Entiat and Mad Rivers Fish Habitat Analysis Using the Instream Flow Incremental Methodology

March 1995
Revised
February 2004

Open File Technical Report #95-166

Department of Ecology

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SUMMARY

The Washington State Department of Ecology conducted an instream flow study in the Entiat River using the Instream Flow Incremental Methodology. The study provides information about the relationship between streamflows and fish habitat which can be used in developing minimum instream flow requirements for fish in the Entiat and Mad Rivers. Two sites, each composed of six transects, were chosen to represent the upper and lower Entiat River. The sites were located at River Miles 16.2 and 1.0, respectively. On the Mad River, one site composed of eight transects at RM 1.0 was chosen to represent the river. Tillicum Creek was not modeled due to its small size, however, streamflow measurements were taken on one transect at RM 0.5 at the same time the other river sites were measured. Streamflow measurements and substrate information were recorded at high, medium and low flows.

This information was entered into the IFG4 hydraulic model to simulate the distribution of water depths and velocities with respect to substrate and cover under a variety of flows. Using the HABTAT model, the simulated information was then used to generate an index of change in available habitat relative to changes in flow; this index is referred to as "weighted usable area" (WUA).

Determination of a minimum instream flow for the Entiat and Mad Rivers will require setting priorities for river reaches, fish species and lifestages. Different fish species and lifestages exist simultaneously in the river and each has a different flow requirement. There is no single flow that will simultaneously provide optimum habitat for all fish species and lifestages.

In addition, minimum instream flows must include flows necessary for incubation of fish eggs, smolt out-migration, fish passage to spawning grounds, and prevention of stranding fry and juveniles. Other variables which have to be considered include water temperature, water quality, and sediment load. These variables were not addressed in this study.

No instream flow recommendations are made in this report. This would require an evaluation of the environmental variables listed above on the river and the long-range fishery management objectives of the state and federal natural resource agencies and affected Tribes. Key results of the IFIM study are portrayed in the table below:

ACKNOWLEDGEMENTS

Field assistance was provided by Bob Steele and Roger Willms (Department of Fisheries) and Dave Catterson (Department of Ecology). Jeff Marti (Department of Ecology) provided graphics and editing assistance in the preparation of this report.

In the revised report, there are new WUA graphs to correct typographical and calculation errors found in the original report. New hydrographs were developed from current USGS data.

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Introduction

The Washington Department of Ecology is mandated by the 1971 Water Resources Act (Chapter 90.54 RCW) to maintain base flows necessary to provide for preservation of wildlife, fish, scenic, aesthetic and other environmental values. To determine appropriate base flows for fish habitat, Ecology often uses the Instream Flow Incremental Methodology (IFIM) to generate the necessary information. The base or minimum flows determined by Ecology cannot take away any existing water rights and serve to protect existing water right users by restricting new upstream diverters if the river is already experiencing low flows. This information may be used by Ecology to determine the impact of future water appropriations on fish habitat or to condition new water rights to protect instream flows for fish habitat.

Study participants included staff from the Washington Department of Ecology and the Washington Department of Fisheries and Wildlife.

Project Background

Location and Description

The Entiat River Basin is located in on the eastern slopes of the Cascade Mountains in northeast Chelan County. The watershed drains approximately 419 square miles of land. The headwaters of the Entiat River are about 9,000 feet above sea level. The river then drops 8,300 feet in elevation over a distance of 47.8 miles to reach the Columbia River near the town of Entiat at an elevation of about 700 feet. Two major tributaries drain into the Entiat, the North Fork Entiat at River Mile 33 and the Mad River at River Mile 10.5. The Entiat River flows through the site of a previous glacier with a U-shaped valley upstream of Ardenvoir and a V-shaped valley downstream filled with silt, sand, gravel, cobble.

Water Quality

Monitoring of water quality data on the Entiat River has indicated excursions (a situation where water quality conditions do not meet the standards) of temperature and pH standards. Ongoing monitoring of the river is conducted by the Department of Ecology at ambient monitoring station 46A070 located at River Mile 1.5 at a private bridge 1.2 miles up the Entiat River road. Because of these excursions, the Entiat River is listed on the Washington State Department of Ecology's 303(d) list of water bodies which fail to meet state water quality standards.

Streamflows in the Entiat River vary throughout the year. The natural or historic flow is unknown since the quantity of water diverted from the Entiat River and its tributaries diversions is unknown. There are large wooden and concrete canals and many pumps taking water directly out of the streams and rivers, but these flow diversions have not been measured. The existing gage did not start until 1957, decades after these diversions began. The hydrographs can only show the normal range of river flows without the water used consumptively by the diversions. Just the surface diversions (not counting the wells, which are usually large in size and number) in other eastern Washington rivers usually divert around 50% of the natural river flow. One has to be aware that a hydrograph of an eastern Washington river based on USGS data from the last 40 years does not show the historic or natural flow of the river especially during summer/fall when irrigation is under way. A rough approximation of natural low summer flow can be had by multiplying the flow numbers on the hydrograph at that time of year by 2.

The yearly exceedence flows for the Upper and Lower Entiat River are portrayed in Appendix D. The Upper Entiat graphs is based upon weekly averages from a 1957-93 period of record obtained from the USGS gage near Ardenvoir at river mile 18. The Lower Entiat graph is based upon a more limited period of record from a discontinued USGS Gage which was located near Entiat at RM 0.25. A synthesized hydrograph for this river and other small streams in the basin was done by the U.S. Department of Agriculture and is in Appendix D.

A 1979 river basin study by the U.S. Department of Agriculture, the Forest Service, the Soil Conservation Service et al described the soil erosion, and fires, and water use in the Entiat River basin. They found massive erosion problems continuing in 1980 from the 1970 forest fire that burned 22 percent of the watershed. Another big fire occurred in 1976. Floods and landslides occurred in 1972, 1974, and 1977. (Note: Since the report, 52,000 acres burned in the lower watershed in 1988 and more than that burned in 1994.) Revegetation was expected to be completed by 1984. The mean annual water yield was up 44% from the 1970 fire but expected to drop to normal by 1984 (Agriculture 1979).

Wenatchee National Forest makes up about 87% of the basin. The private land is mostly in orchards in the lower valley right along the river, but private land exists just along the river upriver to Burns Creek, about halfway up the basin. About 2900 feet of orchard riverfront suffers severe erosion. Nearly 72% of the sediment in the river is from erosion of the stream sides (Agriculture 1979).

The town of Ardenvoir uses Mad River water for its domestic drinking water supply for 14 families and the mill. Pack River company supplies the water through a 12-inch redwood pipe with no filtration. About 15 surface water diversions from the Entiat River and 6 diversions from tributaries feed into irrigation canals for sprinkler irrigation of the orchards and pastures. A map shows the orchards and pastures to start just upstream of Ardenvoir and run along the Entiat River down to its mouth (Agriculture 1979).

Fishery Status

The Entiat River watershed is a high priority for fish protection. The American Fisheries Society (AFS) has identified the Entiat River summer steelhead as being at a high risk of extinction (Nehlson 1991). Also, as part of the 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI), the Washington State Department of Fisheries and Wildlife identified both the spring chinook and summer steelhead stocks as being "depressed" (Fisheries 1993).

These AFS and SASSI status ratings are described below:

AFS STATUS - A set of ratings ranging from Of Special Concern to Extinct. The rating "High Risk" (at high risk of extinction) refers to those populations whose spawning escapements are declining; fewer than one adult fish returns to spawn from each parent spawner. Populations with escapements of less than 200 in the last one to five years were placed in this category unless the escapements were historically small. A stock in this category is likely to meet the threshold for listing as endangered under the Endangered Species Act.

SASSI STATUS - A set of status ratings ranging from Healthy to Extinct. The rating "depressed," means a stock of fish whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely.

Fish History - There were large runs of chinook, coho, and steelhead prior to 1898. The last big chinook run was in 1904 and surveys in the 1930's found almost no salmon. In 1939 and 1940 chinook and steelhead runs blocked by Grand Coulee were transferred to the Entiat River. The Entiat Hatchery was built on the river in 1941 and planted catchable rainbows into the river. The hatchery switched to salmon in 1974 and the Entiat River average spring chinook escapement was estimated at 1122 fish in 1980 (Agriculture 1979). However, the 1992 SASSI report notes that since the Entiat River spring chinook redd count started in 1962, the three lowest redd counts occurred in the last 4 years (1989, 1991, 1992).

The best anadromous spawning area in the Entiat River occurs from Fox Creek (RM 27.7) down to Stormy Creek (RM 18.4). The spring chinook most heavily use the 6 miles downstream from Fox Creek. The gravel spawning beds in these 6 miles were completely silted in from the flood of 1972, but were almost back to their original composition by 1977 along with a restoration in the numbers of spawning spring chinook in this reach. However, the flood of 1977 had recovered the lower Entiat River with silt again. Fisheries had an artificial spawning channel near Fox Creek for spring chinook in 1980. The Mad River was considered to be the principal steelhead producer in the Entiat system and was well known for its Dolly Varden (Agriculture 1979).

The 1989 Entiat River Subbasin Salmon and Steelhead Plan by the Washington State Departments of Fisheries and Wildlife, and the Tribes reviewed the fish use and constraints to fish production in the Entiat River. They found the major limiting factor, as in all tributaries to the Columbia River, are the dams, but after that factor, the major inriver limiting factor is the low late summer/early fall streamflows in the Entiat River. The flows are low enough that the wetted stream width is often pulled away from streamside cover and undercut banks (Fisheries 1989).

The Entiat River is managed for spring chinook and steelhead, though it also has summer chinook, sockeye, and coho. A barrier to anadromous fish exists at RM 33.8, with resident trout existing upstream. A passage problem exists at RM 16.5 at the Roundy Diversion Dam. Spring chinook have difficulty passing this low wooden dam (Fisheries 1989).

The Entiat National Fish Hatchery releases 0.6 to 1 million spring chinook yearly and the Chelan PUD hatchery releases 40,000 steelhead smolts yearly into the Entiat River system for mitigation agreements.

Spring chinook adults migrate up into the Entiat River in May and June, hold in the river, and spawn mid-August until mid-September. Juveniles will rear year round in the river and outmigrate in May and June.

Summer steelhead adults will migrate up into the Entiat River every month but June, but peak immigration is in October and November and again in February and March. They then hold in the river, and spawn in April, May, June. Juveniles will rear year round and outmigrate March through June (Fisheries 1989).

Study Methods

Overview of IFIM methodology

The IFIM methodology was selected as the best available method for predicting how the quantity of available fish habitat changes in response to incremental changes in streamflow. This methodology was developed by the U.S. Fish and Wildlife Service in the late 1970s (Bovee 1982).

The IFIM involves putting site-specific streamflow and habitat data into a group of models collectively called PHABSIM (physical habitat simulation). The most common model is IFG4, which uses multiple transects to predict depths and velocities in a river over a range of flows. IFG4 creates a cell for each measured point along the transect or cross-section. Each cell has an average water depth and water velocity associated with a type of substrate or cover for a particular flow. The cell's area is measured in square feet. Fish habitat is defined in the computer model by the variables of velocity, depth, substrate, and/or cover. These are important habitat variables that can be measured, quantified, and predicted.

The IFIM is used nationwide and is accepted by most resource managers as the best available tool for determining the relationship between flows and fish habitat. However, the methodology only uses four variables in hydraulic simulation. At certain flows, such as extreme low flows, other variables such as fish passage, food supply (aquatic insects), competition between fish species, and predators (birds, larger fish, etc.) may be of overriding importance. In addition to the PHABSIM models, IFIM may include reviewing water quality, sediment, channel stability, temperature, hydrology, and other variables that affect fish production. These additional variables are not analyzed in this report.
After the IFG4 model is calibrated and run, its output is entered into another model (HABTAT) with data describing fish habitat preferences in terms of depth, velocity, substrate, and cover. These preferences

vary according to fish species and life-stage (adult spawning and juvenile rearing).

The output of the HABTAT model is an index of fish habitat known as Weighted Useable Area (WUA). The preference factor for each variable at a cell is multiplied by the other variables to arrive at a composite, weighted preference factor for that cell. For example, a velocity preference of 1.0 multiplied by a depth preference of 0.9, then multiplied by a substrate preference of 0.8 equals a composite factor of 0.72 for that cell. This composite-preference factor is multiplied by the number of square feet of area in that cell.

A summation of all the transect cells' areas results in the total number of square feet of preferred habitat available at a specified flow. This quantity is normalized to 1,000 feet of stream or river. The final model result is a listing of fish habitat values (WUA) in units of square feet per 1,000 feet of stream. The WUA values are listed with their corresponding flows (given in cubic feet per second).

Study Site and Transect Selection
Preliminary study sites were selected for the IFIM study by reviewing topographic maps. Actual site selection was done during field visits. Two IFIM sites where used to model the Entiat River. The Lower Entiat River site at river mile 1.0 represents the lower 10 miles of the river. This reach is characterized as mostly boulder/cobble riffle due to channelization and riprap from past flood control activities. The Upper Entiat River site is upstream of the town of Ardenvoir (RM 10.5) is at RM 16.2 which represents the river from around RM 10 up to Fox Creek at RM 27.7. This reach contains gravel/cobble bars and more typical pool/riffle sequences.

The existing USGS gage (Near Ardenvoir, gage number 12452800) is at RM 18 and the old gage site (At Entiat, 12453000) was at RM 0.25. The IFIM flows for fish at the Upper Entiat River site would apply to the USGS gage, Entiat River Near Ardenvoir (12452800), while the IFIM flows for the Lower Entiat River site would apply to the old USGS gage, Entiat River at Entiat (12453000). Six transects for both the upper and lower sites were chosen to represent the river; these transect sites are shown in the tables below.

UPPER ENTIAT RIVER TRANSECT SITES

Transect #	Location	Site Description
1	River Mile 16.2	large gravel bar, pool
2	43 feet upstream of #1	large gravel bar, glide
3	99 feet upstream of #2	large gravel bar, shallow glide
4	90 feet upstream of #3	sand, pool
5	158 feet upstream of #4	cobble, glide/chute
6	171 feet upstream of #5	gravel, glide

LOWER ENTIAT RIVER TRANSECT SITES

Transect #	Location	Site Description
1	River Mile 1.0	cobble, shallow riffle
2	103 feet upstream of #1	cobble, glide
3	100 feet upstream of #2	cobble, deep glide
4	135 feet upstream of #3	boulder, riffle
5	274 feet upstream of #4	boulder, riffle
6	350 feet upstream of #5	boulder, glide

MAD RIVER TRANSECT SITES

The Mad River transect sites were set at equal distances from each other to provide equal weighting.

Transect #	Site Description
1	cobble/boulder, pool
2	cobble/boulder, riffle
3	boulder, riffle
4	gravel, shallow riffle
5	cobble, glide
6	cobble, shallow riffle
7	cobble, shallow riffle
8	cobble/boulder, shallow riffle

Field Procedures

IFIM measurements were taken in July (high flow), August (medium flow) and October (low flow) of 1992. We measured flows on the Upper Entiat at 164, 121 and 55 cfs. Flows measured on the Lower Entiat were 290, 140, and 80 cfs. Flows measured on the Mad River were taken at at flows of 40, 21, and 16 cfs. Flows were measured on Tillicum Creek at 2.9, 2.3, and 2.1 cfs. Measurement of water depth, water velocity, substrate composition, and cover were made at various intervals along each transect.

A temporary gage at each site was used to verify that streamflow at each transect remained steady during measurement. Transects were marked using survey hubs and flagging. Water velocity was measured using standard USGS methods with a calibrated Swoffer velocity meter mounted on a top-set wading rod.

Water surface elevations and stream-bank profiles were surveyed with a survey level and stadia rod. These points were referenced to an arbitrary, fixed bench mark. Substrate composition and cover were assessed by visually estimating the percent of the two main particle size classes and type of cover according to a scale recommended by the Washington Departments of Fisheries and Wildlife. This scale is included as Appendix E.

Hydraulic Model

Calibration Philosophy

Calibration of the hydraulic model involved checking the velocities and depths predicted by the model against velocities and depths measured in the field. This included examining indicators of the model's accuracy such as mean error and Velocity Adjustment Factor (VAF). The calibration philosophy was to change data or to manipulate data using a computer calibration option only when doing so would improve the model's ability to extrapolate without reducing the accuracy of predicted depths and velocities at the measured calibration flows.

Calibration of the IFG4 model was done cell by cell for each transect to decide whether the predicted cell velocities adequately represented measured velocities. Generally, if the predicted cell velocity at the calibration flow was within 0.2 feet per second (fps) of the measured cell velocity, the predicted velocity was considered adequate. Any change to a calibration velocity was limited to a change of 0.2 fps. The 0.2 fps was thought to be reasonable considering the normal range of velocity measurement error. All cell velocities were reviewed at the highest and lowest extrapolated flows to ensure that extreme cell velocities were not predicted.

Indicators of Model Accuracy
Two indicators of the IFG4 model's accuracy in predicting depths and velocities are the mean error and the Velocity Adjustment Factor (VAF). See Appendix B for mean errors and VAFS for each transect at each site.

The mean error is the ratio of the calculated flow (from depths and velocities at the measured flows) to the predicted flow (from depth and velocity regressions). As a rule of thumb, the mean error for the calculated discharge should be less than 10 percent.

The Velocity Adjustment Factor (VAF) for a three-flow IFG4 hydraulic model indicates whether the flow predicted from the velocity/discharge regressions matches the flow predicted from the stage/discharge regressions. The velocities predicted from the velocity/discharge regressions for a transect are all multiplied by the same VAF to achieve the flow predicted from the stage/discharge regression. Calculating and comparing the flows predicted from two different regressions gives an indication as to whether or not some of the model's assumptions are being met.

A range in the VAF value of 0.9 to 1.1 is considered good, 0.85 to 0.9 and 1.1 to 1.15 fair, 0.8 to 0.85 and 1.15 to 1.20 marginal, and less than 0.8 and more than 1.2 poor (Milhous 1989). The standard extrapolation range is 0.4 times the low calibration flow and 2.5 times the high calibration flow. The extrapolation range of the model is usually limited when two or more transects have VAFs which fall below 0.8 or above 1.2.

Options in IFG4 Model
Several options are available in the IFG4 hydraulic model Milhous 1984). Ecology's standard method is to set all the options to zero except for option 8 which is set at 2, and option 13 to 1 to get a summary of the velocity adjustment factors. The standard options were used for the models in this study.

Site Specific Calibration
A three-flow IFG4 model with six transects was run for the Upper Entiat site. The IFG4 input file, a summary of the calibration details, data changes, and the velocity adjustment factors are included as Appendix B. The mean errors of the stage/discharge regressions range from 2.2 to 7.0. The velocity adjustment factors range from 0.81 to 1.03 allowing an extrapolation range from 28 to 410 cfs.

A three-flow IFG4 model with six transects was run for the Lower Entiat site. The IFG4 input file, a summary of the calibration details, data changes, and the velocity adjustment factors are included as Appendix B. The mean errors of the stage/discharge regressions range from 1.8 to 5.7. The velocity adjustment factors range from 0.88 to 1.01 allowing an extrapolation range from 32 to 725 cfs.

A three-flow IFG4 model was used for transects 1,4,5,6,7,8 and a one-flow high flow IFG4 model was used for transects 2 and 3 for the Mad River site. The IFG4 input file, a summary of the calibration details, data changes, and the velocity adjustment factors are included as Appendix B. The mean errors of the stage/discharge regressions range from 0.3 to 10.6. The velocity adjustment factors for the three-flow model range from 0.81 to 1.03 allowing an extrapolation range from 28 to 410 cfs.

Transect Weighting
The table below lists the percent weighting each transect received relative to the whole site. Transect weighting is determined one of two ways: either the model automatically determines weighting for each transect by using the distance between the transects or transect weight is set to predetermined levels by specifying distances between transects and upstream weighting (referred to as composite weighting). Composite weighting is done when the transects are located far apart and the distances between the transects would create incorrect weighing, or the investigator wants to increase the weight of a particular

type of fish habitat for that site.

Transect weighting for the Upper and Lower Entiat River sites was done using the distances between the transects. Transect weighting for the Mad River site was done using composite weighting where all of the transects were given equal weighting.

Transect Weighting for the Upper Entiat Site

Transect #	1	2	3	4	5	6
Percent of Total Site	3.83	12.66	16.84	22.1	29.32	15.24

Transect Weighting for the Lower Entiat Site

Transect #	1	2	3	4	5	6
Percent of Total Site	5.35	10.55	12.21	21.26	32.43	18.19

Transect Weighting for the Mad River Site

Transect #	1	2	3	4	5	6	7	8
Percent of Total Site	12.5	12.54	12.54	12.54	12.54	12.54	12.55	12.19

Agency Approval of the Hydraulic Model

Brad Caldwell of the Department of Ecology and Hal Beecher of the Department of Wildlife met May 6, 1994 and after reviewing the calibration details decided the hydraulic models were adequate for the extrapolation ranges listed above.

Habitat Use Model (HABTAT)

Options Used in HABTAT

The HABTAT program combines the depths and velocities predicted from the IFG4 hydraulic model with the depths, velocities, cover, and substrate preferences from the habitat-use curves. The HABTAT program calculates WUA for each flow modeled. The IOC options used in HABTAT were IOC 00000 00101 00000 000.

