USGS Gage: 12449950
Methow River near Pateros, WA

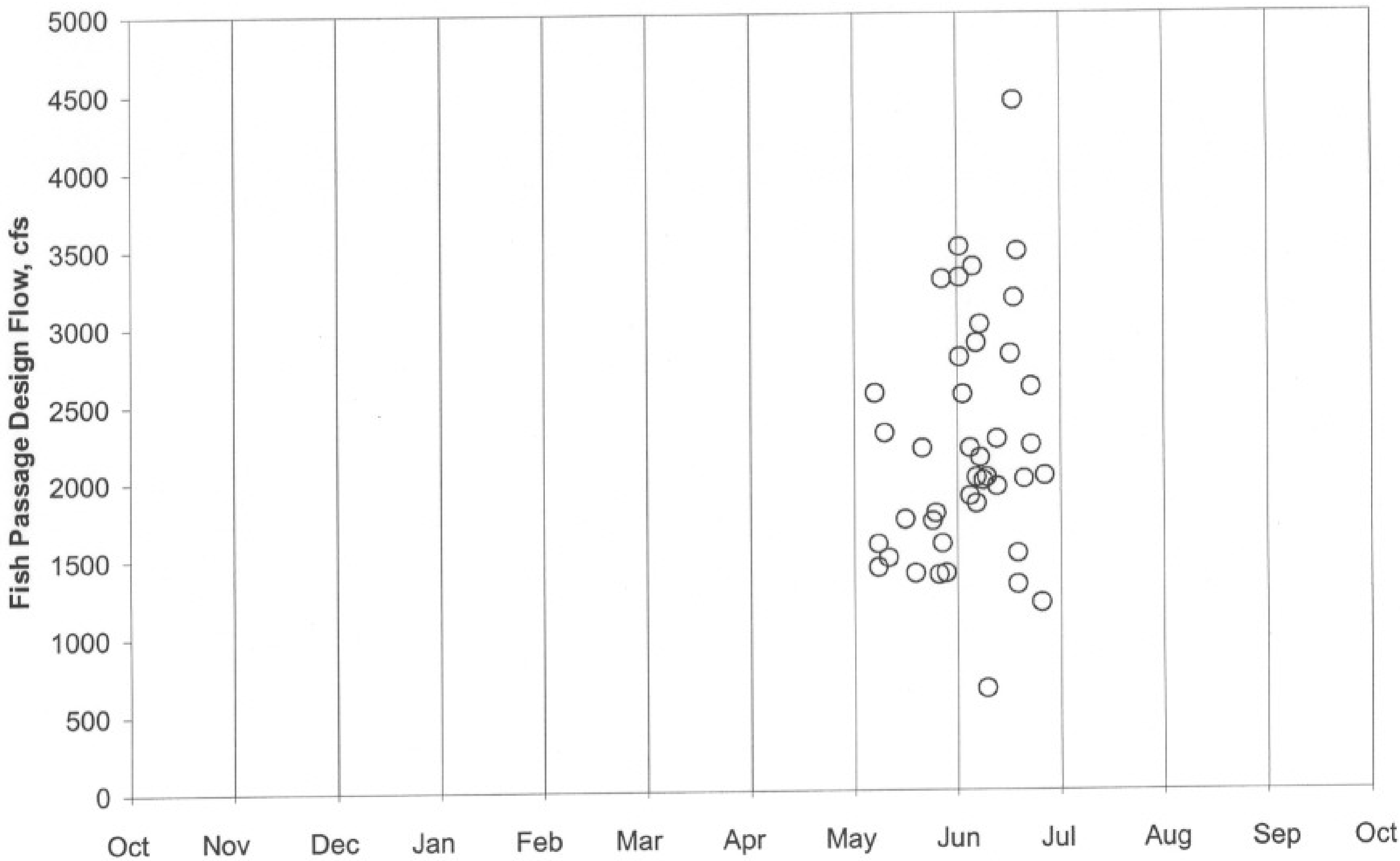



USGS Gage: 12451000
Stehekin River at Stehekin, WA
Fish Passage Design Flow, cfs
14000
12000
10000
8000
6000
4000
2000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

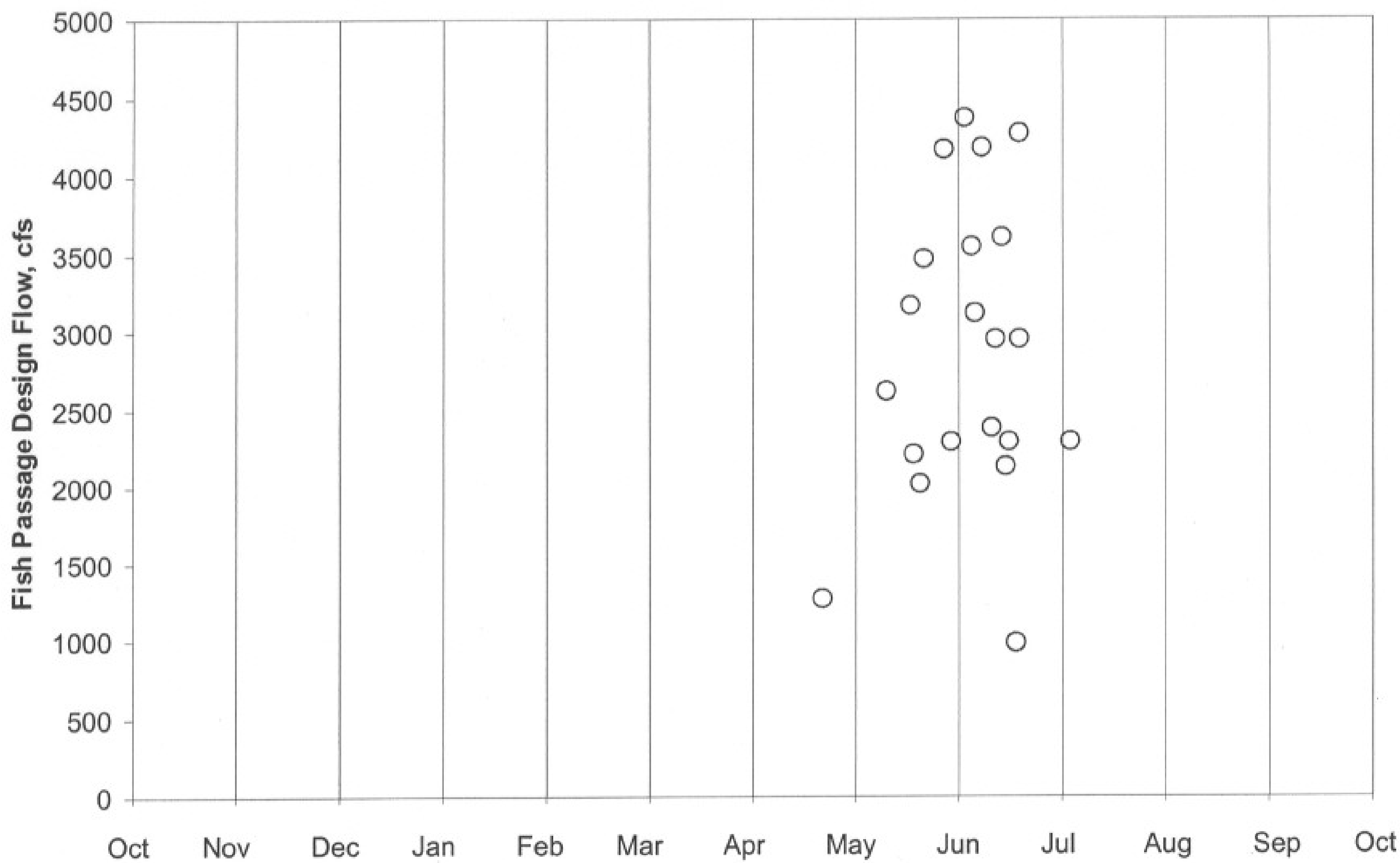
USGS Gage: 12451500
Railroad Creek at Lucerne, WA



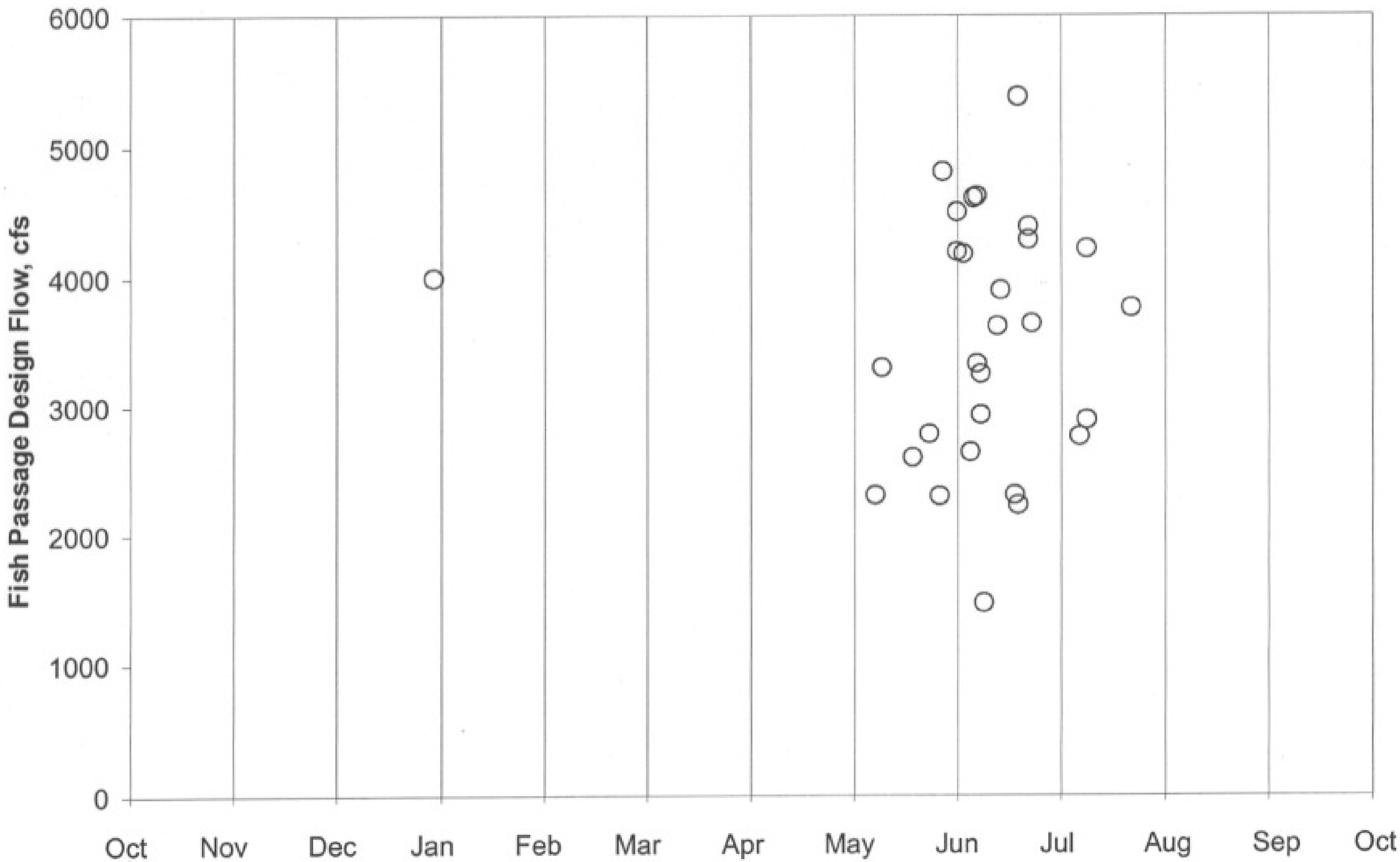
USGS Gage: 12452800
Entiat River near Ardenvoir, WA

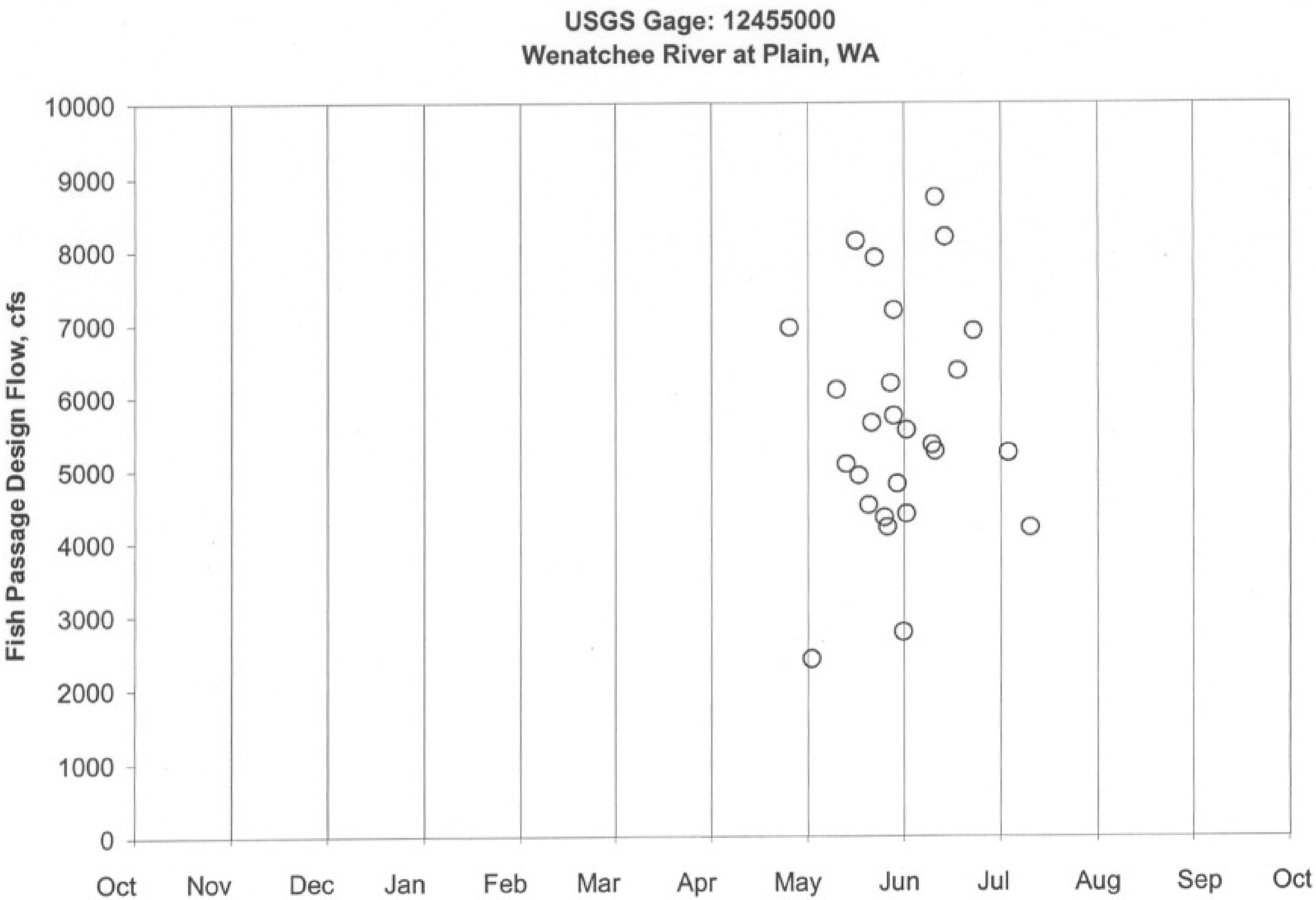


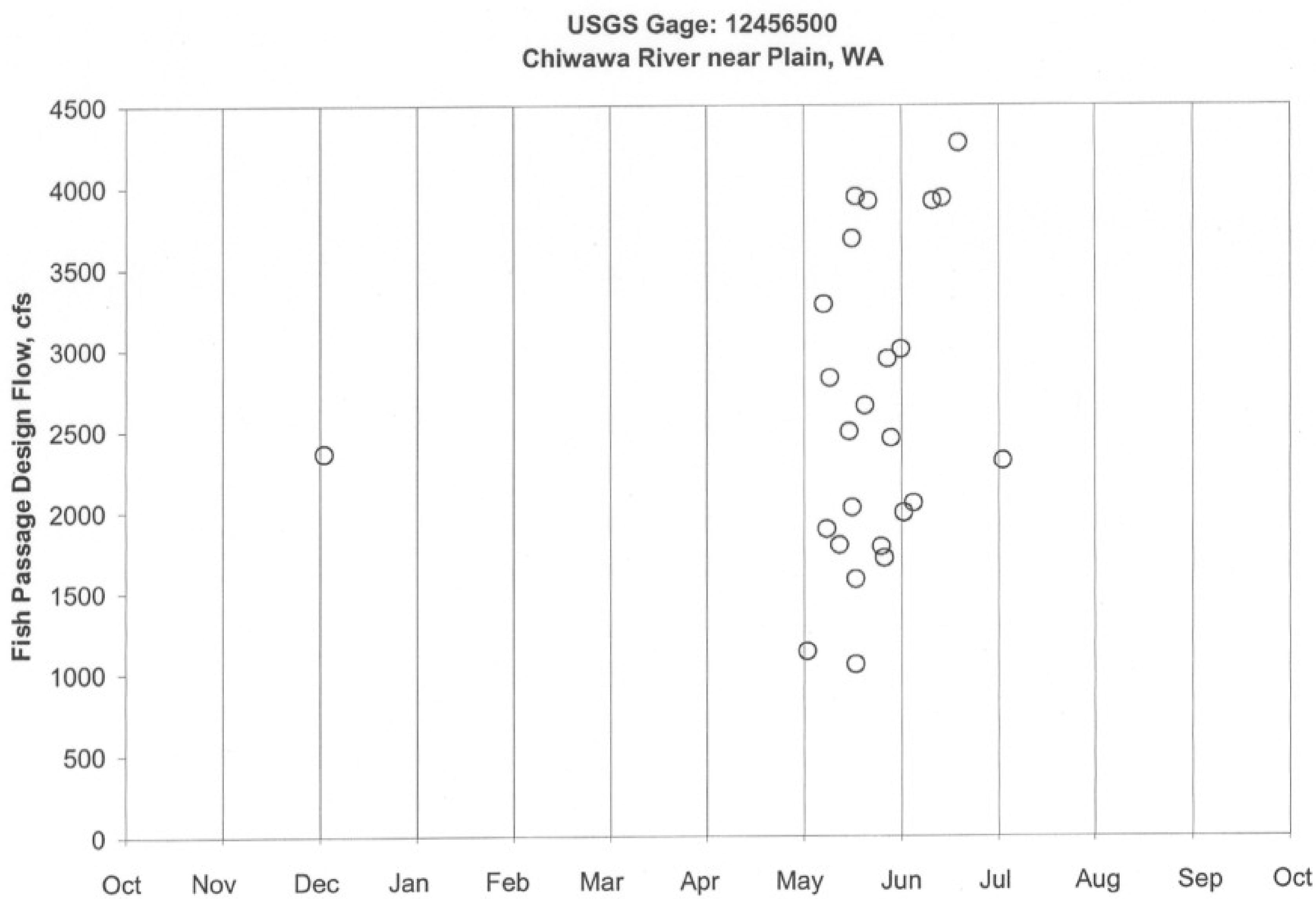
USGS Gage: 12453000
Entiat River at Entiat, WA

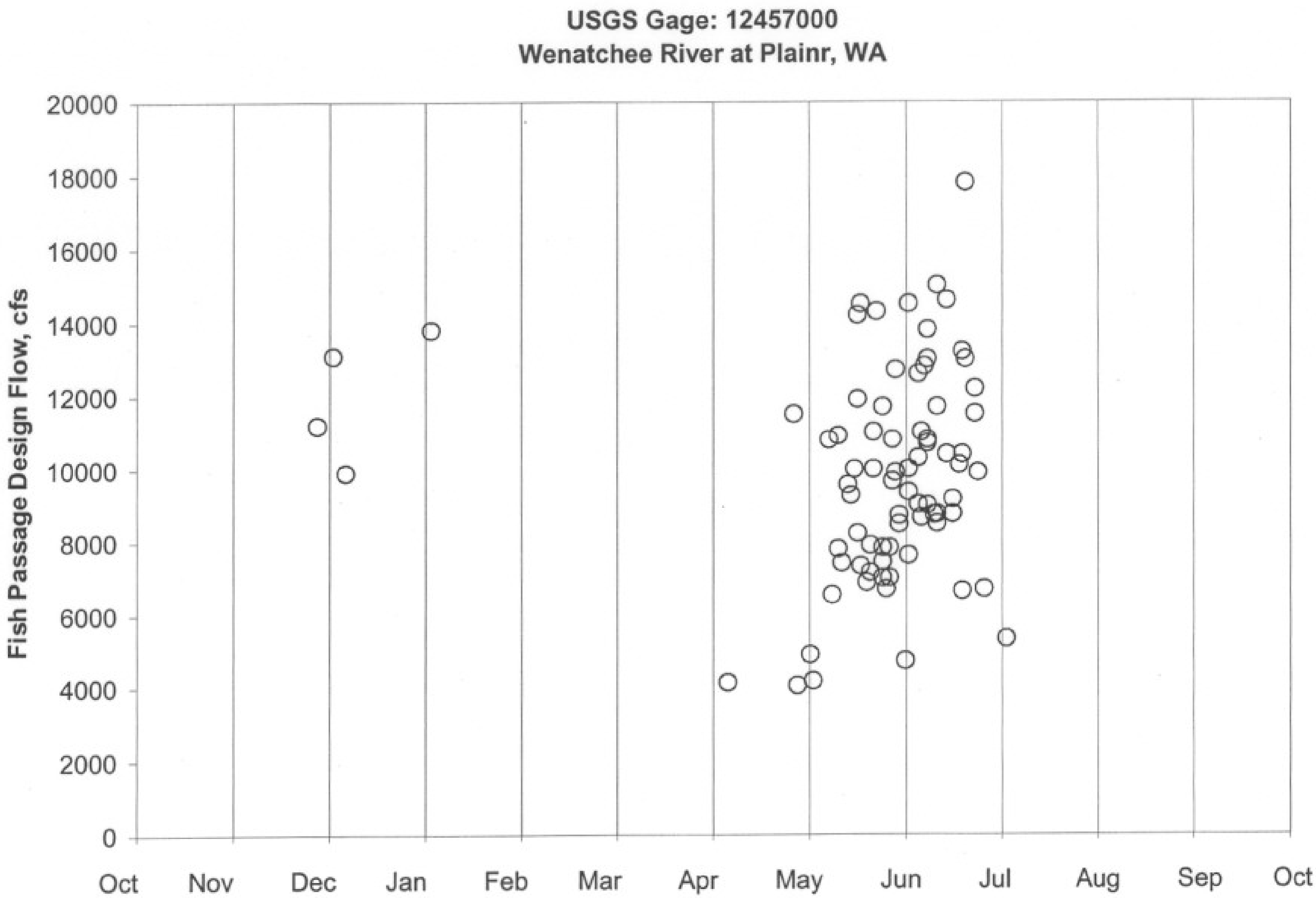


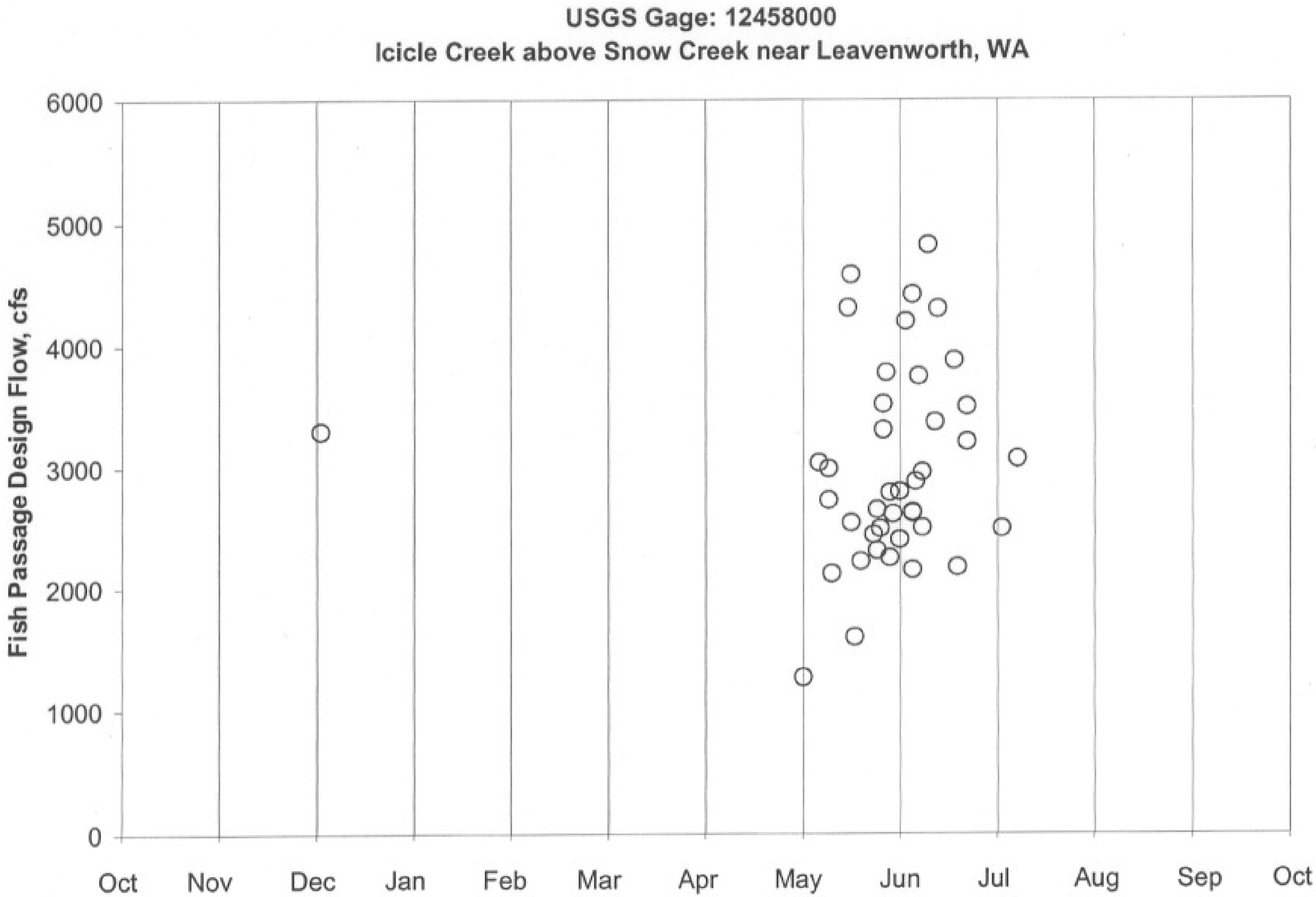
USGS Gage: 12454000
White River near Plain, WA



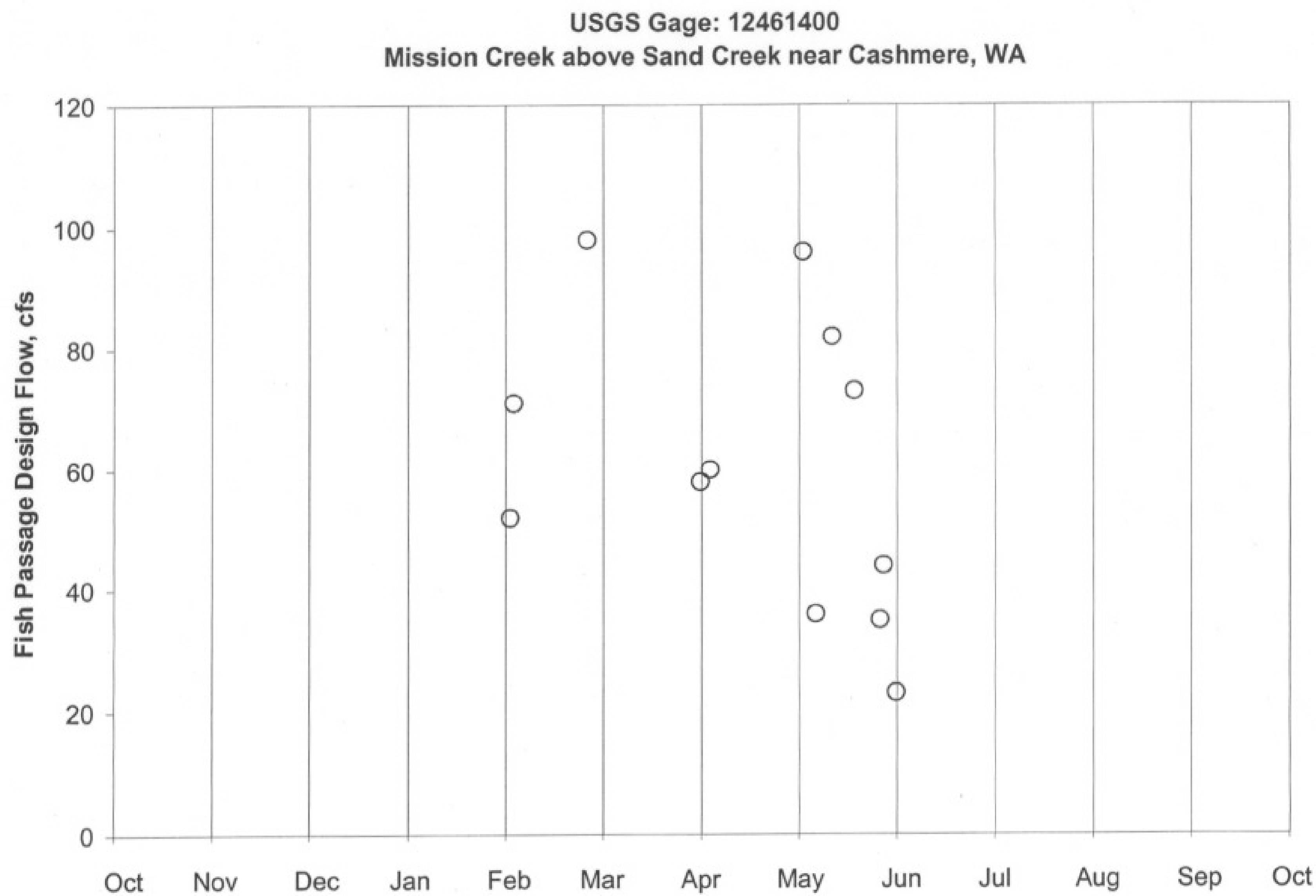

USGS Gage: 12455000
Wenatchee River at Plain, WA
Fish Passage Design Flow, cfs
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct


USGS Gage: 12456500
Chiwawa River near Plain, WA
Fish Passage Design Flow, cfs
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct


USGS Gage: 12457000
Wenatchee River at Plainr, WA
Fish Passage Design Flow, cfs
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

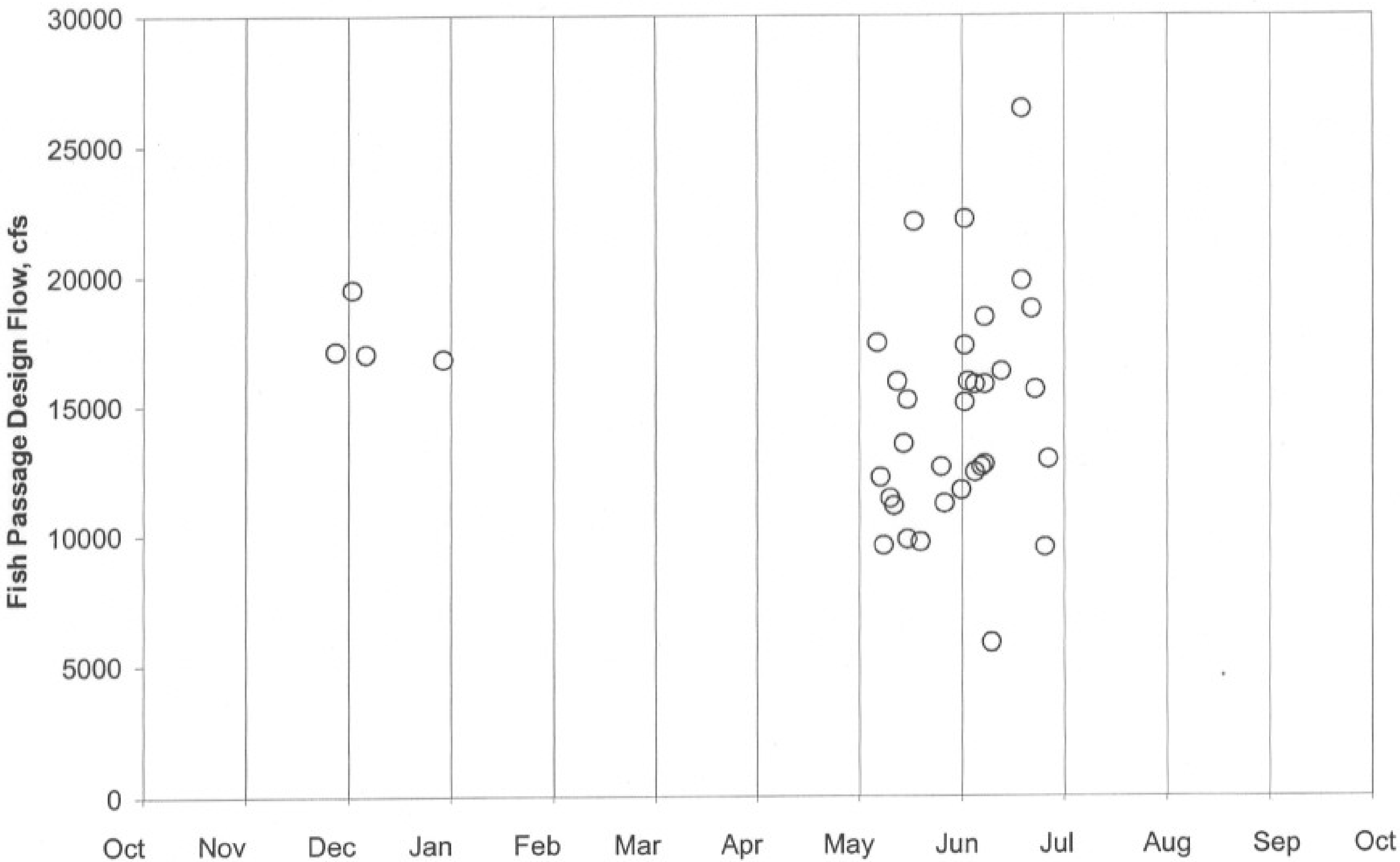


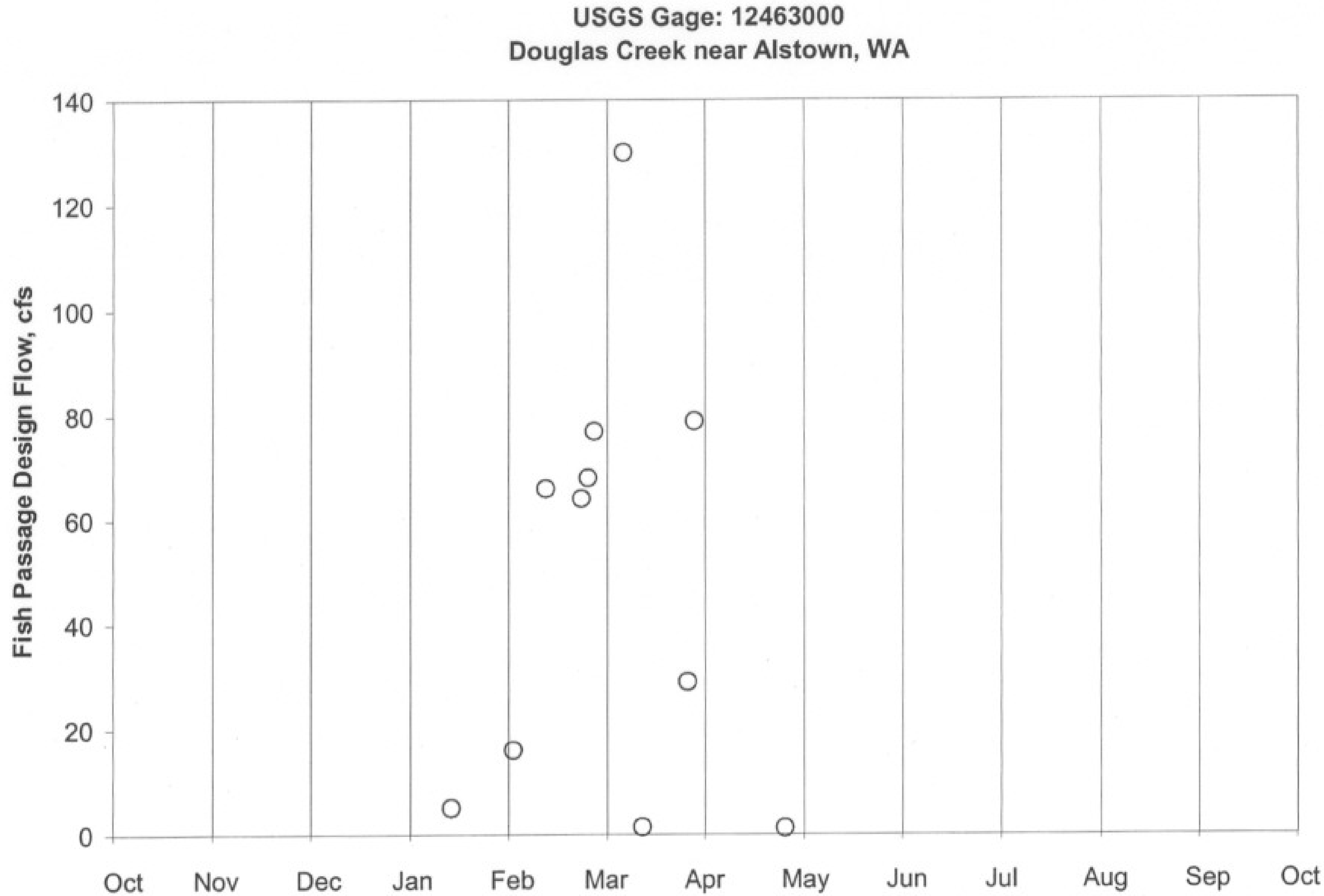
USGS Gage: 12458000
Icicle Creek above Snow Creek near Leavenworth, WA
Fish Passage Design Flow, cfs
6000
5000
4000
3000
2000
1000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct



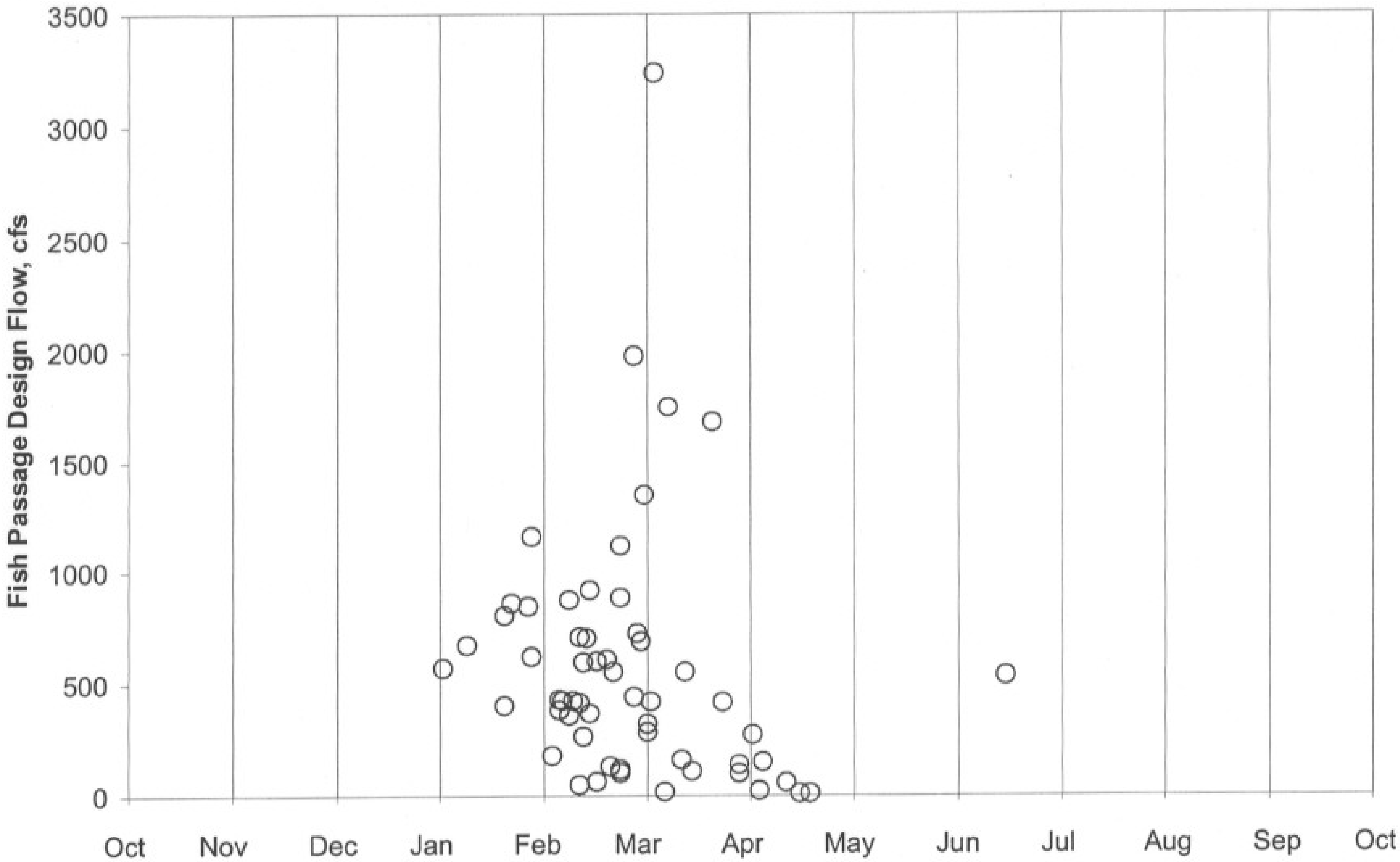
USGS Gage: 12461400
Mission Creek above Sand Creek near Cashmere, WA
Fish Passage Design Flow, cfs
0
20
40
60
80
100
120
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

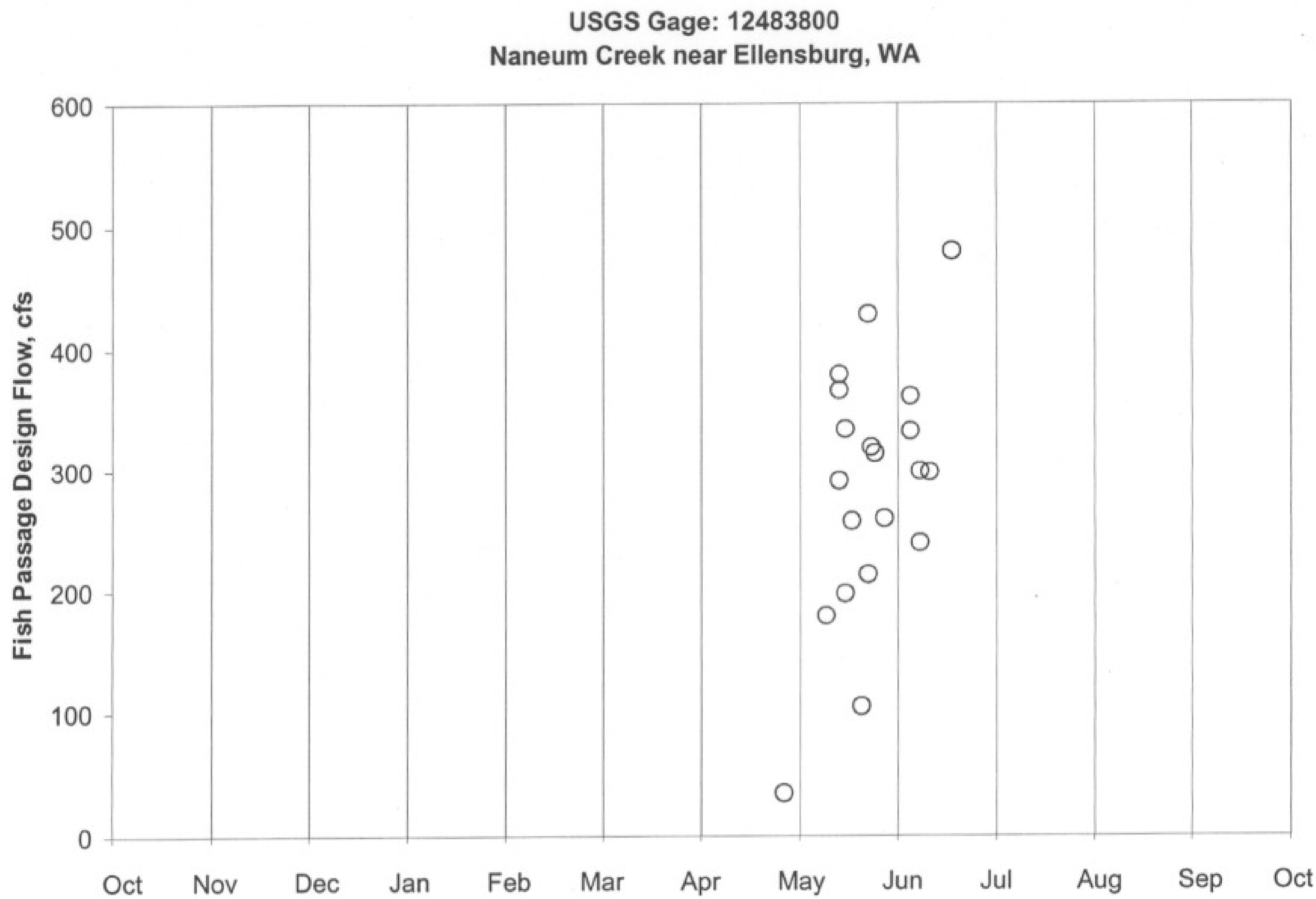
USGS Gage: 12462500
Wenatchee River at Monitor, WA

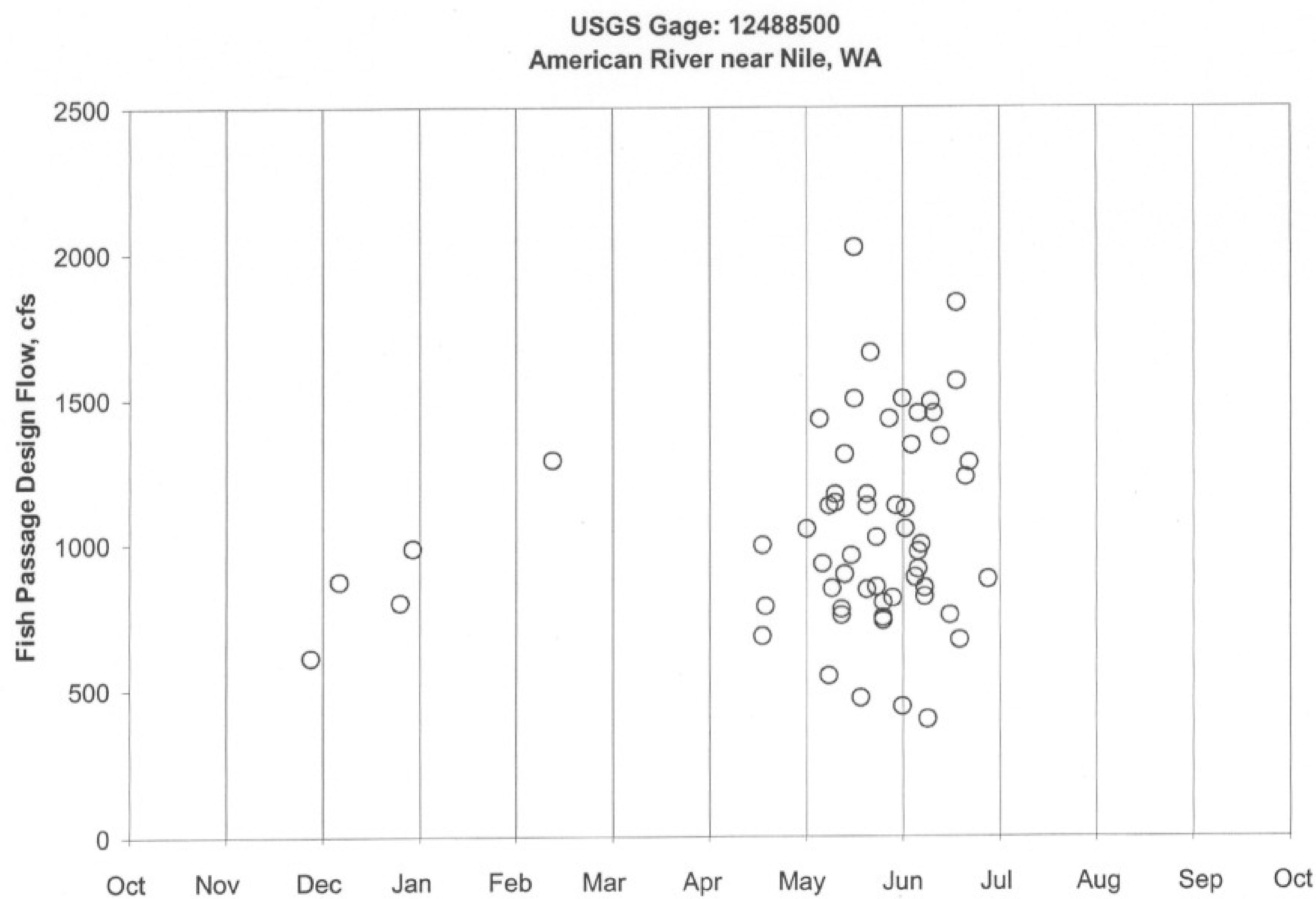



USGS Gage: 12463000
Douglas Creek near Alstown, WA
Fish Passage Design Flow, cfs
0
20
40
60
80
100
120
140
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

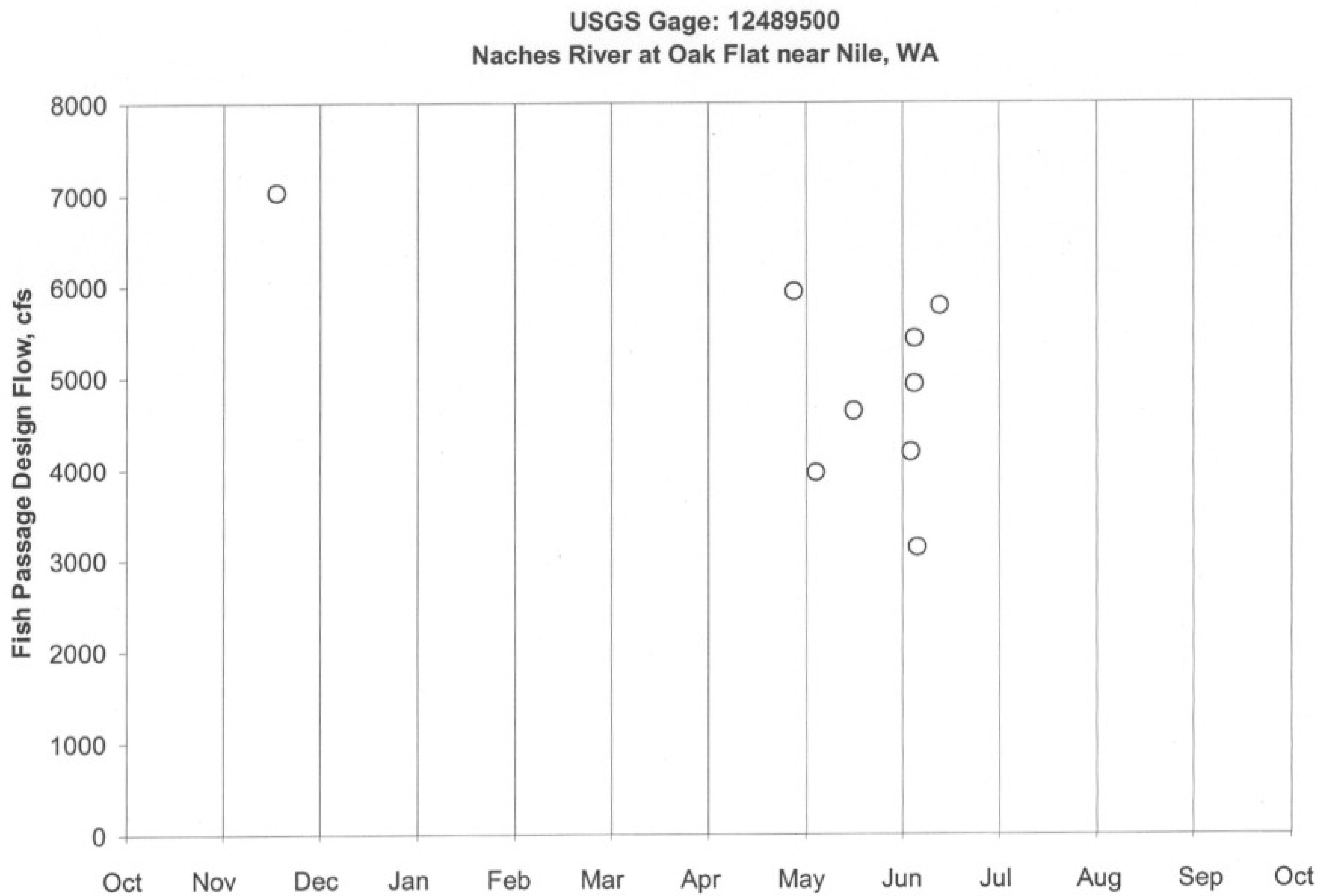
USGS Gage: 12465000
Crab Creek at Irby, WA



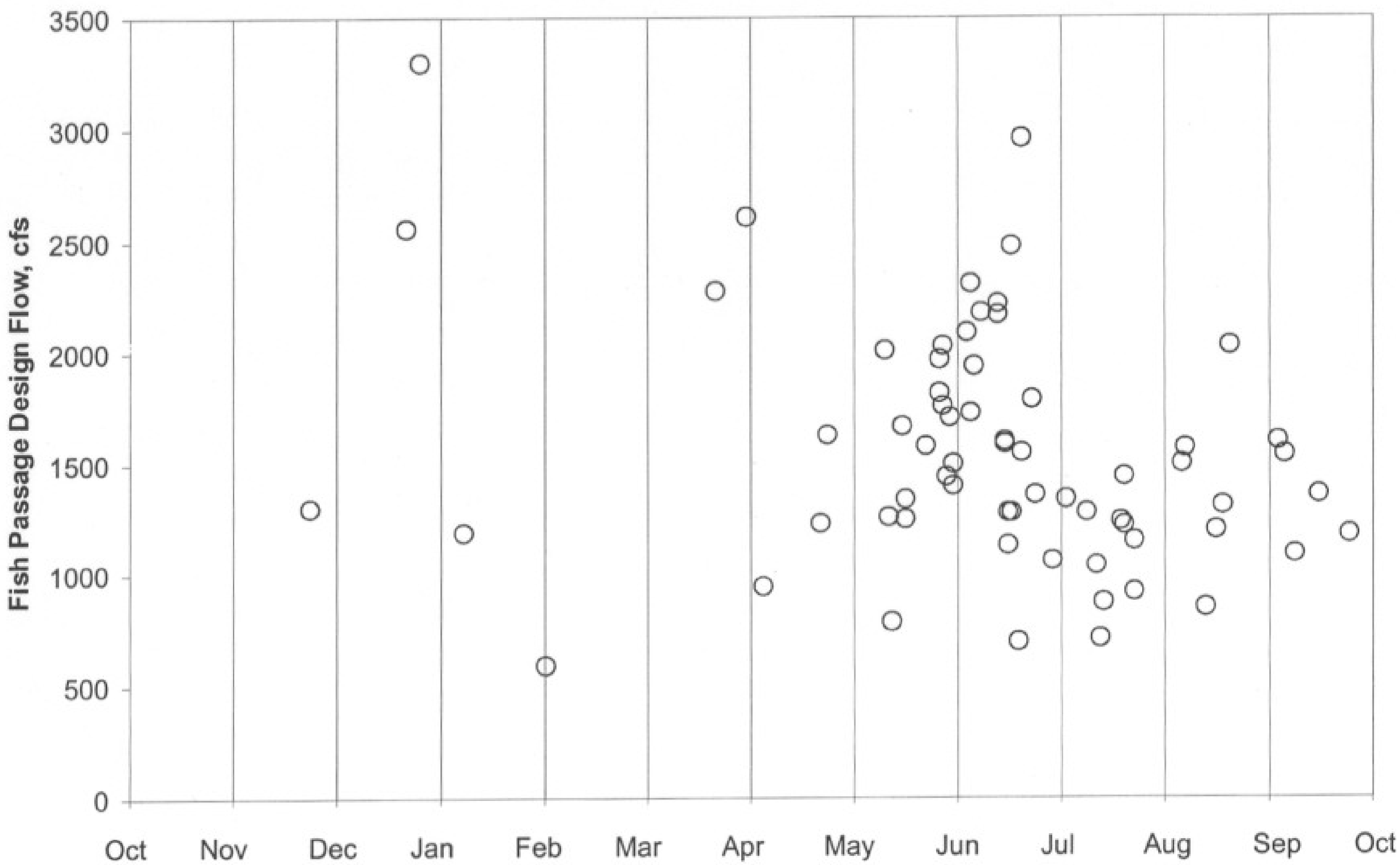

USGS Gage: 12483800
Naneum Creek near Ellensburg, WA
Fish Passage Design Flow, cfs
0
100
200
300
400
500
600
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct



