BEFORE THE MONTANA BOARD OF NATURAL

RESOURCES AND CONSERVATION

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IN THE MATTER OF WATER)
RESERVATION APPLICATION NOS.)
69903-41Q 71895-41I 72578-41L)
70115-41F 71956-41S 71579-41T)
70117-41H 71997-41J 72580-41A)
70118-41H 71998-41S 72581-41I)
70119-41H 72153-41P 72582-41I)
70270-41B 72154-41K 72583-41P)
71537-41P 72155-41A 72584-41S)
71688-41L 72256-41P 72585-41M)
71889-41Q 72307-41Q 72586-41P)
71890-41K 72574-41O 72587-41G)
71891-41P 72575-41K 72588-40C)
71892-41G 72576-40E 73198-41I)
71893-41E 72577-41P 73199-41S)
71894-41I IN THE UPPER)
MISSOURI RIVER BASIN)

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DEPARTMENT OF FISH, WILDLIFE AND PARKS'
REBUTTAL TESTIMONY

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Rebuttal testimony submitted in support

of the Department of Fish, Wildlife and Parks'

application for instream flow to reservations

in the upper Missouri River Basin

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December 17, 1991

BEFORE THE MONTANA BOARD OF NATURAL

RESOURCES AND CONSERVATION

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Rebuttal testimony submitted in support of the Department of Fish, Wildlife and Parks' application for instream flow to reservations in the upper Missouri River Basin

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CERTIFICATE OF SERVICE

* * * * * * * * * * * * *

I hereby certify that on the 17th day of December, 1991, the Montana Department of Fish, Wildlife and Parks' (Department) filed rebuttal testimony and exhibits in support of its application for reservation of water in the Missouri River Basin above Fort Peck Dam. A copy of this testimony was served by hand-delivering the original and three (3) true and accurate copies to:

Peter T. Stanley
% Department of Natural Resources and Conservation
1520 East Sixth
Helena, MT 59620

and by depositing true and accurate copies, postage prepaid, in the United States Post Office at Helena, Montana, to the following locations:

Bozeman Water Rights Field Office
11 North tracy
Bozeman, Montana 59715

Western Montana College Library
710 South Atlantic
Dillon, Montana 59725

Madison Valley Public Library
Box 178/210 Main Street
Ennis, Montana 59729

Glasgow Water Rights Field Office
839 1st Avenue South
Glasgow, Montana 59230

Great Falls Public Library
301 2nd Avenue North
Great Falls, Montana 59401

Lewistown City Library
701 W. Main Street
Lewistown, Montana 59457

Roundup Community Library
Box 717
Roundup, Montana 59072

Sheridan Public Library
Box 417
Sheridan, Montana 59749

John Gregory Library
Box 649
Whitehall, Montana 59759

DATED, this 17th day of December, 1991.

Robert N. Lane

Robert N. Lane
Chief Legal Counsel
Montana Department of Fish, Wildlife and Parks
1420 East Sixth Avenue
Helena, Montana 59620

LIST OF WITNESSES FOR THE
DEPARTMENT OF FISH, WILDLIFE AND PARKS'
REBUTTAL TESTIMONY

1. Fred Nelson - Wesche Rebuttal
2. Fred Nelson - Perkins Rebuttal
3. Liter Spence
4. Richard Oswald
5. Bill Hill
6. Wade Fredenberg
7. John Duffield

PRE-FILED REBUTTAL TESTIMONY

OF FREDERICK A. NELSON

on behalf of

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. Please state your name and business address.

A. Fred Nelson, MDFWP, 1400 South 19th Avenue, Bozeman, Montana 59715.

Q. What is your present employment?

A. I am a fisheries biologist employed by the Montana Department of Fish, Wildlife and Parks.

Q. Please state your educational background and experience.

A. This information was already presented in previous testimony I filed for this reservation proceeding on behalf of MDFWP. That testimony included a description of my instream flow-related training and a vita.

Q. What is the purpose of this testimony?

A. The purpose is to rebut elements of the objector's testimony of Thomas A. Wesche, water resource consultant for the Montana Association of Conservation Districts.

Q. What is the essence of the last paragraph on page 2 of Mr. Wesche's testimony?

A. Mr. Wesche is, in my opinion, attempting to show that the wetted perimeter inflection point method for deriving instream flow recommendations has little acceptance as a valid instream flow method and that a more sophisticated method, the Instream Flow Incremental Method (IFIM), is the method of choice.

Q. Is wetted perimeter an accepted method for deriving instream flow recommendations?

A. Yes. Mr. Wesche's own publication (Reiser, Wesche and Estes 1989), which surveys instream flow practices in North America, refers to the wetted perimeter method as one of the "Other commonly applied methods" in North America. (This publication is attached as Attachment A.) According to Reiser, Wesche and Estes (1989), wetted perimeter is the third most used or recognized method in North America.

Q. Which states and provinces are using the wetted perimeter method, according to Reiser, Wesche and Estes (1989).

A. Six states and provinces - Idaho, Michigan, Montana, North Carolina, Virginia and British Columbia - are listed as using wetted perimeter. For three other states - Washington, Oregon and Colorado - wetted perimeter criteria are components of their methods. Wyoming is another state that uses wetted perimeter criteria - the same method as Colorado - in its instream flow requests, according to Tom Annear, instream flow coordinator for the Wyoming Dept. of Game and Fish, in a phone conversation with Fred Nelson on December 5, 1991. In Alaska, "other proven methods" are accepted (Reiser, Wesche and Estes 1989). According to Chris Estes, instream flow coordinator for the Alaska Dept. of Fish and Game and co-author of Mr. Wesche's publication, wetted perimeter is one of these other proven methods (phone conversation with Fred Nelson on Dec. 6, 1991).

At least 11 states and provinces, many located in the Northwest and Northern Rocky Mountains, recognize the wetted perimeter method and methods that incorporate wetted perimeter criteria.

Q. Mr. Wesche's testimony states that "Washington and Idaho, which formerly used a wetted perimeter approach, now require IFIM for instream flow studies." Is this correct?

A. On December 6, 1991, I spoke to Hal Beecher, instream flow biologist for the Washington Dept. of Wildlife, and Will Reid, fisheries program coordinator for the Idaho Dept. of Fish and Game. Both called the above statement of Mr. Wesche inaccurate. In Washington, the Toe-Width Method, which utilizes wetted perimeter/inflection point criteria, continues to be used today, and is Washington's most commonly used method in the state's overall instream flow program. IFIM is basically restricted to evaluating small hydro and other major developments. In Idaho, IFIM is not required for <u>all</u> instream flow studies, although it is currently the most commonly used method. According to Will Reid, most of the pending instream flow requests of Idaho Dept. of Fish and Game were quantified using the wetted perimeter method.

Q. Is IFIM the method of choice for Montana's water reservation process?

A. No. The legal protection afforded to instream flows will, in many respects, dictate which methods are suitable. Unlike the majority of states, Montana has a water reservation process that legally recognizes instream flows and incorporates them into the legal framework that governs water rights. Montana's legal framework is the Doctrine of Prior Appropriation. Under this doctrine, the MDFWP, as holder of the instream reservation, can place a call on junior water users once the streamflow falls below the amount of the granted instream reservation, provided there are junior users with priority dates after July 1, 1985, which is the priority for the Missouri Basin water reservations. The nature of Montana's water rights system demands that a minimum flow be associated with the instream reservation. This minimum, when reached, would trigger an action by the MDFWP (a call on junior users).

Instream flow methods designed for deriving minimum flows are called standard setting methods. Wetted perimeter is a widely accepted standard setting method. IFIM is not a standard setting method, but an incremental method. IFIM is not designed to provide minimum flow recommendations. (Refer to pg. 5 of the Prefiled Direct Testimony of Fred Nelson for a description of the IFIM Method.)

A paper by Clair Stalnaker, leader of the Instream Flow Group within the U.S. Fish and Wildlife Service that developed the IFIM, and Woody Trihey, a former staff member of the Instream Flow Group, is attached to this rebuttal testimony (see Attachment B). Trihey and Stalnaker (1985) define:

> "Standard-Setting Methodologies - measurement and interpretive techniques designed to generate a flow value(s) which is intended to maintain the fishery at some acceptable level.
>
> Incremental Methods - techniques designed to generate a relationship between the quality of an instream resource, such as the fishery habitat, and streamflow."

They also state that "Standard Setting is most appropriate for:

* Protecting the existing instream resource;

* State water allocation permits or reservations;"

The developers of IFIM recognize the inappropriateness of their method for setting minimum instream flows. They also recognize its inappropriateness for use in the water reservation process.

Q. Does Mr. Wesche recommend that MDFWP use the IFIM for deriving its minimum flow requests for the water reservation process?

A. Page 2 of Mr. Wesche's testimony implies that IFIM is a better method based on the results of his poll of the states. In two specific cases, Red Rock River - Reach 2 and Ruby River - Reach 2, Mr. Wesche calls for the use of IFIM (see pg. 4 and 5 of Mr. Wesche's testimony). However, he neglects to mention the unsuitability of IFIM for Montana's reservation process, a fact the developers of IFIM (the Instream Flow Group) have long recognized.

Q. The first paragraph of page 3 of Mr. Wesche's testimony dwells on the HQI method. Briefly describe this method.

A. Mr. Wesche states "The HQI is a multiple regression model based on a series of abiotic and biotic independent variables which allows estimation of trout standing crop during the late summer/fall period. Independent variables included in the model are late summer stream flow, annual stream flow variation, water temperature, nitrate nitrogen concentration, water velocity, substrate, cover, eroding stream banks, and stream width, as well as fish food abundance and diversity. Each of these variables has been shown to be related to trout standing crop."

Q. Where is the HQI method used?

A. According to Reiser, Wesche and Estes (1989), HQI has but one adherent, the State of Wyoming.

Q. Mr. Wesche ends the above description of HQI with the statement that "Each of these variables has been shown to be related to trout standing crop." Is this correct?

A. This statement is generally true. However, identifying all relevant variables and defining their relationship to fish is extremely difficult. The validity of the HQI approach depends on the accuracy of the trout standing crop predictions that are derived from the mathematical analysis of the model's many variables. Wyoming has had the most success. Other states have been unable to match the degree of accuracy obtained by Wyoming.

Q. Is HQI a valid method?

A. Yes. The State of Wyoming has had good success with the method under the state's newly acquired instream flow legislation.

Q. Was the HQI approach tried in Montana?

A. Yes. A rigorous test of the HQI concept was conducted by MDFWP in 112 stream reaches in Montana's Flathead drainage (Fraley and Graham 1982). The results, however, were discouraging when viewing HQI as an instream flow tool.

Q. Has Wyoming documented some shortcomings with the HQI method?

A. Yes. Conder and Annear (1987) - both are involved with the instream flow program of Wyoming Game and Fish - state:

> "While we have had good results with the trout standing crop estimates developed from the HQI in Wyoming, it is not a panacea. We have had inconsistent results with HQI in highly productive canyon habitats and in small high-elevation streams that support brook and cutthroat trout. Our data base is also inadequate to fully evaluate the HQI performance in large streams".

Q. How should the HQI approach be viewed in relation to MDFWP's instream reservation application?

A. HQI is one of many instream flow methods available for use. Like all methods, it has shortcomings, as pointed out by Conder and Annear (1987). When HQI was tested in Montana, it proved unworkable as an instream flow method. These limitations did not put HQI in the forefront of candidate methods for use in Montana's water reservation process.

Mr. Wesche is incorrect if the intention of his testimony is to show that HQI is a better method than wetted perimeter and that HQI is better suited for Montana's reservation process.

Q. Pages 3 and 4 of Mr. Wesche's testimony address perceived shortcomings of the wetted perimeter method. Does the method have shortcomings?

A. All instream flow methods have shortcomings and all are open to criticism. Wetted perimeter is no exception. Mr. Wesche believes that because wetted perimeter fails to fully analyze the distribution of bottom substrates and water velocities across a riffle, the microinvertebrate drift, hydraulic geometry, bed element variability, microtopography and the degree of embeddedness, the method lacks merit. No standard setting method in existence analyzes all these intertwining factors nor is there hope that one will ever emerge in the future. To address Mr. Wesche's criticisms, MDFWP would have to leave the realm of accepted instream flow methods and proceed to full-blown, long-term, million dollar +, biological studies that will define the exact relationships between fish, food and flows for each of the 281 stream reaches in MDFWP's application. The impracticality of this approach is obvious.

Q. How does MDFWP view wetted perimeter and food production?

A. MDFWP believes that a cover of water is paramount to the survival of the gill-breathing food items that are produced in stream riffles. One can argue endlessly about the interactions of velocity, substrate, invertebrate drift, microtopography, etc. in determining food production. But in the end, without a cover of water there is no food production. The wetted perimeter method addresses this basic tenet.

Q. On page 4 of his testimony, Mr. Wesche further criticizes the wetted perimeter method by questioning the validity of the break (inflection) point concept. Respond to this.

A. The break point, which is the point where the rate of change begins to accelerate, as in wetted perimeter, is a commonly used concept in the current body of instream flow methods. Mr. Wesche himself has published instream flow work that incorporates the break point approach (Wesche 1973).

Q. In the last paragraph of page 3 of Mr. Wesche's testimony, he questions the credibility of MDFWP's flow requests based on the unavailability of the requested flows on some streams during the late season. Respond to this.

A. Mr. Wesche makes the often repeated argument that the requested flows must be available at all times. This argument is flawed for a number of reasons:

1) If MDFWP was to recommend an instream flow that was always available in the stream, we'd be asking for the historic low flow - the lowest flow that ever occurred on the stream. Only then would the request never exceed water availability. On streams already overburdened by excessive irrigation depletions, the historic low could be zero or near zero flow. Such a request would ensure the destruction of the fishery. Historic lows protect nothing. Such a recommendation is analogous to asking a farmer to produce his crops using only the amount of water available during the worst drought year on record. It's inconceivable that historic low flows could qualify as the minimum instream flows needed to protect the resource.

2) Flow requests of MDFWP exceed the normal late season water availability on some streams. A common reason is that late season flows already reflect massive irrigation depletions and are but a fraction of the flows that occurred in the undepleted or natural state. Comparing the flow requests to the flows that once occurred in the natural state provides a far better and

fairer measure of how much of a stream's annual water yield is being requested for instream use. On those streams where existing irrigation depletions have already overburdened the stream, criticizing MDFWP's instream flow requests on the grounds that MDFWP is asking for too much of the pittance that remains is unjustified.

3. This much repeated water availability argument also fails to take into account the legal framework that governs Montana's water law. The granted instream reservation will have a late priority date of July 1, 1985. This entitles MDFWP to place a call only on junior water users, if any exist, when flows drop below the amount of the granted reservations.

   An instream flow reservation does not guarantee that the granted flows will always be available; it merely establishes the instream flow level that will trigger a "call" response by MDFWP. In its application, MDFWP is asking that flows up to the amount of its requests be reserved for instream use. We are not asking that the full amount of these requests be maintained continuously.

Q. Pages 4-10 of Mr. Wesche's testimony addresses his concerns regarding specific instream flow requests of MDFWP. What format will MDFWP use in its response?

A. MDFWP will list each stream in the same order used by Mr. Wesche in his testimony. For those streams where Mr. Wesche disputes the wetted perimeter inflection points, a copy of the wetted perimeter-flow curve that was included with MDFWP's reservation application, is attached to this rebuttal testimony. A line was drawn on each of the curves to help identify inflection points.

Red Rock River-Reach 2

MDFWP stands by its request for 60 cfs, based on the upper inflection point. The actual break appears to occur at about 75 cfs, making 60 cfs a conservative estimate (see Attachment C). The 60 cfs request amounts to 19% of the undepleted average annual flow for the Red Rock River (325 cfs), as estimated by the SCS (1975). As discussed earlier, the undepleted or natural flow provides a fairer baseline for comparing the instream flow requests. In his testimony (Warm Springs Creek and Cut Bank Creek), Mr. Wesche finds "25% of estimated mean annual flow" reasonable.

Mr. Wesche also calls for the use of IFIM on the Red Rock River. The inappropriateness of IFIM was discussed earlier in this rebuttal testimony.

Big Sheep Creek

Mr. Wesche questioned why 5 cross-sections were field measured and only 1 used in the analysis. Page 2-68 of MDFWP's application states "Five cross-sections were established to describe the various habitat types". The various habitat types included habitats other than riffles. Only one riffle cross-section was among the 5. At the time, MDFWP was exploring additional instream flow approaches, which later proved unworkable. Consequently, the non-riffle cross-sections were not used.

Page 2-66 of MDFWP's application states that "These springs provide about 56% of the flow during the early fall months". Whether or not this qualifies Big Sheep Creek as a spring creek is questionable. Regardless, the issue is irrelevant. MDFWP was able to collect the needed field data (at a high, medium and low flow) for Big Sheep Creek to calibrate the wetted perimeter computer program, thus enabling MDFWP to use the wetted perimeter method. The reason the base flow approach was used to derive flow requests for most spring creeks was because their stable flow regimes prevented the collection of the needed calibration data at different flows. Thus, the wetted perimeter method, MDFWP's method of choice, could not be used for the vast majority of spring creeks.

Horse Prairie Creek

The study area was located in the natural channel "near stream mile 2 (T10S, R11W, Sec. 9A)". The reason why only 2 of 5 cross-sections were used was previously explained under Big Sheep Creek.

Mr. Wesche finds fault with MDFWP's 36 cfs request, using "the relatively low trout standing stocks" as partial justification. As mentioned in MDFWP's application (pg. 2-100), the fish present tended to be larger-size. "Eighty percent of the brown trout were 13 inches and longer, with each weighing an average of 1.3 pounds."

The 7,590-foot-long fish study section supported an average of 46 pounds of trout per 1,000 ft. While this may be relatively low for a stream the size of Horse Prairie Creek, it certainly does not warrant a low inflection point recommendation. Further, Horse Prairie Creek has additional fishery values beyond its resident fish populations. As stated in MDFWP's application, "Horse Prairie Creek provides spawning habitat for both wild brown and rainbow trout inhabiting Clark Canyon Reservoir." MDFWP stands by its 36 cfs request.

It should be noted that the 36 cfs equals 22% of the estimated undepleted average annual flow (166 cfs) for Horse Prairie Creek (SCS 1975). This is less than the 25% standard that Mr. Wesche advocates as reasonable (see Cut Bank and Warm Springs creeks).

Beaverhead River-Reach 2

The primary justification for the 200 cfs request was not the results of a study completed 35 years ago by the U.S. Fish and Wildlife Service. MDFWP's request is based on the wetted perimeter method, a fact that is clear in the application (pg. 2-111). The study of 35 years ago merely supports the 200 cfs request.

Mr. Wesche states "While the WP-flow plot shows a minor break point at 200 cfs, no lower break point is evident". MDFWP contends that the break (inflection) point is clear and cannot be described as "minor" (see Attachment D).

The absence of a definable lower inflection point on the WP-flow plot is irrelevant for the Beaverhead River and most of the other streams in MDFWP's application. This is because:

1) MDFWP maintains a list of streams in the state that have an existing fishery or the potential for a fishery. For the Missouri Basin above Fort Peck Dam, the list contains 2,739 streams. MDFWP has requested instream flow reservations for 248 of the 2,739 streams, which is 9% of the total. Clearly, MDFWP has not blanketed the basin with instream flow requests. MDFWP has pared its requests to include the "best" waters. Because the basin's "best" waters are involved, upper inflection point recommendations are the norm. Thus, the presence or absence of a discernible lower inflection point was basically irrelevant to MDFWP and the needs of the fishery resource. Had the abundance of lesser waters been included in the application of MDFWP, requests at or above the lower inflection point would have been common, making the lower inflection point critical to the analyses of instream flow needs.
2) Page 50 in Exhibit No. 1 (Leathe and Nelson 1989) of MDFWP's pre-trial testimony states "The plot of wetted perimeter versus flow for stream riffle cross-sections generally, but not always, shows two points, referred

> to as break or inflection points, where the rate of increase of wetted perimeter changes." MDFWP recognizes that a lower inflection point may not be discernible in some cases. Having two inflection points is not an absolute requirement of the method. MDFWP has never insisted that two inflection points are always present. The absence of a lower inflection point does not violate any hard and fast rule established by MDFWP.

Mr. Wesche calls the trout population of the Beaverhead River-Reach 2 "relatively low". Page 2-111 of MDFWP's application states:

> "In 1988, population work in Reach #2 at Dillon (about river mile 55) showed an estimated 325 age II and older brown trout per 1,000 ft of river. Near the river's mouth downstream from Dillon, brown trout numbers declined to about 128 age II and older per 1,000 ft in 1988."

Three hundred twenty-five trout per 1,000 ft (1,716 per mile) is not low by standards for southwest Montana. As the river progresses downstream to its mouth, trout numbers are reduced to about 676 per mile, a relatively low level, but a level still higher than the populations in the neighboring and larger Jefferson River, where from 250-500 trout are found per mile. To categorize the trout populations throughout Reach 2 as "relatively low" is inaccurate.

Mr. Wesche further criticizes the 200 cfs request on the basis of "the apparent failure to consider likely hydraulic geometry changes in response to dam installation". This criticism is puzzling. The wetted perimeter work was conducted after Clark Canyon Dam was constructed and thus would reflect the post-dam hydraulic geometry.

Mr. Wesche concludes that the 200 cfs request "appears unreasonably high". If Mr. Wesche's own 25% standard of reasonableness (see Warm Springs and Cut Bank creek) is applied to Reach 2, we find that the 200 cfs request equals about 29% of the undepleted average annual flow for the Beaverhead River above the junction of the Ruby River (SCS 1975). If the undepleted average annual flow of the Ruby River is included, the request is 20% (SCS 1975). Based on Mr. Wesche's own standard, 200 cfs is not unreasonably high.

A further criticism by Mr. Wesche is "this reach is exceptionally long and has two major tributaries entering, Ruby River and Blacktail Deer Creek. I question the appropriateness of just one request for such a hydrologically (and likely hydraulically) varied reach."

This criticism is based on the assumption that each reach designated in MDFWP's application represents a stream segment having the same flow regime, instream flow requirement, and channel configuration throughout its length. This assumption is incorrect. Page 1-90 of MDFWP's application states:

> "Protection of instream flows will be accomplished by what has become known as the "Reach Concept." For most waters, tributaries in particular, most instream flow recommendations were derived at a site near the stream's mouth, with the designated reach extending from the mouth to the headwaters. As defined by MDFWP, a designated reach merely serves to identify those junior water users who will be subject to the instream reservation, which was derived and will be monitored at a site on the lower stream. A reach, as defined by DFWP, does not represent a stream segment having the same flow regime and instream flow requirement throughout its length. It is, simply, a means to identify those junior users who would be contacted if DFWP makes a "call" for its water."

The concept of monitoring instream reservations at or near a river's mouth is supported in the Board's Order for the Yellowstone River Basin Reservation Applications, 1978. Instream reservations for some major rivers were granted at the river's mouth. These include the Powder River (flows 218 miles within Montana), Tongue River (210 miles in Montana), Bighorn River (84 miles within Montana), and Stillwater River (68 miles long).

For the Missouri Basin rivers where more than one reach were identified in MDFWP's application, the intention is to monitor instream flow reservations at or near the reaches' downstream boundaries.

If MDFWP was required to separate all rivers into segments having a similar flow regime, instream flow requirement and channel geometry, it's likely the Beaverhead River would be comprised of 10 or more reaches, rather than the two in MDFWP's application. The impracticality of this approach for the reservation process is obvious.