Habitat Preference Curves

Site specific data on fish preferences for depth, velocity, substrate, and cover was gathered by Department of Fisheries and Wildlife biologists.

Biologists observed spring chinook, steelhead, and bull trout juveniles at selected transects at regular intervals along the length of the study stream. They snorkeled across each transect to mark locations of fish and measured depth, mean water column velocity, substrate and cover at regularly spaced intervals across each transect. As they recorded the measurements of depth, velocity, substrate and cover, they also recorded the number of fish of each species in the immediate vicinity of each measurement. The biologists marked fish locations with weighted flags color-coded for each species.

Habitat availability was calculated and compared against actual fish use to determine fish preference. These fish preference values were then compared against fish preference curves which have been compiled by the agencies. The amount of weight given to the site specific preference curves depended upon how many observations were gathered, how well they compared to the existing body of observations, and whether the observations covered the full range of habitat that would be available from low to high flow. A report by Hal Beecher on the calculations and habitat observations is included in Appendix C.

Fish preference curves for the Entiat and Mad Rivers were agreed to by the Department of Ecology (represented by the author) and the Department of Fisheries and Wildlife (Hal Beecher) at an August, 12, 1993 meeting. The site-specific preference curves generated by this study were used with changes to the steelhead juvenile curves for depth and velocity. Existing agency preference curves were used for chinook and steelhead juvenile substrate and cover, chinook and steelhead spawning, and all lifestages of bull trout. These preference curves are listed in Appendix C.

Results and Discussion

The results are the fish habitat versus flow curves in Appendix A.

Factors To Consider When Developing A Flow Regime

Determining a minimum instream flow for a river or stream in the Entiat basin requires more than choosing the peak WUA flow for one lifestage of one species at one reach from the IFIM study. Because multiple lifestages existing simultaneously in a river, no specific flow will provide an optimum flow for all lifestages and species. Setting a minimum instream flow requires ranking the importance of each fish species and lifestage. This ranking requires considering long-range management plans for the fishery resources as determined by the state and federal natural resource agencies and the affected Tribes.

In addition, minimum instream flows must include flows necessary for incubation of fish eggs, smolt out-migration, fish passage to spawning grounds, and prevention of stranding of fry and juveniles. Other variables which have to be considered include water temperature, water quality, and sediment load. None of these variables were measured in this IFIM study. Therefore, reaching a conclusion about an appropriate minimum instream flow involves integrating the results of the IFIM study with consideration of these additional variables.

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Appendix A

Habitat (Weighted Useable Area) versus Flow Graphs

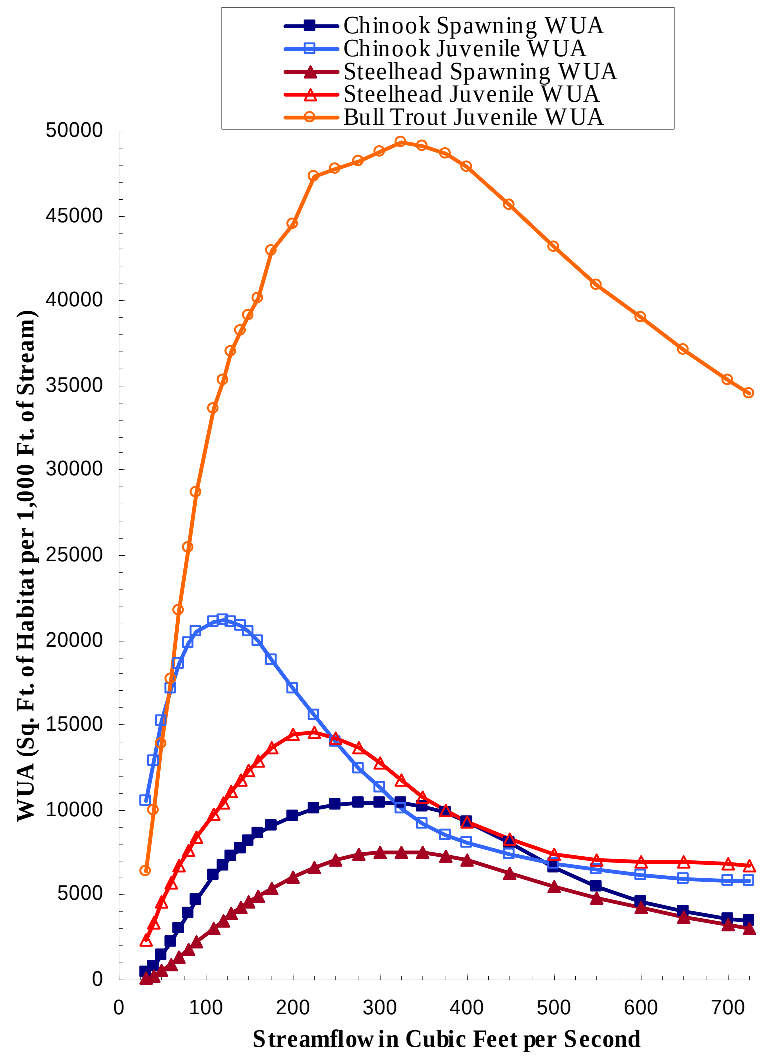
Figure 1: Lower Entiat River
Figure 2a and 2b Upper Entiat River
Figure 3a and 3b Mad River

Wetted Width (width of the wetted channel) verses Flow Graphs

Figure 4: Lower Entiat River
Figure 5: Upper Entiat River
Figure 6: Mad River

Figure 1

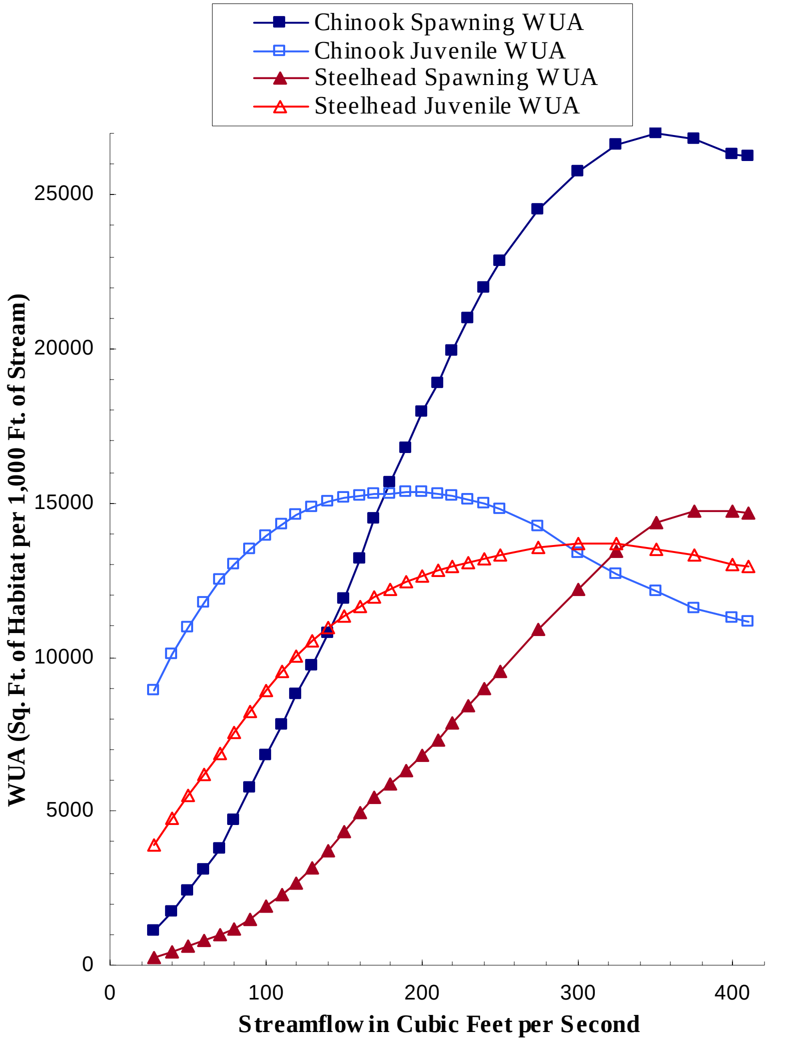
Lower Entiat River at RM 1.0: Fish Habitat (WUA) vs Flow							Percent of Peak Habitat vs Flow				



Flow (cfs)	Chinook Spawning WUA	Chinook Juvenile WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA	Bull Trout Juvenile WUA	Chinook Spawning % WUA	Chinook Juvenile % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA	Bull Trout Juvenile % WUA
32	466	10556	103	2358	6369	4%	50%	1%	16%	13%
40	826	12891	247	3373	10009	8%	61%	3%	23%	20%
50	1437	15242	530	4581	13871	14%	72%	7%	31%	28%
60	2196	17182	897	5772	17750	21%	81%	12%	39%	36%
70	3054	18647	1324	6750	21776	29%	88%	18%	46%	44%
80	3909	19840	1771	7620	25453	37%	94%	23%	52%	52%
90	4693	20559	2208	8412	28675	45%	97%	29%	58%	58%
110	6113	**21132**	3049	9785	33580	59%	**100%**	40%	67%	68%
120	6710	**21203**	3470	10451	35355	64%	**100%**	46%	71%	72%
130	7279	21094	3876	11098	36953	70%	99%	51%	76%	75%
140	7787	20826	4257	11738	38230	75%	98%	56%	80%	77%
150	8234	20470	4597	12341	39129	79%	97%	61%	84%	79%
160	8607	19930	4928	12885	40100	82%	94%	65%	88%	81%
175	9049	18862	5392	13624	42912	87%	89%	71%	93%	87%
200	9644	17144	6097	14451	44543	92%	81%	81%	99%	90%
225	10073	15601	6662	**14624**	47332	96%	74%	88%	**100%**	96%
250	10300	14020	7069	14263	47810	99%	66%	94%	98%	97%
275	10388	12480	7375	13638	48209	99%	59%	98%	93%	98%
300	**10447**	11306	**7534**	12802	48718	**100%**	53%	**100%**	88%	99%
325	10370	10145	**7560**	11760	**49331**	99%	48%	**100%**	80%	**100%**
350	10165	9225	7469	10772	**49135**	97%	44%	99%	74%	**100%**
375	9828	8576	7315	9987	48674	94%	40%	97%	68%	99%
400	9347	8095	7041	9311	47901	89%	38%	93%	64%	97%
450	8026	7354	6236	8270	45610	77%	35%	82%	57%	92%
500	6602	6867	5461	7359	43213	63%	32%	72%	50%	88%
550	5460	6447	4794	7053	40920	52%	30%	63%	48%	83%
600	4624	6128	4217	6968	39028	44%	29%	56%	48%	79%
650	3990	5931	3688	6918	37146	38%	28%	49%	47%	75%
700	3600	5873	3249	6800	35367	34%	28%	43%	46%	72%
725	3431	5861	3050	6731	34538	33%	28%	40%	46%	70%

Figure 2a

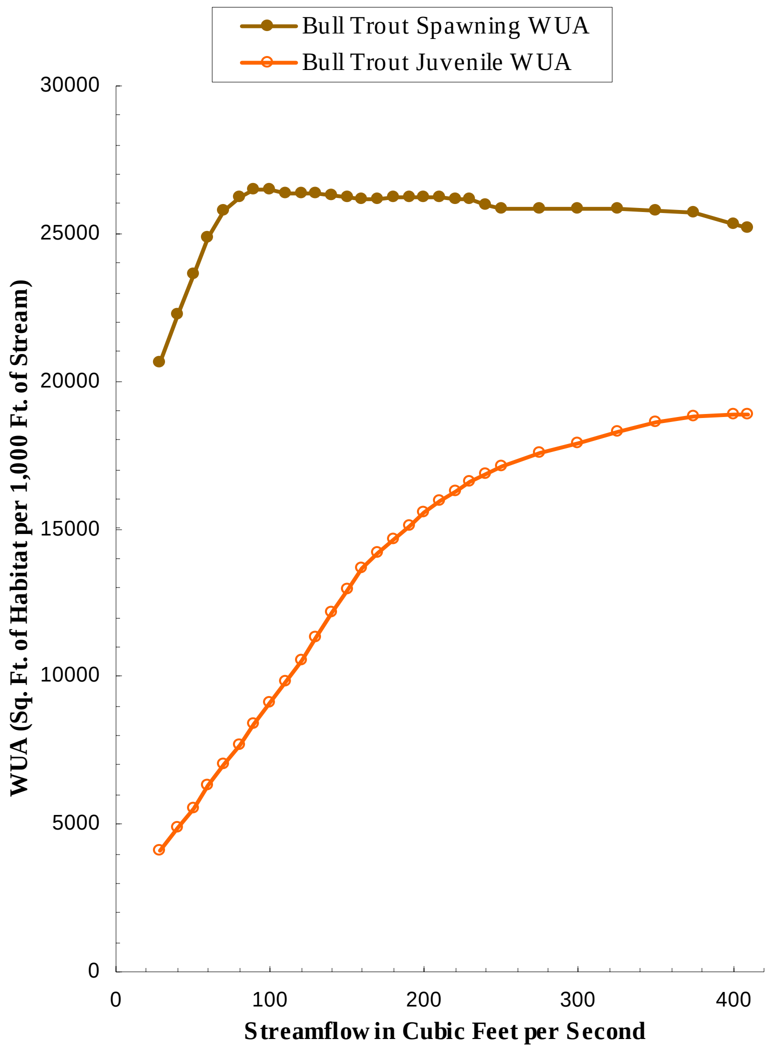
Upper Entiat River at RM 16.2: Fish Habitat (WUA) vs Flow



Flow (cfs)	Chinook Spawning WUA	Chinook Juvenile WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA	Percent of Peak Habitat vs Flow: Chinook Spawning % WUA	Chinook Juvenile % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
28	1143	8889	264	3899	4%	58%	2%	28%
40	1763	10103	447	4781	7%	66%	3%	35%
50	2401	10940	621	5526	9%	71%	4%	40%
60	3077	11782	813	6205	11%	77%	6%	45%
70	3776	12484	981	6864	14%	81%	7%	50%
80	4697	13025	1192	7548	17%	85%	8%	55%
90	5758	13514	1516	8221	21%	88%	10%	60%
100	6807	13945	1895	8897	25%	91%	13%	65%
110	7824	14301	2285	9524	29%	93%	16%	70%
120	8810	14614	2690	10058	33%	95%	18%	73%
130	9728	14844	3161	10557	36%	97%	21%	77%
140	10769	15021	3739	10967	40%	98%	25%	80%
150	11917	15150	4361	11336	44%	99%	30%	83%
160	13169	15220	4958	11672	49%	99%	34%	85%
170	14471	**15269**	5463	11955	54%	**100%**	37%	87%
180	15647	**15311**	5893	12217	58%	**100%**	40%	89%
190	16803	**15341**	6335	12441	62%	**100%**	43%	91%
200	17983	**15339**	6824	12629	67%	**100%**	46%	92%
210	18888	**15297**	7313	12792	70%	**100%**	50%	93%
220	19954	15219	7886	12942	74%	99%	54%	95%
230	21006	15112	8448	13083	78%	99%	57%	96%
240	21954	14976	8999	13194	81%	98%	61%	96%
250	22832	14813	9565	13308	84%	97%	65%	97%
275	24512	14238	10878	13562	91%	93%	74%	99%
300	25743	13391	12219	**13689**	95%	87%	83%	**100%**
325	26657	12697	13460	**13687**	99%	83%	91%	**100%**
350	**27031**	12146	14385	13518	**100%**	79%	98%	99%
375	26790	11599	**14728**	13307	99%	76%	**100%**	97%
400	26323	11241	**14727**	13033	97%	73%	**100%**	95%
410	26227	11158	14650	12924	97%	73%	99%	94%

Figure 2b

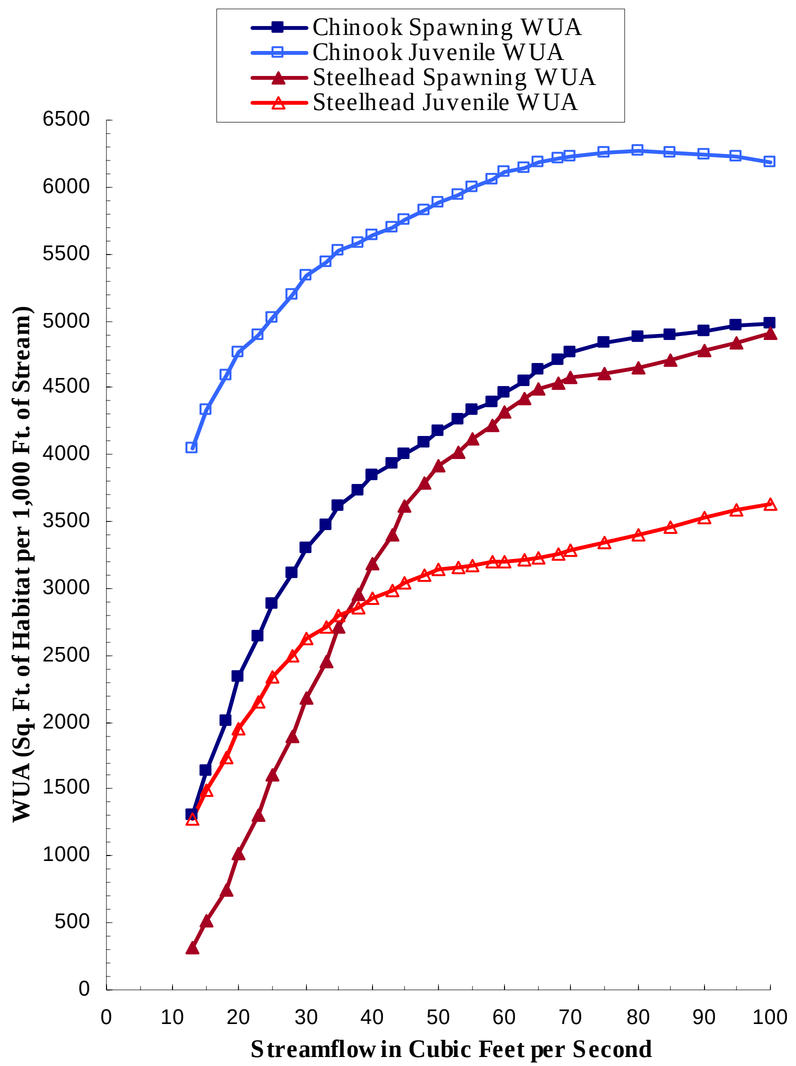
Upper Entiat River at RM 16.2: Fish Habitat (WUA) vs Flow



Flow (cfs)	Bull Trout Spawning WUA	Bull Trout Juvenile WUA	Percent of Peak Habitat vs Flow: Bull Trout Spawning % WUA	Percent of Peak Habitat vs Flow: Bull Trout Juvenile % WUA
28	20658	4085	78%	22%
40	22265	4865	84%	26%
50	23648	5558	89%	29%
60	24880	6329	94%	34%
70	25783	7037	97%	37%
80	26246	7703	99%	41%
90	**26469**	8420	**100%**	45%
100	**26460**	9134	**100%**	48%
110	**26386**	9833	**100%**	52%
120	**26334**	10535	**99%**	56%
130	**26352**	11307	**100%**	60%
140	26300	12162	99%	65%
150	26210	12944	99%	69%
160	26185	13638	99%	72%
170	26158	14184	99%	75%
180	26206	14651	99%	78%
190	26232	15108	99%	80%
200	26236	15544	99%	82%
210	26220	15918	99%	84%
220	26182	16267	99%	86%
230	26130	16602	99%	88%
240	25948	16876	98%	90%
250	25840	17117	98%	91%
275	25820	17576	98%	93%
300	25854	17922	98%	95%
325	25854	18287	98%	97%
350	25787	18594	97%	99%
375	25694	**18829**	97%	**100%**
400	25331	**18854**	96%	**100%**
410	25212	**18842**	95%	**100%**