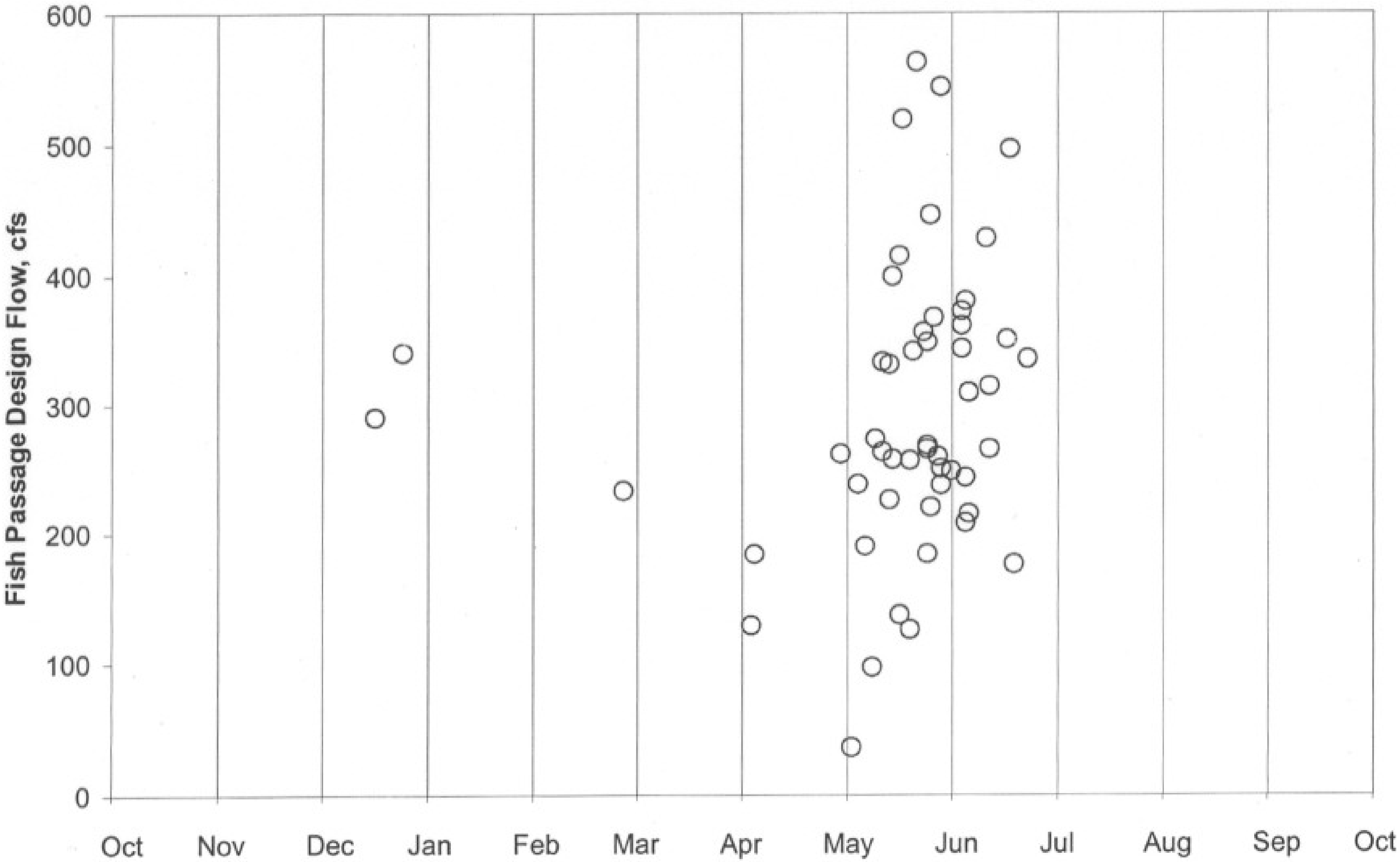
USGS Gage: 12488500
American River near Nile, WA
Fish Passage Design Flow, cfs
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct


USGS Gage: 12489500
Naches River at Oak Flat near Nile, WA
Fish Passage Design Flow, cfs
8000
7000
6000
5000
4000
3000
2000
1000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

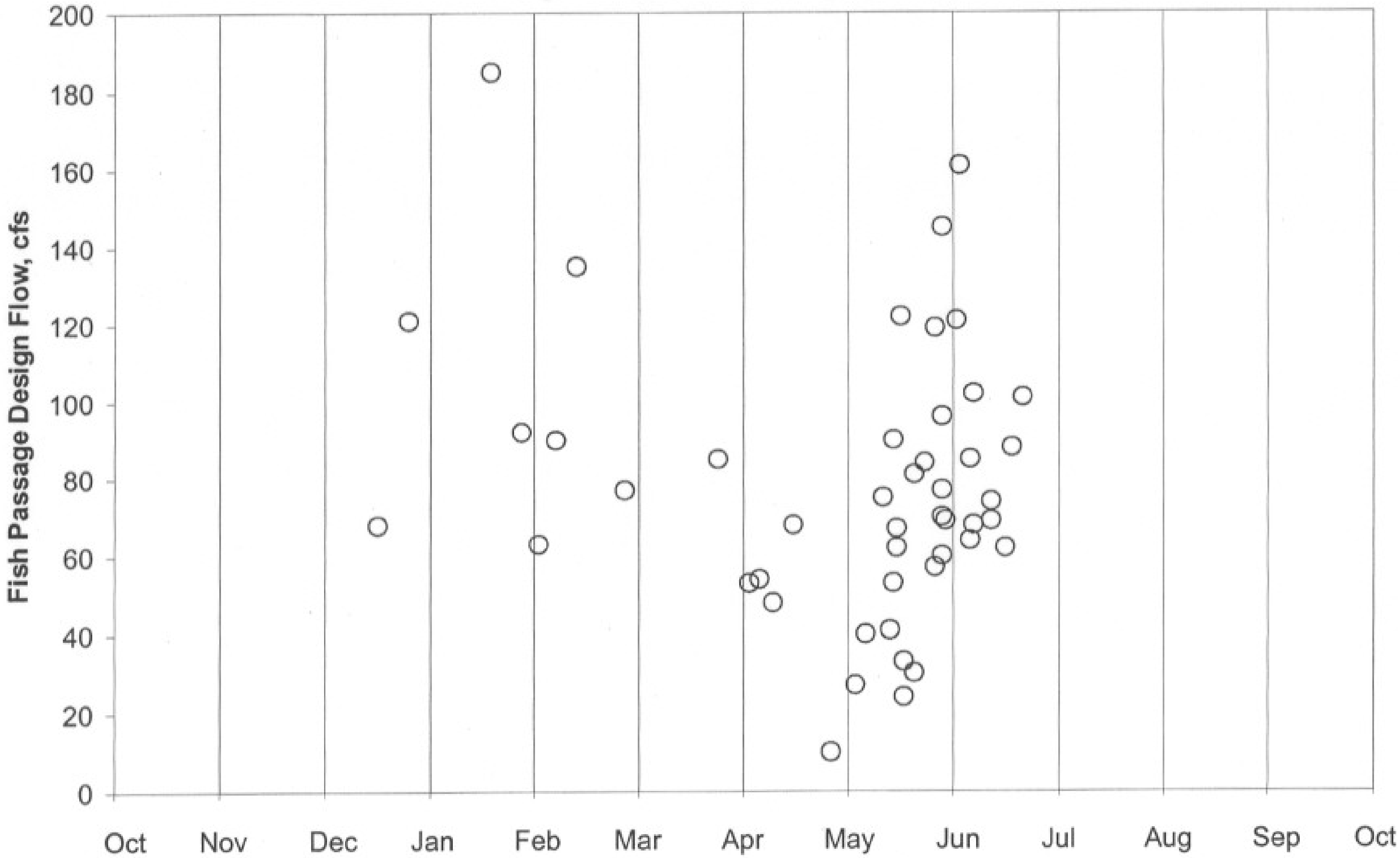
USGS Gage: 12492500
Tieton River at Canal Headworks near Naches, WA

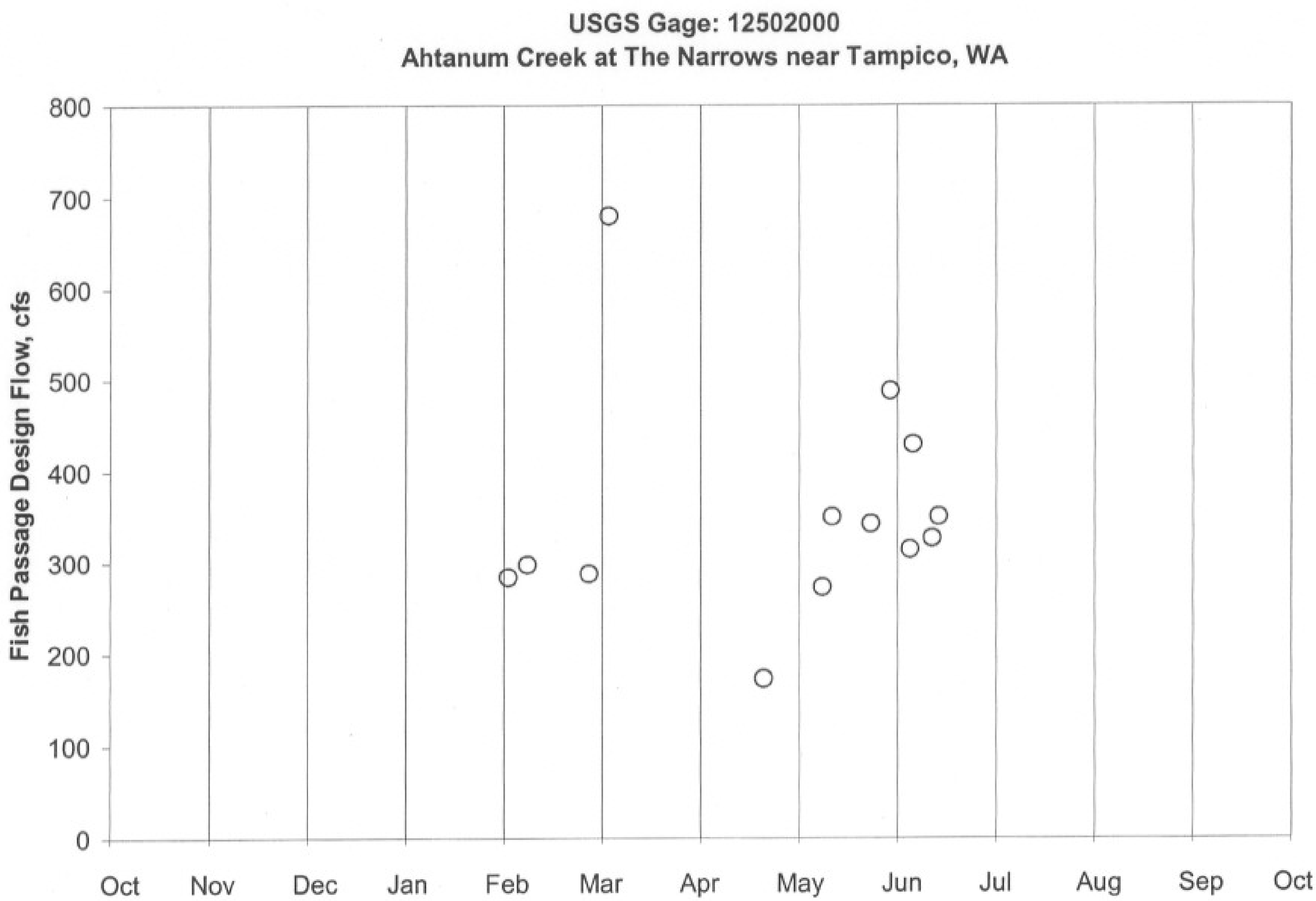


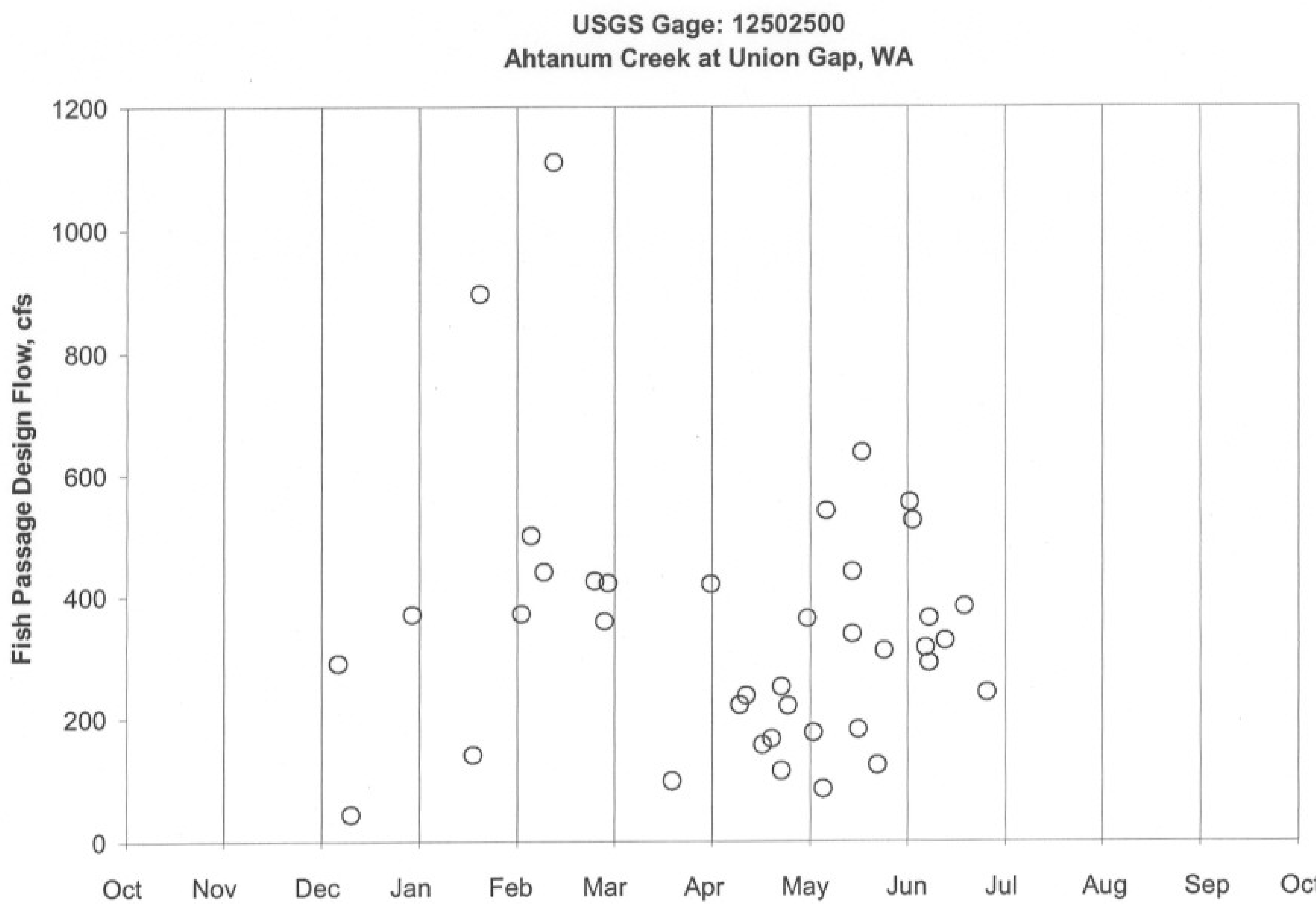
USGS Gage: 12500500
North Fork Ahtanum Creek near Tampico, WA



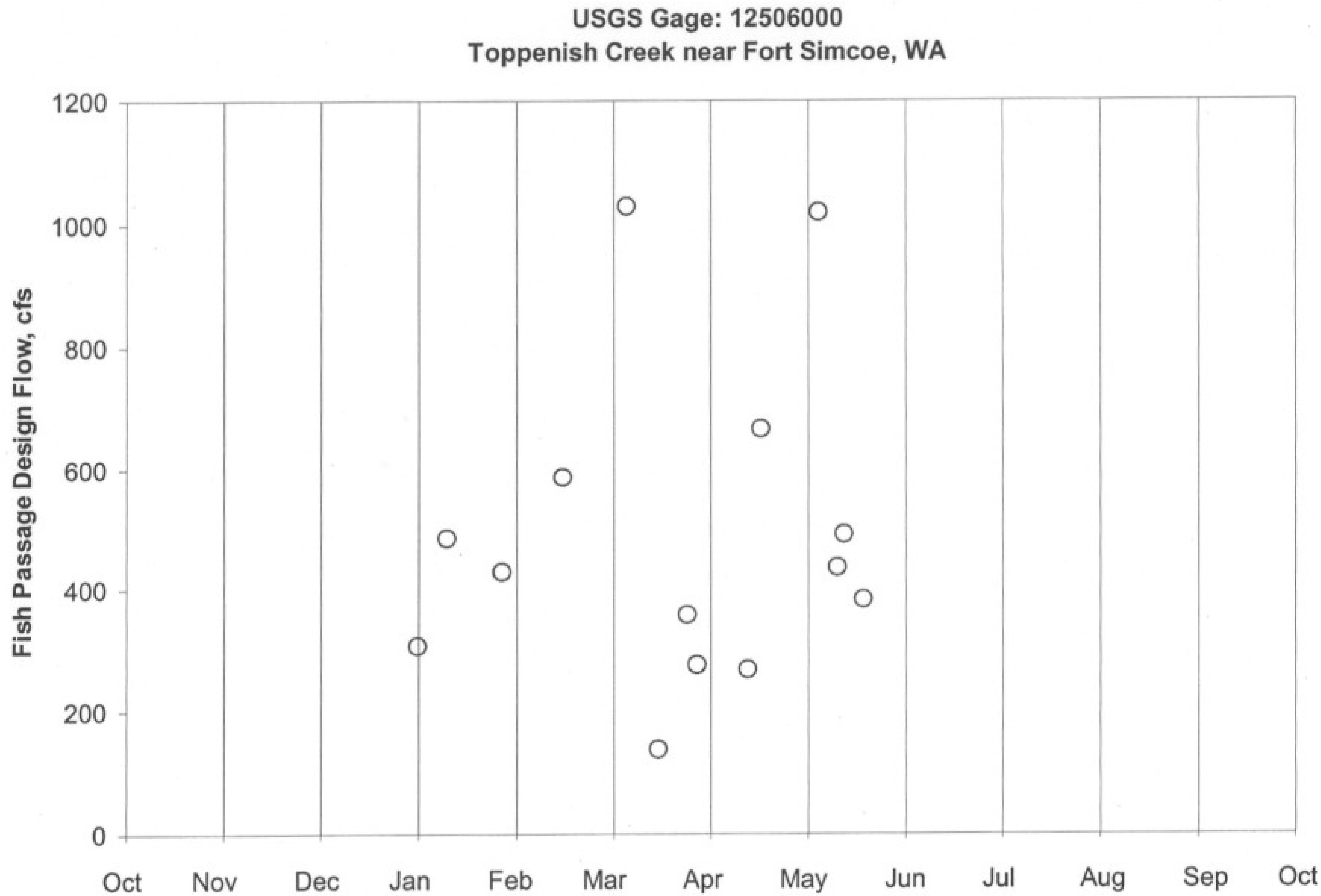
USGS Gage: 12501000
South Fork Ahtanum Creek at Conrad Ranch near Tampico, WA

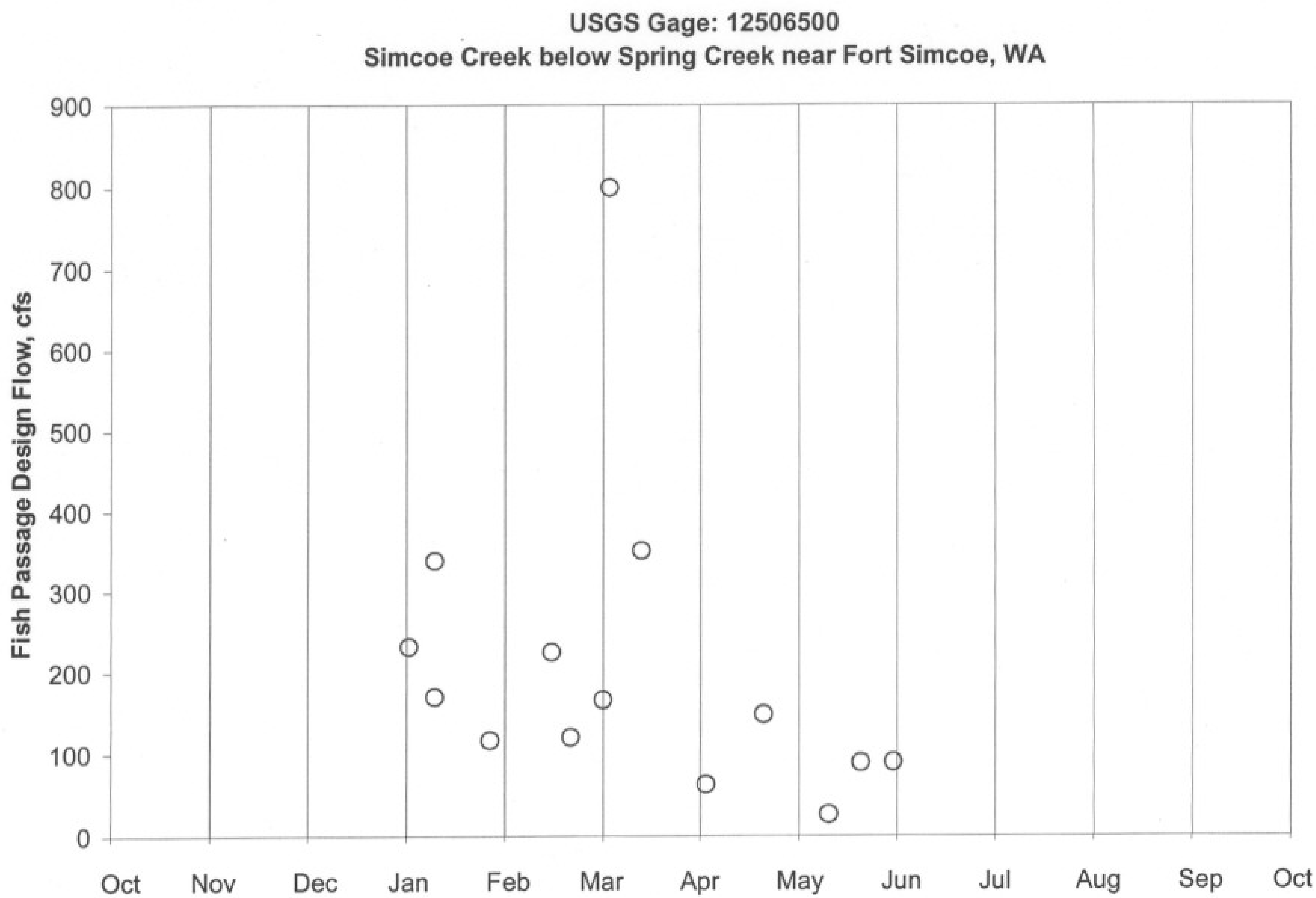



USGS Gage: 12502000
Ahtanum Creek at The Narrows near Tampico, WA
Fish Passage Design Flow, cfs
800
700
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct



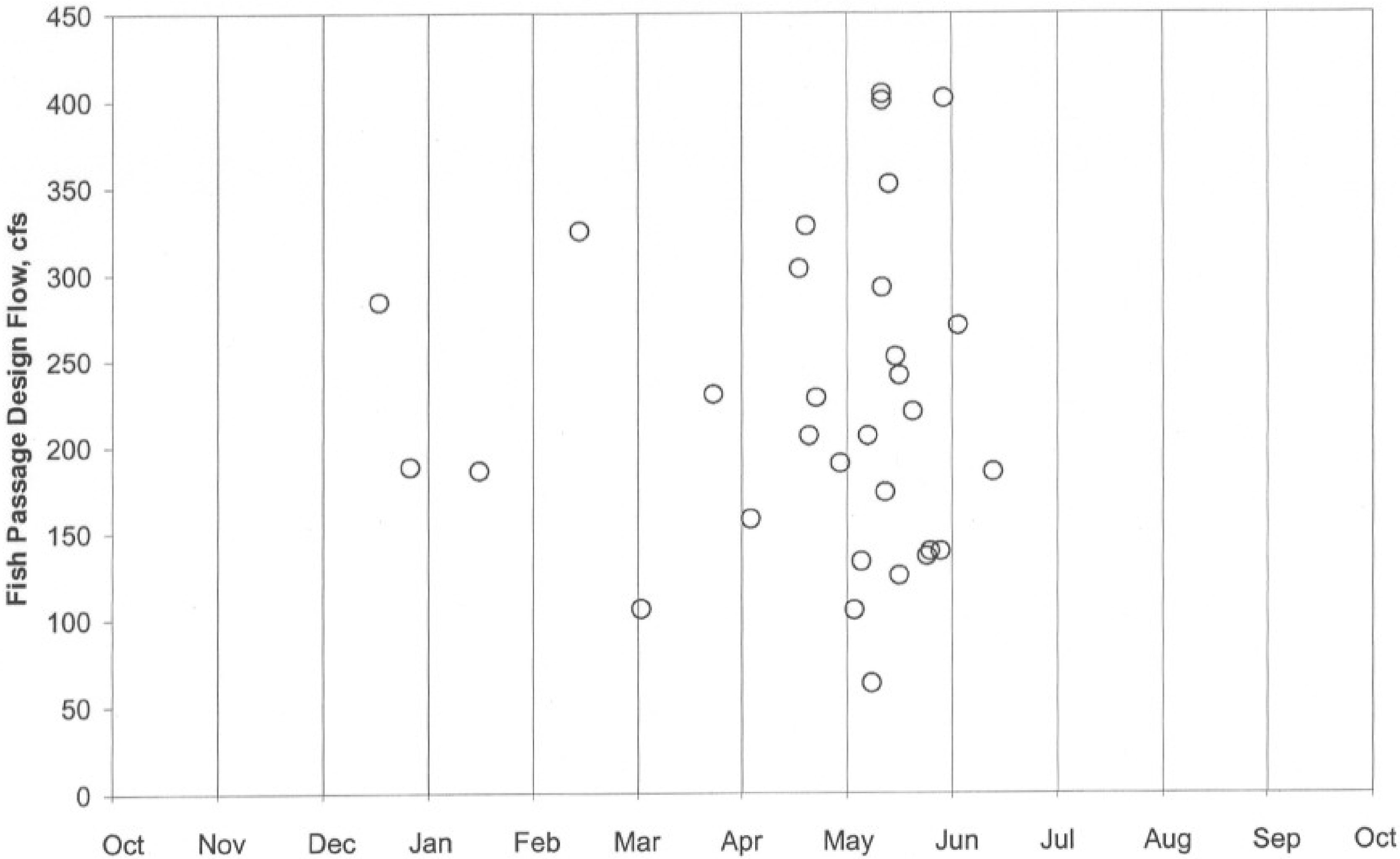
USGS Gage: 12502500
Ahtanum Creek at Union Gap, WA
Fish Passage Design Flow, cfs
1200
1000
800
600
400
200
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

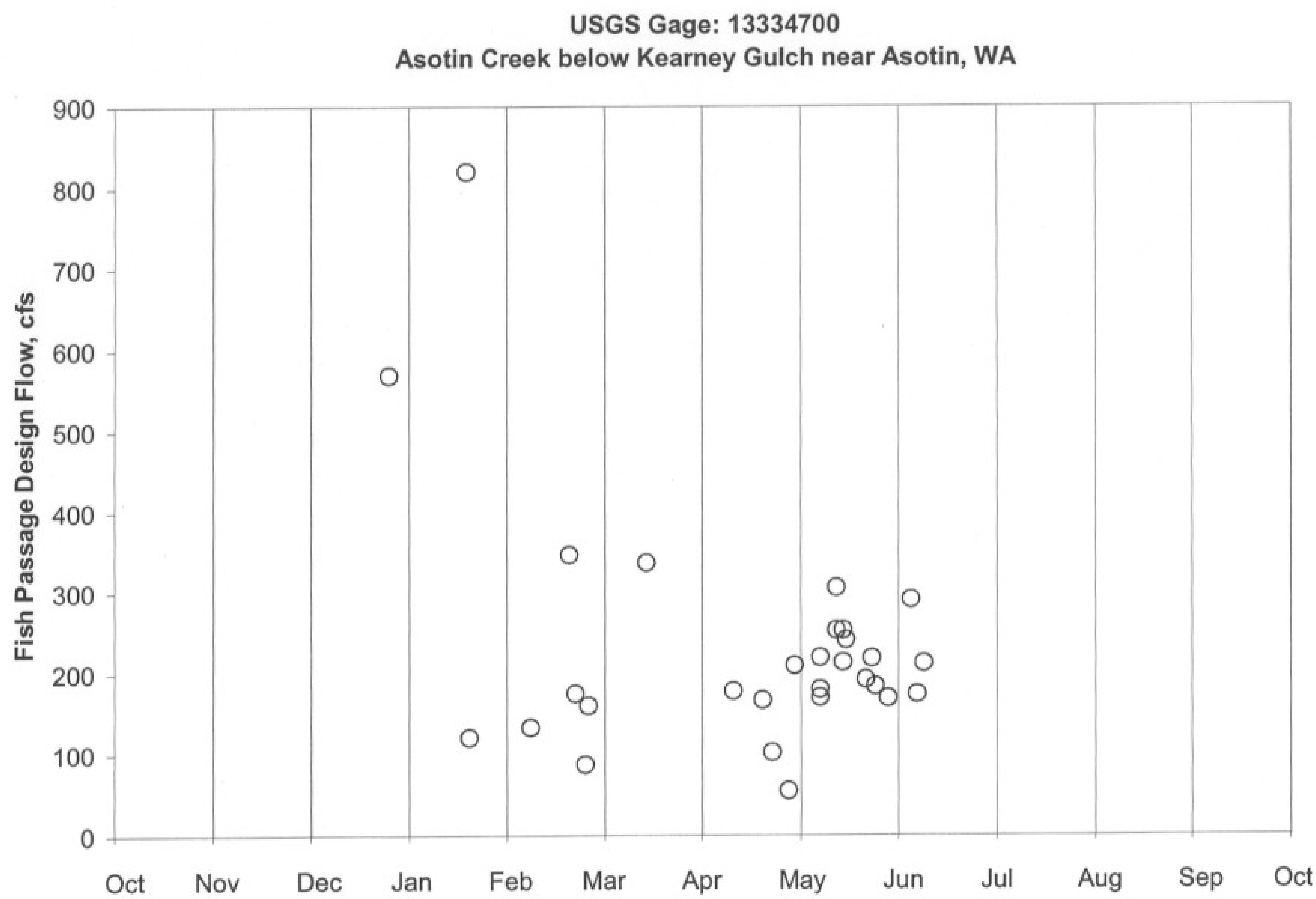

USGS Gage: 12506000
Toppenish Creek near Fort Simcoe, WA
Fish Passage Design Flow, cfs
1200
1000
800
600
400
200
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

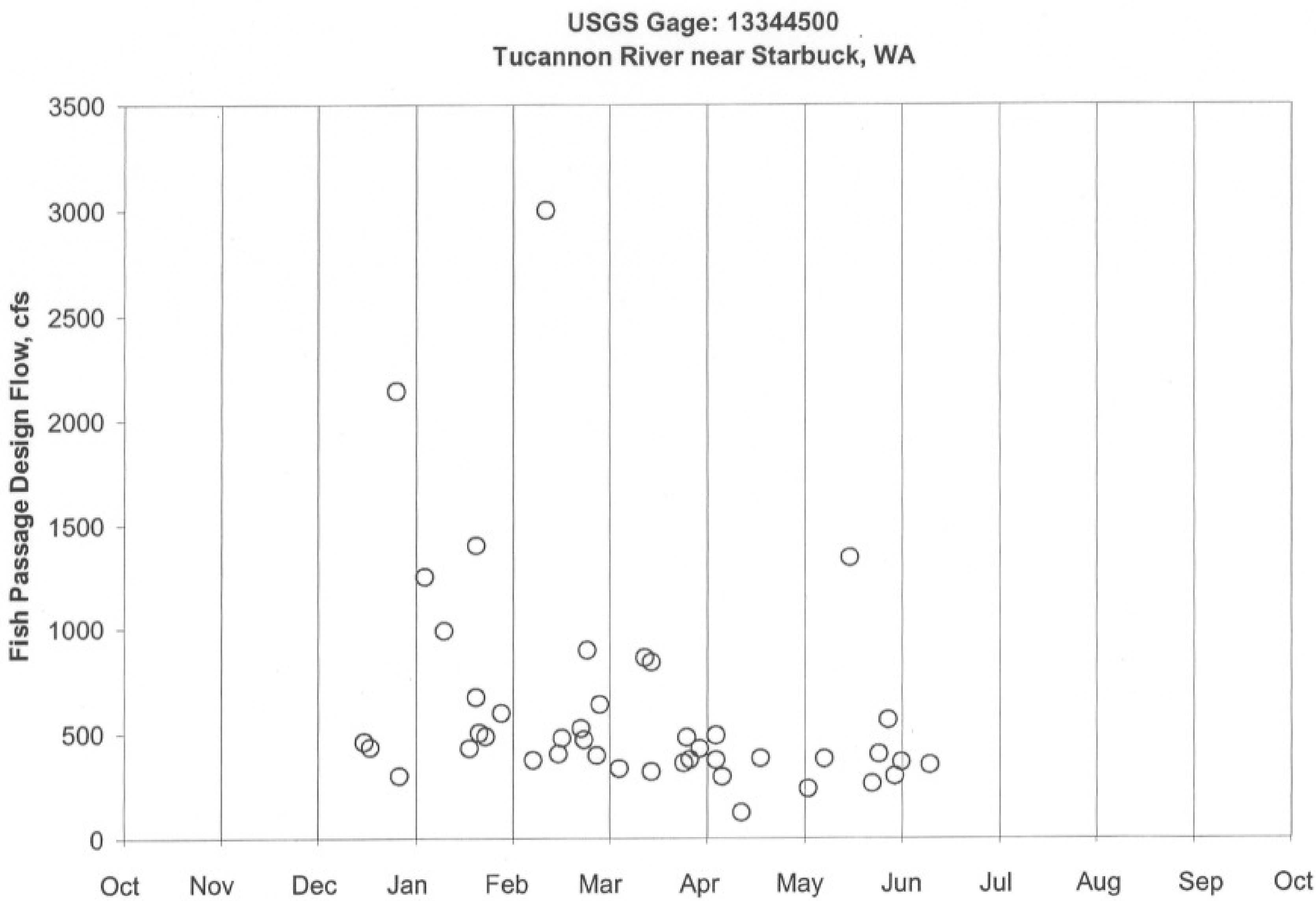


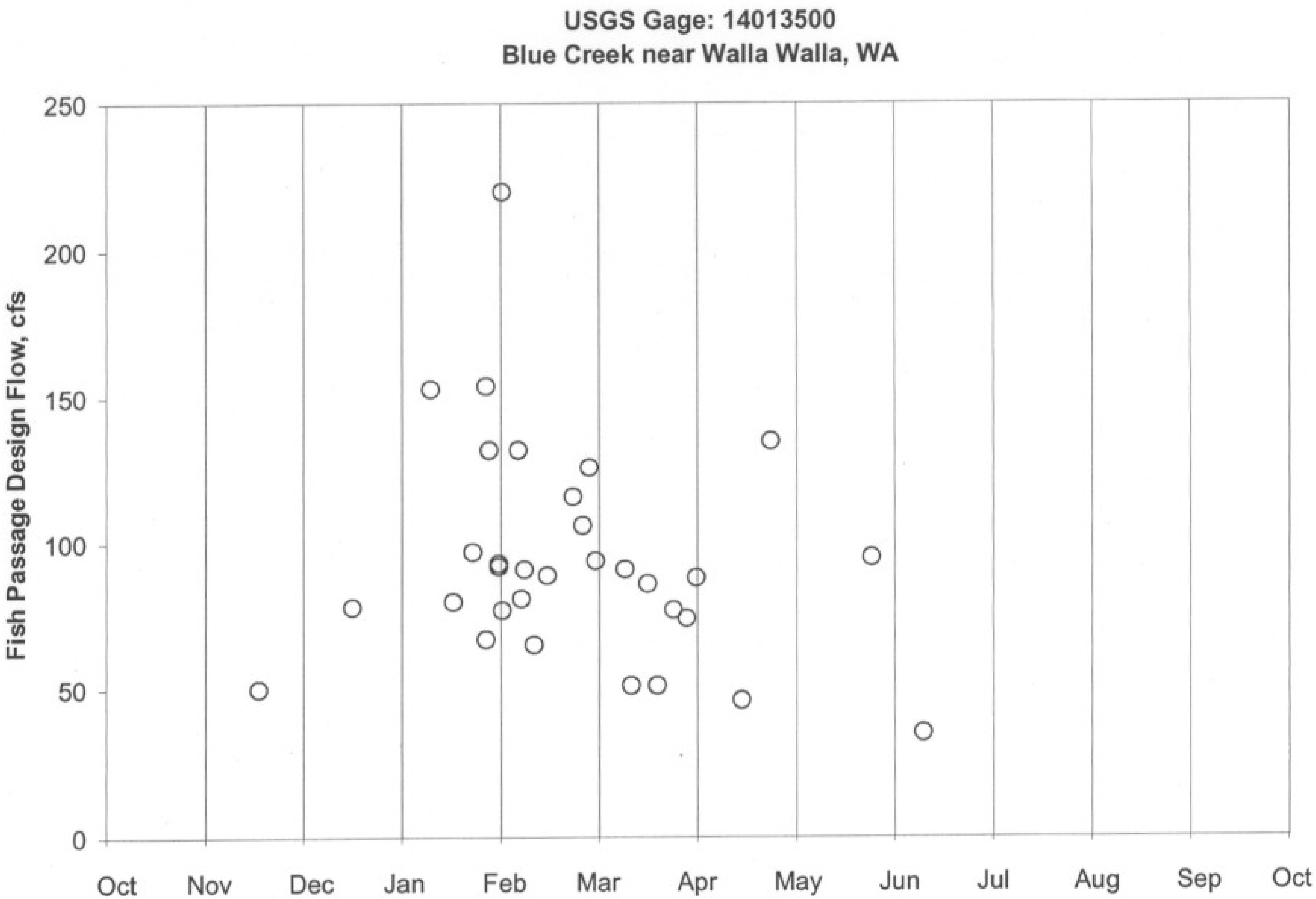
USGS Gage: 12506500
Simcoe Creek below Spring Creek near Fort Simcoe, WA
Fish Passage Design Flow, cfs
900
800
700
600
500
400
300
200
100
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

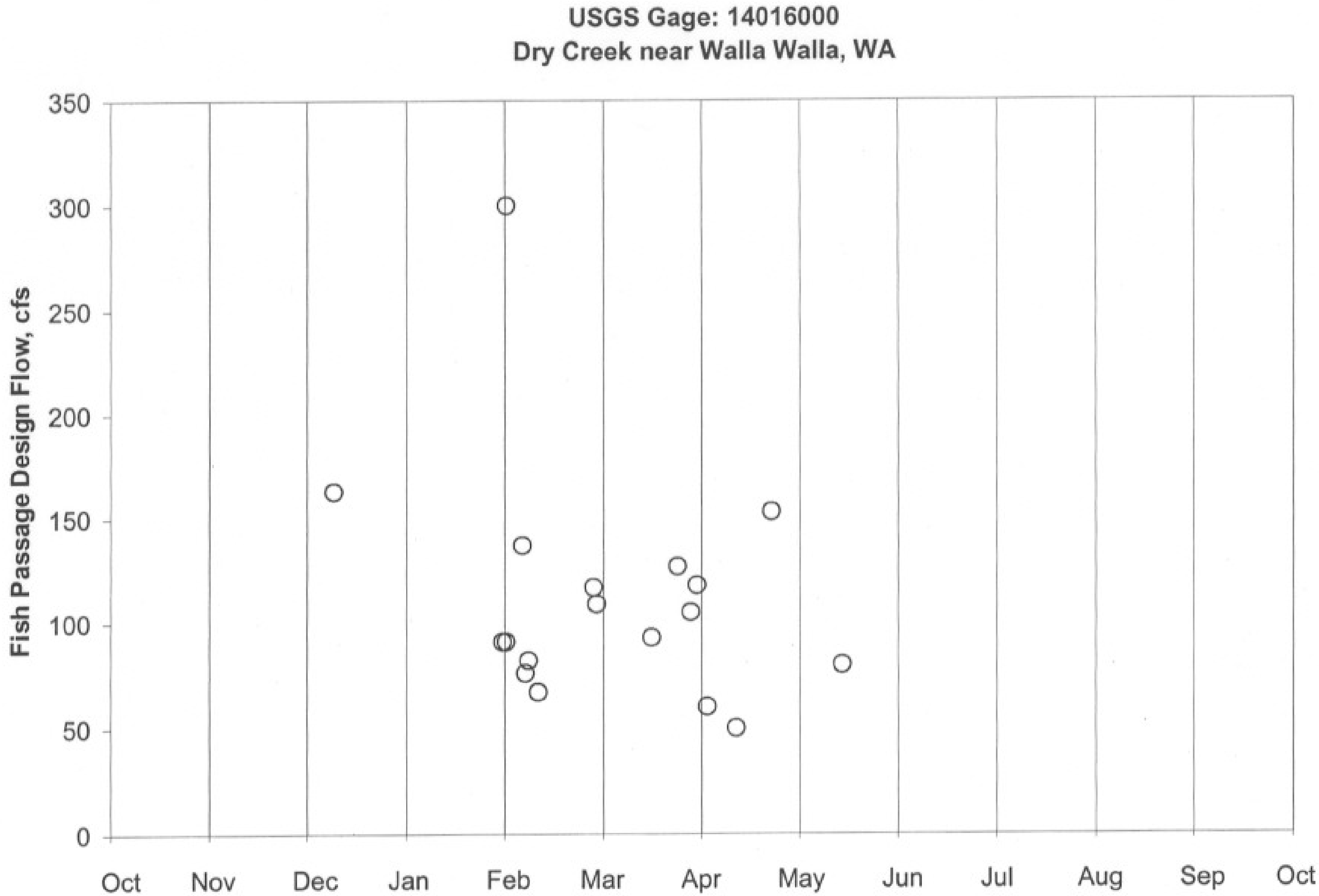
USGS Gage: 13334500
Asotin Creek near Asotin, WA



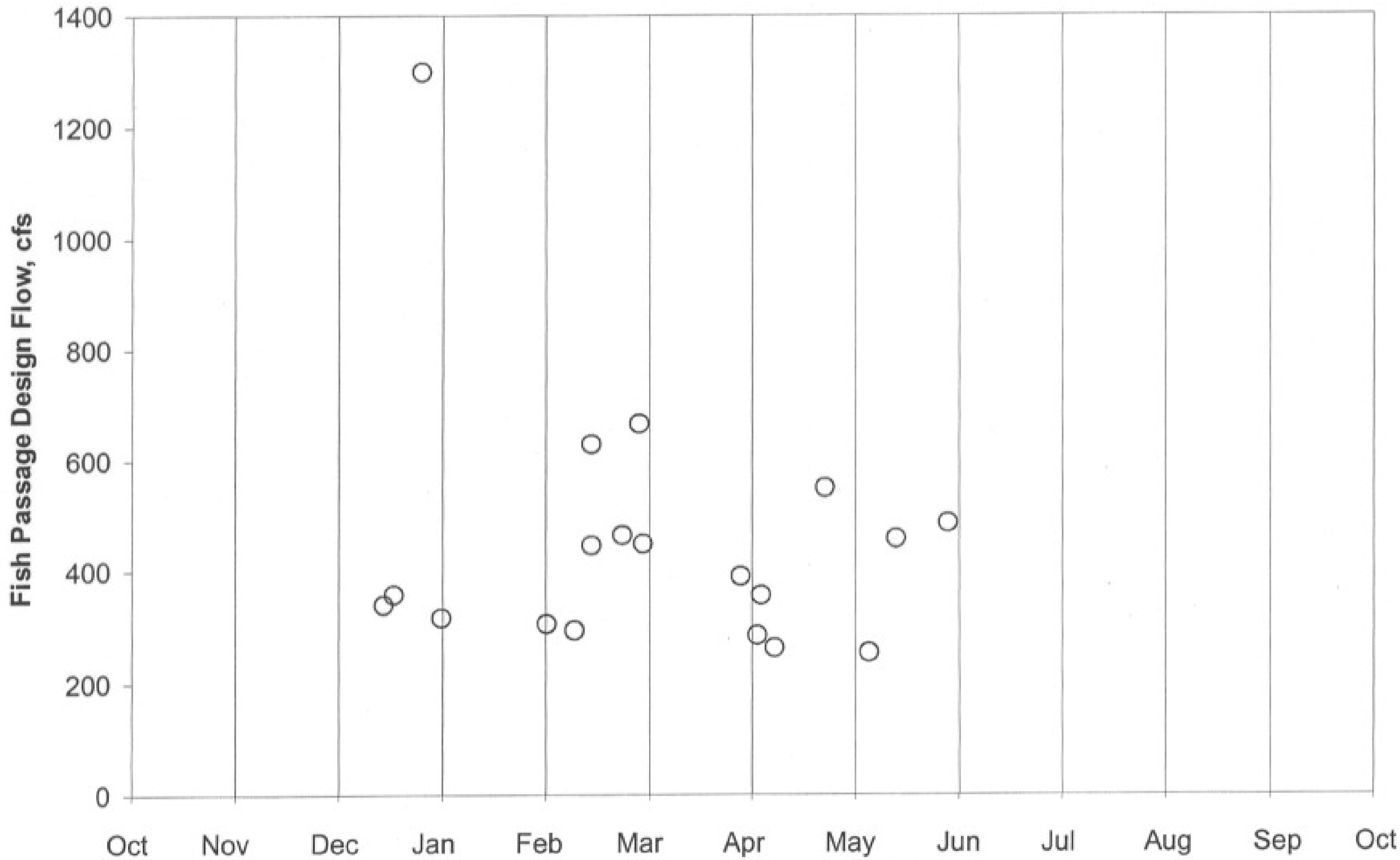

USGS Gage: 13334700
Asotin Creek below Kearney Gulch near Asotin, WA
Fish Passage Design Flow, cfs
0
100
200
300
400
500
600
700
800
900
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

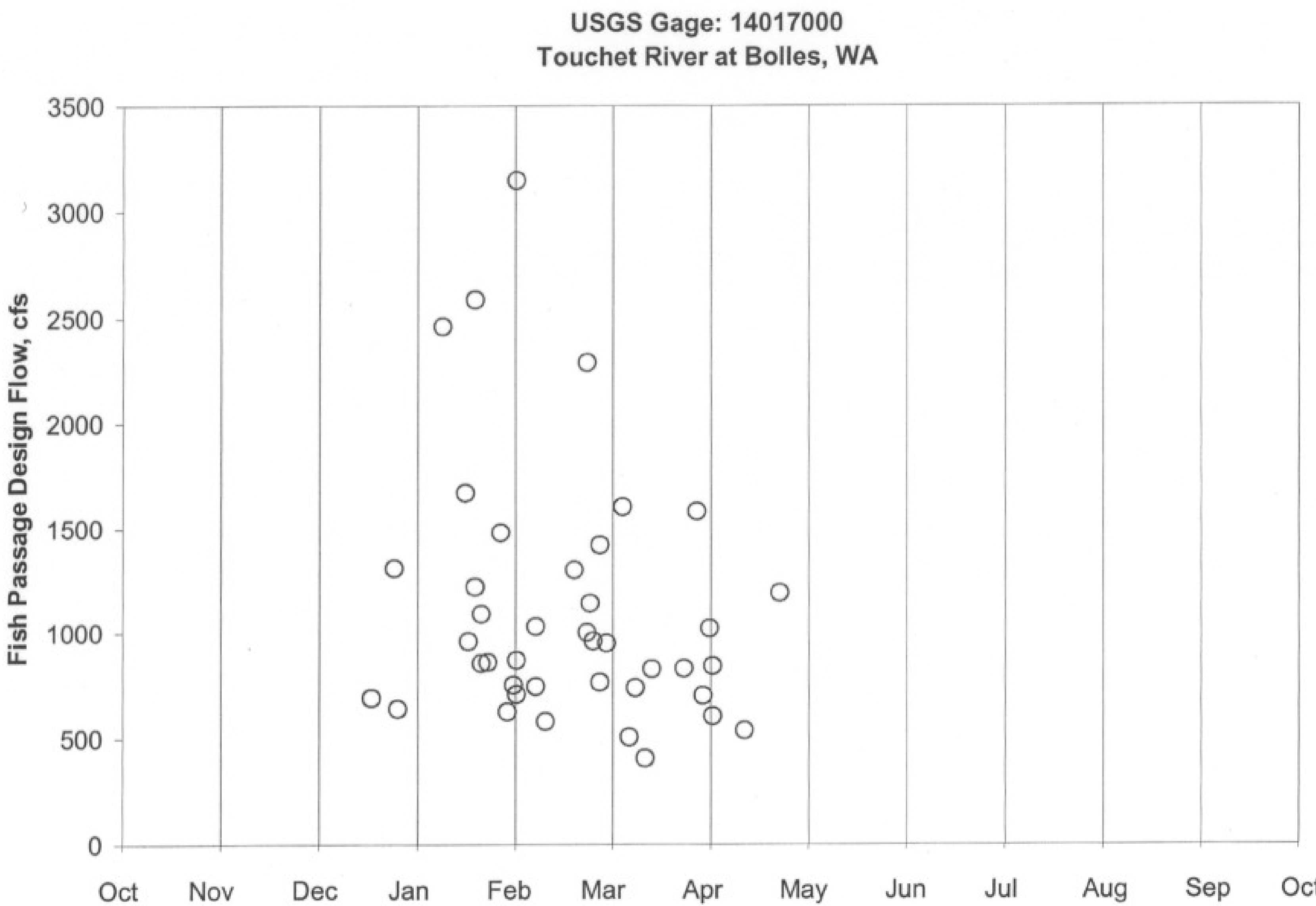

USGS Gage: 13344500
Tucannon River near Starbuck, WA
Fish Passage Design Flow, cfs
3500
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct


USGS Gage: 14013500
Blue Creek near Walla Walla, WA
Fish Passage Design Flow, cfs
250
200
150
100
50
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

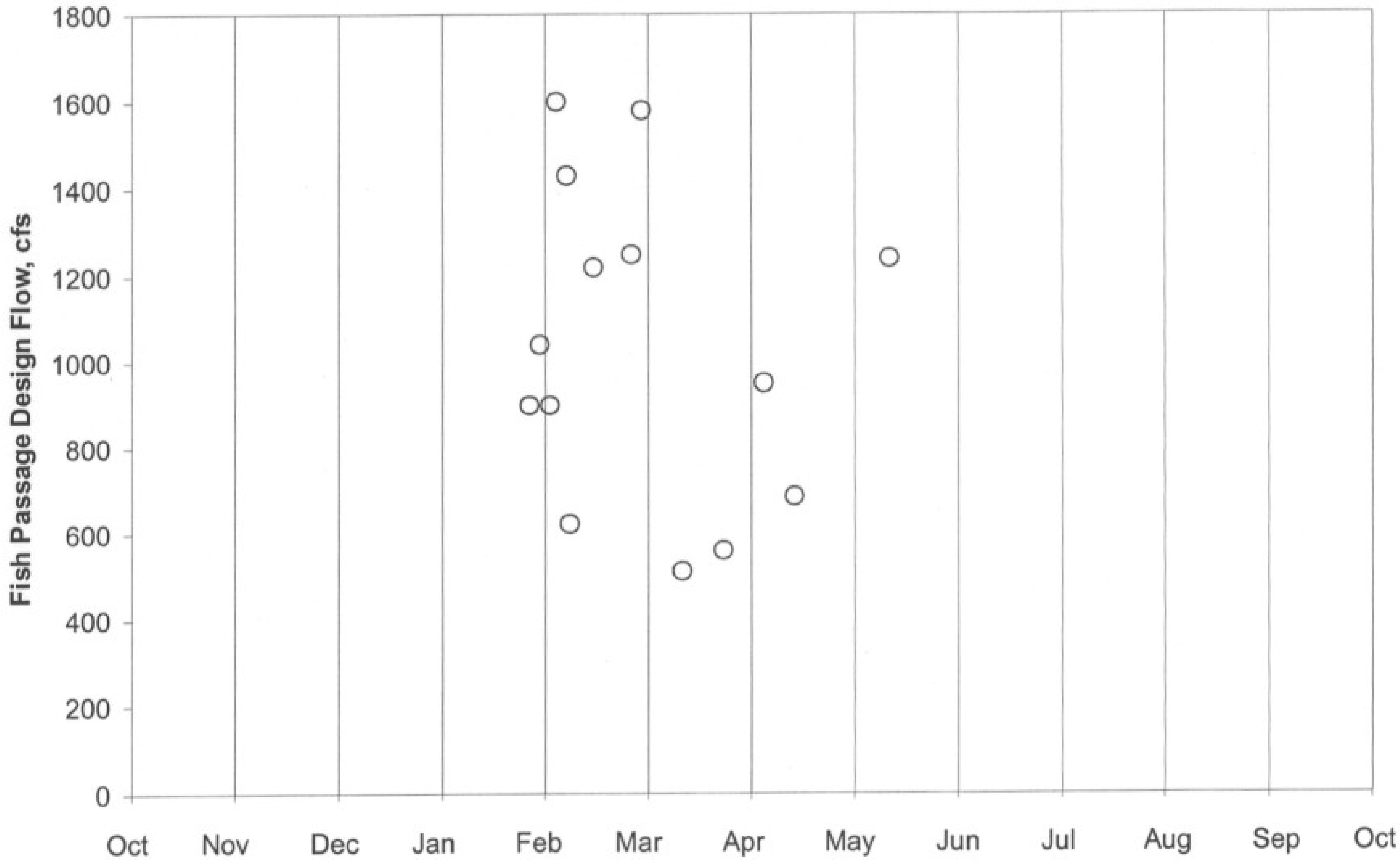

USGS Gage: 14016000
Dry Creek near Walla Walla, WA
Fish Passage Design Flow, cfs
350
300
250
200
150
100
50
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

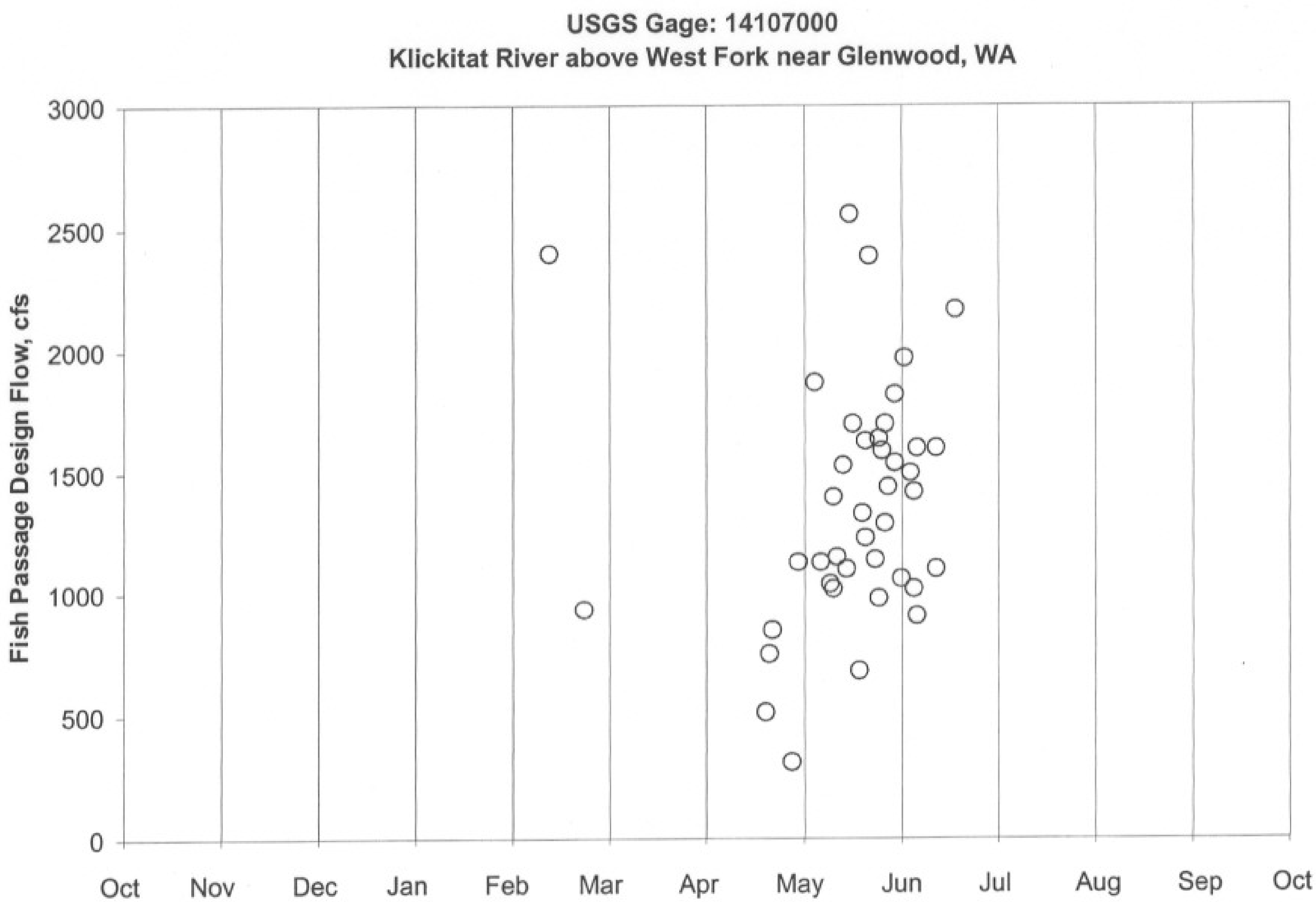
USGS Gage: 14016500
East Fork Touchet River near Dayton, WA