<u>Blacktail Deer Creek</u>

MDFWP did not adopt the high inflection point recommendation for Blacktail Deer Creek, choosing a mid-range request of 42 cfs. Mr. Wesche claims "The logic of this request is inconsistent with the WPIPM as described in the Direct Testimony of MDFWP personnel." MDFWP requested a mid-range flow because of the stated fishery values on page 2-138 of its application. The application states:

> "A 5,280 ft section of Blacktail Deer Creek was electrofished on July 29 and August 11, 1980. One hundred fifty-six brook trout, ranging from 3.0-13.9 inches, and 14 rainbow trout from 6.6-14.7 inches were captured. Other species present were mountain whitefish, mottled sculpin and longnose dace.
>
> The standing crop of brook trout was estimated using a mark-recapture method (Table 2-33). This section supported about 69 brook trout 5.0 inches and longer, weighing 24 pounds, per 1,000 ft of stream. Thirty-five percent of the trout were 10.0 inches and longer, with each weighing between 0.5 and 1.3 pounds. Due to the low numbers of rainbow trout captured, a standing crop estimate was not possible."

Page 2-139 further states:

> "Due to environmental problems - summer dewatering being the most notable - trout numbers throughout much of Blacktail Deer Creek are less than expected for a stream of its size. A flow midway (42 cfs) between the lower and upper inflection points is, therefore, requested."

Mr. Wesche correctly states that the 42 cfs request equals 78% of the <u>historic</u> or depleted average annual flow. The quantified flows for Blacktail Deer Creek in USGS (1989) are for the gauge site located 14 miles upstream from the creek's mouth. Flows at this site reflect diversions to irrigate about 4,000 acres (Shields and White, 1981). The historic average annual flow at this site does not reflect the average annual flow that would be available at the creek's mouth if no depletions occurred. This shortcoming of the historic average annual flow for Blacktail Deer Creek should be recognized when comparing MDFWP's flow request.

<u>Ruby River - Reach 2</u>

MDFWP stands by its upper inflection point request of 40 cfs (see Attachment E). Fishery values described on pg. 2-150 of MDFWP's application warrant a high inflection point request, not the 25 cfs advocated by Mr. Wesche.

The 40 cfs request is more than reasonable, based on Mr. Wesche's own 25% standard of reasonableness (see Warm Springs and Cut Bank creeks). The 40 cfs equals about 13% of the estimated undepleted average annual flow for the Ruby River (SCS 1975) and 19% of the depleted average annual flow (USGS 1989).

Mr. Wesche further advocates the use of IFIM for deriving instream flow requests on the Ruby River. The inappropriateness of IFIM was discussed earlier in my testimony.

Big Hole River - Reach 1

MDFWP stands by its upper inflection point request of 180 cfs. The 180 cfs is a conservative estimate of the upper inflection point (see Attachment F). Mr. Wesche's contention that the upper inflection point occurs at 60 cfs is incorrect. Such a flow recommendation would lead to an inordinately low instream flow. Sixty cfs equals but 10% of the depleted average annual flow for the Big Hole River below Mudd Creek, near Wisdom (USGS 1989). The upper inflection point request of MDFWP (180 cfs) equals 30% and is far more realistic with regard to the fishery needs. Reach 1 is the arctic grayling stronghold on the Big Hole River. The fluvial or stream-dwelling grayling is being considered for threatened or endangered status.

Big Hole River - Reach 2

MDFWP stands by its upper inflection point request of 800 cfs. Mr. Wesche's contention that there is no discernible inflection point is incorrect (see Attachment G).

Mr. Wesche's contention that the 800 cfs request is suspect because tape sag and wind could have overly influenced the wetted perimeter results is farfetched. If these factors were in fact a serious problem, field techniques practiced by MDFWP would have minimized their alleged threat. The metal tape used for the cross-sectional measurements was tightly stretched across the channel and held firmly in place with vise gripes attached to metal stakes. The tape rested on heavy, metal tripods that were placed in the river along each cross-section.

Mr. Wesche also contends that the wetted perimeter difference between 800 and 600 cfs is relatively small because it only amounts to a 3.9% decrease. This 3.9% decrease equals an additional 9 ft of dry channel, an amount that MDFWP considers significant.

Mr. Wesche also suggests that Reach #2 should be sub-divided into several more reaches. MDFWP's response to this suggestion was previously covered under Beaverhead River - Reach 2. The 140-mile-long Big Hole River was already divided into three reaches. MDFWP believes that three is adequate for the reservation process.

Big Hole River - Reach 3

Based on the quality of the fishery, Mr. Wesche apparently supports the 650 cfs instream flow request. However, he disputes the reach length (study design). Refer to Beaverhead River - Reach 2 for MDFWP's response.

The 650 cfs request equals 54% of the depleted average annual flow for the Big Hole River at the USGS gauge site near Melrose (USGS 1989) and equals 45% of the estimated undepleted or natural average annual flow of the river at its mouth (SCS 1975).

Warm Springs Creek

Here, Mr. Wesche presents 25% of the estimated mean annual flow as a reasonable instream flow standard.

Swamp Creek

The lower inflection point for Swamp Creek is not well defined and MDFWP may have erred in attempting to identify one. However, the critical element is the well defined, and hardly subjective, upper inflection point at 8 cfs, which is MDFWP's instream flow request (see Attachment H). Swamp Creek provides critical habitat for the fluvial arctic grayling, a species being considered for endangered or threatened status. An 8 cfs request is well justified based on fishery values. It should be noted that 8 cfs equals 23% of the depleted average annual flow (USGS 1989), which meets Mr. Wesche's 25% standard (see Cut Bank and Warm Springs creeks).

North Fork Big Hole River

MDFWP stands by its 30 cfs upper inflection point request. While the upper inflection is not clearly defined, there can be no denying that the loss of wetted perimeter greatly accelerates as flow decreases (see Attachment I). MDFWP has conservatively estimated the upper inflection point at 30 cfs. Thirty cfs is 20% of the depleted average annual flow for the North Fork (USGS 1989), which is well within Mr. Wesche's 25% standard of reasonableness.

The North Fork's resident fish population is not relatively low as Mr. Wesche claims. Page 2-244 of MDFWP's application states:

> "This 1,000 ft section supported approximately 168 trout 4 inches and longer, weighing 52 pounds, About 24% of the population exceeded 10 inches and trout exceeding one pound comprised 10% of the estimated biomass. The large size of the fish coupled with the fairly substantial numbers make the North Fork one of the more popular brook trout fisheries in the Big Hole drainage."

Fishery values on the North Fork go beyond its resident fish populations. As MDFWP's application states, the fluvial arctic grayling - a potential endangered/threatened species - inhabits the North Fork. These fishery values more than justify the high inflection point recommendation of 30 cfs. The presence or absence of an identifiable lower inflection point is, therefore, irrelevant to the North Fork and MDFWP's analysis of the instream flow needs.

The reason only 2 of 5 cross-sections were used in the analysis was previously explained under Big Sheep Creek.

Jerry Creek

MDFWP stands by its upper inflection point recommendation of 7 cfs (see Attachment J). Seven cfs is a conservative estimate of where the break actually occurs. Mr. Wesche's contention that a 3 cfs request is more reasonable is unsupported.

The fishery values of Jerry Creek revolve around the fact that the creek supports westslope cutthroat trout, which, like the arctic grayling, is a species of "special concern" that presently occupies but a small fraction of its historic range in Montana. Another important consideration is the spawning/rearing habitat that Jerry Creek provides for rainbow trout from the Big Hole River. These values, which are discussed on pg 2-315 and 2-316 of MDFWP's application, warrant instream flow protection at the high inflection flow of 7 cfs.

Mr. Wesche's contention that rainbow trout spawning occurs at or near spring runoff when water is abundant and, therefore, cannot support MDFWP's instream flow request, fails to consider important phases of the trouts' reproductive cycle. Once spawning is completed and the fertilized eggs are deposited in the bottom gravel, a 30-60 day incubation period is required before the eggs hatch and emerge from the gravel as fry. Fry can leave the creek after a few days or weeks and some may remain over winter or a number of winters before out-migrating to the main river. In addition for spawning, adequate flow must also be maintained during the period of egg incubation and fry emergence, for the out-migration of fry, and to provide year-round habitat for wintering young. All are important for reproduction to succeed. A problem on many spawning tributaries is the stream dewatering that occurs when eggs are incubating and fry are out-migrating. Losses can be severe, destroying the annual reproductive contribution. Mr. Wesche's contention that successful rainbow trout reproduction depends only on the spring runoff is incorrect.

Jefferson River

MDFWP stands by its upper inflection point request of 1,100 cfs. Mr. Wesche's contention that a distinct upper inflection point occurs at 700 cfs is incorrect (see Attachment K). Refer to Beaverhead River - Reach 2 and Big Hole River - Reach 2 for responses to Mr. Wesche's comments on study design (reach length of 84 miles) and measurement problems (the wind and sagging tape factors).

Mr. Wesche's contention that the requested 1,100 cfs appears excessive for the Jefferson River is unfounded and unsupported. The SCS (1975) estimated the undepleted average annual flow at Three Forks to be 2,869 cfs. MDFWP's request is 38% of this. MDFWP does not believe that 38% is excessive for a river with the Jefferson's fishery potential.

Boulder River - Reach 3

Because a midrange flow of 47 cfs was requested, Mr. Wesche claims MDFWP was inconsistent with the application of the wetted perimeter method. MDFWP's midrange request is based on an evaluation of the fishery resource. Page 2-370 of MDFWP's application states:

> "A 6,150 ft section of Reach #3 was electrofished in 1974. Except for a single brook trout, the brown trout was the only game species captured. A mark-recapture estimate showed that this section supported an estimated 242 age I and older brown trout, weighing 70 pounds, per 1,000 ft of stream. While the population level is significantly higher than that in Reach #2, it is still less than expected for a river the size of the Boulder.
>
> A spawning run of brown trout, some in the 5 pound class, enters the Boulder River each fall. The run is blocked in most years at an irrigation diversion dam at about river mile 2. On October 28, 1977, 216 brown

trout, averaging 15.3 inches in length and ranging up to 23.3 inches, were captured by electrofishing in a 200 ft section below the dam. Subsequent tag return data indicated that most of these spawners resided in the lower Jefferson River. Additional tagging studies conducted in later years confirmed this finding.

When considering the magnitude of the sediment deposits that inundate the lower Boulder River and its spawning gravel, the capability of the river to produce young brown trout recruits for the Jefferson River fishery is obviously limited. However, the fact that a significant number of brown trout spawners annually ascend the Boulder - a stream providing only marginal spawning habitat - is indicative of the poor state of other spawning sites for the Jefferson River trout population. The value of the Boulder River as a spawning tributary may, therefore, be greater than previously thought."

MDFWP stands by its 47 cfs request. The above described fishery values do not warrant a lower inflection point request, as claimed by Mr. Wesche.

MDFWP's instream request of 47 cfs is 22% of the estimated undepleted average annual flow for the Boulder River at its mouth (SCS 1975). This is within the 25% standard that Mr. Wesche claims is reasonable (see Warm Springs and Cut Bank creeks).

Gallatin River - Reach 2

Much of Mr. Wesche's criticisms relate to the reach length (study design). Again, Mr. Wesche incorrectly assumed that a reach is a river segment having a similar flow regime, instream flow requirement and channel geometry throughout its length. Refer to Beaverhead River - Reach 2 for MDFWP's response.

Mr. Wesche's challenge of MDFWP's 400 cfs request is based on an incorrect assumption (what a reach is) and on some possible inadequacies in a fish population study that he did not review. These criticisms have little merit.

Gallatin River - Reach 3

MDFWP agrees that the flow request appears excessive based on the flows that remain in this highly depleted river. Current streamflows reflect depletions to irrigate about 110,000 acres (Shields and White 1981) and municipal depletions for the City of Bozeman. Regardless of the amount requested by MDFWP, the Board is limited to granting no more than 50% of the average annual flow on gauged streams (this gauged flow reflects massive summer depletions). For the Gallatin River at Logan, this 50% limitation equals 537 cfs. Under law, the flow request of 1,000 cfs cannot be granted.

Hyalite Creek - Reach 1

MDFWP stands by its 28 cfs upper inflection point request. Mr. Wesche's contention that the "trout population data (mostly smaller rainbow)" does not justify the 28 cfs request is incorrect. Page 2-555 of MDFWP's application states:

> "A 1,000 ft section of upper Hyalite Creek within the Gallatin National Forest was electrofished on September 5 and October 8, 1980. Two hundred eighty-four rainbow trout, ranging from 3.3-17.6 inches, and one 7.6 inch brook trout were captured. The mottled sculpin was the only other species present.
>
> The standing crop of rainbow trout, the predominant trout species, was estimated using a mark-recapture method (Table 2-159). The estimate shows that this 1,000 ft section supported about 624 rainbow trout (3.3 inches and longer), weighing 75 pounds. Of the tributary streams electrofished in the Gallatin drainage, Hyalite Creek supported one of the highest populations of rainbow trout.
>
> A few cutthroat trout, believed to be drifters from Hyalite Reservoir, inhabit the upper stream."

The turbulent, high elevation, mountain tributaries in the Gallatin drainage do not grow large trout. Pan-size trout of 7-10 inches are the norm. Relative to other mountain streams in the drainage, the fishery of Hyalite is considered well above average. An upper inflection point request is warranted.

Without explanation, Mr. Wesche further claims that the "apparent historic water use in the lower portions of the reach" warrants a low inflection point recommendation of 14 cfs.

Deep Creek

MDFWP never claimed that the wetted perimeter method is perfect. We recognized the problems associated with its application on Deep Creek and corrected the flow request to an amount that equaled about 34% of depleted average annual flow. The problem we encountered was spelled out in the application for the scrutiny of all. A failure or even a group of failures is to be expected for a method the MDFWP admits is not perfect.

Wise River

Mr. Wesche states "Based upon the identification of several other potential limiting factors (heavy metals pollution, channel alterations, historic dewatering), the selection of an upper break point flow as a minimum to sustain a low quality fishery is questionable at best."

MDFWP has not given up on the Wise River, a stream with the potential to provide a far better fishery if habitat abuses, particularly mine pollution, were abated. MDFWP's justification for the 35 cfs request was clearly stated on pg. 2-313 of its application, which reads:

> "Results of past and more recent electrofishing surveys indicate that fish populations throughout the entire length of the Wise River are depressed. This could be a result of numerous factors, including angling pressure, metals pollution from Elkhorn Creek, habitat losses and channel alterations resulting from the dam failure in 1927, and the dewatering of the lower 5 miles of river. If these problems were abated, particularly the mine pollution, the fishery of the Wise River could substantially improve. For this reason, the high inflection point flow (35 cfs), although not warranted by the depressed state of existing fish populations, is requested. Should the river be reclaimed in the future, a 35 cfs reservation would help insure that the flow is sufficient to accommodate a potentially expanding trout population."

It should be noted that MDFWP's 35 cfs request is 19% of the river's average annual flow (USGS 1989), derived for the gauge at stream mile 9.

Flat Creek

The relevance of Mr. Wesche's criticism depends on the location of the transbasin diversion that enters Flat Creek from the upper Dearborn River. Mr. Wesche calls for two reaches; one in the natural unaugmented channel above the diversion entrance and one below in the augmented channel. The transbasin diversion enters Flat Creek about 30-35 miles upstream from the creek's mouth. Consequently, virtually all of the 32-mile-long-reach is within the augmented section, making Mr. Wesche's criticism irrelevant.

Smith River - Reach 1

MDFWP stands by its 90 cfs upper inflection point request. An upper inflection point clearly occurs at about 90 cfs, not at 50 cfs as claimed by Mr. Wesche (see Attachment L).

Sheep Creek

Mr. Wesche again incorrectly assumes that a reach is a stream segment having a similar flow regime, instream flow requirement, and channel configuration throughout its length. Refer to Beaverhead River-Reach 2 for further testimony on this point.

The gage site that Mr. Wesche refers to in his criticism is located at stream mile 28 of Sheep Creek (see pg. 1-30 through 1-31b of MDFWP's application). At the mouth of Sheep Creek, where the requested instream flow is intended to be monitored, the depleted average annual flow is 90 cfs (USGS 1989). MDFWP's upper inflection point request equals 39% of the 90 cfs.

The fishery values for Sheep Creek do not justify a lower inflection point recommendation as called for by Mr. Wesche. Sheep Creek supports a substantial resident trout population, comprised of an estimated 945 rainbow trout per 1,016 ft of stream (see pg. 3-168 of MDFWP's application). The excellent small stream fishery of Sheep Creek warrants an upper inflection point recommendation.

Sun River - Reach 2

Mr. Wesche appears to find MDFWP's 130 cfs request acceptable, although he objects to the excessive reach length. See Beaverhead River - Reach 2 for MDFWP's response to Mr. Wesche's criticism of reach length.

Shonkin Creek

MDFWP stands by its upper inflection point request of 7 cfs. Mr. Wesche's contention that the upper inflection occurs at 6 cfs is not supported by the wetted perimeter curve (see Attachment M).

Marias River - Reach 1

The breakpoint on the wetted perimeter flow relationship for Reach 1 is not clear-cut. However, there is an increase in the rate of drop at 200 cfs (see Attachment N). The 200 cfs request represents a conservative estimate of the site of the breakpoint.

USGS (1989) shows average annual flows of 1,100 cfs for the Marias River above Tiber Reservoir and 910 cfs near Shelby. The 200 cfs request is well within Mr. Wesche's 25% standard of reasonableness.

Mr. Wesche states that "use of the WPIPM (wetted perimeter method) for a reach predominated by walleye, not trout, appears to conflict with the intended application of the method." How the application of wetted perimeter to the Marias River - Reach 1 conflicts with the intended purpose of the method is not explained. MDFWP presumes that Mr. Wesche is contending that invertebrate food production in stream riffles is irrelevant to walleye. Brown (1971) states:

> "Most kinds of aquatic invertebrates are eaten by both small and large walleyes. Adults feed heavily on small fish when these are available."

Rainbow trout, while not the most abundant game fish in Reach 1, are commonly found. The average size for rainbow trout is large, averaging nearly two pounds. Invertebrate food production is important to the maintenance of this trout fishery.

Marias River - Reach 3

MDFWP stands by its upper inflection point request of 560 cfs (see Attachment O). It should be noted that there is an error in Figure 3-59 (Attachment O) of MDFWP's application. The 560 cfs upper inflection point request was incorrectly identified at 680 cfs.

Mr. Wesche questions the reasonableness of the requested flow based on the predominance of sauger, not trout, in the fishery. He does not explain the rationale for this criticism. Again, MDFWP presumes that Mr. Wesche is contending that invertebrate food production in stream riffles is irrelevant to sauger. Brown (1971) states:

> "The food of young saugers is almost entirely aquatic insects and crustaceans. Adults continue to utilize these organisms but feed mainly on small fish of any available species."

The production of invertebrate food items is also important for mountain whitefish, shovelnose sturgeon, walleye, channel catfish, burbot, and brown trout, which are other species in Reach 3 (Brown 1971).

The exceptional fishery values of Reach 3 warrant the upper inflection point request. These fishery values are discussed on page 3-261 and 3-262 of MDFWP's application.

Cut Bank Creek

MDFWP stands by its high inflection point request of 75 cfs for Cut Bank Creek. As stated on page 3-290 of MDFWP's application, "Cut Bank Creek is an important fishery because it is the only trout stream readily available to persons in the Cut Bank area". By area standards, Cut Bank Creek is an important fishery resource and warrants a high inflection point request.

It should be noted that Mr. Wesche again raises his 25% standard of reasonableness.

Teton River

A 35 cfs instream flow request for a major tributary in the mid-Missouri Basin is not unreasonable to MDFWP. While the river environment suffers from long-term abuse, MDFWP has not given up on the river's potential as a fishery. We stand by the 35 cfs upper inflection point request.

Big Spring Creek - Reach 1

Mr. Wesche faults the 110 cfs request of MDFWP that was based on the wetted perimeter method. He calls for the Base Flow Approach due to the spring origins of the creek. Base flow for Reach 1 at its downstream boundary is 110 cfs (USGS 1989), the same as MDFWP's request.

Big Elk Creek

MDFWP stands by its original request of 9.5 cfs on Big Elk Creek. In our opinion, the upper inflection point is clearly defined at this level (see Attachment P). The observation that large numbers of adult brown trout were massed in one pool at a flow of 4.8 cfs clearly indicates that a flow level of 3.0, or even 4.8 cfs, is inadequate. Photo documentation is available to corroborate these observations. Brown trout are a species that seeks cover for protection. When instream cover is dewatered, the only viable option for these fish is to seek the cover provided by water depth, hence the concentration of fish in pools. It should also be reiterated that flows from Big Elk Creek are crucial to maintaining instream flow in Reach #1 of the Musselshell River.

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Frederick A. Nelson, being duly sworn, states that the foregoing testimony is true.

Dated this 16th day of December, 1991.

Frederick A Nelson

Frederick A. Nelson

Subscribed and sworn to before me this 16th day of December, 1991.

Curtis E. Larsen

Notary Public for the State of Montana
Residing at Helena, Montana
My commission expires July 6, 1994

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Status of Instream Flow Legislation and Practices in North America

Dudley W. Reiser, Thomas A. Wesche, and Christopher Estes

ABSTRACT

This paper presents the results of two nonstatistical surveys (completed in 1981 and 1986) that solicited information from state and federal agencies concerning instream flow issues and practices in North America. Forty-six states and 12 Canadian provinces responded to the survey. Fifteen of the 46 states reported legislative recognition of instream flows for fisheries protection. In Canada, individual provinces generally lacked instream flow legislation, although federal legislation existed that could be used. The most commonly applied method (in use in 38 states or provinces) for assessing instream flow requirements, as reported in the survey, was the Fish and Wildlife Service Instream Flow Incremental Methodology (IFIM). Major research needs cited by survey respondents included (1) more species habitat information and preference curves, (2) techniques for determining instream flows for atypical conditions, and (3) testing of fish habitat:flow:production relationships.

Increases in the number of proposed water development projects in North America have forced fisheries biologists to predict the level of effects that result from such projects. When water is developed for agricultural, municipal, industrial, and power production uses, the magnitude, timing and duration of natural flows may be altered, thereby affecting the availability and quality of fisheries habitat (Peters 1982). Therefore, the biologist needs to determine the amount of water that must be left in the stream to maintain aquatic resources at some desired level. Such flows are often termed "instream flows." To this end, a number of formal methodologies for prescribing instream flow (IF) needs have been developed (Stalnaker and Arnette 1976; Wesche and Rechard 1980; EA Engineering, Science, and Technology, Inc. 1986).

Today, although various state and federal resource agencies agree that instream flows for fisheries should be a recognized use of water, they differ as to how instream flows are legally perceived and/or derived. In addition, because of geographic differences, instream flow problems will vary by region with fish species (Peters 1982).

In 1981, the Water Development and Streamflow Committee (WDASC) of the Western Division of the American Fisheries Society (WDAFS) surveyed the western United States and part of Canada and Mexico (WDAFS 1981) regarding IF procedures and programs and to assess their effectiveness for providing flows to sustain fishery resources. The WDASC repeated and expanded the survey in 1986 to include all of North America. In this paper, we summarize the results of both surveys, emphasizing the expanded 1986 survey. McKinney and Taylor (1988) provides a more comprehensive summary of some western state programs and we recommend it as a supplement to this paper.

Survey Format

We undertook the 1986 survey by mail using a questionnaire patterned after the 1981 survey, the results of which were summarized but never formally published (WDAFS 1981). The questionnaire solicited information on:

- status, title, and effectiveness of current instream flow legislation;
- name of agency(ies) administering instream flow activities;
- methods used for assessing IF needs;
- basis for selecting a given method;
- ways in which field results are used in formulating an IF recommendation;
- major IF related research needs; and
- other concerns related to IF's.