Figure 3a

Mad River (RM 1.0): Fish Habitat (WUA) vs Flow

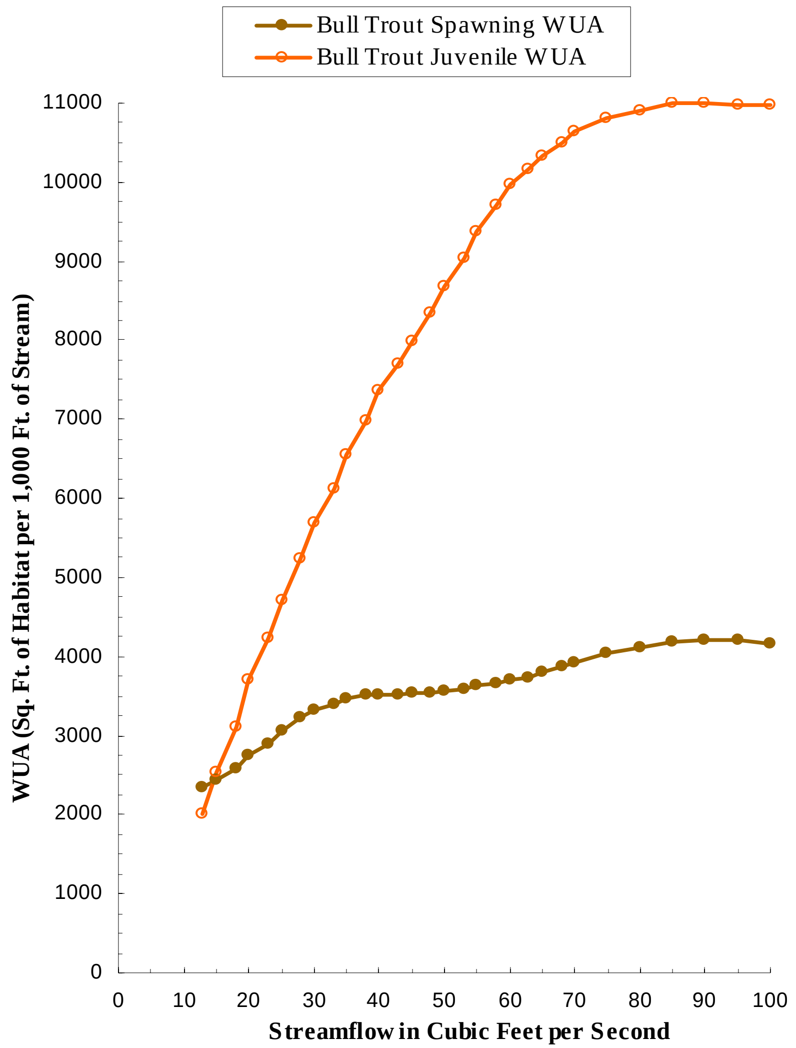


Percent of Peak Habitat vs Flow

Flow (cfs)	Chinook Spawning WUA	Chinook Juvenile WUA	Steelhead Spawning WUA	Steelhead Juvenile WUA	Chinook Spawning % WUA	Chinook Juvenile % WUA	Steelhead Spawning % WUA	Steelhead Juvenile % WUA
13	1299	4040	315	1270	26%	64%	6%	35%
15	1641	4338	520	1496	33%	69%	11%	41%
18	2007	4588	747	1737	40%	73%	15%	48%
20	2339	4767	1025	1947	47%	76%	21%	54%
23	2639	4900	1299	2149	53%	78%	26%	59%
25	2890	5028	1600	2334	58%	80%	33%	64%
28	3109	5195	1899	2501	62%	83%	39%	69%
30	3307	5331	2187	2628	66%	85%	45%	72%
33	3477	5436	2451	2715	70%	87%	50%	75%
35	3611	5520	2711	2793	73%	88%	55%	77%
38	3734	5582	2957	2862	75%	89%	60%	79%
40	3842	5639	3191	2932	77%	90%	65%	81%
43	3933	5697	3406	2989	79%	91%	69%	82%
45	4009	5756	3610	3047	81%	92%	74%	84%
48	4092	5823	3783	3102	82%	93%	77%	85%
50	4174	5888	3913	3141	84%	94%	80%	86%
53	4258	5942	4016	3162	86%	95%	82%	87%
55	4330	5995	4120	3178	87%	96%	84%	87%
58	4389	6059	4225	3193	88%	97%	86%	88%
60	4468	6110	4326	3203	90%	98%	88%	88%
63	4555	6148	4417	3215	92%	98%	90%	88%
65	4636	6181	4486	3233	93%	99%	91%	89%
68	4712	6207	4539	3258	95%	99%	93%	90%
70	4768	6225	4579	3291	96%	99%	93%	91%
75	4835	**6258**	4612	3347	97%	**100%**	94%	92%
80	4873	**6264**	4643	3401	98%	**100%**	95%	94%
85	4890	**6261**	4710	3457	98%	**100%**	96%	95%
90	4923	**6247**	4778	3523	99%	**100%**	97%	97%
95	4966	6223	4836	3585	**100%**	99%	99%	99%
100	4978	6180	**4903**	**3636**	**100%**	99%	**100%**	**100%**

Figure 3b

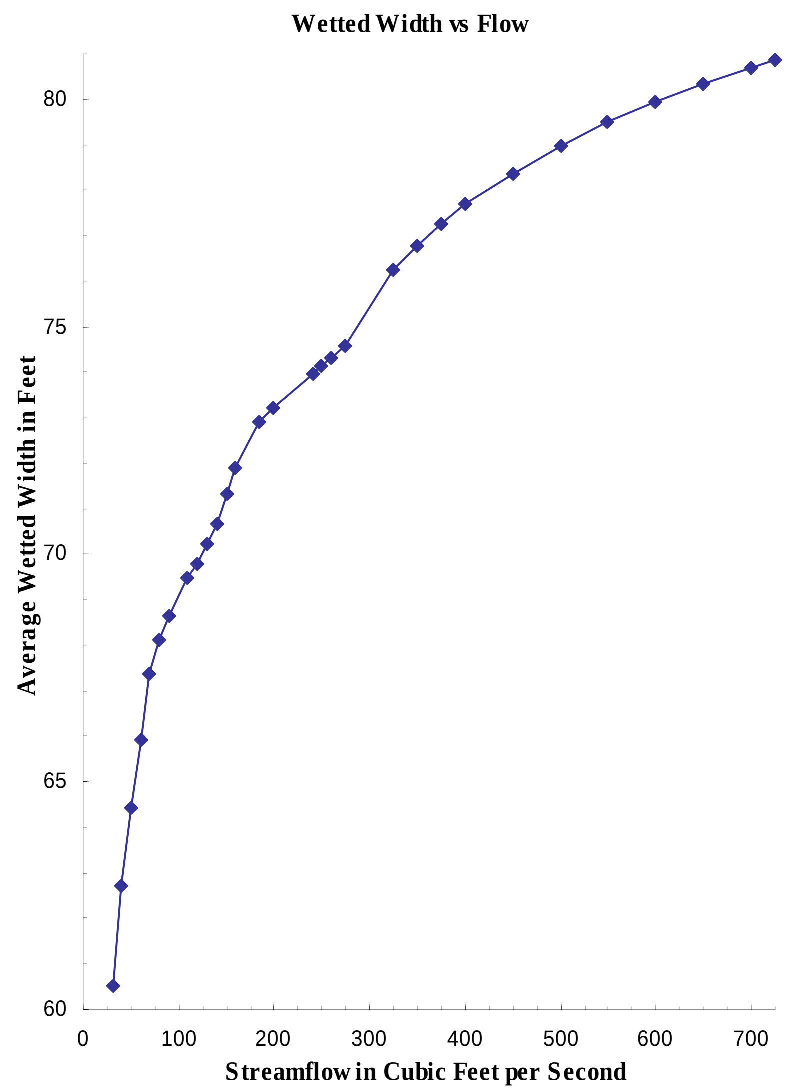
Mad River (RM 1.0): Fish Habitat (WUA) vs Flow



Flow (cfs)	Bull Trout Spawning WUA	Bull Trout Juvenile WUA	Percent of Peak Habitat vs Flow: Bull Trout Spawning % WUA	Percent of Peak Habitat vs Flow: Bull Trout Juvenile % WUA
13	2346	2006	56%	18%
15	2442	2542	58%	23%
18	2586	3098	61%	28%
20	2742	3695	65%	34%
23	2902	4222	69%	38%
25	3066	4719	73%	43%
28	3218	5245	77%	48%
30	3327	5694	79%	52%
33	3407	6112	81%	56%
35	3462	6559	82%	60%
38	3505	6984	83%	63%
40	3516	7375	84%	67%
43	3521	7694	84%	70%
45	3530	7997	84%	73%
48	3542	8337	84%	76%
50	3564	8687	85%	79%
53	3586	9034	85%	82%
55	3623	9385	86%	85%
58	3658	9717	87%	88%
60	3698	9980	88%	91%
63	3736	10164	89%	92%
65	3807	10328	91%	94%
68	3862	10491	92%	95%
70	3922	10634	93%	97%
75	4038	10814	96%	98%
80	4123	10904	98%	99%
85	4179	**10998**	99%	**100%**
90	**4206**	**11005**	**100%**	**100%**
95	**4199**	**10986**	**100%**	**100%**
100	4169	**10981**	99%	**100%**

Figure 4

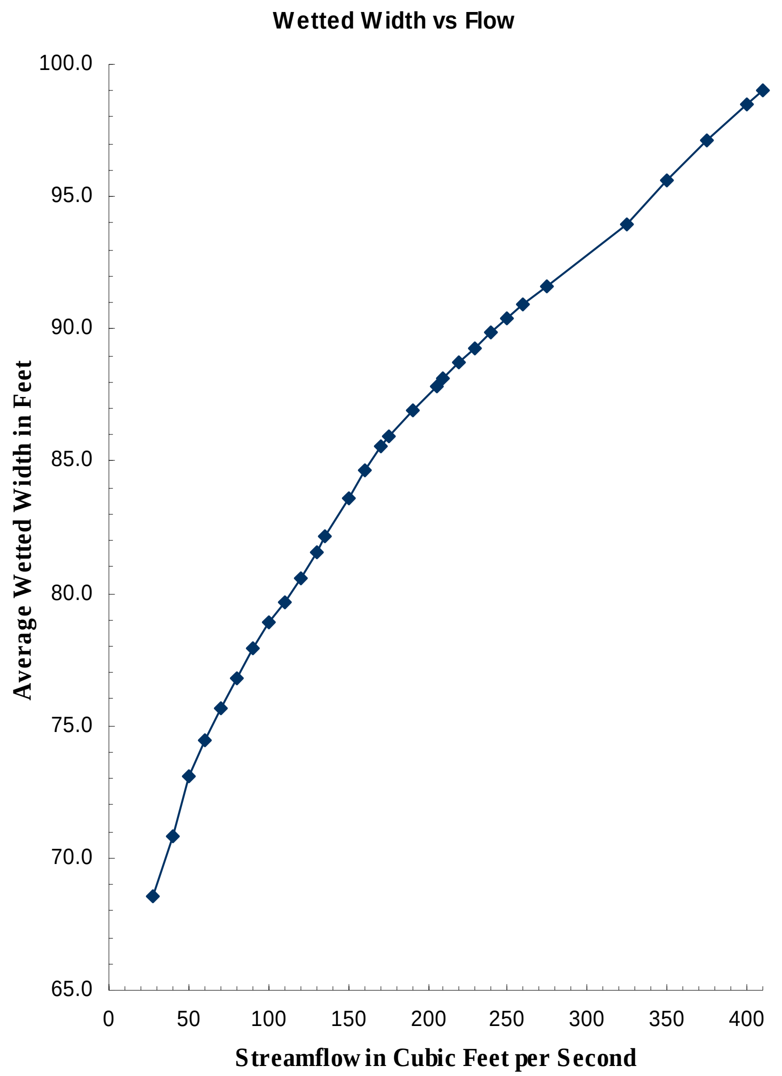
Lower Entiat River at RM 1.0: Average Wetted Width



Flow (cfs)	Wetted Width (feet)
32	60.5
40	62.7
50	64.4
60	66.0
70	67.4
80	68.1
90	68.6
110	69.5
120	69.8
130	70.3
140	70.7
150	71.3
160	71.9
185	72.9
200	73.2
240	74.0
250	74.2
260	74.3
275	74.6
325	76.3
350	76.8
375	77.3
400	77.7
450	78.4
500	79.0
550	79.5
600	80.0
650	80.3
700	80.7
725	80.9

Figure 5

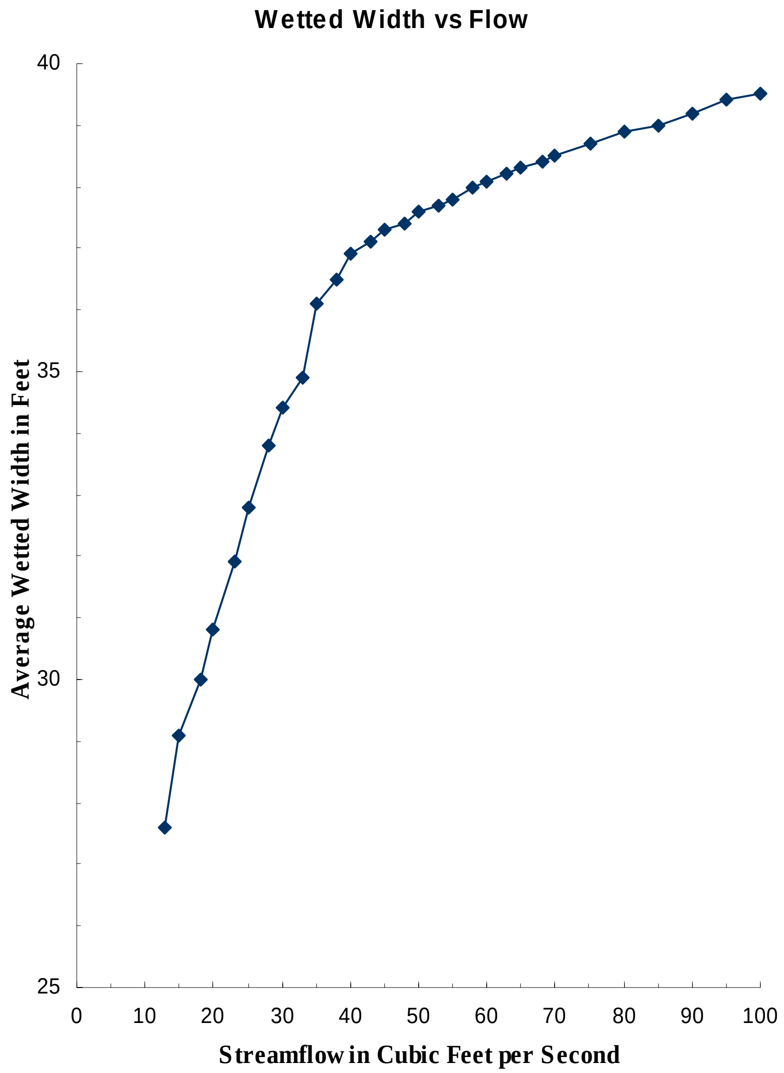
Upper Entiat River at RM 16.2: Average Wetted Width



Flow (cfs)	Wetted Width (feet)
28	68.6
40	70.8
50	73.1
60	74.5
70	75.6
80	76.8
90	77.9
100	78.9
110	79.6
120	80.5
130	81.5
136	82.2
150	83.6
160	84.6
170	85.5
175	85.9
190	86.9
205	87.8
210	88.1
220	88.7
230	89.3
240	89.9
250	90.4
260	90.9
275	91.6
325	94.0
350	95.6
375	97.1
400	98.5
410	99.0

Figure 6

Mad River at RM 1.0: Average Wetted Width



Flow (cfs)	Wetted Width (feet)
13	27.6
15	29.1
18	30
20	30.8
23	31.9
25	32.8
28	33.8
30	34.4
33	34.9
35	36.1
38	36.5
40	36.9
43	37.1
45	37.3
48	37.4
50	37.6
53	37.7
55	37.8
58	38
60	38.1
63	38.2
65	38.3
68	38.4
70	38.5
75	38.7
80	38.9
85	39
90	39.2
95	39.4
100	39.5

Appendix B

Calibration Information

B1. IFG4 Input File
B2. Summary of Calibration Details
B3. Summary of Data Changes
B4. Velocity Adjustment Factors

Appendix B1 IFG4 Input Files

Upper Entiat River at RM 16.2

```
Measured 164 cfs on 7-28-92, 121 cfs on 8-13-92, and 55 cfs on 10-6-92
IOC       11000002000010000 10 1
QARD  28.0
QARD  40.0
QARD  50.0
QARD  60.0
QARD  70.0
QARD  80.0
QARD  90.0
QARD 100.0
QARD 110.0
QARD 120.0
QARD 130.0
QARD 140.0
QARD 150.0
QARD 160.0
QARD 170.0
QARD 180.0
QARD 190.0
QARD 200.0
QARD 210.0
QARD 220.0
QARD 230.0
QARD 240.0
QARD 250.0
QARD 275.0
QARD 300.0
QARD 325.0
QARD 350.0
QARD 375.0
QARD 400.0
QARD 410.0
XSEC   1.0       0.0 .50     95.76    .00250
       1.0  0.0101.9  2.0101.2  4.096.52  5.096.57  6.095.87  7.095.73
       1.0  8.095.23  9.0 95.2 10.095.22 11.094.72 12.095.43 13.095.07
       1.0 14.0 94.6 15.093.67 16.093.87 17.092.97 18.0 92.6 19.0 92.6
       1.0 20.092.63 21.092.83 22.092.93 23.093.07 24.093.23 25.093.33
       1.0 27.593.67 30.094.02 32.594.67 35.0 95.3 37.596.37 40.097.34
       1.0 41.597.44 60.098.66 80.099.26100.0100.5138.0100.8145.797.44
       1.0147.597.14150.096.64152.596.69155.096.74157.596.94160.097.09
       1.0162.597.14165.097.29167.597.34169.597.44177.099.06188.099.46
       1.0208.097.36218.0101.0
NS     1.0       .80       .10       .10     21.90     16.80     16.90
NS     1.0     18.90     81.50     81.90     87.80     87.50     87.50
NS     1.0     76.50     76.40     67.50     76.40     67.80     86.50
NS     1.0     86.50     76.50     76.50     62.80     67.50     27.70
NS     1.0     26.80     26.60     64.70     64.70     52.80     64.50
NS     1.0     64.50     46.50     46.50     11.50     65.50     64.80
NS     1.0     64.80     64.80     54.60     56.80     46.60     46.80
```

Appendix B1 IFG4 Input Files (Continued)

```
NS     1.0     41.60     41.50     61.50     46.50     65.50     65.50
NS     1.0     65.50       .80
CAL1   1.0     97.44    163.60
VEL1   1.0 0.00 0.00 0.00 -.05 -.06 -.08 -.15  .26  .40  .92 1.97 3.31
VEL1   1.0 4.81 3.20 4.19 4.47 3.97 3.96 3.55 3.25 2.79 2.33 1.51 1.47
VEL1   1.0  .27 -.35 -.26 -.44 -.60 0.00
VEL1   1.0 0.00  .03  .03  .03  .14  .13  .17  .05 0.00
VEL1   1.0
CAL2   1.0     97.20    120.70
VEL2   1.0           0.00 0.00  .03  .13  .96  .13  .17  .34 2.19 3.74
VEL2   1.0 3.69 3.39 3.89 3.69 3.26 3.08 2.58 2.35 1.90 1.59 1.33  .86
VEL2   1.0  .09  .49  .20 -.39 -.28
VEL2   1.0 0.00 0.00 0.00 0.00 0.00 0.00 0.00
VEL2   1.0
CAL3   1.0     96.86     55.00
VEL3   1.0           0.00 0.00 -.10 -.11 -.03  .05  .14  .30  .48 1.33
VEL3   1.0 1.96 1.92 2.68 2.30 1.90 1.68 1.36 1.17  .74  .69  .49  .16
VEL3   1.0  .08  .10 -.17 -.27 -.05
VEL3   1.0
VEL3   1.0
XSEC   2.0      43.0 .50     95.76    .00250
       2.0  0.0101.2  2.599.16  4.697.45  6.097.25  7.096.46  8.095.91
       2.0  9.095.29 10.094.84 11.094.68 12.094.71 13.094.84 14.094.71
       2.0 15.094.71 16.094.81 17.094.84 18.094.84 19.094.84 20.094.91
       2.0 22.594.93 25.095.41 27.596.06 30.095.56 32.596.76 35.097.06
       2.0 37.597.35 40.097.45 53.097.86 73.098.66 93.099.66123.0100.5
       2.0127.297.45128.0 97.1130.096.49132.595.61135.095.63137.595.93
       2.0140.096.14142.596.68145.096.83147.597.13149.197.45162.099.26
       2.0182.099.26197.097.96206.0101.5256.0101.5
NS     2.0     86.80     86.80     68.60     68.50     86.50     86.50
NS     2.0     86.50     78.80     76.80     76.80     76.80     76.80
NS     2.0     76.80     67.80     67.90     62.70     62.70     62.70
 NS     2.0     65.50     56.80     54.50     46.90     45.50     46.70
NS     2.0     52.80     52.80     62.50     64.50     11.50     11.50
NS     2.0     11.50     11.50     12.90     51.50     51.50     35.50
NS     2.0     43.90     42.50     42.50     52.80     52.80     56.50
NS     2.0     56.50     56.50       .80       .80
CAL1   2.0     98.44    163.60
VEL1   2.0 0.00            .36 1.20 2.53 2.75 5.87 4.92 5.20 5.89 6.21
VEL1   2.0 5.47 4.61 4.55 4.78 4.52 3.90 2.07  .48 -.02 0.00 0.00 0.00
VEL1   2.0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 -.03 -.03 0.00 0.00 0.00
VEL1   2.0 0.00  .28  .12 0.00
CAL2   2.0     98.22    120.70
VEL2   2.0                     1.58 1.62 2.27 5.53 5.23 5.38 5.99 4.99
VEL2   2.0 4.20 4.04 4.13 4.00 3.81 2.70  .76  .13 -.24 -.64 -.20 0.00
VEL2   2.0 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
VEL2   2.0 0.00 0.00 0.00 0.00
CAL3   2.0     97.89     54.60
VEL3   2.0                      .24  .41 1.11 3.71 4.50 4.15 3.06 2.47
VEL3   2.0 2.65 2.77 2.40 1.90 1.40 1.08  .48 -.05 -.38-.013 0.00 0.00
VEL3   2.0 0.00 0.00 0.00 0.00
```