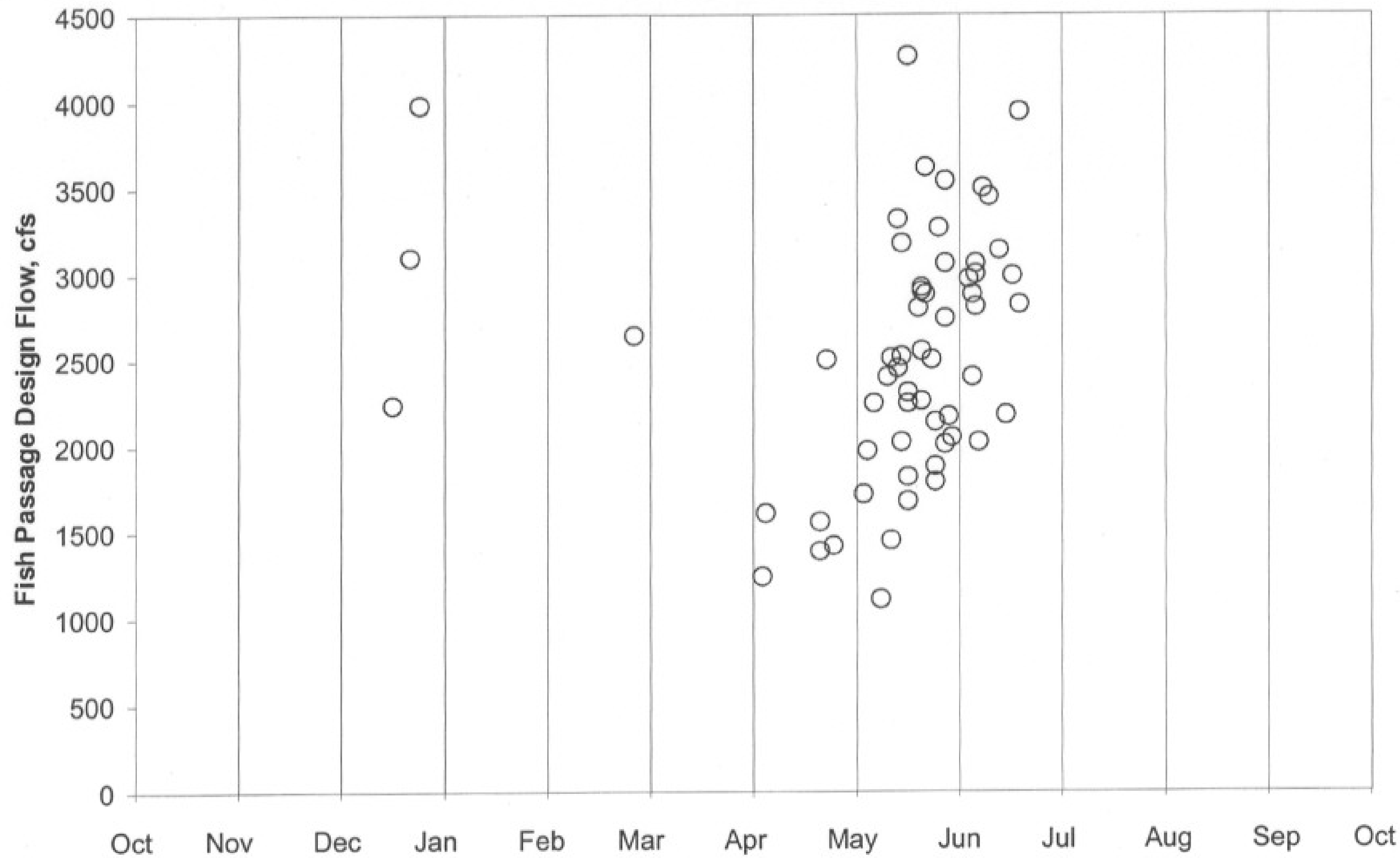

USGS Gage: 14017000
Touchet River at Bolles, WA
Fish Passage Design Flow, cfs
3500
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

USGS Gage: 14017500
Touchet River near Touchet, WA

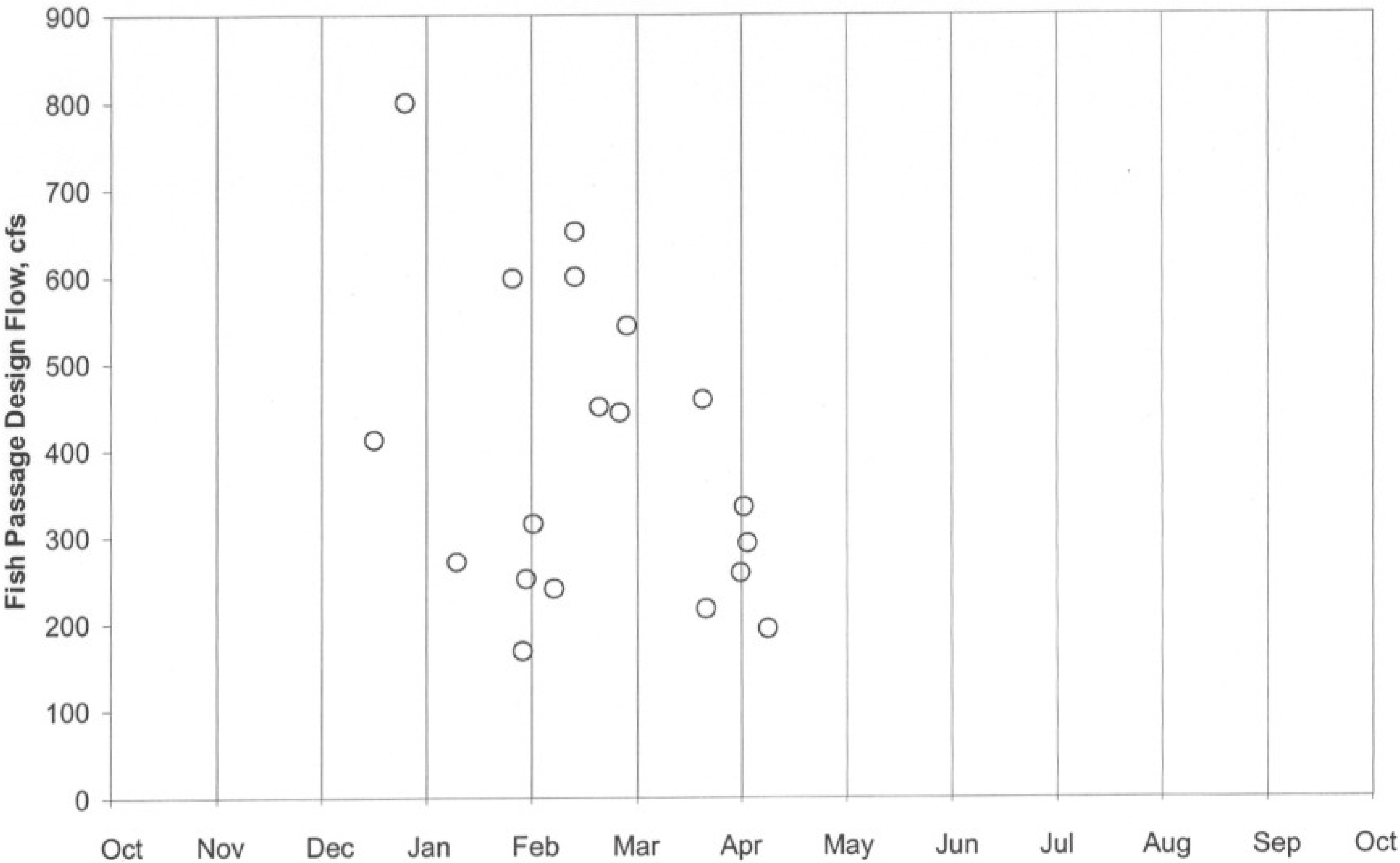


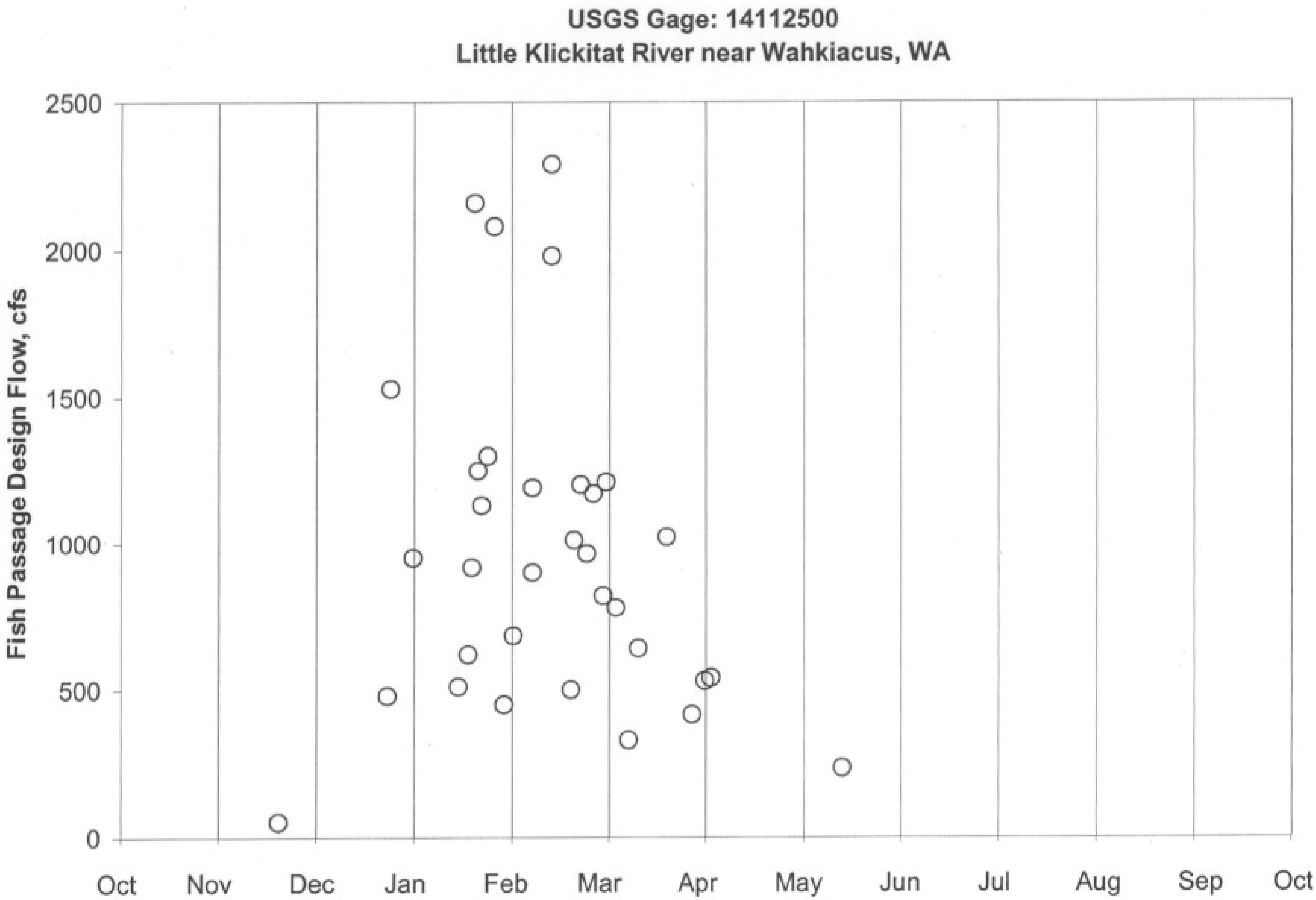

USGS Gage: 14107000
Klickitat River above West Fork near Glenwood, WA
Fish Passage Design Flow, cfs
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

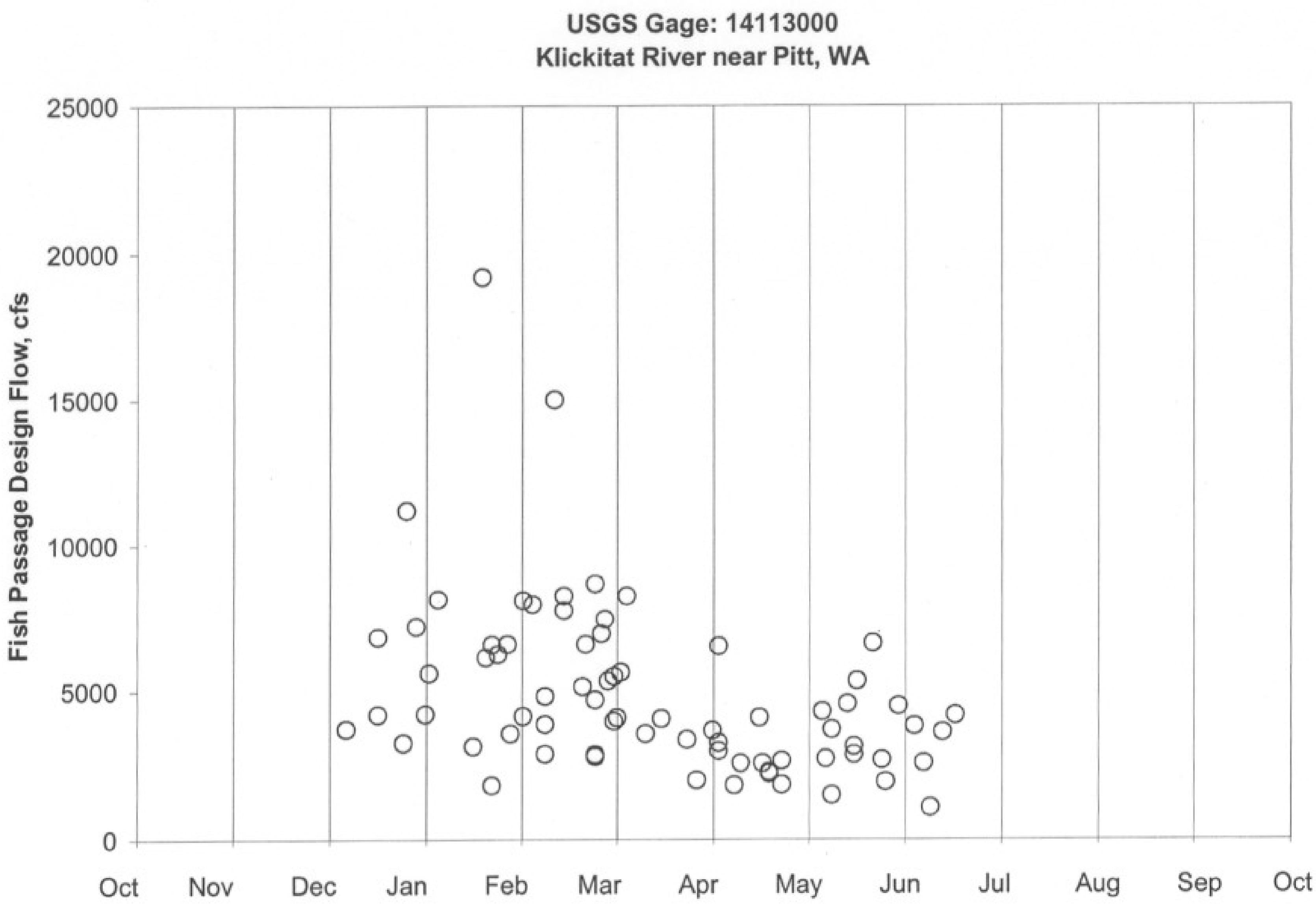
USGS Gage: 14110000
Klickitat River near Glenwood, WA



USGS Gage: 14112000
Little Klickitat River near Goldendale, WA

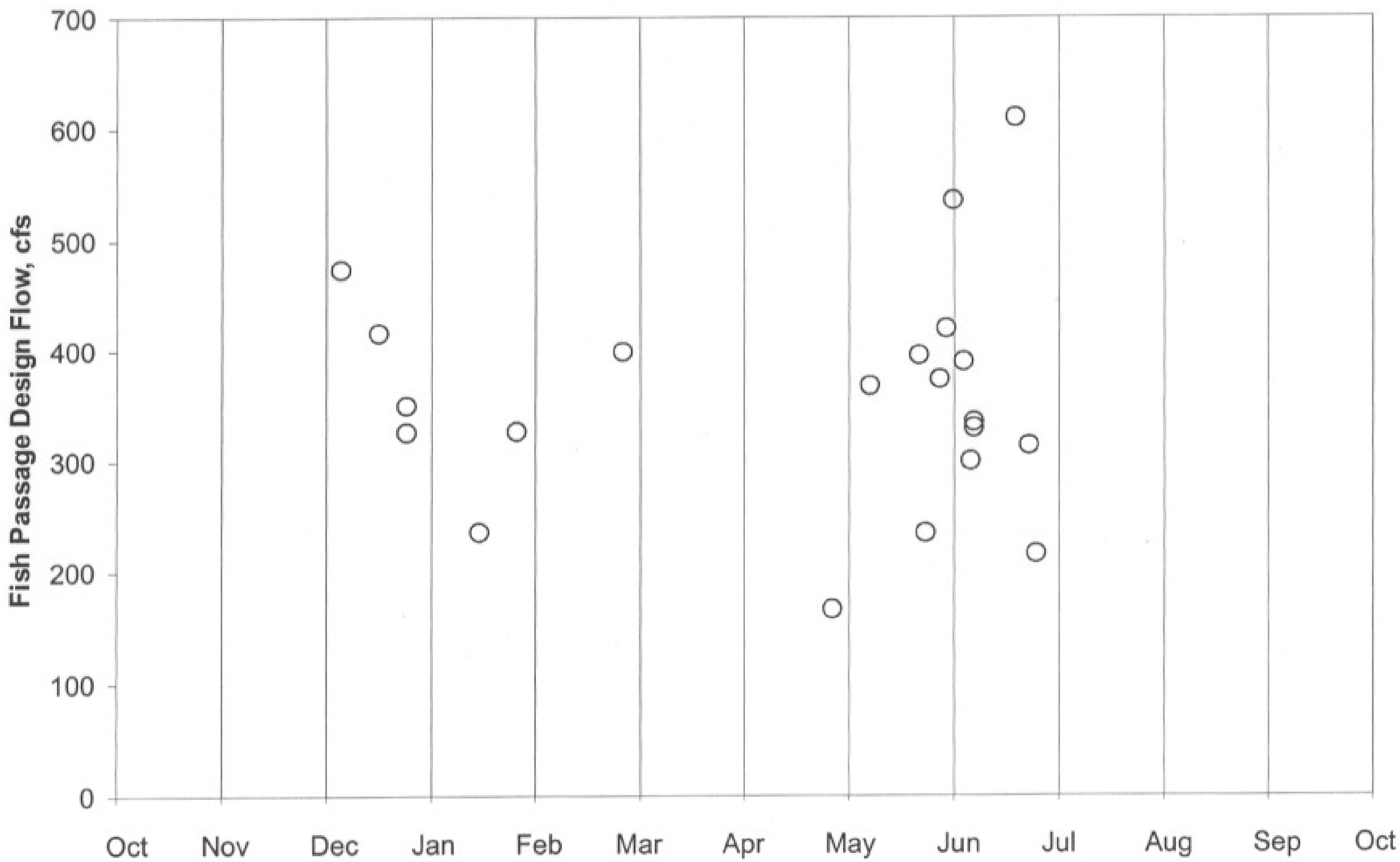


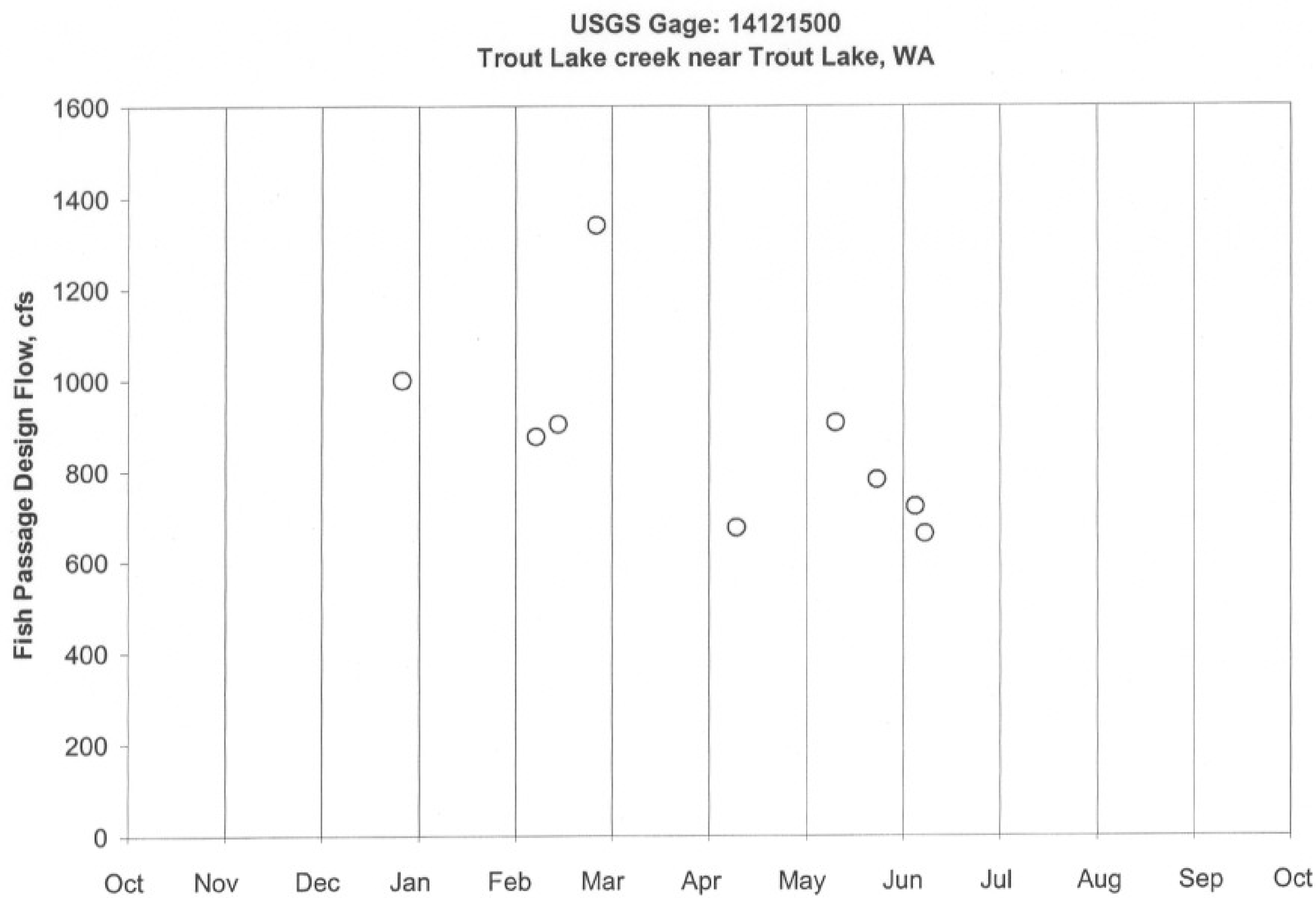

USGS Gage: 14112500
Little Klickitat River near Wahkiacus, WA
Fish Passage Design Flow, cfs
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

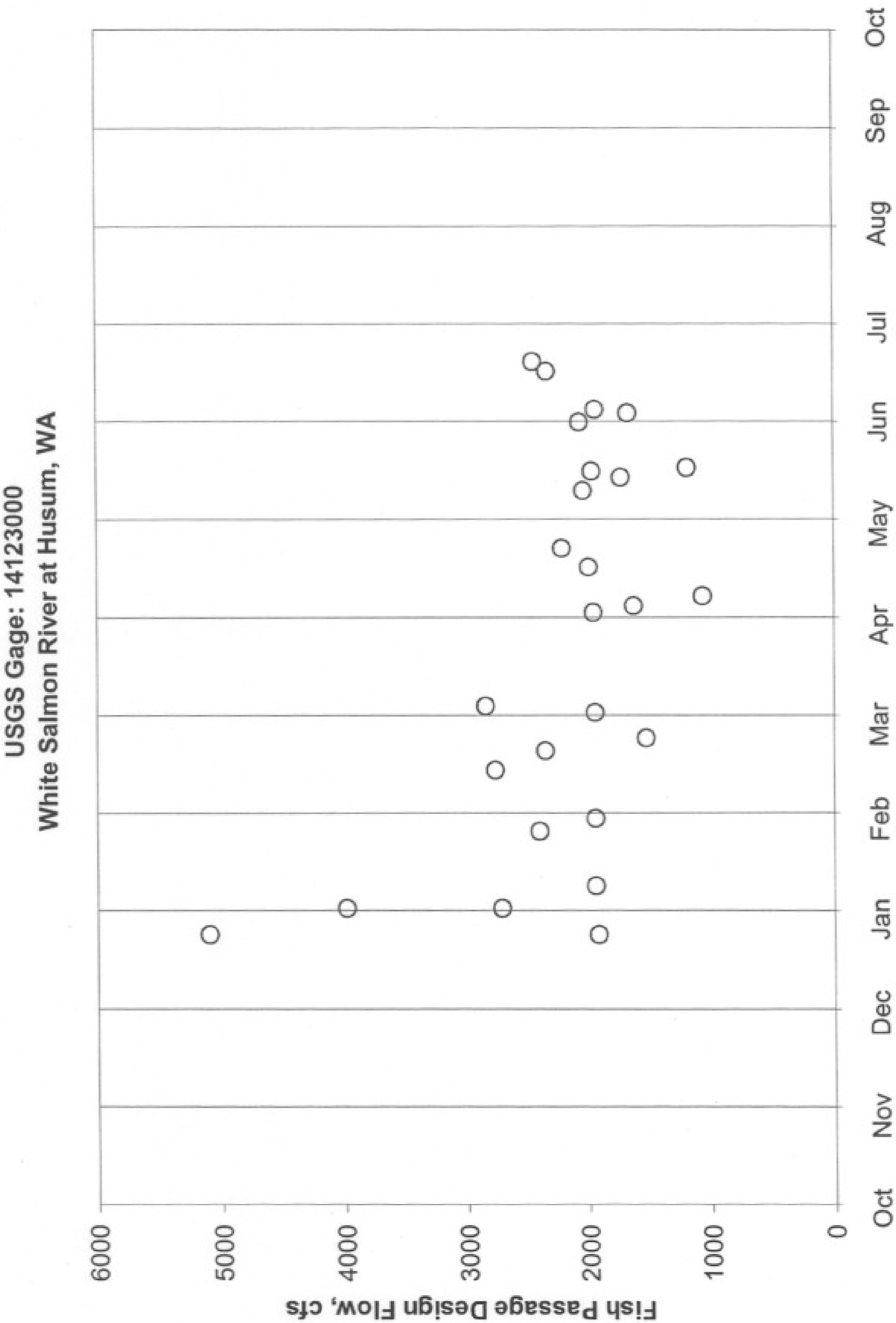


USGS Gage: 14113000
Klickitat River near Pitt, WA
Fish Passage Design Flow, cfs
25000
20000
15000
10000
5000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

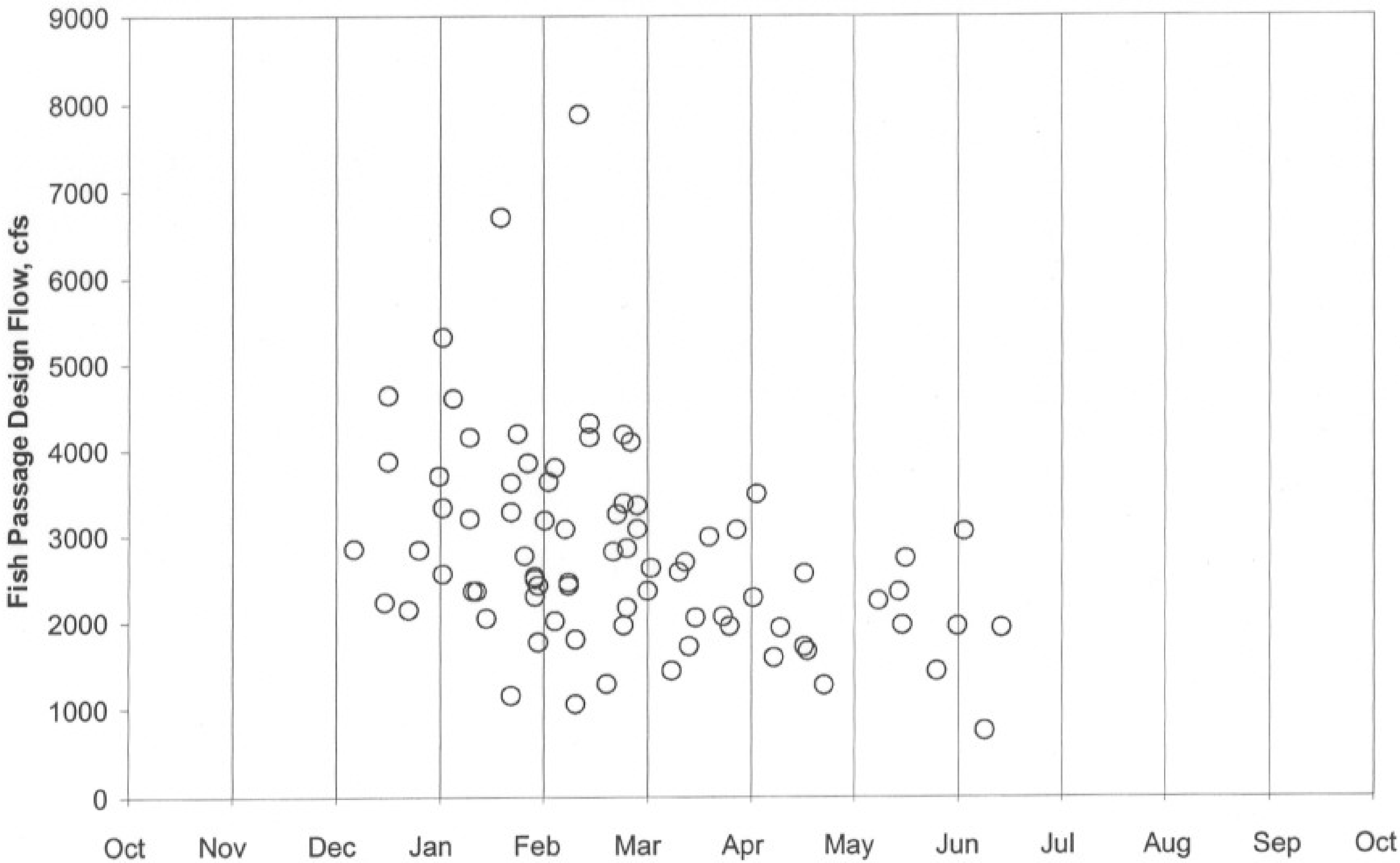
USGS Gage: 14121300
White Salmon River below Cascades Creek near Trout Lake, WA



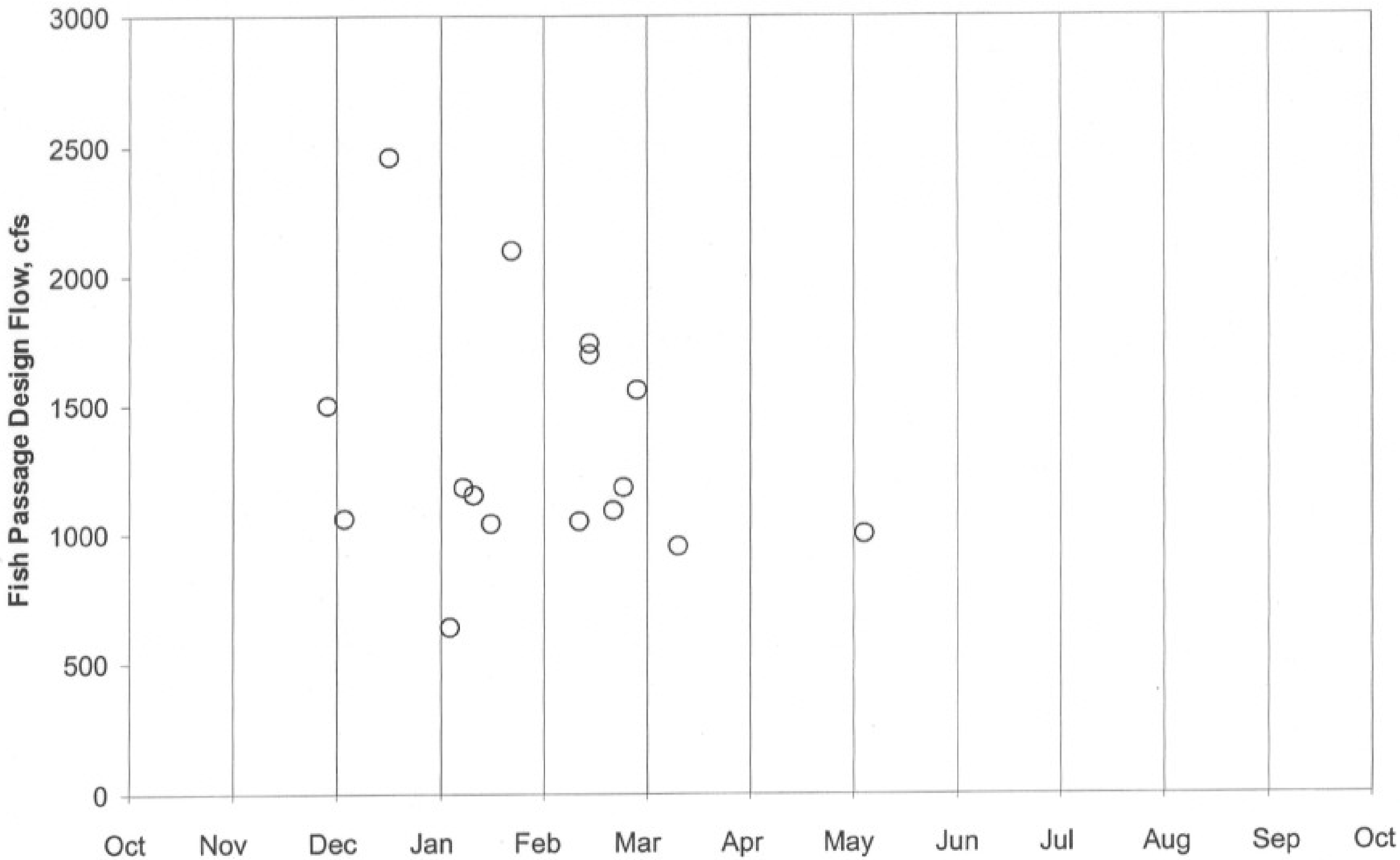

USGS Gage: 14121500
Trout Lake creek near Trout Lake, WA
Fish Passage Design Flow, cfs
1600
1400
1200
1000
800
600
400
200
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

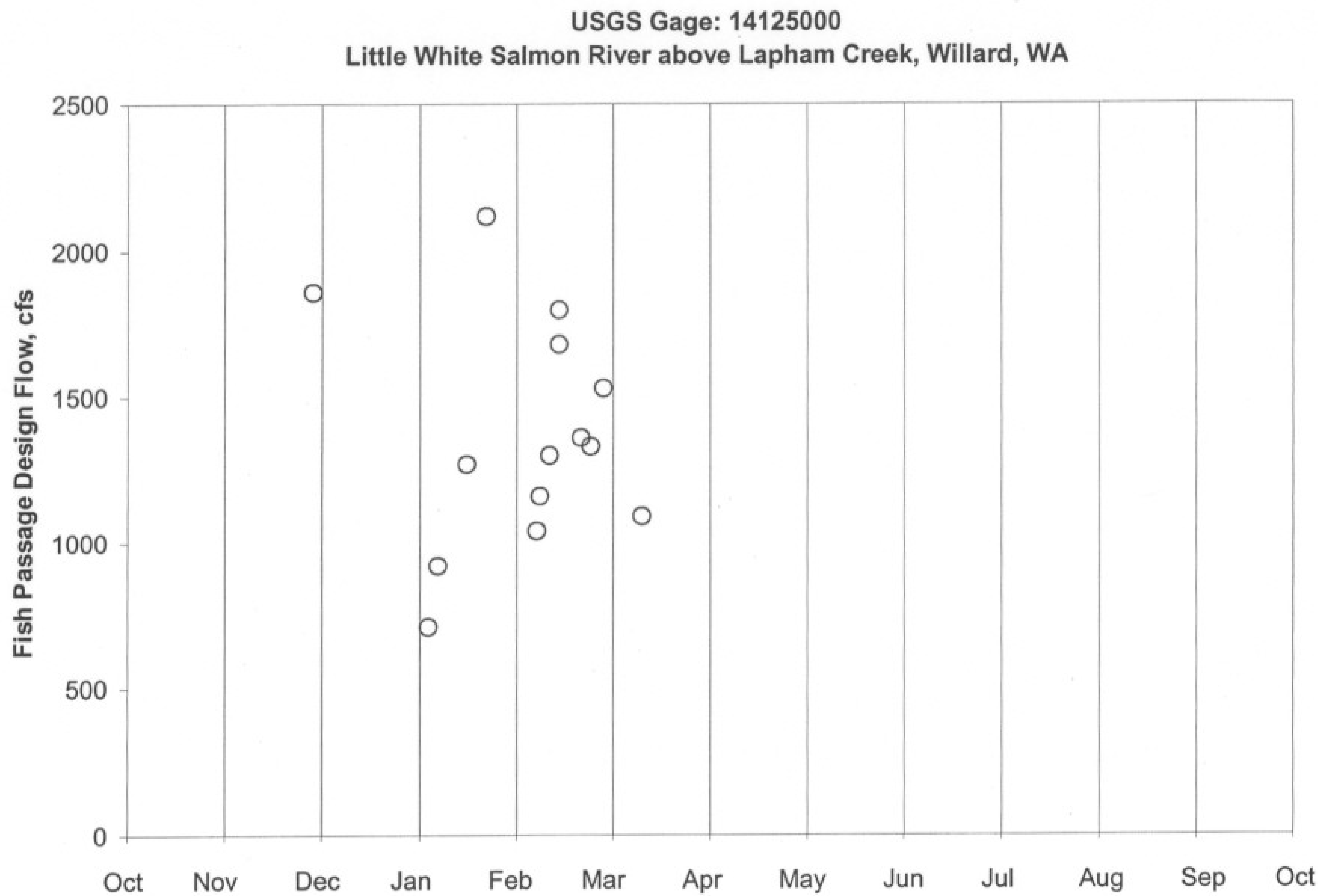

USGS Gage: 14123000
White Salmon River at Husum, WA
Fish Passage Design Flow, cfs
6000
5000
4000
3000
2000
1000
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

USGS Gage: 14123500
White Salmon River near Underwood, WA

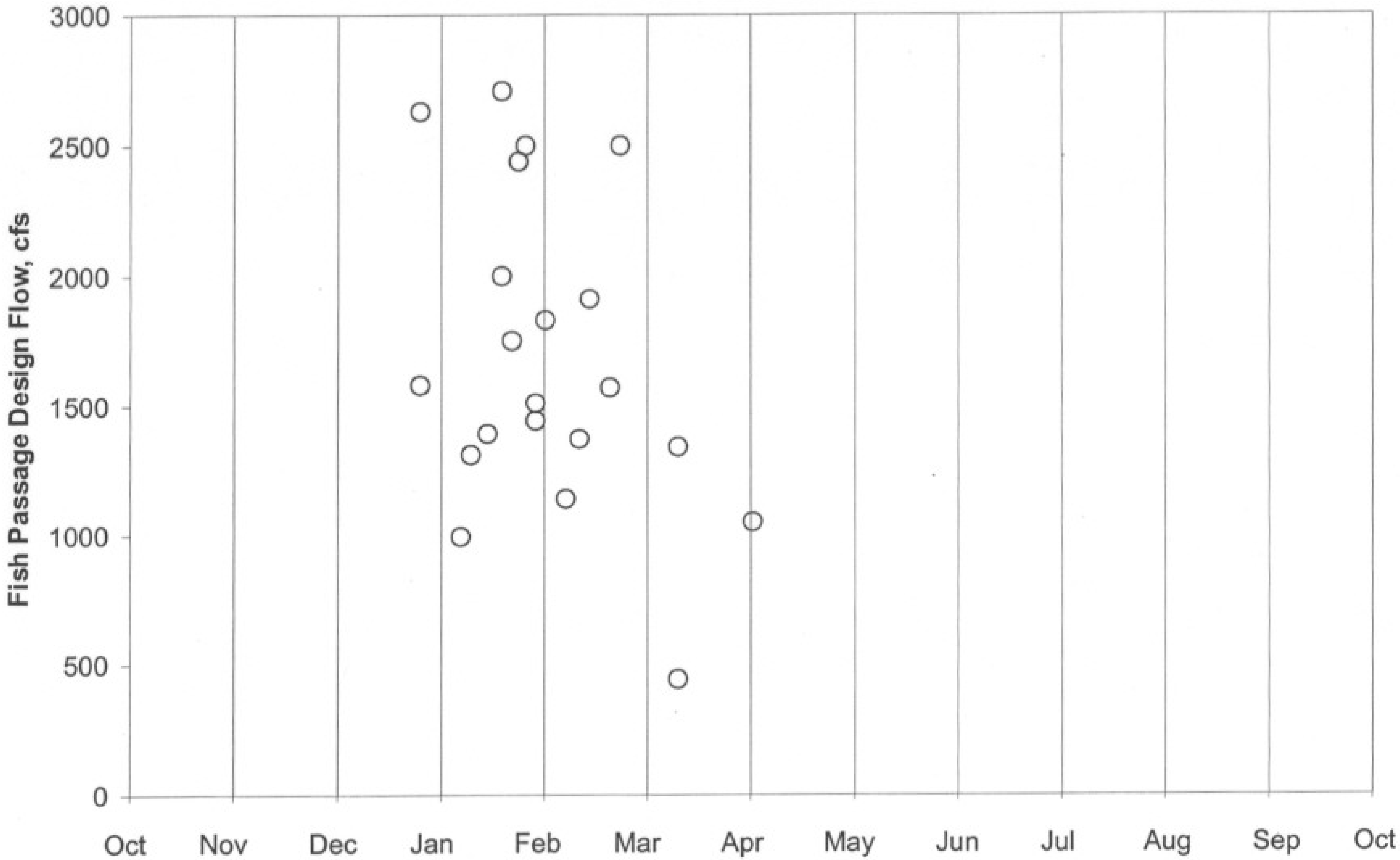


USGS Gage: 14124500
Little White Salmon River at Willard , WA

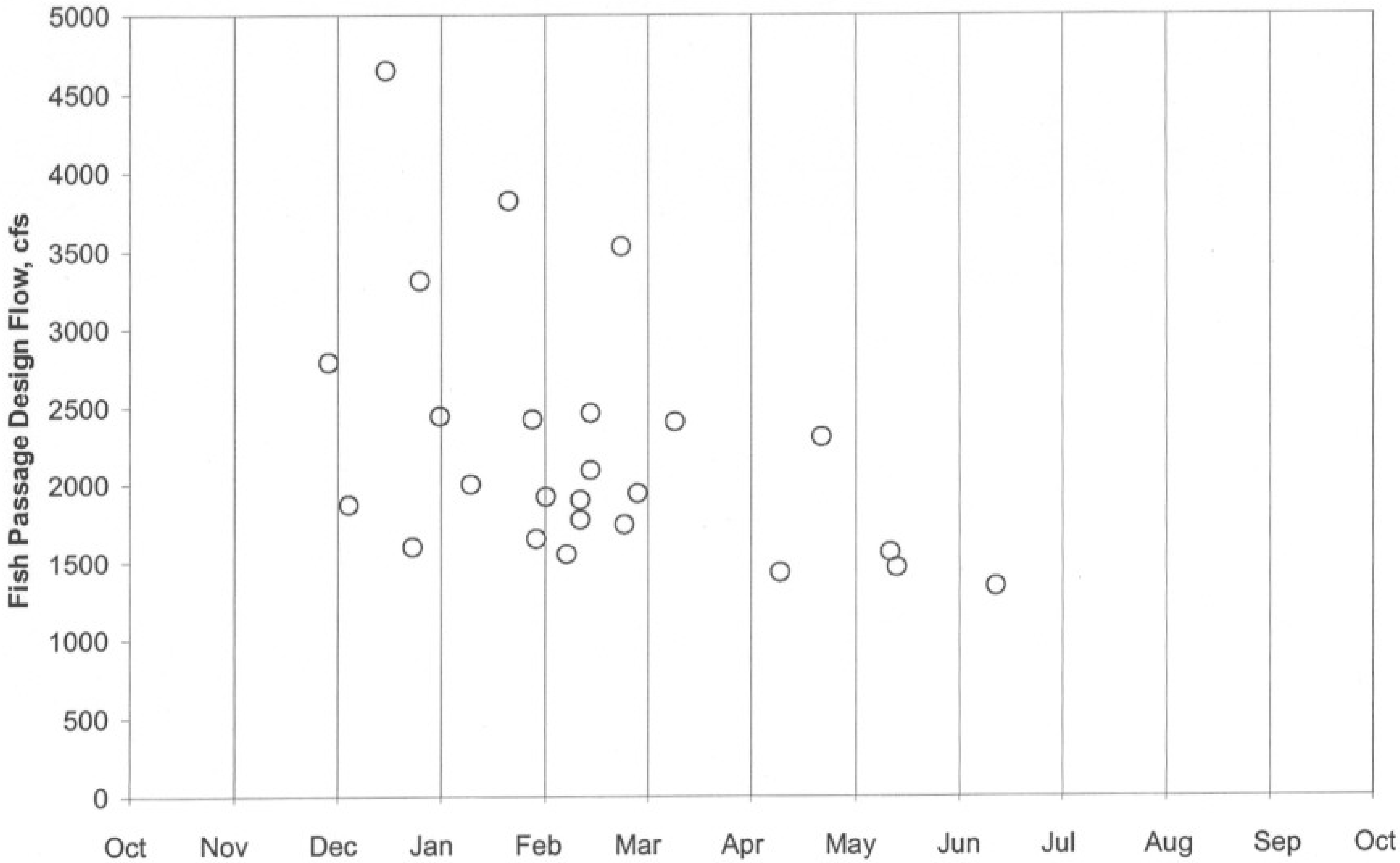



USGS Gage: 14125000
Little White Salmon River above Lapham Creek, Willard, WA
Fish Passage Design Flow, cfs
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct

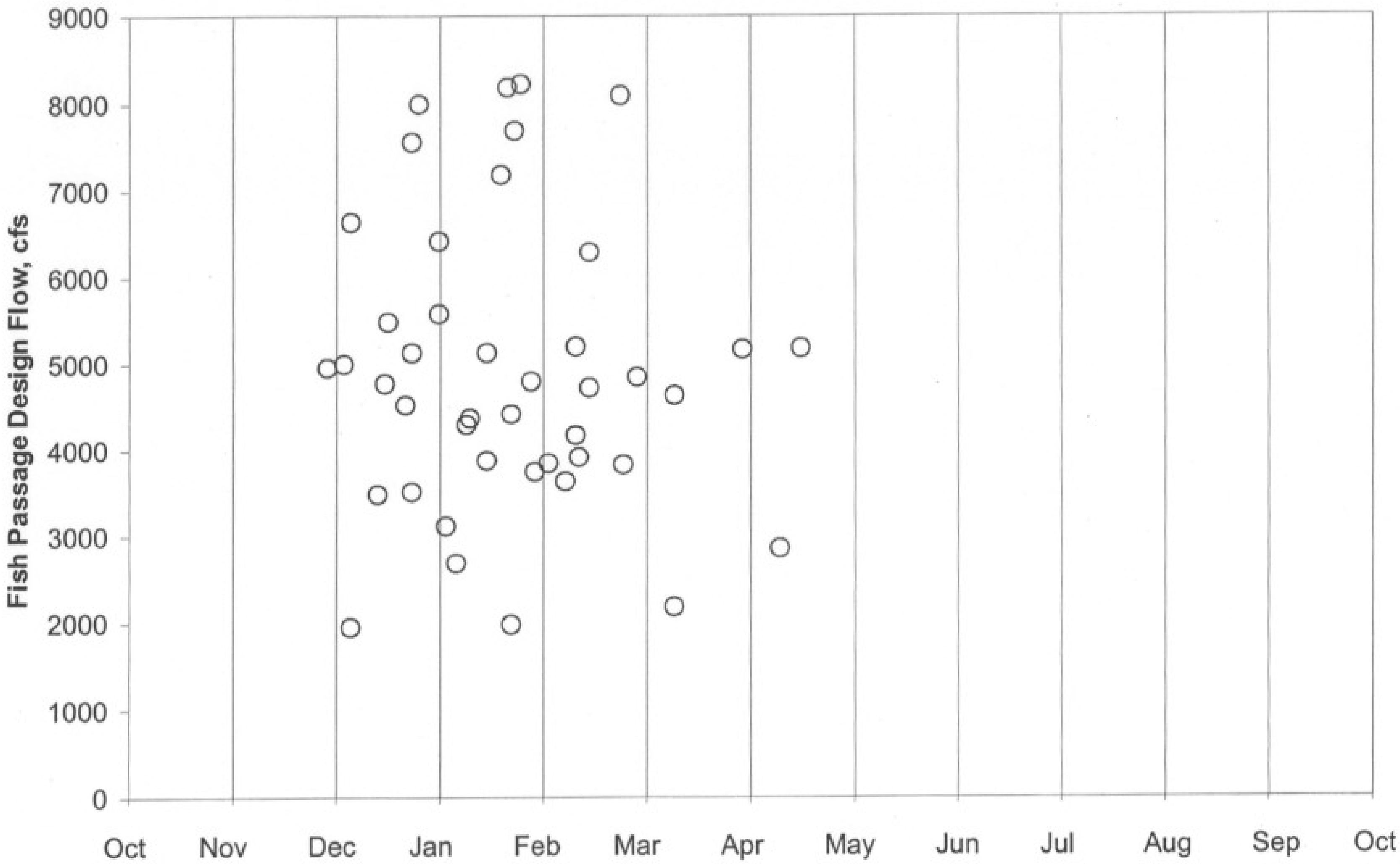
USGS Gage: 14125500
Little White Salmon River near Cook, WA



USGS Gage: 14127000
Wind River above Trout Creek near Carson, WA



USGS Gage: 14128500
Wind River near Carson, WA



APPENDIX D

DESIGN EXAMPLE

DESIGN EXAMPLE

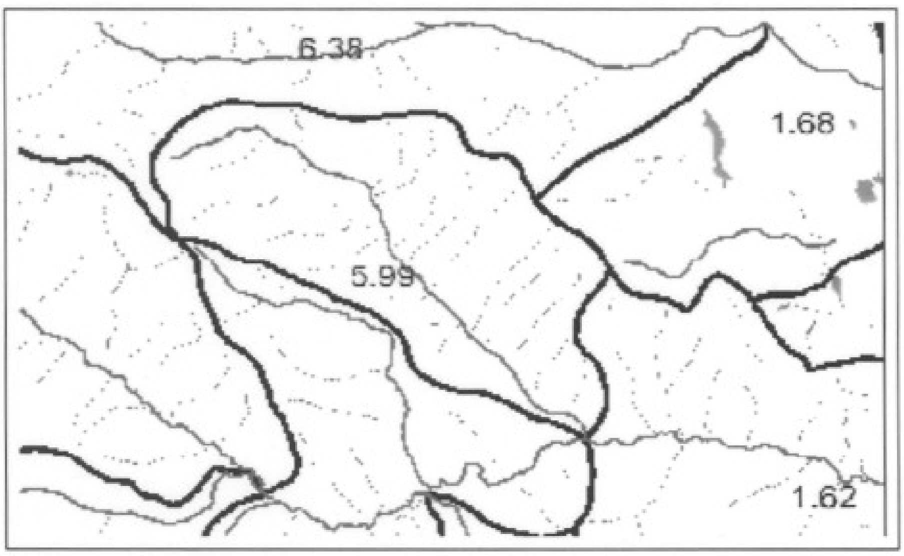
Appendix D provides a detailed design example for determining the fish passage design flow at an ungaged site.

Design Example: Little Bridge Creek (Tributary of Twisp River)

1.) Locate stream and design site on 1 : 250,000 Quadrangle

2.) Calculate area of watershed upstream of site **Watershed Area = 15.25 mi^2**

3.) Locate 6th Field HUC and stream on appropriate Fish Passage Design Flow Map



4.) Multiply 6th Field HUC factor $\left(\frac{Q_{FP4}}{\text{Area}}\right)$ with watershed area

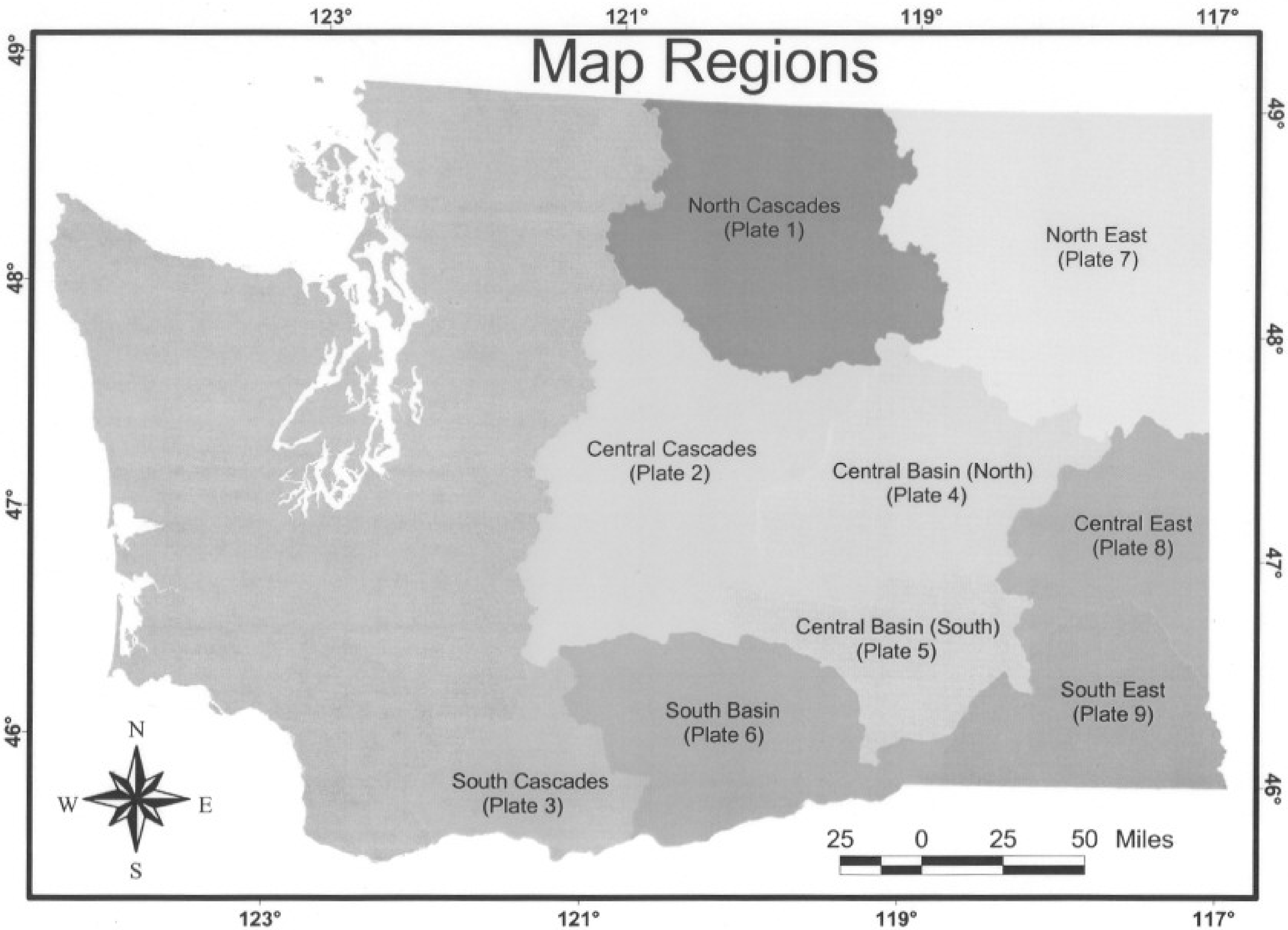
$$Q_{FP4} = \left(5.99\frac{\text{cfs}}{\text{mi}^2}\right)\cdot\left(15.25\text{mi}^2\right) \Rightarrow \mathbf{Q_{FP4} = 91.4\ cfs}$$

APPENDIX E

DESIGN FLOW MAPS

DESIGN FLOW MAPS

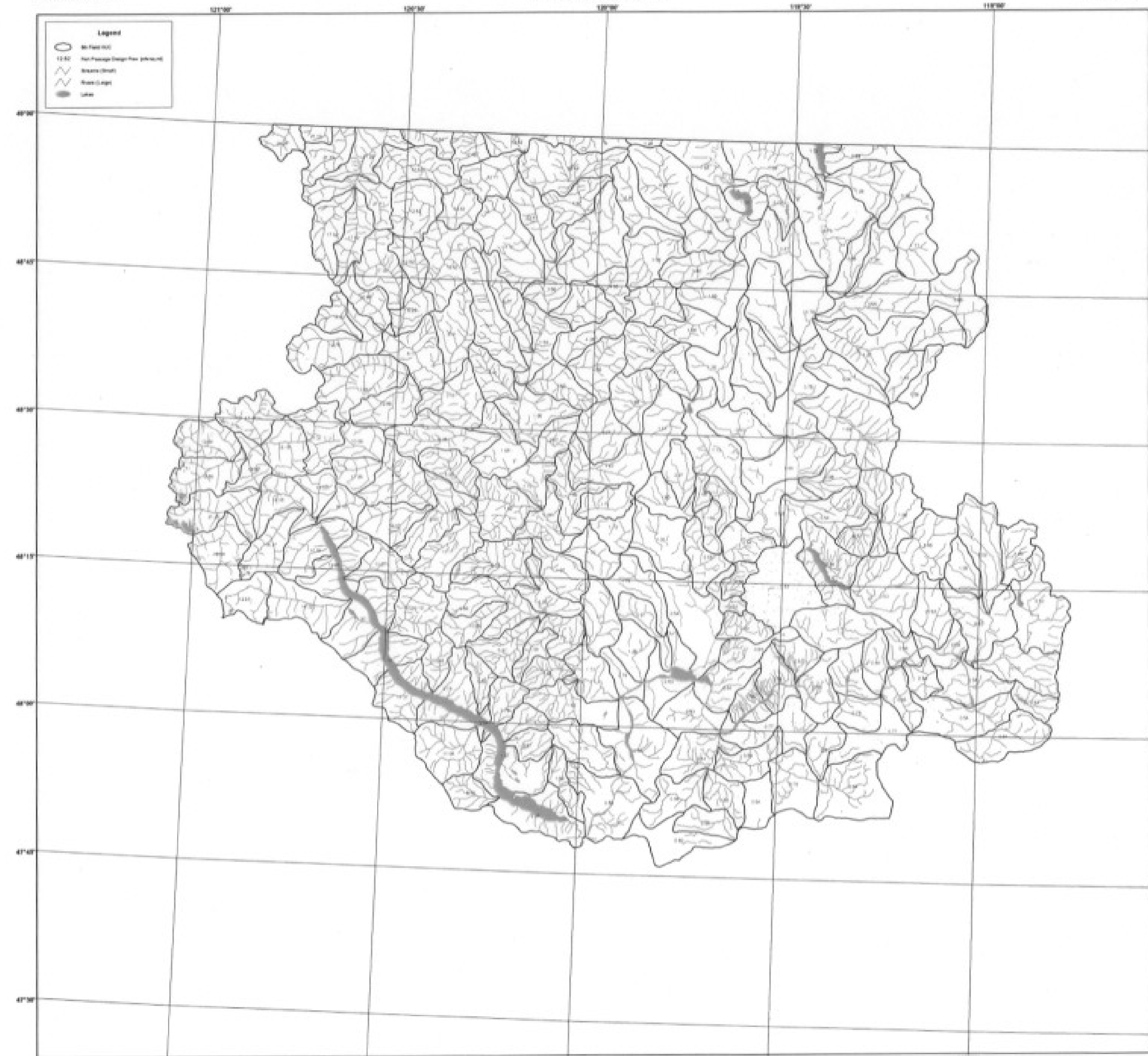
Appendix E provides the design flow maps needed for estimating Q_{FP4} at an ungaged site. These maps are provided on (Disk 1) in "PDF" format at a 1:250,000 scale. A reference map is provided to aid in choosing the appropriate design map.