We sent 202 questionnaires to 186 agencies in the 50 states and to 16 agencies in 12 Canadian provinces that administer fish and wildlife resources, and in some instances water resources. For many states, we also sent questionnaires to the federal agency administering federal regulations in that area, e.g., Fish and Wildlife Service (FWS).

Survey Results

We received responses to 100 of the 202 mailed questionnaires, a return rate of 49.5%. The non-responding states, provinces, and territories were Connecticut, Iowa, Maryland, District of Columbia, Prince Edward Island, Quebec, Saskatchewan, and the Yukon Territory. Summary responses for each state or province are presented in Table 1.

Instream Flow Legislation

Fifteen of 46 states (33%) reported legislative recognition of instream flows for fish and aquatic resource protection (Fig. 1). Several noted that other related legislation addressed instream flows; most commonly, statutes concerning water quality and quantity for industrial, agricultural, and domestic uses. Not surprisingly, 9 of the 15 states (60%) that have IF legislation are in the western U.S. where the concept for and impetus behind the preservation of instream flows for fish and wildlife had its origins (Fig. 1). Water law in

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Table 1. Summary of responses to the 1986 instream flow questionnaire

State/province	Status of IF legislation	Title of IF legislation	Effectiveness of legislation	Agencies administering IF	IF field methods used	Major IF research needs
Alabama	None	N/A	N/A	FERC, AL Dept. Environ. Mgt; COE	IFIM, AVDEPTH, Tennant	Test validity of IFIM on resident cool and warmwater species; development of preference curves for these species
Alaska	Enacted	AS 46.15.145 of the AK Water Use Act	Untested	AK DNR; AK Dept. Fish & Game	IFIM, Tennant, and other proven methods	Need methods tested and modified for Alaskan conditions; local preference curves, better fish data bases, more gauging stations
Arizona	None; legislation was proposed for 1986 but not introduced	N/A	N/A	AZ Dept. Water Res. BOR, USFWS	IFIM	Preference curves for native species including T&E; do the species including T&E; do the parameters of depth, velocity, substrate and cover adequately predict fish habitat
Arkansas	Enacted	State Act 1051	Untested	AR Soil and Water Comm.	AR method, (discharge) testing, IFIM	Validation of models; develop better mechanistic models based on biomass and numbers; emphasis on evaluating community rather than 1-2 indicator species
California	None (related legislation: Section 5937 of Fish and Game Code)	N/A	N/A	State Water Res. Control Board; CA DF&G determines need and quantity	IFIM (IFG4); USFS has used R-2 cross; other methods considered	Validation of models; flushing flow studies; need more generalized stream models that work with invertebrates; evaluate effects of prolonged low flows on fish populations; is tributary recruitment sufficient to seed mainstem habitat; remove subjectivity of IFIM so it can be uniformly applied
Colorado	Enacted	Senate Bill 97 (passed in 1973); additional legislation in 1987	Variable	CO Water Conserv. Board; flow recommendations made by CO Div. Wildlife	R-2 Cross, as specified in S.B. 97; select cases use IFIM	Validation of weighted useable area (WUA) as a function of fish population; i.e., does habitat relate to fish?
Delaware	None	N/A	N/A	N/A	Evaluate water quality with respect to flow	Instream flows are not a major issue in Delaware and no instream flow problems have developed in the state
Florida	None (related legislation)	N/A	N/A	FL Game and Fresh. Fish. Comm; FL DNR; FL Dept. Env. Reg.	Based on water quality standards and local conditions	Need to determine optimal flow for river systems; address problems of water quality and flow fluctuations
Georgia	None (related legislation)	N/A	N/A	GA Environ. Protection Div; GA Water Res. Mgt.	7Q10; IFIM (PHABSIM)	Need habitat curves for eastern streams; need new techniques for southeastern streams
Hawaii	Enacted	HI Instream Use Act of 1982	Untested	HI Dept. Land & Nat. Res. Div. of Water & Land Dev.	IFIM is being tested; have used Q90 values	Need to define microhabitat requirements of native stream fauna (molluscs, gobies, etc); correlate habitat to fish production; determine applicability of IFIM to high gradient streams
Idaho	Enacted	1978 Minimum Streamflow Act	Unknown	ID Dept. Water Res; ID Dept. Fish & Game makes recommendations	IFIM; Wetted Perimeter	Need more stream and species-specific probability-of-use information
Illinois	None	N/A	N/A	IL Div. of Water Res.	IFIM	Need definition of relationship of flow:habitat:fish population
Indiana	Enacted (several codes relate to flow releases from dams)	IN Code 13-2-6.1, Water Resource Mgt.	Untested	Nat. Res. Comm. of IN DNR, Div of Water provides tech. input	IFIM (IFG4 & WSP); Tennant	Determine which streams need IF protection and how to set flow needs; more individuals trained in IF methods
Kansas	Enacted	1980 Minimum Desirable Streamflow Act	High	Chief Engineer, Div. of Water Res. of Board of Agriculture	IFIM	Validate response of standing crops to varying flow regimes; assess adequacy of established minimum flows
Kentucky	None (pending)	N/A	N/A	KY Div. Water. Nat. Res. & Environ. Protection	Professional judgment; Tennant	More streamflow data for the state, present coverage is thin; flushing flows; water quality effects; low flow augmentation for wastewater plants
Louisiana	None	N/A	N/A	Not Stated	Little need for IF determinations	Preference curves for warmwater stream fishes
Maine	None (related legislation)	N/A	N/A (Related legislation is effective)	ME Dept. Environ. Protection; Dept. Inland Fisheries & Wildlife	HEP and IFIM and modifications thereof; also professional judgment	Accurate predictive models for small watersheds; preference curves for northeastern species; assess population response to flow establishment (follow-up studies); habitat inventories of all watersheds; fish behavior studies related to flow regulations; techniques for using HEP and IFIM in deep, riverine habitat; assess effects of winter-time flow regulation; assess effects of flow regulation on substrate composition

Table 1. (*continued*)

State/province	Status of IF legislation	Title of IF legislation	Effectiveness of legislation	Agencies administering IF	IF field methods used	Major IF research needs
Massachusetts	None	N/A	N/A	MA Water Res. Comm; MA Div. Fisheries & Wildlife	MA Balance; Aquatic baseflow; 7Q10	Habitat requirement data of important eastern species for use with IFIM; information on minimum flow needs in flow-through ponds
Michigan	None	N/A	N/A	MI DNR, State Water Res. Comm.	Wetted Perimeter; velocity-habitat method (similar)	HSI model verification; HSI model development for invertebrates; HSI development for nongame fish species
Minnesota	Enacted (1977, 1981)	MN Statutes 195.39, Sub 1, 105.41	Effective	MN DNR, Div. of Waters	In the process of reviewing methods	Assess applicability of existing HSI curves for fish species in Minnesota; develop techniques to assess impacts of peaking flows on aquatic systems; evaluate existing IF methods for use in MN; test validity of fish biomass - habitat relationships
Mississippi	None (attempted but failed in legislature)	N/A	N/A	MS Bureau of Pollution Control; MS Dept. Wildlife & Fisheries	IFIM; also standard hydrological methods	Suitability indices for warmwater systems in southeastern U.S.; research to assess effects of diverted streams and gravel operations
Missouri	Pending (water bill introduced into 1986 legislation)	House Bill 1470	Untested	MO DNR; MO Dept. of Conserv.	IFIM (WSP and IFG4); Tennant; personal experience	More models; more stream gauges to monitor discharge
Montana	Enacted	Water Use Act of 1973	Effective	MT Dept. Fish Wildlife and Parks quantifies rights; DNR and Conserv. reviews applications; Board of Nat. Res. & Conserv. grants rights	Wetted perimeter/inflection point; others considered	Summarize data of biological responses to flows; flow needs for wetlands and riparian habitats; impacts of rapid fluctuations on fish; biological needs of flushing flows; assess impacts of winter water depletion on fish; assess effects on existing small hydro on fish; legal means to augment flows in depleted streams
Nebraska	Enacted (1984)	Instream Appropriations, 46.2, 107 to 46.2, 119; Bill 1106	Untested	NE Nat. Res. Districts (24); NE Game & Parks Comm. specifies reaches; Nat. Res. Comm. files application; Director Wat. Res. grants permit	None specified	Determine channel maintenance flows in alluvial streams; can cross section change in dominant discharge be used to predict long term change in width, depth, etc.
Nevada	None	N/A	N/A	NV State Water Engineer; NV Dept. of Wildlife	None specified	None at present
New Hampshire	None (attempted but failed in legislature)	N/A	N/A	NH Fish & Game; NH Water Res. Board	Aquatic Base Flow; IFIM; HEC-2; site specific data; historical flow data	Suitability curves for northeastern species including Atlantic salmon; determine if differences in SI curves exist between large and small streams
New Jersey	None	N/A	N/A	NJ Dept. of Environ. Protection, Div. of Water Res.	MT Method; New England Method; 7Q10	Better define characteristics of New Jersey's streams; develop minimum flow procedure that will protect aquatic biota; define minimum flows to protect fresh/saltwater interface; more information on fish screening and passage
New Mexico	None (attempted but failed in legislature)	N/A	N/A	NM State Water Engineer	No specific methods; IFIM has been used	Develop curves for T&E species; determine habitat needs of native fish species
New York	None	N/A (regional legislation passed for 31 reservoir releases)	Inadequate	NY Dept. of Environ. Conserv.; Div. of Fish & Wildlife; Div. of Reg. Affairs; NY Dept. of Health	IFIM, professional "eye-balling," flow duration curves	Improved habitat electivity curves for fish & aquatic invertebrates; establish flow; habitat:production relationships; develop electivity curves for recreational activities (boating, fishing, etc.) water quality-flow relationships; assess effects of pulsing or peaking flows
North Carolina	None (related legislation)	N/A	Cumbersome	NC Div. of Wildlife; Res. Div. of Water Res.; Div. of Environ. Mgt.	IFIM, wetted perimeter, September median flow	Warmwater riverine fish preference curves
North Dakota	None	N/A	N/A	ND State Water Comm.; Game & Fish Dept.	Tennant	Habitat needs of forage and gamefish of intermittent prairie streams; better fisheries data on streams; define physical parameters relating habitat to flow; data to define minimal flow needs
Ohio	None	N/A	N/A	OH DNR, Div. of Water	Standard USGS methods	Assess impacts of flow modification due to small scale hydro; need adequate staff and funding to work on instream flow problems
Oklahoma	None	N/A	N/A	OK Water Res. Board	IFIM, Tennant	Determine flow requirements for optimum sportfishing; transbasin flow diversions; impacts of flow regulation on fisherman use; evaluate significance of intermittent streams; develop IF methods for large rivers; work on water quality models

Table 1. (*continued*)

State/province	Status of IF legislation	Title of IF legislation	Effectiveness of legislation	Agencies administering IF	IF field methods used	Major IF research needs
Oregon	Enacted	ORS 536.325 (1985)	Untested	Water Res. Comm.; OR Dept. of Fish & Wildlife (determines flow needs)	IFIM and versions; Oregon method	Evaluate IFIM habitat: flow relationships; develop and validate low cost methods for water resources planning and small projects
Pennsylvania	Enacted	Clean Streams Law of 1975	Low flows still impact fisheries	PA Dept. of Water Res.; PA Fish Comm.	Q(7-10); 30% Avg. Annual Flow (Tennant); 0.25 cfsm	Effects of water quality, flow fluctuations and reduced flow; validate IFIM; and validate fish models for eastern streams
Rhode Island	None	N/A	N/A	RI Div. of Fish & Wildlife	N/A	Current wetlands and dam legislation allows control of instream flows
South Dakota	None (under consideration)	N/A	N/A	SD Dept. Game, Fish & Parks; SD Dept. Water & Nat. Res.	IFIM; sag tape (cursory surveys)	Habitat suitability curves of midwestern fishes; refine and document hydraulic models; water quality changes related to flow regulation; assess fish populations in all SD streams; match populations to available habitat
Tennessee	None (related legislation)	N/A	N/A	TN Office of Water Mgt; TN Wildlife Res. Agency; TVA	IFIM; visual assessment	None stated
Texas	Enacted	House Bill 2, 1985; Parks & Wildlife Code 12.0011 and 12.024	Untested	TX Water Comm.; TX Water Development Board; TX Parks & Wildlife Dept.	IFIM	Assess surface water availability for future development; more extensive data base; effects of flow fluctuations and water quality changes
Utah	Enacted	House Bill 58; Instream Flow Amendment 1986	Untested	UT Div. of Water Res.; UT Div. Wildlife Res. (recommend flows)	IFIM; Tennant	Effects of peaking on fisheries; improve preference curves of cutthroat trout; develop preference curves for non-gamefish; test habitat: fish population relationships; establish flushing flow methods
Vermont	None (attempted in 1974–1980)	N/A	N/A	VT Dept. of Fish & Wildlife; VT Dept. of Water Res.	VT Fisheries Flow Needs Method; IFIM; New England Aquatic Baseflow (ABF)	Regional habitat suitability curves; effects of short-term flow fluctuations on habitat use; long-term effects of flow by-pass on channel morphology; test relationship of flow and fish community structure, growth and abundance
Virginia	None (related legislation)	N/A	N/A	VA State Water Control Board; VA Comm. of Game & Inland Fisheries	Wetted perimeter; 7Q10; IFIM	Validate suitability models for eastern streams; verify model use for warmwater streams; test relationship of habitat and fish production; assess long-term changes in fish population resulting from flow regulation; are instream flows a limiting factor to fish
Washington	Enacted	Minimum Water Flows and Levels Act (1969); Water Resources Act of 1971	Effective but controversial	WA Dept. of Ecology; WA Dept. of Game; WA Dept. Fisheries	IFIM; USGS Toe-Width; Tennant	Methods for high gradient streams; improved salmonid habitat preference curves; verification of habitat preference curves; need big river flow models; test fish production vs. habitat/flow
West Virginia	None	N/A	N/A	WV DNR Wildlife Div.	IFIM; Aquatic Baseflow (ABF); Tennant	More species specific biological information; evaluate fluctuating flows
Wisconsin	None (related legislation)	N/A	N/A (Related legislation effective)	WI DNR	IFIM, hydraulic models; habitat computation using Reynold's numbers; judgment; water quality	Regional life history information; life history information for invertebrates; more hydrological data and gauging stations; user friendly IFIM software
Wyoming	None (attempted but failed in 1985)	N/A	N/A	WY Game and Fish Dept. WY State Conserv. Comm.	IFIM (IFG-4, IFG-1); Habitat Quality Index (HQI); Tennant	Validation of IFIM; winter flow needs; flushing flows; verification of flow recommendations
CANADA Alberta	None (related legislation)	N/A	N/A	AB Fish and Wildlife Div.; AB Environ.	Tennant, IFIM	More acceptable biological curves; personal computer programs; hydraulic models for use in ice-covered conditions; public relations to raise awareness of instream flows
British Columbia	None (related legislation)	N/A	Less than 0.5% of water allocated for IF use	BC Ministry of Environ., Water Mgt. Branch; Fish and Wildlife Branch	Tennant; Wetted perimeter; IFIM	Calibrate MT Method to BC validate flow; fish population relation; develop methods to assess recreational needs; multidisciplinary approach to IF studies; validate habitat models
Manitoba	None (related legislation)	N/A	N/A	Government of MB, Water Res. Branch	IFIM; Tennant; correlate year class to spawning flow	Optimum flows for overwintering fish and egg incubation; maximum and minimum flows for spawning; relationship of low flow to water quality
New Brunswick	None (related legislation)	N/A	N/A	NB Dept. of Municipal Affairs and Environ.	25% of Avg. Ann. Flow (Tennant); IFIM	Entire range of instream flow research is needed
Northwest Territories	None (related legislation)	N/A	N/A	Dept. Renewable Res.	N/A	Review of instream flow related research

Table 1. (*continued*)

State/province	Status of IF legislation	Title of IF legislation	Effectiveness of legislation	Agencies administering IF	IF field methods used	Major IF research needs
Nova Scotia	None (related legislation)	N/A	N/A	NS Dept. of Environ.	Tennant; IFIM	Determine if habitat changes influence fish populations; validate hydraulic models; assess salmonid overwintering requirements; assess effects of short-term flow reductions
Newfoundland Labrador	None	N/A	N/A	Dept. of Environ.	Tennant, WSP, IFIM	Examine production vs. flow relationships; develop habitat preference curves for local species; assess river geomorphometry as it relates to flow change
Ontario	None (related legislation: Canada Fisheries Act)	N/A	N/A	ON Ministry of Nat. Res.; Ministry of Environ.	Use various methods - none preferred; have used IFIM; water quality models	Develop data base of flow use and cross-sectional area for important habitats; assess relationship between life stages and flows; evaluate IF methods for Canada; adapt IF methods for other uses; develop methods to evaluate water quality problems; integrate risk assessment into water quality studies

the West is primarily based on the doctrine of prior appropriation which states, "first in time is first in right"; whereas the riparian doctrine predominates in the East. The prior appropriation doctrine has put a premium on unappropriated water in western streams. Three western states, Arizona, New Mexico, and Wyoming noted that legislation had been introduced for consideration, but had failed to pass (note: Wyoming passed IF legislation in 1986).

Six eastern states reported having a formal IF protection statute. In Mississippi, New Hampshire, and Vermont legislation had been introduced but failed to pass; in Kentucky, Missouri, South Dakota, and Virginia legislation was pending as of 1986. The importance of IFs is apparently becoming widely recognized.

Most respondents indicated the effectiveness of newly enacted legislation was largely "untested." States that reported legislation as "effective" include Kansas, Minnesota, Montana, and Washington. Even among these, problems related to budget, overappropriation, and controversy were cited. Passage of formal legislation does not guarantee preservation of fishery resources, although it is an important and necessary first step.

In Canada, formal IF legislation was generally lacking. However, the majority of the provinces noted that related legislation existed that can be used for protecting instream resources. In particular, the Canada Fisheries Act, in force in all of Canada, specifies that the Ministry of Fisheries and Oceans can designate a sufficient flow to protect fishery resources. In Alberta, Saskatchewan, Manitoba, and Ontario (4 of 10 provinces) execution of the act has been delegated to the province. Where it has been applied, it has been effective. An abundance of water and a historical low demand for the resource were cited as reasons for lack of IF legislation in Newfoundland. Indeed, most streams and rivers in Canada remain free-flowing and unregulated. Thus, competition for a limited water resource has not become as intense as in the United States. Canada has the enviable position of having the opportunity to adopt instream flow legislation and reserve instream flows before intense resource competition develops.

Use of Instream Flow Methodology

Respondents reported a wide array of methods for determining instream flows (Fig. 2), ranging from office methods such as the Tennant (1975) and Aquatic Baseflow (ABF; USFWS 1981) techniques which are based largely on historical flow records, to field/office methods such as the Instream Flow Incremental Methodology (IFIM; Bovee 1982) and the Habitat Quality Index

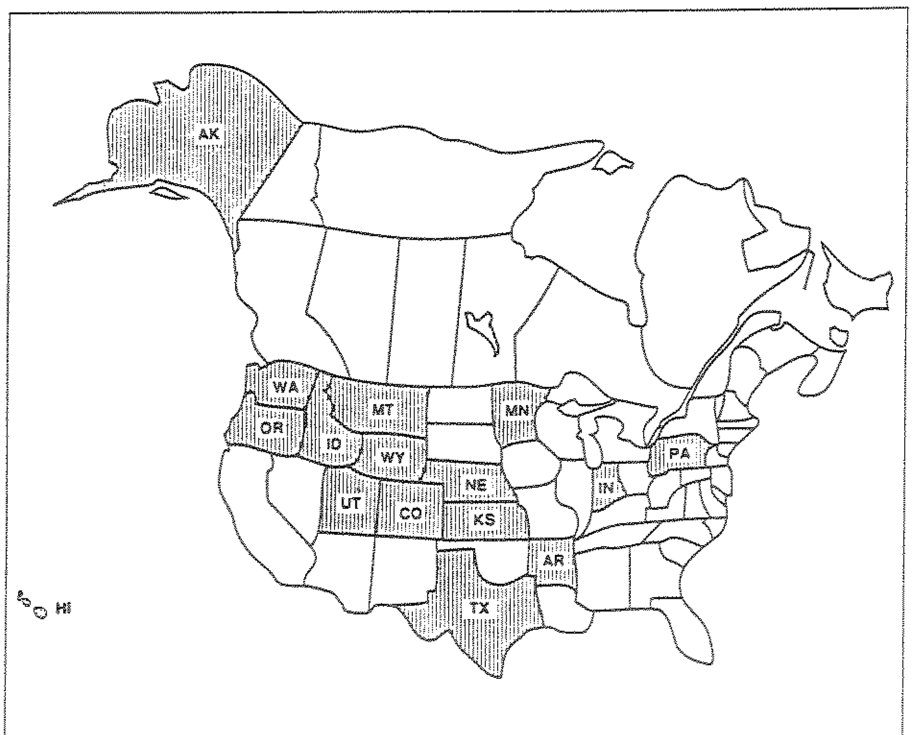

Figure 1. States having formal instream flow legislation as of 1986.

(HQI; Binns and Eiserman 1979) in which the collection of detailed field data is integral to making flow recommendations. We refer the reader to the summary review reports of Wesche and Rechard (1980), Stalnaker and Arnette (1976), EA Engineering, Science, and Technology, Inc. (1986), and the proceedings of the Symposium on Instream Flow Needs (Orsborn and Allman eds. 1976), for detailed information on specific methods.

The most commonly used instream flow method is the IFIM. This method was cited as being used in 38 states or provinces, and was listed by 24 respondents as the preferred method. In California, Washington, and Idaho it is the required technique for conducting instream flow studies. The IFIM and its component computer software package, the Physical Habitat Simulation (PHABSIM) system, were derived in the late 1970s by the FWS Instream Flow Group (IFG) (now the Instream Flow and Aquatic Systems Group), in Fort Collins, Colorado. The method was a modification of earlier techniques (Waters 1976; Collings 1972), which provided incremental assessments of effects of flow reduction on fish habitat. Unlike other methodologies, the IFIM is an interdisciplinary process used to evaluate the effects of individual or combined flows on habitat availability for individual or combinations of species and life phases. The most commonly practiced IFIM technique is to collect physical and biological data following procedures that allow for analyses using the PHABSIM, a series of computer programs. The IFIM provides the most detailed and graphic approach for assessing effects of water resource developments on fish habitat. Due to its utility, the many reports and information papers produced by the IFG since 1976, and the IFG short-course offerings of "hands-on" training, it is not surprising that the IFIM is so widely applied today.

The Tennant Method is frequently used in selected states and provinces. Twelve respondents listed the method as commonly used, usually as an office technique for providing reconnaissance-level evaluations of instream flow requirements. In Alaska, New Jersey, and North Dakota, the Tennant Method or a modification thereof (Estes 1987) was cited as the primary technique for deriving instream flow recommendations. In North Dakota, it is the only method recognized.