Appendix B1 IFG4 Input Files (Continued)

```
VEL3   2.0
XSEC   3.0      99.0 .50     96.66    .00250
       3.0 -4.0103.0  0.0101.2  2.0100.5  3.798.44  7.097.53  8.096.65
       3.0 10.095.72 12.596.08 15.096.15 17.595.93 20.096.03 22.596.15
       3.0 25.096.57 27.596.82 30.0 97.1 32.597.33 35.0 97.4 40.097.43
       3.0 45.097.41 50.097.38 55.097.32 60.0 97.1 65.097.22 70.097.25
       3.0 75.097.41 80.097.62 85.097.85 90.097.83 95.098.13 98.898.44
       3.0105.098.86130.099.26147.098.26151.098.96154.0101.3200.0101.3
NS     3.0       .80       .80     88.80     87.50     87.50     86.50
NS     3.0     86.50     64.60     65.50     65.50     56.50     53.80
NS     3.0     62.90     62.90     62.90     64.80     64.60     64.60
NS     3.0     64.60     64.60     65.50     65.50     65.50     56.50
NS     3.0     56.60     56.60     54.70     51.50     51.50     51.50
NS     3.0     52.50     56.50     56.50     54.05       .80       .80
CAL1   3.0     98.44    163.60
VEL1   3.0                    1.35 1.34 1.88 1.94 1.94 2.04 1.94 1.91
VEL1   3.0 1.59 1.72 1.96 1.84 2.06 1.83 1.57 1.52 1.30 1.15  .81  .67
VEL1   3.0  .64  .32  .30  .11 0.00
CAL2   3.0     98.22    120.70
VEL2   3.0                    1.20 1.12 2.03 2.02 1.95 1.75 1.94 1.62
VEL2   3.0 1.64 1.88 1.79 1.65 2.25 1.66 1.45 1.29  .75  .85  .79  .59
VEL2   3.0  .33  .32 0.00 0.00 0.00
CAL3   3.0     97.89     54.60
VEL3   3.0                    0.00 1.02  .98 1.35 1.46  .64  .86 1.60
VEL3   3.0 1.59 1.03 1.91 1.36 1.79 1.13  .93  .64  .57  .34  .21 0.00
VEL3   3.0 0.00 0.00 0.00 0.00
XSEC   4.0      90.0 .50     96.66    .00250
       4.0  0.0103.2  3.099.08  4.698.48  5.098.23  7.596.14 10.096.19
       4.0 12.594.05 15.093.52 17.593.22 20.093.02 22.593.12 25.093.22
       4.0 27.593.69 30.093.85 32.593.95 35.094.32 37.594.45 40.094.85
       4.0 42.595.09 45.095.67 47.595.45 50.095.84 52.596.57 55.0 96.0
       4.0 57.596.27 60.096.45 62.596.55 65.0 96.8 67.5 97.0 70.0 97.2
       4.0 72.597.37 75.097.52 77.597.88 80.098.18 82.593.38 85.098.25
       4.0 87.498.48 88.098.88 98.0100.2108.0101.5
NS     4.0       .80     86.80     66.50     66.50     82.90     82.80
NS     4.0       .50     82.80     82.80     21.90     21.90     21.90
NS     4.0       .50     21.90     21.90     21.90     24.90     25.90
NS     4.0     92.50     92.50     25.90     29.50     92.50     26.80
NS     4.0     61.50     62.50     62.50     62.50     62.50     26.60
NS     4.0     52.50     25.50     42.70     42.50     14.50     12.50
NS     4.0     12.50     12.50       .80       .80
CAL1   4.0     98.48    163.60
VEL1   4.0               0.00 0.00 0.00  .08  .15  .38  .64  .71  .76
VEL1   4.0  .73 1.09 1.12 1.15 1.14 1.17 1.25 1.05  .99  .94  .99  .97
VEL1   4.0  .79  .74  .56  .65  .48  .36  .34  .10  .16 0.00
VEL1   4.0
CAL2   4.0     98.27    120.70
VEL2   4.0                    0.00 0.00  .07  .08  .33  .38  .48  .58
VEL2   4.0  .68  .84  .87  .77  .83  .93 1.03  .72  .80  .80  .81  .74
VEL2   4.0  .61  .54  .46  .39  .26  .24  .25  .08 0.00 0.00
VEL2   4.0
```

Appendix B1 IFG4 Input Files (Continued)

```
CAL3   4.0     97.91     54.60
VEL3   4.0                    0.00 0.00 0.00  .04  .09  .13  .22  .32
VEL3   4.0  .25  .43  .52  .42  .49  .49  .45  .42  .42  .41  .42  .37
VEL3   4.0  .15  .15  .05 0.00 0.00 0.00 0.00 0.00
VEL3   4.0
XSEC   5.0     158.0 .50     96.66    .00250
       5.0 -1.0103.2  0.0100.9  5.298.49  7.598.26  8.094.95 10.092.64
       5.0 12.592.74 15.092.87 17.593.27 20.0 93.8 22.5 94.2 25.094.57
       5.0 27.594.77 30.094.97 32.594.92 35.095.15 37.595.27 40.095.47
       5.0 42.595.52 45.095.57 47.595.74 50.095.87 52.596.07 55.096.27
       5.0 57.596.42 60.096.47 62.596.52 65.096.64 67.596.98 70.096.92
       5.0 72.597.09 75.097.15 80.097.85 85.098.39 85.998.49 95.099.68
       5.0105.0101.0115.0102.1160.0102.1
NS     5.0       .80       .80     88.50     86.90     86.90     82.80
NS     5.0     86.80     26.80     62.50     62.50     62.50     62.50
NS     5.0     52.50     52.50     62.50     26.80     26.80     26.60
NS     5.0     25.70     26.80     25.80     25.70     52.50     52.80
NS     5.0     46.50     65.50     65.50     65.50     57.90     56.80
NS     5.0     56.80     56.80     56.50     56.50     56.50     65.50
NS     5.0       .80       .80       .80
CAL1   5.0     98.49    163.60
VEL1   5.0                 .42 0.00  .15  .29  .25  .49  .44  .74  .75
VEL1   5.0  .86  .92  .82  .94  .87 1.14 1.11 1.17 1.02 1.09 1.03 1.23
VEL1   5.0 1.06 1.16 1.19 1.09  .95  .84  .79  .42 0.00 0.00
VEL1   5.0
CAL2   5.0     98.28    120.70
VEL2   5.0               0.00 0.00  .06  .15  .13  .23  .45  .51  .64
VEL2   5.0  .64  .74  .74  .77  .81  .98  .84  .80  .94  .90  .97  .91
VEL2   5.0 1.04 1.08  .92  .73  .64  .60  .38  .17 0.00
VEL2   5.0
CAL3   5.0     97.94     54.60
VEL3   5.0                    0.00  .03  .05  .08  .13  .13  .20  .19
VEL3   5.0  .30  .40  .40  .39  .50  .47  .52  .50  .55  .43  .58  .66
VEL3   5.0  .56  .39  .40  .49  .36  .21  .09 0.00 0.00
VEL3   5.0
XSEC   6.0     171.0 .50     96.66    .00250
       6.0-50.0100.4  0.0100.4 10.099.68 20.098.78 22.598.53 25.098.43
       6.0 27.5 98.2 30.098.05 32.597.75 35.097.32 37.597.12 40.096.87
       6.0 42.596.65 45.0 96.6 47.596.47 50.096.32 52.596.25 55.096.22
       6.0 57.596.12 60.096.12 62.595.93 65.095.92 67.595.92 70.0 95.9
       6.0 72.5 95.9 75.096.12 77.596.28 80.096.32 82.596.42 85.096.53
       6.0 87.596.95 90.097.23 92.597.45 95.097.83 97.598.22 99.198.53
       6.0103.099.28106.0100.6108.0102.7112.0103.2
NS     6.0       .80       .80       .80     64.70     54.60     54.80
NS     6.0     56.70     57.90     65.60     65.60     65.50     64.90
NS     6.0     64.90     64.80     56.60     46.60     46.70     46.50
NS     6.0     52.50     52.60     56.90     54.60     52.50     54.50
NS     6.0     65.60     65.50     56.70     56.80     56.50     56.50
NS     6.0     56.70     53.90     54.80     54.80     56.70     56.70
NS     6.0     54.80       .80       .80       .80
CAL1   6.0     98.53    163.60
```

Appendix B1 IFG4 Input Files (Continued)

```
VEL1   6.0                         0.00  .12  .32  .48  .40  .73  .78
VEL1   6.0  .88 1.13  .96 1.07 1.28 1.42 1.38 1.57 1.53 1.44 1.45 1.61
VEL1   6.0 1.51 1.62 1.56 1.53 1.49 1.33 1.31 1.26  .85  .73  .31
VEL1   6.0
CAL2   6.0     98.31     120.70
VEL2   6.0                              0.00  .22  .35  .35  .55  .56
VEL2   6.0  .78  .80  .90  .99 1.03 1.12 1.24 1.20 1.23 1.21 1.33 1.32
VEL2   6.0 1.34 1.35 1.52 1.28 1.10 1.06 1.03  .83  .62  .38 0.00
VEL2   6.0
CAL3   6.0     97.96      54.60
VEL3   6.0                                        0.00  .16  .25  .32
VEL3   6.0  .39  .48  .54  .59  .66  .63  .73  .82  .69  .79  .79  .79
VEL3   6.0  .85  .85  .80  .78  .69  .59  .58  .48  .12 0.00
VEL3   6.0
ENDJ
```

Appendix B1 IFG4 Input Files (Continued)

Lower Entiat River at River Mile 1.0

```
Measured 7-21-92 at 290 cfs, 8-12-92 at 140 cfs, and 10-7-92 at 80 cfs
IOC       11000002000010000 10 1
QARD 725.0
QARD 700.0
QARD 650.0
QARD 600.0
QARD 550.0
QARD 500.0
QARD 450.0
QARD 400.0
QARD 375.0
QARD 350.0
QARD 325.0
QARD 300.0
QARD 275.0
QARD 250.0
QARD 225.0
QARD 200.0
QARD 175.0
QARD 160.0
QARD 150.0
QARD 140.0
QARD 130.0
QARD 120.0
QARD 110.0
QARD  90.0
QARD  80.0
QARD  70.0
QARD  60.0
QARD  50.0
QARD  40.0
QARD  32.0
XSEC   1.0       0.0 .50     92.04    .00250
       1.0 -7.0100.1  0.095.53  2.094.29  5.092.77  8.092.44 11.0 92.5
       1.0 14.092.77 17.093.17 20.093.12 23.0 92.9 26.093.02 29.0 93.3
       1.0 32.093.71 35.092.92 38.093.32 41.093.17 44.093.17 47.0 93.3
       1.0 50.092.99 53.092.27 56.092.14 59.0 92.1 62.092.24 65.092.44
       1.0 68.092.64 71.092.24 74.092.04 77.092.07 80.092.89 83.092.64
       1.0 86.093.02 89.093.19 90.494.29 93.095.03 95.196.33105.098.33
NS     1.0     87.80     87.80     87.80     82.80     79.80     78.80
NS     1.0     76.80     78.80     78.80     76.80     78.90     76.90
NS     1.0     78.90     78.80     78.70     76.70     78.80     78.80
NS     1.0     78.80     78.80     78.80     78.80     78.80     78.80
NS     1.0     78.80     76.80     72.80     78.80     97.50     97.50
NS     1.0     87.50     82.50     82.50     78.60     78.60       .80
CAL1   1.0     94.29    293.00
VEL1   1.0                -.10  .53 2.33 2.47 1.70  .41  .60 2.11 2.44
VEL1   1.0 2.22 2.41 2.82 2.34 1.95 2.19 2.75 2.88 2.89 2.18 3.43 1.88
VEL1   1.0 2.58 2.31 3.15 3.28 2.66 1.47  .24
```

Appendix B1 IFG4 Input Files (Continued)

```
CAL2   1.0     93.73    131.00
VEL2   1.0                 .08  .65 1.72  .85 1.04  .01 1.54 1.03 1.71
VEL2   1.0 0.00  .97 2.00 1.24 1.45 1.49  .99 1.95 2.34 2.57 1.91 2.27
VEL2   1.0 2.18 1.98 1.72 2.50 3.75 2.06  .72  .04
CAL3   1.0     93.49     80.00
VEL3   1.0                 .21  .71 1.13 0.00  .37  .19  .93  .62 1.13
VEL3   1.0 0.00  .39 1.24  .80 0.00  .86  .56 1.88 1.68 2.09 1.98 2.04
VEL3   1.0 1.60 1.34 1.26 1.74 2.69 1.53  .53 0.00
XSEC   2.0     103.0 .50     92.13    .00250
       2.0 -6.0100.1  0.095.93  2.095.23  3.294.67  5.093.58  8.094.07
       2.0 11.0 93.5 14.092.96 17.092.86 20.092.83 23.0 93.2 26.092.58
       2.0 29.092.61 32.092.63 35.092.66 38.092.41 41.092.35 44.092.28
       2.0 47.092.63 50.092.46 53.092.48 56.092.18 59.092.38 62.092.13
       2.0 65.092.76 68.092.86 71.092.93 74.093.16 77.092.99 80.094.19
       2.0 81.094.67 84.096.23 86.897.23 91.0100.1
NS     2.0     87.80     87.80     87.80     87.50     82.50     82.50
NS     2.0     82.50     78.80     72.50     72.50     78.80     76.90
NS     2.0     76.90     78.70     78.70     78.90     78.80     78.90
NS     2.0     76.90     78.80     78.90     78.90     78.90     76.90
NS     2.0     97.50     97.50     79.80     78.70     78.60     78.70
NS     2.0     78.70     78.60     78.60       .80
CAL1   2.0     94.67    293.00
VEL1   2.0                           .31 1.02 1.26 1.05 1.70 2.06 2.06
VEL1   2.0 1.41 2.39 2.89 3.00 2.47 2.79 2.86 2.69 2.15 2.15 2.20 2.16
VEL1   2.0 2.44 1.76 2.20 2.19 2.27  .44
CAL2   2.0     94.16    131.00
VEL2   2.0                           .10  .50  .64  .57  .69 1.33 1.36
VEL2   2.0  .72 1.47 1.97 1.99 1.74 2.10 1.76 1.73 1.80 1.65 1.57 1.46
VEL2   2.0 1.38 1.17 1.37 1.43 1.40
CAL3   2.0     93.96     80.00
VEL3   2.0                                .25  .30  .07  .65 1.16  .98
VEL3   2.0  .44 1.21 1.47 1.36 1.25 1.41 1.44 1.33 1.34 1.11  .89  .76
VEL3   2.0  .89  .87  .87 1.08
XSEC   3.0     100.0 .50     92.13    .00250
       3.0 -5.0100.3  0.097.03  2.095.43  3.4 94.9  5.094.04  8.092.89
       3.0 11.091.99 14.0 91.3 17.091.54 20.091.79 23.091.84 26.091.79
       3.0 29.091.84 32.092.24 35.092.54 38.092.34 41.092.35 44.0 92.8
       3.0 47.093.17 50.093.22 53.093.15 56.093.86 59.094.01 62.0 93.9
       3.0 65.094.04 68.094.21 70.0 94.9 72.095.53 73.296.23 81.0100.0
NS     3.0     87.80     87.80     87.80     87.80     98.50     98.50
NS     3.0     82.50     82.50     82.50     87.50     78.70     78.80
NS     3.0     78.80     78.90     78.90     78.90     72.80     72.80
NS     3.0     72.08     72.80     78.90     78.90     78.80     78.80
NS     3.0     72.80     72.80     76.70     78.60     78.60       .80
CAL1   3.0     94.90    293.00
VEL1   3.0                      .27  .69 1.91 2.31 2.13 2.42 2.95 3.19
VEL1   3.0 3.65 1.79 2.44 2.50 2.14 1.86 2.16 1.89 2.51 1.41 2.07 1.22
VEL1   3.0  .60 0.00
CAL2   3.0     94.32    131.00
VEL2   3.0                     0.00  .19 1.35 1.65 1.23 1.24 1.68 1.94
VEL2   3.0 1.93 1.14  .99 1.36 1.64 1.09 1.21  .75 1.27  .74  .53 1.01
```

Appendix B1 IFG4 Input Files (Continued)

```
VEL2   3.0  .56 0.00
CAL3   3.0     94.09     80.00
VEL3   3.0                     0.00  .14  .87  .94  .84 .91 1.20 1.45
VEL3   3.0 1.43 1.10  .78 1.16 1.05  .64 1.00  .21  .70            .91
VEL3   3.0 0.00
XSEC   4.0     135.0 .50     93.92    .00250
       4.0 -5.0100.1  0.096.33  2.6 95.9  4.0 95.5  7.094.55 10.094.43
       4.0 13.094.42 16.093.95 19.094.35 22.094.48 25.094.75 28.095.15
       4.0 31.094.23 34.094.32 37.094.38 40.094.35 43.093.98 46.094.17
       4.0 49.094.42 52.094.05 55.0 94.0 58.094.07 61.093.92 64.094.45
       4.0 67.094.55 70.094.72 73.095.05 77.8 95.9 80.096.73 82.598.03
       4.0 86.0100.1
NS     4.0     87.80     87.80     71.80     71.80     72.70     82.80
NS     4.0     87.70     87.60     78.80     87.50     87.50     87.50
NS     4.0     87.70     78.70     78.80     87.50     87.50     78.60
NS     4.0     78.50     78.60     87.80     78.80     87.50     87.50
NS     4.0     72.90     78.50     72.70     78.80     78.60     78.60
NS     4.0     00.80
CAL1   4.0     95.90    293.00
VEL1   4.0                0.00 1.24  .41 2.99 2.89 3.88 2.79 1.63 4.55
VEL1   4.0 3.51 1.66 2.10 2.79 2.39 3.41 2.01 1.72 2.74 4.79 3.71 2.66
VEL1   4.0 2.88 1.18 1.44
CAL2   4.0     95.35    131.00
VEL2   4.0                     1.11  .36 2.84 3.13 1.78 2.14 .214 2.58
VEL2   4.0 1.99 1.00  .97 1.59  .50 1.90 1.68 1.24 2.25 3.74 2.30 1.84
VEL2   4.0 1.81 1.19  .98
CAL3   4.0     95.20     80.00
VEL3   4.0                     1.02  .24 2.80 2.02 2.04 0.00 1.26
VEL3   4.0  .97 1.51  .79  .75 1.07 1.85 1.66 1.06  .34 3.33 2.42 0.00
VEL3   4.0 1.19  .15  .10
XSEC   5.0     274.0 .50     96.24    .00250
       5.0 -5.0103.2  0.099.47  2.098.87  4.998.28  8.097.26  9.097.17
       5.0 11.097.24 14.096.89 17.096.71 20.096.67 23.096.37 26.096.31
       5.0 29.096.24 32.096.27 35.096.31 38.096.97 41.097.41 44.096.64
       5.0 47.096.52 50.096.44 53.096.34 56.096.34 59.097.11 62.096.57
       5.0 65.097.51 68.096.67 71.096.67 74.096.34 77.096.34 80.097.98
       5.0 83.097.75 85.198.28 87.899.67 96.0103.2
NS     5.0       .80     88.80     88.80     18.50     85.90     86.80
NS     5.0     78.50     87.50     87.50     87.50     87.50     87.50
NS     5.0     87.50     87.50     87.80     87.80     87.50     87.50
NS     5.0     87.50     78.50     78.50     78.50     78.50     78.50
NS     5.0     87.50     72.70     87.50     82.60     82.70     82.80
NS     5.0     82.80     85.80     87.80       .80
CAL1   5.0     98.28    293.00
VEL1   5.0                      .09 1.69  .45 3.27 1.88 1.73 3.75 5.07
VEL1   5.0 2.51 2.97 2.82 3.01 3.38 3.20 2.31 2.73 3.22 3.04 3.61 1.94
VEL1   5.0 1.93 2.19 1.56 1.31 1.63  .96  .83
CAL2   5.0     97.76    131.00
VEL2   5.0                     0.00  .46 1.08 1.78  .18 1.49 2.05 2.76
VEL2   5.0 1.91 1.69 2.38 1.70 0.00 2.29 1.95 2.30 2.71  .79 2.44  .36
VEL2   5.0  .48 1.05 1.42 1.18  .89      0.00
```