Map Regions
North Cascades
(Plate 1)
Central Cascades
(Plate 2)
South Cascades
(Plate 3)
Central Basin (North)
(Plate 4)
Central Basin (South)
(Plate 5)
South Basin
(Plate 6)
North East
(Plate 7)
Central East
(Plate 8)
South East
(Plate 9)
123°
121°
119°
117°
49°
48°
47°
46°
N
S
E
W
25 0 25 50 Miles

Albrook Hydraulics Laboratory
Washington State University

Prepared in cooperation with
Washington State Department of Transportation

Plate 1 - Fish Passage Design Flows
North Cascades Region



Fish Passage Design Flows for Eastern Washington

By

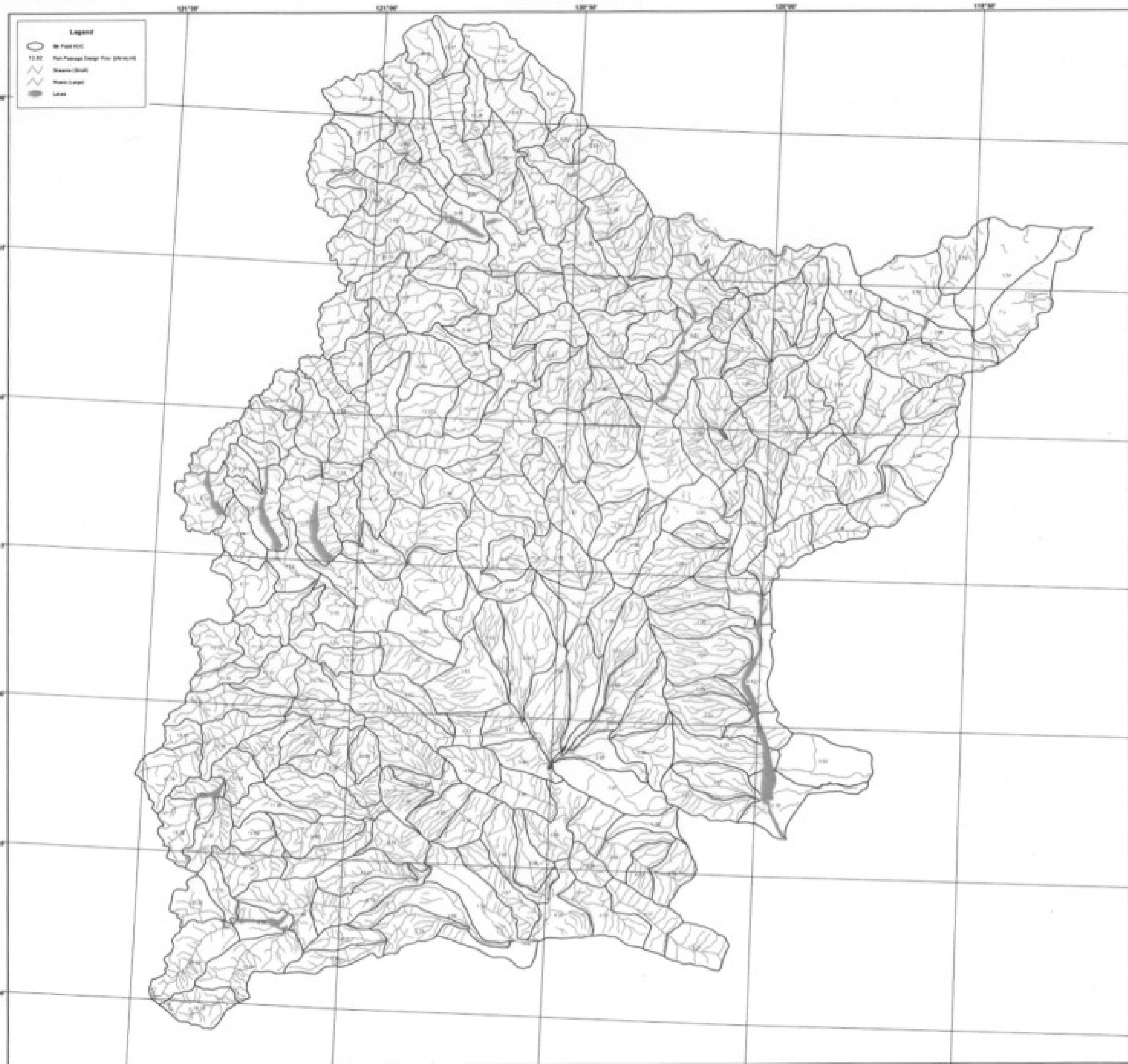
E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou

2001

Albrook Hydraulics Laboratory
Washington State University

Prepared in cooperation with
Washington State Department of Transportation

Plate 2 - Fish Passage Design Flows
Central Cascades Region



Fish Passage Design Flows for Eastern Washington

By
E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou
2001

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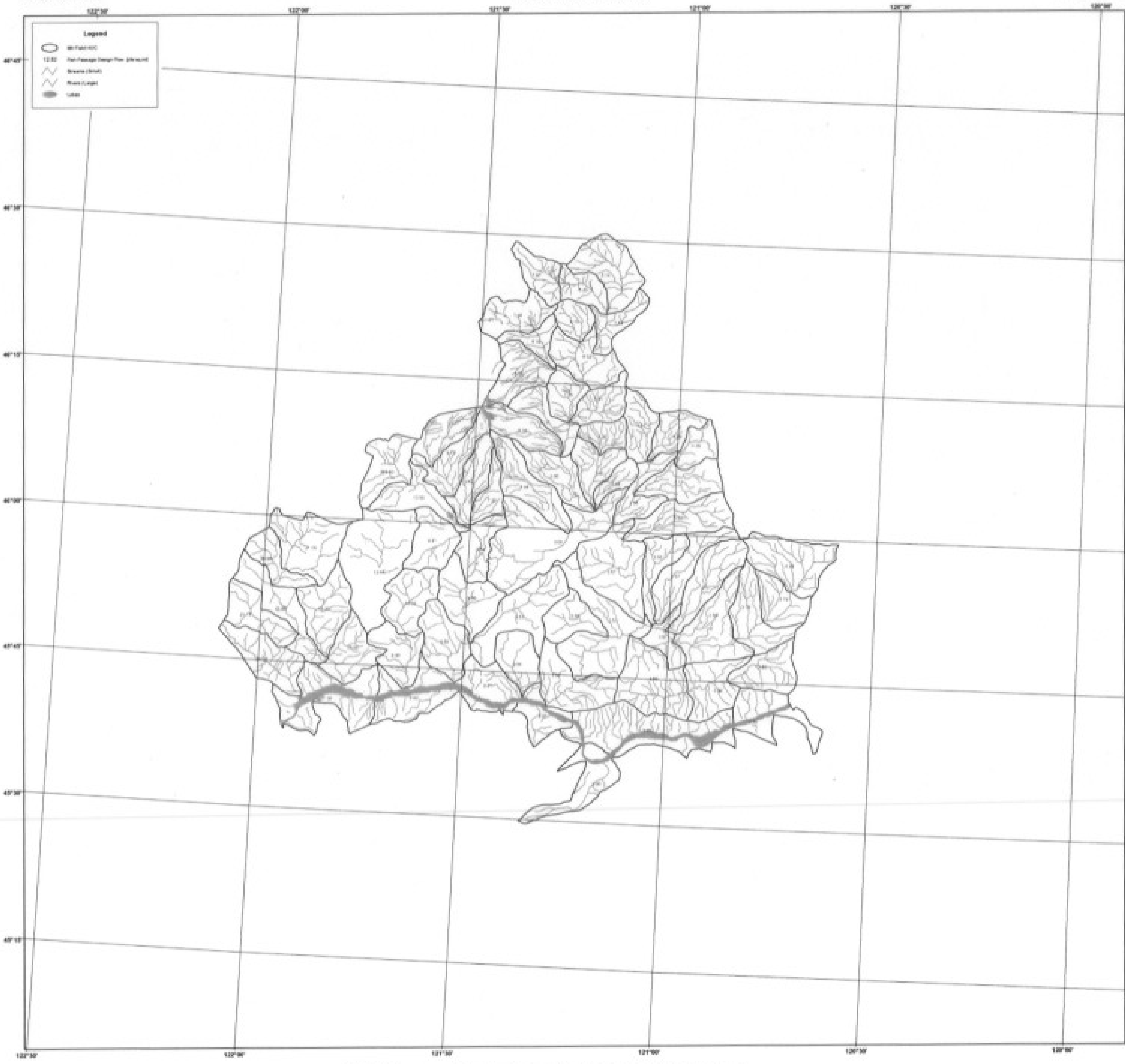
Plate 3 - Fish Passage Design Flows
South Cascades Region



Fish Passage Design Flows for Eastern Washington

By

E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou

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Washington State University

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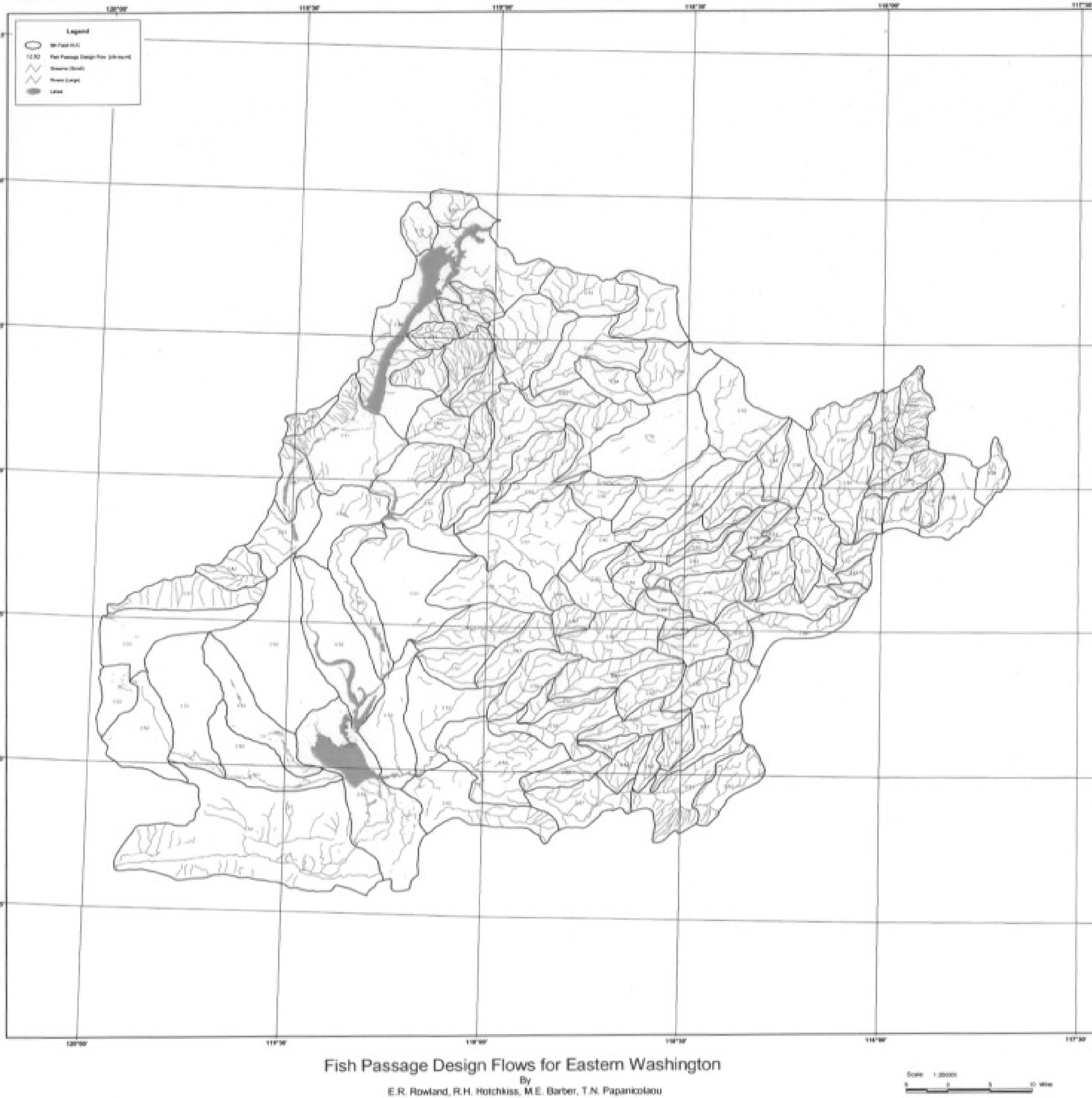
Plate 4 - Fish Passage Design Flows
Central Basin (North) Region



Fish Passage Design Flows for Eastern Washington

By

E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou

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Washington State University

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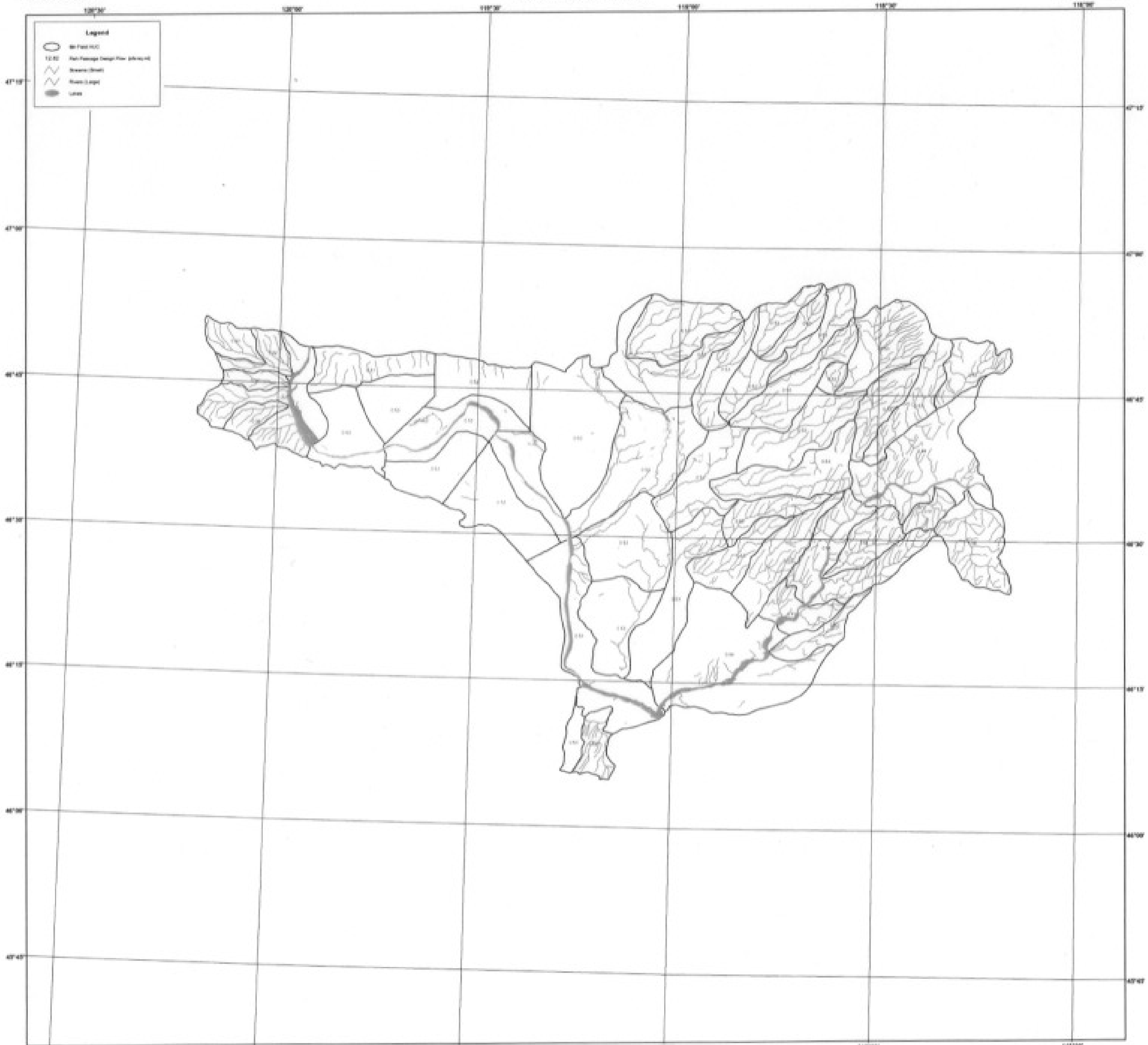
Plate 5 - Fish Passage Design Flows
Central Basin (South) Region



Fish Passage Design Flows for Eastern Washington

By
E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou
2001

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Washington State University

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Plate 6 - Fish Passage Design Flows
South Basin Region

Fish Passage Design Flows for Eastern Washington

By

E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou

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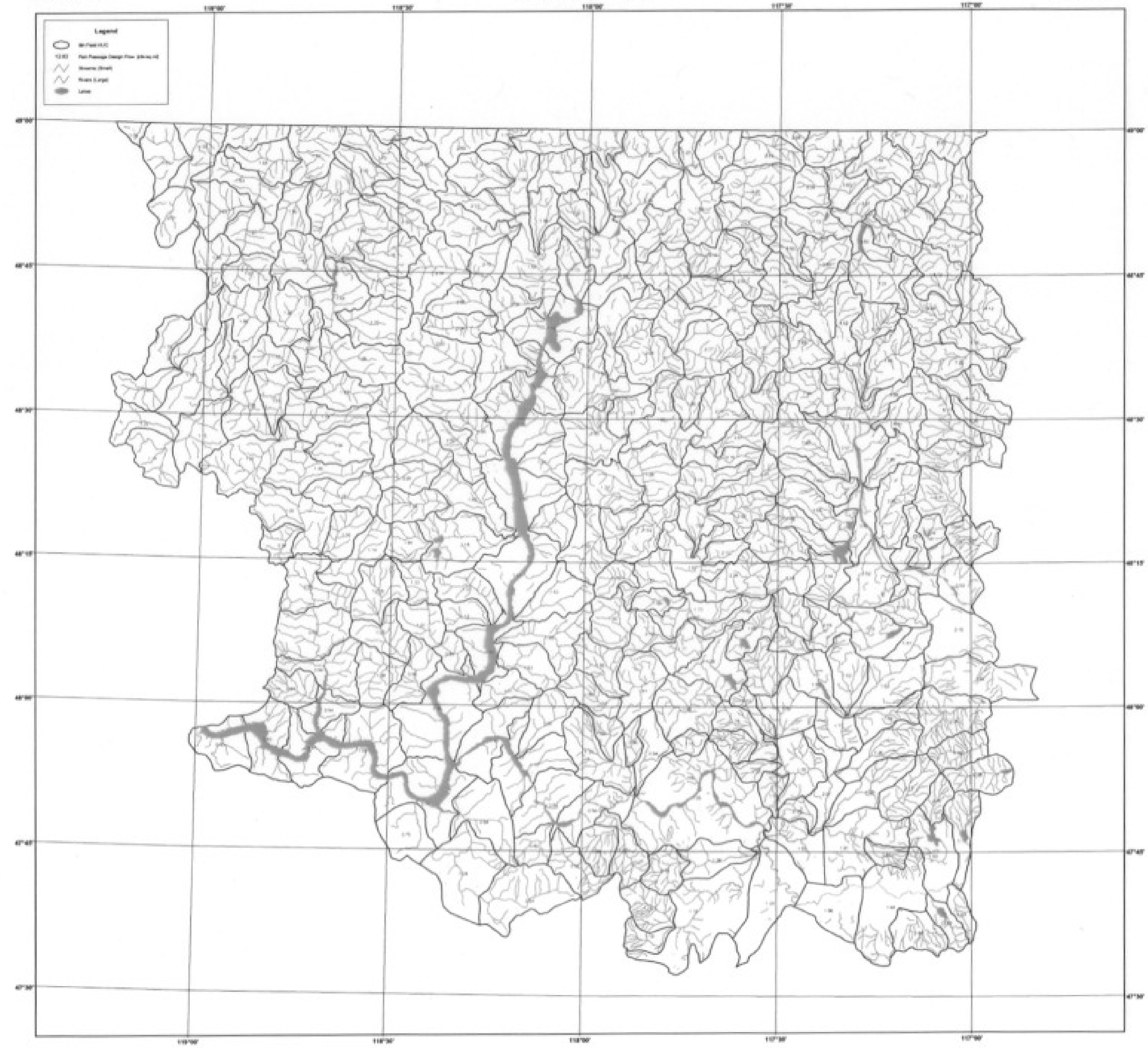

Fish Passage Design Flows for Eastern Washington

By

E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou

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Scale 1:350000

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Washington State University

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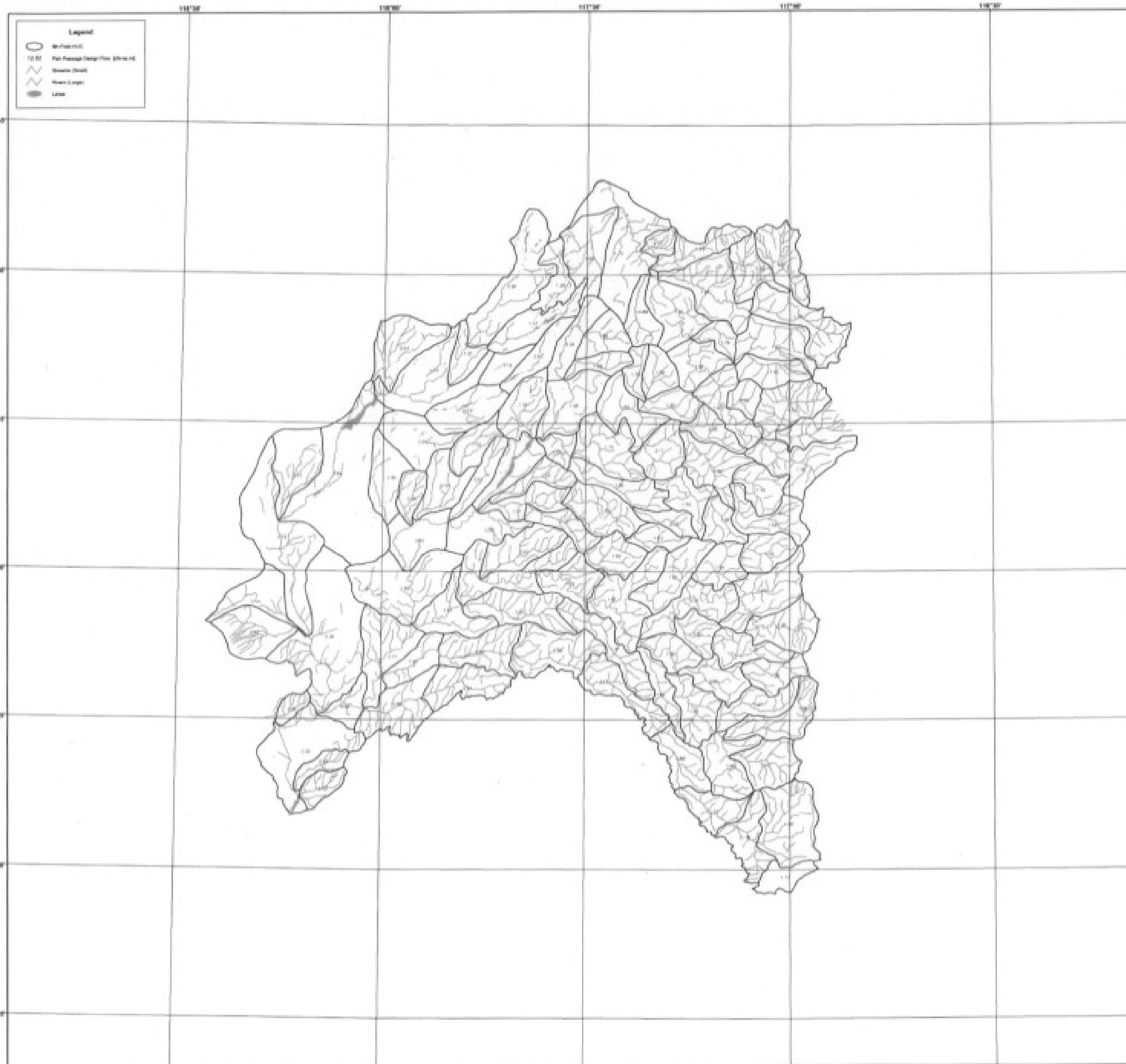
Plate 6 - Fish Passage Design Flows
Central East Region



Fish Passage Design Flows for Eastern Washington

By

E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou

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Scale 1:250000

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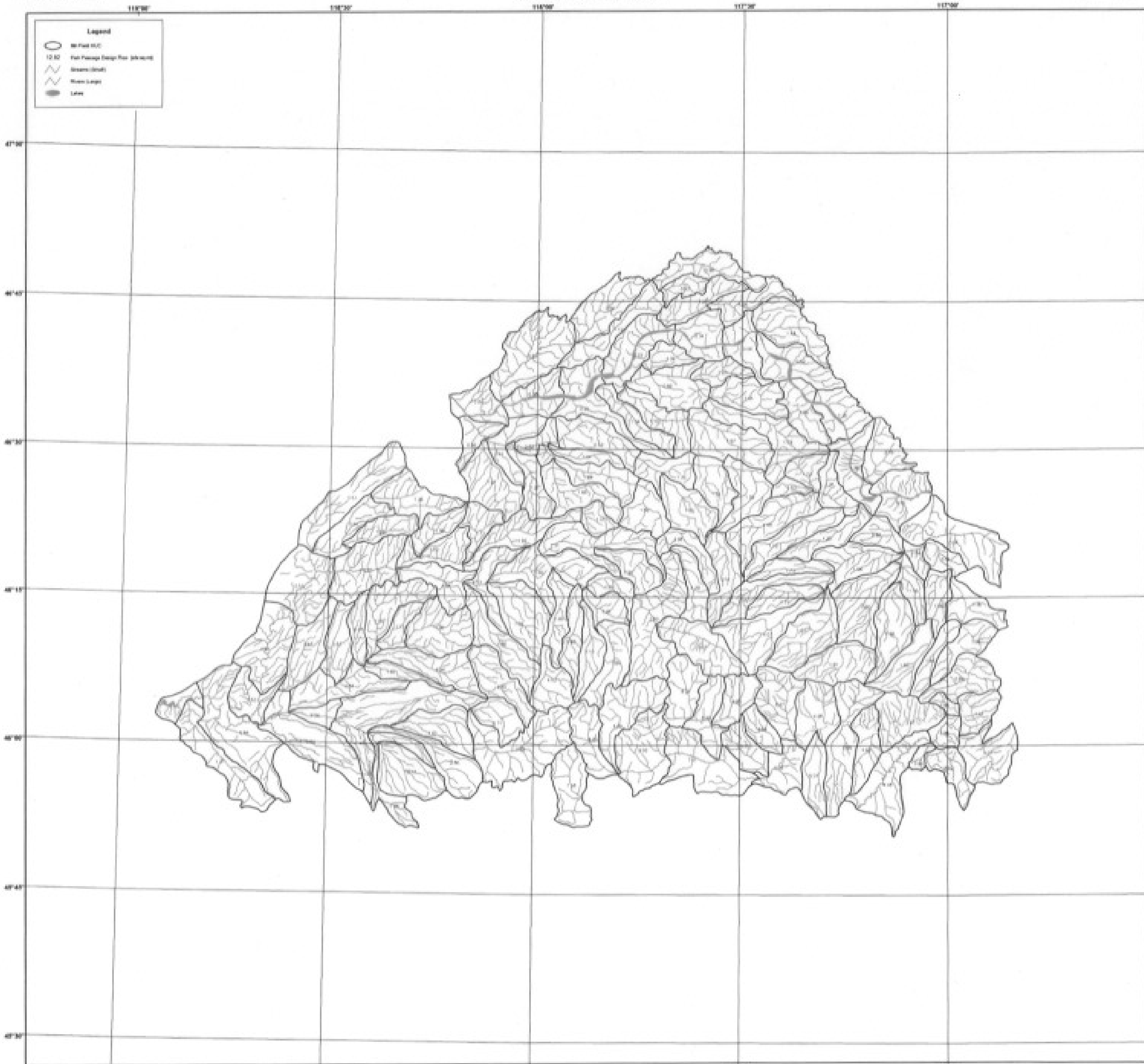


Fish Passage Design Flows for Eastern Washington

By
E.R. Rowland, R.H. Hotchkiss, M.E. Barber, T.N. Papanicolaou
2001

APPENDIX F

MEAN DAILY DISCHARGE RECORDS AND RATING TABLES FOR WSU GAGING STATIONS

BLACK CANYON CREEK

LOCATION.-- Latitude: 48:02:57, Longitude: 120:03:04, Okanagon County, Black Canyon Rd., tributary of Methow River ->Columbia River

DRAINAGE AREA.-- 11.3 mi2

GAGE ELEVATION.-- 1982 ft

MEAN ANNUAL PRECIPITATION.-- 680 mm

MEAN WATER STRESS INDEX.-- 39 %

PERIOD OF RECORD.-- May 26, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed in bank upstream of culvert past Snow Park. PVC pipe is supported by roots, rocks and rebar.
Ice dam occurred downstream of gauge during winter months. The ice dam influenced the stage readings recorded at the gage over a period of time during winter.
*** - indicates data missing during gage malfunction.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 6.83 cfs on 10/28/00, gage height, 1.28 ft; minimum discharge, 0.56 cfs on 8/2/01, gage height, 0.40 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	4.7	2.2	1.3	1.0
2	XX	XX	XX	XX	XX	XX	XX	XX	4.1	2.4	1.2	1.1
3	XX	XX	XX	XX	XX	XX	XX	XX	3.7	3.5	1.2	1.1
4	XX	XX	XX	XX	XX	XX	XX	XX	3.5	3.6	1.2	1.1
5	XX	XX	XX	XX	XX	XX	XX	XX	3.4	3.0	1.2	1.1
6	XX	XX	XX	XX	XX	XX	XX	XX	3.3	2.8	1.1	1.1
7	XX	XX	XX	XX	XX	XX	XX	XX	3.3	2.9	1.1	1.0
8	XX	XX	XX	XX	XX	XX	XX	XX	3.3	2.6	1.1	1.0
9	XX	XX	XX	XX	XX	XX	XX	XX	3.2	2.5	1.0	1.0
10	XX	XX	XX	XX	XX	XX	XX	XX	3.0	2.5	0.9	1.1
11	XX	XX	XX	XX	XX	XX	XX	XX	3.2	2.3	0.9	1.1
12	XX	XX	XX	XX	XX	XX	XX	XX	4.9	2.1	0.9	1.0
13	XX	XX	XX	XX	XX	XX	XX	XX	3.3	2.2	1.0	1.0
14	XX	XX	XX	XX	XX	XX	XX	XX	3.1	2.2	1.0	1.0
15	XX	XX	XX	XX	XX	XX	XX	XX	2.9	2.4	1.0	1.0
16	XX	XX	XX	XX	XX	XX	XX	XX	2.9	2.3	1.0	1.0
17	XX	XX	XX	XX	XX	XX	XX	XX	2.8	2.0	0.9	1.0
18	XX	XX	XX	XX	XX	XX	XX	XX	2.8	1.8	1.0	1.1
19	XX	XX	XX	XX	XX	XX	XX	XX	2.8	1.8	1.0	1.1
20	XX	XX	XX	XX	XX	XX	XX	XX	2.8	1.8	1.0	1.1
21	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.7	1.0	1.2
22	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.7	1.0	1.2
23	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.7	0.9	1.3
24	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.7	0.9	1.3
25	XX	XX	XX	XX	XX	XX	XX	XX	2.4	1.7	0.9	1.3
26	XX	XX	XX	XX	XX	XX	XX	XX	2.3	1.6	0.9	1.2
27	XX	XX	XX	XX	XX	XX	XX	4.4	2.3	1.6	1.0	1.1
28	XX	XX	XX	XX	XX	XX	XX	4.1	2.3	1.5	1.0	1.0
29	XX	XX	XX	XX	XX	XX	XX	3.9	2.1	1.4	1.0	1.0
30	XX	XX	XX	XX	---	XX	XX	4.3	2.3	1.3	1.0	1.1
31	XX	---	XX	XX	---	XX	---	5.6	---	1.3	1.0	---
TOTAL									91.0	66.3	31.4	32.7
MEAN									3.0	2.1	1.0	1.1
MAX									4.9	3.6	1.3	1.3
MIN									2.1	1.3	0.9	1.1
AC-FT									180	132	62	65

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.1	5.0	4.8	3.2	2.4	***	***	***	***	1.4	0.8	XX
2	1.0	5.1	4.8	3.1	2.4	***	***	***	***	1.3	0.8	XX
3	1.0	5.1	4.6	3.1	2.3	***	***	***	***	1.2	0.8	XX
4	1.0	5.3	4.5	3.0	2.4	***	***	***	***	1.2	XX	XX
5	1.2	5.2	4.4	3.2	2.3	***	***	***	***	1.1	XX	XX
6	1.4	5.1	4.3	3.1	2.2	***	***	***	***	1.2	XX	XX
7	1.5	5.1	4.1	3.1	2.0	***	***	***	***	1.2	XX	XX
8	1.6	5.5	3.9	3.2	2.5	***	***	***	***	1.1	XX	XX
9	1.7	5.6	3.7	3.0	2.5	***	***	***	***	1.1	XX	XX
10	1.8	5.5	3.4	2.8	2.4	***	***	***	2.0	1.0	XX	XX
11	1.7	5.2	3.3	2.8	2.4	***	***	***	1.9	1.0	XX	XX
12	1.7	5.4	3.4	2.7	2.4	***	***	***	2.0	1.0	XX	XX
13	1.8	5.3	3.6	2.7	2.4	***	***	***	1.8	1.1	XX	XX
14	1.9	5.2	3.6	2.6	2.4	***	***	***	1.7	0.9	XX	XX
15	2.0	5.0	3.9	2.4	2.4	***	***	***	1.6	1.0	XX	XX
16	2.2	5.3	4.1	2.7	2.4	***	***	***	1.5	1.2	XX	XX
17	2.5	5.0	4.2	3.1	2.3	***	***	***	1.5	1.2	XX	XX
18	2.6	5.1	4.0	3.0	2.4	***	***	***	1.5	1.1	XX	XX
19	2.7	5.1	4.0	2.9	2.4	***	***	***	1.4	1.0	XX	XX
20	3.4	5.1	3.9	2.8	2.3	***	***	***	1.4	1.0	XX	XX
21	3.2	5.0	4.0	2.8	2.2	***	***	***	1.3	1.3	XX	XX
22	3.2	4.9	3.9	2.7	2.2	***	***	***	1.3	1.3	XX	XX
23	3.4	5.0	3.8	2.7	2.1	***	***	***	1.3	1.3	XX	XX
24	3.4	4.9	3.7	2.6	2.1	***	***	***	1.3	1.0	XX	XX
25	3.5	5.0	3.6	2.6	1.9	***	***	***	1.4	0.9	XX	XX
26	3.6	5.0	3.7	2.6	***	***	***	***	1.4	0.8	XX	XX
27	3.7	4.9	3.7	2.5	***	***	***	***	2.4	0.8	XX	XX
28	5.7	4.8	3.5	2.5	***	***	***	***	1.8	0.8	XX	XX
29	5.2	5.0	3.5	2.4	---	***	***	***	1.5	0.8	XX	XX
30	4.8	4.9	3.3	2.5	---	***	***	***	1.4	0.8	XX	XX
31	5.0	---	3.3	2.5	---	***	---	***	---	0.8	XX	---
TOTAL	80.4	153.5	120.4	87.3	57.2				33.5	32.9	2.3	
MEAN	2.6	5.1	3.9	2.8	2.3				1.6	1.1	0.8	
MAX	5.7	5.6	4.8	3.2	2.5				2.4	1.4	0.7	
MIN	1.0	4.8	3.3	2.4	1.9				1.3	0.8	0.7	
AC-FT	159.5	304.5	238.8	173.1	113.4				66.5	65.2	4.6	

BOWMAN CREEK

LOCATION.-- Latitude: 45:56:10, Longitude: 120:58:41, Klickitat County, Garrison Road, tributary of Canyon Creek -> Little Klickitat River -> Klickitat River -> Columbia River

DRAINAGE AREA.-- 13.4 mi2

GAGE ELEVATION.-- 2320 ft

MEAN ANNUAL PRECIPITATION.-- 818 mm

MEAN WATER STRESS INDEX.-- 56 %

PERIOD OF RECORD.-- June 14, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed under bridge at upstream end with boulders protecting gauge.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 48.0 cfs on 5/23/01, gage height, 1.22 ft; minimum discharge, 0.0 cfs on 2/28/01, gage height, 0.15 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.0	6.7	1.8
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.6	5.9	1.9
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.7	5.8	1.5
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.9	5.9	1.8
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.0	6.2	1.8
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.6	6.2	2.1
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.3	5.5	2.2
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.2	5.7	2.6
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.5	6.0	1.7
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.5	5.0	2.5
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.9	4.0	2.6
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.4	3.4	2.9
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.4	3.6	3.3
14	XX	XX	XX	XX	XX	XX	XX	XX	7.3	5.7	3.4	4.1
15	XX	XX	XX	XX	XX	XX	XX	XX	7.0	4.8	3.4	4.0
16	XX	XX	XX	XX	XX	XX	XX	XX	6.8	5.0	3.2	3.1
17	XX	XX	XX	XX	XX	XX	XX	XX	7.8	6.0	3.4	2.9
18	XX	XX	XX	XX	XX	XX	XX	XX	7.2	7.3	2.8	3.6
19	XX	XX	XX	XX	XX	XX	XX	XX	6.4	6.2	2.7	4.2
20	XX	XX	XX	XX	XX	XX	XX	XX	8.1	6.8	2.4	3.2
21	XX	XX	XX	XX	XX	XX	XX	XX	9.7	6.6	2.8	2.8
22	XX	XX	XX	XX	XX	XX	XX	XX	8.1	7.3	3.2	1.1
23	XX	XX	XX	XX	XX	XX	XX	XX	7.4	5.8	3.9	0.5
24	XX	XX	XX	XX	XX	XX	XX	XX	8.7	6.0	5.0	0.5
25	XX	XX	XX	XX	XX	XX	XX	XX	8.7	6.0	4.0	0.6
26	XX	XX	XX	XX	XX	XX	XX	XX	8.8	5.3	3.5	0.7
27	XX	XX	XX	XX	XX	XX	XX	XX	9.6	5.9	2.6	0.9
28	XX	XX	XX	XX	XX	XX	XX	XX	10.1	6.3	2.3	1.3
29	XX	XX	XX	XX	XX	XX	XX	XX	9.2	6.9	2.6	1.9
30	XX	XX	XX	XX	---	XX	XX	XX	8.2	7.5	3.2	3.3
31	XX	---	XX	XX	---	XX	---	XX	---	8.5	2.9	---
TOTAL										194.8	127.1	67.6
MEAN										6.3	4.1	2.3
MAX										8.5	4.1	2.3
MIN										4.7	2.3	0.5
AC-FT										386	252	134

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER **2000** TO SEPTEMBER **2001**
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3.4	0.4	0.2	0.1	0.1	0.2	5.4	16.6	16.8	12.1	4.8	XX
2	1.1	0.6	0.2	0.1	0.2	0.2	4.3	13.9	11.3	12.7	6.4	XX
3	0.7	0.7	0.2	0.1	0.2	0.2	3.0	15.2	10.5	14.0	6.3	XX
4	0.7	0.6	0.1	0.2	0.4	0.2	3.0	17.1	9.7	14.7	6.1	XX
5	0.5	0.5	0.1	0.3	0.4	0.4	2.9	16.0	10.9	13.8	5.4	XX
6	0.4	0.6	0.1	0.2	0.2	0.5	3.2	13.8	13.4	10.7	XX	XX
7	0.4	0.6	0.1	0.6	0.2	0.6	2.4	16.4	16.7	10.9	XX	XX
8	0.5	0.7	0.1	0.3	0.2	0.9	2.1	18.9	17.3	11.6	XX	XX
9	0.7	0.4	0.1	0.1	0.2	0.8	2.2	17.3	14.8	11.3	XX	XX
10	1.0	0.2	0.1	0.1	0.1	0.7	2.5	15.9	13.0	11.7	XX	XX
11	1.3	0.1	0.3	0.1	0.1	0.7	3.0	18.9	9.9	12.3	XX	XX
12	1.0	0.2	0.8	0.1	0.2	0.8	2.3	21.9	6.9	12.2	XX	XX
13	1.4	0.1	0.8	0.2	0.2	1.0	2.2	18.9	9.6	10.0	XX	XX
14	1.2	0.1	0.4	0.1	0.1	1.0	2.0	16.3	11.9	8.4	XX	XX
15	0.6	0.1	0.1	0.1	0.1	0.9	2.9	18.3	11.5	7.4	XX	XX
16	0.9	0.3	0.1	0.2	0.1	0.7	4.2	17.7	11.3	5.7	XX	XX
17	1.1	0.1	0.1	0.2	0.1	0.9	5.5	13.3	8.7	4.7	XX	XX
18	1.6	0.1	0.1	0.1	0.1	2.2	5.7	15.3	9.6	4.3	XX	XX
19	1.0	0.1	0.1	0.1	0.1	7.3	4.5	17.3	12.0	5.2	XX	XX
20	1.7	0.1	0.1	0.1	0.2	3.6	5.2	17.1	15.0	5.7	XX	XX
21	0.8	0.1	0.1	0.1	0.2	2.9	5.7	20.6	17.0	6.9	XX	XX
22	0.4	0.2	0.1	0.1	0.3	3.0	5.1	25.6	15.0	7.7	XX	XX
23	0.3	0.1	0.1	0.1	0.3	3.9	5.9	30.7	11.6	10.5	XX	XX
24	0.3	0.1	0.1	0.1	0.2	5.3	8.9	30.2	8.9	9.6	XX	XX
25	0.4	0.1	0.1	0.2	0.2	12.1	15.3	26.3	7.4	7.8	XX	XX
26	0.6	0.2	0.1	0.1	0.2	7.1	25.2	25.7	10.6	7.6	XX	XX
27	0.6	0.2	0.1	0.1	0.2	4.3	21.5	21.8	15.9	7.1	XX	XX
28	1.0	0.1	0.1	0.1	0.2	6.1	17.9	15.2	12.1	6.8	XX	XX
29	0.8	0.1	0.1	0.1	---	5.3	12.3	11.6	11.1	5.2	XX	XX
30	0.5	0.1	0.1	0.1	---	5.6	19.1	15.5	11.9	6.1	XX	XX
31	0.4	---	0.1	0.1	---	6.4	---	19.8	---	5.1	XX	---
TOTAL	27.6	7.9	5.3	4.7	5.4	85.7	205.6	579.2	362.5	280.0		
MEAN	0.9	0.3	0.2	0.2	0.2	2.8	6.9	18.7	12.1	9.0		
MAX	3.4	0.7	0.8	0.6	0.4	12.1	25.2	30.7	17.3	14.7		
MIN	0.3	0.1	0.1	0.1	0.1	0.2	2.0	11.6	6.9	4.3		
AC-FT	54.7	15.6	10.5	9.4	10.8	170.0	407.8	1148.8	718.9	555.3		

BUCK CREEK

LOCATION.-- Latitude: 45:51:34, Longitude: 121:30:58, Klickitat County, Big Buck Creek Road, tributary of White Salmon River -> Columbia River

DRAINAGE AREA.-- 13.8 mi2

GAGE ELEVATION.-- 364 ft

MEAN ANNUAL PRECIPITATION.-- 1057 mm

MEAN WATER STRESS INDEX.-- 37 %

PERIOD OF RECORD.-- June 12, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed at downstream end of bridge on boulder that has been cemented to bridge abutment.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 83.3 cfs on 9/12/00, gage height, 1.87 ft; minimum discharge, 4.9 cfs on 8/9/00, gage height, 0.78 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	9.9	5.9	24.3
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	10.1	5.9	25.3
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	10.4	6.1	26.8
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	10.1	6.5	33.5
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	9.0	6.2	38.8
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	8.6	6.2	43.9
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	8.1	6.1	44.8
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.2	6.1	37.3
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	8.1	5.9	37.4
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	8.2	5.2	40.4
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	8.3	6.0	48.2
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	8.1	6.2	49.6
13	XX	XX	XX	XX	XX	XX	XX	XX	17.5	7.5	6.2	48.8
14	XX	XX	XX	XX	XX	XX	XX	XX	16.1	7.0	6.8	49.3
15	XX	XX	XX	XX	XX	XX	XX	XX	15.5	6.7	7.2	44.2
16	XX	XX	XX	XX	XX	XX	XX	XX	15.0	6.7	6.0	44.2
17	XX	XX	XX	XX	XX	XX	XX	XX	14.6	6.4	6.2	47.8
18	XX	XX	XX	XX	XX	XX	XX	XX	14.1	6.6	6.3	45.5
19	XX	XX	XX	XX	XX	XX	XX	XX	14.0	6.3	6.4	42.5
20	XX	XX	XX	XX	XX	XX	XX	XX	13.7	6.3	6.6	41.2
21	XX	XX	XX	XX	XX	XX	XX	XX	12.5	6.2	8.9	39.1
22	XX	XX	XX	XX	XX	XX	XX	XX	12.2	6.1	10.8	35.8
23	XX	XX	XX	XX	XX	XX	XX	XX	12.0	6.2	12.2	36.9
24	XX	XX	XX	XX	XX	XX	XX	XX	11.9	6.2	12.9	37.9
25	XX	XX	XX	XX	XX	XX	XX	XX	11.5	6.2	13.0	38.7
26	XX	XX	XX	XX	XX	XX	XX	XX	10.9	6.3	13.0	39.3
27	XX	XX	XX	XX	XX	XX	XX	XX	10.6	6.0	14.6	40.2
28	XX	XX	XX	XX	XX	XX	XX	XX	10.3	5.9	16.6	42.6
29	XX	XX	XX	XX	XX	XX	XX	XX	9.7	6.0	21.6	41.6
30	XX	XX	XX	XX	---	XX	XX	XX	9.6	6.0	26.2	24.6
31	XX	---	XX	XX	---	XX	---	XX	---	5.9	22.0	---
TOTAL									231.9	226.7	296.0	1190.7
MEAN									12.9	7.3	9.5	39.7
MAX									17.5	10.4	26.2	49.6
MIN									9.6	5.9	5.2	24.3
AC-FT									460	450	587	2362

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	11.1	7.8	9.8	8.7	9.5	12.2	34.0	25.1	10.6	8.5	6.2	XX
2	8.9	7.2	9.5	8.6	15.5	14.0	32.0	22.5	10.9	8.3	6.2	XX
3	8.6	7.1	9.2	8.6	21.3	13.3	29.6	21.3	10.7	8.2	6.1	XX
4	8.4	7.6	8.9	8.8	25.6	13.5	27.5	20.6	10.4	8.1	6.1	XX
5	8.1	7.2	8.7	10.2	35.1	13.9	26.1	19.8	10.5	8.0	6.1	XX
6	7.9	7.0	8.6	11.4	23.6	13.8	26.1	18.8	10.3	7.9	XX	XX
7	7.9	6.8	8.5	10.5	18.0	15.3	24.0	18.2	10.1	7.8	XX	XX
8	7.8	8.3	8.4	9.9	15.3	18.5	22.5	17.6	10.0	7.6	XX	XX
9	8.3	8.0	8.6	9.5	13.9	20.1	21.1	17.0	10.3	7.1	XX	XX
10	8.0	7.2	8.5	9.3	12.8	18.5	21.5	15.9	10.1	6.3	XX	XX
11	7.9	7.5	8.3	9.2	12.0	17.4	24.2	14.8	11.0	6.7	XX	XX
12	7.6	8.8	8.2	9.0	11.2	17.4	21.7	14.5	10.7	6.7	XX	XX
13	7.7	9.0	8.2	9.7	10.7	18.7	20.6	14.0	10.1	6.7	XX	XX
14	7.9	9.3	8.7	10.7	10.5	20.3	19.7	16.0	9.9	6.6	XX	XX
15	7.4	8.6	12.5	9.9	10.7	19.8	19.1	18.0	9.8	6.6	XX	XX
16	6.5	8.2	10.7	9.4	12.0	18.9	19.0	17.4	9.8	6.6	XX	XX
17	6.7	8.0	18.2	9.1	10.9	18.0	19.0	15.7	9.8	6.7	XX	XX
18	8.0	8.0	11.0	8.8	11.0	24.7	19.0	14.9	9.7	6.6	XX	XX
19	8.1	7.9	10.0	8.7	10.9	51.0	18.9	14.4	8.8	6.5	XX	XX
20	9.5	8.0	9.6	8.6	10.9	43.5	18.8	13.9	8.7	6.7	XX	XX
21	8.8	8.1	9.3	8.9	12.2	35.6	18.4	13.6	8.7	6.7	XX	XX
22	8.3	7.9	9.3	8.7	13.4	31.0	18.0	12.9	8.6	6.4	XX	XX
23	8.3	8.5	9.1	8.7	13.7	29.1	17.7	12.3	8.5	6.3	XX	XX
24	8.3	8.9	9.2	8.9	13.4	28.6	17.5	11.8	8.9	6.2	XX	XX
25	8.4	9.1	9.1	8.7	12.7	30.2	17.5	11.5	9.1	6.2	XX	XX
26	8.5	9.6	8.8	8.7	12.2	32.8	17.5	11.2	8.8	6.1	XX	XX
27	8.5	11.4	8.6	8.6	11.9	32.3	17.1	11.1	11.4	6.1	XX	XX
28	9.0	9.3	8.6	8.5	11.8	35.8	17.1	11.3	9.6	6.2	XX	XX
29	8.5	9.1	8.6	9.0	---	34.3	16.8	11.0	8.9	6.2	XX	XX
30	7.6	10.5	8.6	9.1	---	33.4	24.2	10.8	8.7	6.7	XX	XX
31	7.6	---	8.7	9.3	---	34.2	---	10.7	---	6.3	XX	---
TOTAL	253.9	250.0	291.9	285.5	402.6	760.1	646.2	478.9	293.5	213.6		
MEAN	8.2	8.3	9.4	9.2	14.4	24.5	21.5	15.4	9.8	6.9		
MAX	11.1	11.4	18.2	11.4	35.1	51.0	34.0	25.1	11.4	8.5		
MIN	6.5	6.8	8.2	8.5	9.5	12.2	16.8	10.7	8.5	6.1		
AC-FT	503.7	495.9	579.0	566.3	798.6	1507.6	1281.8	949.8	582.2	423.6		

BUTLER CREEK

LOCATION.-- Latitude: 45:54:53, Longitude: 120:42:18, Klickitat County, Highway 97, tributary of Little Klickitat River -> Klickitat River -> Columbia River

DRAINAGE AREA.-- 11.6 mi2

GAGE ELEVATION.-- 2165 ft

MEAN ANNUAL PRECIPITATION.-- 589 mm

MEAN WATER STRESS INDEX.-- 68 %

PERIOD OF RECORD.-- June 15, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed at downstream of CMP on end of concrete wingwall. The USGS previously gauged this stream, at or very close to this location.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 42.8 cfs, gage height 1.89 ft; minimum discharge, 0.48 cfs, gage height, 0.98 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.6	0.8	0.6
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.5	0.8	0.7
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.6	0.8	0.7
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.7	0.8	0.8
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.6	0.8	0.8
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.5	0.7	0.7
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.3	0.7	0.7
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.1	0.7	0.7
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	2.0	0.7	0.8
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.9	0.6	0.8
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.9	0.7	0.8
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.7	0.7	0.7
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.6	0.6	0.7
14	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.6	0.6	0.6
15	XX	XX	XX	XX	XX	XX	XX	XX	9.9	1.5	0.6	0.6
16	XX	XX	XX	XX	XX	XX	XX	XX	8.9	1.5	0.6	0.6
17	XX	XX	XX	XX	XX	XX	XX	XX	8.1	1.4	0.6	0.6
18	XX	XX	XX	XX	XX	XX	XX	XX	7.6	1.4	0.6	0.6
19	XX	XX	XX	XX	XX	XX	XX	XX	6.8	1.3	0.7	0.6
20	XX	XX	XX	XX	XX	XX	XX	XX	6.2	1.3	0.7	0.6
21	XX	XX	XX	XX	XX	XX	XX	XX	5.8	1.2	0.7	0.6
22	XX	XX	XX	XX	XX	XX	XX	XX	5.2	1.2	0.6	0.6
23	XX	XX	XX	XX	XX	XX	XX	XX	4.8	1.2	0.6	0.6
24	XX	XX	XX	XX	XX	XX	XX	XX	4.5	1.1	0.6	0.6
25	XX	XX	XX	XX	XX	XX	XX	XX	4.1	1.1	0.5	0.6
26	XX	XX	XX	XX	XX	XX	XX	XX	3.8	1.1	0.6	0.6
27	XX	XX	XX	XX	XX	XX	XX	XX	3.6	1.0	0.6	0.6
28	XX	XX	XX	XX	XX	XX	XX	XX	3.4	1.0	0.6	0.6
29	XX	XX	XX	XX	XX	XX	XX	XX	3.1	1.0	0.6	0.7
30	XX	XX	XX	XX	---	XX	XX	XX	2.8	0.9	0.6	1.1
31	XX	---	XX	XX	---	XX	---	XX	---	0.9	0.6	---
TOTAL										50.5	20.3	20.3
MEAN										1.6	0.7	0.7
MAX										2.7	0.8	1.1
MIN										0.9	0.5	0.6
AC-FT										100	40	40

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.5	0.9	1.0	1.1	1.2	2.0	18.8	27.7	5.4	1.6	0.7	XX
2	0.9	0.9	1.0	1.1	1.3	2.0	16.0	26.1	5.0	1.4	0.6	XX
3	0.8	0.9	1.1	1.1	1.4	1.9	13.6	24.7	4.7	1.3	0.6	XX
4	0.8	1.0	1.0	1.2	2.3	2.0	12.3	24.0	4.2	1.3	0.6	XX
5	0.8	1.1	1.0	1.7	4.2	2.2	11.0	23.2	4.2	1.2	0.6	XX
6	0.7	1.0	1.0	1.7	2.4	2.6	10.5	20.5	4.0	1.1	XX	XX
7	0.7	1.0	1.0	1.3	1.6	3.1	9.1	20.6	3.6	1.1	XX	XX
8	0.7	1.3	1.0	1.3	2.0	4.1	8.2	22.0	3.5	1.0	XX	XX
9	0.7	1.1	1.0	1.2	1.9	4.4	7.8	21.2	3.4	0.9	XX	XX
10	0.9	1.0	1.0	1.2	1.7	4.1	7.8	20.0	3.0	0.9	XX	XX
11	1.0	0.8	0.9	1.2	1.6	4.2	8.2	19.9	3.0	0.9	XX	XX
12	0.9	0.8	0.8	1.2	1.5	4.3	7.2	21.1	3.1	0.8	XX	XX
13	0.9	0.9	0.9	1.2	1.5	5.3	6.8	21.5	3.0	0.8	XX	XX
14	0.8	0.9	0.9	1.2	1.5	5.8	6.5	24.2	2.7	0.7	XX	XX
15	0.8	0.9	1.0	1.2	1.5	5.5	7.0	30.2	2.5	0.8	XX	XX
16	0.8	0.8	1.1	1.0	1.5	4.8	8.2	28.9	2.3	0.8	XX	XX
17	0.8	0.9	1.1	1.1	1.4	4.5	9.6	26.1	2.2	0.8	XX	XX
18	0.8	0.9	1.0	1.1	1.5	11.3	9.9	23.2	2.1	0.9	XX	XX
19	0.8	0.8	1.0	1.1	1.5	33.2	9.8	21.0	2.0	0.8	XX	XX
20	1.5	0.8	1.0	1.1	1.5	21.6	10.2	18.3	1.9	0.9	XX	XX
21	1.4	0.8	1.0	1.1	1.7	16.2	11.2	16.8	1.8	1.1	XX	XX
22	0.9	0.8	1.0	1.2	1.8	15.0	11.1	16.2	1.7	1.0	XX	XX
23	0.9	0.8	1.1	1.2	1.8	14.7	11.1	15.6	1.6	0.9	XX	XX
24	0.8	0.9	1.1	1.2	1.9	15.0	13.6	14.6	1.7	0.8	XX	XX
25	0.8	1.0	1.0	1.1	1.8	27.9	18.9	12.5	1.9	0.7	XX	XX
26	0.9	1.1	1.0	1.2	1.9	24.7	24.2	10.8	1.8	0.6	XX	XX
27	0.9	1.1	1.1	1.1	1.8	18.8	24.9	9.4	3.0	0.6	XX	XX
28	1.0	1.0	1.1	1.1	1.8	21.0	22.7	8.2	2.4	0.6	XX	XX
29	1.1	1.0	1.1	1.1	---	20.5	17.8	7.3	1.9	0.6	XX	XX
30	1.0	1.0	1.1	1.1	---	19.0	26.2	6.6	1.7	0.7	XX	XX
31	0.9	---	1.2	1.2	---	19.4	---	6.0	---	1.0	XX	---
TOTAL	28.3	28.3	31.6	37.1	49.5	341.0	380.4	588.4	85.2	28.8		
MEAN	0.9	0.9	1.0	1.2	1.8	11.0	12.7	19.0	2.8	0.9		
MAX	1.5	1.3	1.2	1.7	4.2	33.2	26.2	30.2	5.4	1.6		
MIN	0.7	0.8	0.8	1.0	1.2	1.9	6.5	6.0	1.6	0.6		
AC-FT	56.1	56.1	62.7	73.6	98.1	676.4	754.5	1167.0	169.0	57.1		