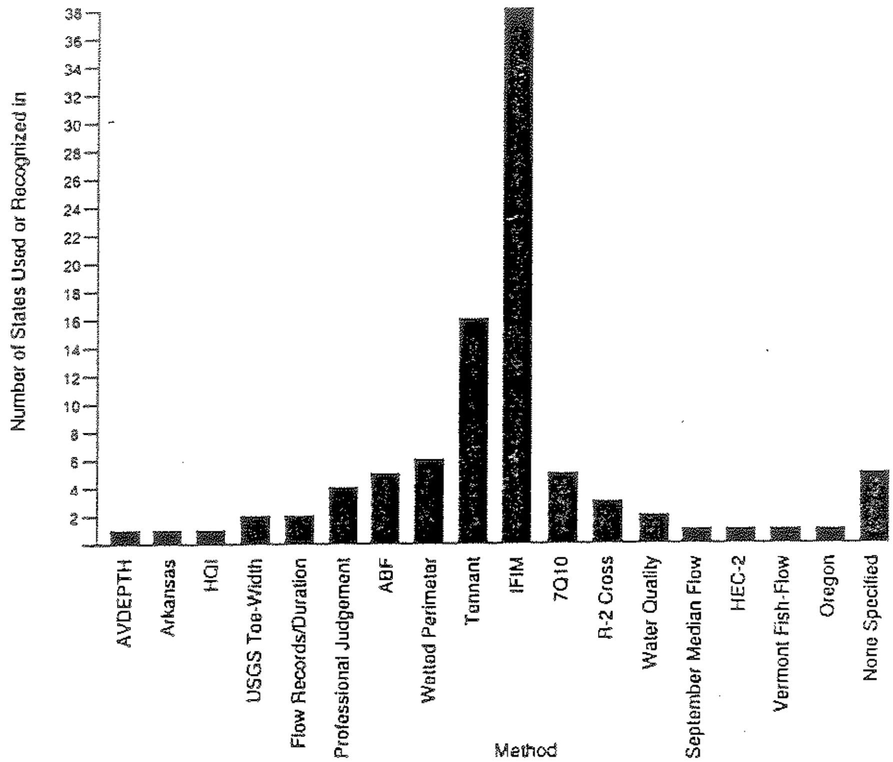

Figure 2. Instream flow methods presently applied in North American and their relative frequency of use. For a description of methods, see Wesche and Rechard (1980), and EA Engineering, Science, and Technology, Inc. (1986).

Other commonly applied methods are the Wetted Perimeter (WP), the ABF, and the 7Q10. The WP method was listed as the primary technique in Michigan and Montana, the latter requiring its use for making instream flow recommendations. The ABF technique was developed for and is used primarily in New England. The 7Q10 method (defined as the flow which is greater than the 7-day 10-year low flow event) is generally applied when instream water quality problems exist. Eastern and southeastern states have used it most frequently (Fig. 2).

Professional judgment was also cited as a viable and currently used approach. We find this encouraging and hope that the application of all methodologies, no matter how complex or sophisticated, leaves room for professional judgment in formulating recommendations.

Several respondents noted that specific methods for quantifying IF requirements have not been designated. Minnesota, for example, was reviewing various methods for applicability to their stream systems. Other states in this category lack a general instream flow statute, for example, Nevada and New Mexico. More states and provinces will probably adopt or require specific methods for conducting IF investigations. This would insure that all studies are conducted and flow recommendations derived using the same techniques. However, there are risks in requiring a set method, the major one being that new or revised methods may be developed which are more appropriate or valid than those previously required. In addition, the complexity and costs for application of a "required" method, may, under some circumstances and for some projects, be more than necessary for assessing flow regulation effects on the aquatic resource, as determined by less rigorous methods. Thus, it may be more appropriate to establish guidelines for determining whether an analysis is valid as opposed to specifying which analysis is performed.

Needs for Instream Flow Research

The major areas of instream flow research cited by respondents as needed are listed on the next page in order of decreasing frequency (the number of times each area was listed as a primary or secondary need respectively, is shown in parenthesis).

- Need more species habitat information and preference curves developed for local areas, including curves for threatened and endangered (T&E) species, warmwater species, and regional curves developed for eastern, southeastern, and southwestern species (11,4).
- Develop new methods or techniques for determining flow requirements for different conditions. Respondents indicated that specific methods are needed for assessing instream flow problems: in small watersheds and high gradient streams; to assess peaking impacts; for determining channel maintenance flows; for assessing effects of short term flow fluctuations; for sport fishing and recreational needs; to determine incubation flows and overwintering flows; and for planning purposes. (9,10).
- Validate and test the IFIM to determine if Weighted Usable Area (WUA) does relate to fish production (5,1).
- Determine if a relationship exists between Flow: Habitat: Fish Production and define the relationship (5,10).
- Validate and test the existing Habitat Suitability Index Models (HSI) and modify to local conditions (3,2).
- Develop more hydrologic and water resource data throughout the state or province (2,2).
- Develop new and validate existing water quality models (1,5).
- Modify and adapt the IFIM to local conditions (e.g., high gradient streams or large, deep rivers) (0,3).
- Validate existing and develop new hydraulic models (0,3).
- Determine flushing flow requirements for streams (0,3).
- Need more fish life history information (0,2).
- Need more funding support and staff to handle IF issues (0,1).
- Develop public awareness programs explaining the benefits of IF uses (0,1).
- Need to assess the adequacy of existing flows for maintenance of the fishery resource (0,1).

With regard to the most frequently cited research need, preference curves are required for application of the IFIM, and the frequency of interest in this research need relates to the widespread use of the IFIM technique. The development of appropriate curves for use with the IFIM PHABSIM is often the most time-consuming and controversial aspect of its application. Most respondents citing this need were from the eastern and midwestern portions of North America, including Georgia, Louisiana, Massachusetts, Minnesota, Mississippi, New Hampshire, North Carolina, New York, South Dakota, Vermont, and Virginia, where the IFIM PHABSIM has only recently been applied. Two western states, Arizona and New Mexico, cited the need for development of curves for T&E species.

There is still an apparent need for the development of new methods to address specific IF problems. Nineteen respondents cited this need, listing several areas of application. One area receiving little attention to date is that of assessing recreational IF needs. This includes sport fishing opportunities, rafting and canoeing, fish and wildlife viewing, and other recreation associated with riverine systems. To date, essentially all methods have focused on IF requirements from a biological perspective. In the future, methods will be needed for integrating sociological needs into the flow-need assessment process.

The validation of the relationship between flow, habitat, and fish production was cited as a research need 21 times, 6 of which specifically mentioned the validation of the IFIM PHABSIM. All quantitative IF methods in use are based on determining flows needed to meet some quantity of habitat assumed to be crucial for sustaining fish populations. Unfortunately, the linkage establishing a relationship between habitat and fish populations has not been adequately established. Thus, flows necessary for habitat preservation may be different from flows required for sustaining the fish population. Interestingly, it has been a decade since Wesche (1980) noted the fallacy in the then "state of the art" IF methods that no available methodology addresses the question of potential biological consequences. This same deficiency remains today. Although some research has attempted to address this issue, (e.g., Scott and Shirvell 1987; Conder and Annear 1987; Orth and Maughan 1982) the results have been inconclusive, narrowly useful, or controversial in interpretation. Clearly, as indicated by the number of respondents, this area of research should be intensified in the future.

Comparison with 1981 Survey Results

Since 1981, an additional three states have enacted formal IF legislation: Hawaii (limited to certain islands), Utah, and Texas. Wyoming, Arizona, and New Mexico have made repeated unsuccessful attempts to pass IF legislation during 1981–1986; Wyoming has since enacted such legislation.

As in 1986, the 1981 respondents emphasized the need to collect local data on spawning, incubation, rearing, and fish-passage habitat data to refine or develop stream-specific habitat suitability curves. They also stressed the need to improve and simplify procedures for evaluating aquatic habitat alterations and a need to share information and procedures. Some respondents stressed the importance of quantifying federal reserve water rights linked to federal lands (e.g., national forests and lands administered by the Bureau of Land Management). The methods used in 1981 were similar to those employed in 1986 and ranged from IFIM to professional judgment, with the selection of a given method based on the nature of the problem, time, financial and logistical constraints, and the reliability and legal acceptability of the method.

The 1986 survey of instream flow issues reveals increasing emphasis on preserving aquatic resources in North America's rivers. It should be useful not only for comparing present programs among states or provinces, but also for prioritizing research efforts among those areas perceived as most needed and with the widest application. A similar survey in about 5 years (1992) might usefully update the status of instream flow activities in North America.

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ATTACHMENT B

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Evolution and Application of Instream Flow Methodologies to Small Hydropower Developments: An Overview of the Issues[1]

E. Woody Trihey[2] and Clair B. Stalnaker[3]

Abstract.--Methods for evaluating instream flow needs have evolved over the last 30 years resulting in two categories which are defined as "standard-setting" and "incremental". Standard-setting methodolgies refer to those measurement and interpretative techniques designed to generate a flow value(s) which is intended to maintain the fishery at some acceptable level. Incremental methodologies on the other hand are organized and repeatable processes by which: (1) a fishery habitat/streamflow relationship and the hydrology of the stream are transformed into a baseline habitat time series; (2) proposed water management alternatives are quantified and compared with the baseline; and (3) project operating rules are negotiated. A hierarchial approach to small-hydro instream flow analysis is suggested.

Several techniques exist today which, to varying degrees, are capable of either identifying a base streamflow necessary to maintain instream resources at some acceptable level or quantifying the incremental response of the instream resource to naturally occurring or project-induced changes in streamflow, stream temperature, sediment transport, or water quality. These techniques were developed primarily to resolve conflicts resulting from excessive allocation of streamflow to out-of-stream uses. Central to the evolution of instream flow methodologies are western water law (appropriation doctrine), Federal water policy (e.g., the Carey Act) and environmental concerns (e.g., NEPA). A discussion of the evolution of institutional awareness and the quantification of instream flow needs is found in Stalnaker (1982).

Today we are discussing instream flow methodologies due to yet another institutional stimulus that is particularly applicable to small scale hydropower development. This stimulus is the Public Utility Regulatory Policies Act of 1978 (PURPA). Without the economic incentives provided by this Act--which stimulate small scale hydropower development on steep gradient headwater streams--little interest or need for new or modified instream flow methods would exist.

In this paper, we define methods as specific techniques for measuring or predicting changes in important physical, chemical, or biological variables of the stream environment. Methodologies on the other hand, are collections of methods sequenced in organized repeatable processes which identify the response of specific resources to changes in water, sediment, chemical, and/or nutrient supply. Quantifying these changes leads to either specific limits on streamflow modifications necessary for protecting the existing instream resource or identification of impacts and tradeoffs among the resource uses evaluated. Consequently, neither a fish sampling method nor a hydraulic simulation method constitute an instream flow methodology. They are simply methods for examining important variables.

A brief review of the evolution of instream flow methodologies from early studies to the small-hydro era shows that during the 1950's and 1960's the concentration was on the construction of large federally-funded irrigation and hydropower projects in the West, particularly those of the Bureau of Reclamation and to a lesser extent the Corps of Engineers. Due to the nature of western water law and the fact that most of these projects were predominantly associated with downstream diversions for

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rrigation, fisheries biologists were logically ost concerned about periodic dewatering of atural streams during the spring runoff and the ow flow season while water was stored in these arge reservoirs. In addition, throughout most f the West, the irrigation season coincides ith a period of low stream flow. Consequently, he diversion of streamflow into irrigation anals and fields can completely dry up sections f natural streams during late summer and fall. he occurrence of these two types of pertuba-ions caused fisheries biologists to seek identi-ication of a base streamflow that would ensure ish survival through periods of low flow and he phrase "minimum flow" was coined (Orsborn nd Allman 1976). The minimum flow was a stream-low "standard" which was meant to constrain ither project storage or irrigation diversion uring the low flow season. Throughout the emainder of the year, projects did not affect lows, streamflows were usually greater than the minimum flow", and fish populations were assumed o be out of danger. Thus, a standard-setting ethodology evolved that is defined as any set f methods (techniques) designed to generate low recommendations to maintain the fishery or ecreational activity at some acceptable level see table 1 for definitions).

A second major stimulus for identifying nstream flow "needs" was the water allocation rocedures of the western States. The States' ater planning policies were meant to assist the tate engineer, state water administration ffice, or the State legislature in estab-ishing some end point or limit on water use ermits for out-of-stream consumptive uses. ithin the institutional framework and philosophy f water administrators, minimum flows were reserved" by the State to maintain instream ishery resources.

In practice, the degree of protection fforded the fishery varies considerably both ithin and among the States (Lamb and Meshorer 983). In the relatively "water rich" Pacific orthwest, minimum flow standards were meant to rotect a viable and diverse fishery, often xisting prior to the proposed development and he term "resource maintenance flows" came into ogue.

In other western States where streamflow as scarce and economic incentives associated ith out-of-stream uses were readily apparent, inimum flow standards were adopted to provide he minimum amount of water necessary to keep he stream channel wet. Minimum flows of this ype could maintain a fishery of some sort but ere not intended to maintain fish populations t predevelopment levels.

Because of the diversity in "minimum flow" bjectives, many different methodologies were eveloped by State fishery agencies to quantify he "minimum flow", each narrowly focused on a articular definition of minimum flow. Many of these methodologies and their associated criteria are described by Stalnaker and Arnette (1976) and Wesche and Rechard (1980).

A third stimulus for the quantification of a "minimum flow" was the Clean Water Act of 1972 and its subsequent amendments. In order to design sewage treatment plants so that effluent would not degrade water quality in receiving streams during low flow periods, engineers at the Environmental Protection Agency (and the former Public Health Administration) chose the 7 day Q_{10} low flow statistic as the low flow quantity (standard) of the receiving water in which the effluent must be diluted. This flow is the lowest which occurs for 7 consecutive days in a 10-year period, thus waste treatment plants designed to meet water quality standards at this level were assumed to be adequate.

Most standard-setting methodologies can generally be categorized as either hydrologic,

Table 1. Definitions of methods as used in this paper.

Instream Flow Methods - techniques to measure, describe, or predict the value of some variable assumed to be important to the general well being of some instream use or user.

Instream Flow Methodology - a collection and integration of several instream flow methods (techniques) arranged in an organized process for the purpose of: (1) developing flow recommendations for stated management objectives; (2) quantifying the impacts of potential water management alternatives on instream resources; (3) developing mitiga-tion plans for specific water management schemes; or (4) negotiating project operat-ing rules and flow releases.

Standard-Setting Methodologies - measurement and interpretive techniques designed to generate a flow value(s) which is intended to main-tain the fishery at some acceptable level.

Incremental Methods - techniques designed to generate a relationship between the quality of an instream resource, such as the fishery habitat, and streamflow.

Incremental Methodology - an organized and repeatable process by which: (1) a fishery habitat/streamflow relationship and the hydrology of the stream are transformed into a baseline habitat time series; (2) proposed water management alternatives are quantified and compared with the base-line; and (3) project operating rules are negotiated. Items 2 and 3 are often itera-tive processes involving trade offs among instream and out-of-stream uses.

which lead to minimum flow recommendations based on streamflow statistics (e.g., 40% of mean annual flow), or hydraulic, which lead to recommendations based on some streamflow-dependent habitat index (e.g., the break in the wetted perimeter vs. flow relationship). Methodologies developed to set minimum flow standards on streams for the purpose of State water allocation or to protect water quality in receiving streams were nearly always based on analyses of the historic streamflow record. Minimum standards were often indexed to flow amounts equalled or exceeded 90% of the time; 10% of the mean annual flow; 7 day Q_{10}, or even the lowest daily flow on record. An excellent discussion of these different standard-setting methods are found in Wesche and Rechard (1980) and Loar and Sale (1981).

The problem with basing the well-being of fish populations on low-flow statistics is that the long term effects of artificially maintaining these minimum flows is seldom the same as infrequent, naturally occurring, short term effects that may appear in the historic record (e.g., three drought years in a row is uncommon). The ability of fish populations to compensate for a one-in-ten-year low flow event may give the false impression that the fish population will remain healthy and viable if this minimum flow (drought) condition were imposed year after year. As water projects were built and operated, it became apparent that in many cases the fishery resources were decimated as a result of the planners' and hydrologists' illogically assigned low-flow statistics.

Streamflow releases immediately downstream from the large federal water impoundments built during the 1950's and 60's were not as constrained by the low-flow statistics of the particular stream because upstream storage was very large, and water could be stored and carried over from one season to another and, in many cases, from one year to another. Therefore, instream flow methodologies developed to determine minimum flow recommendations below large reservoirs tend to focus upon stabilizing or even enhancing the downstream fishery. This came about because the normal project operation tended to provide fairly cold water releases in amounts often in excess of natural, mid-summer, preproject streamflows. In addition, many of the large storage reservoirs were built on streams in arid environments and as a result of the cool water release the downstream fishery was often converted from warm water species to trout. Hence, maintenance of the predevelopment fish population was not always the motivating factor when quantifying the minimum flow. In several instances intentionally replacing the predevelopment fishery with a viable trout fishery was the objective of the "minimum flow."

Definition of acceptable levels of the post-development fishery is quite variable and ranges from the minimum flow needed for the maintenance of the existing fishery to enhancement or even changing or maximizing of fish populations. In the past thirty years, several of the resource agencies have conducted biological studies on unregulated streams for the purpose of examining correlations between fish standing crop and the instream flow as determined from one of the standard setting methods. Trout populations in the intermountain west have been shown to remain healthy and viable when minimum flows during the summer low flow months are in the range of 30 to 60% of the mean annual flow (Elser 1972; Wesche and Rechard 1973; Stalnaker and Arnette 1976), keeping in mind that flows are well above these minimums during most of the remainder of the year. In trout streams possessing a relatively rectangular cross-sectional shape, it has also been found that a "minimum flow" at or above the inflection point of a wetted perimeter versus discharge plot generally maintains the fishery in a healthy status (Nelson 1980), but again, streamflows associated with these studies were well above the "minimum" value during most of the year.

Post audit studies conducted for the Fish and Wildlife Service by Hazel (1976) and Nelson et al. (1976) found that for 90% of the western Federal water projects evaluated, the minimum flow agreed upon was frequently violated during drought cycles. Inasmuch as the identification of minimum streamflows had evolved with the understanding that they would protect the fishery during the low-flow season and droughts, the wide-scale violation of these standards prompted notable concern on the part of the general public, fisheries managers, and the water planning community.

The Water Resources Council and the numerous River Basin Commissions provided an impetus throughout the 1960's for planning the multiple use of water. This impetus on multiple use planning and the poor track record of protecting instream values using standard-setting methodologies led to the request by many resource agencies for stricter permitting requirements, including monitoring and enforcement clauses. Enforcement is likely only when the trade-offs between offstream uses and instream uses are clear. Hence, more sophisticated methodologies were needed to address the "what if" questions and in particular, "What happens to the fishery resource when the streamflow (standard) identified for maintaining the fishery is not delivered?" (Orsborn and Allman 1976).

This state of affairs in the late 1960's and early 70's led to many symposia and meetings where a need was expressed for methodologies which would answer the "what if" questions proposed by the water development and planning community. Allred (1976) presented the perspective of the water administrator when he said "if instream flow interests expect to compete with other uses for limited water supplies, they must be able to demonstrate with the same type of analyses and approach as other uses the need for instream flows and the affect of not obtaining those flows".

Consequently, during the last decade we have seen the development of instream flow assessment methods which attempt to evaluate fish habitat on the basis of the hydraulic, structural, and water quality aspects of the stream environment. These methods are generally referred to as "incremental" in nature because of the need to examine different increments of streamflow (table 1). The common product of incremental methods is a relationship between fish habitat and stream flow. Important pioneers of this approach were Collings et al. (1972), who used binary depth, velocity, and substrate criteria to evaluate the influence of incremental changes in streamflow on the quality of spawning habitat for salmon in Washington streams. Also Waters (1976) applied weighted criteria for depth, velocity and substrate/cover and introduced computer simulation to evaluate the response of rainbow trout habitat to streamflow variations in California. The application of hydraulic modeling methods in conjunction with streamflow dependent criteria for fish habitat began with single transect methods such as the R2 CROSS procedure introduced by the Forest Service (Issacson 1976; Weatherred et al. 1981). Single transect methods were followed by more sophisticated multiple transect, hydraulic modeling methods adapted from Water Surface Profile simulation models commonly used by the Corps of Engineers, the Bureau of Reclamation, and the Soil Conservation Service.

The Bureau of Reclamation assisted the Montana Department of Fish and Game by modifying their water surface profile program to provide greater resolution of hydraulic conditions in stream channels. Single values for mean reach velocity and depth were replaced with depth and velocity predictions in a number of cells across transects within the study site, and the wetted perimeter at each transect was calculated as a function of streamflow (Dooley 1976). The development and refinement of hydraulic simulation methods to facilitate evaluation of habitat conditions under broader ranges of instream hydraulic conditions has continued to the present (Milhous 1984). A well known example is the physical habitat simulation model-PHABSIM (Milhous et al. 1981) which is an important component method within the Instream Flow Incremental Methodology (IFIM) as described by Bovee (1982).

In this overview of instream flow methods and methodologies, it is important to consider the fact that all techniques have evolved from experience gained through empirical studies. The predictive techniques and computer simulation models which can be used today with limited field measurements are based upon the experience and knowledge gained from previous field studies. For most cases more can be learned about the dynamics of the stream system today with fewer field measurements than were necessary 20 years ago. However, there are still many situations in which an extensive number of repetitive field measurements are necessary. As more elaborate simulation models become available for use in the determination of instream flow requirements, a greater need exists to critically evaluate and fully document the underpinning assumptions of the simulation models chosen for each instream flow study. Whenever natural conditions cannot readily be described by existing formulae or theory, empirical data is always as good as, and in most cases better than, simulated data. For example, in those situations where instream hydraulic conditions are not compatible with standard application of existing hydraulic simulation models, additional time and resources will be required to conduct the necessary empirical studies before reliable incremental solutions can be provided.

It should also be recognized that simplified "rule-of-thumb" methods and methodologies are generally derived from large data bases. Once these empirical data bases have been obtained and sufficient knowledge of the interactions between physical processes and biologic responses is gained simplifying assumptions can be made without jeopardizing the reliability of forecasts. A good, simplified, rule-of-thumb methodology cannot be developed prior to acquiring broad experience with the situation.

We now have two basic types of instream flow methodologies for fisheries: (1) those for protecting existing resources by setting instream flow standards for streams, which can then serve as constraints on development; and (2) those for quantifying trade-offs by describing the response of fish habitat to streamflow alterations.

All instream flow investigations should be viewed as part of a phased process in which standard setting can be a precursor to incremental analyses and each have an important role. Whenever a specific project: (1) has relatively benign impacts; (2) is proposed where limited fisheries or recreational values exist; or (3) is not anticipated for development for several years in the future, standard setting as the first phase is most appropriate. In such cases the specific methods chosen depend on the resource agencies' management policy, the region of the county, and the aquatic organisms of concern.

The second phase commences when alteration of the streamflow, stream temperature, channel structure or water chemistry is proposed and has prompted questions concerning the effects of these alterations on the fisheries and recreation interests. In other words, phase two commences when the water development interests begin asking what will happen if the minimum flow standards are violated. This could also be initiated by the resource agencies seeking opportunities to improve the existing fish populations or to alter the species composition.

This phase is site-specific and data intensive. Streamflow time series, project operating rules, and species habitat response curves are necessary intermediate products of this phase.

Despite the successes, fisheries biologists have not yet achieved the capability of forecasting the number of fishes produced in response to any particular water management scheme. This question is being brought up more and more in present-day water development and constitutes a third phase. Within the next decade or so a scramble is expected for research and method development aimed at predicting changes in numbers of fish resulting from flow and channel alterations. This will be similar to the 1970's when methods to quantify the response of fish habitat to streamflow were developed. Only after reaching this third phase can we begin to quantify the economic value of altering the instream resource. This will provide an equivalent basis for comparison of fishery resources with other instream/out-of-stream values.

The numerous instream flow methods and methodologies that now exist provide sufficient analytical tools to evaluate hydropower development on small streams. Perhaps the most difficult aspect of evaluating the instream flow concerns associated with a small hydropower development is in the selection of appropriate cost-effective study methods and agreeing on a methodological process. In brief:

Standard Setting is most appropriate for:

- Protecting the existing instream resource;
- State Water Plans;
- State Water Allocation permits or reservations; and
- Identifying target flow for use during project feasibility studies.