Appendix B1 IFG4 Input Files (Continued)

```
CAL3   5.0     97.58     80.00
VEL3   5.0                     0.00  .43  .12 1.01  .30  .58 1.52 2.39
VEL3   5.0 1.61 1.21 2.73 1.05 0.00 2.06 1.10 2.09 2.04 0.00 1.70 1.29
VEL3   5.0  .10  .54  .79  .92  .70
XSEC   6.0     350.0 .50     98.22    .00250
       6.0 -8.0103.2  0.0101.2  2.0100.7 3.65100.8  5.0100.3  7.599.67
       6.0 10.099.02 12.598.66 15.098.59 17.598.39 20.098.44 22.598.22
       6.0 25.098.52 27.598.39 30.098.22 32.598.56 35.098.44 37.598.51
       6.0 40.098.91 42.598.62 45.099.01 47.598.94 50.098.97 52.599.14
       6.0 55.098.76 57.598.92 60.098.77 62.598.75 65.0100.2 67.5100.3
       6.0 70.0101.0 72.5100.7 74.2100.8 76.0101.3 77.4101.7 79.0103.2
NS     6.0     87.90     87.90     87.90     28.50     22.90     28.70
NS     6.0     82.50     87.50     86.70     85.80     87.60     86.70
NS     6.0     82.70     72.80     72.80     78.50     72.80     78.50
NS     6.0     87.50     78.70     72.80     78.50     78.50     78.80
NS     6.0     67.50     76.50     68.70     87.80     87.90     78.50
NS     6.0     81.80     72.80     61.50     87.80     87.80       .80
CAL1   6.0    100.75    293.00
VEL1   6.0                     0.00  .26 1.67 2.30 2.52 3.13 2.49 2.95
VEL1   6.0 2.44 2.71 3.09 2.65 2.03 2.19 2.55 2.70 2.88 2.52 2.35 1.94
VEL1   6.0 3.04 2.77 2.47 2.19 1.47 0.00 0.00  .15
CAL2   6.0    100.13    131.00
VEL2   6.0                          0.00  .99 1.56 1.26 2.39 1.73 1.66
VEL2   6.0 1.48 1.92 1.52 1.46 1.65 1.70 1.73 1.67 1.91 1.56 1.15 1.23
VEL2   6.0 2.13 1.85 1.66  .96
CAL3   6.0     99.89     80.00
VEL3   6.0                          0.00 1.00 0.00 1.43 2.01 1.70 1.10
VEL3   6.0  .93 1.33 1.13 1.24 1.08 1.33 1.61 1.50 1.19  .97  .77  .71
VEL3   6.0 1.36 1.26 1.32 0.00
ENDJ
```

Appendix B1 IFG4 Input Files (Continued)

Mad River at River Mile 1.0

```
Mad River at RM 1.0 measured on 7-14-92, 8-11-92, and 10-7-92
at flows of 40.1, 21.3, and 15.8 cfs, respectively.
IOC       01000002000010000 10 1
QARD 100.0
QARD  95.0
QARD  90.0
QARD  85.0
QARD  80.0
QARD  75.0
QARD  70.0
QARD  67.5
QARD  65.0
QARD  62.5
QARD  60.0
QARD  57.5
QARD  55.0
QARD  52.5
QARD  50.0
QARD  47.5
QARD  45.0
QARD  42.5
QARD  40.0
QARD  37.5
QARD  35.0
QARD  32.5
QARD  30.0
QARD  27.5
QARD  25.0
QARD  22.5
QARD  20.0
QARD  17.5
QARD  15.0
QARD  12.5
XSEC   1.0       5.5 .50     92.75    .00250
       1.0 -3.0100.2  0.098.15  4.096.95  6.994.12  8.093.92 10.093.63
       1.0 11.093.36 12.093.24 14.092.88 16.092.83 18.093.16 19.093.73
       1.0 20.092.48 21.091.96 22.091.84 23.091.73 24.091.58 25.091.41
       1.0 27.091.21 29.091.56 31.091.92 33.091.94 35.091.64 37.091.74
       1.0 39.092.48 41.092.74 43.093.58 45.494.12 47.094.85 49.095.35
       1.0 64.0101.4
NS     1.0     88.80     88.80     88.80     87.90     87.90     78.80
NS     1.0     78.50     87.50     87.50     72.80     87.50     87.50
NS     1.0     78.80     68.80     68.90     72.80     72.70     72.60
NS     1.0     83.70     48.80     52.80     52.80     25.70     28.60
NS     1.0     78.50     78.50     87.80     18.50       .80       .80
NS     1.0       .80
CAL1   1.0     94.12     40.10
VEL1   1.0 0.00               0.00  .18 1.21  .19  .28  .18 1.38 1.43
VEL1   1.0 1.84  .89 1.80 2.24 1.48  .55  .58  .30  .41  .52 0.00 0.00
```

Appendix B1 IFG4 Input Files (Continued)

```
VEL1   1.0  .29 1.11 0.00
CAL2   1.0     93.81     21.30
VEL2   1.0                           .07  .50  .24  .04  .05 0.00 0.00
VEL2   1.0  .79  .50  .93 1.77 1.06  .28  .53  .23  .07  .01 0.00 0.00
VEL2   1.0 0.00  .60 0.00
CAL3   1.0     93.80     15.80
VEL3   1.0                           .02  .41  .16 0.00  .12  .53  .41
VEL3   1.0 1.10  .27  .68  .82  .43  .13  .28  .23  .08  .12 0.00 0.00
VEL3   1.0 0.00  .49 0.00
XSEC   2.0      11.0 .50     93.95    .00250
       2.0 -3.0100.6  0.098.15  9.096.55 13.494.96 15.094.56 17.093.86
       2.0 19.093.46 20.093.36 21.093.66 22.093.66 23.093.66 25.093.66
       2.0 26.093.76 27.094.26 28.094.06 29.093.96 30.094.16 31.094.16
       2.0 32.094.06 33.093.86 34.093.66 35.093.66 36.094.16 37.094.16
       2.0 38.093.36 39.093.46 41.093.66 43.094.66 47.094.76 49.094.96
       2.0 50.095.85 51.698.25 53.6100.3
NS     2.0     88.80     88.80     88.80     81.90     81.90     82.90
NS     2.0     38.50     76.50     76.50     76.50     76.50     76.50
NS     2.0     78.80     82.80     87.90     78.70     78.80     78.50
NS     2.0     87.50     87.50     87.80     87.80     87.80     86.80
NS     2.0     86.90     87.70     28.50     82.80     81.80     81.80
NS     2.0     88.80     88.80       .80
CAL1   2.0     94.96     40.10     40.10
VEL1   2.0                      0.00  .10  .48 1.29 1.32 2.55 3.94 3.50
VEL1   2.0 3.16  .45  .94 3.23  .43  .26  .40  .53 3.06 1.48 4.33 3.67
VEL1   2.0 2.55  .46  .20 1.71 0.00
CAL2   2.0     94.68     21.30     21.30
VEL2   2.0
VEL2   2.0
VEL2   2.0
CAL3   2.0     94.60     15.80     15.80
VEL3   2.0
VEL3   2.0
VEL3   2.0
XSEC   3.0      11.0 .50     93.95    .00250
       3.0 -6.0101.5  0.098.45  7.0102.0 10.099.35 21.3 95.4 22.0 94.3
       3.0 24.0 94.3 26.0 94.1 27.0 93.9 28.0 93.7 29.0 93.5 30.0 92.8
       3.0 31.0 92.8 32.0 93.6 33.0 93.2 34.0 93.4 35.0 93.1 36.0 93.2
       3.0 37.0 93.2 38.0 93.1 39.0 93.1 41.0 93.9 43.0 94.2 46.0 95.0
       3.0 47.0 94.7 49.0 95.4 51.096.25 52.396.85 55.0103.5
NS     3.0     88.80       .80     83.90     83.90     83.90     88.90
NS     3.0     88.90     88.90     28.50     82.50     83.90     82.90
NS     3.0     86.90     82.60     82.60     82.70     82.80     88.90
NS     3.0     88.90     87.80     87.90     86.90     88.90     88.90
NS     3.0     88.90     83.90     83.90     83.90       .80
CAL1   3.0     95.40     40.10     40.10
VEL1   3.0                           .29  .30  .34  .54  .40  .38  .66
VEL1   3.0  .26  .32  .20 2.50 3.17 2.48 2.06 1.64  .26 -.14 0.00 1.92
VEL1   3.0 2.79
CAL2   3.0     95.06     21.30     21.30
VEL2   3.0
```

Appendix B1 IFG4 Input Files (Continued)

```
VEL2   3.0
VEL2   3.0
CAL3   3.0     95.01     15.80     15.80
VEL3   3.0
VEL3   3.0
VEL3   3.0
XSEC   4.0      11.0 .50     97.08    .00250
       4.0 -9.5102.1  0.098.45  1.398.35  2.597.83  4.097.65  6.097.53
       4.0  8.097.51 10.097.51 12.097.6  14.097.83 16.097.5  18.097.9
       4.0 20.098.05 22.098.15 24.098.25 26.098.25 28.098.15 30.098.15
       4.0 32.097.96 34.097.86 36.097.45 40.097.45 42.097.38 44.097.25
       4.0 44.097.08 46.097.28 48.097.87 49.097.94 50.098.25 52.7100.4
       4.0 54.0103.5
NS     4.0     88.80       .80       .80     12.50     28.60     32.80
NS     4.0     34.90     34.90     34.90     36.90     63.60     52.60
NS     4.0     46.50     52.70     56.80     56.80     56.60     56.50
NS     4.0     65.60     65.80     65.70     65.70     65.50     65.50
NS     4.0     65.50     58.50     87.80     87.80     87.80     88.80
NS     4.0     82.50
CAL1   4.0     98.35     40.10
VEL1   4.0                -.31 -.41  .21  .78 1.74 1.13  .20 0.00 -.14
VEL1   4.0 -.14 0.00 0.00 0.00  .42  .85  .86 1.52 1.94 2.24 3.11 3.20
VEL1   4.0 2.55 2.26  .18 0.00 0.00
CAL2   4.0     98.02     21.30
VEL2   4.0                0.00  .18  .41  .77  .76  .51  .28  .06 0.00
VEL2   4.0                                 .33 1.30 1.96 1.82 2.99 3.03
VEL2   4.0 1.87 1.57 0.00 0.00
CAL3   4.0     97.97     15.80
VEL3   4.0                0.00 0.00  .15  .22 0.00  .25 0.00  .14 0.00
VEL3   4.0                                0.00  .69 1.45 1.63 2.56 2.76
VEL3   4.0 1.98 1.23 0.00 0.00
XSEC   5.0      11.0 .50     98.66    .00250
       5.0 -3.0103.3  0.0100.3  2.099.66  3.999.72  5.099.32  7.098.47
       5.0  9.0 97.9 11.097.17 12.097.22 13.097.33 14.097.63 15.0 97.8
       5.0 16.098.27 17.098.28 18.098.55 19.098.63 20.098.57 22.0 98.9
       5.0 24.098.87 26.099.46 28.099.22 30.099.13 32.099.43 34.099.43
       5.0 36.099.45 38.099.47 40.099.52 42.099.62 42.899.72
NS     5.0     88.80     88.80     88.80     88.80     82.90     82.90
NS     5.0     82.80     72.90     72.90     78.90     78.90     78.90
NS     5.0     67.50     67.90     67.80     67.80     67.80     67.50
NS     5.0     67.50     67.50     67.60     67.60     67.60     67.50
NS     5.0     67.50     67.50     65.80     65.90     62.60
CAL1   5.0     99.72     40.10
VEL1   5.0                     0.00 -.10  .15 1.23 1.69 2.45 2.25 1.43
VEL1   5.0 1.97 2.47 2.24 1.85 1.65 1.04  .62  .28  .76  .47  .31  .34
VEL1   5.0  .26 0.00 0.00 0.00
CAL2   5.0     99.58     21.30
VEL2   5.0                     0.00 -.14 0.00  .58 1.23 1.56  .89  .89
VEL2   5.0 1.72 1.61 1.49 1.02 1.05  .79  .50       .38  .26 0.00  .10
VEL2   5.0 0.00
CAL3   5.0     99.50     15.80
```

Appendix B1 IFG4 Input Files (Continued)

```
VEL3   5.0                         0.00  .10  .44  .96  .87 1.18  .61
VEL3   5.0 1.39 1.09 1.19  .64  .81  .47  .25       .12  .20      0.00
VEL3   5.0 0.00
XSEC   6.0      11.0 .50     98.66    .00250
       6.0 -3.0103.3  0.0100.3  1.399.74  2.499.61  4.097.88  5.097.66
       6.0  6.0 98.0  7.0 97.8  8.098.28  9.098.33 11.098.66 13.098.61
       6.0 15.098.83 17.0 98.9 19.098.85 21.099.08 23.099.31 25.099.46
       6.0 29.099.52 31.099.59 33.099.54 37.099.69 41.099.69 43.199.74
       6.0 45.699.96 55.0101.9
NS     6.0       .80       .80     15.90       .50       .50       .50
NS     6.0     88.80     88.80     76.50     67.80     67.80     67.60
NS     6.0     68.90     75.80     67.80     67.50     67.50     67.50
NS     6.0     76.70     76.70     76.70     76.50     65.80     12.50
NS     6.0       .80       .80
CAL1   6.0     99.74     40.10
VEL1   6.0                    2.72 3.23  .31 -.15  .65 2.83 2.51 2.43
VEL1   6.0 2.10 1.51  .98  .78  .80  .25  .24  .57  .16  .10  .10
VEL1   6.0
CAL2   6.0     99.59     21.30
VEL2   6.0                    2.31 2.09  .11 -.23  .15 2.07 2.06 1.28
VEL2   6.0  .94 1.02  .63  .62  .41  .05 0.00
VEL2   6.0
CAL3   6.0     99.51     15.80
VEL3   6.0                    1.48 1.18  .12  .10  .21 1.61 1.76 1.08
VEL3   6.0  .87  .78  .53  .45  .28 0.00
VEL3   6.0
XSEC   7.0      11.0 .34     98.66    .00250
       7.0 -3.0104.0  0.0103.0  2.0 99.3  4.098.94  6.0 98.7  7.098.75
       7.0  8.098.64  9.0 98.6 10.098.67 12.098.67 14.098.84 15.098.89
       7.0 16.098.77 17.098.74 18.098.69 19.099.19 20.099.32 22.099.45
       7.0 24.099.35 26.0 99.3 28.0 99.5 30.0 99.7 32.099.64 46.0100.6
       7.0 59.0102.0
NS     7.0       .80       .80     88.80     58.70     68.60     68.90
NS     7.0     68.90     68.80     67.70     68.80     78.70     68.60
NS     7.0     78.60     78.60     78.50     78.50     78.50     87.50
NS     7.0     68.80     67.60     67.50     75.80     76.80       .80
NS     7.0       .80
CAL1   7.0     99.79     40.10
VEL1   7.0            .64 2.05 2.92 3.35 3.97 3.14 1.40  .06 1.09 1.69
VEL1   7.0 2.52 2.08 3.75 3.21 1.52  .42  .34 1.20  .63  .70  .64
VEL1   7.0
CAL2   7.0     99.65     21.30
VEL2   7.0            .47 2.42 2.51 2.31 3.32 3.01 1.84  .15 1.41 1.40
VEL2   7.0 1.43 1.97 2.70  .84  .16  .10  .10  .57 0.00
VEL2   7.0
CAL3   7.0     99.57     15.80
VEL3   7.0           0.00 2.01 2.02 2.40 2.90 2.82 1.35  .11 1.05 1.12
VEL3   7.0 1.36 1.55 1.91 1.44 -.56 0.00 0.00 0.00
VEL3   7.0
XSEC   8.0      16.2 .25     99.55    .00250
       8.0 -3.0104.6  0.0102.0  2.4100.6  4.0100.5  5.0100.2  6.099.75
```

Appendix B1 IFG4 Input Files (Continued)

```
       8.0  8.099.55 10.099.65 12.099.85 14.099.85 16.0100.3 18.099.87
       8.0 20.099.85 22.0100.0 24.0100.2 26.0100.4 28.0100.4 29.0100.6
       8.0 30.8100.8 34.0101.4 44.0103.4
NS     8.0     88.50     88.50     88.80     82.90     82.90     82.90
NS     8.0     87.50     78.80     78.90     78.60     78.60     76.90
NS     8.0     78.90     78.80     78.90     78.90     76.70     76.50
NS     8.0     76.50       .80       .80
CAL1   8.0    100.87     40.10
VEL1   8.0                -.10 -.03  .12  .45  .61 2.60 3.77 2.01 2.37
VEL1   8.0 2.90 1.24 1.08 2.93  .99  .79
CAL2   8.0    100.62     21.30
VEL2   8.0                -.18 0.00  .05  .47  .58 1.75 2.58 2.14 2.08
VEL2   8.0 2.60 1.30  .18 2.50  .80
CAL3   8.0    100.61     15.80
VEL3   8.0                0.00 -.10 0.00  .30  .53 1.78 2.53 1.15 2.78
VEL3   8.0 1.87  .64  .79 2.48 0.00
ENDJ
```

Appendix B2 Summary of Calibration Details

Lower Entiat River
Calibration Information for Calculated Discharges

Transect Number	1	2	3	4	5	6
Discharge						
	275.531	298.145	306.117	275.756	299.921	299.88
	138.643	145.584	133.805	118.646	123.532	128.202
	80.256	85.974	82.376	73.893	79.538	77.576
Stage						
	94.29	94.67	94.9	95.9	98.28	100.75
	93.73	94.16	94.32	95.35	97.76	100.13
	93.49	93.96	94.09	95.2	97.58	99.89
Plotting Stage						
	2.25	2.54	2.77	1.98	2.04	2.53
	1.69	2.03	2.19	1.43	1.52	1.91
	1.456	1.83	1.96	1.28	1.34	1.67
Ratio of Measured vs. Predicted Discharge						
	0.974	0.973	0.987	0.978	0.992	0.985
	1.078	1.089	1.042	1.09	1.027	1.049
	0.952	0.944	0.973	0.938	0.981	0.968
Mean Error of stage/discharge relationship for calculated Q						
	4.99	5.62	2.72	5.68	1.78	3.14
Mean Error of stage/discharge relationship for given Q						
	1.75	3.49	3.25	6.66	4.35	3.12
Stage/discharge relationship (S vs. Q) S = A*QB + SZF**						
A =	0.29	0.5401	0.6004	0.2872	0.3924	0.4152
B =	0.3629	0.2704	0.2665	0.3422	0.3192	0.3174
SZF =	92.04	92.13	92.13	93.92	96.24	0.9822
Beta coefficient log/log discharge/stage relationship						
	2.936	3.698	3.753	2.922	3.133	3.15

Appendix B2 Summary of Calibration Details (Continued)

Upper Entiat River
Calibration Information for Calculated Discharges

Transect Number	1	2	3	4	5	6
Discharge						
	180.35	254.24	163.52	164.111	161.218	165.6
	146.058	191.809	128.425	116.139	115.813	122.5
	64.583	100.657	60.4387	48.034	50.679	59.22
Stage						
	97.44	98.44	98.44	98.48	98.49	98.53
	97.2	98.22	98220	98.27	98.28	98.31
	96.86	97.89	97.89	97.91	97.94	97.96
Plotting Stage						
	1.68	2.68	1.78	1.82	1.83	1.87
	1.44	2.46	1.56	1.61	1.62	1.65
	1.1	2.13	1.23	1.25	1.28	1.3
Ratio of Measured vs. Predicted Discharge						
	0.935	0.97	0.954	0.976	0.973	0.978
	1.112	1.042	1.077	1.036	1.042	1.034
	0.962	0.985	0.974	0.989	0.986	0.988
Mean Error of stage/discharge relationship for calculated Q						
	6.99	2.76	4.88	2.35	2.83	2.24
Mean Error of stage/discharge relationship for given Q						
	3.99	4.54	3.77	2.3	3	3.16
Stage/discharge relationship (S vs. Q) S = A*QB + SZF**						
A =	0.203523	0.6852	0.27415	0.3857	0.3847	0.31
B =	0.4011	0.2451	0.3636	0.3027	0.305429	0.35
SZF =	95.76	95.76	96.66	96.66	96.66	96.66
Beta coefficient log/log discharge/stage relationship						
	2.493	4.08	2.75	3.303	3.274	2.858

Appendix B2 Summary of Calibration Details (Continued)

Mad River
Calibration Information for Calculated Discharges

Transect Number	1	2*	3*	4	5	6	7	8
Discharge								
	38	52	38	36	40	40	40	36
	16	21	21	19	22	22	28	20
	12	16	16	13	16	16	20	18
Stage								
	94.12	94.96	95.4	98.35	99.72	99.74	99.79	100.87
	93.81	94.68	95.06	98.02	99.58	99.59	99.65	100.62
	93.8	94.6	95.01	97.97	99.5	99.51	99.57	100.61
Plotting Stage								
	1.37	1.01	1.45	1.27	1.06	1.08	1.13	1.32
	1.06	0.73	1.11	0.94	0.92	0.93	0.99	1.07
	1.05	0.65	1.06	0.89	0.84	0.85	0.91	1.06
Ratio of Measured vs. Predicted Discharge								
	0.994	1.003	0.986	0.982	1.012	1.002	0.99	0.998
	1.173	0.99	1.101	1.12	0.97	0.995	1.026	1.056
	0.857	1.008	0.921	0.906	1.019	1.003	0.985	0.949
Mean Error of stage/discharge relationship for calculated Q								
	10.65	0.69	6.39	7.76	2.04	0.34	1.69	3.64
Mean Error of stage/discharge relationship for given Q								
	9.17	2.2	6.13	7.76	2.88	2.23	2.8	9
Stage/discharge relationship (S vs. Q) S = A*QB + SZF**								
A =	0.5443	0.2369	0.3568	0.3156	0.4263	0.4115	0.3338	0.3906
B =	0.2528	0.3666	0.3831	0.3856	0.2469	0.2622	0.3309	0.3402
SZF =	92.75	93.95	93.95	97.08	98.66	98.66	98.66	99.55
Beta coefficient log/log discharge/stage relationship								
	3.96	2.73	2.61	2.59	4.05	3.81	3.02	2.94