COLOCKUM CREEK

LOCATION.-- Latitude: 47:19:44, Longitude: 120:16:48, Chelan County, Colockum Road, tributary of Columbia River attached to North end of CMP road culvert (right hand side)

DRAINAGE AREA.-- 35.1 mi2

GAGE ELEVATION.-- 1332 ft

MEAN ANNUAL PRECIPITATION.-- 539 mm

MEAN WATER STRESS INDEX.-- 64 %

PERIOD OF RECORD.-- May 27, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed at downstream end of bridge. This gauge was replaced on 7/2/00 due to malfunction.
Local landowners informed WSU that Colockum Creek might run dry during summer months partially due to irrigation practices.
** - denotes data missing due to gage malfunction

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 38.1 cfs, gage height, 3.06 ft; minimum discharge, 0.0 cfs, gage height, -0.12 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	25.7	**	0.7	0.4
2	XX	XX	XX	XX	XX	XX	XX	XX	23.7	1.5	0.7	0.6
3	XX	XX	XX	XX	XX	XX	XX	XX	18.6	1.7	0.7	0.7
4	XX	XX	XX	XX	XX	XX	XX	XX	16.8	2.5	0.7	0.6
5	XX	XX	XX	XX	XX	XX	XX	XX	15.4	2.6	0.7	0.7
6	XX	XX	XX	XX	XX	XX	XX	XX	14.2	2.8	0.6	0.7
7	XX	XX	XX	XX	XX	XX	XX	XX	13.8	2.8	0.5	0.5
8	XX	XX	XX	XX	XX	XX	XX	XX	13.5	2.4	0.4	0.5
9	XX	XX	XX	XX	XX	XX	XX	XX	12.6	2.2	0.4	0.5
10	XX	XX	XX	XX	XX	XX	XX	XX	11.8	2.2	0.4	0.4
11	XX	XX	XX	XX	XX	XX	XX	XX	12.0	1.8	0.4	0.5
12	XX	XX	XX	XX	XX	XX	XX	XX	**	1.3	0.4	0.5
13	XX	XX	XX	XX	XX	XX	XX	XX	**	1.3	0.4	0.5
14	XX	XX	XX	XX	XX	XX	XX	XX	**	1.3	0.4	0.5
15	XX	XX	XX	XX	XX	XX	XX	XX	**	1.3	0.3	0.5
16	XX	XX	XX	XX	XX	XX	XX	XX	**	1.2	0.3	0.3
17	XX	XX	XX	XX	XX	XX	XX	XX	**	1.2	0.3	0.4
18	XX	XX	XX	XX	XX	XX	XX	XX	**	1.3	0.3	0.3
19	XX	XX	XX	XX	XX	XX	XX	XX	**	1.4	0.3	0.4
20	XX	XX	XX	XX	XX	XX	XX	XX	**	1.1	0.3	0.4
21	XX	XX	XX	XX	XX	XX	XX	XX	**	0.9	0.3	0.8
22	XX	XX	XX	XX	XX	XX	XX	XX	**	0.8	0.4	1.1
23	XX	XX	XX	XX	XX	XX	XX	XX	**	0.9	0.4	1.0
24	XX	XX	XX	XX	XX	XX	XX	XX	**	0.8	0.4	0.9
25	XX	XX	XX	XX	XX	XX	XX	XX	**	0.8	0.4	0.9
26	XX	XX	XX	XX	XX	XX	XX	XX	**	0.8	0.4	0.9
27	XX	XX	XX	XX	XX	XX	XX	XX	**	0.8	0.4	0.9
28	XX	XX	XX	XX	XX	XX	XX	14.0	**	0.8	0.4	0.9
29	XX	XX	XX	XX	XX	XX	XX	14.4	**	0.9	0.5	0.9
30	XX	XX	XX	XX	---	XX	XX	15.4	**	0.9	0.4	1.0
31	XX	---	XX	XX	---	XX	---	22.8	---	0.8	0.4	---
TOTAL										43.2	13.7	19.1
MEAN										1.4	0.4	0.6
MAX										2.8	0.7	1.1
MIN										0.8	0.3	0.3
AC-FT										85.7	27.2	37.8

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.0	1.1	1.6	1.5	1.2	1.4	2.7	9.7	5.3	1.5	0.1	0.0
2	0.9	1.2	1.6	1.3	1.2	1.4	2.5	8.0	4.4	1.2	0.1	0.1
3	0.9	1.2	1.6	1.4	1.3	1.3	2.4	7.3	4.3	0.8	0.1	0.0
4	0.9	1.3	1.5	1.4	1.3	1.4	2.5	8.5	4.1	0.6	0.1	0.0
5	0.9	1.4	1.5	1.5	1.3	1.5	2.4	11.8	5.1	0.5	0.1	0.0
6	0.9	1.3	1.5	1.5	1.2	1.6	2.4	10.1	5.6	0.4	0.1	0.0
7	1.0	1.3	1.4	1.3	0.9	1.9	2.3	10.6	4.9	0.4	0.1	0.0
8	1.0	1.6	1.4	1.4	1.2	2.3	2.1	14.1	4.6	0.3	0.1	0.0
9	1.0	1.5	1.4	1.5	1.2	2.7	2.0	16.3	5.1	0.3	0.1	0.0
10	1.0	1.4	1.4	1.6	1.2	2.5	2.3	15.6	4.3	0.5	0.1	0.0
11	1.1	1.3	1.1	1.6	1.3	2.3	2.6	18.2	3.9	0.4	0.1	0.0
12	1.0	1.5	1.7	1.6	1.2	2.8	2.5	24.6	3.5	0.4	0.1	0.0
13	1.0	1.5	3.5	1.6	1.2	3.2	2.5	24.4	3.4	0.4	0.1	0.0
14	1.0	1.5	1.6	1.6	1.2	2.7	2.4	19.7	3.0	0.2	0.1	0.1
15	1.0	1.3	1.5	1.5	1.2	2.4	2.3	18.0	2.4	0.2	0.1	0.1
16	1.1	1.4	1.5	1.1	1.1	2.1	2.2	19.0	2.5	0.2	0.1	0.0
17	1.0	1.3	1.6	1.4	1.1	2.0	2.5	16.1	2.1	0.5	0.0	0.0
18	1.1	1.3	1.5	1.3	1.1	2.1	3.0	13.8	1.9	0.6	0.0	0.0
19	1.0	1.3	1.5	1.3	0.9	2.6	2.9	13.5	1.8	0.5	0.0	0.0
20	1.2	1.3	1.5	1.3	0.9	2.3	3.0	12.8	1.6	0.6	0.0	0.0
21	1.2	1.2	1.5	1.3	0.9	2.2	3.4	12.1	1.2	0.6	0.0	0.0
22	1.1	1.0	1.5	1.3	0.9	2.1	3.5	12.1	1.0	0.7	0.0	0.1
23	1.1	1.0	1.5	1.4	1.0	2.1	3.7	12.0	1.1	0.6	0.1	0.0
24	1.1	1.3	1.5	1.3	1.1	2.2	4.2	11.7	1.0	0.5	0.1	0.0
25	1.2	1.4	1.6	1.3	1.1	3.0	5.8	9.6	0.8	0.3	0.0	0.0
26	1.2	1.5	1.6	1.3	1.1	3.4	9.9	8.6	1.3	0.3	0.1	0.0
27	1.2	1.4	1.6	1.2	1.2	3.0	12.2	7.9	2.5	0.2	0.1	0.0
28	1.4	1.4	1.5	1.2	1.3	2.7	13.1	6.7	2.5	0.1	0.1	0.0
29	1.5	1.6	1.5	1.2	---	2.7	11.1	6.7	1.9	0.1	0.1	0.0
30	1.3	1.6	1.5	1.2	---	2.6	10.4	6.4	1.7	0.1	0.1	0.1
31	1.2	---	1.5	1.2	---	2.5	---	6.1	---	0.1	0.1	---
TOTAL	33.3	40.4	48.6	42.5	31.9	70.9	126.7	391.9	88.3	14.0	2.0	1.3
MEAN	1.1	1.3	1.6	1.4	1.1	2.3	4.2	12.6	2.9	0.5	0.1	0.0
MAX	1.5	1.6	3.5	1.6	1.3	3.4	13.1	24.6	5.6	1.5	0.1	0.1
MIN	0.9	1.0	1.1	1.1	0.9	1.3	2.0	6.1	0.8	0.1	0.0	0.0
AC-FT	66.0	80.1	96.4	84.3	63.3	140.6	251.3	777.4	175.2	27.7	3.9	2.6

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	0.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	0.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	0.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	XX	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	XX	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	XX	---	XX	XX	---	XX	---	XX	---	XX	XX	---
TOTAL												
MEAN												
MAX												
MIN												
AC-FT												

LIBBY CREEK

LOCATION.-- Latitude: 48:13:50, Longitude: 120:07:01, Okanagon County, Highway 53, tributary of Methow River -> Columbia River attached to North end of CMP road culvert (right hand side)

DRAINAGE AREA.-- 41.7 mi2

GAGE ELEVATION.-- 1391 ft

MEAN ANNUAL PRECIPITATION.-- 776 mm

MEAN WATER STRESS INDEX.-- 39 %

PERIOD OF RECORD.-- May 27, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed at downstream end of bridge with Galvanized pipe extended into water for added protection.
Golder & Associates began monitoring the same location some time after installation of the WSU stream gage.
Data from Golder & Associates gage was used from 8/4/01 to 11/8/01
*** - indicates missing data due to a gage malfunction

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 119.7 cfs, gage height, 3.11 ft; minimum discharge, 0.0 cfs, gage height, 0.05 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	31.4	25.7	13.3	6.6
2	XX	XX	XX	XX	XX	XX	XX	XX	30.9	23.0	13.0	6.6
3	XX	XX	XX	XX	XX	XX	XX	XX	31.0	23.8	12.8	7.0
4	XX	XX	XX	XX	XX	XX	XX	XX	32.0	24.3	12.9	7.3
5	XX	XX	XX	XX	XX	XX	XX	XX	34.7	22.9	12.7	7.1
6	XX	XX	XX	XX	XX	XX	XX	XX	35.2	22.7	12.5	7.1
7	XX	XX	XX	XX	XX	XX	XX	XX	33.7	22.0	12.2	7.0
8	XX	XX	XX	XX	XX	XX	XX	XX	33.8	21.5	11.9	7.0
9	XX	XX	XX	XX	XX	XX	XX	XX	32.8	20.9	10.9	6.7
10	XX	XX	XX	XX	XX	XX	XX	XX	31.6	20.2	11.1	6.7
11	XX	XX	XX	XX	XX	XX	XX	XX	30.5	19.8	10.7	6.5
12	XX	XX	XX	XX	XX	XX	XX	XX	31.2	19.4	10.3	6.2
13	XX	XX	XX	XX	XX	XX	XX	XX	30.8	18.7	10.5	5.6
14	XX	XX	XX	XX	XX	XX	XX	XX	31.5	18.0	9.8	5.9
15	XX	XX	XX	XX	XX	XX	XX	XX	32.9	17.9	9.4	5.8
16	XX	XX	XX	XX	XX	XX	XX	XX	31.6	17.4	9.5	5.9
17	XX	XX	XX	XX	XX	XX	XX	XX	31.4	17.3	9.2	5.8
18	XX	XX	XX	XX	XX	XX	XX	XX	32.1	16.8	9.2	5.8
19	XX	XX	XX	XX	XX	XX	XX	XX	32.0	16.7	9.3	4.9
20	XX	XX	XX	XX	XX	XX	XX	XX	31.1	16.2	9.1	4.8
21	XX	XX	XX	XX	XX	XX	XX	XX	32.1	15.9	9.1	4.9
22	XX	XX	XX	XX	XX	XX	XX	XX	32.1	16.0	8.7	5.2
23	XX	XX	XX	XX	XX	XX	XX	XX	30.4	15.9	8.2	5.0
24	XX	XX	XX	XX	XX	XX	XX	XX	29.9	15.6	8.0	4.7
25	XX	XX	XX	XX	XX	XX	XX	XX	29.6	15.1	7.8	4.6
26	XX	XX	XX	XX	XX	XX	XX	XX	29.2	14.7	6.8	4.5
27	XX	XX	XX	XX	XX	XX	XX	31.5	28.7	14.6	6.8	4.7
28	XX	XX	XX	XX	XX	XX	XX	31.3	28.6	14.1	7.0	4.7
29	XX	XX	XX	XX	XX	XX	XX	31.0	28.4	13.8	7.0	4.7
30	XX	XX	XX	XX	---	XX	XX	31.3	28.3	14.2	6.8	4.8
31	XX	---	XX	XX	---	XX	---	31.6	---	13.7	6.9	---
TOTAL									939.6	568.5	303.4	174.0
MEAN									31.3	18.3	9.8	5.8
MAX									35.2	25.7	13.3	7.3
MIN									28.3	13.7	6.8	4.5
AC-FT									1863.7	1127.6	601.7	345.1

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5.2	7.5	6.4	5.7	5.4	8.7	8.5	***	13.8	9.6	6.3	0.0
2	5.1	7.5	6.4	5.6	5.3	8.3	17.8	***	13.6	9.4	5.4	0.0
3	5.0	7.4	6.2	5.5	5.0	7.9	12.2	***	12.3	8.9	4.6	0.0
4	5.0	8.1	5.6	5.5	5.2	8.0	12.4	***	11.3	8.6	4.6	0.0
5	4.7	7.8	6.0	5.6	5.1	8.3	10.2	***	11.6	8.2	4.0	0.0
6	4.9	7.4	6.0	5.2	4.9	8.2	9.0	***	12.8	7.7	3.4	0.0
7	5.4	7.3	6.0	19.1	19.6	8.3	8.6	***	11.9	7.5	2.3	0.0
8	5.2	8.3	6.1	15.1	42.7	9.0	***	***	11.7	7.2	2.2	0.0
9	5.2	8.5	6.0	5.4	29.3	11.1	***	***	11.7	6.7	1.7	0.0
10	5.3	7.5	47.4	5.5	9.0	9.3	***	***	11.3	5.6	1.2	0.0
11	5.3	6.9	82.8	5.5	4.9	9.0	***	***	11.1	5.1	0.1	0.0
12	5.2	7.1	63.7	5.5	8.6	9.0	***	***	10.8	4.7	0.2	0.0
13	5.1	7.2	52.0	5.4	4.7	9.4	***	***	10.3	5.8	0.0	0.0
14	5.2	6.6	63.3	5.3	4.8	9.0	***	5.2	9.8	4.8	0.0	0.0
15	5.2	6.6	67.8	4.9	4.7	8.7	***	6.1	9.8	4.8	0.0	0.0
16	5.9	7.7	58.6	13.7	4.8	8.5	***	4.5	9.3	6.0	0.0	0.0
17	7.2	6.6	28.5	22.8	4.6	8.4	***	5.7	9.1	7.9	0.0	0.0
18	7.1	6.7	5.8	5.5	4.9	8.7	***	4.9	8.4	6.7	0.0	0.0
19	6.8	6.7	5.6	5.1	4.9	8.6	***	3.9	7.9	6.0	0.0	0.0
20	7.7	7.0	5.5	5.1	4.9	8.5	***	3.5	8.0	5.5	0.0	0.0
21	8.0	6.6	5.7	5.3	4.9	8.3	***	3.3	8.5	6.1	0.0	0.0
22	7.3	10.9	5.7	5.2	4.9	8.2	***	3.5	9.6	6.2	0.3	0.0
23	7.1	7.1	5.7	5.3	4.8	8.2	***	14.7	9.7	6.2	2.9	0.0
24	7.1	6.5	5.7	5.2	4.8	8.5	***	20.0	8.5	5.5	2.5	0.0
25	7.1	6.6	5.8	5.3	8.6	9.5	***	20.8	8.6	4.7	1.3	0.0
26	6.9	6.6	5.8	5.3	8.6	9.2	***	19.8	8.1	4.2	0.8	0.0
27	7.0	6.4	5.8	5.2	9.1	8.9	***	19.9	10.3	3.5	0.0	0.0
28	11.9	7.4	5.8	5.1	10.2	8.9	***	18.9	12.1	3.9	0.0	0.0
29	9.5	7.2	5.7	4.9	---	8.6	***	15.9	11.0	3.1	0.0	0.0
30	8.0	6.4	5.8	7.9	---	8.6	***	13.2	9.8	3.3	0.0	0.0
31	7.5	---	5.8	9.9	---	8.6	---	12.9	---	6.0	0.0	---
TOTAL	199.1	218.0	599.3	221.5	239.2	270.6			312.6	189.5	43.6	0.0
MEAN	6.4	7.3	19.3	7.1	8.5	8.7			10.4	6.1	1.4	0.0
MAX	11.9	10.9	82.8	22.8	42.7	11.1			13.8	9.6	6.3	0.0
MIN	4.7	6.4	5.5	4.9	4.6	7.9			7.9	3.1	0.0	0.0
AC-FT	395.0	432.5	1188.7	439.4	474.4	536.7			620.1	375.9	86.4	0.0

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	0.0	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	0.0	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	0.0	---	XX	XX	---	XX	---	XX	---	XX	XX	---
TOTAL	0.0											
MEAN	0.0											
MAX	0.0											
MIN	0.0											
AC-FT	0.0											

LITTLE BRIDGE CREEK

LOCATION.-- Latitude: 48:22:46, Longitude: 120:17:06, Okanagon County, National Forest Development Road 44, tributary of Twisp River -> Methow River ->Columbia River

DRAINAGE AREA.-- 24.3 mi2

GAGE ELEVATION.-- 2136 ft

MEAN ANNUAL PRECIPITATION.-- 756 mm

MEAN WATER STRESS INDEX.-- 36 %

PERIOD OF RECORD.-- May 27, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- A hole was dug into the bank through which PVC and Galvanized pipe are braced against roots and rocks.
Water cuts under bank at this location, providing a protective site for the instrument.
Flow through culvert was identified to be supercritical over the entire length.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 171.9 cfs, gage height, 2.92 ft; minimum discharge, 0.3 cfs, gage height, 0.87 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	21.6	17.4	2.4	0.9
2	XX	XX	XX	XX	XX	XX	XX	XX	20.4	12.6	2.3	0.9
3	XX	XX	XX	XX	XX	XX	XX	XX	20.7	12.7	2.2	0.9
4	XX	XX	XX	XX	XX	XX	XX	XX	26.8	11.7	2.2	1.1
5	XX	XX	XX	XX	XX	XX	XX	XX	61.6	9.9	2.2	1.1
6	XX	XX	XX	XX	XX	XX	XX	XX	78.6	9.2	2.0	1.1
7	XX	XX	XX	XX	XX	XX	XX	XX	48.8	8.6	1.9	1.0
8	XX	XX	XX	XX	XX	XX	XX	XX	41.7	8.4	1.8	0.9
9	XX	XX	XX	XX	XX	XX	XX	XX	34.6	8.3	1.8	0.9
10	XX	XX	XX	XX	XX	XX	XX	XX	27.4	8.0	1.7	1.0
11	XX	XX	XX	XX	XX	XX	XX	XX	21.8	7.6	1.6	0.9
12	XX	XX	XX	XX	XX	XX	XX	XX	22.5	7.3	1.6	0.9
13	XX	XX	XX	XX	XX	XX	XX	XX	21.0	7.0	1.5	0.9
14	XX	XX	XX	XX	XX	XX	XX	XX	30.8	6.4	1.5	0.9
15	XX	XX	XX	XX	XX	XX	XX	XX	73.5	6.3	1.5	0.9
16	XX	XX	XX	XX	XX	XX	XX	XX	48.4	6.1	1.4	0.9
17	XX	XX	XX	XX	XX	XX	XX	XX	42.5	5.8	1.4	0.8
18	XX	XX	XX	XX	XX	XX	XX	XX	53.3	5.4	1.4	0.8
19	XX	XX	XX	XX	XX	XX	XX	XX	48.1	4.9	1.5	0.8
20	XX	XX	XX	XX	XX	XX	XX	XX	33.7	4.8	1.4	0.8
21	XX	XX	XX	XX	XX	XX	XX	XX	47.6	4.6	1.4	0.9
22	XX	XX	XX	XX	XX	XX	XX	XX	52.1	4.9	1.4	0.9
23	XX	XX	XX	XX	XX	XX	XX	XX	29.8	5.9	1.3	0.9
24	XX	XX	XX	XX	XX	XX	XX	XX	24.2	4.5	1.3	0.9
25	XX	XX	XX	XX	XX	XX	XX	XX	24.7	3.9	0.9	0.9
26	XX	XX	XX	XX	XX	XX	XX	XX	23.6	3.6	0.9	0.9
27	XX	XX	XX	XX	XX	XX	XX	24.7	23.9	3.4	0.9	0.8
28	XX	XX	XX	XX	XX	XX	XX	23.7	28.8	3.2	0.9	0.9
29	XX	XX	XX	XX	XX	XX	XX	22.0	30.7	3.1	0.9	1.0
30	XX	XX	XX	XX	---	XX	XX	23.6	21.9	2.9	0.9	1.2
31	XX	---	XX	XX	---	XX	---	23.0	---	2.6	0.9	---
TOTAL									1085.0	211.1	46.9	27.7
MEAN									36.2	6.8	1.5	0.9
MAX									78.6	17.4	2.4	1.2
MIN									20.4	2.6	0.9	0.8
AC-FT									2152.0	418.7	93.0	55.0

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.3	1.7	1.6	1.4	1.4	1.4	34.1	12.0	12.6	3.9	1.0	0.5
2	1.1	1.7	1.6	1.4	1.4	1.4	38.2	12.0	11.6	3.7	0.9	0.5
3	1.1	1.7	1.5	1.4	1.4	1.4	22.3	11.2	10.3	3.5	0.9	0.5
4	1.2	2.0	2.2	1.4	1.5	1.4	40.7	11.6	9.4	3.4	0.9	0.5
5	1.2	1.8	1.5	1.5	1.5	1.5	40.1	10.6	9.7	3.2	0.8	0.5
6	1.2	1.7	1.5	1.4	1.4	1.6	52.0	9.8	9.3	3.0	0.8	0.5
7	1.3	1.7	1.5	1.2	1.4	1.9	48.8	11.4	8.5	2.9	0.8	0.5
8	1.4	1.9	1.6	1.6	1.8	2.3	58.7	12.8	8.0	2.8	0.7	0.5
9	1.4	2.0	1.5	1.5	1.4	3.6	76.9	11.8	8.0	2.6	0.7	0.4
10	1.4	1.8	1.4	1.5	1.4	4.3	33.6	11.3	7.5	2.4	0.7	0.4
11	1.5	2.2	1.9	1.5	1.4	5.1	42.4	12.4	7.5	2.2	0.7	0.4
12	1.4	2.4	1.6	1.5	1.3	8.1	46.6	14.8	7.2	2.2	0.6	0.4
13	1.4	1.7	1.6	1.5	1.4	11.1	44.3	17.3	6.8	2.5	0.6	0.4
14	1.4	4.6	2.6	1.4	1.4	15.1	36.3	16.6	6.5	2.1	0.7	0.4
15	1.4	26.1	6.3	1.3	1.4	9.8	41.8	14.5	6.0	1.9	0.6	0.5
16	1.5	34.1	7.4	1.1	1.4	13.6	58.0	13.1	5.8	2.0	0.6	0.5
17	1.8	28.1	7.6	1.7	1.3	20.0	47.6	11.8	5.5	2.5	0.6	0.5
18	1.7	24.9	6.3	1.5	1.4	15.3	29.5	11.3	5.4	2.0	0.5	0.4
19	1.6	8.6	4.2	1.4	1.4	18.9	23.0	11.2	5.3	1.9	0.5	0.4
20	1.9	5.5	2.6	1.4	1.4	19.3	24.8	10.7	5.2	1.8	0.5	0.4
21	1.8	7.8	1.8	1.4	1.5	19.8	20.8	11.0	4.8	2.0	0.5	0.5
22	1.6	54.3	1.5	1.4	1.5	28.5	17.6	14.6	4.6	2.3	0.7	0.4
23	1.6	76.8	1.4	1.4	1.5	35.8	17.5	40.9	4.4	2.4	0.9	0.4
24	1.7	45.2	1.4	1.4	1.5	39.8	19.7	83.3	4.3	2.0	0.6	0.4
25	1.7	16.0	1.3	1.5	1.3	37.6	27.1	64.5	4.5	1.8	0.5	0.5
26	1.7	1.7	1.4	1.5	1.3	43.9	28.2	43.1	4.2	1.7	0.5	0.7
27	1.8	1.6	1.4	1.4	1.3	21.9	22.6	34.7	4.8	1.5	0.5	0.5
28	2.8	7.3	1.4	1.4	1.4	31.4	22.8	24.9	4.7	1.4	0.5	0.5
29	2.3	4.0	1.3	1.4	---	40.7	16.1	15.0	4.2	1.4	0.5	0.5
30	1.9	1.6	1.4	1.4	---	45.4	12.7	12.5	4.0	1.4	0.5	0.5
31	1.7	---	1.4	1.4	---	38.0	---	11.8	---	1.4	0.5	---
TOTAL	48.7	372.6	73.6	44.4	39.6	539.9	1044.7	604.4	200.5	71.5	20.2	14.0
MEAN	1.6	12.4	2.4	1.4	1.4	17.4	34.8	19.5	6.7	2.3	0.7	0.5
MAX	2.8	76.8	7.6	1.7	1.8	45.4	76.9	83.3	12.6	3.9	1.0	0.7
MIN	1.1	1.6	1.3	1.1	1.3	1.4	12.7	9.8	4.0	1.4	0.5	0.4
AC-FT	96.5	739.1	145.9	88.2	78.6	1070.8	2072.2	1198.8	397.6	141.8	40.0	27.7

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.5	1.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	0.5	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	0.5	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	0.5	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	0.6	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	0.8	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	0.8	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	0.8	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	0.8	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	0.9	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	1.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	1.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	1.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	1.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	1.1	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	1.2	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	1.6	---	XX	XX	---	XX	---	0.0	---	XX	XX	---
TOTAL	32.0											
MEAN	1.0											
MAX	1.8											
MIN	0.5											
AC-FT	63.4											

LOUP LOUP CREEK

LOCATION.-- Latitude: 48:21:59, Longitude: 119:44:46, Okanagon County, Highway 20, tributary of Summit Creek -> Okanagon River -> Columbia River

DRAINAGE AREA.-- 44.2 mi2

GAGE ELEVATION.-- 2119 ft

MEAN ANNUAL PRECIPITATION.-- 509 mm

MEAN WATER STRESS INDEX.-- 76 %

PERIOD OF RECORD.-- May 26, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge was installed to concrete at downstream end of culvert. Fish have been sited several times at this stream

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 23.9 cfs, gage height, 1.76 ft; minimum discharge, 0.3 cfs, gage height, 0.56 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.6	0.8	0.7
2	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.3	0.8	0.7
3	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.6	0.8	0.8
4	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.7	0.9	0.8
5	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.6	0.9	0.8
6	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.4	0.8	0.8
7	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.5	0.8	0.8
8	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.4	0.8	0.9
9	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.5	0.8	0.8
10	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.5	0.8	0.8
11	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.4	0.8	0.8
12	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.3	0.8	0.8
13	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.2	0.7	0.8
14	XX	XX	XX	XX	XX	XX	XX	XX	2.1	1.1	0.7	0.8
15	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.1	0.7	0.8
16	XX	XX	XX	XX	XX	XX	XX	XX	1.9	1.3	0.7	0.9
17	XX	XX	XX	XX	XX	XX	XX	XX	1.9	1.7	0.7	1.3
18	XX	XX	XX	XX	XX	XX	XX	XX	1.8	1.2	0.7	1.5
19	XX	XX	XX	XX	XX	XX	XX	XX	1.8	1.1	0.8	1.0
20	XX	XX	XX	XX	XX	XX	XX	XX	1.9	1.2	0.8	1.4
21	XX	XX	XX	XX	XX	XX	XX	XX	2.0	1.1	0.9	1.8
22	XX	XX	XX	XX	XX	XX	XX	XX	1.8	1.1	0.8	2.1
23	XX	XX	XX	XX	XX	XX	XX	XX	1.8	1.1	0.7	2.2
24	XX	XX	XX	XX	XX	XX	XX	XX	1.7	1.0	0.7	2.3
25	XX	XX	XX	XX	XX	XX	XX	XX	1.7	1.0	0.7	2.0
26	XX	XX	XX	XX	XX	XX	XX	2.3	1.6	1.0	0.7	1.1
27	XX	XX	XX	XX	XX	XX	XX	2.3	1.6	1.0	0.7	1.0
28	XX	XX	XX	XX	XX	XX	XX	2.2	1.4	1.0	0.7	1.1
29	XX	XX	XX	XX	XX	XX	XX	2.2	1.5	0.9	0.8	1.6
30	XX	XX	XX	XX	---	XX	XX	2.3	1.6	0.9	0.7	2.1
31	XX	---	XX	XX	---	XX	---	2.2	---	0.9	0.7	---
TOTAL									57.4	38.6	23.8	35.2
MEAN									1.9	1.2	0.8	1.2
MAX									2.6	1.7	0.9	2.3
MIN									1.4	0.9	0.7	0.7
AC-FT									113.9	76.5	47.3	69.7

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.4	1.2	1.1	4.9	2.1	2.4	1.2	1.0	1.0	0.9	0.6	0.4
2	2.1	1.2	1.1	4.8	2.2	2.0	1.1	1.0	0.9	0.8	0.6	0.4
3	1.4	1.2	1.1	4.8	2.2	1.8	1.1	1.0	1.0	0.8	0.6	0.4
4	2.2	1.2	1.1	4.8	2.2	1.4	1.2	1.1	0.9	0.8	0.6	0.4
5	2.9	1.2	1.1	4.8	2.2	1.4	1.2	1.1	1.0	0.8	0.5	0.4
6	3.2	1.2	1.1	4.6	2.1	1.6	1.2	1.1	1.0	0.8	0.6	0.9
7	2.2	1.2	1.1	8.9	6.3	1.6	1.2	1.1	0.9	0.8	0.6	1.7
8	1.6	1.3	1.1	4.7	3.9	1.7	1.1	1.1	0.9	0.7	0.7	1.7
9	2.0	1.4	1.1	4.7	2.9	2.1	1.1	1.1	0.9	0.7	0.6	1.7
10	2.7	1.2	1.2	4.7	2.3	1.9	1.1	1.1	0.9	0.7	0.6	1.6
11	3.8	1.1	2.8	4.7	2.1	1.9	1.1	1.1	0.9	0.7	0.5	1.6
12	2.8	1.1	3.2	4.7	3.0	2.2	1.1	1.1	0.9	0.6	0.5	1.6
13	1.3	1.1	6.0	4.7	2.1	2.3	1.1	1.1	0.9	0.8	0.5	1.6
14	1.3	1.1	5.0	4.6	2.1	1.7	1.1	1.1	0.8	0.7	0.4	1.6
15	1.3	1.0	3.6	4.5	2.0	1.5	1.1	1.2	0.8	0.6	0.4	1.6
16	1.4	1.1	3.0	12.4	2.0	1.4	1.1	1.2	0.8	1.0	0.4	1.5
17	1.5	1.0	2.6	10.9	3.0	1.3	1.1	1.1	0.7	1.0	0.4	1.5
18	1.5	1.1	2.3	4.6	2.1	1.5	1.1	1.2	0.7	0.8	0.4	1.4
19	1.5	1.0	8.0	4.6	2.1	1.5	1.1	1.1	0.8	0.7	0.4	1.4
20	1.7	1.2	21.0	4.5	2.1	1.3	1.1	1.0	0.8	0.7	0.4	1.4
21	1.6	1.1	12.2	4.6	2.1	1.3	1.1	1.1	0.8	0.8	0.4	1.5
22	1.5	1.1	5.1	4.8	2.2	1.3	1.1	1.1	0.8	0.9	0.7	1.5
23	1.6	1.1	5.1	4.6	2.2	1.2	1.1	1.1	0.8	0.9	0.8	1.4
24	1.6	1.1	5.0	3.4	2.2	1.2	1.1	1.1	0.7	0.7	0.6	1.4
25	1.6	1.1	4.9	2.3	2.3	1.9	1.1	1.1	0.8	0.7	0.5	1.4
26	1.6	1.1	4.9	2.2	2.8	1.4	1.1	1.0	0.8	0.6	0.5	1.8
27	1.7	1.1	4.9	2.5	3.0	1.2	1.1	1.1	1.3	0.6	0.5	1.5
28	3.6	1.0	4.8	2.1	3.3	1.3	1.3	1.0	1.1	0.7	0.5	1.3
29	1.6	1.1	4.8	2.1	---	1.2	1.1	0.9	1.0	0.6	0.5	1.3
30	1.3	1.1	4.8	2.4	---	1.3	1.0	1.0	0.9	0.6	0.4	1.3
31	1.3	---	4.9	2.7	---	1.2	---	1.0	---	0.6	0.4	---
TOTAL	59.8	34.0	130.0	145.6	71.0	49.2	33.3	33.5	26.7	23.3	15.8	39.3
MEAN	1.9	1.1	4.2	4.7	2.5	1.6	1.1	1.1	0.9	0.8	0.5	1.3
MAX	3.8	1.4	21.0	12.4	6.3	2.4	1.3	1.2	1.3	1.0	0.8	1.8
MIN	1.3	1.0	1.1	2.1	2.0	1.2	1.0	0.9	0.7	0.6	0.4	0.4
AC-FT	118.6	67.5	257.9	288.8	140.8	97.5	66.1	66.4	52.9	46.3	31.3	77.9

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.3	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	1.2	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	1.2	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	1.2	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	1.3	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	1.4	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	1.5	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	1.3	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	1.3	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	1.3	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	1.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	1.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	1.2	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	1.5	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	1.5	---	XX	XX	---	XX	---	XX	---	XX	XX	---
TOTAL	39.7											
MEAN	1.3											
MAX	1.6											
MIN	1.1											
AC-FT	78.8											

LOWER PESHASTIN CREEK

LOCATION.-- Latitude: 47:23:49, Longitude: 120:39:11, Chelan County, Forest Road 7320, tributary of Wenatchee River -> Columbia River

DRAINAGE AREA.-- 36.4 mi2

GAGE ELEVATION.-- 2585 ft

MEAN ANNUAL PRECIPITATION.-- 817 mm

MEAN WATER STRESS INDEX.-- 40 %

PERIOD OF RECORD.-- May 28, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed at downstream end of bridge. Large scour hole under bridge provides great fish habitat.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 147 cfs, gage height, 2.98 ft; minimum discharge, 0.5 cfs, gage height, 1.24 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	27.3	6.0	2.3	1.4
2	XX	XX	XX	XX	XX	XX	XX	XX	22.0	6.3	2.2	1.5
3	XX	XX	XX	XX	XX	XX	XX	XX	18.2	7.3	2.1	1.7
4	XX	XX	XX	XX	XX	XX	XX	XX	12.4	7.0	2.1	1.9
5	XX	XX	XX	XX	XX	XX	XX	XX	12.8	6.2	2.0	1.9
6	XX	XX	XX	XX	XX	XX	XX	XX	13.5	5.8	1.9	1.9
7	XX	XX	XX	XX	XX	XX	XX	XX	24.3	5.5	1.9	1.8
8	XX	XX	XX	XX	XX	XX	XX	XX	23.9	5.0	1.8	1.7
9	XX	XX	XX	XX	XX	XX	XX	XX	28.2	5.4	1.8	2.1
10	XX	XX	XX	XX	XX	XX	XX	XX	30.0	5.0	1.7	2.0
11	XX	XX	XX	XX	XX	XX	XX	XX	26.0	4.5	1.7	1.9
12	XX	XX	XX	XX	XX	XX	XX	XX	37.3	4.2	1.7	1.7
13	XX	XX	XX	XX	XX	XX	XX	XX	19.6	4.0	1.7	1.6
14	XX	XX	XX	XX	XX	XX	XX	XX	13.2	3.8	1.7	1.6
15	XX	XX	XX	XX	XX	XX	XX	XX	17.3	3.8	1.7	1.5
16	XX	XX	XX	XX	XX	XX	XX	XX	14.1	3.8	1.6	1.5
17	XX	XX	XX	XX	XX	XX	XX	XX	13.2	3.8	1.6	1.5
18	XX	XX	XX	XX	XX	XX	XX	XX	10.1	3.6	1.6	1.5
19	XX	XX	XX	XX	XX	XX	XX	XX	12.9	3.5	1.7	1.5
20	XX	XX	XX	XX	XX	XX	XX	XX	9.7	3.4	1.7	1.5
21	XX	XX	XX	XX	XX	XX	XX	XX	10.7	3.3	1.7	1.9
22	XX	XX	XX	XX	XX	XX	XX	XX	10.0	3.1	1.6	2.1
23	XX	XX	XX	XX	XX	XX	XX	XX	9.3	3.1	1.5	1.9
24	XX	XX	XX	XX	XX	XX	XX	XX	8.7	3.0	1.4	1.9
25	XX	XX	XX	XX	XX	XX	XX	XX	8.2	2.9	1.4	1.8
26	XX	XX	XX	XX	XX	XX	XX	XX	7.7	2.8	1.4	1.8
27	XX	XX	XX	XX	XX	XX	XX	XX	7.3	2.8	1.4	1.7
28	XX	XX	XX	XX	XX	XX	XX	9.9	6.8	2.7	1.4	1.7
29	XX	XX	XX	XX	XX	XX	XX	35.3	6.4	2.6	1.4	1.7
30	XX	XX	XX	XX	---	XX	XX	32.8	6.1	2.5	1.4	2.0
31	XX	---	XX	XX	---	XX	---	30.1	---	2.4	1.4	---
TOTAL									466.9	128.8	52.4	51.9
MEAN									15.6	4.2	1.7	1.7
MAX									37.3	7.3	2.3	2.1
MIN									6.1	2.4	1.4	1.4
AC-FT									926.1	255.5	104.0	102.9

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.1	2.6	2.9	2.8	2.7	5.2	47.3	66.8	13.3	4.7	1.7	1.0
2	1.9	2.6	2.9	2.8	2.9	5.2	42.3	55.1	12.3	4.3	1.6	1.0
3	1.8	2.6	2.8	2.8	2.8	5.2	36.8	48.4	11.5	4.0	1.5	0.9
4	1.8	3.5	2.7	2.9	2.9	5.1	33.3	46.3	10.7	3.8	1.6	0.9
5	1.8	3.2	2.7	3.6	2.9	5.2	31.2	47.9	11.7	3.6	1.5	0.9
6	1.8	2.9	2.7	10.3	2.8	5.7	30.5	44.2	10.9	3.4	1.4	0.9
7	1.8	2.8	2.6	3.5	3.1	8.4	28.8	41.7	9.6	3.3	1.4	0.9
8	1.8	3.1	2.7	3.4	2.9	12.9	26.7	42.6	9.4	3.2	1.3	0.9
9	1.8	3.0	2.7	3.1	2.9	15.9	25.0	44.1	9.8	3.0	1.3	0.9
10	1.8	2.8	2.7	3.0	2.8	17.5	25.3	42.0	8.4	2.8	1.3	0.8
11	1.9	2.5	2.6	3.0	2.8	19.0	25.3	40.8	8.0	2.7	1.2	0.8
12	1.9	2.6	2.6	2.9	2.8	20.1	24.6	44.0	7.9	2.7	1.1	0.8
13	1.8	2.7	3.0	3.0	2.8	25.9	23.7	48.8	7.4	2.6	1.1	0.8
14	1.8	2.7	3.4	2.9	2.8	28.0	22.9	46.8	6.9	2.4	1.0	0.8
15	1.8	2.6	3.9	2.9	2.8	27.1	23.2	43.4	6.5	2.4	1.0	0.8
16	2.1	2.7	3.7	3.3	3.0	24.6	26.9	40.5	6.2	2.4	0.9	0.8
17	2.6	2.6	3.9	2.9	2.9	22.7	38.0	35.7	5.8	2.4	0.9	0.8
18	2.4	2.6	3.6	2.8	2.9	28.6	46.0	32.1	5.7	2.3	0.9	0.7
19	2.1	2.6	3.3	2.8	2.9	49.4	47.9	29.4	5.5	2.2	0.9	0.7
20	2.7	2.7	3.2	2.8	3.0	48.0	47.5	27.1	5.2	2.2	0.9	0.8
21	2.7	2.6	3.1	2.9	3.0	44.5	49.3	25.8	5.1	2.2	0.9	0.7
22	2.5	2.7	3.6	2.8	3.1	42.7	51.3	26.1	4.8	2.2	1.5	0.8
23	2.5	2.9	3.1	2.8	3.2	43.2	52.6	27.9	4.5	2.4	1.9	0.8
24	2.6	2.9	3.1	2.8	3.3	45.7	64.6	28.9	4.8	2.1	1.6	0.8
25	2.6	2.9	3.0	2.7	5.4	66.4	84.1	27.1	4.9	1.9	1.4	0.8
26	2.6	2.9	2.9	2.7	3.6	75.0	115.1	24.1	4.6	1.8	1.3	0.9
27	2.6	3.1	2.9	4.2	4.0	57.9	132.6	21.5	8.5	1.8	1.2	0.9
28	3.1	2.8	2.9	2.6	4.6	48.2	120.5	19.2	7.1	1.7	1.2	0.9
29	3.0	3.0	2.8	2.6	---	44.7	92.4	17.1	5.5	1.8	1.1	0.9
30	2.8	2.9	2.8	2.6	---	42.5	80.1	15.6	5.1	1.8	1.1	1.0
31	2.7	---	2.8	2.7	---	44.0	---	14.4	---	1.7	1.0	---
TOTAL	69.2	84.0	93.8	98.8	87.6	934.5	1495.6	1115.4	227.9	81.8	38.8	25.2
MEAN	2.2	2.8	3.0	3.2	3.1	30.1	49.9	36.0	7.6	2.6	1.3	0.8
MAX	3.1	3.5	3.9	10.3	5.4	75.0	132.6	66.8	13.3	4.7	1.9	1.0
MIN	1.8	2.5	2.6	2.6	2.7	5.1	22.9	14.4	4.5	1.7	0.9	0.7
AC-FT	137.2	166.6	186.1	196.0	173.8	1853.6	2966.5	2212.4	452.0	162.2	77.0	50.0

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.0	9.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	0.9	7.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	0.9	6.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	0.9	6.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	0.9	5.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	0.9	4.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	0.9	4.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	1.0	3.9	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	1.0	3.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	1.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	1.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	2.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	7.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	4.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	3.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	3.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	3.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	3.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	3.4	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	4.5	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	10.2	---	XX	XX	---	XX	---	0.0	---	XX	XX	---
TOTAL	71.1											
MEAN	2.3											
MAX	10.2											
MIN	0.9											
AC-FT	140.9											

UPPER PESHASTIN CREEK

LOCATION.-- Latitude: 47:23:23, Longitude: 120:39:29, Chelan County, Forest Road 7320, tributary of Wenatchee River -> Columbia River

DRAINAGE AREA.-- 19.4 mi2

GAGE ELEVATION.-- 2579 ft

MEAN ANNUAL PRECIPITATION.-- 832 mm

MEAN WATER STRESS INDEX.-- 40 %

PERIOD OF RECORD.-- May 20, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed under bridge at downstream end protected by large boulders.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 80.5 cfs, gage height, 2.12 ft; minimum discharge, 0.9 cfs, gage height, 0.56 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	12.3	4.1	1.8	0.9
2	XX	XX	XX	XX	XX	XX	XX	XX	11.7	3.9	1.7	1.0
3	XX	XX	XX	XX	XX	XX	XX	XX	11.4	4.3	1.7	1.2
4	XX	XX	XX	XX	XX	XX	XX	XX	11.4	4.1	1.7	1.3
5	XX	XX	XX	XX	XX	XX	XX	XX	11.8	3.9	1.7	1.2
6	XX	XX	XX	XX	XX	XX	XX	XX	11.8	3.8	1.6	1.2
7	XX	XX	XX	XX	XX	XX	XX	XX	11.1	3.6	1.5	1.2
8	XX	XX	XX	XX	XX	XX	XX	XX	10.5	3.4	1.5	1.2
9	XX	XX	XX	XX	XX	XX	XX	XX	9.7	3.3	1.5	1.4
10	XX	XX	XX	XX	XX	XX	XX	XX	9.0	3.2	1.4	1.4
11	XX	XX	XX	XX	XX	XX	XX	XX	8.6	3.1	1.4	1.3
12	XX	XX	XX	XX	XX	XX	XX	XX	12.6	3.0	1.4	1.2
13	XX	XX	XX	XX	XX	XX	XX	XX	10.8	2.8	1.4	1.1
14	XX	XX	XX	XX	XX	XX	XX	XX	9.9	2.7	1.4	1.1
15	XX	XX	XX	XX	XX	XX	XX	XX	9.2	2.7	1.3	1.1
16	XX	XX	XX	XX	XX	XX	XX	XX	8.5	2.7	1.3	1.0
17	XX	XX	XX	XX	XX	XX	XX	XX	7.9	2.6	1.3	1.0
18	XX	XX	XX	XX	XX	XX	XX	XX	7.4	2.5	1.3	1.1
19	XX	XX	XX	XX	XX	XX	XX	XX	6.9	2.4	1.3	1.1
20	XX	XX	XX	XX	XX	XX	XX	XX	6.5	2.4	1.3	1.0
21	XX	XX	XX	XX	XX	XX	XX	XX	6.2	2.3	1.3	1.4
22	XX	XX	XX	XX	XX	XX	XX	XX	5.8	2.3	1.3	1.3
23	XX	XX	XX	XX	XX	XX	XX	XX	5.6	2.2	1.2	1.2
24	XX	XX	XX	XX	XX	XX	XX	XX	5.4	2.1	1.2	1.2
25	XX	XX	XX	XX	XX	XX	XX	XX	5.1	2.1	1.1	1.2
26	XX	XX	XX	XX	XX	XX	XX	XX	5.0	2.0	1.1	1.1
27	XX	XX	XX	XX	XX	XX	XX	XX	4.8	2.1	1.0	1.1
28	XX	XX	XX	XX	XX	XX	XX	XX	4.6	2.0	1.0	1.1
29	XX	XX	XX	XX	XX	XX	XX	12.8	4.4	2.0	1.1	1.2
30	XX	XX	XX	XX	---	XX	XX	12.8	4.3	2.0	1.1	1.5
31	XX	---	XX	XX	---	XX	---	12.7	---	1.9	1.0	---
TOTAL									249.9	87.5	41.9	35.3
MEAN									8.3	2.8	1.4	1.2
MAX									12.6	4.3	1.8	1.5
MIN									4.3	1.9	1.0	0.9
AC-FT									495.7	173.5	83.1	70.0

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.5	1.5	1.5	1.7	2.7	6.3	30.4	46.2	19.9	16.7	11.2	9.6
2	1.2	1.5	1.6	1.7	2.9	6.0	28.4	40.4	18.3	16.1	11.9	8.7
3	1.2	1.5	1.5	1.8	2.8	7.5	26.2	38.0	17.4	16.3	11.5	8.9
4	1.2	1.9	1.5	1.9	2.9	6.1	25.3	38.3	17.3	16.5	12.2	9.0
5	1.1	1.7	1.5	3.6	3.0	6.3	24.7	38.9	18.0	15.8	11.4	7.6
6	1.1	1.6	1.5	2.6	3.0	6.7	24.6	36.9	17.4	14.6	12.3	7.2
7	1.1	1.6	1.5	2.7	3.7	8.7	23.6	36.9	17.4	14.9	12.2	7.3
8	1.1	1.6	1.5	2.4	2.9	12.2	22.4	37.7	17.8	15.3	11.6	7.4
9	1.1	1.6	1.5	2.2	3.0	14.6	21.7	37.9	18.3	15.3	11.1	7.7
10	1.1	1.7	1.5	2.2	3.0	15.5	22.0	37.1	17.4	14.8	11.3	7.8
11	1.2	3.3	1.5	2.2	3.1	16.5	22.3	37.5	16.6	15.0	11.2	7.9
12	1.1	2.3	1.4	2.2	3.1	16.8	22.1	40.1	15.8	14.6	11.3	8.1
13	1.1	1.9	1.3	2.2	3.2	20.2	21.4	42.0	16.6	14.1	11.3	8.4
14	1.1	1.9	1.2	2.2	3.2	21.3	20.7	39.8	16.3	13.5	10.6	8.6
15	1.1	3.0	1.5	2.2	3.3	20.8	21.4	37.7	16.0	12.5	10.6	8.2
16	1.3	1.7	1.6	2.3	3.3	19.0	24.8	36.4	15.9	11.5	10.4	8.4
17	1.6	1.7	1.8	2.3	3.4	17.7	30.5	33.6	14.8	12.0	10.3	8.1
18	1.4	1.6	1.8	2.2	3.5	21.2	33.8	32.7	14.6	11.8	9.1	7.3
19	1.3	2.3	1.8	2.2	3.6	31.5	34.1	31.9	15.7	11.6	8.5	7.1
20	1.6	1.5	1.8	2.2	3.7	30.4	34.5	29.3	16.4	12.2	8.5	6.9
21	1.5	2.1	1.7	2.3	3.7	28.5	35.5	29.3	17.1	13.2	8.4	7.0
22	1.4	2.9	1.7	2.3	3.9	27.9	36.3	30.7	16.4	12.9	11.6	7.7
23	1.4	1.8	1.6	2.4	4.0	28.6	37.7	32.8	14.8	13.4	12.6	7.8
24	1.4	1.5	1.6	2.4	4.3	29.8	45.2	33.9	14.0	13.1	10.6	8.1
25	1.4	1.5	1.6	2.4	6.0	39.8	55.9	31.7	14.0	12.5	10.3	7.9
26	1.4	1.5	1.6	2.4	10.6	43.5	69.7	29.2	13.8	12.5	10.2	8.6
27	1.4	1.6	1.7	2.5	12.4	34.1	76.5	27.0	18.2	12.3	10.8	7.5
28	1.7	1.5	1.7	2.4	10.3	30.2	71.2	23.7	17.8	12.3	11.1	7.3
29	1.6	1.5	1.7	2.5	---	28.9	59.6	21.6	16.4	11.2	10.8	7.0
30	1.6	1.5	1.7	2.5	---	28.2	53.3	20.9	16.0	10.5	10.7	7.2
31	1.5	---	1.7	2.6	---	29.2	---	21.4	---	10.8	10.4	---
TOTAL	41.2	54.9	49.1	71.9	118.1	654.2	1055.8	1051.5	496.5	419.7	335.9	236.0
MEAN	1.3	1.8	1.6	2.3	4.2	21.1	35.2	33.9	16.5	13.5	10.8	7.9
MAX	1.7	3.3	1.8	3.6	12.4	43.5	76.5	46.2	19.9	16.7	12.6	9.6
MIN	1.1	1.5	1.2	1.7	2.7	6.0	20.7	20.9	13.8	10.5	8.4	6.9
AC-FT	81.8	108.8	97.4	142.7	234.3	1297.6	2094.1	2085.6	984.7	832.5	666.2	468.2

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7.3	21.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	7.0	20.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	6.8	18.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	6.3	17.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	5.9	17.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	6.2	15.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	6.1	13.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	6.9	12.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	6.7	12.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	6.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	8.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	8.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	8.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	8.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	8.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	7.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	7.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	7.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	8.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	7.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	7.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	9.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	17.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	13.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	13.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	14.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	14.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	12.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	12.2	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	14.4	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	21.4	---	XX	XX	---	XX	---	XX	---	XX	XX	---
TOTAL	296.5											
MEAN	9.6											
MAX	21.4											
MIN	5.9											
AC-FT	588.2											

MILL CREEK

LOCATION.-- Latitude: 45:51:34, Longitude: 120:57:47, Klickitat County, Highway 142, tributary of Little Klickitat River -> Klickitat River -> Columbia River

DRAINAGE AREA.-- 28.6 mi2

GAGE ELEVATION.-- 2585 ft

MEAN ANNUAL PRECIPITATION.-- 732 mm

MEAN WATER STRESS INDEX.-- 63 %

PERIOD OF RECORD.-- June 14, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed at downstream end of culvert. This is the location of a discontinued USGS gauging station.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 12.8 cfs, gage height, 1.33 ft; minimum discharge, 3.0 cfs, gage height, 0.60 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.7	5.5	6.3
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.5	5.6	6.5
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.3	5.6	6.5
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.6	5.3	6.8
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.3	4.3	6.7
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.3	4.1	6.5
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.3	3.9	6.4
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.9	4.0	6.5
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.1	3.8	6.6
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.1	3.9	6.6
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	7.1	4.0	6.5
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.8	3.9	6.3
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	6.6	4.1	6.2
14	XX	XX	XX	XX	XX	XX	XX	XX	10.4	6.3	4.5	6.1
15	XX	XX	XX	XX	XX	XX	XX	XX	10.1	5.7	4.7	6.1
16	XX	XX	XX	XX	XX	XX	XX	XX	9.7	5.6	4.6	6.2
17	XX	XX	XX	XX	XX	XX	XX	XX	9.5	5.8	4.6	6.2
18	XX	XX	XX	XX	XX	XX	XX	XX	9.4	6.0	4.7	6.1
19	XX	XX	XX	XX	XX	XX	XX	XX	9.2	5.9	4.9	6.1
20	XX	XX	XX	XX	XX	XX	XX	XX	8.5	5.8	4.9	6.1
21	XX	XX	XX	XX	XX	XX	XX	XX	8.6	5.7	4.8	6.3
22	XX	XX	XX	XX	XX	XX	XX	XX	8.0	5.9	4.7	6.3
23	XX	XX	XX	XX	XX	XX	XX	XX	7.5	6.1	4.6	6.6
24	XX	XX	XX	XX	XX	XX	XX	XX	7.3	6.0	4.3	6.6
25	XX	XX	XX	XX	XX	XX	XX	XX	7.6	5.9	4.4	6.5
26	XX	XX	XX	XX	XX	XX	XX	XX	7.5	6.0	5.0	6.5
27	XX	XX	XX	XX	XX	XX	XX	XX	7.0	5.8	5.4	6.5
28	XX	XX	XX	XX	XX	XX	XX	XX	7.5	5.6	5.4	6.4
29	XX	XX	XX	XX	XX	XX	XX	XX	7.6	5.5	5.9	6.5
30	XX	XX	XX	XX	---	XX	XX	XX	7.7	5.4	6.2	6.9
31	XX	---	XX	XX	---	XX	---	XX	---	5.4	6.2	---
TOTAL										193.9	147.8	192.4
MEAN										6.3	4.8	6.4
MAX										7.7	6.2	6.9
MIN										5.4	3.8	6.1
AC-FT										385	293	382