Incremental Methods are most appropriate for:

- Time series analysis to identify limiting flow conditions;
- Fine tuning a resource maintenance objective (maximum utilization of available water);
- Avoiding or minimizing flow-related impacts; and
- Comparing mitigation alternatives.

When undertaking instream flow studies to support the licensing or relicensing of a small hydro project it is wise to divide the process into three distinct levels of analysis. Depending on the nature of the development and the instream flow related issues, a license application could be successfully supported at any one of these levels. Each level of analysis: reconnaissance; feasibility; and operational design; is intended to provide relevant answers to technical questions of increasing complexity. These analysis levels are summarized in table 2.

It is important to avoid the pitfall of implementing a complex design level field study (e.g., IFIM modeling study) without first completing a feasibility level analysis. Based on experiences of the authors, the most common mistake being made when initiating instream flow studies at small hydro sites has been that of partially completing a reconnaissance level study and immediately undertaking an operation level IFIM modeling study. Too often this is done without first implementing the hydrologic and biologic elements of the feasibility level analysis to determine: (1) if the project has the potential for being compatible with agency policy; and (2) if it is necessary to initiate a complex operational modeling study to design conditions assuring that compatibility.

All participants should recognize that licensing hydro projects is generally a multi-year iterative process and therefore adopting the suggested hierarchical approach outlined in table 2 for the instream flow studies as is common in traditional engineering studies, will, in the long-run, be most cost effective.

Once outside the realm of reconnaissance and feasibility level studies and the application of standard-setting methodologies, the instream flow analyst can no longer ignore the influence of channel structure, channel dynamics, water quality, temperature, and food production on the instream uses. Unfortunately, much of the ability to forecast changes in these habitat components is still predominantly based on empiricism necessitating more time and financial resources. However, these habitat components can be evaluated and integrated into an instream flow assessment. The hydro developer and the fishery manager must therefore assess the decision-making arena in which they are being asked to participate and tailor the methodology accordingly. If identification of a resource maintenance flow is adequate to protect the predevelopment resource for several years in the future, then application of a standard-setting methodology is all that is warranted. If, however, the proposed development will obviously change the predevelopment fishery or recreational value of a stream system, then application of a methodology incorporating the hydrologic, thermal, morphologic, chemical, and biologic aspects of the stream becomes essential to the long range management of the stream system for multiple uses. In order to be useful for decision making, results from incremental methods should be presented in some form of a time series comparison between existing (pre) and post project habitat conditions with the limiting habitat conditions clearly identified. Alternative management scenarios can be evaluated by quantifying the frequency, magnitude and duration

Table 2. Three levels of instream flow analyses for supporting the licensing or relicensing of hydropower projects.

Reconnaissance Level: Goal is to identify questions and concerns.

- Identify project location, configuration and generation.
- Identify fish or recreational interest that may be affected.
- Identify stream segments of primary and secondary concern.
- Identify applicable agency policies, guidelines, and fish management goals.
- Determine whether major issues are likely to arise from project incompatibility with resource requirements or with agency policy.
- If project appears benign and compatible with agency policies proceed to Exemption Process.
- If project compatibility with fish management goals cannot be adequately defined then proceed to feasibility study.

Feasibility Level: Goal is to establish the compatibility of the proposed development and existing instream uses.

- Quantify streamflow regime

  1) annual hydrograph
  2) monthly duration curves
  3) baseline time series analysis

- Identify seasonal species distribution and relative abundance.
- Discuss influence of streamflow on distribution and abundance.
- Determine maintenance streamflow "standards" for stream.
- Forecast with-project streamflow regime.
- Compare with-project streamflows to maintenance standards and identify major issues.
- If the proposed project or proposed project and accompanying mitigation is compatible with agency policy, prepare an Exhibit E using the maintenance standards as conditions for licensing.

Table 2. (concluded)

- If the proposed project appears compatible with agency policy, but impacts need to be quantified or mitigation measures agreed upon, proceed to design and operation level studies.

Operation Level: Goal is to quantify impacts, develop mitigation measures, establish project operating rules and conditions.

- Convene scoping meeting to:

  1) Determine major issues and establish format of the analytic comparison needed for decision-making.

  2) Design project-specific methodology.

     (Assemble appropriate methods and criteria to evaluate the physical, chemical, and biological issues identified during the feasibility study and scoping process).

- Conduct necessary field investigations and analyses.
- Quantify impacts.
- Determine mitigation opportunities.
- Negotiate settlement and conditions.
- Proceed with licensing.

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of the limiting habitat conditions associated with each alternative.

All in all, the state-of-the-art has greatly advanced from the early 1950's when instream flow concerns first arose. When water is available and legal and institutional recognition exists for protecting and managing an existing fishery resource technology is available for maintaining existing habitat conditions. This can be done quite well for salmonid fishes in cold water stream environments, and fairly well for cool water species because of the numerous studies made of these species. Given sufficient time and resources for studying and developing appropriate habitat criteria for warm water species, management for protection of these stream environments is also quite feasible. However, when physical and chemical changes are imposed upon a stream system, producing a very different mix of these conditions, and the flow regime is radically changed, the ability to predict the response of the physical habitat, the benthic organisms, and consequently the fish population is rather poor and represents an area for needed physical and biological research.

The current (third) phase of methods development focuses on stream channel dynamics, sediment transport, temperature, water quality, and species interactions. Only when changes in the physical/chemical components of the environment can be integrated with aquatic species response models will the desired predictive third phase of water management become operational.

ISSUES RELATED TO THE SMALL HYDRO/FISHERIES ARENA

- Agency promulgated instream flow methodologies must include well documented criteria for interpretation, stated management goals, and policy relevant to the type of development proposed.
- Standard-setting of protection or maintenance flows should be a part of every water planning process and incorporated into the feasibility phase of hydro-project developments.
- Channel form and substrate transport conditions are too often overlooked and can be critical in alluvial streams and gravel limited streams.
- Hydraulic simulation and hydrograph synthesis techniques are only building blocks in some overall process and should not be referred to as instream flow methodologies.
- Basic research is needed on aquatic organisms and community response to stream environment changes before the state-of-the-art can move from the present single species habitat protection or enhancement approach to water development forecasting and economic comparisons among instream and out-of-stream uses.

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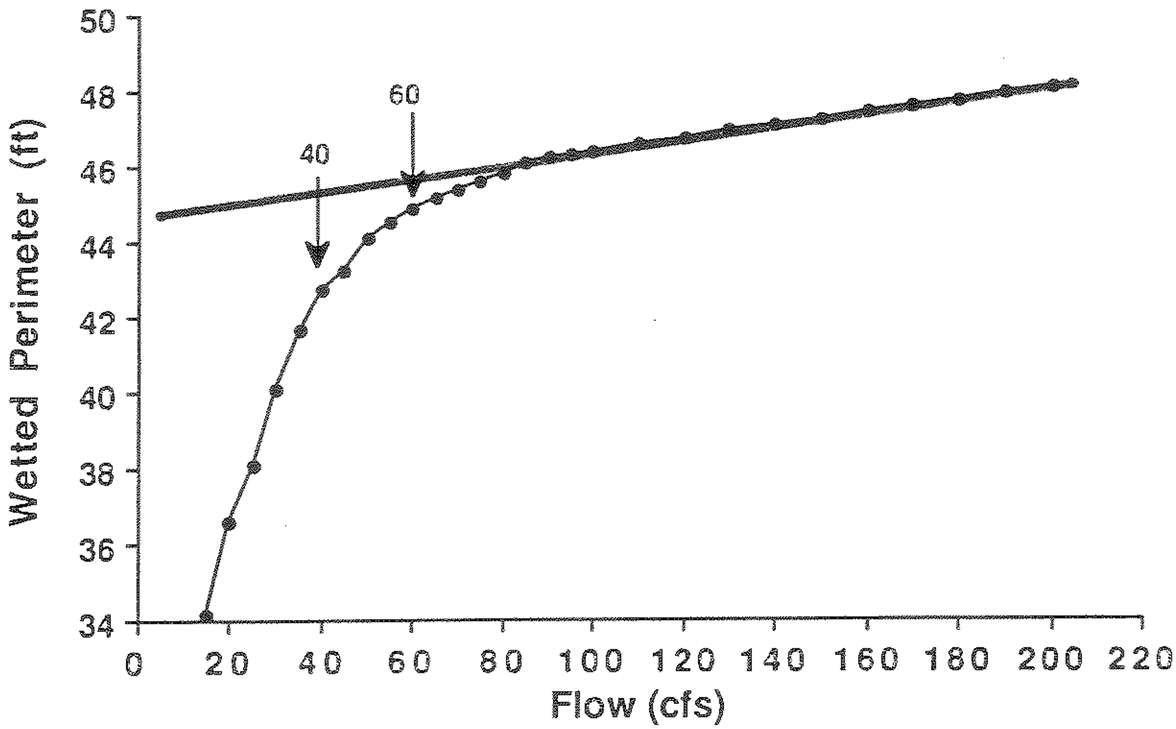


Figure 2-4. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Reach #2 of the Red Rock River.

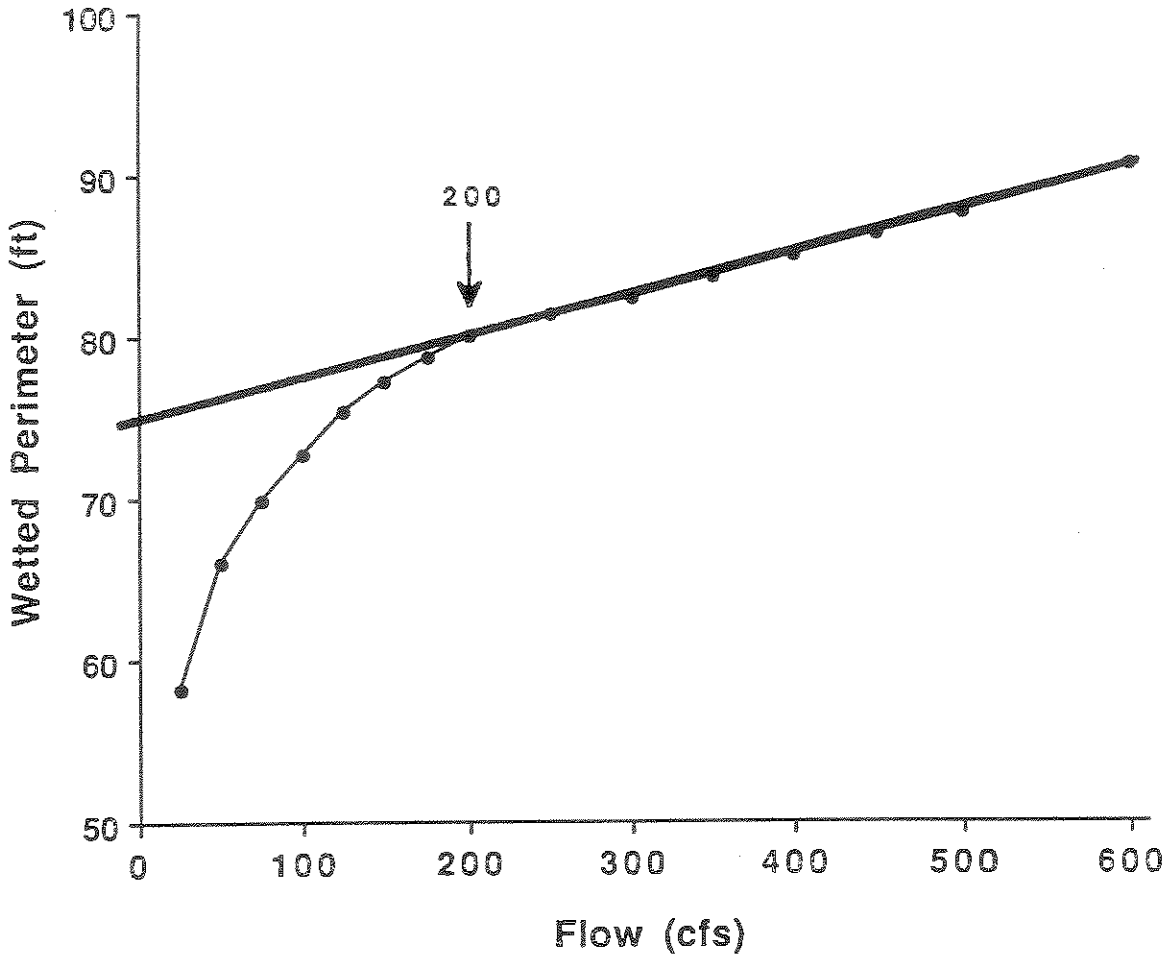


Figure 2-30. The relationship between wetted perimeter and flow for a composite of seven riffle cross-sections in Reach #2 of the Beaverhead River.

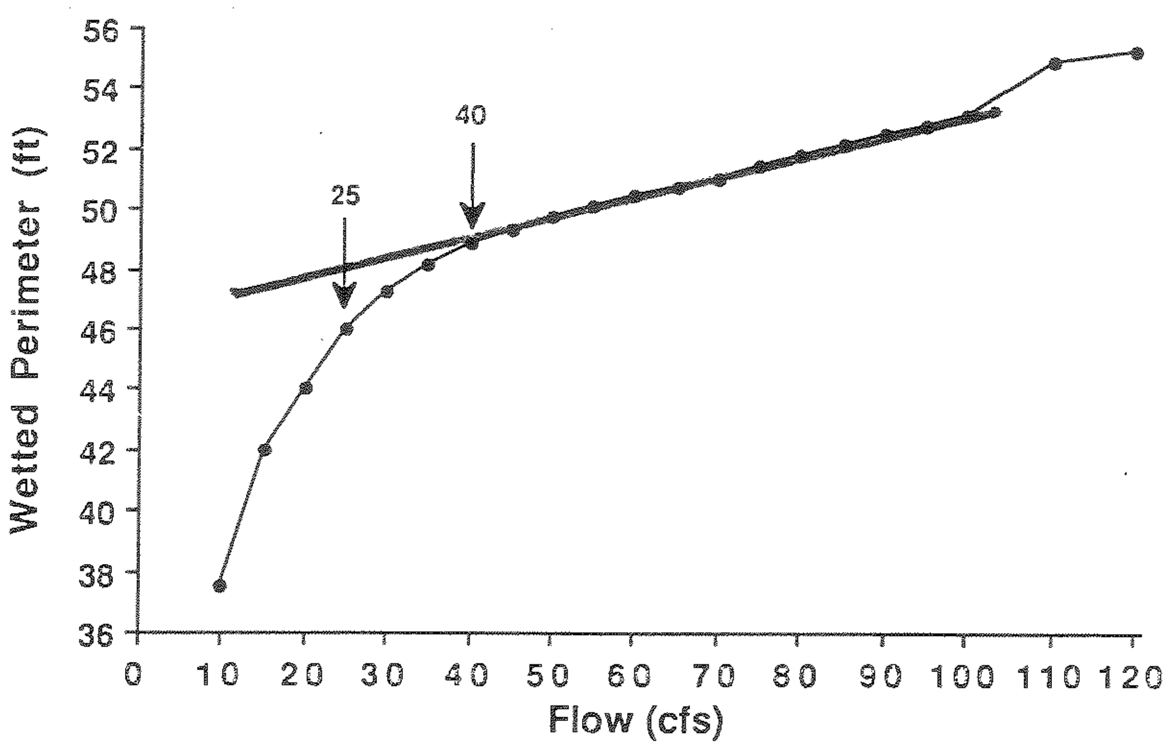


Figure 2-40. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in Reach #2 of the Ruby River.

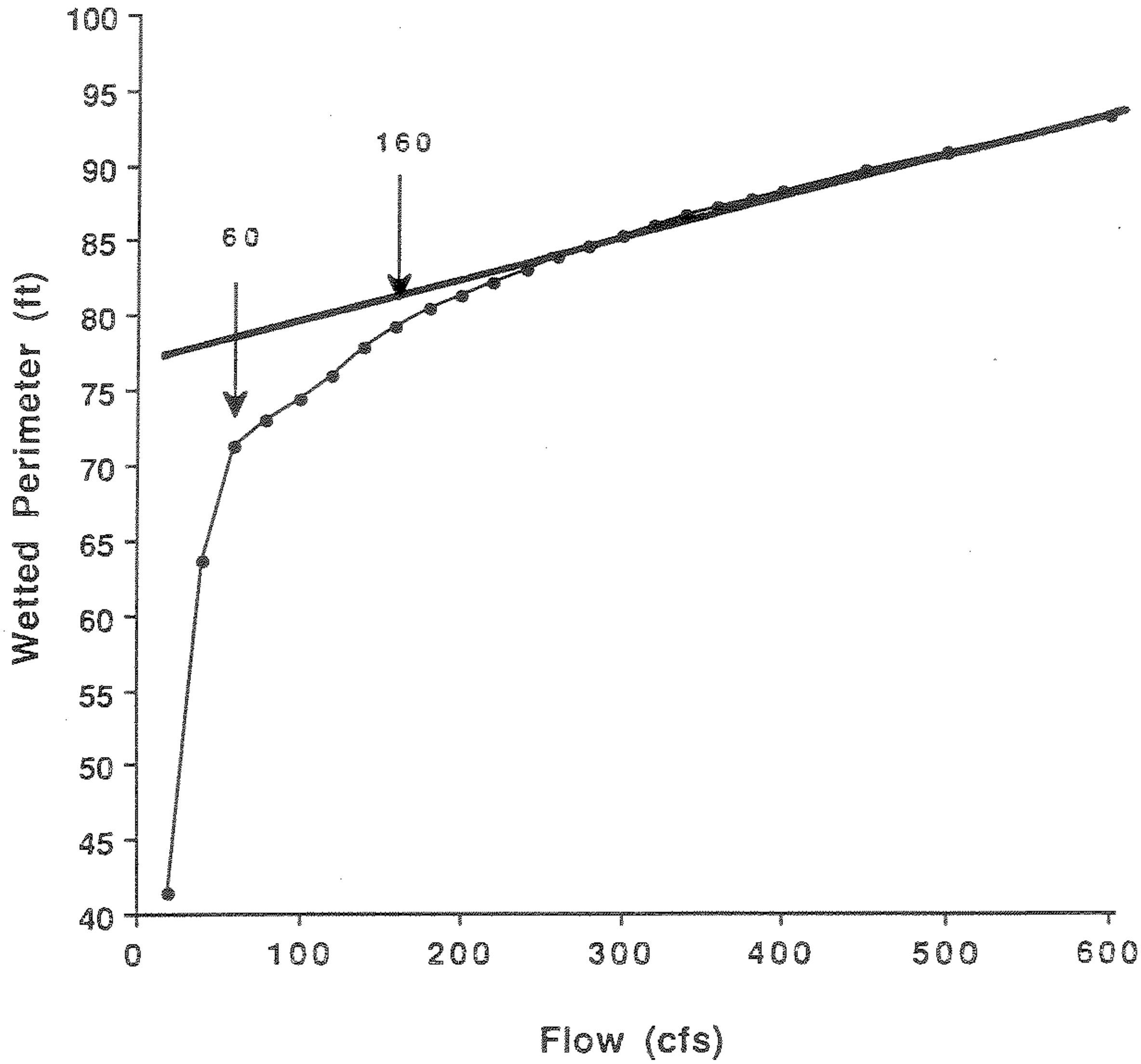


Figure 2-50. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in Reach #1 of the Big Hole River.

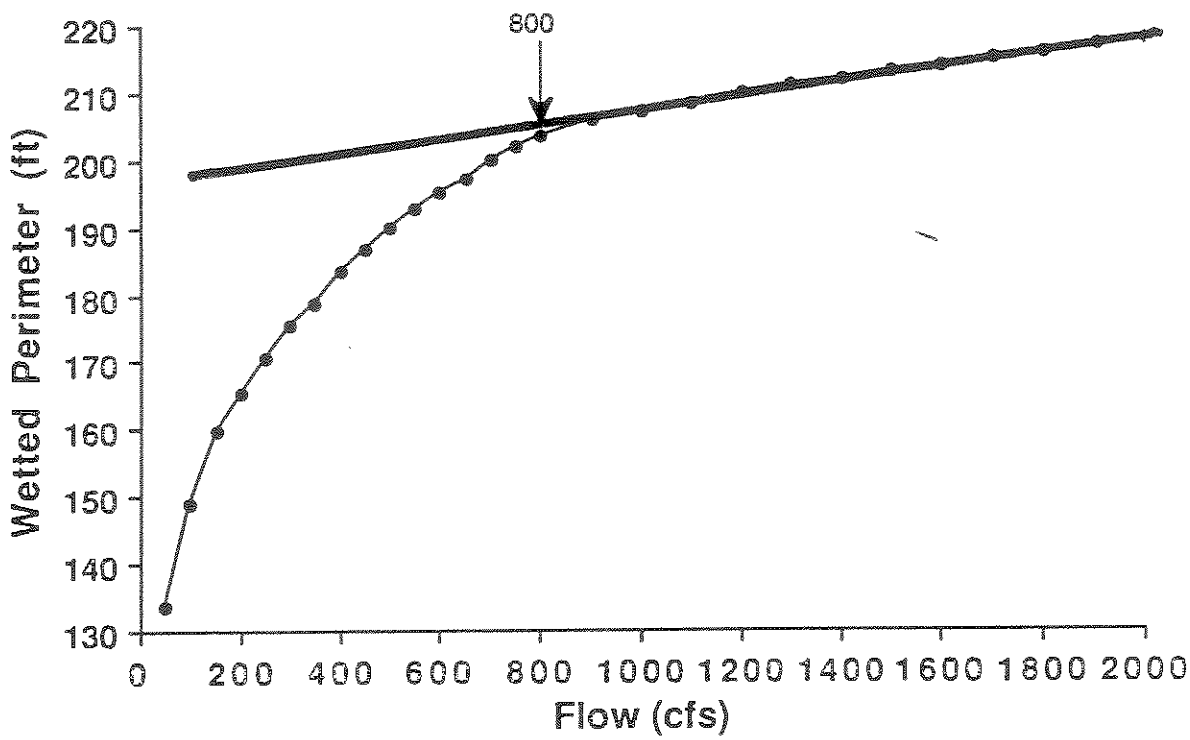


Figure 2-51. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Reach #2 of the Big Hole River.

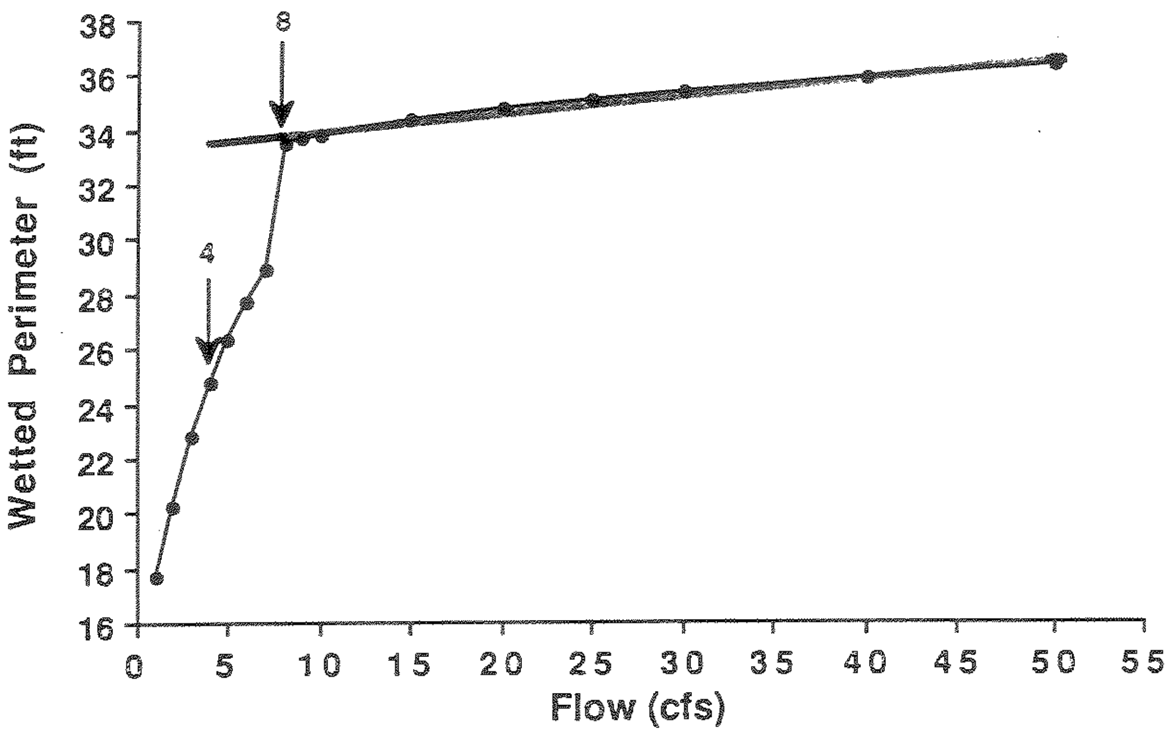


Figure 2-59. The relationship between wetted perimeter and flow for a composite of two riffle cross-sections in Swamp Creek.