*Indicates a 1-flow model was run for this transect

Appendix B3 Summary of Data Changes (Continued)

Appendix B3 Summary of Data Changes

Data Changes for Upper Entiat River Site

Cell Velocities Changed for Calibration

Transect	Vertical	Velocity	Change
1	26	3	0 to 0.1
3	5	3	.05 to 0
4	32	2	.14 to .08
4	35		changed N of .33 to 3

Data Changes for Lower Entiat River Site

Cell Velocities Changed for Calibration

Transect	Vertical	Velocity	Change
1	7	1	2.67 to 2.47
1	7	2	.65 to .85
1	17	3	.06 to 0
4	10	3	.24 to 0
4	21	1	2.94 to 2.74
4	24	3	.25 to 0
5	17	2	.34 to 0
5	17	3	.04 to 0
6	8	3	.26 to 0
6	28	3	.13 to 0

Data Changes for Mad River Site

Cell Velocities Changed for Calibration

Transect	Vertical	Velocity	Change
1	11	1	1.58 to 1.38
1	11	2	.02 to 0
1	11	3	.33 to .53
1	12	1	1.63 to 1.43
1	12	2	.12 to 0
1	12	3	.21 to .41
1	16	2	1.97 to 1.77
1	16	3	1.02 to .82
1	17	1	1.68 to 1.48
1	17	2	.86 to 1.06
1	17	3	.23 to .43
1	19	1	.38 to .58
1	19	2	.73 to .53
1	19	3	.48 to .28
1	20	1	.10 to .30
1	20	3	.43 to .23

Transect	Vertical	Velocity	Change
1	23	1	.12 to 0
1	24	1	.18 to 0
1	25	2	.04 to 0
1	26	1	1.31 to 1.11
1	26	2	.40 to .60
1	26	3	.29 to .49
4	8	3	.12 to 0
7	3	1	.84 to .64
7	3	2	.27 to .47
7	20	1	1.40 to 1.20
7	20	2	.37 to .57

Appendix B3 Summary of Data Changes (Continued)

Appendix B4 Velocity Adjustment Factors

Upper Entiat River at RM 16.2
Measured 164 cfs on 7-28-92, 121 cfs on 8-13-92, and 55 cfs on 10-6-92

Transect	Flow (cfs)	VAF
1.00	28.0	0.908
1.00	40.0	0.959
1.00	50.0	0.984
1.00	60.0	1.000
1.00	70.0	1.009
1.00	80.0	1.015
1.00	90.0	1.018
1.00	100.0	1.019
1.00	110.0	1.018
1.00	120.0	1.016
1.00	130.0	1.012
1.00	140.0	1.009
1.00	150.0	1.004
1.00	160.0	0.999
1.00	170.0	0.994
1.00	180.0	0.988
1.00	190.0	0.982
1.00	200.0	0.976
1.00	210.0	0.970
1.00	220.0	0.963
1.00	230.0	0.957
1.00	240.0	0.950
1.00	250.0	0.944
1.00	275.0	0.927
1.00	300.0	0.911
1.00	325.0	0.894
1.00	350.0	0.878
1.00	375.0	0.863
1.00	400.0	0.847
1.00	410.0	0.841
2.00	28.0	0.913
2.00	40.0	0.963
2.00	50.0	0.989
2.00	60.0	1.006
2.00	70.0	1.018
2.00	80.0	1.026
2.00	90.0	1.031
2.00	100.0	1.034
2.00	110.0	1.035
2.00	120.0	1.035
2.00	130.0	1.033
2.00	140.0	1.032
2.00	150.0	1.029
2.00	160.0	1.026

Transect	Flow (cfs)	VAF
2.00	170.0	1.023
2.00	180.0	1.019
2.00	190.0	1.015
2.00	200.0	1.011
2.00	210.0	1.006
2.00	220.0	1.002
2.00	230.0	0.997
2.00	240.0	0.992
2.00	250.0	0.988
2.00	275.0	0.976
2.00	300.0	0.964
2.00	325.0	0.952
2.00	350.0	0.940
2.00	375.0	0.928
2.00	400.0	0.917
2.00	410.0	0.912
3.00	28.0	0.901
3.00	40.0	0.941
3.00	50.0	0.963
3.00	60.0	0.978
3.00	70.0	0.988
3.00	80.0	0.994
3.00	90.0	0.999
3.00	100.0	1.002
3.00	110.0	1.003
3.00	120.0	1.003
3.00	130.0	1.002
3.00	140.0	1.000
3.00	150.0	0.997
3.00	160.0	0.994
3.00	170.0	0.990
3.00	180.0	0.986
3.00	190.0	0.981
3.00	200.0	0.976
3.00	210.0	0.970
3.00	220.0	0.965
3.00	230.0	0.959
3.00	240.0	0.953
3.00	250.0	0.947
3.00	275.0	0.931
3.00	300.0	0.914
3.00	325.0	0.897
3.00	350.0	0.880
3.00	375.0	0.862

Appendix B4 Velocity Adjustment Factors (Continued)

3.00	400.0	0.844
3.00	410.0	0.837

Transect	**Flow (cfs)**	**VAF**
4.00	28.0	0.810
4.00	40.0	0.868
4.00	50.0	0.899
4.00	60.0	0.920
4.00	70.0	0.936
4.00	80.0	0.947
4.00	90.0	0.955
4.00	100.0	0.961
4.00	110.0	0.964
4.00	120.0	0.965
4.00	130.0	0.966
4.00	140.0	0.966
4.00	150.0	0.965
4.00	160.0	0.963
4.00	170.0	0.961
4.00	180.0	0.959
4.00	190.0	0.956
4.00	200.0	0.953
4.00	210.0	0.950
4.00	220.0	0.946
4.00	230.0	0.942
4.00	240.0	0.938
4.00	250.0	0.934
4.00	275.0	0.923
4.00	300.0	0.912
4.00	325.0	0.900
4.00	350.0	0.888
4.00	375.0	0.876
4.00	400.0	0.863
4.00	410.0	0.858
5.00	28.0	0.941
5.00	40.0	0.974
5.00	50.0	0.990
5.00	60.0	1.000
5.00	70.0	1.006
5.00	80.0	1.010
5.00	90.0	1.012
5.00	100.0	1.012
5.00	110.0	1.011
5.00	120.0	1.009
5.00	130.0	1.007
5.00	140.0	1.003
5.00	150.0	1.000
5.00	160.0	0.996
5.00	170.0	0.991
5.00	180.0	0.987
5.00	190.0	0.982
5.00	200.0	0.977

5.00	210.0	0.971
5.00	220.0	0.966

Transect	**Flow (cfs)**	**VAF**
5.00	230.0	0.960
5.00	240.0	0.954
5.00	250.0	0.949
5.00	275.0	0.934
5.00	300.0	0.918
5.00	325.0	0.902
5.00	350.0	0.886
5.00	375.0	0.870
5.00	400.0	0.854
5.00	410.0	0.847
6.00	28.0	0.964
6.00	40.0	0.984
6.00	50.0	0.993
6.00	60.0	0.999
6.00	70.0	1.003
6.00	80.0	1.006
6.00	90.0	1.007
6.00	100.0	1.007
6.00	110.0	1.006
6.00	120.0	1.005
6.00	130.0	1.004
6.00	140.0	1.002
6.00	150.0	1.000
6.00	160.0	0.998
6.00	170.0	0.995
6.00	180.0	0.992
6.00	190.0	0.990
6.00	200.0	0.987
6.00	210.0	0.983
6.00	220.0	0.980
6.00	230.0	0.977
6.00	240.0	0.974
6.00	250.0	0.970
6.00	275.0	0.962
6.00	300.0	0.953
6.00	325.0	0.944
6.00	350.0	0.935
6.00	375.0	0.925
6.00	400.0	0.916
6.00	410.0	0.913

Appendix B4 Velocity Adjustment Factors (Continued)

Lower Entiat River at River Mile 1.0

Measured 7-21-92 at 290 cfs, 8-12-92 at 140 cfs, and 10-7-92 at 80 cfs

Transect	Flow (cfs)	VAF
1.00	725.0	0.882
1.00	700.0	0.889
1.00	650.0	0.902
1.00	600.0	0.915
1.00	550.0	0.929
1.00	500.0	0.943
1.00	450.0	0.957
1.00	400.0	0.971
1.00	375.0	0.978
1.00	350.0	0.985
1.00	325.0	0.991
1.00	300.0	0.998
1.00	275.0	1.003
1.00	250.0	1.008
1.00	225.0	1.012
1.00	200.0	1.015
1.00	175.0	1.017
1.00	160.0	1.017
1.00	150.0	1.016
1.00	140.0	1.015
1.00	130.0	1.013
1.00	120.0	1.011
1.00	110.0	1.005
1.00	90.0	0.990
1.00	80.0	0.979
1.00	70.0	0.967
1.00	60.0	0.952
1.00	50.0	0.944
1.00	40.0	0.913
1.00	32.0	0.883
2.00	725.0	0.944
2.00	700.0	0.947
2.00	650.0	0.954
2.00	600.0	0.961
2.00	550.0	0.968
2.00	500.0	0.974
2.00	450.0	0.979
2.00	400.0	0.984
2.00	375.0	0.987
2.00	350.0	0.989
2.00	325.0	0.991
2.00	300.0	0.993
2.00	275.0	0.994
2.00	250.0	0.995
2.00	225.0	0.996

Transect	Flow (cfs)	VAF
2.00	200.0	0.996
2.00	175.0	0.996
2.00	160.0	0.996
2.00	150.0	0.996
2.00	140.0	0.995
2.00	130.0	0.995
2.00	120.0	0.994
2.00	110.0	0.993
2.00	90.0	0.990
2.00	80.0	0.988
2.00	70.0	0.986
2.00	60.0	0.983
2.00	50.0	0.980
2.00	40.0	0.977
2.00	32.0	0.974
3.00	725.0	0.921
3.00	700.0	0.925
3.00	650.0	0.934
3.00	600.0	0.943
3.00	550.0	0.952
3.00	500.0	0.961
3.00	450.0	0.970
3.00	400.0	0.978
3.00	375.0	0.982
3.00	350.0	0.986
3.00	325.0	0.989
3.00	300.0	0.993
3.00	275.0	0.996
3.00	250.0	0.998
3.00	225.0	1.000
3.00	200.0	1.002
3.00	175.0	1.003
3.00	160.0	1.003
3.00	150.0	1.003
3.00	140.0	1.002
3.00	130.0	1.002
3.00	120.0	1.001
3.00	110.0	1.000
3.00	90.0	0.996
3.00	80.0	0.993
3.00	70.0	0.990
3.00	60.0	0.982
3.00	50.0	0.973

Appendix B4 Velocity Adjustment Factors (Continued)

Transect	Flow (cfs)	VAF
3.00	40.0	0.956
3.00	32.0	0.938
4.00	725.0	0.898
4.00	700.0	0.905
4.00	650.0	0.919
4.00	600.0	0.933
4.00	550.0	0.947
4.00	500.0	0.960
4.00	450.0	0.972
4.00	400.0	0.983
4.00	375.0	0.988
4.00	350.0	0.993
4.00	325.0	0.997
4.00	300.0	1.000
4.00	275.0	1.002
4.00	250.0	1.003
4.00	225.0	1.003
4.00	200.0	1.001
4.00	175.0	0.996
4.00	160.0	0.993
4.00	150.0	0.989
4.00	140.0	0.985
4.00	130.0	0.980
4.00	120.0	0.974
4.00	110.0	0.967
4.00	90.0	0.950
4.00	80.0	0.940
4.00	70.0	0.947
4.00	60.0	0.929
4.00	50.0	0.906
4.00	40.0	0.879
4.00	32.0	0.853
5.00	725.0	0.868
5.00	700.0	0.876
5.00	650.0	0.893
5.00	600.0	0.910
5.00	550.0	0.926
5.00	500.0	0.943
5.00	450.0	0.958
5.00	400.0	0.973
5.00	375.0	0.980
5.00	350.0	0.986
5.00	325.0	0.993
5.00	300.0	0.998
5.00	275.0	1.003
5.00	250.0	1.007
5.00	225.0	1.010
5.00	200.0	1.011

Transect	Flow (cfs)	VAF
5.00	175.0	1.011
5.00	160.0	1.009
5.00	150.0	1.006
5.00	140.0	1.003
5.00	130.0	0.999
5.00	120.0	0.995
5.00	110.0	0.989
5.00	90.0	0.975
5.00	80.0	0.966
5.00	70.0	0.957
5.00	60.0	0.943
5.00	50.0	0.924
5.00	40.0	0.892
5.00	32.0	0.859
6.00	725.0	1.016
6.00	700.0	1.015
6.00	650.0	1.014
6.00	600.0	1.014
6.00	550.0	1.013
6.00	500.0	1.012
6.00	450.0	1.010
6.00	400.0	1.009
6.00	375.0	1.008
6.00	350.0	1.006
6.00	325.0	1.005
6.00	300.0	1.003
6.00	275.0	1.001
6.00	250.0	0.998
6.00	225.0	0.995
6.00	200.0	0.992
6.00	175.0	0.989
6.00	160.0	0.986
6.00	150.0	0.985
6.00	140.0	0.983
6.00	130.0	0.980
6.00	120.0	0.976
6.00	110.0	0.973
6.00	90.0	0.964
6.00	80.0	0.959
6.00	70.0	0.954
6.00	60.0	0.949
6.00	50.0	0.943
6.00	40.0	0.937
6.00	32.0	0.932

Appendix B4 Velocity Adjustment Factors (Continued)

Mad River at RM 1.0 measured on 7-14-92, 8-11-92, and 10-7-92 at flows of 40.1, 21.3, and 15.8 cfs, respectively.

Transect	Flow (cfs)	VAF
1.00	100.0	0.810
1.00	95.0	0.827
1.00	90.0	0.843
1.00	85.0	0.858
1.00	80.0	0.874
1.00	75.0	0.889
1.00	70.0	0.903
1.00	67.5	0.910
1.00	65.0	0.917
1.00	62.5	0.923
1.00	60.0	0.930
1.00	57.5	0.935
1.00	55.0	0.941
1.00	52.5	0.945
1.00	50.0	0.950
1.00	47.5	0.953
1.00	45.0	0.956
1.00	42.5	0.959
1.00	40.0	0.960
1.00	37.5	0.960
1.00	35.0	0.958
1.00	32.5	0.955
1.00	30.0	0.950
1.00	27.5	0.943
1.00	25.0	0.933
1.00	22.5	0.920
1.00	20.0	0.902
1.00	17.5	0.879
1.00	15.0	0.849
1.00	12.5	0.818
2.00	100.0	1.485
2.00	95.0	1.452
2.00	90.0	1.418
2.00	85.0	1.383
2.00	80.0	1.346
2.00	75.0	1.308
2.00	70.0	1.268
2.00	67.5	1.247
2.00	65.0	1.226
2.00	62.5	1.205
2.00	60.0	1.182
2.00	57.5	1.160
2.00	55.0	1.136
2.00	52.5	1.112
2.00	50.0	1.087
2.00	47.5	1.061
2.00	45.0	1.034
2.00	42.5	1.006
2.00	40.0	0.976
2.00	37.5	0.945
2.00	35.0	0.912
2.00	32.5	0.877
2.00	30.0	0.840
2.00	27.5	0.800
2.00	25.0	0.758
2.00	22.5	0.712
2.00	20.0	0.663
2.00	17.5	0.609
2.00	15.0	0.549
2.00	12.5	0.485
3.00	100.0	1.351
3.00	95.0	1.331
3.00	90.0	1.311
3.00	85.0	1.289
3.00	80.0	1.266
3.00	75.0	1.242
3.00	70.0	1.217
3.00	67.5	1.203
3.00	65.0	1.189
3.00	62.5	1.175
3.00	60.0	1.160
3.00	57.5	1.144
3.00	55.0	1.128
3.00	52.5	1.112
3.00	50.0	1.094
3.00	47.5	1.076
3.00	45.0	1.057
3.00	42.5	1.037
3.00	40.0	1.016
3.00	37.5	0.991
3.00	35.0	0.965
3.00	32.5	0.937
3.00	30.0	0.907
3.00	27.5	0.876
3.00	25.0	0.841
3.00	22.5	0.804
3.00	20.0	0.763
3.00	17.5	0.719
3.00	15.0	0.665
3.00	12.5	0.600

Appendix B4 Velocity Adjustment Factors (Continued)

Transect	Flow (cfs)	VAF	Transect	Flow (cfs)	VAF
4.00	100.0	0.816	5.00	40.0	0.986
4.00	95.0	0.828	5.00	37.5	0.989
4.00	90.0	0.840	5.00	35.0	0.993
4.00	85.0	0.853	5.00	32.5	0.996
4.00	80.0	0.866	5.00	30.0	0.999
4.00	75.0	0.879	5.00	27.5	1.001
4.00	70.0	0.893	5.00	25.0	1.003
4.00	67.5	0.900	5.00	22.5	1.005
4.00	65.0	0.907	5.00	20.0	1.006
4.00	62.5	0.914	5.00	17.5	1.006
4.00	60.0	0.921	5.00	15.0	1.005
4.00	57.5	0.928	5.00	12.5	1.001
4.00	55.0	0.936	6.00	100.0	0.890
4.00	52.5	0.943	6.00	95.0	0.899
4.00	50.0	0.950	6.00	90.0	0.908
4.00	47.5	0.957	6.00	85.0	0.917
4.00	45.0	0.965	6.00	80.0	0.926
4.00	42.5	0.972	6.00	75.0	0.934
4.00	40.0	0.978	6.00	70.0	0.943
4.00	37.5	0.985	6.00	67.5	0.947
4.00	35.0	0.990	6.00	65.0	0.952
4.00	32.5	0.994	6.00	62.5	0.956
4.00	30.0	0.997	6.00	60.0	0.960
4.00	27.5	0.997	6.00	57.5	0.964
4.00	25.0	0.995	6.00	55.0	0.969
4.00	22.5	0.991	6.00	52.5	0.973
4.00	20.0	0.985	6.00	50.0	0.977
4.00	17.5	0.978	6.00	47.5	0.981
4.00	15.0	0.971	6.00	45.0	0.985
4.00	12.5	0.963	6.00	42.5	0.990
5.00	100.0	0.898	6.00	40.0	0.994
5.00	95.0	0.905	6.00	37.5	0.997
5.00	90.0	0.913	6.00	35.0	1.001
5.00	85.0	0.920	6.00	32.5	1.004
5.00	80.0	0.928	6.00	30.0	1.007
5.00	75.0	0.935	6.00	27.5	1.009
5.00	70.0	0.942	6.00	25.0	1.011
5.00	67.5	0.946	6.00	22.5	1.012
5.00	65.0	0.950	6.00	20.0	1.009
5.00	62.5	0.954	6.00	17.5	1.004
5.00	60.0	0.957	6.00	15.0	0.996
5.00	57.5	0.961	6.00	12.5	0.982
5.00	55.0	0.965	7.00	100.0	0.836
5.00	52.5	0.968	7.00	95.0	0.853
5.00	50.0	0.972	7.00	90.0	0.870
5.00	47.5	0.976	7.00	85.0	0.887
5.00	45.0	0.979	7.00	80.0	0.903
5.00	42.5	0.983	7.00	75.0	0.919

Appendix B4 Velocity Adjustment Factors (Continued)

Transect	Flow (cfs)	VAF
7.00	70.0	0.934
7.00	67.5	0.942
7.00	65.0	0.949
7.00	62.5	0.956
7.00	60.0	0.963
7.00	57.5	0.969
7.00	55.0	0.976
7.00	52.5	0.982
7.00	50.0	0.988
7.00	47.5	0.993
7.00	45.0	0.998
7.00	42.5	1.003
7.00	40.0	1.007
7.00	37.5	1.010
7.00	35.0	1.013
7.00	32.5	1.015
7.00	30.0	1.016
7.00	27.5	1.016
7.00	25.0	1.013
7.00	22.5	1.008
7.00	20.0	1.001
7.00	17.5	0.991
7.00	15.0	0.976
7.00	12.5	0.955
8.00	100.0	0.987
8.00	95.0	0.988
8.00	90.0	0.988
8.00	85.0	0.989
8.00	80.0	0.990
8.00	75.0	0.991
8.00	70.0	0.992
8.00	67.5	0.993
8.00	65.0	0.993
8.00	62.5	0.994
8.00	60.0	0.994
8.00	57.5	0.995
8.00	55.0	0.996
8.00	52.5	0.996
8.00	50.0	0.997
8.00	47.5	0.997
8.00	45.0	0.998
8.00	42.5	0.999
8.00	40.0	1.000
8.00	37.5	1.001
8.00	35.0	1.002
8.00	32.5	1.003
8.00	30.0	1.004
8.00	27.5	1.005
8.00	25.0	1.006