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	7.3	7.0	7.1	6.7	6.2	7.1	9.8	10.3	5.9	5.8	5.8	XX
2	6.8	7.0	7.1	6.7	6.6	6.9	9.6	9.8	6.9	5.8	5.8	XX
3	6.7	7.0	7.1	6.7	6.5	6.7	9.4	9.5	7.0	6.0	5.4	XX
4	6.7	7.1	7.0	6.8	7.1	7.0	9.1	9.3	6.5	6.4	5.6	XX
5	6.7	7.2	6.9	7.3	7.8	7.2	8.9	9.2	5.9	6.2	5.3	XX
6	6.6	7.3	6.9	7.1	7.0	7.4	8.8	9.1	5.9	5.9	XX	XX
7	6.6	7.6	6.9	6.0	5.3	7.7	8.7	9.0	5.6	6.0	XX	XX
8	6.6	7.8	6.8	7.2	6.8	8.0	8.5	8.8	5.3	5.8	XX	XX
9	6.7	7.5	6.8	6.6	7.1	7.9	8.3	8.8	4.8	5.7	XX	XX
10	6.9	7.3	6.8	6.7	6.7	7.7	8.3	8.7	4.8	5.6	XX	XX
11	7.0	6.7	5.6	6.8	6.7	7.7	8.8	8.1	4.9	5.3	XX	XX
12	6.8	6.4	5.2	6.7	6.6	7.6	8.5	7.5	5.4	4.6	XX	XX
13	6.8	7.3	5.9	6.8	6.4	7.8	8.3	7.5	5.6	4.7	XX	XX
14	6.8	7.3	6.5	6.7	6.5	7.9	8.2	7.8	4.7	5.3	XX	XX
15	6.8	6.7	7.0	6.6	6.5	8.0	8.1	8.9	4.7	5.7	XX	XX
16	6.8	6.4	7.5	4.9	6.6	7.9	8.3	8.8	4.9	5.7	XX	XX
17	6.8	7.5	7.8	6.5	6.4	7.8	8.5	9.3	5.1	5.7	XX	XX
18	6.8	7.0	6.8	7.1	6.5	8.5	8.6	9.1	4.7	5.8	XX	XX
19	6.8	6.8	7.1	6.8	6.5	11.5	8.6	8.8	4.5	5.5	XX	XX
20	7.5	6.9	7.1	6.4	6.5	10.3	8.6	8.6	4.6	4.6	XX	XX
21	7.4	6.9	6.9	6.5	6.7	9.6	8.7	7.8	4.3	5.1	XX	XX
22	7.0	5.6	6.9	6.5	6.9	9.3	8.7	5.8	4.2	5.8	XX	XX
23	7.0	7.2	7.1	6.5	6.8	9.3	8.6	5.7	4.2	6.7	XX	XX
24	7.0	7.4	7.0	6.5	6.8	9.4	8.5	6.9	4.4	6.2	XX	XX
25	7.0	7.2	6.8	6.2	6.6	11.4	8.8	6.6	4.8	4.0	XX	XX
26	7.0	7.2	6.7	6.5	6.6	10.9	9.6	6.2	4.6	4.5	XX	XX
27	7.1	7.3	6.8	6.3	6.4	10.4	9.8	6.1	6.6	5.7	XX	XX
28	7.3	6.9	6.8	6.3	6.3	10.4	9.6	6.1	6.6	5.9	XX	XX
29	7.2	7.1	6.7	6.4	---	10.0	9.4	6.2	6.1	5.7	XX	XX
30	7.1	7.2	6.7	6.2	---	9.8	10.0	6.3	6.0	6.4	XX	XX
31	7.0	---	6.8	6.2	---	9.8	---	5.9	---	6.2	XX	---
TOTAL	214.5	211.7	211.2	203.2	185.4	268.8	265.5	246.4	159.3	174.5		
MEAN	6.9	7.1	6.8	6.6	6.6	8.7	8.9	7.9	5.3	5.6		
MAX	7.5	7.8	7.8	7.3	7.8	11.5	10.0	10.3	7.0	6.7		
MIN	6.6	5.6	5.2	4.9	5.3	6.7	8.1	5.7	4.2	4.0		
AC-FT	425.5	419.8	418.9	403.0	367.8	533.1	526.7	488.7	316.0	346.2		

MISSION CREEK

LOCATION.-- Latitude: 47:30:14, Longitude: 120:28:26, Chelan County, Mission Creek Road, tributary of Wenatchee River -> Columbia River

DRAINAGE AREA.-- 80.8 mi2

GAGE ELEVATION.-- 876 ft

MEAN ANNUAL PRECIPITATION.-- 579 mm

MEAN WATER STRESS INDEX.-- 60 %

PERIOD OF RECORD.-- May 28, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed at downstream end of bridge. Significant amount of sediment depositoin was cleaned out from around the gage sensor on 8/5/01; sediment was negatively influencing the gage height recorder.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 644 cfs on 12/17/00, gage height, 2.13 ft; minimum discharge, 0.0 cfs, gage height, -0.11 ft
*Maximum discharge estimate is too extreme for this creek.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	24.1	5.8	0.6	1.3
2	XX	XX	XX	XX	XX	XX	XX	XX	21.4	5.8	0.4	1.0
3	XX	XX	XX	XX	XX	XX	XX	XX	21.2	6.9	0.4	0.9
4	XX	XX	XX	XX	XX	XX	XX	XX	19.4	6.9	0.3	0.9
5	XX	XX	XX	XX	XX	XX	XX	XX	18.3	6.1	0.6	0.4
6	XX	XX	XX	XX	XX	XX	XX	XX	17.6	5.9	0.5	1.1
7	XX	XX	XX	XX	XX	XX	XX	XX	17.4	5.8	0.2	1.7
8	XX	XX	XX	XX	XX	XX	XX	XX	19.1	5.1	0.1	1.7
9	XX	XX	XX	XX	XX	XX	XX	XX	17.4	4.9	0.3	1.9
10	XX	XX	XX	XX	XX	XX	XX	XX	15.8	4.6	0.3	2.7
11	XX	XX	XX	XX	XX	XX	XX	XX	15.6	3.8	0.6	2.8
12	XX	XX	XX	XX	XX	XX	XX	XX	29.4	3.4	0.6	2.3
13	XX	XX	XX	XX	XX	XX	XX	XX	21.4	3.3	0.6	2.1
14	XX	XX	XX	XX	XX	XX	XX	XX	19.5	3.4	0.3	2.0
15	XX	XX	XX	XX	XX	XX	XX	XX	16.9	3.1	0.2	2.0
16	XX	XX	XX	XX	XX	XX	XX	XX	16.9	3.2	0.1	1.9
17	XX	XX	XX	XX	XX	XX	XX	XX	16.8	2.7	0.1	1.9
18	XX	XX	XX	XX	XX	XX	XX	XX	15.8	2.2	0.3	1.6
19	XX	XX	XX	XX	XX	XX	XX	XX	14.5	2.3	0.4	2.0
20	XX	XX	XX	XX	XX	XX	XX	XX	12.8	2.6	0.6	1.8
21	XX	XX	XX	XX	XX	XX	XX	XX	10.5	2.1	0.9	2.3
22	XX	XX	XX	XX	XX	XX	XX	XX	9.3	1.9	1.0	3.0
23	XX	XX	XX	XX	XX	XX	XX	XX	9.0	1.6	1.3	3.1
24	XX	XX	XX	XX	XX	XX	XX	XX	8.7	2.2	1.2	3.4
25	XX	XX	XX	XX	XX	XX	XX	XX	8.5	1.4	0.5	3.7
26	XX	XX	XX	XX	XX	XX	XX	XX	8.4	1.2	0.5	4.1
27	XX	XX	XX	XX	XX	XX	XX	XX	7.4	1.1	0.6	4.3
28	XX	XX	XX	XX	XX	XX	XX	25.8	6.9	1.2	0.5	4.6
29	XX	XX	XX	XX	XX	XX	XX	23.9	6.5	1.4	0.5	3.5
30	XX	XX	XX	XX	---	XX	XX	25.4	6.5	1.1	0.7	1.5
31	XX	---	XX	XX	---	XX	---	26.3	---	0.8	1.3	---
TOTAL									453.1	103.5	16.5	67.4
MEAN									15.1	3.3	0.5	2.2
MAX									29.4	6.9	1.3	4.6
MIN									6.5	0.8	0.1	0.4
AC-FT									899	205	33	134

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.4	2.5	4.2	3.8	3.5	4.5	20.2	33.6	8.4	3.3	0.0	0.1
2	1.4	2.7	4.3	3.8	3.7	4.3	17.9	26.7	8.3	2.4	0.0	0.1
3	1.4	2.8	4.1	3.8	3.8	4.1	15.2	24.6	8.1	1.6	0.0	0.1
4	1.4	3.7	4.0	3.8	4.0	4.3	14.1	25.5	7.9	1.2	0.0	0.0
5	1.5	3.9	3.9	4.0	4.1	4.4	13.3	28.1	8.5	0.9	0.1	0.0
6	1.5	3.5	4.0	4.3	4.1	4.5	13.1	24.8	9.2	0.7	0.2	0.1
7	1.6	3.5	3.8	4.3	3.7	5.4	12.3	23.3	8.3	0.8	0.1	0.1
8	1.5	4.2	3.8	5.0	3.3	7.2	11.3	25.3	9.1	0.6	0.1	0.8
9	1.5	4.6	3.8	4.5	3.7	9.6	10.7	23.8	12.1	0.4	0.2	2.4
10	1.5	4.4	3.7	4.1	4.5	10.2	11.4	20.1	9.4	0.1	0.2	4.6
11	1.5	3.5	2.9	4.1	3.7	9.8	12.5	20.4	8.2	0.3	0.1	4.0
12	1.5	4.1	4.8	3.9	4.9	9.6	12.4	26.2	8.2	0.1	0.2	2.1
13	1.4	4.4	20.9	3.9	3.2	12.4	11.9	31.9	7.5	0.4	0.2	0.3
14	1.5	4.5	24.3	3.9	3.0	13.6	11.5	26.9	7.0	0.4	0.2	2.2
15	1.6	3.7	59.3	3.6	3.1	11.5	11.6	25.3	6.0	0.3	0.2	2.0
16	1.7	4.8	152.6	3.2	3.3	10.7	12.2	24.9	5.0	0.5	0.2	3.3
17	2.0	4.2	318.1	3.2	3.4	9.9	17.0	20.1	4.6	0.4	0.1	3.2
18	1.9	4.6	13.9	4.0	3.1	11.4	26.7	17.4	4.7	0.6	0.1	2.5
19	1.8	3.5	4.9	3.7	3.2	20.9	29.0	15.8	3.8	0.5	0.1	4.7
20	2.1	4.5	24.1	3.4	3.2	20.6	25.8	16.1	3.2	0.4	0.1	6.7
21	2.5	3.7	4.1	3.5	3.2	17.9	26.7	13.6	3.0	0.2	0.1	4.6
22	2.5	3.7	4.1	3.4	3.3	15.9	29.9	15.0	2.6	1.9	0.2	2.8
23	2.5	4.9	4.0	3.4	3.4	14.9	28.7	16.0	2.1	0.0	0.8	2.2
24	2.6	3.8	4.1	3.5	3.5	16.1	30.1	15.4	1.9	0.1	2.7	1.7
25	2.7	4.9	3.8	3.5	3.6	28.0	43.8	13.6	2.5	0.1	5.1	1.3
26	2.7	4.5	3.7	3.4	3.9	32.9	66.9	12.0	1.9	0.0	7.4	1.9
27	2.7	4.4	3.8	3.2	4.0	25.7	88.3	11.2	6.3	0.0	6.1	2.9
28	3.2	3.8	3.8	3.5	4.4	21.1	77.2	10.1	7.5	0.1	0.4	2.8
29	2.9	5.1	3.7	3.3	---	20.3	46.5	9.8	5.1	0.1	0.1	0.0
30	2.5	4.3	3.8	3.2	---	18.7	38.9	9.7	4.4	0.0	0.0	0.0
31	2.4	---	3.8	3.6	---	18.2	---	9.1	---	0.0	0.1	---
TOTAL	61.0	120.6	707.9	115.7	101.9	418.6	787.2	616.3	184.7	18.2	25.5	59.7
MEAN	2.0	4.0	22.8	3.7	3.6	13.5	26.2	19.9	6.2	0.6	0.8	2.0
MAX	3.2	5.1	318.1	5.0	4.9	32.9	88.3	33.6	12.1	3.3	7.4	6.7
MIN	1.4	2.5	2.9	3.2	3.0	4.1	10.7	9.1	1.9	0.0	0.0	0.0
AC-FT	120.9	239.2	1404.1	229.5	202.1	830.3	1561.5	1222.4	366.4	36.1	50.6	118.5

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.0	0.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	0.0	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	0.0	0.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	0.0	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	0.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	0.0	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
30	0.0	XX	XX	XX	---	XX	XX	XX	XX	XX	XX	XX
31	0.7	---	XX	XX	---	XX	---	0.0	---	XX	XX	---
TOTAL	0.7											
MEAN	0.0											
MAX	0.7											
MIN	0.0											
AC-FT	1.4											

NILE CREEK

LOCATION.-- Latitude: 46:50:18, Longitude: 120:57:00, Yakima County, Nile Road, tributary of Naches River -> Yakima River -> Columbia River

DRAINAGE AREA.-- 31.7 mi2

GAGE ELEVATION.-- 2021 ft

MEAN ANNUAL PRECIPITATION.-- 1025 mm

MEAN WATER STRESS INDEX.-- 25 %

PERIOD OF RECORD.-- May 30, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed at downstream end of concrete box culvert. Local landowner informed WSU that the culvert is scheduled for replacement. There is an extremely large scour pool at downstream end of culvert. The gauge was replaced on 8/10/00 due to malfunction as a result of vandalism, and on 2/18/01 due to unknown malfunction.
*** - indicates data that was lost during gage malfunction

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 39.3 cfs, gage height, 1.60 ft; minimum discharge, 0.0 cfs, gage height, 0.28 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	30.5	8.0	***	1.2
2	XX	XX	XX	XX	XX	XX	XX	XX	24.7	7.2	***	1.3
3	XX	XX	XX	XX	XX	XX	XX	XX	23.8	7.5	***	1.8
4	XX	XX	XX	XX	XX	XX	XX	XX	24.4	8.2	***	1.7
5	XX	XX	XX	XX	XX	XX	XX	XX	25.6	8.0	***	1.8
6	XX	XX	XX	XX	XX	XX	XX	XX	25.8	7.7	***	1.9
7	XX	XX	XX	XX	XX	XX	XX	XX	25.8	7.0	***	1.7
8	XX	XX	XX	XX	XX	XX	XX	XX	25.8	6.5	***	1.5
9	XX	XX	XX	XX	XX	XX	XX	XX	24.3	6.0	***	1.6
10	XX	XX	XX	XX	XX	XX	XX	XX	22.5	***	***	1.9
11	XX	XX	XX	XX	XX	XX	XX	XX	21.4	***	0.7	2.1
12	XX	XX	XX	XX	XX	XX	XX	XX	29.2	***	0.8	1.7
13	XX	XX	XX	XX	XX	XX	XX	XX	24.7	***	0.7	1.1
14	XX	XX	XX	XX	XX	XX	XX	XX	23.3	***	0.7	0.9
15	XX	XX	XX	XX	XX	XX	XX	XX	22.4	***	0.7	0.8
16	XX	XX	XX	XX	XX	XX	XX	XX	20.2	***	0.7	0.8
17	XX	XX	XX	XX	XX	XX	XX	XX	18.8	***	0.6	0.8
18	XX	XX	XX	XX	XX	XX	XX	XX	17.7	***	0.3	0.9
19	XX	XX	XX	XX	XX	XX	XX	XX	16.8	***	0.4	1.0
20	XX	XX	XX	XX	XX	XX	XX	XX	15.9	***	0.5	1.0
21	XX	XX	XX	XX	XX	XX	XX	XX	14.6	***	0.4	1.6
22	XX	XX	XX	XX	XX	XX	XX	XX	13.6	***	0.2	2.6
23	XX	XX	XX	XX	XX	XX	XX	XX	12.5	***	0.2	2.7
24	XX	XX	XX	XX	XX	XX	XX	XX	11.6	***	0.3	2.4
25	XX	XX	XX	XX	XX	XX	XX	XX	10.9	***	0.2	2.0
26	XX	XX	XX	XX	XX	XX	XX	XX	10.3	***	0.4	2.0
27	XX	XX	XX	XX	XX	XX	XX	XX	9.5	***	0.3	1.8
28	XX	XX	XX	XX	XX	XX	XX	XX	8.8	***	0.4	1.7
29	XX	XX	XX	XX	XX	XX	XX	XX	8.3	***	0.4	1.6
30	XX	XX	XX	XX	---	XX	XX	35.3	8.3	***	0.4	2.0
31	XX	---	XX	XX	---	XX	---	31.3	---	***	0.7	---
TOTAL									571.8			47.8
MEAN									19.1			1.6
MAX									30.5			2.7
MIN									8.3			0.8
AC-FT									1134			95

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	5.4	6.4	***	***	***	9.3	11.0	16.1	10.2	2.9	0.2	2.0
2	5.3	6.1	***	***	***	6.6	10.1	13.7	9.7	2.5	0.3	1.8
3	3.7	5.8	***	***	***	6.5	9.3	13.5	9.3	2.5	0.4	1.1
4	3.0	6.5	***	***	***	6.2	8.7	13.3	8.8	2.1	0.3	0.7
5	2.7	8.7	***	***	***	6.0	8.3	14.5	8.4	1.6	0.2	0.4
6	2.6	8.3	***	***	***	6.2	8.2	13.8	8.1	1.5	0.2	0.2
7	2.4	7.7	***	***	***	6.9	8.0	13.1	7.9	1.1	0.2	0.4
8	2.4	9.2	***	***	***	8.5	7.5	14.5	7.9	1.3	0.3	0.3
9	2.4	8.9	***	***	***	9.4	7.1	16.2	7.8	1.5	0.5	0.2
10	2.8	8.0	***	***	***	9.6	7.6	15.7	7.7	1.4	0.4	0.4
11	3.2	***	***	***	***	9.8	8.6	16.2	7.6	1.4	0.1	0.3
12	3.2	***	***	***	***	10.6	8.0	18.3	7.7	1.4	0.4	0.3
13	3.0	***	***	***	***	11.7	7.5	21.5	7.3	1.3	0.8	0.2
14	2.9	***	***	***	***	11.8	7.1	20.7	6.9	0.9	0.7	0.2
15	2.9	***	***	***	***	11.1	6.9	19.3	6.1	0.8	0.8	0.8
16	2.9	***	***	***	***	10.0	7.2	19.2	5.5	0.9	1.0	1.0
17	3.8	***	***	***	***	9.1	8.9	16.7	5.3	1.2	1.1	0.9
18	4.5	***	***	***	***	9.4	10.5	15.5	5.1	1.2	1.1	0.6
19	4.0	***	***	***	4.7	11.8	10.7	14.9	4.6	0.9	1.1	0.7
20	4.5	***	***	***	4.7	12.7	10.4	14.7	4.5	1.0	0.9	1.0
21	6.7	***	***	***	4.7	11.4	10.5	13.5	3.6	1.1	1.0	1.1
22	6.6	***	***	***	4.8	10.9	11.0	15.0	2.7	0.9	1.6	1.1
23	5.7	***	***	***	4.8	11.2	11.3	16.8	2.8	0.6	2.8	1.1
24	5.2	***	***	***	5.0	12.4	12.1	18.4	3.2	0.5	3.2	1.4
25	5.0	***	***	***	6.3	15.3	14.3	17.4	3.7	0.5	2.4	1.5
26	5.0	***	***	***	6.6	15.4	18.5	15.8	3.2	0.7	2.2	2.0
27	5.0	***	***	***	7.6	13.2	21.9	14.3	6.8	0.7	1.6	2.4
28	5.7	***	***	***	8.1	11.4	21.1	13.2	8.8	0.9	1.6	2.6
29	6.6	***	***	***	---	10.7	18.4	12.4	6.2	0.7	1.8	2.4
30	6.9	***	***	***	---	10.4	17.8	11.4	4.0	0.5	1.4	2.4
31	6.5	---	***	***	---	10.4	---	10.8	---	0.3	1.6	---
TOTAL	132.4					316.0	328.4	480.3	191.2	36.7	32.4	31.3
MEAN	4.3					10.2	10.9	15.5	6.4	1.2	1.0	1.0
MAX	6.9					15.4	21.9	21.5	10.2	2.9	3.2	2.6
MIN	2.4					6.0	6.9	10.8	2.7	0.3	0.1	0.2
AC-FT	262.7					626.7	651.4	952.7	379.3	72.8	64.3	62.1

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.4	9.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	2.3	7.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	2.1	6.9	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	2.0	6.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	1.6	6.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	1.3	6.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	0.8	6.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	0.4	6.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	0.5	6.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	0.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	0.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	0.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	0.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	0.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	0.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

16	0.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	0.7	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	0.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	0.9	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	1.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
21	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
22	1.4	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
23	3.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
24	3.9	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
25	3.6	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
26	3.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
27	3.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
28	3.8	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
29	4.1	XX	XX	XX	—	XX	XX	XX	XX	XX	XX	XX
30	4.7	XX	XX	XX	—	XX	XX	XX	XX	XX	XX	XX
31	6.8	—	XX	XX	—	XX	—	XX	—	XX	XX	—
TOTAL	61.5											
MEAN	2.0											
MAX	6.8											
MIN	0.4											
AC-FT	122.0											

PATAHA CREEK

LOCATION.-- Latitude: 46:16:33, Longitude: 117:31:08, Garfield County, Forest Road 040, tributary of Tucannon River -> Snake River, attached to North end of CMP road culvert (right hand side)

DRAINAGE AREA.-- 9.4 mi2

GAGE ELEVATION.-- 3960 ft

MEAN ANNUAL PRECIPITATION.-- 1155 mm

MEAN WATER STRESS INDEX.-- 51 %

PERIOD OF RECORD.-- May 20, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed near location of stream re-habilitation site. Log check dams were installed downstream of the culvert prior to installation of WSU gauge. Rainbow trout, Brook trout verified. During winter months the stream froze over. The freezing of the stream caused the water level logger to record stage in error.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 44.3 ft3/s Nov. 24, 2000, gage height, 2.02 ft; minimum discharge, 0.07 ft3/s Dec 21, 2000, gage height, 1.25 ft.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	4.3	1.8	1.1	1.0
2	XX	XX	XX	XX	XX	XX	XX	XX	4.1	1.7	1.1	1.2
3	XX	XX	XX	XX	XX	XX	XX	XX	3.8	1.7	1.1	1.1
4	XX	XX	XX	XX	XX	XX	XX	XX	3.6	9.0	1.0	1.1
5	XX	XX	XX	XX	XX	XX	XX	XX	3.5	1.6	1.0	1.1
6	XX	XX	XX	XX	XX	XX	XX	XX	3.3	1.6	1.0	1.1
7	XX	XX	XX	XX	XX	XX	XX	XX	3.2	1.6	1.0	1.1
8	XX	XX	XX	XX	XX	XX	XX	XX	3.5	1.6	1.0	1.1
9	XX	XX	XX	XX	XX	XX	XX	XX	3.3	1.6	1.0	1.1
10	XX	XX	XX	XX	XX	XX	XX	XX	3.3	1.5	1.0	1.4
11	XX	XX	XX	XX	XX	XX	XX	XX	3.1	1.5	1.0	1.3
12	XX	XX	XX	XX	XX	XX	XX	XX	4.0	1.4	1.0	1.2
13	XX	XX	XX	XX	XX	XX	XX	XX	3.3	1.3	1.0	1.1
14	XX	XX	XX	XX	XX	XX	XX	XX	2.9	1.3	1.0	1.1
15	XX	XX	XX	XX	XX	XX	XX	XX	2.8	1.3	1.0	1.1
16	XX	XX	XX	XX	XX	XX	XX	XX	2.7	1.3	1.0	1.1
17	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.3	1.0	1.0
18	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.3	1.0	1.0
19	XX	XX	XX	XX	XX	XX	XX	XX	2.5	1.2	1.0	1.0
20	XX	XX	XX	XX	XX	XX	XX	4.1	2.4	1.2	1.0	1.1
21	XX	XX	XX	XX	XX	XX	XX	4.0	2.4	1.2	1.0	1.3
22	XX	XX	XX	XX	XX	XX	XX	3.6	2.3	1.2	1.0	1.1
23	XX	XX	XX	XX	XX	XX	XX	3.4	2.2	1.1	1.0	1.1
24	XX	XX	XX	XX	XX	XX	XX	3.6	2.2	1.1	1.0	1.1
25	XX	XX	XX	XX	XX	XX	XX	3.5	2.1	1.1	1.0	1.1
26	XX	XX	XX	XX	XX	XX	XX	3.3	2.0	1.1	1.0	1.1
27	XX	XX	XX	XX	XX	XX	XX	3.4	2.0	1.1	1.0	1.1
28	XX	XX	XX	XX	XX	XX	XX	3.3	1.9	1.1	1.0	1.1
29	XX	XX	XX	XX	XX	XX	XX	3.7	1.9	1.0	1.0	1.1
30	XX	XX	XX	XX	---	XX	XX	3.5	1.8	1.1	1.0	1.4
31	XX	---	XX	XX	---	XX	---	4.8	---	1.1	1.0	---
TOTAL									85.7	49.0	31.6	33.9
MEAN									2.9	1.6	1.0	1.1
MAX									4.3	9.0	1.1	1.4
MIN									1.8	1.0	1.0	1.0
AC-FT									170	97	63	67

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.8	1.1	5.5	0.8	0.4	0.3	2.1	27.5	1.6	0.8	0.7	XX
2	1.2	1.1	8.5	0.8	0.4	0.3	2.1	20.0	1.5	0.8	0.7	XX
3	1.2	1.1	11.3	0.8	0.3	0.3	1.9	14.4	1.5	0.8	0.7	XX
4	1.1	1.2	9.2	0.8	0.4	0.3	1.6	12.6	1.4	0.8	0.7	XX
5	1.1	1.2	6.5	0.8	0.5	0.3	1.5	12.0	1.6	0.8	0.7	XX
6	1.1	1.1	6.7	0.7	0.4	0.3	1.4	9.5	1.5	0.8	0.7	XX
7	1.1	1.2	5.0	0.7	0.3	0.3	1.3	8.2	1.4	0.7	XX	XX
8	1.1	1.1	23.8	0.7	0.3	0.3	1.2	8.4	1.3	0.7	XX	XX
9	1.1	1.1	19.1	0.7	0.4	0.4	1.2	8.7	1.3	0.7	XX	XX
10	1.1	1.4	12.7	0.7	0.4	0.4	1.1	7.6	1.2	0.7	XX	XX

11	1.1	2.4	16.4	0.6	0.3	0.4	1.1	6.6	1.2	0.7	XX	XX
12	1.1	4.6	21.0	0.6	0.3	0.4	1.0	8.3	1.2	0.7	XX	XX
13	1.1	4.5	34.7	0.6	0.3	0.4	1.0	10.1	1.2	0.7	XX	XX
14	1.0	6.4	25.9	0.6	0.3	0.4	0.9	10.1	1.1	0.7	XX	XX
15	1.0	7.6	16.6	0.5	0.3	0.4	0.9	10.1	1.1	0.7	XX	XX
16	1.0	9.1	11.4	0.5	0.3	0.4	1.0	9.7	1.0	0.7	XX	XX
17	1.0	14.2	9.4	0.5	0.3	0.4	1.3	7.4	1.0	0.7	XX	XX
18	1.0	10.1	12.6	0.4	0.3	0.4	2.1	6.1	1.0	0.7	XX	XX
19	1.0	17.0	12.7	0.5	0.3	0.5	2.5	5.1	0.9	0.7	XX	XX
20	1.1	7.2	11.4	0.5	0.3	0.6	2.7	4.3	0.9	0.7	XX	XX
21	1.3	10.4	8.0	0.4	0.3	0.6	2.5	3.7	0.9	0.7	XX	XX
22	1.1	8.8	2.0	0.4	0.3	0.6	2.4	3.3	0.9	0.7	XX	XX
23	1.1	31.0	2.9	0.4	0.3	0.7	2.5	2.9	0.9	0.7	XX	XX
24	1.1	30.3	1.4	0.4	0.3	0.8	2.9	2.6	0.9	0.7	XX	XX
25	1.1	16.5	1.1	0.4	0.3	1.0	4.1	2.4	0.9	0.7	XX	XX
26	1.1	6.3	1.0	0.4	0.3	1.2	7.3	2.2	0.9	0.7	XX	XX
27	1.2	4.6	0.9	0.4	0.3	1.2	12.6	2.1	1.2	0.7	XX	XX
28	1.2	5.3	0.9	0.3	0.3	1.4	16.0	2.2	1.1	0.6	XX	XX
29	1.2	7.2	0.9	0.3	---	1.4	11.6	1.9	0.9	0.6	XX	XX
30	1.1	8.0	0.9	0.3	---	1.4	16.8	1.7	0.9	0.7	XX	XX
31	1.1	---	0.8	0.4	---	1.6	---	1.6	---	0.7	XX	---
TOTAL	35.1	223.3	301.2	16.8	9.3	19.4	108.9	233.2	34.3	22.0		
MEAN	1.1	7.4	9.7	0.5	0.3	0.6	3.6	7.5	1.1	0.7		
MAX	1.8	31.0	34.7	0.8	0.5	1.6	16.8	27.5	1.6	0.8		
MIN	1.0	1.1	0.8	0.3	0.3	0.3	0.9	1.6	0.9	0.6		
AC-FT	69.7	442.8	597.5	33.3	18.5	38.5	215.9	462.5	68.0	43.5		

PATIT CREEK

LOCATION.-- Latitude: 46:20:17, Longitude: 117:53:46, Columbia County, Range Grade Road, tributary of Touchet River -> Walla Walla River -> Columbia River

DRAINAGE AREA.-- 50.1 mi2

GAGE ELEVATION.-- 1877 ft

MEAN ANNUAL PRECIPITATION.-- 817 mm

MEAN WATER STRESS INDEX.-- 59 %

PERIOD OF RECORD.-- June 16, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed to concrete at downstream end of bridge. The gauge was installed in a large scour pool with calm water for safe placement.
The creek ran dry during the months of DATE to DATE.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 1830 cfs on 5/3/01, gage height, 3.33 ft; minimum discharge, 0.0 cfs, gage height, -0.46 ft
*Maximum estimated discharge is unreasonable. Need flow measurements at higher stages to correct.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.1	0.0	0.0
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.1	0.0	0.0
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.1	0.0	0.0
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.1	0.0	0.0
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.0	0.0	0.0
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.1	0.0	0.0
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.0	0.0	0.0
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	1.0	0.0	0.0
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.9	0.0	0.0
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.8	0.0	0.0
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.7	0.0	0.0
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.0	0.0
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.0	0.0
14	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.0	0.0
15	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.0	0.0
16	XX	XX	XX	XX	XX	XX	XX	XX	4.5	0.5	0.0	0.0
17	XX	XX	XX	XX	XX	XX	XX	XX	4.2	0.4	0.0	0.0
18	XX	XX	XX	XX	XX	XX	XX	XX	4.1	0.5	0.0	0.0
19	XX	XX	XX	XX	XX	XX	XX	XX	3.7	0.4	0.0	0.0
20	XX	XX	XX	XX	XX	XX	XX	XX	3.4	0.4	0.0	0.0
21	XX	XX	XX	XX	XX	XX	XX	XX	3.1	0.3	0.0	0.0
22	XX	XX	XX	XX	XX	XX	XX	XX	2.8	0.2	0.0	0.0
23	XX	XX	XX	XX	XX	XX	XX	XX	2.6	0.1	0.0	0.0
24	XX	XX	XX	XX	XX	XX	XX	XX	2.4	0.0	0.0	0.0
25	XX	XX	XX	XX	XX	XX	XX	XX	2.2	0.0	0.0	0.0
26	XX	XX	XX	XX	XX	XX	XX	XX	2.0	0.0	0.0	0.0
27	XX	XX	XX	XX	XX	XX	XX	XX	1.8	0.0	0.0	0.0
28	XX	XX	XX	XX	XX	XX	XX	XX	1.6	0.0	0.0	0.0
29	XX	XX	XX	XX	XX	XX	XX	XX	1.4	0.0	0.0	0.0
30	XX	XX	XX	XX	---	XX	XX	XX	1.3	0.0	0.0	0.0
31	XX	---	XX	XX	---	XX	---	XX	---	0.0	0.0	---
TOTAL										15.8	0.0	0.0
MEAN										0.5	0.0	0.0
MAX										1.1	0.0	0.0
MIN										0.0	0.0	0.0
AC-FT										31	0	0

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.0	0.0	0.6	1.9	4.5	8.8	121.6	412.8	4.9	3.5	0.0	XX
2	0.0	0.0	0.7	1.8	6.5	10.5	112.1	389.8	4.1	3.2	0.0	XX
3	0.0	0.0	0.7	1.7	8.4	9.1	96.4	598.4	3.6	3.2	0.0	XX
4	0.0	0.0	0.8	1.7	39.1	8.5	65.6	133.2	3.3	3.0	0.0	XX
5	0.0	0.0	0.8	1.8	182.5	9.6	60.6	68.1	3.3	2.0	0.0	XX
6	0.0	0.0	0.8	2.2	59.9	12.9	71.6	66.5	4.1	1.7	0.0	XX
7	0.0	0.0	0.8	2.1	35.0	16.2	54.3	45.9	3.4	1.5	XX	XX
8	0.0	0.0	0.8	2.5	26.9	21.7	42.4	31.8	3.3	1.9	XX	XX
9	0.0	0.0	0.8	2.3	21.2	24.7	37.9	26.4	3.3	2.5	XX	XX
10	0.0	0.0	0.8	2.2	16.9	23.5	34.9	22.4	2.9	2.3	XX	XX
11	0.0	0.0	0.7	2.1	13.6	21.5	40.7	32.9	2.7	1.7	XX	XX
12	0.0	0.0	0.7	2.1	11.5	19.5	56.9	37.6	2.8	1.8	XX	XX
13	0.0	0.0	0.7	2.2	10.5	22.1	64.3	29.7	3.6	2.2	XX	XX
14	0.0	0.0	0.7	2.8	9.0	25.8	57.8	23.2	3.0	1.6	XX	XX
15	0.0	0.0	0.7	2.4	8.7	24.3	54.2	39.6	3.0	1.4	XX	XX
16	0.0	0.0	0.8	2.1	7.8	24.1	63.6	29.7	2.8	1.0	XX	XX
17	0.0	0.0	1.0	1.8	7.1	21.5	57.0	25.5	2.6	0.9	XX	XX
18	0.0	0.0	1.0	1.9	6.8	25.5	62.7	26.2	2.9	0.9	XX	XX
19	0.0	0.0	1.1	1.9	6.9	40.3	60.4	20.4	3.0	0.4	XX	XX
20	0.0	0.0	1.1	1.8	7.1	46.6	50.2	16.1	2.9	0.0	XX	XX
21	0.0	0.0	1.1	2.1	7.5	42.0	47.0	13.1	2.9	0.0	XX	XX
22	0.0	0.0	1.2	3.2	9.9	38.9	42.6	11.9	2.4	0.0	XX	XX
23	0.0	0.0	1.5	3.7	11.3	39.8	34.8	12.0	2.4	0.0	XX	XX
24	0.0	0.0	2.3	4.3	10.9	44.3	99.8	12.1	2.1	0.0	XX	XX
25	0.0	0.0	2.3	4.4	10.6	51.5	252.4	9.5	2.3	0.0	XX	XX
26	0.0	0.0	2.3	4.3	9.5	49.4	62.5	6.5	2.3	0.0	XX	XX
27	0.0	0.0	2.2	4.5	8.6	44.4	49.0	5.6	2.6	0.0	XX	XX
28	0.0	0.0	2.2	5.1	8.3	55.6	44.6	5.5	3.4	0.0	XX	XX
29	0.0	0.3	2.1	4.4	---	61.1	58.0	5.2	3.6	0.0	XX	XX
30	0.0	0.5	2.1	3.9	---	61.9	214.8	4.4	3.6	0.0	XX	XX
31	0.0	---	2.0	3.8	---	75.9	---	4.2	---	0.0	XX	---
TOTAL	0.0	0.9	37.4	85.0	566.5	981.3	2170.7	2165.9	93.0	36.6		
MEAN	0.0	0.0	1.2	2.7	20.2	31.7	72.4	69.9	3.1	1.2		
MAX	0.0	0.5	2.3	5.1	182.5	75.9	252.4	598.4	4.9	3.5		
MIN	0.0	0.0	0.6	1.7	4.5	8.5	34.8	4.2	2.1	0.0		
AC-FT	0.0	1.8	74.3	168.5	1123.7	1946.4	4305.4	4295.9	184.4	72.6		

ROCK CREEK

LOCATION.-- Latitude: 46:52:52, Longitude: 120:58:48, Yakima County, Highway 410, tributary of Naches River -> Yakima River -> Columbia River

DRAINAGE AREA.-- 17.4 mi2

GAGE ELEVATION.-- 2169 ft

MEAN ANNUAL PRECIPITATION.-- 1054 mm

MEAN WATER STRESS INDEX.-- 21 %

PERIOD OF RECORD.-- May 30, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed at downstream end of concrete box culvert. Poor design of culvert at upstream end with water flowing into diversion headwall. Next culvert upstream has large cottonwood tree growing on top of it. This gauge was replaced on DATE, when malfunction occurred due to changing battery in cold weather. No data was lost during the replacement of this gauge.
*On May 24, 2001, at 15:30, an abrupt and unexplained drop in gage height occurred which resulted in very low flows thereafter.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 261 cfs, gage height, 2.12 ft; minimum discharge, 0.0 cfs, gage height, -0.10 ft
*Maximum estimated discharge is too extreme for this creek.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	6.0	2.4	1.2	1.1
2	XX	XX	XX	XX	XX	XX	XX	XX	5.6	2.3	1.0	1.1
3	XX	XX	XX	XX	XX	XX	XX	XX	5.2	2.5	1.0	1.2
4	XX	XX	XX	XX	XX	XX	XX	XX	4.9	2.7	1.1	1.2
5	XX	XX	XX	XX	XX	XX	XX	XX	4.8	2.5	1.0	1.3
6	XX	XX	XX	XX	XX	XX	XX	XX	4.8	2.5	1.0	1.3
7	XX	XX	XX	XX	XX	XX	XX	XX	4.8	2.4	1.1	1.2
8	XX	XX	XX	XX	XX	XX	XX	XX	4.8	2.1	1.0	1.2
9	XX	XX	XX	XX	XX	XX	XX	XX	4.5	2.1	1.0	1.2
10	XX	XX	XX	XX	XX	XX	XX	XX	4.4	2.1	1.0	1.3
11	XX	XX	XX	XX	XX	XX	XX	XX	4.5	2.1	1.0	1.3
12	XX	XX	XX	XX	XX	XX	XX	XX	5.0	2.0	1.0	1.2
13	XX	XX	XX	XX	XX	XX	XX	XX	4.3	1.9	1.1	1.1
14	XX	XX	XX	XX	XX	XX	XX	XX	4.1	1.9	1.1	1.1
15	XX	XX	XX	XX	XX	XX	XX	XX	4.0	1.9	1.1	1.1
16	XX	XX	XX	XX	XX	XX	XX	XX	3.7	1.9	8.5	1.2
17	XX	XX	XX	XX	XX	XX	XX	XX	3.5	1.9	1.3	1.2
18	XX	XX	XX	XX	XX	XX	XX	XX	3.4	1.9	1.1	1.3
19	XX	XX	XX	XX	XX	XX	XX	XX	3.3	1.8	1.2	1.4
20	XX	XX	XX	XX	XX	XX	XX	XX	3.1	1.7	1.2	1.3
21	XX	XX	XX	XX	XX	XX	XX	XX	3.0	1.7	1.1	1.6
22	XX	XX	XX	XX	XX	XX	XX	XX	2.9	1.6	1.1	1.6
23	XX	XX	XX	XX	XX	XX	XX	XX	2.8	1.5	1.1	8.1
24	XX	XX	XX	XX	XX	XX	XX	XX	2.9	1.4	1.0	3.7
25	XX	XX	XX	XX	XX	XX	XX	XX	2.9	1.3	1.0	2.6
26	XX	XX	XX	XX	XX	XX	XX	XX	2.7	1.3	1.0	2.0
27	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.3	1.0	1.8
28	XX	XX	XX	XX	XX	XX	XX	XX	2.5	1.3	1.0	1.5
29	XX	XX	XX	XX	XX	XX	XX	XX	2.6	1.3	1.0	1.4
30	XX	XX	XX	XX	---	XX	XX	5.8	2.4	1.3	1.1	1.7
31	XX	---	XX	XX	---	XX	---	6.2	---	1.2	1.1	---
TOTAL									116.3	57.7	40.5	50.5
MEAN									3.9	1.9	1.3	1.7
MAX									6.0	2.7	8.5	8.1
MIN									2.4	1.2	1.0	1.1
AC-FT									231	114	80	100

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.4	3.4	2.9	2.4	2.3	2.2	4.5	5.6	0.4	1.2	0.7	XX
2	1.8	3.3	3.0	2.4	2.3	2.1	4.4	5.2	1.0	1.1	0.6	XX
3	1.6	3.3	2.9	2.4	2.2	3.2	4.2	4.9	0.9	1.0	0.6	XX
4	1.6	3.8	2.9	2.5	2.2	2.0	4.2	4.8	0.8	0.9	0.6	XX
5	1.6	3.8	2.9	2.7	2.3	2.1	4.1	4.8	0.8	0.9	XX	XX
6	1.9	3.7	2.9	2.7	2.1	2.2	4.1	4.5	0.8	0.9	XX	XX
7	59.7	3.7	2.9	4.3	2.3	2.4	3.9	4.3	0.8	0.9	XX	XX
8	69.2	3.8	2.9	2.5	2.4	2.7	3.8	4.4	0.8	0.8	XX	XX
9	110.7	3.0	3.8	2.4	1.7	2.8	3.6	4.4	0.8	0.8	XX	XX
10	85.4	2.8	2.9	2.4	1.6	2.7	3.8	4.1	0.6	0.8	XX	XX
11	60.1	3.4	15.1	2.5	1.6	2.8	3.9	3.9	0.8	0.8	XX	XX
12	5.6	5.8	30.9	2.5	4.0	3.1	3.6	3.8	1.0	0.8	XX	XX
13	3.8	3.6	47.0	2.6	1.8	3.6	3.5	3.7	1.1	0.8	XX	XX
14	2.5	3.6	60.5	2.6	2.5	3.4	3.4	3.6	1.1	0.7	XX	XX
15	3.6	10.2	124.9	2.3	1.8	3.2	3.3	3.6	1.1	0.7	XX	XX
16	2.7	16.9	35.9	10.9	1.8	3.0	3.5	3.6	1.1	0.8	XX	XX
17	2.9	10.8	4.6	11.7	1.8	2.8	3.9	3.3	1.1	0.8	XX	XX
18	2.7	8.9	2.5	2.5	1.8	3.1	4.0	3.1	1.1	0.8	XX	XX
19	2.7	7.3	2.4	2.1	1.8	3.7	4.2	2.9	1.1	0.8	XX	XX
20	3.2	4.6	2.4	2.2	1.9	3.5	4.4	2.7	1.0	0.8	XX	XX
21	3.5	7.6	2.5	2.2	1.9	3.5	4.6	2.6	1.0	0.8	XX	XX
22	3.3	16.4	2.5	2.1	1.9	3.6	5.0	2.4	1.0	0.7	XX	XX
23	3.3	15.7	2.5	2.3	1.9	3.8	5.1	2.3	1.0	0.7	XX	XX
24	3.5	21.4	2.5	2.3	2.0	4.2	5.5	1.5	1.1	0.7	XX	XX
25	3.6	12.5	2.5	2.3	2.2	5.2	6.6	0.0	1.3	0.6	XX	XX
26	3.5	2.9	2.5	2.2	3.5	5.2	7.0	0.1	1.2	0.6	XX	XX
27	3.5	2.9	2.6	3.8	3.9	4.6	7.7	0.0	1.8	0.6	XX	XX
28	3.7	3.6	2.5	2.2	4.7	4.3	7.3	0.1	1.6	0.7	XX	XX
29	3.5	2.9	2.5	2.2	---	4.1	6.4	0.5	1.3	0.7	XX	XX
30	3.4	2.8	2.5	2.2	---	4.0	6.1	0.5	1.2	0.7	XX	XX
31	3.3	---	2.5	2.2	---	4.2	---	0.3	---	0.7	XX	---
TOTAL	463.8	198.4	383.8	94.6	64.1	103.3	139.5	91.3	30.9	24.5	2.6	
MEAN	15.0	6.6	12.4	3.1	2.3	3.3	4.7	2.9	1.0	0.8	0.6	
MAX	110.7	21.4	124.9	11.7	4.7	5.2	7.7	5.6	1.8	1.2	0.7	
MIN	1.6	2.8	2.4	2.1	1.6	2.0	3.3	0.0	0.4	0.6	0.6	
AC-FT	920.0	393.6	761.2	187.7	127.1	204.9	276.7	181.2	61.3	48.6	5.1	

S. FORK ASOTIN CREEK

LOCATION.-- Latitude: 46:13:32, Longitude: 117:16:48, Asotin County, South Fork Asotin Creek Road, tributary of Snake River -> Columbia River

DRAINAGE AREA.-- 36.6 mi2

GAGE ELEVATION.-- 2346 ft

MEAN ANNUAL PRECIPITATION.-- 597 mm

MEAN WATER STRESS INDEX.-- 53 %

PERIOD OF RECORD.-- May 20, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed to boulder under bridge near location of stream re-habilitation site. This is a step-pool type stream bounded by trees and pasture in areas.
Upstream of the gauge site stream re-habilitation efforts have been taken to improve the riverine habitat.
The gauge malfunctioned during cold weather battery replacement. The gauge was replaced on a following trip.
*** - Indicates data lost during gage malfunction.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 24.9 cfs, gage height, 1.25 ft; minimum discharge, 2.3 cfs, gage height, 0.41 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.2	3.6	3.2
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.0	3.5	3.8
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.1	3.5	3.5
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.0	3.5	3.5
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.0	3.4	3.4
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.2	3.4	3.3
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	5.1	3.4	3.2
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.9	3.3	3.2
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.9	3.3	3.3
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.7	3.4	3.4
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.6	3.3	4.0
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.6	3.2	3.4
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.5	3.2	3.2
14	XX	XX	XX	XX	XX	XX	XX	XX	XX	4.3	3.2	3.2
15	XX	XX	XX	XX	XX	XX	XX	XX	0.1	4.3	3.2	3.1
16	XX	XX	XX	XX	XX	XX	XX	XX	6.4	4.2	3.1	3.1
17	XX	XX	XX	XX	XX	XX	XX	XX	6.3	4.2	3.1	3.1
18	XX	XX	XX	XX	XX	XX	XX	XX	6.3	4.2	3.1	3.0
19	XX	XX	XX	XX	XX	XX	XX	XX	6.1	4.2	3.2	3.0
20	XX	XX	XX	XX	XX	XX	XX	XX	6.1	4.1	3.1	3.0
21	XX	XX	XX	XX	XX	XX	XX	XX	6.1	4.0	3.1	3.6
22	XX	XX	XX	XX	XX	XX	XX	XX	6.0	4.0	3.0	3.5
23	XX	XX	XX	XX	XX	XX	XX	XX	5.8	4.0	3.1	3.0
24	XX	XX	XX	XX	XX	XX	XX	XX	5.7	3.9	3.1	3.0
25	XX	XX	XX	XX	XX	XX	XX	XX	5.7	3.9	3.1	2.9
26	XX	XX	XX	XX	XX	XX	XX	XX	5.6	3.9	3.1	2.9
27	XX	XX	XX	XX	XX	XX	XX	XX	5.5	3.8	3.0	2.9
28	XX	XX	XX	XX	XX	XX	XX	XX	5.4	3.7	3.0	2.8
29	XX	XX	XX	XX	XX	XX	XX	XX	5.4	3.7	3.0	2.8
30	XX	XX	XX	XX	---	XX	XX	XX	5.3	3.7	3.1	3.3
31	XX	---	XX	XX	---	XX	---	XX	---	3.7	3.1	---
TOTAL										135.6	99.5	96.5
MEAN										4.4	3.2	3.2
MAX										5.2	3.6	4.0
MIN										3.7	3.0	2.8
AC-FT										268.9	197.4	191.4

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	4.5	2.6	***	***	***	***	9.1	23.3	10.9	4.6	3.7	XX
2	3.4	2.5	***	***	***	***	9.1	21.1	10.8	4.4	3.6	XX
3	3.1	2.6	***	***	***	***	8.8	18.6	9.4	4.4	3.5	XX
4	3.1	2.9	***	***	***	***	8.4	17.7	7.6	4.3	3.7	XX
5	3.0	2.8	***	***	***	***	8.2	17.4	6.9	4.4	3.8	XX
6	2.9	2.7	***	***	***	***	8.3	16.5	6.7	4.3	3.6	XX
7	2.9	2.6	***	***	***	***	8.4	16.0	5.6	4.2	XX	XX
8	2.9	2.8	***	***	***	***	8.2	16.1	6.2	4.1	XX	XX
9	2.9	2.7	***	***	***	***	8.0	16.3	6.0	4.0	XX	XX
10	3.0	2.5	***	***	***	***	8.1	15.8	5.4	4.0	XX	XX
11	3.0	2.5	***	***	***	***	8.5	15.5	5.3	3.9	XX	XX
12	3.1	***	***	***	***	***	8.2	15.3	5.5	3.9	XX	XX
13	3.0	***	***	***	***	***	8.2	15.0	5.6	3.9	XX	XX
14	2.9	***	***	***	***	***	8.1	15.4	5.3	3.8	XX	XX
15	2.8	***	***	***	***	***	8.1	15.3	5.1	3.8	XX	XX
16	2.9	***	***	***	***	6.3	8.3	14.9	4.9	5.0	XX	XX
17	2.9	***	***	***	***	6.2	9.0	13.3	4.9	4.4	XX	XX
18	2.9	***	***	***	***	6.2	10.3	13.2	4.8	4.1	XX	XX
19	3.0	***	***	***	***	6.9	11.1	13.7	4.8	4.0	XX	XX
20	3.3	***	***	***	***	8.0	11.2	13.4	4.8	4.0	XX	XX
21	3.4	***	***	***	***	7.7	11.0	13.2	4.7	4.2	XX	XX
22	2.8	***	***	***	***	7.7	10.7	13.0	4.6	4.0	XX	XX
23	2.7	***	***	***	***	7.7	10.8	12.8	4.5	3.9	XX	XX
24	2.7	***	***	***	***	8.1	11.6	12.6	4.6	3.8	XX	XX
25	2.7	***	***	***	***	9.1	13.5	12.4	4.7	3.7	XX	XX
26	2.7	***	***	***	***	9.5	15.7	12.2	4.8	3.6	XX	XX
27	3.0	***	***	***	***	9.1	17.4	12.0	6.2	3.6	XX	XX
28	3.1	***	***	***	***	9.1	21.6	11.7	6.3	3.6	XX	XX
29	3.3	***	***	***	---	8.9	20.6	11.5	5.2	3.7	XX	XX
30	2.8	***	***	***	---	8.6	20.8	11.3	4.8	3.9	XX	XX
31	2.7	---	***	***	---	8.6	---	11.1	---	3.9	XX	---
TOTAL	93.2	**	**	**	**	**	329.2	457.7	177.1	125.6		
MEAN	3.0	**	**	**	**	**	11.0	14.8	5.9	4.1		
MAX	4.5	**	**	**	**	**	21.6	23.3	10.9	5.0		
MIN	2.7	**	**	**	**	**	8.0	11.1	4.5	3.6		
AC-FT	184.8	**	**	**	**	**	652.9	907.8	351.2	249.1		

S. FORK COPPEI CREEK

LOCATION.-- Latitude: 46:10:44, Longitude: 118:06:27, Walla Walla County, South Fork Coppei Road, tributary of Touchet River -> Walla Walla River -> Columbia River

DRAINAGE AREA.-- 12.5 mi2

GAGE ELEVATION.-- 1791 ft

MEAN ANNUAL PRECIPITATION.-- 825 mm

MEAN WATER STRESS INDEX.-- 51 %

PERIOD OF RECORD.-- June 15, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed to concrete at downstream end of bridge. Extreme rain event occurred during one discharge measurement.
Notable rise in stage height occurred during this event.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 246 cfs, gage height, 2.71 ft; minimum discharge, 0.2 cfs, gage height, 0.60 ft
*Maximum estimated discharge is too high for this creek.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.2	0.4
2	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.3	0.7
3	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.3	0.4
4	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.2	0.4
5	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.2	0.4
6	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.2	0.4
7	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.2	0.4
8	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.2	0.4
9	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.2	0.4
10	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.2	1.1
11	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.3	0.2	0.7
12	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.3	0.3	0.5
13	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.3	0.3	0.4
14	XX	XX	XX	XX	XX	XX	XX	XX	XX	0.3	0.3	0.4
15	XX	XX	XX	XX	XX	XX	XX	XX	7.9	0.3	0.3	0.4
16	XX	XX	XX	XX	XX	XX	XX	XX	5.7	0.3	0.3	0.4
17	XX	XX	XX	XX	XX	XX	XX	XX	4.3	0.3	0.3	0.4
18	XX	XX	XX	XX	XX	XX	XX	XX	3.3	0.3	0.2	0.3
19	XX	XX	XX	XX	XX	XX	XX	XX	2.6	0.3	0.3	0.3
20	XX	XX	XX	XX	XX	XX	XX	XX	2.0	0.3	0.3	0.4
21	XX	XX	XX	XX	XX	XX	XX	XX	1.7	0.3	0.3	0.4
22	XX	XX	XX	XX	XX	XX	XX	XX	1.5	0.3	0.3	0.4
23	XX	XX	XX	XX	XX	XX	XX	XX	1.3	0.3	0.3	0.4
24	XX	XX	XX	XX	XX	XX	XX	XX	1.1	0.3	0.3	0.4
25	XX	XX	XX	XX	XX	XX	XX	XX	1.0	0.3	0.3	0.4
26	XX	XX	XX	XX	XX	XX	XX	XX	0.9	0.3	0.3	0.4
27	XX	XX	XX	XX	XX	XX	XX	XX	0.7	0.3	0.3	0.3
28	XX	XX	XX	XX	XX	XX	XX	XX	0.7	0.3	0.3	0.3
29	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.3	0.3	0.3
30	XX	XX	XX	XX	---	XX	XX	XX	0.6	0.3	0.4	1.3
31	XX	---	XX	XX	---	XX	---	XX	---	0.3	0.4	---
TOTAL										11.2	8.5	13.8
MEAN										0.4	0.3	0.5
MAX										0.6	0.4	1.3
MIN										0.3	0.2	0.3
AC-FT										22	17	27

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	3.6	0.9	4.2	3.6	5.3	10.1	39.9	100.2	8.3	5.8	5.4	XX
2	1.3	0.9	3.7	3.2	11.9	12.9	38.1	88.0	7.9	5.4	5.4	XX
3	0.7	0.8	3.4	3.0	13.5	12.1	36.6	75.5	7.7	5.2	5.3	XX
4	0.6	1.0	3.0	3.1	48.3	12.1	40.0	66.6	7.4	5.3	5.4	XX
5	0.5	1.1	2.6	4.8	117.4	13.3	47.7	58.5	7.5	5.1	5.4	XX
6	0.5	1.0	2.3	6.5	48.0	14.8	56.9	53.4	7.4	6.2	5.3	XX
7	0.5	1.0	2.1	5.4	30.9	15.5	55.8	50.0	7.0	5.3	XX	XX
8	0.5	2.3	1.9	4.6	23.9	17.1	49.9	47.1	6.8	5.3	XX	XX
9	0.5	2.3	1.7	4.1	19.5	17.7	44.0	43.8	6.7	5.2	XX	XX
10	0.5	1.9	1.7	3.7	17.1	16.5	42.9	41.1	6.3	5.2	XX	XX
11	0.5	1.6	1.5	3.6	15.6	15.4	66.8	38.2	6.3	5.6	XX	XX
12	0.5	1.5	1.8	3.7	14.5	14.7	73.5	35.1	6.9	5.5	XX	XX
13	0.5	1.5	1.6	3.9	13.2	14.9	64.7	31.9	7.1	5.5	XX	XX
14	0.5	1.5	1.9	5.0	12.3	15.2	57.0	33.6	6.5	5.3	XX	XX
15	0.5	1.5	1.6	4.2	11.9	14.6	52.0	53.7	6.1	5.3	XX	XX
16	0.5	1.4	1.6	3.9	11.1	16.9	50.4	57.8	5.8	5.3	XX	XX
17	0.5	1.4	3.0	3.7	10.5	17.0	53.5	42.2	5.7	5.4	XX	XX
18	0.5	1.2	2.3	3.6	10.4	19.1	67.3	34.2	5.6	5.3	XX	XX
19	0.5	1.2	3.1	3.8	10.2	27.6	67.8	28.6	5.5	5.3	XX	XX
20	0.8	1.1	2.7	3.7	10.0	27.5	60.4	25.0	5.4	5.5	XX	XX
21	2.4	1.1	2.5	7.0	10.0	23.4	53.4	22.3	5.2	5.6	XX	XX
22	1.2	1.1	3.2	14.8	11.0	20.6	47.4	20.4	5.1	5.4	XX	XX
23	0.9	1.1	9.4	12.2	11.4	19.0	43.9	18.1	5.0	5.3	XX	XX
24	0.8	1.3	15.4	11.0	11.3	18.8	42.2	15.4	5.0	5.2	XX	XX
25	0.8	1.6	10.0	9.7	11.0	21.4	41.1	13.2	5.1	5.2	XX	XX
26	0.7	2.7	7.4	8.6	10.7	22.1	40.1	12.1	5.1	5.2	XX	XX
27	0.8	6.8	6.3	7.5	10.2	21.0	39.9	11.0	5.7	5.0	XX	XX
28	1.0	5.6	5.5	6.6	10.0	26.4	41.9	10.3	5.8	5.1	XX	XX
29	1.2	4.3	4.9	5.8	---	26.8	41.2	9.3	5.4	5.3	XX	XX
30	1.1	4.4	4.4	5.2	---	25.6	78.1	8.8	5.4	5.9	XX	XX
31	1.0	---	4.0	5.2	---	32.4	---	8.5	---	5.7	XX	---
TOTAL	26.3	57.1	120.6	174.8	540.9	582.4	1534.4	1153.7	186.5	166.7		
MEAN	0.8	1.9	3.9	5.6	19.3	18.8	51.1	37.2	6.2	5.4		
MAX	3.6	6.8	15.4	14.8	117.4	32.4	78.1	100.2	8.3	6.2		
MIN	0.5	0.8	1.5	3.0	5.3	10.1	36.6	8.5	5.0	5.0		
AC-FT	52.1	113.2	239.1	346.6	1072.9	1155.3	3043.4	2288.4	370.0	330.6		

STEMILT CREEK

LOCATION.-- Latitude: 47:17:35, Longitude: 120:09:18, Chelan County, Stemilt Creek Road, tributary of Columbia River

DRAINAGE AREA.-- 24.6 mi2

GAGE ELEVATION.-- 1739 ft

MEAN ANNUAL PRECIPITATION.-- 657 mm

MEAN WATER STRESS INDEX.-- 51 %

PERIOD OF RECORD.-- May 28, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Gauge installed at downstream end of bridge. Trout were identified on several occasions.
The stream ran dry with the exception of water in some large pools, leaving fish stranded.
Local landowners identified this occurrence as the result of new irrigation practices by a separate landowner.
The gage was replaced on 9/28/00 due to unknown malfunction.
*** - indicates missing data during gage malfunction.

EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 20.0 cfs, gage height, 1.14 ft; minimum discharge, 0.0 cfs, gage height, -0.13 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	14.8	***	***	***
2	XX	XX	XX	XX	XX	XX	XX	XX	14.4	***	***	***
3	XX	XX	XX	XX	XX	XX	XX	XX	13.8	***	***	***
4	XX	XX	XX	XX	XX	XX	XX	XX	13.9	***	***	***
5	XX	XX	XX	XX	XX	XX	XX	XX	13.4	***	***	***
6	XX	XX	XX	XX	XX	XX	XX	XX	13.1	***	***	***
7	XX	XX	XX	XX	XX	XX	XX	XX	13.8	***	***	***
8	XX	XX	XX	XX	XX	XX	XX	XX	14.2	***	***	***
9	XX	XX	XX	XX	XX	XX	XX	XX	14.1	***	***	***
10	XX	XX	XX	XX	XX	XX	XX	XX	14.1	***	***	***
11	XX	XX	XX	XX	XX	XX	XX	XX	13.9	***	***	***
12	XX	XX	XX	XX	XX	XX	XX	XX	17.6	***	***	***
13	XX	XX	XX	XX	XX	XX	XX	XX	18.4	***	***	***
14	XX	XX	XX	XX	XX	XX	XX	XX	16.7	***	***	***
15	XX	XX	XX	XX	XX	XX	XX	XX	15.8	***	***	***
16	XX	XX	XX	XX	XX	XX	XX	XX	13.6	***	***	***
17	XX	XX	XX	XX	XX	XX	XX	XX	11.0	***	***	***
18	XX	XX	XX	XX	XX	XX	XX	XX	9.4	***	***	***
19	XX	XX	XX	XX	XX	XX	XX	XX	5.8	***	***	***
20	XX	XX	XX	XX	XX	XX	XX	XX	1.2	***	***	***
21	XX	XX	XX	XX	XX	XX	XX	XX	0.6	***	***	***
22	XX	XX	XX	XX	XX	XX	XX	XX	2.3	***	***	***
23	XX	XX	XX	XX	XX	XX	XX	XX	3.1	***	***	***
24	XX	XX	XX	XX	XX	XX	XX	XX	1.9	***	***	***
25	XX	XX	XX	XX	XX	XX	XX	XX	1.5	***	***	***
26	XX	XX	XX	XX	XX	XX	XX	XX	1.1	***	***	***
27	XX	XX	XX	XX	XX	XX	XX	XX	0.1	***	***	***
28	XX	XX	XX	XX	XX	XX	XX	14.2	0.0	***	***	***
29	XX	XX	XX	XX	XX	XX	XX	13.8	0.2	***	***	2.8
30	XX	XX	XX	XX	---	XX	XX	14.7	0.5	***	***	2.6
31	XX	---	XX	XX	---	XX	---	15.5	---	***	***	---
TOTAL									274.3			
MEAN									9.1			
MAX									18.4			
MIN									0.0			
AC-FT									544.1			

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	2.4	2.5	2.3	2.2	2.6	2.5	2.7	2.8	0.1	0.0	0.0	0.1
2	2.4	2.2	2.4	2.2	2.7	2.5	2.6	2.3	0.1	0.0	0.0	0.1
3	2.6	2.2	2.3	2.2	2.5	2.5	2.6	2.2	0.1	0.0	0.0	0.0
4	3.4	2.4	2.3	2.3	2.6	2.6	2.9	2.3	0.0	0.0	0.2	0.0
5	3.9	2.4	2.3	2.4	2.5	2.6	2.7	2.5	0.2	0.0	0.2	0.0
6	3.9	2.4	2.2	2.3	2.5	2.6	2.7	2.5	0.6	0.7	0.0	0.0
7	4.0	2.3	2.1	2.2	2.1	2.6	2.6	2.4	1.4	0.0	0.0	0.0
8	4.0	2.5	2.0	2.3	2.7	2.7	2.5	2.4	1.6	0.0	0.0	0.1
9	3.7	2.5	2.0	2.3	2.7	3.0	2.5	2.6	1.7	0.0	0.0	0.2
10	3.0	2.4	2.0	2.3	2.6	2.8	2.6	2.9	1.1	0.0	0.0	0.1
11	3.0	2.0	1.6	2.3	2.6	2.7	2.9	3.0	0.4	0.0	0.0	0.0
12	2.9	2.3	1.5	2.3	2.5	2.6	2.8	3.3	0.0	0.5	0.0	0.1
13	2.9	2.4	1.5	2.4	2.5	2.8	2.6	3.4	0.0	0.3	0.0	0.1
14	2.9	2.4	1.7	2.3	2.5	2.7	2.6	2.0	0.1	0.1	0.0	0.1
15	2.8	2.2	1.9	2.3	2.5	2.5	2.5	0.9	0.0	0.1	0.0	0.2
16	2.9	2.6	1.9	2.0	2.5	2.4	2.5	1.0	0.0	0.0	0.0	0.1
17	3.2	2.2	1.9	2.4	2.5	2.5	2.5	0.9	0.0	0.1	0.0	0.1
18	3.3	2.5	1.8	2.5	2.6	2.6	2.1	0.8	0.0	0.1	0.0	0.0
19	3.3	2.4	1.9	2.5	2.6	2.8	1.8	1.0	0.0	0.0	0.0	0.0
20	3.9	2.4	1.8	2.5	2.6	2.6	1.7	1.6	0.0	0.0	0.0	0.0
21	4.1	2.3	1.9	2.6	2.6	2.6	1.8	0.9	0.0	0.0	0.0	0.1
22	3.9	2.3	1.9	2.5	2.6	2.6	1.8	0.3	0.0	0.0	0.0	0.5
23	3.9	2.3	1.9	2.5	2.6	2.6	2.0	0.3	0.0	0.0	0.0	0.4
24	4.0	2.2	2.0	2.4	2.5	2.7	2.0	1.4	0.0	0.0	0.0	0.2
25	3.9	1.8	2.0	2.4	2.5	3.0	1.5	1.5	0.0	0.0	0.1	0.1
26	4.2	2.0	2.1	2.5	2.4	3.0	2.1	0.4	0.0	0.0	0.0	0.1
27	6.4	2.1	2.1	2.5	2.5	2.8	2.7	0.6	0.0	0.0	0.0	0.1
28	4.7	2.1	2.0	2.6	2.5	2.7	3.5	0.5	0.0	0.0	0.0	0.3
29	2.7	2.2	2.1	2.6	---	2.7	3.4	0.6	0.0	0.0	0.0	0.6
30	2.6	2.2	2.1	2.6	---	2.7	3.2	0.6	0.0	0.0	0.0	0.3
31	2.6	---	2.2	2.7	---	2.7	---	0.3	---	0.0	0.0	---
TOTAL	107.3	68.5	61.8	74.1	70.9	82.8	74.3	50.0	7.5	2.1	0.7	4.2
MEAN	3.5	2.3	2.0	2.4	2.5	2.7	2.5	1.6	0.3	0.1	0.0	0.1
MAX	6.4	2.6	2.4	2.7	2.7	3.0	3.5	3.4	1.7	0.7	0.2	0.6
MIN	2.4	1.8	1.5	2.0	2.1	2.4	1.5	0.3	0.0	0.0	0.0	0.0
AC-FT	212.8	135.8	122.7	147.0	140.7	164.2	147.3	99.2	14.9	4.2	1.4	8.3

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.5	2.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
2	1.2	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
3	1.7	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
4	1.5	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
5	1.2	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
6	1.2	1.2	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
7	1.3	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
8	1.3	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
9	1.2	1.5	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
10	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
11	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
12	1.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
13	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
14	1.0	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
15	1.1	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
16	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
17	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
18	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
19	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX
20	1.3	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX

TUMALUM CREEK

LOCATION.-- Latitude: 46:21:33, Longitude: 117:41:02, Columbia County, Tucannon Road, tributary of Tucannon River -> Snake River -> Columbia River

DRAINAGE AREA.-- 15.8 mi2

GAGE ELEVATION.-- 1975 ft

MEAN ANNUAL PRECIPITATION.-- 832 mm

MEAN WATER STRESS INDEX.-- 50 %

PERIOD OF RECORD.-- May 20, 2000 to current year

GAGE.-- Pressure transducer with data logger, model WL14X-003 by Global Water Inc.,

REMARKS.-- Installed to concrete at downstream end of culvert. Very close to Tucannon River potentially making it a spawning stream. Changes were noted in downstream reach of stream, which in turn affected the recording of stage height a minor amount.

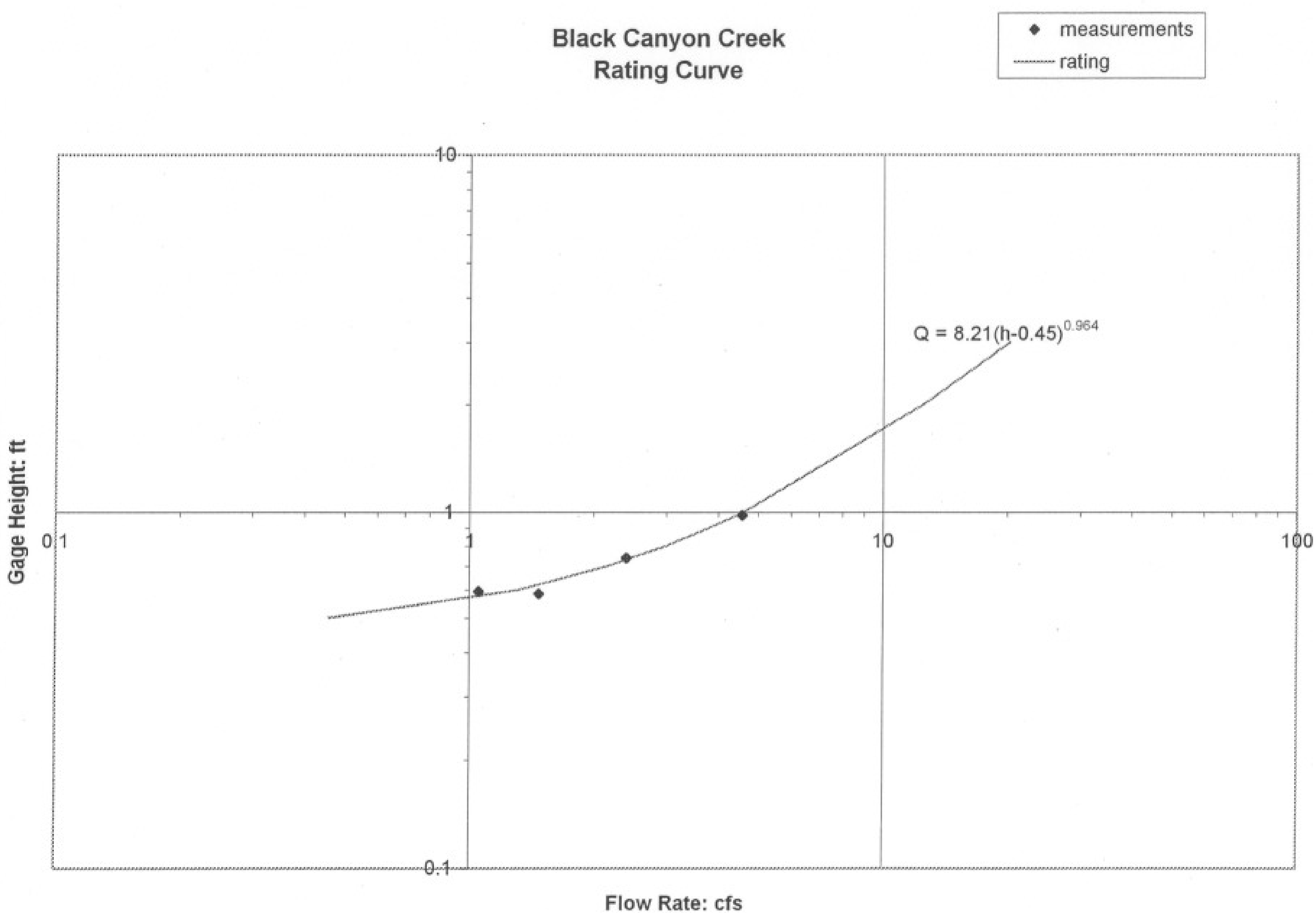
EXTREMES FOR PERIOD OF RECORD.-- Maximum discharge, 1.8 cfs, gage height, 0.84 ft; minimum discharge, 0.17 cfs, gage height, 0.43 ft

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1999 TO SEPTEMBER 2000
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3
2	XX	XX	XX	XX	XX	XX	XX	XX	0.7	0.4	0.3	0.4
3	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
4	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
5	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
6	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3
7	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
8	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
9	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
10	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.4	0.3	0.4
11	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
12	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.4
13	XX	XX	XX	XX	XX	XX	XX	XX	0.6	0.3	0.3	0.4
14	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.3	0.3	0.4
15	XX	XX	XX	XX	XX	XX	XX	XX	0.5	0.3	0.3	0.4
16	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.3	0.3	0.4
17	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.3	0.3	0.4
18	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.3	0.3	0.4
19	XX	XX	XX	XX	XX	XX	XX	XX	0.4	0.3	0.3	0.4
20	XX	XX	XX	XX	XX	XX	XX	0.7	0.4	0.3	0.3	0.4
21	XX	XX	XX	XX	XX	XX	XX	1.5	0.4	0.3	0.3	0.4
22	XX	XX	XX	XX	XX	XX	XX	0.9	0.4	0.3	0.3	0.4
23	XX	XX	XX	XX	XX	XX	XX	0.7	0.4	0.3	0.3	0.4
24	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3	0.4
25	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3	0.4
26	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3	0.4
27	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3	0.4
28	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3	0.4
29	XX	XX	XX	XX	XX	XX	XX	0.6	0.4	0.3	0.3	0.4
30	XX	XX	XX	XX	---	XX	XX	0.6	0.4	0.3	0.3	0.4
31	XX	---	XX	XX	---	XX	---	0.7	---	0.3	0.3	---
TOTAL									14.9	10.8	9.0	11.4
MEAN									0.5	0.3	0.3	0.4
MAX									0.7	0.4	0.3	0.4
MIN									0.4	0.3	0.3	0.3
AC-FT									29.5	21.5	17.9	22.6

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2000 TO SEPTEMBER 2001
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	0.3	0.3	0.4	0.3	0.3	0.3	0.4	0.6	0.9	1.1	1.0	XX
2	0.2	0.3	0.4	0.3	0.4	0.4	0.4	0.5	0.9	1.1	0.9	XX
3	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.5	0.9	1.1	0.9	XX
4	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.5	0.9	1.1	0.9	XX
5	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.5	1.0	1.1	0.9	XX
6	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.6	1.0	1.2	0.9	XX
7	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.6	1.0	1.2	XX	XX
8	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.6	1.0	1.1	XX	XX
9	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.6	1.0	1.1	XX	XX
10	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.6	1.0	1.1	XX	XX
11	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.6	1.1	1.1	XX	XX
12	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.6	1.1	1.1	XX	XX
13	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.6	1.1	1.0	XX	XX
14	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.7	1.1	1.0	XX	XX
15	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.7	1.1	1.0	XX	XX
16	0.3	0.3	0.4	0.3	0.4	0.3	0.4	0.7	1.1	1.0	XX	XX
17	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.7	1.1	1.0	XX	XX
18	0.2	0.3	0.3	0.3	0.4	0.3	0.4	0.7	1.2	1.0	XX	XX
19	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.7	1.2	1.1	XX	XX
20	0.3	0.3	0.3	0.3	0.4	0.3	0.4	0.7	1.1	1.1	XX	XX
21	0.2	0.3	0.3	0.3	0.4	0.3	0.4	0.8	1.1	1.1	XX	XX
22	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.8	1.1	1.1	XX	XX
23	0.2	0.3	0.4	0.3	0.4	0.3	0.5	0.8	1.1	1.1	XX	XX
24	0.2	0.3	0.4	0.3	0.4	0.3	0.5	0.8	1.1	1.0	XX	XX
25	0.2	0.4	0.3	0.3	0.4	0.3	0.5	0.8	1.1	1.0	XX	XX
26	0.2	0.4	0.3	0.3	0.4	0.3	0.5	0.8	1.1	1.0	XX	XX
27	0.3	0.4	0.3	0.3	0.4	0.4	0.5	0.8	1.3	0.9	XX	XX
28	0.3	0.4	0.3	0.3	0.3	0.3	0.5	0.9	1.2	0.9	XX	XX
29	0.3	0.4	0.3	0.3	---	0.3	0.5	0.9	1.2	0.9	XX	XX
30	0.3	0.4	0.3	0.3	---	0.3	0.6	0.9	1.2	1.0	XX	XX
31	0.3	---	0.3	0.3	---	0.4	---	0.9	---	1.0	XX	---
TOTAL	7.6	9.8	10.9	9.9	11.2	10.3	12.5	21.4	32.5	33.0		
MEAN	0.2	0.3	0.4	0.3	0.4	0.3	0.4	0.7	1.1	1.1		
MAX	0.3	0.4	0.4	0.3	0.4	0.4	0.6	0.9	1.3	1.2		
MIN	0.2	0.3	0.3	0.3	0.3	0.3	0.4	0.5	0.9	0.9		
AC-FT	15.1	19.4	21.7	19.7	22.2	20.4	24.7	42.4	64.4	65.5		



Black Canyon Creek
Rating Curve
measurements
rating
$Q = 8.21(h-0.45)^{0.964}$
Gage Height: ft
Flow Rate: cfs
10
1
0.1
0.1
1
10
100

Black Canyon - Rating Table

Date	Gage Height ft	Flow Rate cfs
5/26/2000	0.977	4.565
7/1/2000	0.738	2.4
8/9/2000	0.585	1.47
9/27/2000	0.593	1.05

	y log Q	x log(h-a)	x^2	y^2	xy
	0.659	-0.277	0.077	0.435	-0.183
	0.380	-0.539	0.290	0.145	-0.205
	0.167	-0.865	0.749	0.028	-0.145
	0.021	-0.840	0.706	0.000	-0.018
sum	1.228	-2.521	1.822	0.608	-0.550

h	Q
0.5	0.5
0.6	1.3
0.7	2.2
0.8	3.0
0.9	3.8
1	4.6
2	12.5
3	20.2

log Q = n log(h-a) + log A

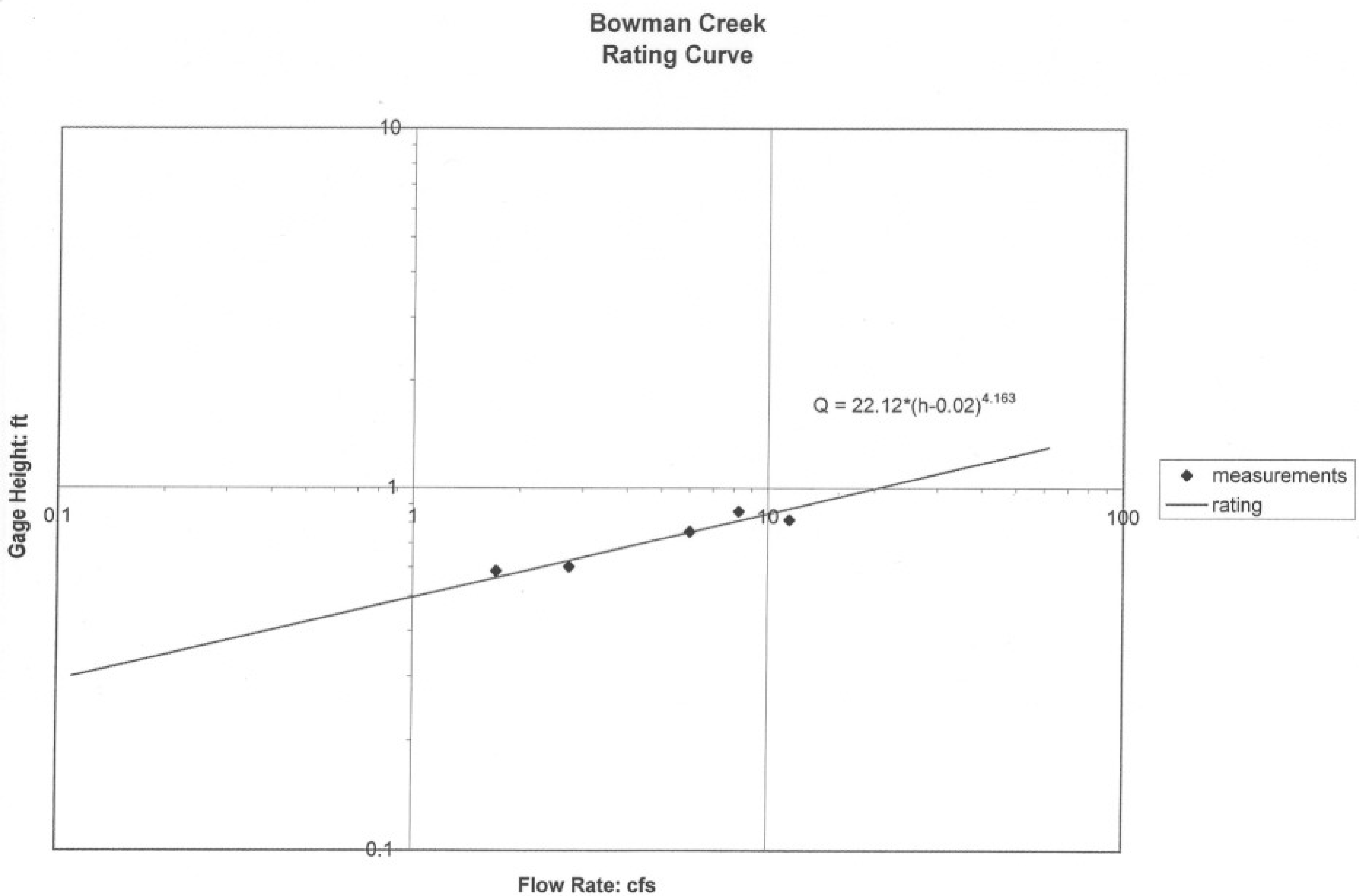
$Q = C(h-a)^n$

Q1	1.5	
Q2	5	
Q3	2.7	
h1	0.62	0.62
h2	1.03	1.03
h3	0.77	0.77
a	0.45	

log A=	0.914
n=	0.964
C=	8.21
N=	4
S_{xx}=	0.233
S_{yy}=	0.231
S_{xy}=	0.224
r =	0.97
r^2 =	0.94

best fit

y = 0.1158x + 0.4486


Bowman Creek
Rating Curve
10
1
0.1
0.1
1
10
100
Q = 22.12*(h-0.02)^4.163
measurements
rating
Gage Height: ft
Flow Rate: cfs

Bowman - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
6/13/2000	0.815	11.51		1.061	-0.100	0.010	1.126	-0.106
7/3/2000	0.755	6.01		0.779	-0.134	0.018	0.607	-0.104
8/11/2000	0.603	2.75		0.439	-0.234	0.055	0.193	-0.103
9/29/2000	0.586	1.72		0.236	-0.247	0.061	0.055	-0.058
5/17/2001	0.86	8.27		0.918	-0.076	0.006	0.842	-0.069
			sum	3.432	-0.791	0.150	2.823	-0.441

Rating	
h	Q
0.3	0.1
0.4	0.4
0.5	1.0
0.6	2.3
0.7	4.4
0.8	7.9
0.9	13.0
1	20.3
1.1	30.5
1.2	44.1
1.3	61.8

Q1	1	
Q2	10	
Q3	3.16	
h1	0.51	0.51
h2	0.83	0.83
h3	0.65	0.65
a	0.02	

log Q = n log(h-a) + log A

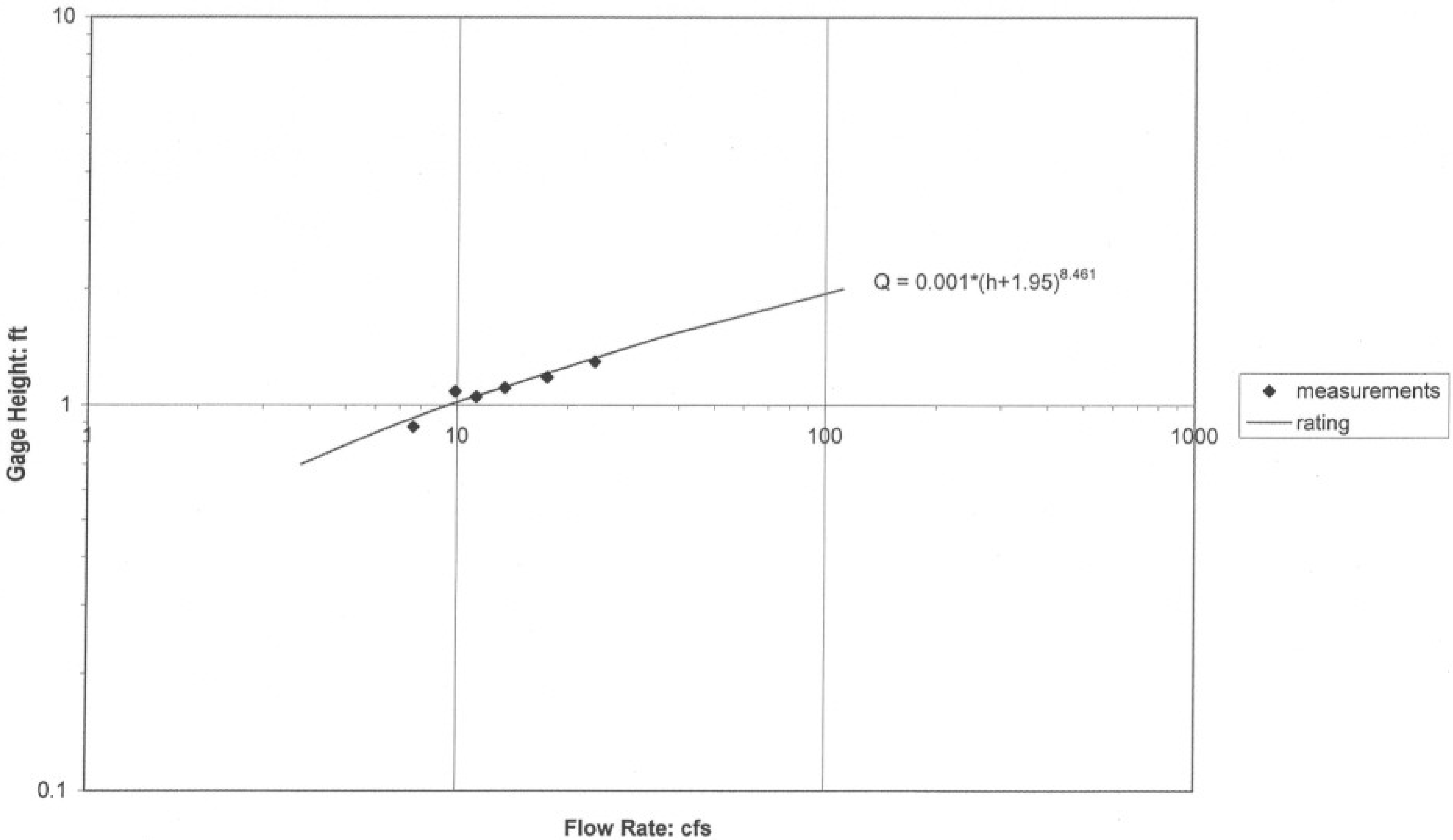
Q = C(h-a)n

log A=	1.345
n=	4.163
C=	22.12
N=	5
S_{xx}=	0.025
S_{yy}=	0.467
S_{xy}=	0.102
r =	0.95
r^2 =	0.91

best fit

$y = 0.5109*x^{0.2127}$

Buck Creek
Rating Curve



Buck - Rating Table

Date	Gage Height ft	Flow Rate cfs
6/12/2000	1.295	23.63
7/3/2000	1.0496	11.3
8/11/2000	0.878	7.61
9/29/2000	1.086	9.89
2/10/2001	1.109	13.5
5/17/2001	1.18	17.6

	y log Q	x log(h-a)	x^2	y^2	xy
	1.373	0.511	0.261	1.886	0.702
	1.053	0.477	0.228	1.109	0.502
	0.881	0.451	0.204	0.777	0.398
	0.995	0.482	0.233	0.990	0.480
	1.130	0.486	0.236	1.278	0.549
	1.246	0.496	0.246	1.551	0.617
sum	6.679	2.903	1.407	7.592	3.249

h	Q
0.7	3.8
0.8	5.2
0.9	7.1
1	9.4
1.5	35.5
2	111.6

Q1	8	
Q2	23	
Q3	13.6	
h1	0.942	0.94
h2	1.286	1.29
h3	1.114	1.11
a	-1.95	

best fit

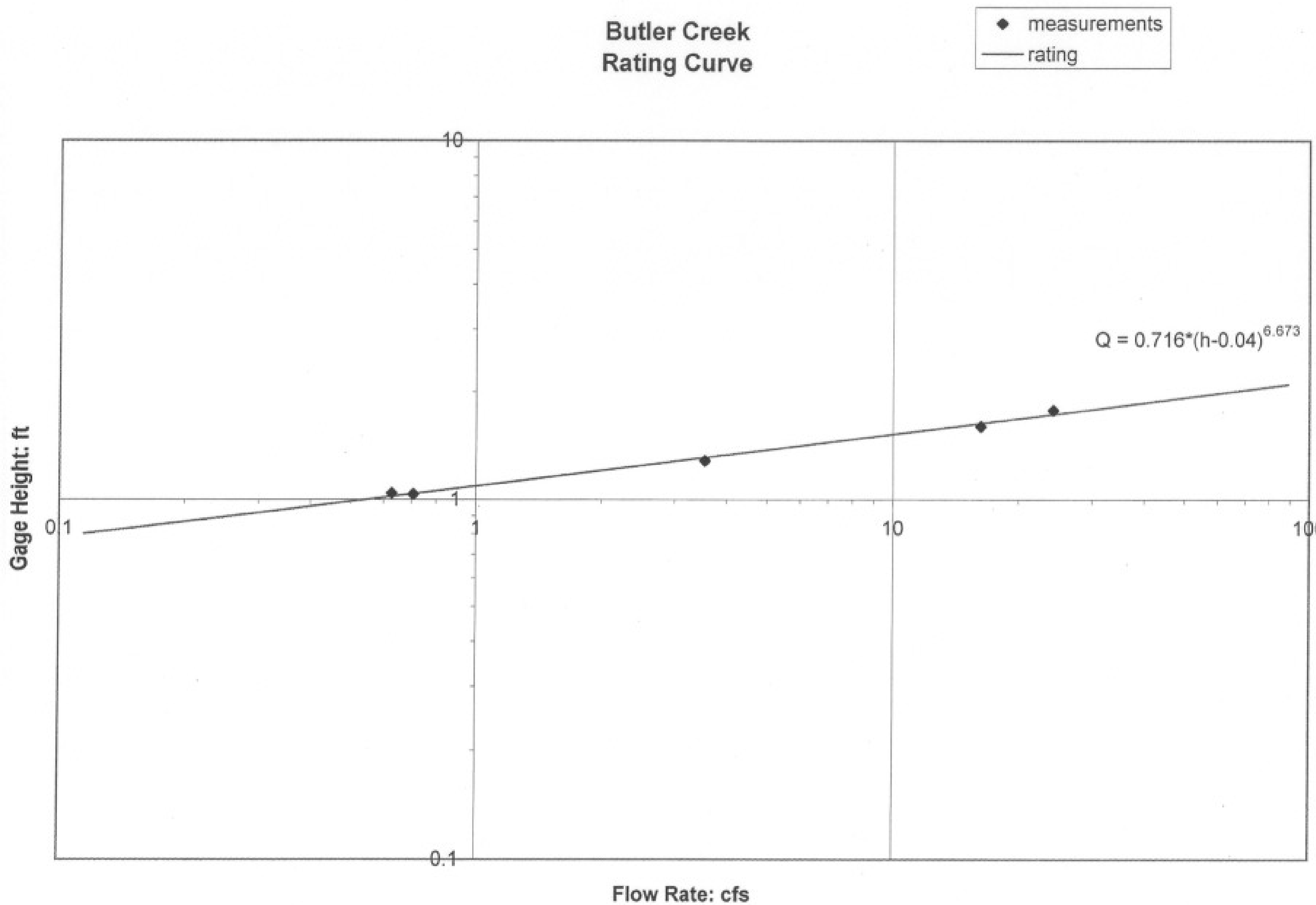
y = 0.3258Ln(x) + 0.2646

log Q = n log(h-a) + log A

Q = C(h-a)n

log A=	-2.981
n=	8.461
C=	0.001
N=	6
S_{xx}=	0.002
S_{yy}=	0.157
S_{xy}=	0.017
r =	0.95
r^2 =	0.91

**Butler Creek
Rating Curve**



Butler - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
6/14/2000	1.601	16.25		1.211	0.193	0.037	1.466	0.234
7/3/2000	1.284	3.55		0.550	0.095	0.009	0.303	0.052
8/10/2000	1.04	0.626		-0.203	0.000	0.000	0.041	0.000
9/29/2000	1.035	0.706		-0.151	-0.002	0.000	0.023	0.000
5/16/2001	1.78	24.2		1.384	0.241	0.058	1.915	0.333
			sum	2.790	0.527	0.104	3.748	0.620

Rating	
h	Q
0.8	0.1
0.9	0.3
1	0.5
1.25	2.6
1.5	8.9
1.75	25.7
2	63.8
2.1	89.0

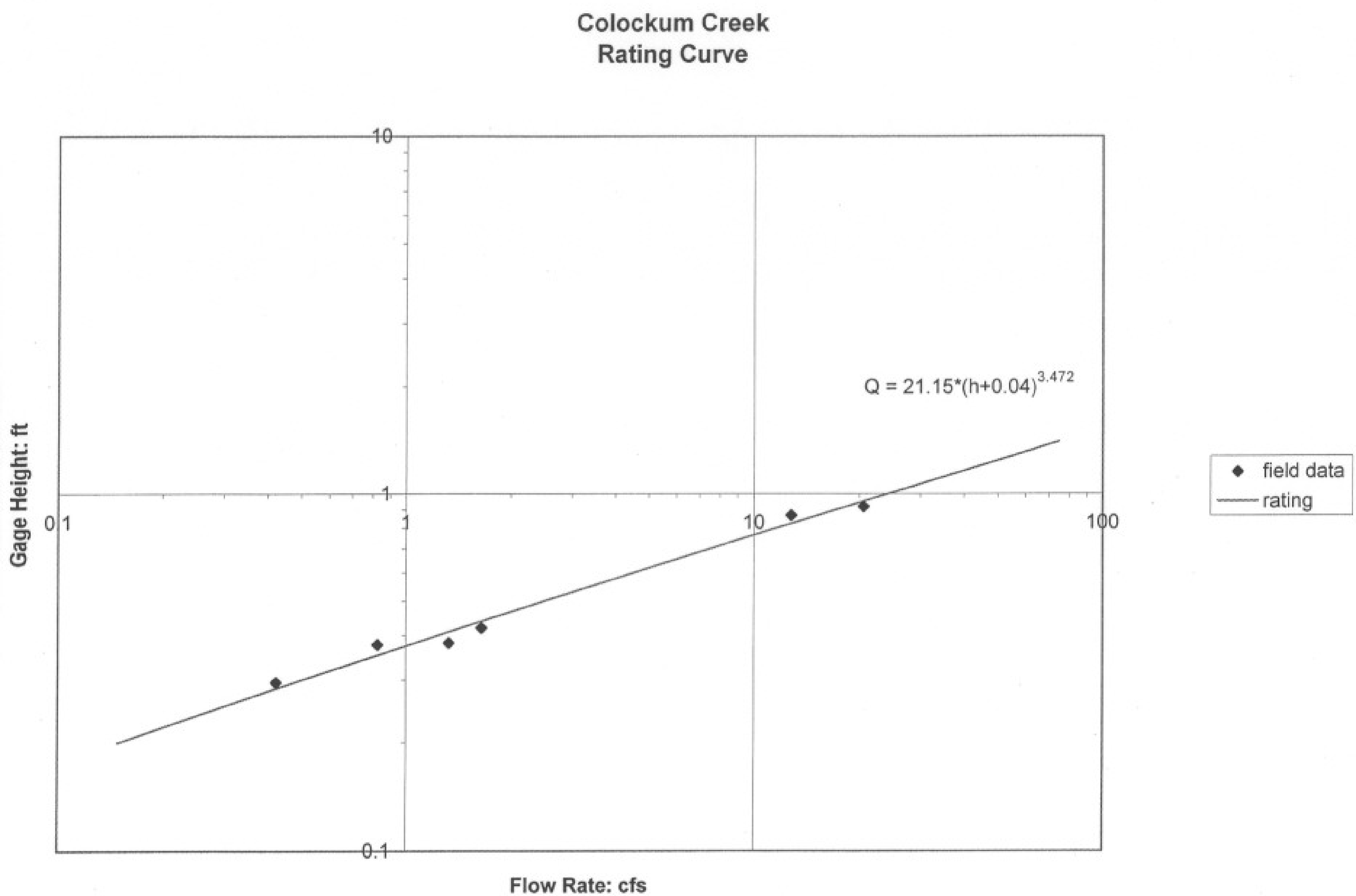
Q1	0.7	
Q2	24	
Q3	4.10	
h1	1.04	1.04
h2	1.73	1.73
h3	1.34	1.34
a	0.04	

log Q = n log(h-a) + log A

Q = C(h-a)n

log A=	-0.145
n=	6.673
C=	0.72
N=	5
S_{xx}=	0.049
S_{yy}=	2.191
S_{xy}=	0.326
r =	1.00
r^2 =	0.99

best fit
y = 1.093x0.1441



Colockum Creek
Rating Curve
Q = 21.15*(h+0.04)^3.472
10
1
0.1
0.1
1
10
100
Gage Height: ft
Flow Rate: cfs
field data
rating

Colockum - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
5/27/2000	0.87	12.77		1.106	-0.041	0.002	1.224	-0.045
7/1/2000	0.381	1.33		0.124	-0.376	0.141	0.015	-0.047
8/9/2000	0.295	0.423		-0.374	-0.475	0.226	0.140	0.177
9/27/2000	0.377	0.826		-0.083	-0.380	0.144	0.007	0.032
2/17/2001	0.42	1.65		0.217	-0.337	0.114	0.047	-0.073
5/15/2001	0.92	20.6		1.314	-0.018	0.000	1.726	-0.023
			sum	2.305	-1.626	0.627	3.159	0.021

Rating	
h	Q
0.2	0.1
0.3	0.5
0.5	2.5
0.8	11.5
0.9	17.1
1	24.2
1.25	51.2
1.4	75.0

Q1	0.4	
Q2	20	
Q3	2.83	
h1	0.28	0.28
h2	0.94	0.94
h3	0.52	0.52
a	-0.04	

log Q = n log(h-a) + log A

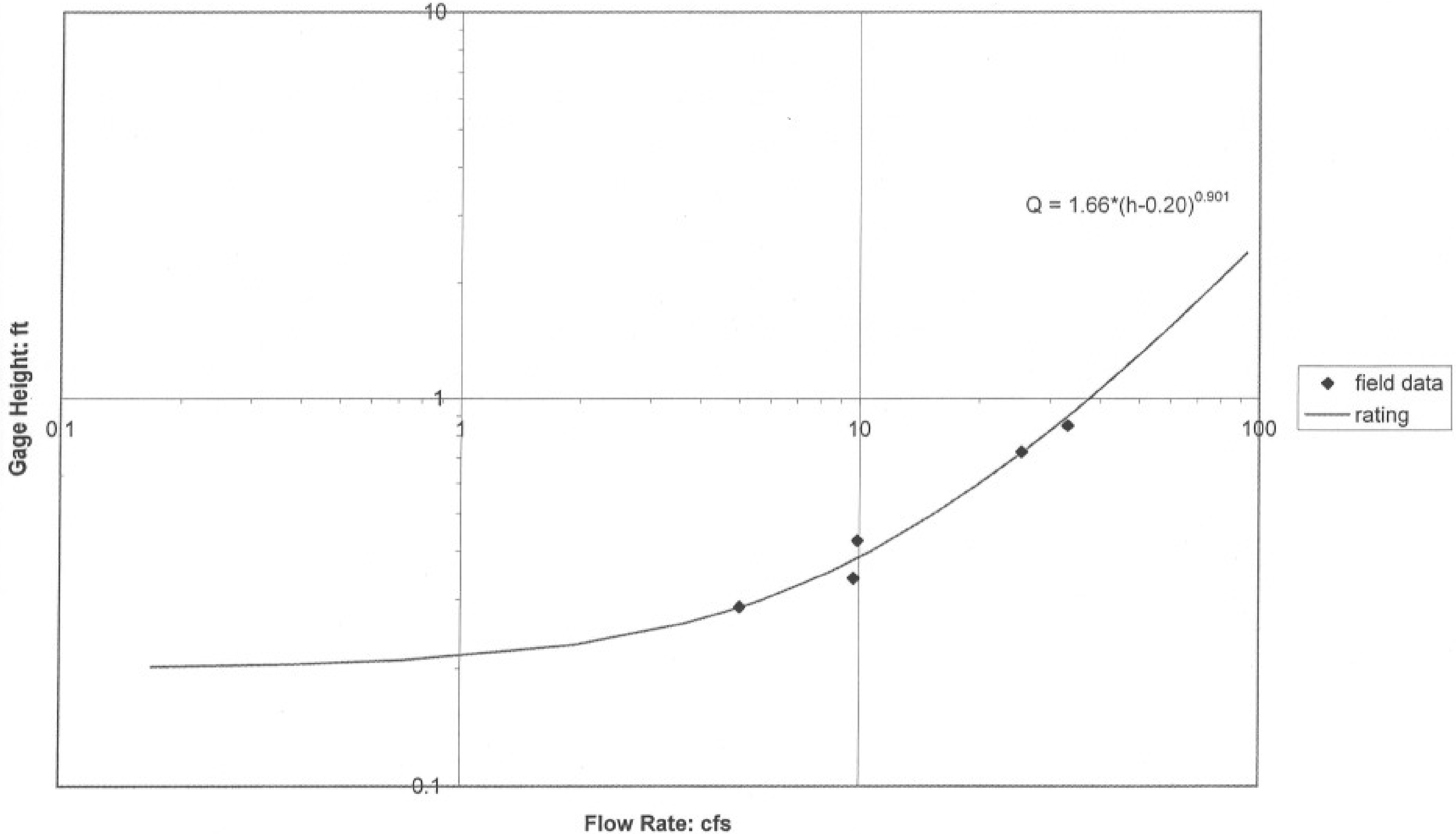
Q = C(h-a)n

log A=	1.325
n=	3.472
C=	21.146
N=	6
S_{xx}=	0.186
S_{yy}=	2.274
S_{xy}=	0.645
r =	0.99
r^2 =	0.99

best fit

y = .3758x^.3053

Libby Creek
Rating Curve



Libby - Rating Table

Date	Gage Height	Flow Rate		y	x			
	ft	cfs		log Q	log(h-a)	x^2	y^2	xy
5/26/2000	0.85	33.13		1.520	-0.185	0.034	2.311	-0.281
7/1/2000	0.726	25.5		1.407	-0.276	0.076	1.978	-0.389
8/8/2000	0.426	9.9		0.996	-0.640	0.410	0.991	-0.637
9/27/2000	0.287	5.02		0.701	-1.045	1.093	0.491	-0.733
5/15/2001	0.34	9.68		0.986	-0.844	0.713	0.972	-0.833
			sum	5.609	-2.991	2.326	6.744	-2.872

Q1	5	
Q2	22	
Q3	10.49	
h1	0.29	0.29
h2	0.64	0.64
h3	0.40	0.40
a	0.20	

best fit

y = 0.0205x + 0.185

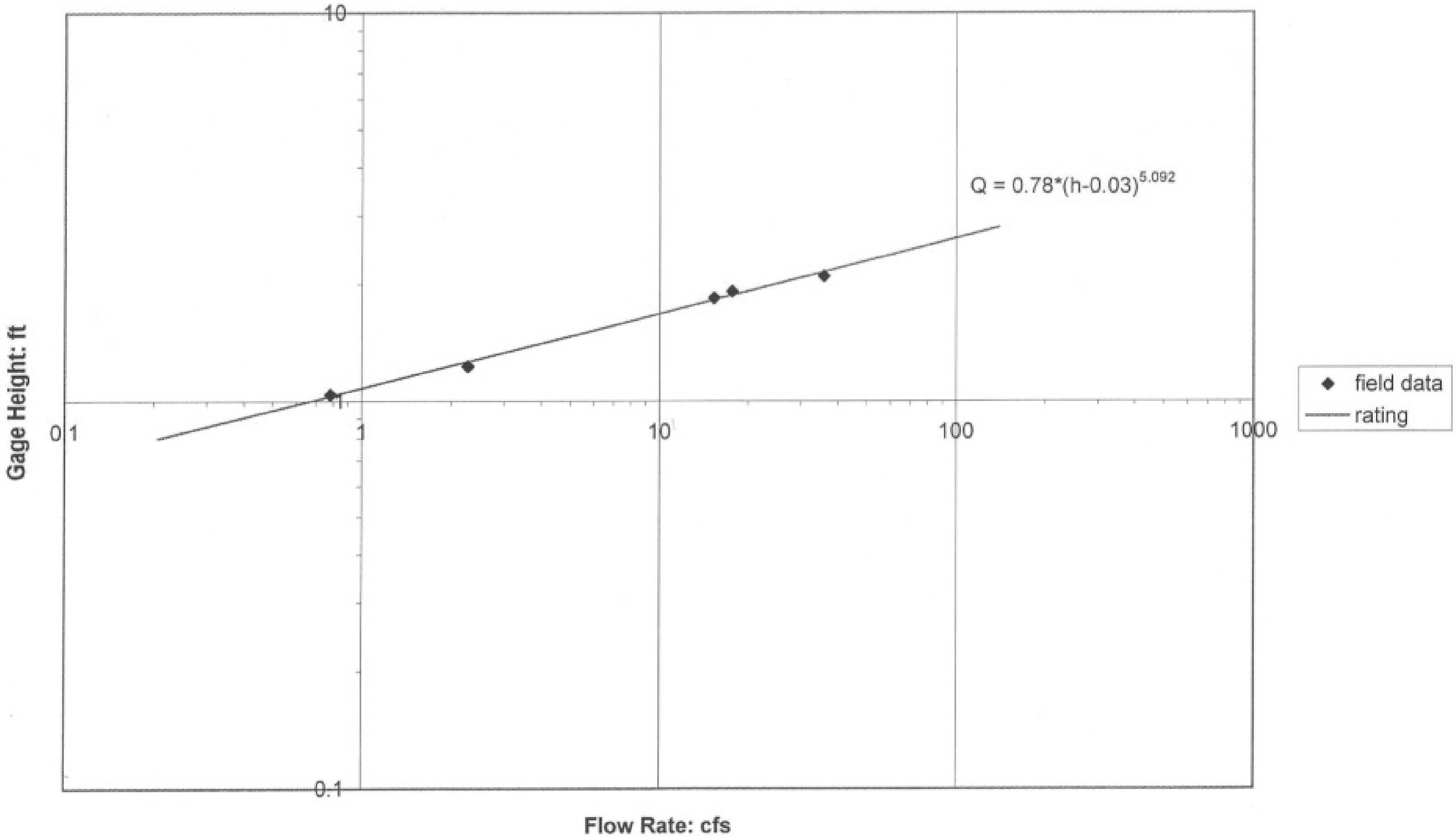
log Q = n log(h-a) + log A

Q = C(h-a)n

log A=	1.661
n=	0.901
C=	45.78
N=	5
S_{xx}=	0.537
S_{yy}=	0.452
S_{xy}=	0.483
r =	0.98
r^2 =	0.96

Rating	
h	Q
0.202	0.2
0.205	0.4
0.21	0.7
0.23	1.9
0.26	3.6
0.28	4.7
0.3	5.8
0.35	8.3
0.4	10.7
0.5	15.5
0.6	20.1
0.7	24.5
0.8	28.9
0.9	33.2
1	37.44207
1.3	49.88507
1.5	57.98808
1.7	65.96811
1.8	69.91782
2	77.74569
2.2	85.48774
2.4	93.15338

Little Bridge Creek
Rating Curve



Little Bridge - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
5/26/2000	2.095	35.81		1.554	0.316	0.100	2.415	0.491
6/30/2000	1.915	17.6		1.246	0.276	0.076	1.551	0.344
8/8/2000	1.23	2.27		0.356	0.081	0.007	0.127	0.029
9/27/2000	1.04	0.784		-0.106	0.006	0.000	0.011	-0.001
5/14/2001	1.84	15.3		1.185	0.259	0.067	1.403	0.306
			sum	4.235	0.937	0.249	5.508	1.169

Rating	
h	Q
0.8	0.2
0.9	0.4
1	0.7
1.25	2.1
1.5	5.5
1.75	12.3
2	24.6
2.1	31.7
2.3	50.7
2.5	77.9
2.8	139.7

Q1	0.8	
Q2	40	
Q3	5.66	
h1	1.03	1.03
h2	2.19	2.19
h3	1.50	1.50
a	0.03	

log Q = n log(h-a) + log A

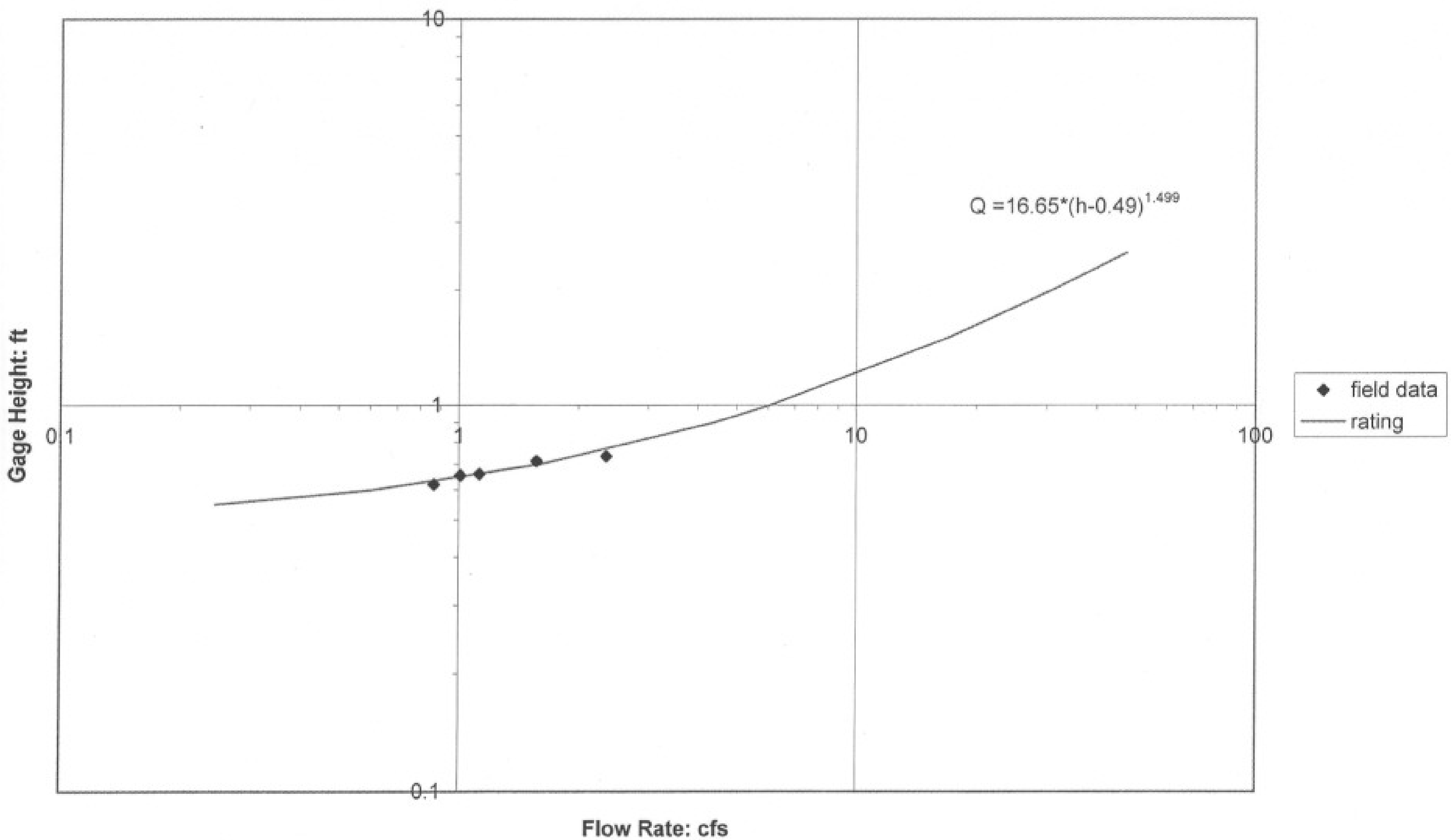
Q = C(h-a)n

log A=	-0.108
n=	5.092
C=	0.78
N=	5
S_{xx}=	0.074
S_{yy}=	1.921
S_{xy}=	0.375
r =	1.00
r^2 =	0.99

best fit

y = 1.0777x^.1919

Loup Loup Creek
Rating Curve



Loup Loup - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
5/25/2000	0.735	2.35		0.371	-0.611	0.373	0.138	-0.227
6/30/2000	0.713	1.57		0.196	-0.652	0.425	0.038	-0.128
8/8/2000	0.62	0.866		-0.062	-0.886	0.785	0.004	0.055
9/26/2000	0.6552	1.01		0.004	-0.782	0.612	0.000	-0.003
5/14/2001	0.66	1.13		0.053	-0.770	0.592	0.003	-0.041
			sum	0.562	-3.700	2.787	0.183	-0.343

Rating	
h	Q
0.55	0.2
0.6	0.6
0.7	1.6
0.9	4.4
1	6.1
1.5	16.9
2	30.9
2.5	47.4

Q1	1	
Q2	2.3	
Q3	1.52	
h1	0.65	0.65
h2	0.74	0.74
h3	0.69	0.69
a	0.49	

log Q = n log(h-a) + log A

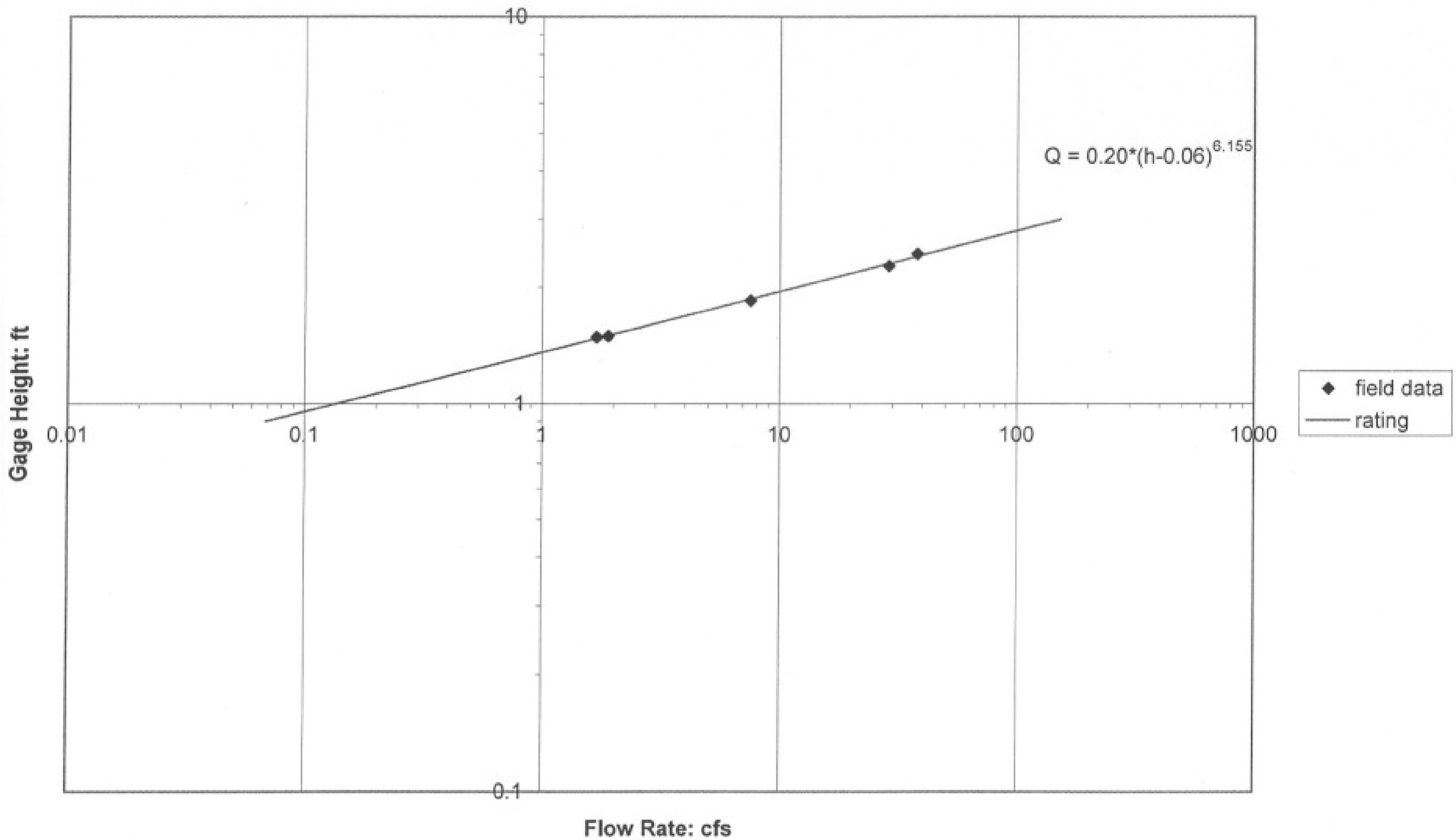
Q = C(h-a)n

log A=	1.222
n=	1.499
C=	16.65
N=	5
S_{xx}=	0.048
S_{yy}=	0.120
S_{xy}=	0.073
r =	0.95
r^2 =	0.91

best fit

y =.1137lnx+.6472

Lower Peshastin Creek
Rating Curve



Lower Peshastin - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
5/28/2000	2.27	28.809		1.460	0.345	0.119	2.130	0.504
7/2/2000	1.843	7.51		0.876	0.252	0.064	0.767	0.221
8/10/2000	1.495	1.89		0.276	0.158	0.025	0.076	0.044
9/28/2000	1.484	1.69		0.228	0.155	0.024	0.052	0.035
5/16/2001	2.44	37.95		1.579	0.377	0.142	2.494	0.596
			sum	4.419	1.288	0.374	5.519	1.400