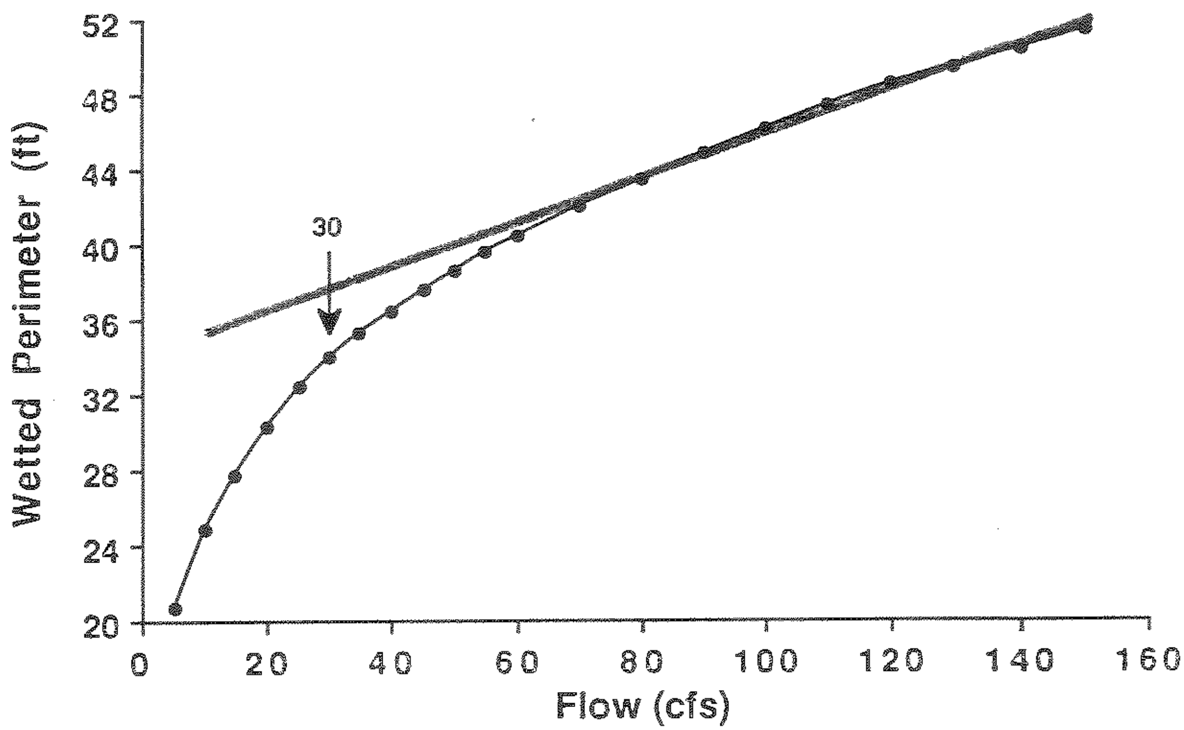


Figure 2-65. The relationship between wetted perimeter and flow for a composite of two riffle cross-sections in the North Fork Big Hole River.

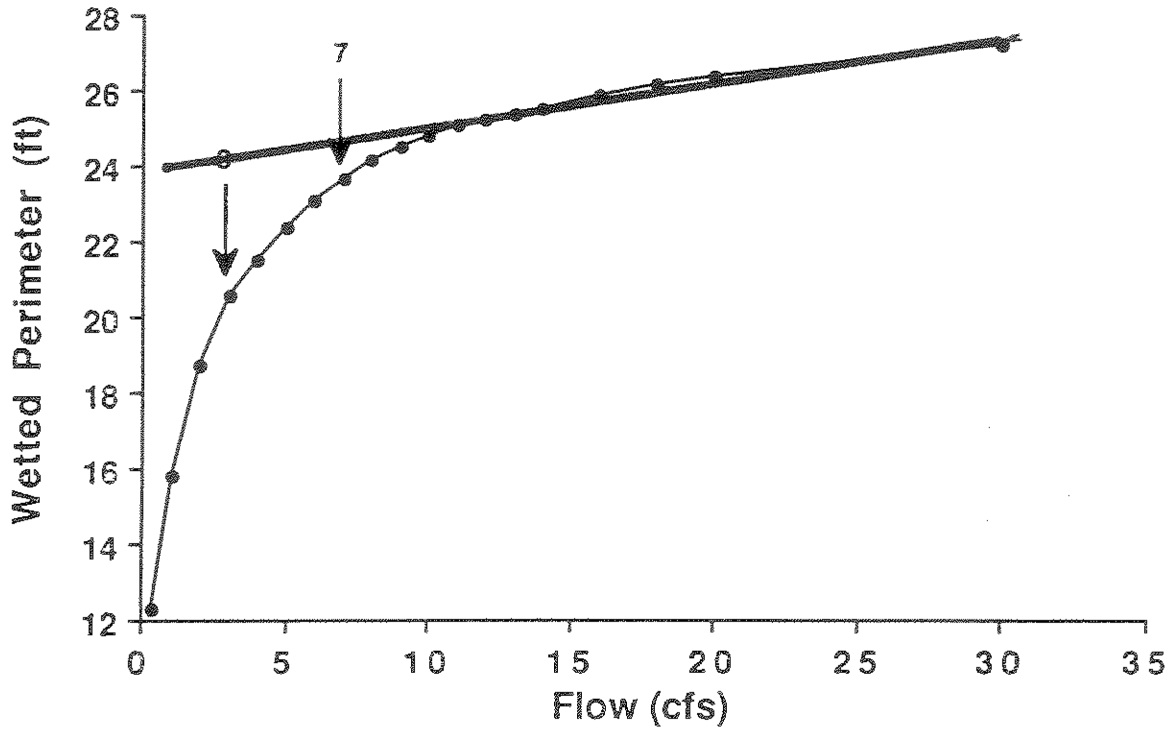


Figure 2-85. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Jerry Creek.

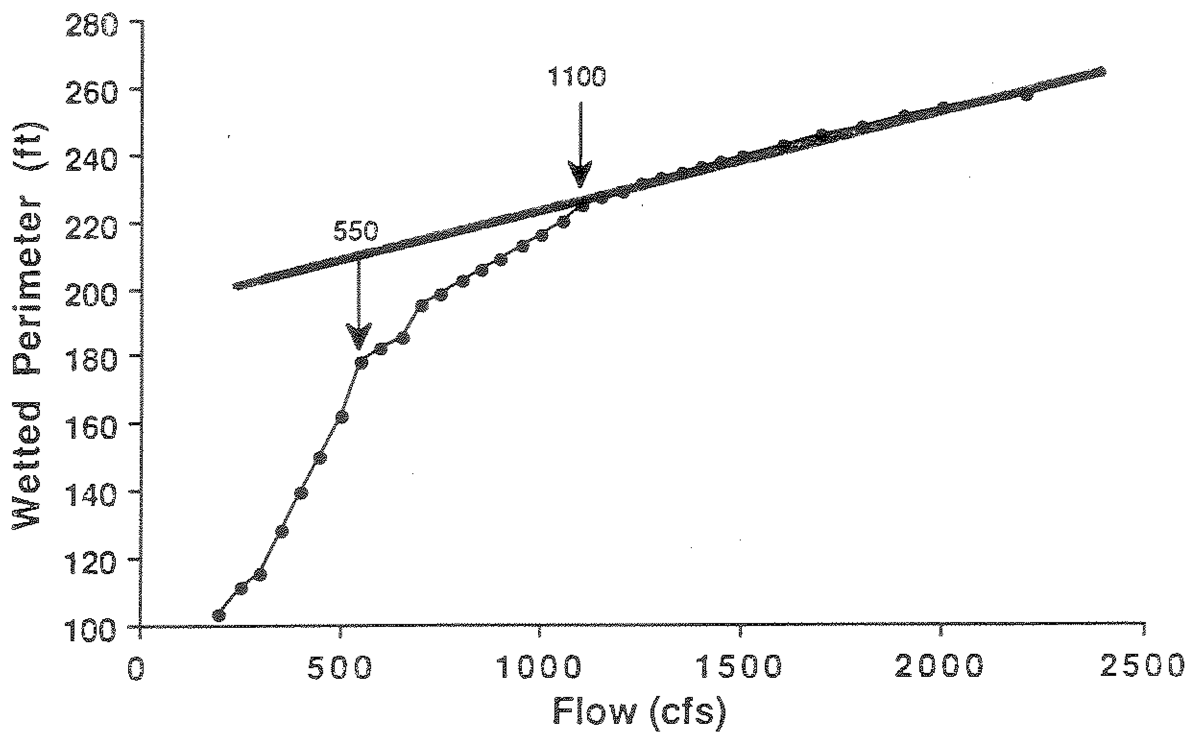


Figure 2-94. The relationship between wetted perimeter and flow for a composite of three riffle cross-sections in the Jefferson River.

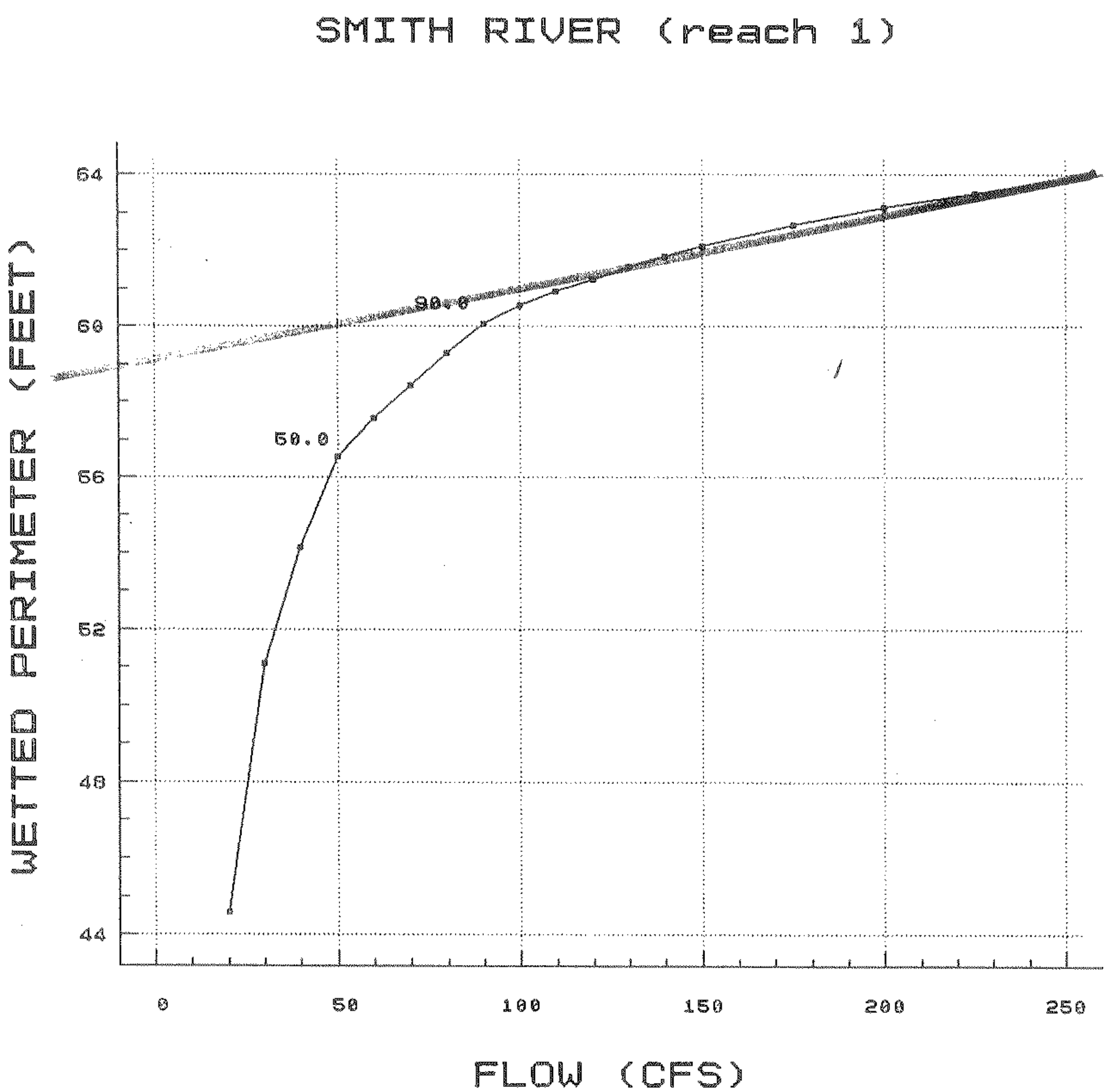


Figure 3-30. The relationship between wetted perimeter and flow for a composite of eight riffle cross sections in Reach 1 of the Smith River.

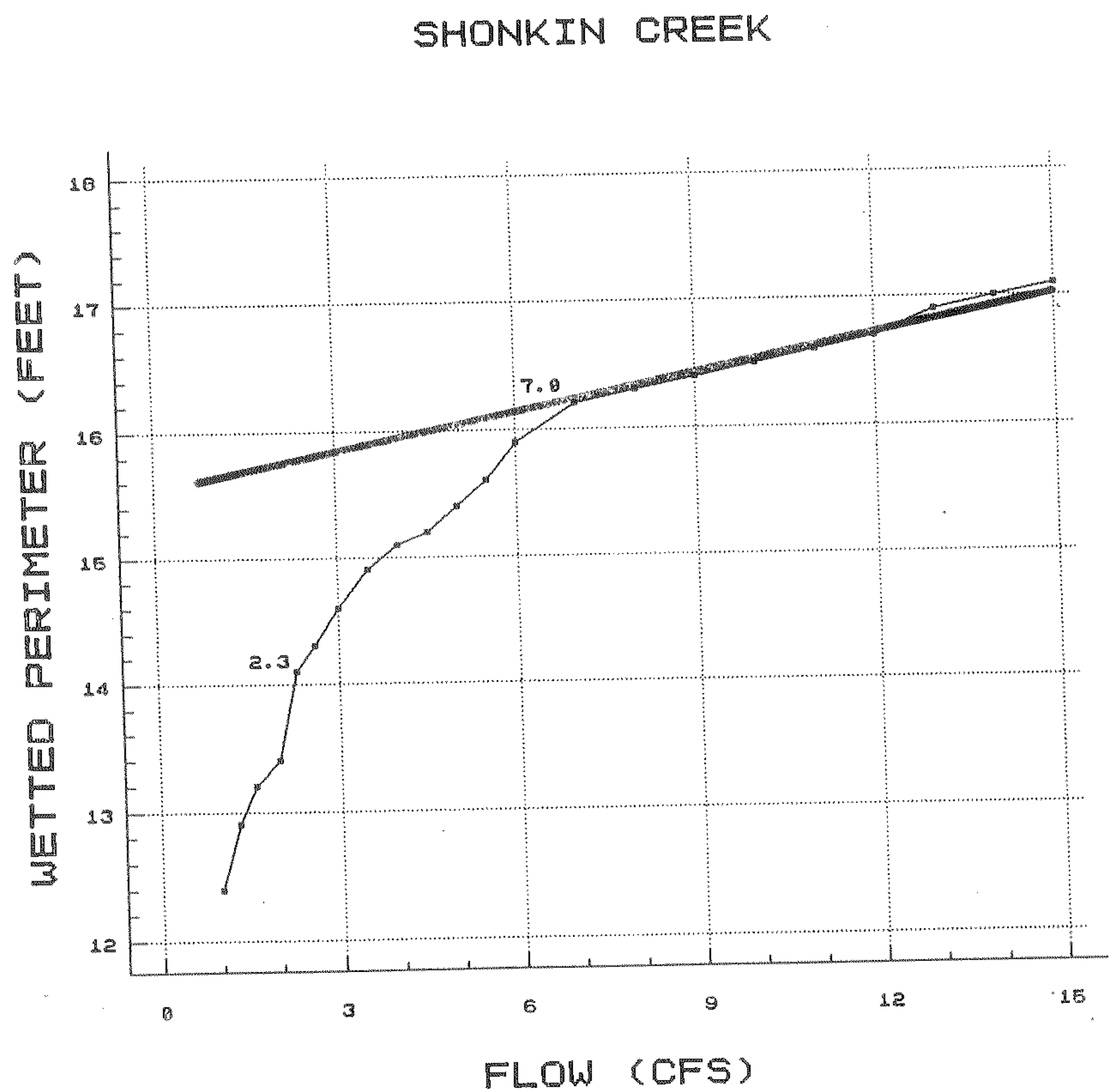


Figure 3-55. The relationship between wetted perimeter and flow for a composite of five riffle cross sections in Shonkin Creek.

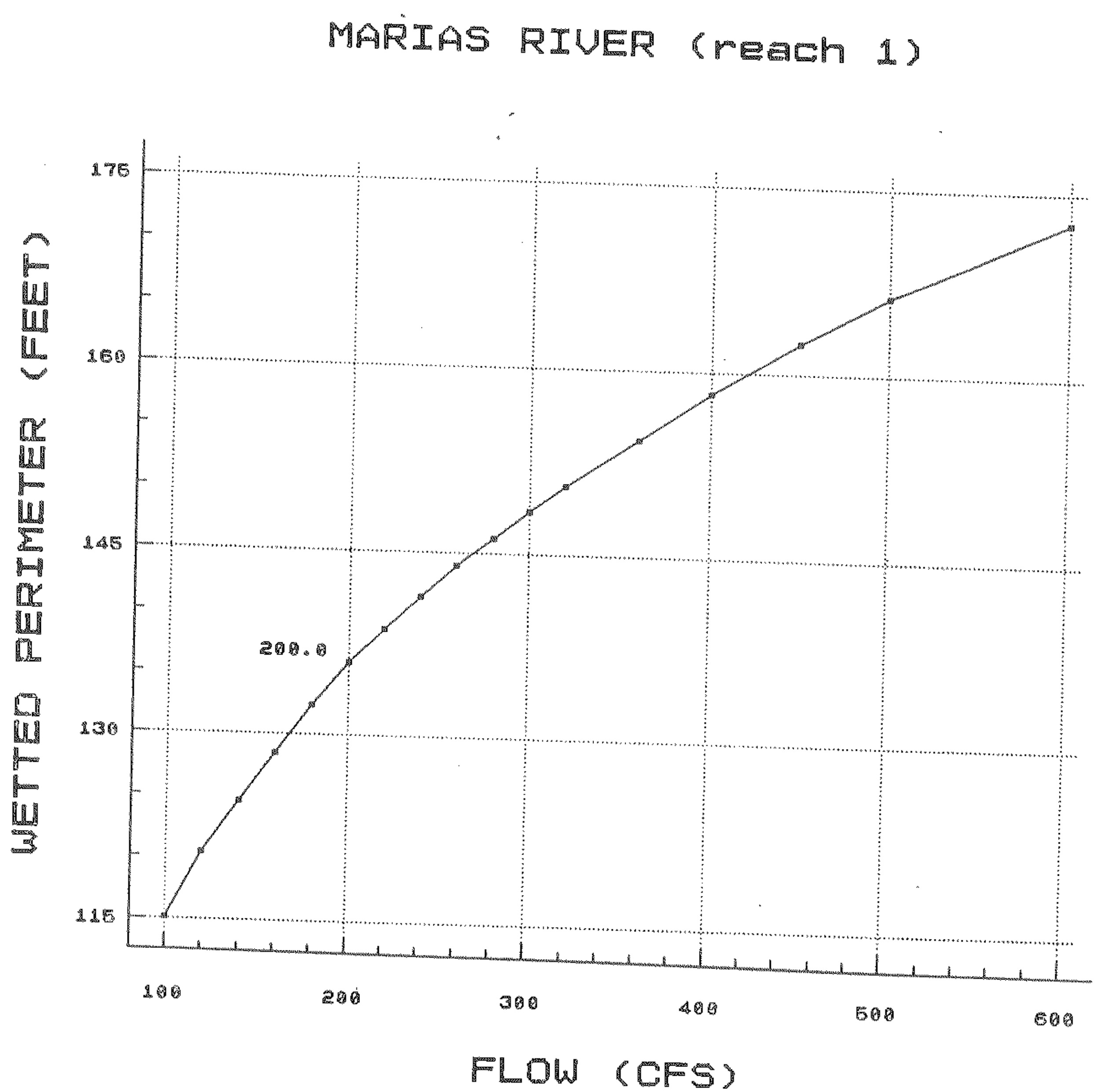


Figure 3-57. The relationship between wetted perimeter and flow for a composite of seven riffle cross sections in Reach 1 of the Marias River.