Transect	Flow (cfs)	VAF
8.00	22.5	1.008
8.00	20.0	1.011
8.00	17.5	1.014
8.00	15.0	1.019
8.00	12.5	1.027

Appendix C Habitat Use Curve Data

FISHCRV for Entiat River, Approved by Department of Fisheries and Wildlife (Hal Beecher) 5-6-94

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H   101  9 10 67  0 Steelhead                    Spawning
V   101  0.00  0.00  1.00  0.00  1.60  0.44  2.50  0.97  2.90  1.00  3.25  1.00
V   101  3.80  0.62  6.00  0.00 100.0  0.00
D   101  0.00  0.00  0.65  0.00  0.85  0.44  1.00  1.00  1.50  1.00  1.90  0.73
D   101  2.30  0.58  3.70  0.06  6.00  0.06 100.0  0.00
S   101  0.00  0.00 16.50  0.50 16.90  0.10 20.50  0.00 23.90  0.05 24.50  0.50
S   101 24.90  0.10 26.50  0.50 26.90  0.10 27.50  0.15 27.90  0.03 28.50  0.00
S   101 29.90  0.00 32.50  0.25 32.90  0.45 37.50  0.40 37.90  0.48 40.50  0.50
S   101 40.90  0.90 44.90  1.00 46.90  1.00 52.50  0.50 52.90  0.90 54.50  1.00
S   101 56.90  1.00 57.50  0.65 57.90  0.93 62.50  0.50 62.90  0.90 64.50  1.00
S   101 66.90  1.00 67.50  0.65 67.90  0.93 68.50  0.50 68.90  0.90 69.50  0.50
S   101 69.90  0.90 72.50  0.15 72.90  0.27 73.50  0.40 73.90  0.32 75.50  0.65
S   101 75.90  0.37 76.50  0.65 76.90  0.37 77.50  0.30 77.90  0.30 78.50  0.15
S   101 78.90  0.27 79.50  0.15 79.90  0.27 80.50  0.00 82.90  0.00 85.50  0.50
S   101 85.90  0.10 86.50  0.50 86.90  0.10 87.50  0.15 87.90  0.03 88.50  0.00
S   101 92.90  0.00 96.50  0.50 96.90  0.10 97.50  0.15 97.90  0.03 98.50  0.00
S   101 100.0  0.00
H   102  8  8 90  0 Steelhead    (changed 5-6-94 D&V)       Juvenile
V   102  0.00  0.15  0.80  1.00  1.70  1.00  2.30  0.75  3.00  0.10  4.00  0.00
V   102  5.00  0.00  100.  0.00
D   102  0.00  0.00  0.70  0.00  1.30  0.24  1.80  0.44  2.10  1.00  4.00  1.00
D   102  5.00  1.00  100.  0.00
S   102  0.00  0.00  0.10  1.00  0.20  1.00  0.30  1.00  0.40  1.00  0.50  0.80
S   102  0.60  0.80  0.70  0.20  0.80  0.20  0.90  0.10 10.50  0.10 13.90  0.10
S   102 20.50  0.10 23.90  0.10 24.50  0.15 24.90  0.11 26.50  0.30 26.90  0.14
S   102 27.50  0.40 27.90  0.16 28.50  0.55 28.90  0.19 29.50  0.20 29.90  0.12
S   102 30.50  0.10 33.90  0.10 37.50  0.40 37.90  0.16 40.50  0.15 40.90  0.19
S   102 45.50  0.25 45.90  0.21 46.50  0.35 46.90  0.23 52.50  0.20 52.90  0.28
S   102 56.50  0.40 56.90  0.32 57.50  0.50 57.90  0.34 62.50  0.30 62.90  0.46
S   102 64.50  0.35 64.90  0.47 65.50  0.40 65.90  0.48 66.50  0.50 66.90  0.50
S   102 67.50  0.60 67.90  0.52 68.50  0.75 68.90  0.55 69.50  0.40 69.90  0.48
S   102 72.50  0.40 72.90  0.64 73.50  0.40 73.90  0.64 75.50  0.50 75.90  0.66
S   102 76.50  0.60 76.90  0.68 77.50  0.70 77.90  0.70 78.50  0.85 78.90  0.73
S   102 79.50  0.50 79.90  0.66 82.50  0.55 82.90  0.91 85.50  0.65 85.90  0.93
S   102 86.50  0.75 86.90  0.95 87.50  0.85 87.90  0.97 88.50  1.00 88.90  1.00
S   102 89.50  0.65 89.90  0.93 92.50  0.20 92.90  0.30 96.50  0.30 96.90  0.32
S   102 97.50  0.50 97.90  0.34 98.50  0.65 98.90  0.37 99.50  0.30 100.0  0.30
H   201  7  7 64  0 Bull Trout                   Spawning
V   201  0.00  1.00  0.55  1.00  0.80  0.84  1.20  0.76  1.80  0.53  4.50  0.00
V   201 100.0  0.00
D   201  0.00  0.00  0.39  0.00  0.65  1.00  0.85  1.00  1.70  0.91 10.00  0.91
D   201 100.0  0.00
S   201  0.00  0.00 10.50  0.00 13.90  0.10 16.50  0.25 16.90  0.05 20.50  0.00
S   201 23.90  0.10 24.50  0.50 24.90  0.10 26.50  0.25 26.90  0.05 27.50  0.00
S   201 29.90  0.00 32.50  0.50 32.90  0.90 37.50  0.50 37.90  0.90 40.50  0.50
S   201 40.90  0.90 45.50  1.00 45.90  1.00 46.50  0.75 46.90  0.95 52.50  0.50
S   201 52.90  0.90 56.50  0.75 56.90  0.95 57.50  0.50 57.90  0.90 62.50  0.25
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S   201 62.90  0.45 64.50  0.75 64.90  0.55 65.50  0.75 65.90  0.55 66.50  0.50
S   201 66.90  0.50 67.50  0.25 67.90  0.45 68.50  0.25 68.90  0.45 69.50  0.25
S   201 69.90  0.45 70.50  0.00 72.90  0.00 73.50  0.50 73.90  0.10 75.50  0.50
S   201 75.90  0.10 76.50  0.25 76.90  0.05 77.50  0.00 77.90  0.00 82.90  0.00
S   201 85.50  0.50 85.90  0.10 86.50  0.25 86.90  0.05 87.50  0.00 92.90  0.00
S   201 96.50  0.25 96.90  0.05 97.50  0.00 100.0  0.00
H   202  6  7 90  0 Bull Trout                        Juvenile
V   202  0.00  0.13  0.35  0.19  1.30  1.00  3.20  1.00  6.03  0.00 100.0  0.00
D   202  0.00  0.00  0.49  0.00  0.60  0.02  0.85  0.11  1.00  1.00  5.00  1.00
D   202 100.0  0.00
S   202  0.00  0.00  0.10  1.00  0.20  1.00  0.30  1.00  0.40  1.00  0.50  0.80
S   202  0.60  0.80  0.70  0.20  0.80  0.20  0.90  0.10 10.50  0.10 13.90  0.10
S   202 20.50  0.10 23.90  0.10 24.50  0.15 24.90  0.11 26.50  0.30 26.90  0.14
S   202 27.50  0.40 27.90  0.16 28.50  0.55 28.90  0.19 29.50  0.20 29.90  0.12
S   202 30.50  0.10 33.90  0.10 37.50  0.40 37.90  0.16 40.50  0.15 40.90  0.19
S   202 45.50  0.25 45.90  0.21 46.50  0.35 46.90  0.23 52.50  0.20 52.90  0.28
S   202 56.50  0.40 56.90  0.32 57.50  0.50 57.90  0.34 62.50  0.30 62.90  0.46
S   202 64.50  0.35 64.90  0.47 65.50  0.40 65.90  0.48 66.50  0.50 66.90  0.50
S   202 67.50  0.60 67.90  0.52 68.50  0.75 68.90  0.55 69.50  0.40 69.90  0.48
S   202 72.50  0.40 72.90  0.64 73.50  0.40 73.90  0.64 75.50  0.50 75.90  0.66
S   202 76.50  0.60 76.90  0.68 77.50  0.70 77.90  0.70 78.50  0.85 78.90  0.73
S   202 79.50  0.50 79.90  0.66 82.50  0.55 82.90  0.91 85.50  0.65 85.90  0.93
S   202 86.50  0.75 86.90  0.95 87.50  0.85 87.90  0.97 88.50  1.00 88.90  1.00
S   202 89.50  0.65 89.90  0.93 92.50  0.20 92.90  0.30 96.50  0.30 96.90  0.32
S   202 97.50  0.50 97.90  0.34 98.50  0.65 98.90  0.37 99.50  0.30 100.0  0.30
H   301  9  7 60  0 Chinook   Rivers (changed 5-6-94 sub)   Spawning
V   301  0.00  0.00  0.50  0.00  1.00  0.10  1.30  0.70  1.75  1.00  3.00  1.00
V   301  3.50  0.70  4.00  0.00 100.0  0.00
D   301  0.00  0.00  0.50  0.00  1.00  0.75  1.20  1.00  3.40  1.00  5.00  0.00
D   301 100.0  0.00
S   301  0.00  0.00 28.70  0.00 32.80  0.24 34.90  0.37 35.50  0.65 36.90  0.37
S   301 38.50  0.15 41.60  0.60 42.50  0.00 42.70  0.70 43.90  0.93 45.50  1.00
S   301 46.90  1.00 48.80  0.80 51.50  0.00 52.50  0.00 52.60  0.60 52.80  0.80
S   301 53.80  0.89 53.90  0.93 54.50  1.00 56.90  1.00 57.90  0.93 58.50  0.50
S   301 58.70  0.70 61.50  0.00 62.50  0.00 62.60  0.60 62.90  0.90 63.60  0.72
S   301 64.50  1.00 66.50  1.00 67.50  0.65 67.90  0.93 68.60  0.60 68.90  0.90
S   301 71.80  0.24 72.50  0.00 72.60  0.18 72.90  0.27 75.80  0.44 76.50  0.65
S   301 76.90  0.37 78.50  0.15 78.90  0.27 79.80  0.24 81.50  0.00 82.90  0.00
S   301 83.70  0.09 83.90  0.03 85.80  0.20 85.90  0.10 86.50  0.50 86.90  0.10
S   301 87.50  0.15 87.90  0.03 88.50  0.00 92.50  0.00 97.50  0.15 98.50  0.00
H   302  9  7 76    Chinook Rivers & Streams (5-6-94 sub)   Juvenile
V   302  0.00  0.30  0.50  1.00  0.90  1.00  1.80  0.60  2.20  0.15  3.60  0.00
V   302  5.00  0.00  6.00  0.00 100.0  0.00
D   302  0.00  0.00  0.49  0.00  0.80  0.28  1.20  0.75  1.60  1.00  5.00  1.00
D   302 100.0  1.00
S   302  0.00  0.00  0.10  1.00  0.40  1.00  0.50  0.80  0.60  1.00  0.70  0.10
S   302 12.90  0.10 14.50  0.20 15.90  0.12 16.80  0.18 16.90  0.14 18.50  0.55
S   302 18.90  0.19 21.90  0.10 25.90  0.12 26.60  0.26 26.80  0.18 27.70  0.28
S   302 28.50  0.55 28.70  0.37 32.80  0.10 34.90  0.12 35.50  0.20 36.90  0.14
S   302 38.50  0.55 41.60  0.22 45.50  0.30 46.50  0.40 46.90  0.32 48.80  0.44
S   302 51.50  0.30 52.50  0.20 54.50  0.30 54.80  0.30 56.50  0.40 56.90  0.32
S   302 57.90  0.34 58.50  0.65 58.70  0.51 61.50  0.30 62.50  0.30 62.90  0.46
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S   302 63.60  0.34 64.50  0.40 64.90  0.48 65.50  0.40 66.50  0.50 67.50  0.60
S   302 67.90  0.52 68.60  0.70 68.90  0.55 71.80  0.58 72.50  0.40 72.90  0.64
S   302 76.90  0.68 78.50  0.85 78.90  0.73 79.80  0.62 81.50  0.55 81.80  0.85
S   302 81.90  0.91 82.50  0.55 82.90  0.91 83.70  0.73 83.90  0.91 85.80  0.86
S   302 85.90  0.93 86.50  0.75 86.90  0.95 87.50  0.85 87.90  0.97 88.50  1.00
S   302 88.90  1.00 92.50  0.20 97.50  0.50 98.50  0.65
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FISHCRV Mad River, Hal approved 5-6-94