Rating	
h	Q
0.9	0.1
1.2	0.4
1.4	1.2
1.8	6.0
2	11.8
2.25	24.9
2.5	48.5
2.75	88.3
3	152.7

Q1	2	
Q2	40	
Q3	8.94	
h1	1.51	1.51
h2	2.42	2.42
h3	1.91	1.91
a	0.06	

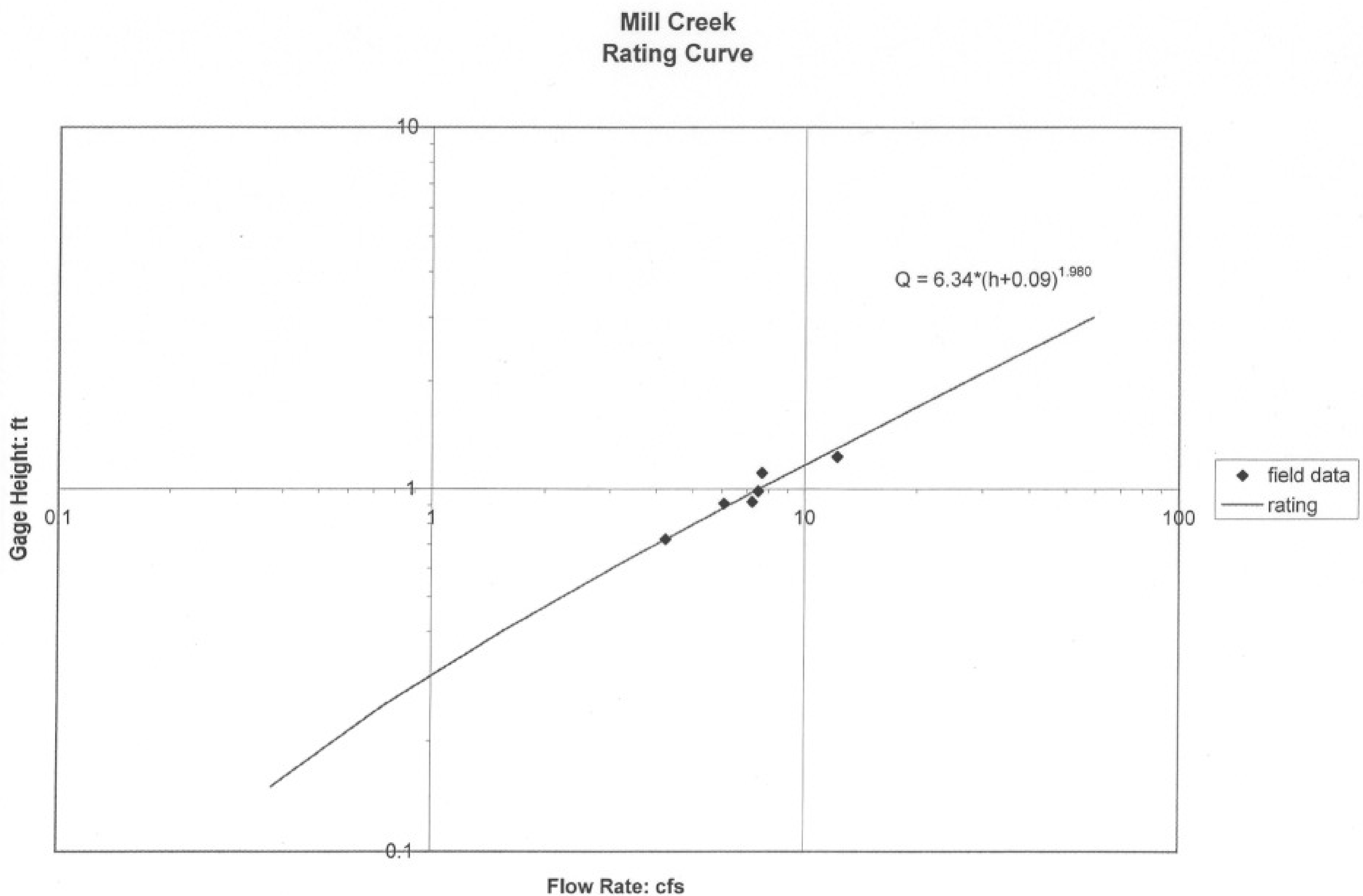
log Q = n log(h-a) + log A

Q = C(h-a)n

log A=	-0.702
n=	6.155
C=	0.20
N=	5
S_{xx}=	0.042
S_{yy}=	1.614
S_{xy}=	0.262
r =	1.00
r^2 =	1.00

best fit

y =1.3554x^.1572



Mill Creek
Rating Curve
Q = 6.34*(h+0.09)^1.980
Gage Height: ft
Flow Rate: cfs
10
1
0.1
0.1
1
10
100
field data
rating

Mill Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
6/13/2000	1.232	12.23		1.087	0.122	0.015	1.182	0.133
7/3/2000	0.985	7.5		0.875	0.032	0.001	0.766	0.028
8/11/2000	0.725	4.24		0.627	-0.088	0.008	0.394	-0.055
9/29/2000	0.922	7.23		0.859	0.006	0.000	0.738	0.005
2/10/2001	0.912	6.08		0.784	0.002	0.000	0.615	0.002
5/17/2001	1.11	7.68		0.885	0.080	0.006	0.784	0.071
		30	sum	5.118	0.155	0.030	4.478	0.184

Rating	
h	Q
0.15	0.4
0.25	0.7
0.4	1.5
0.6	3.0
1	7.5
1.5	15.9
2	27.3
2.5	41.7
3	59.2

Q1	5	
Q2	11.5	
Q3	7.58	
h1	0.81	0.81
h2	1.23	1.23
h3	1.00	1.00
a	-0.09	

log Q = n log(h-a) + log A

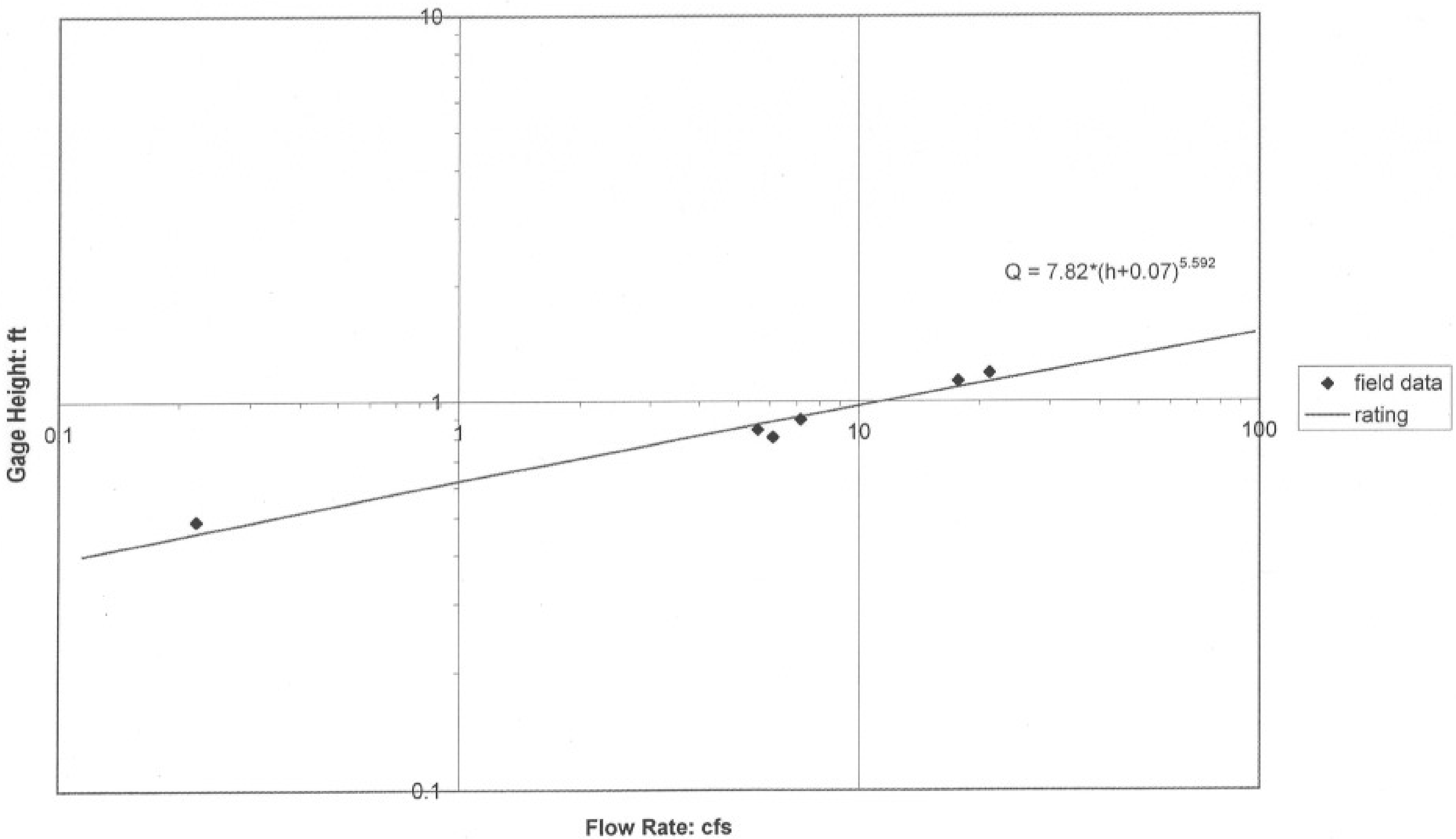
Q = C(h-a)n

log A=	0.802
n=	1.980
C=	6.34
N=	6
S_{xx}=	0.026
S_{yy}=	0.112
S_{xy}=	0.052
r =	0.95
r^2 =	0.91

best fit

y =.3591x^.5046

Mission Creek
Rating Curve



Mission Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
5/27/2000	1.187	21.218		1.327	0.099	0.010	1.760	0.131
7/2/2000	0.897	7.14		0.854	-0.015	0.000	0.729	-0.013
8/9/2000	0.491	0.221		-0.656	-0.252	0.064	0.430	0.166
9/28/2000	0.844	5.58		0.747	-0.040	0.002	0.557	-0.030
2/17/2001	0.807	6.1		0.785	-0.058	0.003	0.617	-0.045
5/15/2001	1.13	17.7		1.248	0.079	0.006	1.557	0.098
			sum	4.305	-0.188	0.085	5.650	0.306

Rating	
h	Q
0.4	0.1
0.6	0.8
0.8	3.6
0.9	6.6
1	11.4
1.1	18.8
1.2	29.8
1.3	45.5
1.4	67.4
1.5	97.4

Q1	0.3	
Q2	20	
Q3	2.45	
h1	0.50	0.5
h2	1.11	1.11
h3	0.75	0.75
a	-0.07	

log Q = n log(h-a) + log A

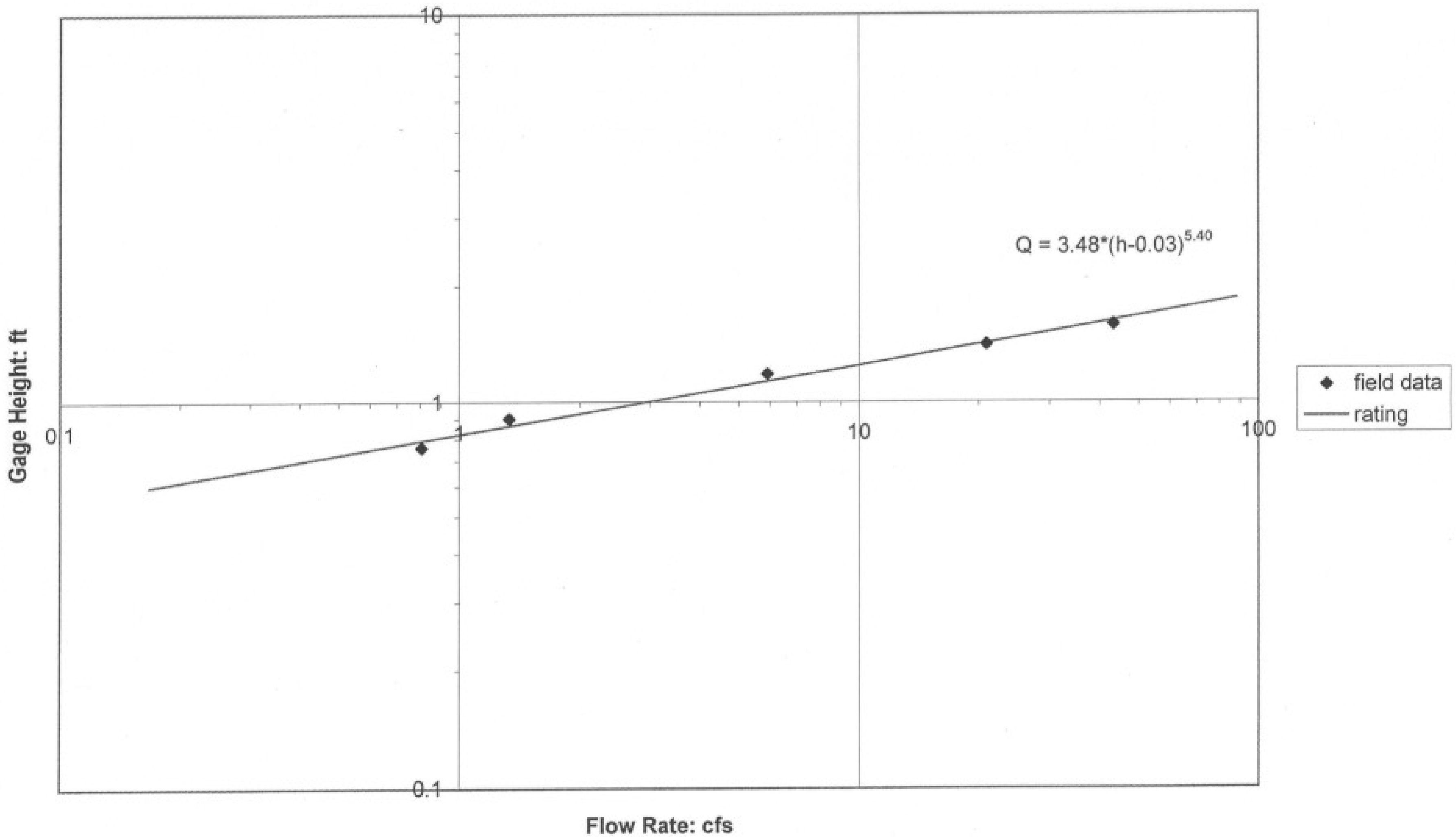
Q = C(h-a)n

log A=	0.893
n=	5.592
C=	7.82
N=	6
S_{xx}=	0.079
S_{yy}=	2.562
S_{xy}=	0.441
r =	0.98
r^2 =	0.96

best fit

y =.6294x^.1884

Nile Creek
Rating Curve



Nile Creek - Rating Table

Date	Gage Height	Flow Rate		y	x			
	ft	cfs		log Q	log(h-a)	x^2	y^2	xy
5/29/2000	1.585	43.238		1.636	0.191	0.037	2.676	0.313
7/3/2000	1.185	5.9		0.771	0.062	0.004	0.594	0.048
8/10/2000	0.76	0.806		-0.094	-0.138	0.019	0.009	0.013
9/29/2000	0.905	1.33		0.124	-0.059	0.003	0.015	-0.007
5/16/2001	1.41	20.9		1.320	0.139	0.019	1.743	0.184
			sum	3.757	0.195	0.082	5.037	0.549

Rating	
h	Q
0.6	0.2
0.8	0.8
0.9	1.6
1	3.0
1.3	12.7
1.5	27.9
1.7	55.5
1.85	88.3

Q1	0.9	
Q2	40	
Q3	6.00	
h1	0.82	0.82
h2	1.59	1.59
h3	1.14	1.14
a	0.03	

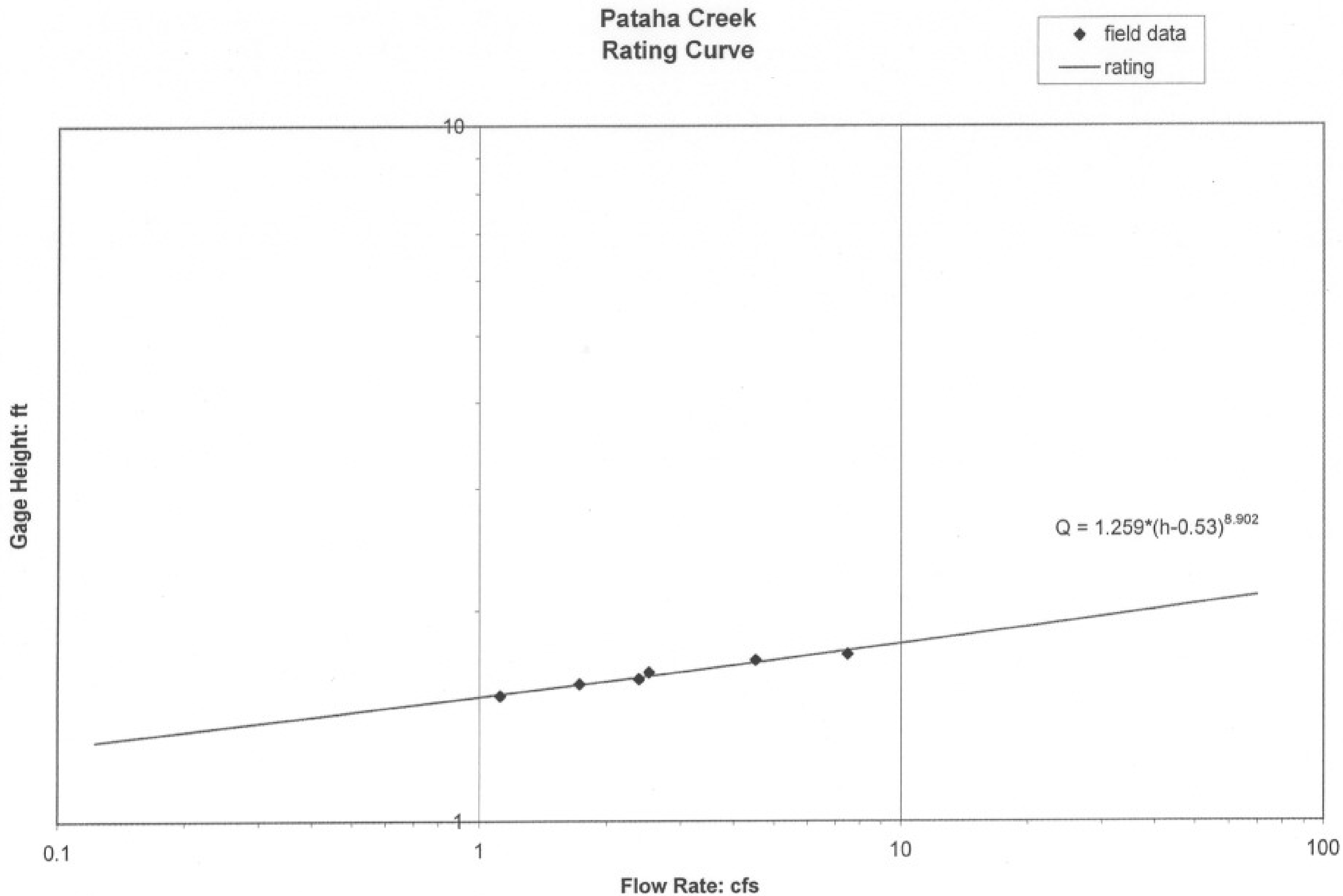
log Q = n log(h-a) + log A

Q = C(h-a)n

log A=	0.541
n=	5.400
C=	3.48
N=	5
S_{xx}=	0.075
S_{yy}=	2.214
S_{xy}=	0.403
r =	0.99
r^2 =	0.98

best fit

y = 0.8305x0.1767


Pataha Creek
Rating Curve
field data
rating
10
1
Gage Height: ft
Q = 1.259*(h-0.53)^8.902
0.1
1
10
100
Flow Rate: cfs

Pataha Creek - Rating Table

Date	Gage Height	Flow Rate
	ft	cfs
5/19/2000	1.697	4.512
6/15/2000	1.6316	2.526
7/4/2000	1.57	1.73
8/12/2000	1.51	1.12
10/1/2000	1.596	2.39
5/18/2001	1.73	7.48

	y	x			
	log Q	log(h-a)	x^2	y^2	xy
	0.654	0.067	0.004	0.428	0.044
	0.402	0.042	0.002	0.162	0.017
	0.238	0.017	0.000	0.057	0.004
	0.049	-0.009	0.000	0.002	0.000
	0.378	0.028	0.001	0.143	0.011
	0.874	0.079	0.006	0.764	0.069
sum	2.596	0.224	0.014	1.556	0.144

h	Q
1.3	0.1
1.4	0.4
1.5	1.0
1.6	2.3
1.7	5.1
1.8	10.6
1.9	20.8
2	38.9
2.1	69.8

Q1	1.2	
Q2	7	
Q3	2.9	
h1	1.53	1.53
h2	1.74	1.74
h3	1.63	1.63
a	0.53	

log Q = n log(h-a) + log A

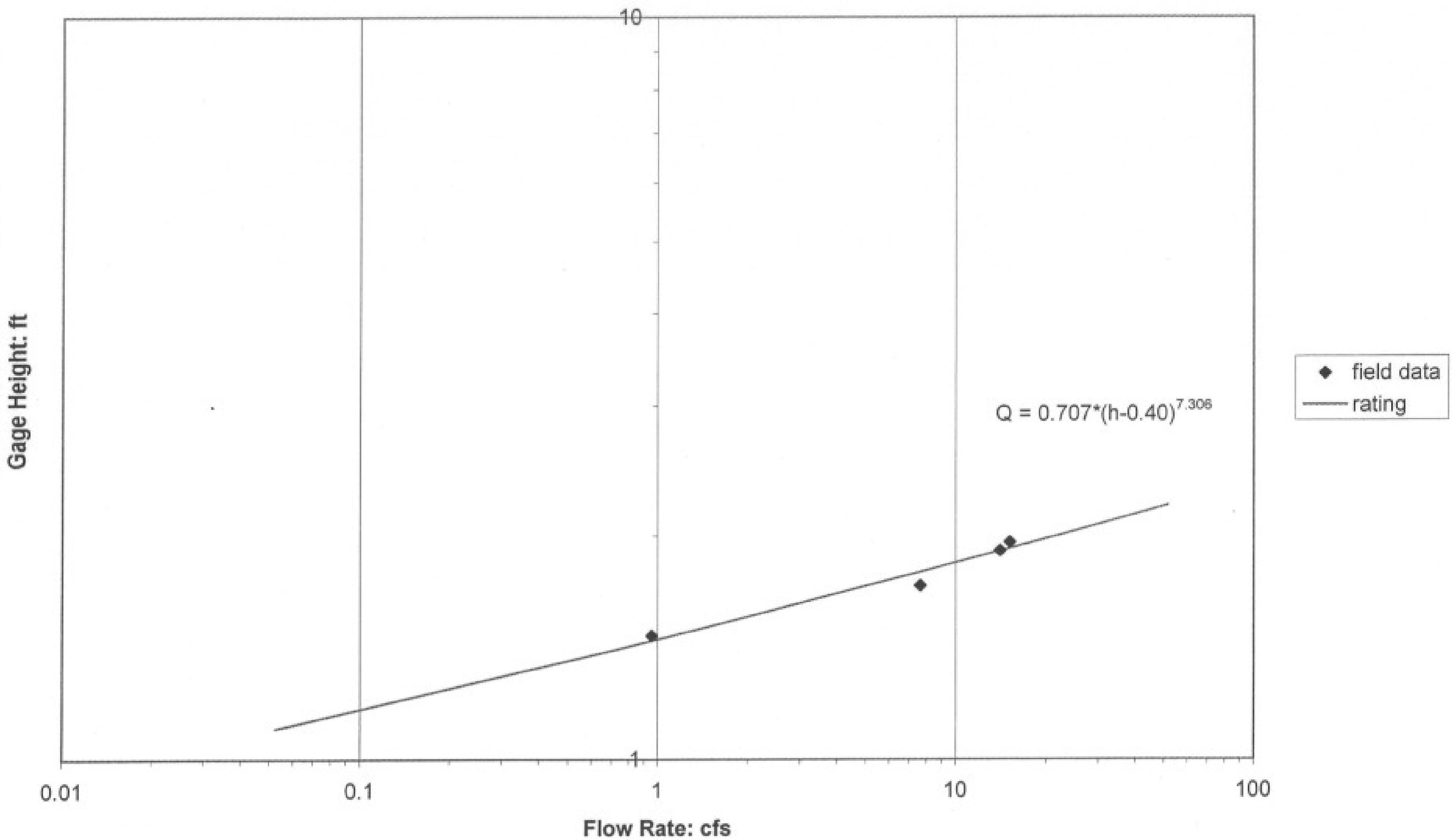
Q = C(h-a)n

log A=	0.100
n=	8.902
C=	1.259
N=	6
S_{xx}=	0.005
S_{yy}=	0.433
S_{xy}=	0.047
r =	0.98
r^2 =	0.97

best fit

$y = 1.5067x^{0.0732}$

Patit Creek
Rating Curve



Patit Creek - Rating Table

Date	Gage Height	Flow Rate
	ft	cfs
6/14/2000	1.7106	7.6255
7/4/2000	1.465	0.956
2/11/2001	1.908	14.1
5/17/2001	1.96	15.2

	y	x			
	log Q	log(h-a)	x^2	y^2	xy
	0.882	0.118	0.014	0.778	0.104
	-0.020	0.028	0.001	0.000	-0.001
	1.149	0.179	0.032	1.321	0.206
	1.182	0.194	0.038	1.397	0.229
sum	3.194	0.520	0.084	3.496	0.539

h	Q
1.1	0.1
1.4	0.7
1.5	1.4
1.8	8.3
1.9	13.7
2	21.9
2.1	34.1
2.2	51.8

log Q = n log(h-a) + log A

$Q = C(h-a)^n$

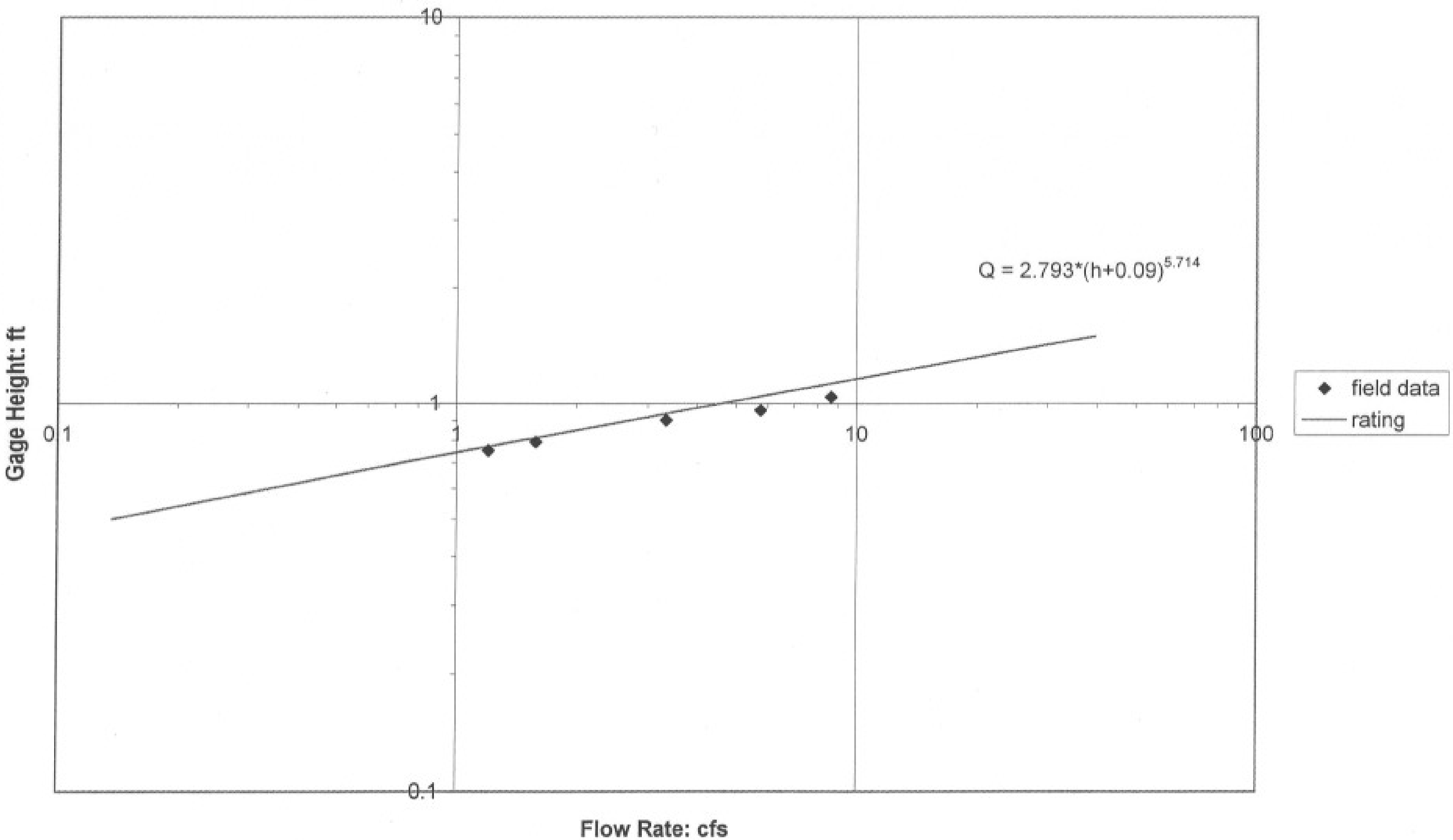
Q1	1.3	
Q2	20	
Q3	5.1	
h1	1.495	1.5
h2	1.964	1.96
h3	1.713	1.71
a	0.40	

log A=	-0.151
n=	7.306
C=	0.707
N=	4.000
S_{xx}=	0.017
S_{yy}=	0.946
S_{xy}=	0.124
r =	0.98
r^2 =	0.96

<u>*best fit*</u>

y = 1.4566x^.0997

Rock Creek
Rating Curve



Rock Creek - Rating Table

Date	Gage Height	Flow Rate
	ft	cfs
5/29/2000	1.04	8.6318
7/3/2000	0.905	3.34
8/10/2000	0.753	1.2
9/29/2000	0.7935	1.58
5/16/2001	0.96	5.75

	y	x	x^2	y^2	xy
	log Q	log(h-a)			
	0.936	0.051	0.003	0.876	0.048
	0.524	-0.004	0.000	0.274	-0.002
	0.079	-0.077	0.006	0.006	-0.006
	0.199	-0.056	0.003	0.039	-0.011
	0.760	0.019	0.000	0.577	0.015
sum	1.738	-0.086	0.012	1.196	0.028

h	Q
0.5	0.1
0.7	0.7
1	4.6
1.1	7.5
1.3	18.3
1.4	27.3
1.5	39.5

log Q = n log(h-a) + log A

$Q = C(h-a)^n$

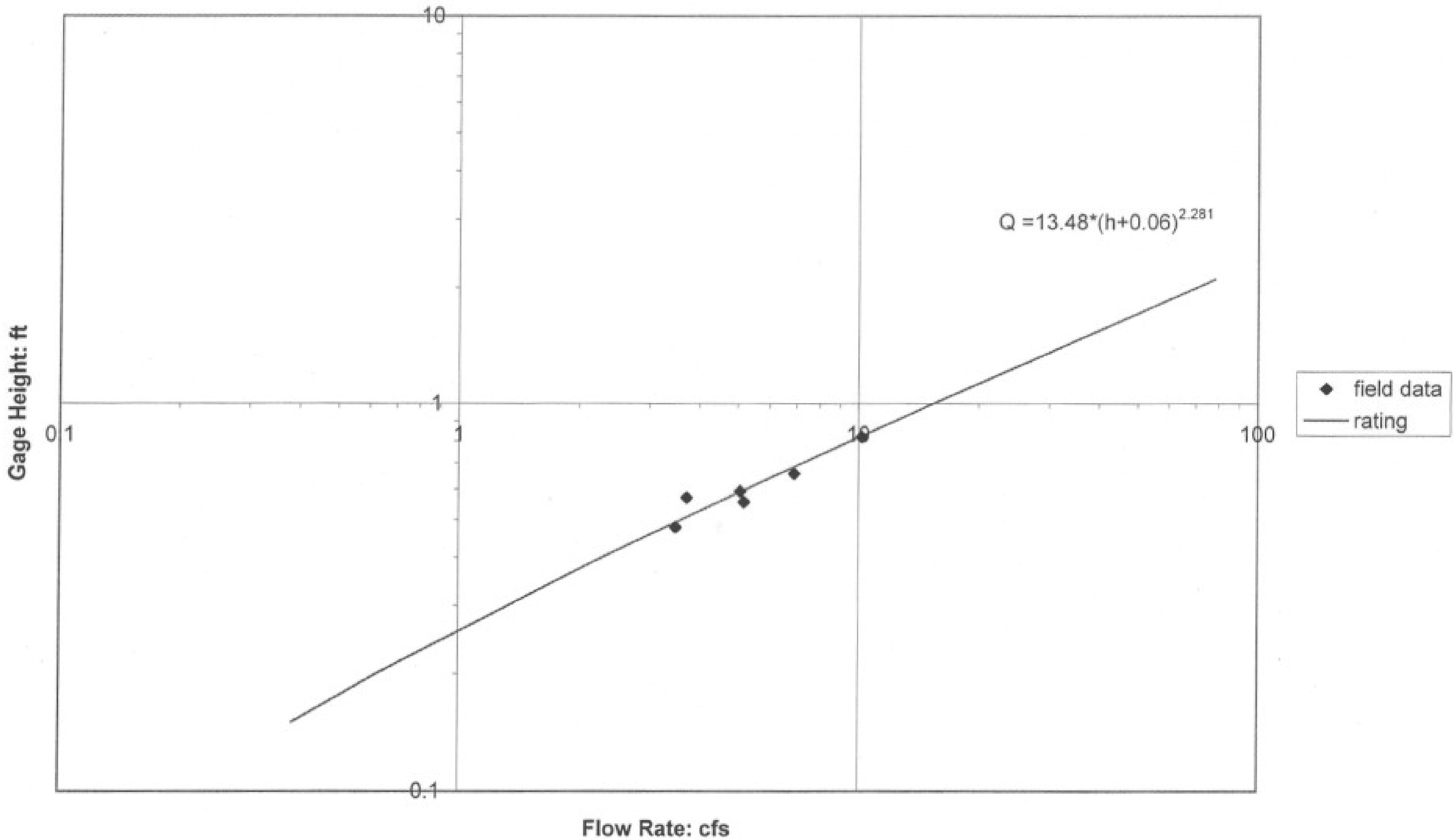
Q1	1.2	
Q2	9	
Q3	3.3	
h1	0.76	0.76
h2	1.04	1.04
h3	0.89	0.89
a	-0.09	

log A=	0.446
n=	5.714
C=	2.793
N=	5
S_{xx}=	0.010
S_{yy}=	0.592
S_{xy}=	0.058
r =	0.75
r^2 =	0.56

best fit

y = 0.7361x^0.1592

South Fork Asotin Creek
Rating Curve



South Fork Asotin Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
6/15/2000	0.658	6.90		0.839	-0.142	0.020	0.704	-0.119
7/4/2000	0.593	5.06		0.704	-0.183	0.033	0.496	-0.129
8/12/2000	0.478	3.49		0.543	-0.267	0.071	0.295	-0.145
10/1/2000	0.556	5.17		0.713	-0.208	0.043	0.509	-0.148
2/3/2001	0.57	3.72		0.571	-0.198	0.039	0.326	-0.113
5/18/2001	0.82	10.2		1.009	-0.054	0.003	1.017	-0.054
			sum	4.379	-1.052	0.210	3.346	-0.708

h	Q
0.15	0.4
0.2	0.6
0.4	2.3
0.6	5.2
0.8	9.6
1	15.4
1.5	37.2
2	70.1
2.1	78.1

Q1	3.5	
Q2	10	
Q3	5.9	
h1	0.502	0.5
h2	0.789	0.79
h3	0.630	0.63
a	-0.06	

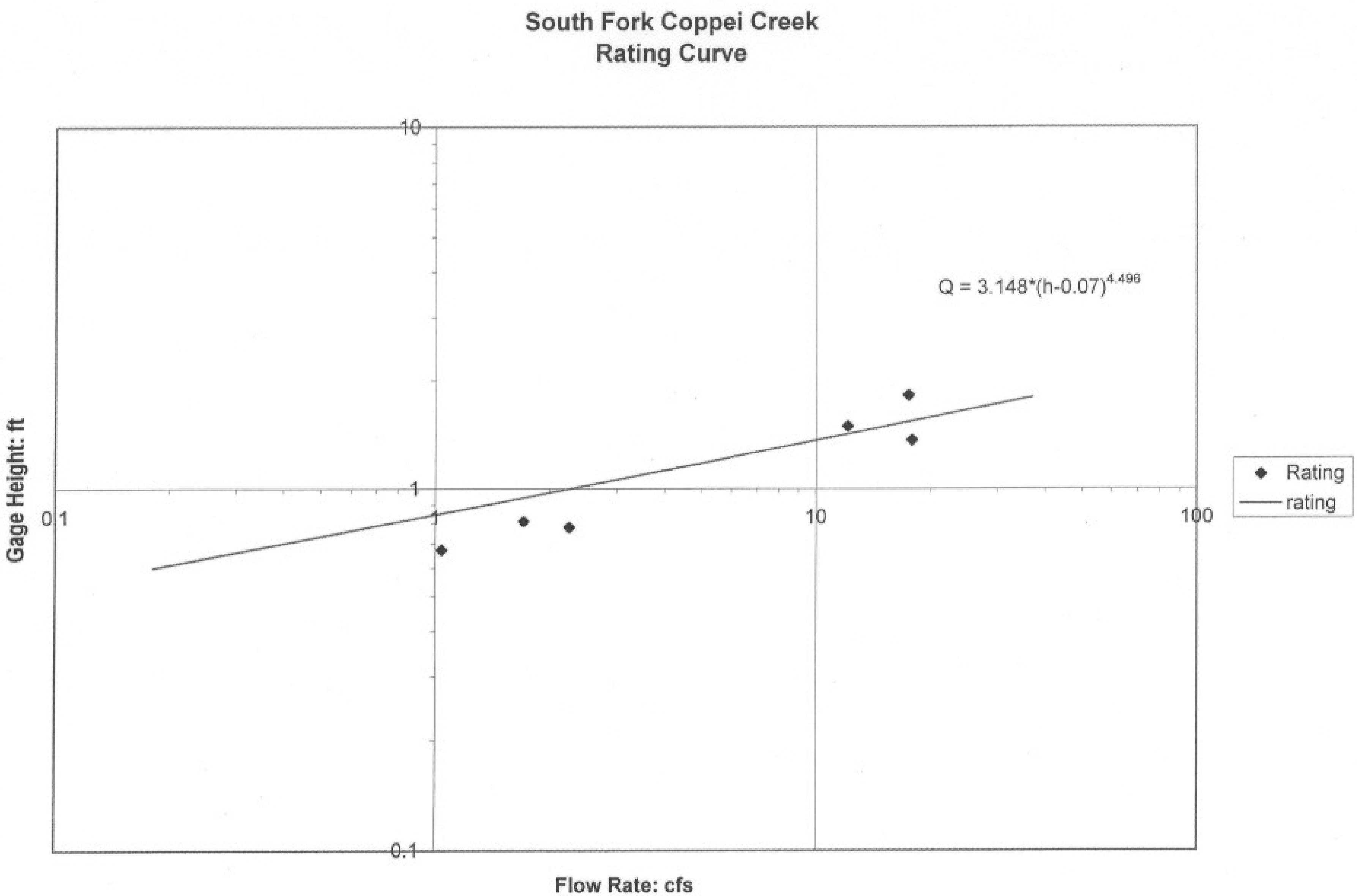
$\log Q = n \log(h-a) + \log A$

$Q = C(h-a)^n$

log A=	1.130
n=	2.281
C=	13.476
N=	6
S_{xx}=	0.026
S_{yy}=	0.151
S_{xy}=	0.059
r =	0.94
r^2 =	0.89

best fit

y = .2932x^.4299


South Fork Coppei Creek
Rating Curve
Q = 3.148*(h-0.07)^4.496
Gage Height: ft
Flow Rate: cfs
10
1
0.1
0.1
1
10
100
Rating
rating

South Fork Coppel Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x^2	y^2	xy
6/15/2000	1.365	17.85		1.252	0.157	0.025	1.567	0.196
7/4/2000	0.81	1.71		0.233	-0.056	0.003	0.054	-0.013
8/12/2000	0.673	1.04		0.017	-0.129	0.017	0.000	-0.002
9/30/2000	0.779	2.25		0.352	-0.071	0.005	0.124	-0.025
2/11/2001	1.49	12.1		1.083	0.193	0.037	1.172	0.209
5/17/2001	1.82	17.5		1.243	0.276	0.076	1.545	0.344
			sum	4.180	0.371	0.163	4.463	0.709

h	Q
0.6	0.2
0.7	0.4
0.9	1.4
1.2	5.5
1.3	8.0
1.4	11.3
1.6	21.3
1.7	28.3
1.8	37.0

Q1	3	
Q2	17	
Q3	7.1	
h1	0.91	0.91
h2	1.55	1.55
h3	1.19	1.19
a	-0.07	

best fit

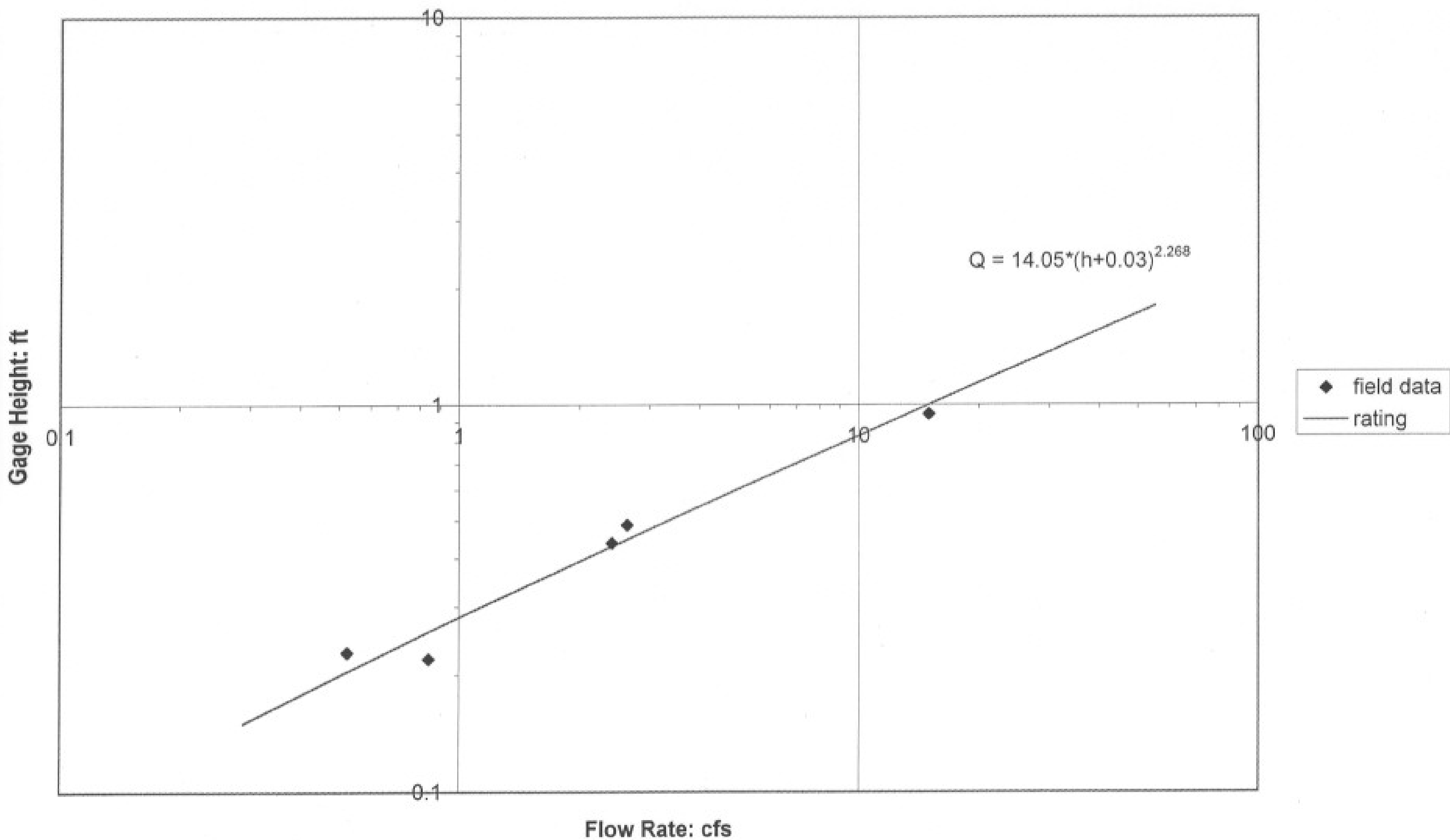
y = .656x^.3099

log Q = n log(h-a) + log A

$Q = C(h-a)^n$

log A=	0.498
n=	4.496
C=	3.148
N=	6
S_{xx}=	0.140
S_{yy}=	1.551
S_{xy}=	0.451
r =	0.97
r^2 =	0.93

Stemilt Creek
Rating Curve



Stemilt Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs
5/27/2000	0.945	14.999
7/1/2000	0.229	0.524
9/28/2000	0.488	2.63
2/17/2001	0.438	2.41
5/15/2001	0.22	0.84

	y log Q	x log(h-a)	x^2	y^2	xy
	1.176	-0.011	0.000	1.383	-0.013
	-0.281	-0.587	0.344	0.079	0.165
	0.420	-0.286	0.082	0.176	-0.120
	0.382	-0.330	0.109	0.146	-0.126
	-0.076	-0.602	0.362	0.006	0.046
sum	1.622	-1.815	0.897	1.790	-0.049

h	Q
0.15	0.3
0.2	0.5
0.27	0.9
0.4	2.1
0.6	4.9
0.8	9.2
1.1	18.5
1.4	31.6
1.6	42.6
1.8	55.3

Q1	0.6	
Q2	14.8	
Q3	3.0	
h1	0.22	0.22
h2	0.97	0.97
h3	0.47	0.47
a	-0.03	

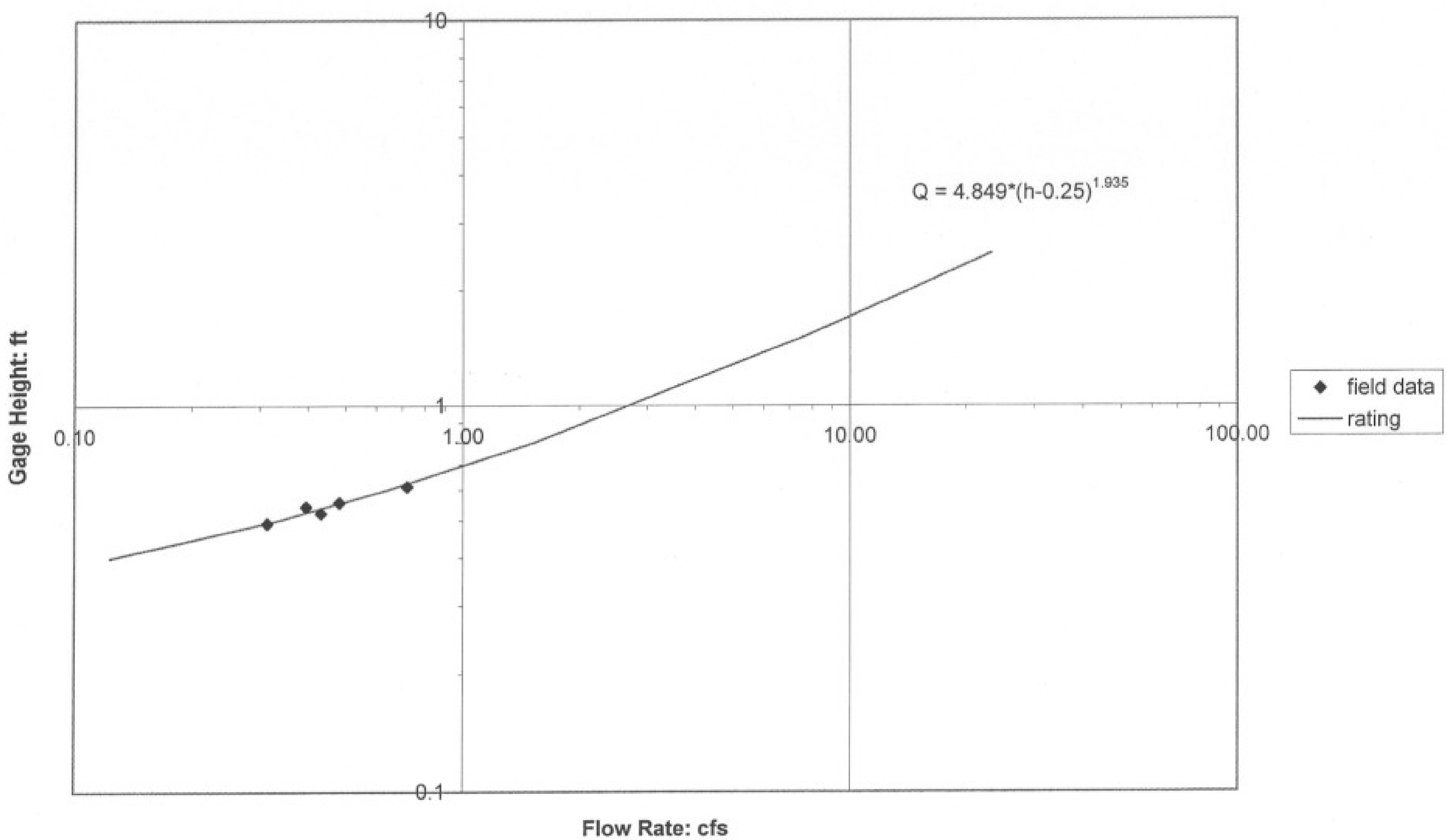
$\log Q = n \log(h-a) + \log A$ $\quad Q = C(h-a)^n$

log A=	1.148
n=	2.268
C=	14.046
N=	5.000
S_{xx}=	0.238
S_{yy}=	1.264
S_{xy}=	0.540
r =	0.98
r^2 =	0.97

best fit

y = .2838x^.458

Tumalum Creek
Rating Curve



Tumalum Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs		y log Q	x log(h-a)	x2	y2	xy
5/31/2000	0.61	0.72		-0.142	-0.440	0.194	0.020	0.063
6/15/2000	0.56	0.48		-0.316	-0.511	0.262	0.100	0.162
7/4/2000	0.52	0.43		-0.364	-0.564	0.318	0.132	0.205
8/12/2000	0.49	0.31		-0.503	-0.616	0.380	0.253	0.310
10/1/2000	0.54	0.40		-0.402	-0.532	0.283	0.162	0.214
5/18/2001	0.63	0.37		-0.503	-0.616	0.380	0.253	0.310
			sum	-2.230	-3.279	1.815	0.920	1.263

h	Q
0.4	0.1
0.5	0.3
0.6	0.6
0.8	1.5
1.5	7.5
2	14.3
2.5	23.3

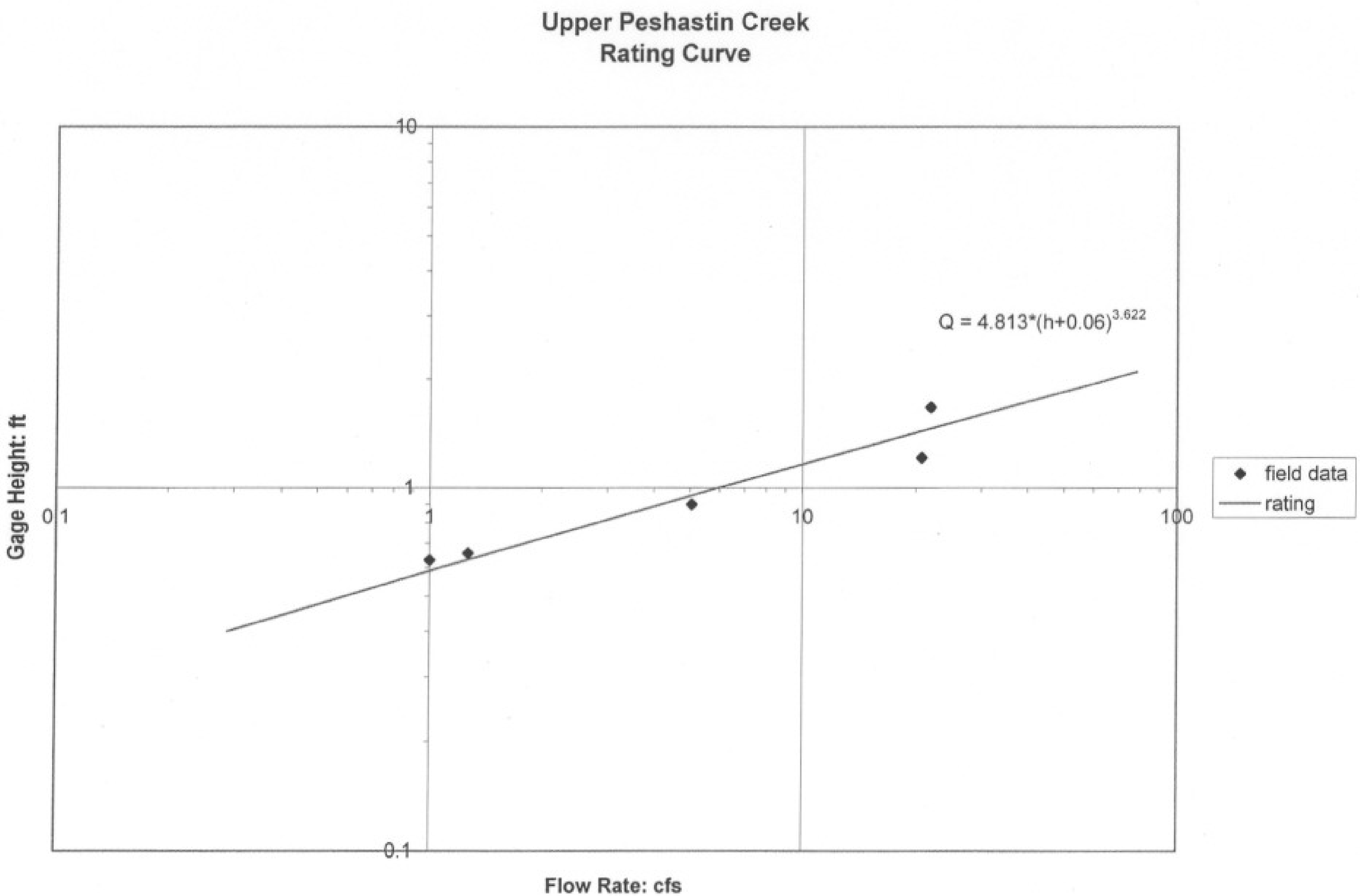
Q1	0.32	
Q2	0.72	
Q3	0.5	
h1	0.50	0.5
h2	0.61	0.61
h3	0.55	0.55
a	0.25	

best fit

y = 0.6674x^0.2558

$\log Q = n \log(h-a) + \log A$ $Q = C(h-a)^n$

log A=	0.686
n=	1.935
C=	4.849
N=	6
S_{xx}=	0.023
S_{yy}=	0.091
S_{xy}=	0.044
r =	0.97
r^2 =	0.93


Upper Peshastin Creek
Rating Curve
Q = 4.813*(h+0.06)^3.622
Gage Height: ft
Flow Rate: cfs
10
1
0.1
10
100
field data
rating

Upper Peshastin Creek - Rating Table

Date	Gage Height ft	Flow Rate cfs
5/28/2000	1.212	20.748
7/2/2000	0.8996	5.05
8/10/2000	0.658	1.27
9/28/2000	0.6297	1
5/16/2001	1.67	21.9

	y log Q	x log(h-a)	x^2	y^2	xy
	1.317	0.104	0.011	1.734	0.137
	0.703	-0.019	0.000	0.495	-0.013
	0.104	-0.145	0.021	0.011	-0.015
	0.000	-0.163	0.026	0.000	0.000
	1.340	0.238	0.056	1.797	0.318
sum	3.465	0.015	0.115	4.037	0.427

h	Q
0.4	0.3
0.6	1.1
1	5.9
1.3	14.7
1.5	24.1
1.7	37.3
1.9	55.1
2.1	78.3

Q1	1.3	
Q2	20	
Q3	5.1	
h1	0.72	0.72
h2	1.51	1.52
h3	1.05	1.05
a	-0.06	

best fit

y = 0.6142*(x^.2702)

$\log Q = n \log(h-a) + \log A$

$Q = C(h-a)^n$

log A=	0.682
n=	3.622
C=	4.813
N=	5
S_{xx}=	0.115
S_{yy}=	1.636
S_{xy}=	0.417
r =	0.96
r^2 =	0.92