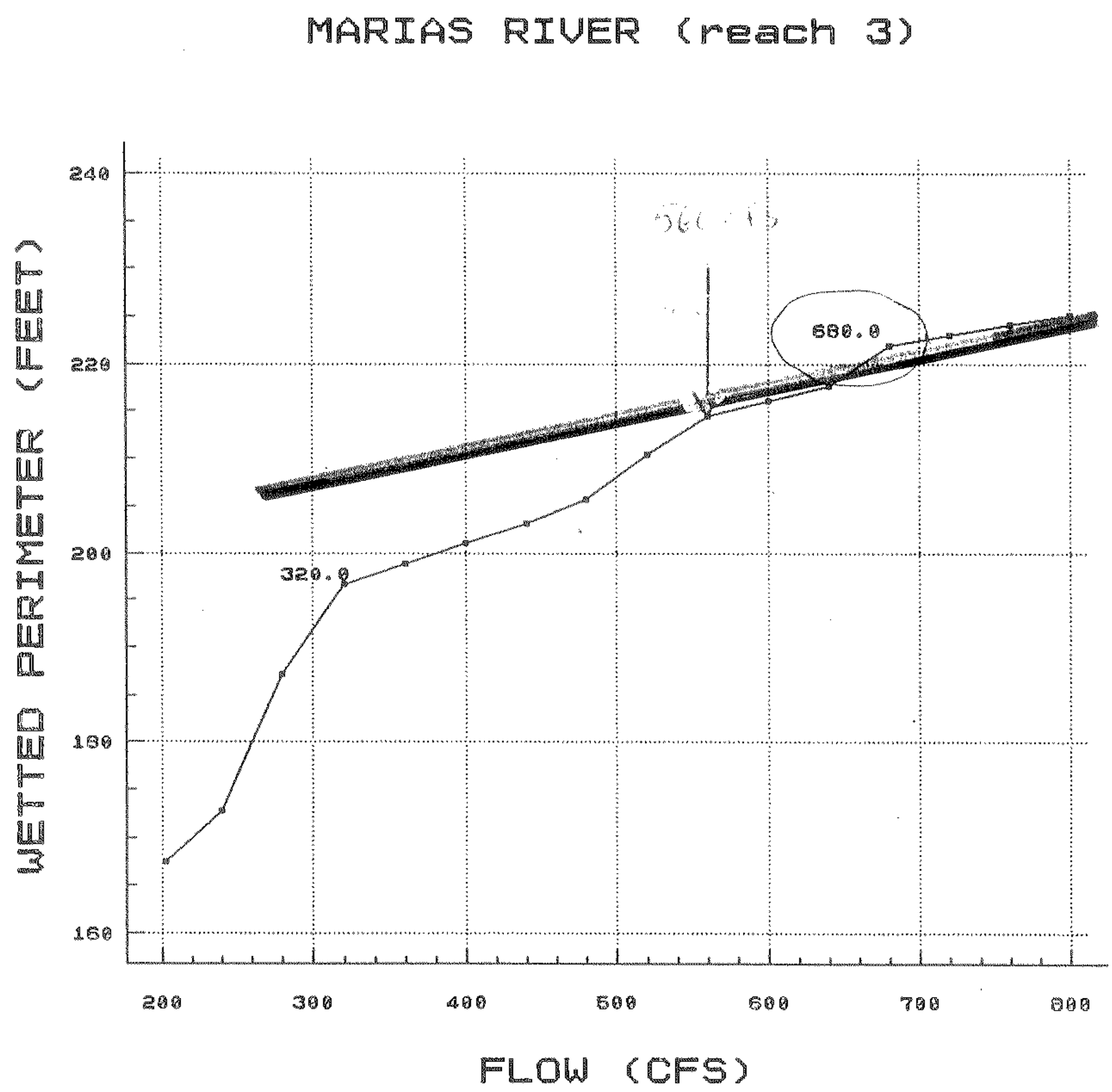
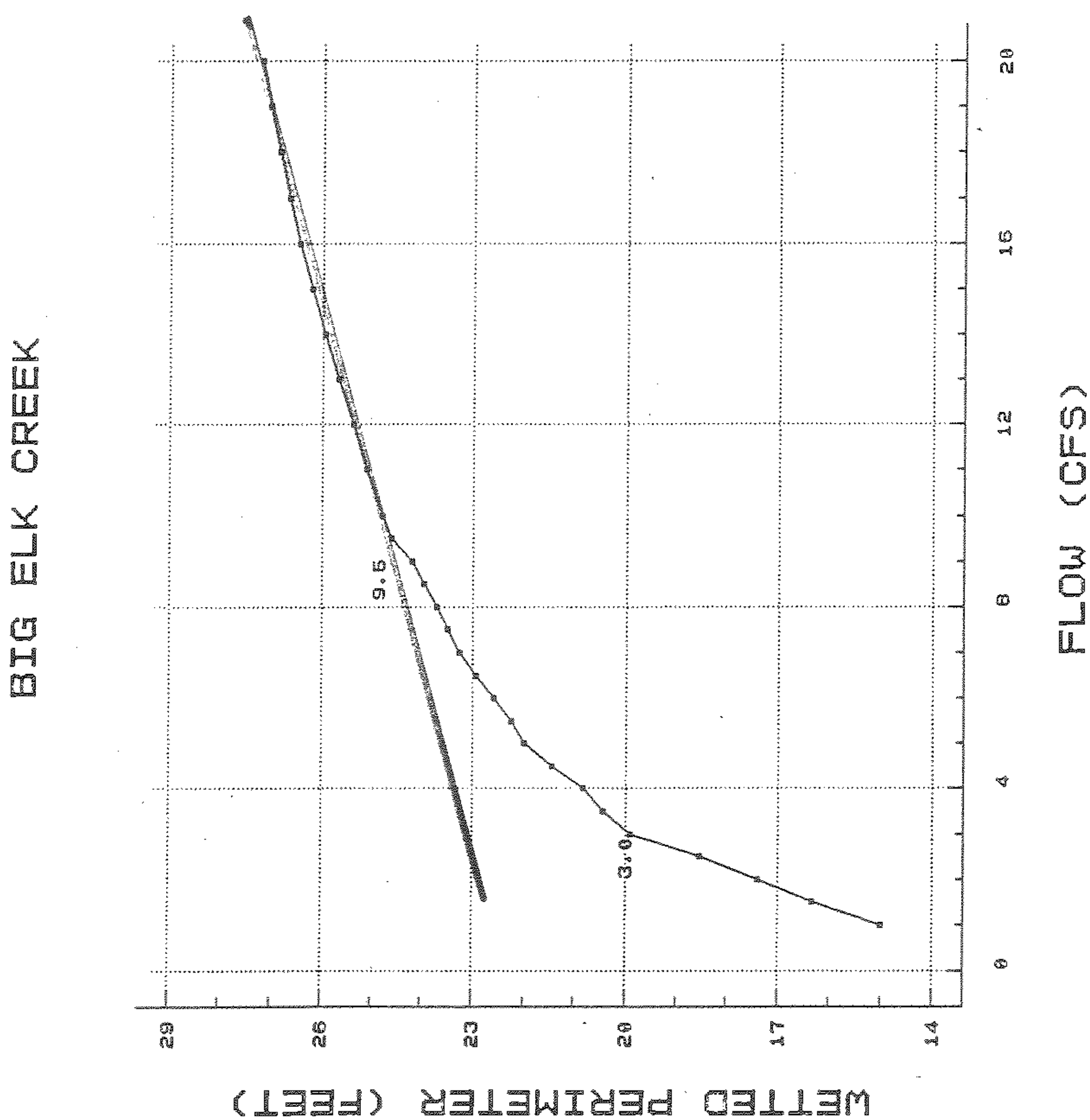


Figure 3-59. The relationship between wetted perimeter and flow for a composite of four riffle cross sections in Reach 3 of the Marias River.


BIG ELK CREEK
FLOW (CFS)
WETTED PERIMETER (FEET)
0
4
8
12
16
20
14
17
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23
26
29
9.6
3.0

PRE-FILED REBUTTAL TESTIMONY

OF FREDERICK A. NELSON

on behalf of

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. Please state your name and business address.

A. Fred Nelson, MDFWP, 1400 South 19th Avenue, Bozeman, Montana 59715.

Q. What is your present employment?

A. I am a fisheries biologist employed by the Montana Department of Fish, Wildlife and Parks.

Q. Please state your educational background and experience.

A. This information was already presented in direct testimony I previously filed for this reservation proceeding on behalf of MDFWP. That testimony included a description of my instream flow-related training and a vita.

Q. What is the purpose of this rebuttal testimony?

A. The purpose is to rebut elements of the objector's testimony of Roger Perkins, consultant for the Missouri River Conservation Districts. The portion of his testimony to be addressed by this rebuttal are contained on pg. 7-21, under headings Mr. Perkins titled <u>Water Availability</u> and <u>Habitat Considerations</u>, and on page 23 under <u>General</u>.

Q. How will you organize this rebuttal testimony?

A. Throughout his testimony, Mr. Perkins makes countless unsubstantiated statements, expresses opinions outside of his field of expertise, deals extensively in speculation, and advances arguments that are not logical. Given the limited timeframe for rebuttal, responding to his testimony on a point-by-point basis is both impractical and unproductive. Instead, MDFWP has attempted to filter out what I perceive to be the focus of his testimony and respond to these issues.

Q. In your opinion, what is Mr. Perkins attempting to show under the heading of <u>Water Availability</u> in his testimony?

A. Mr. Perkins advances the often repeated argument that MDFWP's instream flow requests are invalid because they often exceed the available stream flows on some waters.

Q. Does this argument have flaws?

A. Yes. These are discussed as follows:

1. The argument that water must always be available for MDFWP to hold a reservation is unreasonable. If MDFWP was held to this requirement, the instream flow requests could not exceed the historic low flow of record - the lowest flow ever recorded. Only then would the requests never exceed water availability. On many waters, particularly those already overburdened by irrigation depletions, this requirement could result in instream flow reservations of near zero and possibly zero flows. Such a request would ensure the destruction of the fishery. Historic low flows protect nothing.

2. On some streams, late summer flows already reflect massive summer irrigation depletions. Consumptive users have depleted a large portion of the flow, leaving little for the needs of the fishery. Some depleted flows are but a fraction of the flows that occurred in the undepleted or natural state. On those streams already overburdened by existing irrigation depletions, criticizing MDFWP's instream flow requests on the grounds that MDFWP is asking for too much of the flow that remains is unjustified.

3. This much repeated water availability argument also fails to take into account the legal framework that governs Montana's water law. The granted instream reservations will have a late priority date of July 1, 1985. This entitles MDFWP to place a call only on junior water users, if any exist, when flows drop below the amount of the granted reservations.

   A reservation does not guarantee that the granted flows will always be available; it merely establishes the instream flow level that will trigger a "call" response by MDFWP. In its application, MDFWP is asking that flows up to the amount of its requests be reserved for instream use. We are not asking that the full amount of these requests be maintained continuously. More water cannot be created by an instream reservation.

Q. Are there other problems with Mr. Perkins' water availability argument?

A. Yes. Mr. Perkins selectively applies his water availability argument solely to instream uses. For example, the Conservation Districts submitted 10 project applications that would, in total, divert an additional 310 cfs from the Jefferson River, a river long overburdened by depletions. Mr. Perkins does not address the availability of water for consumptive uses, for which the availability of water is a relevant consideration.

This water availability argument has also failed to halt the issuance of new water permits in the upper Missouri Basin. For example, between 1973-85, 20 new water permits for irrigation were issued in the Jefferson Basin; irrigation permits and applications after 1985 total nine (pg. A-4 and A-5 in the Draft EIS). There are no guarantees that further appropriations won't continue into the future, creating more dewatered streams and further depleting those that are already dewatered.

Q. Is there water available for instream use?

A. Yes. The fact that water continues to flow in Montana's streams in fall and winter, during spring runoff, and during the summer irrigation season - although summer flows may be severely depleted in some - is evidence that there is water available for instream use. If this was not the case, the flow quantifications for the Missouri Basin streams (USGS 1989) would read zero for all months in all years. The fisheries MDFWP studied are also confirmation of flows. MDFWP only requested instream reservations where a fishery now exists.

Q. What will an instream reservation do for the fishery?

A. An instream reservation, if granted today, will maintain the status quo of our stream fisheries. For many streams that are already overburdened by depletions, the status quo does not provide a desirable fishery. A reservation will simply prevent an already undesirable situation from worsening. For streams that presently do not suffer from serious dewatering and provide good fisheries, the reservation will help to ensure that good fisheries are maintained into the future.

Q. What baseline streamflows should be used for comparing the instream flow requests of MDFWP?

A. Because streamflows are often diminished by consumptive diversions, the historic average annual flow (AAF) derived for most streams reflects the depleted, or non-virgin, state. This depleted AAF can be substantially less than the undepleted or natural AAF for the same stream site. The following example from the mid-Missouri River basin demonstrates the potential magnitude of the difference between a depleted and an undepleted AAF.

Example:

Flatwillow Creek is a 119-mile-long tributary to the Musselshell River. Increased diversions for irrigation in about 1930 above USGS gauge #06127900 drastically decreased the AAF from 46.2 cfs (1912-30 period of record) to 14.3 cfs (1930-32, 1935-56 period of record), a reduction of 69% (Shields and White 1981). The AAF of 29 cfs for the entire period of record reflects the post-1930 irrigation development, which is currently about 9,000 irrigated acres.

Thus, the historic AAF of record (29 cfs) is 63% of the virgin or natural AAF that occurred before major depletions.

Comparing the instream flow request to the depleted AAF could make the request appear excessive when, in fact, it's a reasonable amount based on what's actually available before depletion. In the above example, MDFWP's request of 18 cfs is 62% of the depleted average annual flow of record, but 39% of the natural AAF that occurred before major depletions. The analysis that Mr. Perkins performs in Table 1 of his testimony fails to take into account the above discussed problem with the depleted AAF.

Q. Are there other problems with Table 1 of Mr. Perkins' testimony?

A. Yes. Aside from Mr. Perkins' misapplication of the 50% of average annual flow limitation to <u>ungauged</u> streams, the table contains many errors. For example:

1) Average annual flow for South Willow Creek is 35 cfs, not 25 cfs.

2) Beaverhead River near Dillon is not the site where MDFWP intends to monitor its 200 cfs flow request for Reach 2. The correct site is the Beaverhead River near Twin Bridges.

3) The Smith River near Fort Logan reflects flows at the downstream boundary of Reach 1, not Reach 2.

4) The Smith River near Eden reflects flows at the downstream boundary of Reach 2, not Reach 3.

5) The Smith River below its forks does not reflect the flows at the downstream boundary of Reach 1.

6) Sheep Creek at the USGS gauge reflects flows at mile 28 of Sheep Creek, not at the mouth where the reservation is intended to be monitored.

7) North and South forks of Dupuyer Creek -- average annual flows are reversed.

8) Birch Creek -- MDFWP's flow request of 64 cfs is based on the Fixed Percentage Technique. MDFWP requested 40% of the average annual flow of 159 cfs at the USGS gauge near Dupuyer (#06095000), which is the gauge with 10 or more years of record closest to the end of the stream reach (see Attachment B). The wetted perimeter method was not used.

9) The Teton River near Strabane does not reflect flows at the lower boundary of the Teton River reach. This site is located in the upper 1/3 of the designated reach.

Q. A conclusion of Mr. Perkins in his section on <u>Habitat Considerations</u> is: "the net effect of irrigation may be positive by alleviating harsh winter conditions." Is this correct?

A. This conclusion is purely speculative and is not based on factual evidence. Mr. Perkins first states that "irrigation returns warm groundwater to the stream during the harsh winter months and may help the fishery." Then he refers to the pre- and post-irrigation hydrograph, presumably from pg. 43 of the Draft EIS (see Attachment A), to support his statement. The hydrograph compares the natural streamflow for the Taylors Fork to the streamflow pattern that is expected to occur assuming 6,000 acres of new flood irrigation. One would expect the hydrograph to show increased return flows in winter, as implied by Mr. Perkins' argument. It doesn't. In January, February, and March, return flows are virtually zero. Under natural flow conditions, these are the most critical months for survival of fish. There are some increased return flows in the winter months of November and December. Return flows cannot warm the streamflow in winter if there are virtually no return flows in winter. Mr. Perkins then turns to the warm releases below dams in winter, implying that the benefits that may accrue to the downstream fisheries are solely the result of warm winter releases. MDFWP disagrees with his contention. Dams alter many factors that influence downstream fisheries, including flow regimes, productivity, food supply, and summer water temperatures. Impacts can be both beneficial and deleterious.

Mr. Perkins concludes his argument by stating "Even if stream dewatering, sediment and nonpoint pollution have some minor impact on the fish habitat in late summer, the net effect of irrigation may well be positive by alleviating harsh winter conditions." Mr. Perkins, without documentation, brushes aside stream dewatering, sediment and nonpoint pollution as having only minor impacts on fish. He then speculates that the net effect of irrigation may well be positive by alleviating harsh winter conditions. I assume this alleged benefit results from the warm, winter return flows, which appear to be virtually nonexistent during much of the winter (Attachment A), and warm, winter reservoir releases, which Mr. Perkins attributes to irrigation. This entire argument is without a factual basis.

Q. A reference cited by Mr. Perkins states "fish communities may be able to withstand near-drought conditions for one year in ten (or one month per year)". Do you agree with this?

A. Yes, in part. Fish communities in general appear to survive infrequent low flows, as occurs during near-drought conditions. Even then the populations are harmed. However, when these infrequent low flow events become commonplace, fish suffer long-term impacts, causing the fishery to be permanently harmed. Flow depletions can reduce the natural flows to inordinately low levels, levels which rarely, if ever, occur in the natural state.

Figure 4-2 on page 43 of the draft EIS demonstrates this point (see Attachment A). This figure compares the natural streamflow in the Taylors Fork to the streamflow pattern that is expected to occur assuming 6,000 acres of new flood irrigation. Figure 4-2 points out three major impacts. In general, August flows are proportionally more affected by irrigation depletions than are the flows in other months. In the example in Attachment A, the depleted August flow is about 1/5 of the natural August flow. Second, depletions often shift a stream's normal low flow period from mid-winter to the month of August. Third, in a stream depleted for irrigation, the low flows of August are often lower than the winter lows that occurred in the natural state, resulting in permanent adverse impacts to the fishery.

Q. What is the crux of Mr. Perkins' argument in regard to fish being able to withstand near-drought conditions?

A. Mr. Perkins appears to be attempting to show that the low flows resulting from irrigation depletions don't harm fish, because fish can tolerate infrequent low flow events. Mr. Perkins fails to recognize that these once infrequent low flows have now become commonplace on many streams due to irrigation depletions. As a result, what was once a 1-in-10 year flow event in the natural state, has now become common in the depleted state.

Q. Mr. Perkins claims there is no obvious documentation in

MDFWP's application that shows the effect of late summer low flows on fish populations. Is this correct?

A. No. Depressed fisheries in streams depleted by consumptive use are described throughout MDFWP's application and pre-filed direct testimony. Also, refer to pages 7 and 15 in Exhibit 1 of MDFWP's pre-filed direct testimony.

Q. Mr. Perkins quotes a statement from Addendum C, page 12 of MDFWP's Clark Fork Water Reservation Application. (This is Exhibit 1 in MDFWP's pre-filed direct testimony for the Missouri Reservations.) The statement discusses the impacts of the winter environment on fish and concludes with "It is this winter period and its associated low flows that ultimately regulate the capacity of most Montana streams to sustain fish." Is this statement correct?

A. Yes. On undepleted streams, winter appears to be the most critical season influencing trout densities. However, on depleted streams, the habitat reductions that result when irrigation water is removed often limit the population, replacing winter habitat as the ultimate population control. This was discussed in Exhibit 1 of MDFWP's pre-filed direct testimony.

Under natural flows, food supply is believed to be the most important regulator of fish populations in summer. In the warmer months, higher water temperatures initiate fish growth and young fish are hatched and enter the population. The availability of an adequate food supply during these warmer months is essential to the growth and population expansion that generally occurs in summer. This growth and population expansion provides anglers with a harvestable surplus of fish. Anglers will have the opportunity to take a portion of the fish biomass that will normally be lost over winter, without materially impacting future fish abundance. Pages 6-16 of Exhibit 1 of MDFWP's pre-filed direct testimony discusses the relationships between fish, food, and flows.

Q. On page 23 of Mr. Perkins' testimony (under General) he creates an argument to show that the dewatering of a stream by consumptive users leads to a smaller stream channel, which will provide the same or better habitat potential, but on a smaller scale. How does MDFWP respond to this argument?

A. Mr. Perkins ignores the fundamental principle that governs channel shape and form. It is the stream's annual high flow characteristics, not its low flows, that are the major force in the establishment and maintenance of channel form (Emmett 1972, Leopold et al. 1964, Nelson et al. 1986, and U.S.

Bureau of Reclamation 1973). The consumptive users would have to permanently eliminate the high flows of spring runoff before channel size and form could be altered. Even if this was possible, Mr. Perkins provides no evidence that the resulting altered channel would provide "the same or better habitat potential." This argument is based on a misunderstanding of the basic principle that governs channel form.

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Shields, R. and M. White. 1981. Streamflow characteristics of the Hudson Bay and Upper Missouri River Basins, Montana, through 1979. U.S. Geological Survey, Water Resources Investigations 81-32. USGS, Helena, Montana.

U.S. Bureau of Reclamation. 1973. Appendix H-sedimentation. Pages 789-795 <u>in</u>: Design of small dams. U.S. Government Printing Office, Washington D.C.

U.S. Geological Survey. 1989. Estimates of monthly streamflow characteristics at selected sites in the upper Missouri River basin, Montana, base period water years 1937-86. U.S. Geological Survey, Water-Resources Investigations Report 89-4082. U.S.G.S., Helena, MT. 103pp.

Frederick A. Nelson, being duly sworn, states that the foregoing testimony is true.

Dated this 16th day of December, 1991.

Frederick A. Nelson

Frederick A. Nelson

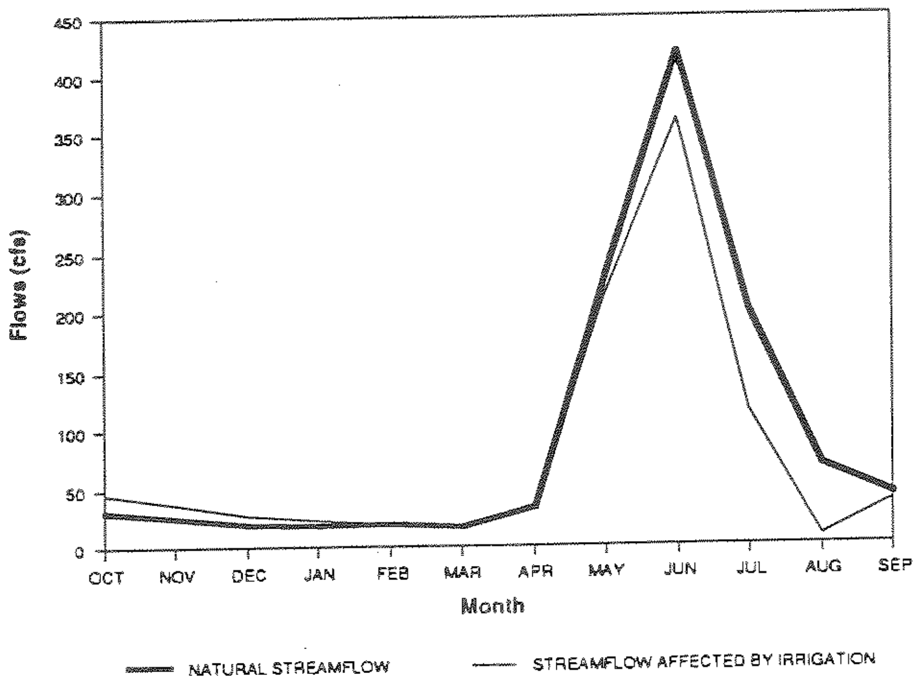
Subscribed and sworn to before me this 16th day of December, 1991.

Debra K. McRae

Notary Public for the State of Montana
Residing at Helena, Montana
My commission expires May 14, 1994

517.39A

Figure 4-2. Natural streamflow pattern contrasted with streamflow pattern affected by irrigation[a]



a. Natural streamflows are based on measured and estimated flows for Taylor Creek in the upper Gallatin drainage near Grayling (USGS gauge #06043000) for the period of record 1928-1986. Streamflows affected by irrigation are estimated assuming 6,000 acres of new flood irrigation.

typically store water for more than one use, with numerous operational constraints.

Water storage and the associated benefits are treated as consumptive uses in Figure 4-1. This is because of the large amounts of water that are returned to the atmosphere through reservoir evaporation.

FLOW RECORDS

When available, stream gauging records provide some indication of streamflow conditions in a basin.

Percentile exceedance flows are the flow rates that have been equalled or exceeded at a given frequency over the period of record. For example, in August at USGS gauging station 06025500 on the Big Hole near Melrose, the 80th percentile flow is 340 cfs and the 20th percentile is 700 cfs for the period of record from 1937 to 1986 (USGS 1989b). That means that average flows of 340 cfs or more have been recorded in 40 of the 50 Augusts (80 percent) from 1937 to 1986. Similarly, only 10 of the 50 Augusts between these years had recorded average flows of 700 cfs or more. In assessing streamflow conditions in the basin, DNRC has generally assumed that the 80th percentile exceedance flow represents a typical low flow condition, while the 20th percentile flow represents a typical high flow condition.