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H   101  9 10 67  0 Steelhead                    Spawning
V   101  0.00  0.00  1.00  0.00  1.60  0.44  2.50  0.97  2.90  1.00  3.25  1.00
V   101  3.80  0.62  6.00  0.00 100.0  0.00
D   101  0.00  0.00  0.65  0.00  0.85  0.44  1.00  1.00  1.50  1.00  1.90  0.73
D   101  2.30  0.58  3.70  0.06  6.00  0.06 100.0  0.00
S   101  0.00  0.00 16.50  0.50 16.90  0.10 20.50  0.00 23.90  0.05 24.50  0.50
S   101 24.90  0.10 26.50  0.50 26.90  0.10 27.50  0.15 27.90  0.03 28.50  0.00
S   101 29.90  0.00 32.50  0.25 32.90  0.45 37.50  0.40 37.90  0.48 40.50  0.50
S   101 40.90  0.90 44.90  1.00 46.90  1.00 52.50  0.50 52.90  0.90 54.50  1.00
S   101 56.90  1.00 57.50  0.65 57.90  0.93 62.50  0.50 62.90  0.90 64.50  1.00
S   101 66.90  1.00 67.50  0.65 67.90  0.93 68.50  0.50 68.90  0.90 69.50  0.50
S   101 69.90  0.90 72.50  0.15 72.90  0.27 73.50  0.40 73.90  0.32 75.50  0.65
S   101 75.90  0.37 76.50  0.65 76.90  0.37 77.50  0.30 77.90  0.30 78.50  0.15
S   101 78.90  0.27 79.50  0.15 79.90  0.27 80.50  0.00 82.90  0.00 85.50  0.50
S   101 85.90  0.10 86.50  0.50 86.90  0.10 87.50  0.15 87.90  0.03 88.50  0.00
S   101 92.90  0.00 96.50  0.50 96.90  0.10 97.50  0.15 97.90  0.03 98.50  0.00
S   101 100.0  0.00
H   102  8  8 90  0 Steelhead    (changed 5-6-94 D&V)       Juvenile
V   102  0.00  0.15  0.80  1.00  1.70  1.00  2.30  0.75  3.00  0.10  4.00  0.00
V   102  5.00  0.00  100.  0.00
D   102  0.00  0.00  0.70  0.00  1.30  0.24  1.80  0.44  2.10  1.00  4.00  1.00
D   102  5.00  1.00  100.  0.00
S   102  0.00  0.00  0.10  1.00  0.20  1.00  0.30  1.00  0.40  1.00  0.50  0.80
S   102  0.60  0.80  0.70  0.20  0.80  0.20  0.90  0.10 10.50  0.10 13.90  0.10
S   102 20.50  0.10 23.90  0.10 24.50  0.15 24.90  0.11 26.50  0.30 26.90  0.14
S   102 27.50  0.40 27.90  0.16 28.50  0.55 28.90  0.19 29.50  0.20 29.90  0.12
S   102 30.50  0.10 33.90  0.10 37.50  0.40 37.90  0.16 40.50  0.15 40.90  0.19
S   102 45.50  0.25 45.90  0.21 46.50  0.35 46.90  0.23 52.50  0.20 52.90  0.28
S   102 56.50  0.40 56.90  0.32 57.50  0.50 57.90  0.34 62.50  0.30 62.90  0.46
S   102 64.50  0.35 64.90  0.47 65.50  0.40 65.90  0.48 66.50  0.50 66.90  0.50
S   102 67.50  0.60 67.90  0.52 68.50  0.75 68.90  0.55 69.50  0.40 69.90  0.48
S   102 72.50  0.40 72.90  0.64 73.50  0.40 73.90  0.64 75.50  0.50 75.90  0.66
S   102 76.50  0.60 76.90  0.68 77.50  0.70 77.90  0.70 78.50  0.85 78.90  0.73
S   102 79.50  0.50 79.90  0.66 82.50  0.55 82.90  0.91 85.50  0.65 85.90  0.93
S   102 86.50  0.75 86.90  0.95 87.50  0.85 87.90  0.97 88.50  1.00 88.90  1.00
S   102 89.50  0.65 89.90  0.93 92.50  0.20 92.90  0.30 96.50  0.30 96.90  0.32
S   102 97.50  0.50 97.90  0.34 98.50  0.65 98.90  0.37 99.50  0.30 100.0  0.30
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H    201  7  7 64  0 Bull Trout                         Spawning
V    201  0.00  1.00  0.55  1.00  0.80  0.84  1.20  0.76  1.80  0.53  4.50  0.00
V    201 100.0  0.00
D    201  0.00  0.00  0.39  0.00  0.65  1.00  0.85  1.00  1.70  0.91 10.00  0.91
D    201 100.0  0.00
S    201  0.00  0.00 10.50  0.00 13.90  0.10 16.50  0.25 16.90  0.05 20.50  0.00
S    201 23.90  0.10 24.50  0.50 24.90  0.10 26.50  0.25 26.90  0.05 27.50  0.00
S    201 29.90  0.00 32.50  0.50 32.90  0.90 37.50  0.50 37.90  0.90 40.50  0.50
S    201 40.90  0.90 45.50  1.00 45.90  1.00 46.50  0.75 46.90  0.95 52.50  0.50
S    201 52.90  0.90 56.50  0.75 56.90  0.95 57.50  0.50 57.90  0.90 62.50  0.25
S    201 62.90  0.45 64.50  0.75 64.90  0.55 65.50  0.75 65.90  0.55 66.50  0.50
S    201 66.90  0.50 67.50  0.25 67.90  0.45 68.50  0.25 68.90  0.45 69.50  0.25
S    201 69.90  0.45 70.50  0.00 72.90  0.00 73.50  0.50 73.90  0.10 75.50  0.50
S    201 75.90  0.10 76.50  0.25 76.90  0.05 77.50  0.00 77.90  0.00 82.90  0.00
S    201 85.50  0.50 85.90  0.10 86.50  0.25 86.90  0.05 87.50  0.00 92.90  0.00
S    201 96.50  0.25 96.90  0.05 97.50  0.00 100.0  0.00
H    202  6  7 90  0 Bull Trout                         Juvenile
V    202  0.00  0.13  0.35  0.19  1.30  1.00  3.20  1.00  6.03  0.00 100.0  0.00
D    202  0.00  0.00  0.49  0.00  0.60  0.02  0.85  0.11  1.00  1.00  5.00  1.00
D    202 100.0  0.00
S    202  0.00  0.00  0.10  1.00  0.20  1.00  0.30  1.00  0.40  1.00  0.50  0.80
S    202  0.60  0.80  0.70  0.20  0.80  0.20  0.90  0.10 10.50  0.10 13.90  0.10
S    202 20.50  0.10 23.90  0.10 24.50  0.15 24.90  0.11 26.50  0.30 26.90  0.14
S    202 27.50  0.40 27.90  0.16 28.50  0.55 28.90  0.19 29.50  0.20 29.90  0.12
S    202 30.50  0.10 33.90  0.10 37.50  0.40 37.90  0.16 40.50  0.15 40.90  0.19
S    202 45.50  0.25 45.90  0.21 46.50  0.35 46.90  0.23 52.50  0.20 52.90  0.28
S    202 56.50  0.40 56.90  0.32 57.50  0.50 57.90  0.34 62.50  0.30 62.90  0.46
S    202 64.50  0.35 64.90  0.47 65.50  0.40 65.90  0.48 66.50  0.50 66.90  0.50
S    202 67.50  0.60 67.90  0.52 68.50  0.75 68.90  0.55 69.50  0.40 69.90  0.48
S    202 72.50  0.40 72.90  0.64 73.50  0.40 73.90  0.64 75.50  0.50 75.90  0.66
S    202 76.50  0.60 76.90  0.68 77.50  0.70 77.90  0.70 78.50  0.85 78.90  0.73
S    202 79.50  0.50 79.90  0.66 82.50  0.55 82.90  0.91 85.50  0.65 85.90  0.93
S    202 86.50  0.75 86.90  0.95 87.50  0.85 87.90  0.97 88.50  1.00 88.90  1.00
S    202 89.50  0.65 89.90  0.93 92.50  0.20 92.90  0.30 96.50  0.30 96.90  0.32
S    202 97.50  0.50 97.90  0.34 98.50  0.65 98.90  0.37 99.50  0.30 100.0  0.30
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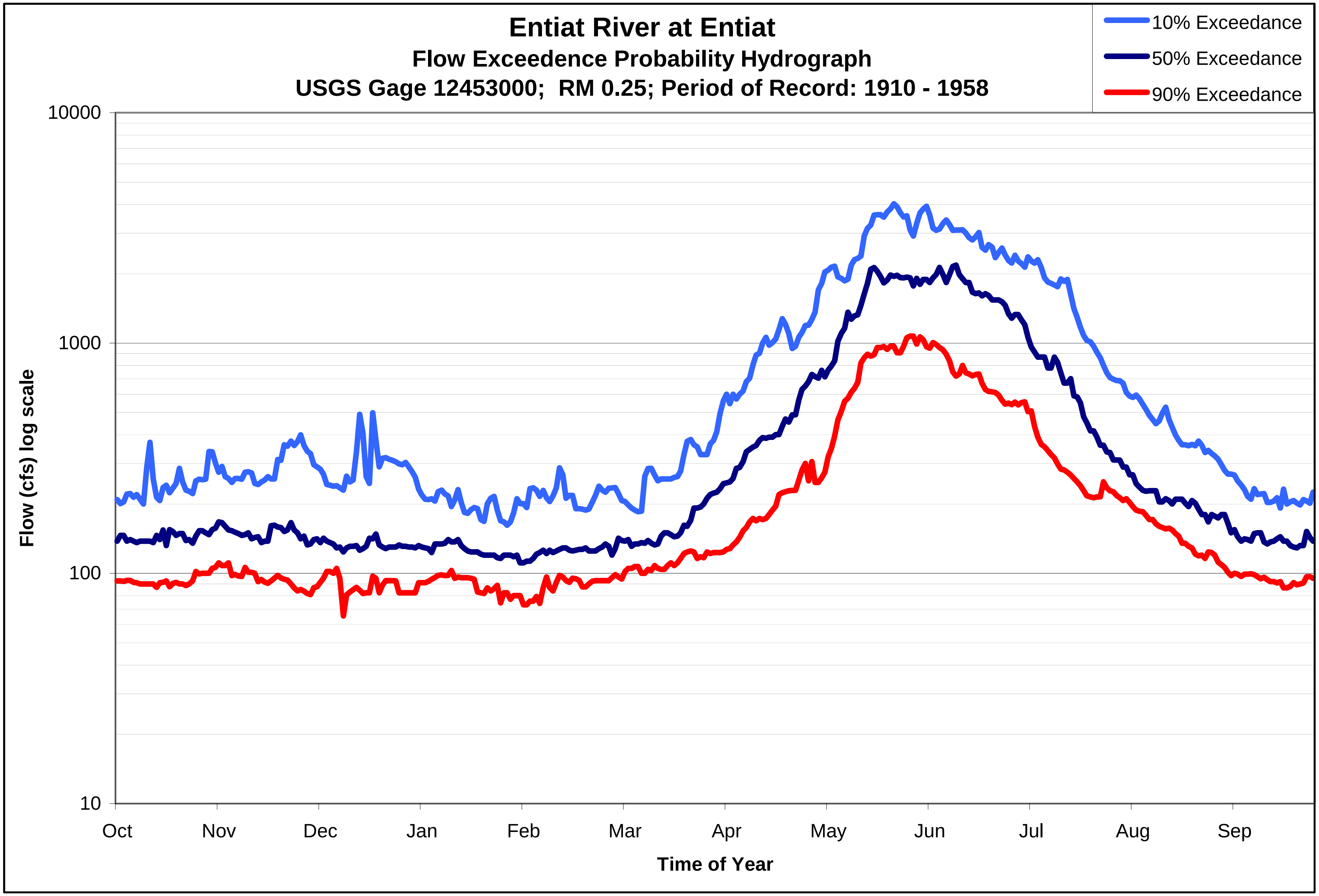
H    302  9  7 76    Chinook Rivers & Streams (5-6-94 sub)   Juvenile
V    302  0.00  0.30  0.50  1.00  0.90  1.00  1.80  0.60  2.20  0.15  3.60  0.00
V    302  5.00  0.00  6.00  0.00 100.0  0.00
D    302  0.00  0.00  0.49  0.00  0.80  0.28  1.20  0.75  1.60  1.00  5.00  1.00
D    302 100.0  1.00
S    302  0.00  0.00  0.10  1.00  0.40  1.00  0.50  0.80  0.60  1.00  0.70  0.10
S    302 12.90  0.10 14.50  0.20 15.90  0.12 16.80  0.18 16.90  0.14 18.50  0.55
S    302 18.90  0.19 21.90  0.10 25.90  0.12 26.60  0.26 26.80  0.18 27.70  0.28
S    302 28.50  0.55 28.70  0.37 32.80  0.10 34.90  0.12 35.50  0.20 36.90  0.14
S    302 38.50  0.55 41.60  0.22 45.50  0.30 46.50  0.40 46.90  0.32 48.80  0.44
S    302 51.50  0.30 52.50  0.20 54.50  0.30 54.80  0.30 56.50  0.40 56.90  0.32
S    302 57.90  0.34 58.50  0.65 58.70  0.51 61.50  0.30 62.50  0.30 62.90  0.46
S    302 63.60  0.34 64.50  0.40 64.90  0.48 65.50  0.40 66.50  0.50 67.50  0.60
S    302 67.90  0.52 68.60  0.70 68.90  0.55 71.80  0.58 72.50  0.40 72.90  0.64
S    302 76.90  0.68 78.50  0.85 78.90  0.73 79.80  0.62 81.50  0.55 81.80  0.85
S    302 81.90  0.91 82.50  0.55 82.90  0.91 83.70  0.73 83.90  0.91 85.80  0.86
S    302 85.90  0.93 86.50  0.75 86.90  0.95 87.50  0.85 87.90  0.97 88.50  1.00
S    302 88.90  1.00 92.50  0.20 97.50  0.50 98.50  0.65
H    304  8  9 60  0 Chinook  Streams  (changed 5-6-94 sub)  Spawning
V    304  0.00  0.00  0.50  0.00  1.00  0.90  1.75  1.00  2.25  1.00  3.00  0.50
V    304  4.00  0.00100.00  0.00
D    304  0.00  0.00  0.50  0.00  1.00  0.75  1.20  1.00  3.00  1.00  3.50  0.50
D    304  4.50  0.07  5.00  0.00100.00  0.00
S    304  0.00  0.00 28.70  0.00 32.80  0.24 34.90  0.37 35.50  0.65 36.90  0.37
S    304 38.50  0.15 41.60  0.60 42.50  0.00 42.70  0.70 43.90  0.93 45.50  1.00
S    304 46.90  1.00 48.80  0.80 51.50  0.00 52.50  0.00 52.60  0.60 52.80  0.80
S    304 53.80  0.89 53.90  0.93 54.50  1.00 56.90  1.00 57.90  0.93 58.50  0.50
S    304 58.70  0.70 61.50  0.00 62.50  0.00 62.60  0.60 62.90  0.90 63.60  0.72
S    304 64.50  1.00 66.50  1.00 67.50  0.65 67.90  0.93 68.60  0.60 68.90  0.90
S    304 71.80  0.24 72.50  0.00 72.60  0.18 72.90  0.27 75.80  0.44 76.50  0.65
S    304 76.90  0.37 78.50  0.15 78.90  0.27 79.80  0.24 81.50  0.00 82.90  0.00
S    304 83.70  0.09 83.90  0.03 85.80  0.20 85.90  0.10 86.50  0.50 86.90  0.10
S    304 87.50  0.15 87.90  0.03 88.50  0.00 92.50  0.00 97.50  0.15 98.50  0.00
```

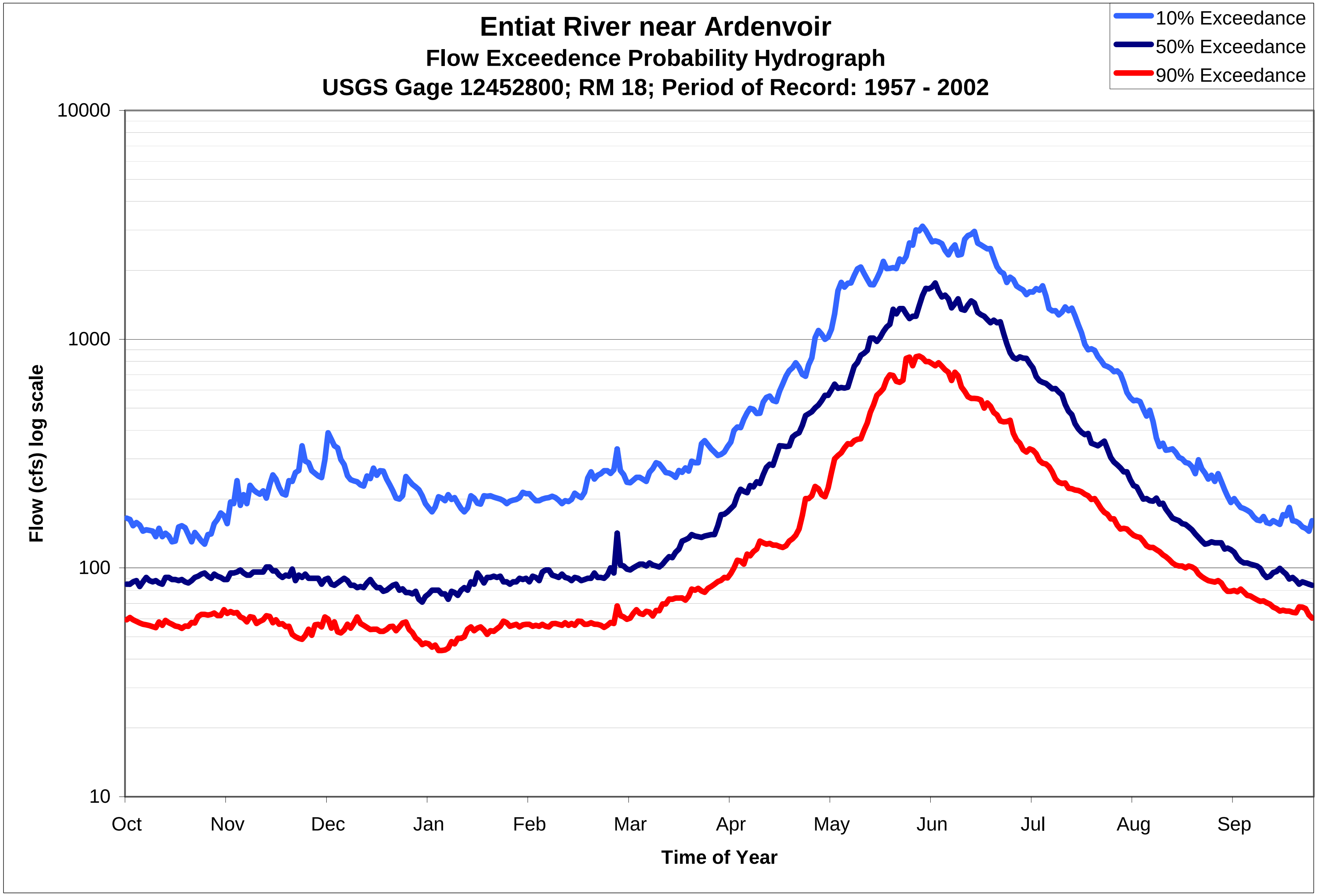
Appendix D

Exceedence Flow Hydrograph

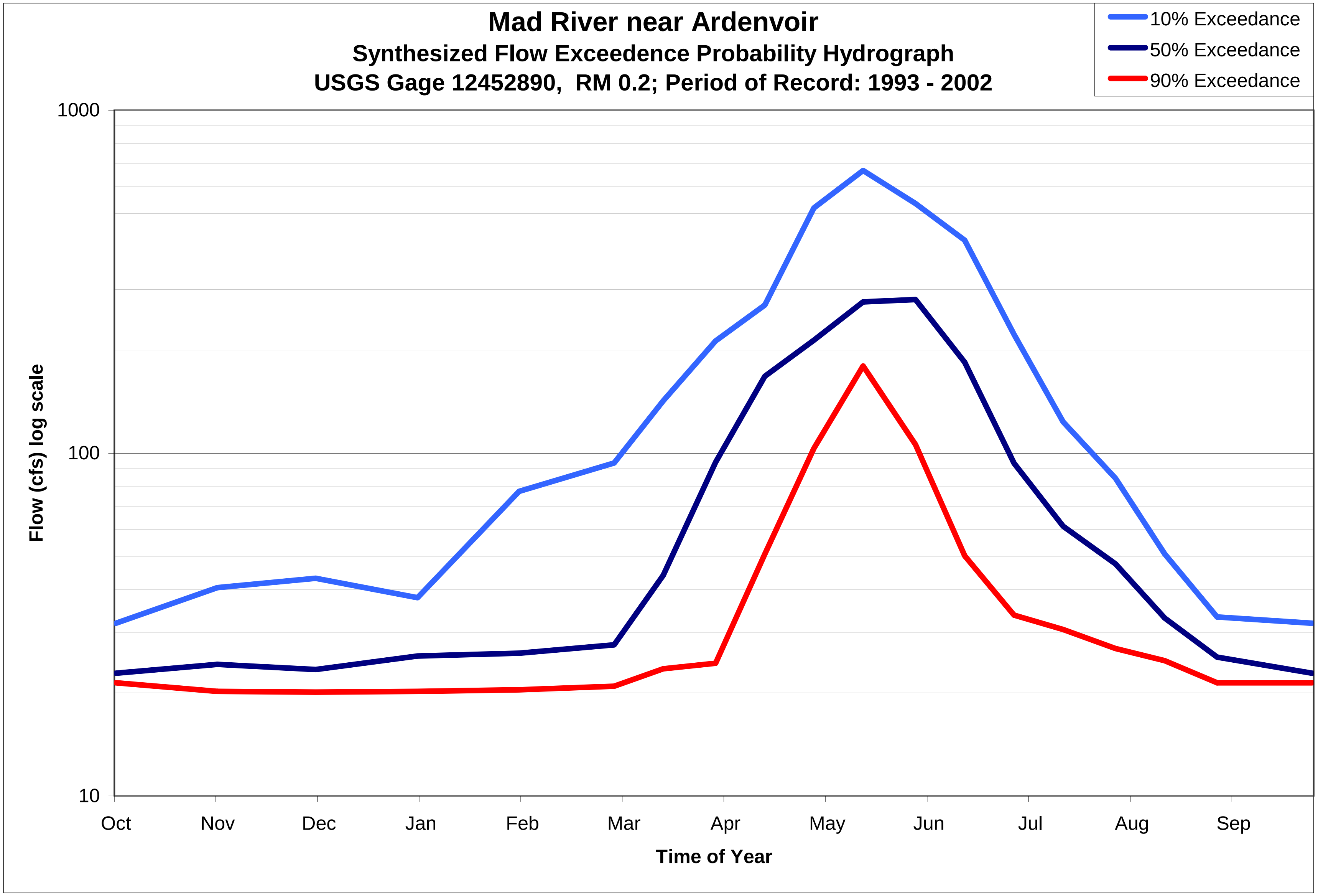
Entiat River near Entiat
Entiat River near Ardenvoir
Mad River near Ardenvoir



Entiat River at Entiat
Flow Exceedence Probability Hydrograph
USGS Gage 12453000; RM 0.25; Period of Record: 1910 - 1958
10% Exceedance
50% Exceedance
90% Exceedance
Flow (cfs) log scale
10000
1000
100
10
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year



Entiat River near Ardenvoir
Flow Exceedence Probability Hydrograph
USGS Gage 12452800; RM 18; Period of Record: 1957 - 2002
10% Exceedance
50% Exceedance
90% Exceedance
10000
1000
100
10
Flow (cfs) log scale
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year


Mad River near Ardenvoir
Synthesized Flow Exceedence Probability Hydrograph
USGS Gage 12452890, RM 0.2; Period of Record: 1993 - 2002
10% Exceedance
50% Exceedance
90% Exceedance
Flow (cfs) log scale
1000
100
10
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Time of Year

Appendix E

Substrate and Cover Codes

Departments of Fisheries & Wildlife
Instream Flow Studies Substrate and Cover Code Application
November 23, 1987

The three-digit code used describes the dominant substrate (the first number, the subdominant substrate (the second number), and the percent of only the dominant substrate (the third number). The percent of the subdominant substrate can be determined by subtraction. Dominant substrate is determined by the largest quality of a certain substrate, not be the size of the substrate. The sum of the percent dominant and the percent subdominant will total 100 percent. The coding will not allow the dominant percent to be less than 50 percent, or greater than 90 percent. All other preference values are determined by using weighted averages. The value of the dominant substrate is multiplied by the percent of the dominant substrate, and the product is added to the product of the subdominant substrate times the percent of subdominant substrate. The sum of all the codes observed times their preference value will be a value between 0.0 and 1.0. The coding should also give a preference value of zero for the entire substrate observation when the code is class zero, one, or two, and is 50 percent or more of the observation. Where there is a situation where addition of two values could equal more than 1.0, the value will default to 1.0. Overhanging vegetation should be counted as cover if it is within 3 to 4 feet of the water surface. Cover values should be incorporated with the substrate values for both salmon and steelhead juvenile life stages and for chinook and steelhead adult holding.

Life Stage and Value of Substrate

			Salmon			Steelhead and Trout			
						Spawning		Rearing/Holding	
Code	Substrate Size In Inches		Juvenile Rearing	Spawning	Adult Holding	Steelhead	Trout	Juvenile & Adult	Steelhead Adult
0	Detritus		.1	0	.1	0	0	.1	.1
1	Silt, Clay		.1	0	.1	0	0	.1	.1
2	Sand		.1	0	.1	0	0	.1	.1
3	Small Gravel	0.1-0.5”	.1	.3	.1	.5	1	.1	.1
4	Medium Gravel	0.5-1.5”	.3	1	.3	1.0	1	.3	.3
5	Large Gravel.	.1.5-3.0”	.3	1	.3	1.0	1	.3	.3
6	Small Cobble	3.0-6.0”	.5	1	.3	1.0	.5	.5	.3
7	Large Cobble	6.0-12.0”	.7	.3*	.3	.3	.0	.7	.3
8	Boulder		1.0	0	1.0	0	0	1.0	1.0
9	Bedrock		.3	0	.3	0	0	.3	.3
0.1	Undercut Bank		1.0	0	1.0	0	0	1.0	1.0
0.2	Overhanging Vegetation		1.0	0	1.0	0	0	1.0	1.0
0.3	Root Wad		1.0	0	1.0	0	0	1.0	1.0
0.4	Log Jam		1.0	0	1.0	0	0	1.0	1.0
0.5	Log Instream		.8	0	.8	0	0	.8	.3
0.6	Submerged Vegetation		1.0	0	.8	0	0	1.0	.8
0.8	Grass/Bushes Up on Bank		.1	0	.1	0	0	.1	.1
0.9	Fine Organic Substrate		.1	0	.1	0	0	.1	.1

(*0.6 for chinook spawning can be used, depending on river size)

Appendix F

Discharge Calculations for Tillicum Creek at RM 0.5

Date Measured: 7/21/92

Location (ft)	Depth (ft)	Velocity (ft/sec)
1.7	0	0
2	0.1	0.05
2.5	0.35	0.43
3	0.4	0.77
3.5	0.25	1.03
3.75	0.4	1.13
4	0.3	1.18
4.25	0.05	1
4.5	0.15	1.14
5	0.1	0.03
5.25	0.25	1.6
5.5	0.25	1.53
5.75	0.25	1.71
6	0.3	1.55
6.25	0.55	1.28
6.5	0.55	1.3
6.75	0.6	0.81
7	0.6	0.78
7.25	0.55	1.36
7.5	0.55	1.76
7.75	0.45	0.82
8	0.5	0.34
8.25	0.7	0.24
8.5	0.5	2.31
8.75	0.65	0.68
9	0.55	0.79
9.25	0.6	0.31
9.5	0	0

Avg. depth=.38 ft
Avg. velocity =.93 ft./sec.
Total discharge = 2.85 cfs

Date Measured: 8-12-92

Location (ft)	Depth (ft)	Velocity (ft/sec)
1.1	0	0
2	0.1	0.7
2.5	0.3	0.32
3	0.5	0.07
3.5	0.5	0.34
4	0.55	0.38
4.5	0.55	0.38
5	0.5	1.18
5.5	0.6	0.72
6	0.6	1.46
6.5	0.6	1.19
7	0.55	1.17
7.5	0.55	0.53
8	0.6	0.22
8.5	0.05	0
9	0	0

Avg. depth=.41 ft.
Avg. velocity = .54 ft./sec.
Total discharge = 2.25 cfs

Date Measured: 10-7-92

Location (ft)	Depth (ft)	Velocity (ft/sec)
4.65	0	0
5	0.1	0
5.5	0.3	0
6	0.5	0
6.5	0.5	0.06
7	0.6	0.93
7.5	0.6	0.93
7.75	0.55	1.17
8	0.65	1.24
8.5	0.3	1.05
8.75	0.35	1.02
9	0.45	1.1
9.25	0.5	0.94
9.5	0.5	1.28
9.75	0.25	1.43
10	0.25	1.41
10.25	0.2	1.09
10.5	0.5	0.03
11	0.2	1.37
11.5	0.3	0.01
12	0.2	0.75
12.5	0.35	0.43
13	0.4	0.16
13.5	0.1	0
13.75	0	0

Avg.depth = 0.35 ft.
Avg. velocity = 0.66 ft./sec.
Total discharge = 2.10 cfs