To help provide a common basis for assessing flow conditions in streams throughout the basin, the USGS, in cooperation with DFWP, estimated the average monthly streamflow records at 341 sites for the 50-year period from 1937 to 1986. USGS then computed new average monthly means and 20th, 50th, 80th, and 90th percentile exceedance flows for each site. The results are published in the Water Resources Investigations Report 89-4082 (USGS 1989) and are used extensively in this draft EIS (Appendix D) and in many of the reservation applications.

HEADWATERS SUBBASIN

Flows of the Gallatin, Madison, and Jefferson rivers and their major tributaries have been measured in several locations by USGS. Average monthly, average annual, and percentile exceedance flows are shown in Table 4-1. Records at gauges near the

ATTACHMENT B

06095000 BIRCH CREEK NEAR DUPUYER, MT

LOCATION.--Lat 48°15', long 112°39', near center of sec.28, T.29 N., R.8 W., Pondera County, Hydrologic Unit 10030201, 0.5 mi (0.8 km) upstream from B canal headgates and 8 mi (13 km) northwest of Dupuyer.

DRAINAGE AREA.--105 mi^2 (272 km^2), approximately.

PERIOD OF RECORD.--August 1907 to September 1937.

REVISED RECORDS.--WSP 1309: 1909, 1912, 1914(M), 1917, 1918.

GAGE.--Nonrecording gage. Altitude of gage is 4,180 ft (1,274 km), from topographic map. Prior to June 29, 1927, nonrecording gages at several sites within 0.5 mi (0.8 km) described site at different datums.

REMARKS.--Several small diversions for irrigation above station. Flow regulated by Swift Dam since 1913.

COOPERATION.--Records furnished by Valier-Montana Land and Water Co.

AVERAGE DISCHARGE.--30 years (1907-37), 159 ft^3/s (4.503 m^3/s), 115,200 acre-ft/yr (142 hm^3/yr).

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge not determined, occurred about June 6, 1908; minimum observed, 3 ft^3/s (0.085 m^3/s) Apr. 7, 1921, and Apr. 4-6, 8, 9, 1937, but may have been less during periods of ice effect.

MONTHLY AND ANNUAL MEAN DISCHARGES 1909-37

MONTH	MAXIMUM (CFS)	MINIMUM (CFS)	MEAN (CFS)	STANDARD DEVIATION (CFS)	COEFFICIENT OF VARIATION	PERCENT OF ANNUAL RUNOFF
OCTOBER	366	13	93	77	.83	5.0
NOVEMBER	492	6.0	68	97	1.43	3.7
DECEMBER	118	6.9	37	38	1.03	2.0
JANUARY	140	6.0	32	35	1.12	1.7
FEBRUARY	212	4.0	36	50	1.37	2.0
MARCH	310	5.7	41	61	1.49	2.2
APRIL	340	7.8	95	81	.85	5.1
MAY	607	61	321	139	.43	17.4
JUNE	1360	101	463	278	.60	25.1
JULY	707	72	332	147	.44	18
AUGUST	418	45	215	119	.55	11.7
SEPTEMBER	300	26	110	74	.67	6.0
ANNUAL	315	46	154	59	.38	100

MAGNITUDE AND PROBABILITY OF ANNUAL LOW FLOW BASED ON PERIOD OF RECORD 1910-37

PERIOD (CONSECUTIVE DAYS)	DISCHARGE, IN CFS, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND NON-EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	20 5%	50 2%	100 1%
1	8.2	4.0	3.0	2.4	2.0	-----
3	8.6	4.4	3.4	2.9	2.5	-----
7	9.0	4.7	3.7	3.1	2.7	-----
14	9.3	4.9	3.9	3.3	2.9	-----
30	9.9	5.4	4.2	3.6	3.1	-----
60	12	6.3	4.8	4.0	3.3	-----
90	14	6.9	5.1	4.1	3.3	-----
120	16	7.9	5.7	4.5	3.6	-----
183	33	16	11	8.1	5.8	-----

MAGNITUDE AND PROBABILITY OF INSTANTANEOUS PEAK FLOW BASED ON PERIOD OF RECORD

DISCHARGE, IN CFS, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT						
1.25 80%	2 50%	5 20%	10 10%	25 4%	50 2%	100 1%
--	-	--	--	--	--	--

WEIGHTED SKEW = --

MAGNITUDE AND PROBABILITY OF ANNUAL HIGH FLOW BASED ON PERIOD OF RECORD 1909-37

PERIOD (CONSECUTIVE DAYS)	DISCHARGE, IN CFS, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	25 4%	50 2%	100 1%
1	738	1380	2100	3550	5190	-----
3	711	1220	1730	2640	3570	-----
7	652	1040	1380	1920	2420	-----
15	579	880	1120	1470	1770	-----
30	501	727	895	1130	1320	-----
60	426	594	705	846	951	-----
90	378	514	595	689	754	-----

DURATION TABLE OF DAILY MEAN FLOW FOR PERIOD OF RECORD 1909-37

DISCHARGE, IN CFS, WHICH WAS EQUALED OR EXCEEDED FOR INDICATED PERCENT OF TIME																
1%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	95%	98%	99%	99.5%	99.9%
849	534	418	345	281	176	111	82	46	21	11	8.2	6.6	5.9	4.6	4.1	3.7

PREFILED REBUTTAL TESTIMONY
OF LITER E. SPENCE
ON BEHALF OF THE
MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. Please state your name and business address.

A. Liter E. Spence, MDFWP, 1420 E. 6th Avenue, Helena, MT 59620.

Q. By whom are you employed, and in what capacity?

A. I am employed by the Montana Department of Fish, Wildlife and Parks. My position is Water Resources Supervisor in the Fisheries Division. My primary responsibility is to implement the Department's instream flow program, which includes obtaining and protecting instream flow reservations and other instream flow water rights.

Q. Have you previously prepared testimony in this proceeding?

A. Yes. I prepared written testimony as part of DFWP's Prefiled Direct Testimony submitted November 1, 1991 and also written Objectors Testimony submitted December 3, 1991.

Q. Does that testimony include statements of your qualifications and experience?

A. Yes, it does, including a description of my instream flow training, experience and a biography.

Q. What is the purpose of this rebuttal testimony?

A. The purpose is to comment on the objector testimony of those persons who objected to DFWP's instream flow reservations being granted because of their concerns about water availability, storage, the adjudication process and DFWP standing. I will also comment specifically on the objector testimony of the following persons: Bonnie Conley-Tolton, Daniel E. Nelson, Ole M. Ueland, Scott V. Hoag, Jr., Gary Elwell, and Roger Perkins.

Q. What format will you use in your testimony?

A. There were many objectors with common concerns about the DFWP reservations affecting water rights and water availability, standing, adjudication and opportunities for new storage. Rather than reply individually to these objectors, I will provide a general response to each concern. However, I will respond individually to the objectors' testimony of those persons listed above.

Q. Many persons, testifying as objectors to the DFWP application, have stated the instream flows should not be granted because many streams are over-appropriated and there is no water available for instream flows unless existing water rights are utilized to provide that additional water. What is DFWP's response to this concern?

A. There seems to be considerable misunderstanding regarding the intent of the DFWP instream reservations. Many objectors believe the instream flows, if they are granted, will come at the expense of their existing water rights so that the level of flow requested by DFWP will be maintained. This is not the case at all.

Water currently being diverted by existing water users is not available for instream flows. Water is available only when it is not actually being diverted during the irrigation season or at other times of the year by these senior users.

July 1, 1985 is the priority date established by the legislature for all reservations that may be granted. Instream reservations will not interfere with water rights that have a priority date before July 1, 1985. Once a priority date is established, the reservation statute specifically states that "... a reservation may not adversely affect any rights in existence at that time." [85-2-316(9)(e), MCA].

The purpose of the instream reservations is to prevent flow conditions from becoming any worse than they are now on streams where water is not always presently available for fully protecting instream values, or where water is available to protect these values, to protect these instream flows against future depletions. Instream flows will not be provided by taking water from anyone's existing water rights. This is against the law. Reservations would be used just like a new water use permit is used. For example, if a new water use permit is granted by the state on a stream where there are already other appropriators, the new permittee has the right to utilize water up to the amount of his permit, but only when water is physically available and not being utilized by senior water users. The same conditions would apply to our instream flows. We could use and protect water up to the amount of the instream reservation but only if it was not already being used by water users with priority dates before July 1, 1985. This is previously discussed in my direct testimony (Spence Direct, page 9).

Q. A number of persons who provided individual objector testimony to the DFWP application have stated that the instream water reservations should not be granted until the adjudication of existing water rights in the basin is completed. What is DFWP's response to that concern?

A. Although it would be good to have the adjudication process completed in the basin, it doesn't appear that the process will be finalized for many years. Water rights will be fully adjudicated only after the issuance of final decrees by the water court. There are no final decrees yet issued in the Missouri Basin above Fort Peck Dam. Before final decrees can be issued by the water court, the water rights of the federal government and the Indian tribes in Montana must be negotiated and resolved by the Reserved Water Rights Compact Commission by July 1, 1999 unless negotiations are suspended. If no compacts are negotiated or negotiations are suspended, the claimed tribal and federal rights must be filed in the adjudication process.

The Reserved Water Rights Compact Commission was established by Section 29 of SB 76 in 1979 (CH. 697). Since that time, one compact has been completed and ratified by Congress (Fort Peck Tribe) and one compact has been approved by the Montana Legislature but not yet ratified by Congress (Northern Cheyenne Tribe). The Reserved Water Rights Compact Commission is currently involved in the compacting process with the Fort Belknap and Rocky Boys Indian reservations. Compact negotiations have either not begun or been completed for any of the federal agencies claiming reserved water rights (BLM, USFS, USFWS, National Park Service).

Completion of the adjudication process will not affect our knowledge of the physical availability of water nor will it alter the need to preserve the status quo of the basin's fisheries.

The legislature has mandated that this Missouri basin water reservation process be completed by July 1, 1992, but there is no legal requirement that the adjudication process be completed by that date or any other time. DFWP is simply a participant in an established legislative process and has accordingly submitted its water reservation requests for the Board to consider.

Q. A number of persons in their individual testimony have claimed that instream flow reservations will, if granted, prohibit the construction of new storage facilities. Many have also stated that storage should be the means by which instream flows are provided rather than utilizing the water reservation process. What is DFWP's response to this concern?

A. The purpose of the instream reservations is to preserve at least a portion of what is left of remaining stream flows on streams where flows have gradually been depleted for over 100 years. Without the reservation process, there is no legal means to protect remaining water important to fisheries in the basin. In most cases, DFWP did not request high flows which occur during the spring runoff period. The requested flows are the minimum required to maintain the fishery resource. If these minimum instream flows are granted by the Board and there is a potential to build a storage project on any of those streams, a portion of the high flows that occur during spring runoff could still be stored by the project as long as the minimum flows are met below the dam.

DFWP considers storage as one of several tools that could be used to improve streamflows. Some objectors have stated that storage should be the sole means of providing instream flows. If storage projects are built to provide "multiple uses", instream flows may be one of the needs that project water should supply. If a new project is constructed on a stream having a fishery, additional downstream flows could be provided so the project can have multiple benefits. DFWP's current instream flow requests could be essentially the same as the flows that would be needed below a new storage project to maintain a healthy fishery. Thus, it would make no difference whether the instream flows are authorized on a stream before a project is built or implemented after the project is built for multiple purposes. The flow needs could be the same. However, DFWP would not have a right to compel the release of stored water for an instream flow reservation if the stored water was being used for other purposes as part of the storage project unless DFWP had a right, contractual or otherwise, to a portion of the stored water.

There may be some future opportunities to build new storage that is cost effective and could provide the multiple benefits of irrigation, recreation and instream flows. However, project costs and the relative priority of new storage projects established in the State Water Plan by the 1991 legislature will have to be favorable. However, due to the widespread dewatered conditions of our streams in the Missouri basin above Fort Peck dam, storage will not solve our instream flow problems on a basin-wide basis. Storage may be a tool to improve streamflows on some streams, but as long as new water permits continue to be issued, it is not a substitute for obtaining instream reservations that will at least maintain the status quo of streamflow in many Missouri basin streams.

Q. A number of persons have expressed concern that DFWP will obtain legal standing in basin water issues if it is granted an instream flow reservation. What is DFWP's response to this concern?

A. There are usually two concerns expressed about standing. First, DFWP would acquire standing to object in the adjudication process and, second, that DFWP would become an objector to new water uses or changes in existing rights in a basin. I will address the adjudication concern first.

DFWP already has standing to object to water rights in the adjudication process because we have our own existing diversionary water rights as well as pre-1973 instream flow rights in many basins. These include diversionary water rights for such purposes as fish hatcheries and wildlife areas and our instream Murphy Rights. There are 28 sub-basins in the Missouri River basin above Fort Peck Dam that are utilized by the water court in the adjudication process. DFWP has some kind of existing, pre-1973 water right in 18 of those basins. Nine of the remaining basins flow directly into downstream basins where DFWP has pre-1973 claims. DFWP, therefore, has standing by virtue of its pre-1973 claims and the basins' hydrological connections in all 28 basins except one, Dry Creek (sub-basin 40D) that directly enters Fort Peck Reservoir. Any reservations that may be granted would not change the Department's standing in those basins because we are already a pre-1973 water right holder and are already participating in the adjudication process.

The second issue concerns standing to object to new permit applications or requests for changes in water use. If instream reservations are granted to DFWP, we would gain additional standing on many stream reaches and, therefore, the right to participate in water decisions in those reaches where instream flows may be adversely affected by new consumptive depletions with consequent harm to the fishery. These decisions include the issuance of new water use permits and applications to change existing water rights (i.e., change in point of diversion, place of use or type of use). DNRC currently denies the Department's objections to new permits and changes where we do not have an established existing water right that could be adversely affected by the requested new permit or change of use, or where the DFWP objection is based on harmful impacts to the fishery of a stream where we do not have a Murphy Right. DFWP currently has this type of standing to object wherever we have Murphy Rights. Murphy Rights held by DFWP are shown in Appendix A. If instream flows are granted, we would have the same rights as any other water user on a stream to object to new water use permits and any changes in existing rights that we could show would adversely affect our water rights.

Q. To which objector's testimony does this rebuttal testimony refer?

A. The testimony of Bonnie Conley-Tolton.

Q. Please describe Ms. Conley-Tolton's objector's testimony and DFWP's response.

A. I am responding to her testimony individually because she attributes some statements in her testimony to me personally.

Ms. Conley-Tolton contends that DFWP is requesting water in streams where no water is available and that DFWP statutorily and administratively was required to demonstrate that requested water is available. She also objects to the reservations on the basis that due to the lack of water available for instream flows, the supposedly required costs of measuring streamflows are not cost effective. I will address the former concern first.

The water reservation administrative rules require all water reservation applicants to provide a water availability analysis on streams where reservations are requested. DFWP provided this information through the USGS publication "Estimates of Monthly Streamflow Characteristics at Selected Sites in the Upper Missouri River Basin Montana, base period water years, 1937-86 (U.S. Geological Survey, Water Resources Investigations Report 89-4082) which is Exhibit 4 of DFWP's direct testimony. The water reservation statutes and rules do not require DFWP to compare the amount of water available to the instream flows requested. Prior to submitting its application, DFWP was not required to, had no means to and did not measure flows over a long period of time on all of the requested streams. Rather, this information was provided through the USGS report and is based on data from streams that <u>are</u> measured over a long period of time and by estimating streamflows on those streams where no gauging record was available.

Ms. Conley-Tolton's overall concern about water availability is similar to the concern of other objectors and has been previously addressed in this testimony.

Secondly, Ms. Conley-Tolton has misinterpreted the stream gauging information we discuss in our application Management Plan (Page 1-90) and the flow measurements she feels are required <u>prior to</u> submittal of an application. Our Management Plan explains the process we have used and plan to use to monitor and protect any instream flows we might be granted in the Missouri basin. The Management Plan addresses some stream gauging that may be required to monitor instream flows so that junior water users can be notified when flows fall below the instream reservations. Stream gauging is expensive and gauging costs are a consideration in any monitoring that will be done by the DFWP. (This is also explained in the Management Plan.) Stream gauging will be required only on streams where there are water users <u>junior</u> to the instream reservations. Some streams already have stream gauges which can be used to monitor instream flows.

Finally, Ms. Conley-Tolton criticizes the instream application because "cost benefit ratios required to be analyzed are woefully out of balance, the costs far exceed the benefits.

The Department of Fish, Wildlife and Parks has admitted as much." She incorrectly infers that a separate cost-benefit analysis was required for the enforcement effort to protect instream flow requests. This is not the case; there is no such requirement in the statutes or administrative rules. DFWP activities under the Management Plan will be evolutionary. DFWP does not have to install a gauge on every stream where instream flows are granted. Whether any gauges are installed at all will depend upon how many, if any, new water use permits are issued. We can utilize existing gauges and be selective in the need for any new gauges by installing them only when enough new water use permits are granted to justify their installation.

Q. To what objector's testimony does this rebuttal testimony pertain?

A. To the objector's testimony of David E. Nelson, U.S. Bureau of Reclamation, for the Beaverhead River reaches #1 and #2.

Q. What is the concern of this objector and what is DFWP's response?

A. Mr. Nelson states that there is no water available in the Beaverhead River reaches #1 and #2 for the DFWP's requested instream flow reservations because the Bureau of Reclamation and other senior water rights have appropriated all the flow in the Beaverhead River.

The DFWP's instream flow request would simply preserve the status quo of the flow conditions existing in the Beaverhead River reaches #1 and #2. The requests would not interfere with the operation of Clark Canyon Reservoir or the East Bench Unit, but would only protect existing flows from water users who might obtain new water use permits with priority dates after July 1, 1985.

Q. To what objector's testimony does this rebuttal testimony pertain?

A. To the testimony of David E. Nelson, Bureau of Reclamation, for Missouri River reaches #2, #3 and #4.

Q. What is the concern of this objector and what are DFWP's responses?

A. Mr. Nelson's concern is that water stored in Canyon Ferry Reservoir is no longer part of the Missouri River natural flow and is not available for appropriation by an instream reservation. He also states DFWP has requested flows which exceed the 50% limitation on instream flows at gauged sites under 85-2-316(6) MCA. I will address the former concern first.

Once water is released from Canyon Ferry Reservoir into the Missouri River it is no longer under the control of the Canyon Ferry project. The water flows into Hauser Reservoir, where it is temporarily stored by the Montana Power Company, which then releases flows into the river below Hauser Dam. From Hauser Dam, the water flows through reach #2 into Holter Reservoir where it is temporarily stored by MPC and then released into reach #3 of the Missouri River below Holter Dam. Water then continues through several other MPC reservoirs into reach #4 which ends at the mouth of the Marias River.

As stated by Mr. Nelson, DFWP currently cooperates with the Bureau and MPC on flow releases. We will continue this cooperation. The reservations are not intended to interfere with reservoir operations, but only to protect the fishery in these river reaches from any future new water uses which might lower flows below the instream reservations of DFWP.

Regarding the 50% limitation on instream flows at gauge sites, Mr. Nelson has provided figures for the average annual flow and 50% of the average annual flow as determined through Water Year 1990. These flows are lower than those used by DFWP in its application (page 1-30) because the last water year used by DFWP when preparing its application was water year 1987, which ended September 30, 1987.

Mr. Nelson also states that since the flows requested by DFWP vary during the year, the request for each period should not exceed 50% of the average flow for that period. Section 85-2-316(6), MCA states only that the Board may not grant instream flows that exceed a maximum of 50% of the <u>average annual</u> flow of record on gauged streams. The statute says nothing about how flows should be established by the Board if the instream flow requests are greater than 50% of the average annual flow. Mr. Nelson's suggestion would penalize the DFWP by providing flows too low during periods which do not include a high flow period. The average <u>annual</u> flow includes flows which occur during the entire year, including the high flow period. There is a big difference between 50% of an average <u>annual</u> flow and 50% of the average flow for a given time period if that period includes only low flow months.

In my pre-filed direct testimony (Spence Direct, page 10) DFWP has suggested a means by which the Board can handle such a situation. DFWP suggests that any reductions in flow be made during the high flow period of the year between May 15 and July 1. This is preferable to making reductions during the irrigation season months when flows are already often too low in a stream reach. We suggest that the average annual flow can be interpreted by volume (acre feet) as well as by flow rate (cfs) and downward adjustments may be made more effectively on an acre feet basis. For example, depending on the size of the required reduction, all of it could be made during one month simply by reducing the total acre feet requested in that month by the amount which is greater than 50% of the average annual flow. The reduced volume granted can then be converted to a flow rate in cfs. Reductions could also be spread over the May 15 to July 1 period by the same means if this would alleviate large impacts of the reductions on the requested flows for a single month. This is a better way to handle required reductions than is recommended by Mr. Nelson.

The average annual flow determined at a gauged site is a moving target. When DFWP was preparing its application, the average annual flows for the period of record through 1987 at various stream gauges were somewhat higher than those presented by Mr. Nelson through Water Year 1990. By the time the Board makes its decision, flow records from Water Year 1991 will be available which will likely show yet another average annual flow at these gauge sites. We need some criteria for the use of these figures which consider the long time period between preparation and submission of an application, preparation for the contested case hearing and the Board's decision.

Q. To what objector's testimony does this rebuttal testimony pertain?

A. To the testimony of David E. Nelson, Bureau of Reclamation, concerning the Sun River reaches #1 and #2.

Q. What is the concern of this objector and what is DFWP's response?

A. Mr. Nelson's concern is that Gibson Reservoir on the Sun River regulates streamflows for irrigation use on the Sun River project and that water is not available for the requested instream flows of DFWP.

DFWP recognizes that Gibson Reservoir regulates streamflows and, as stated earlier in this testimony, is concerned only about protecting from new water uses those flows which presently occur in the Sun River. The instream reservations will not interfere with any current operations of the Sun River project or the water available for those purposes, but will only affect junior water users who may receive water use permits in these stream reaches after July 1, 1985.

Q. To what objector's testimony does this rebuttal testimony pertain?

A. To the testimony of David E. Nelson, Bureau of Reclamation, for the Marias River reaches #2 and #3.

Q. What are the concerns of this objector and what is DFWP's response?

A. The concerns of Mr. Nelson regarding water availability are the same as those for Canyon Ferry Reservoir. He states that, since water is stored in Tiber Reservoir, it is no longer part of the Marias River natural flow and is, therefore, not available for appropriation by an instream flow request. He also states that the requested minimum flows are higher than the maximum allowed under 85-2-316(6), MCA.

The water availability question on the Marias is the same as that for the Missouri River below Canyon Ferry. Once streamflows are released from the dam, whatever flows are released are no longer controlled in the Marias River and could be available for new appropriation except for stored water released for a valid water use downstream. DFWP intends only to protect the flows released into the Marias River below Tiber Dam from any new appropriations that should occur after July 1, 1985.

Secondly, Mr. Nelson states that the only gauge on the Marias River below Tiber Reservoir is the USGS gauge #06101500 on the Marias River near Chester, Montana. Mr. Nelson states the Chester gauge should be used for both reaches #2 and #3. However, there is also a record of streamflow at a USGS gauge on the Marias River near Loma, near the mouth of the Marias River (gauge #06102050). This gauge has a period of record from 1959-1972 (13 years) and is a more appropriate gauge to use for reach #3 of the Marias River than is the Chester gauge. The average annual flow recorded at this gauge for its period of record is 977 cfs. Fifty percent (50%) of this average annual flow is 488 cfs, which is a higher flow than suggested by Mr. Nelson's use of the Chester gauge. The Chester gauge shows the average annual flow is 846 cfs with 50% being 423 cfs. The Board cannot grant more than 50% of the average annual flow <u>of record</u> on these gauged streams. We believe these 13 years of record at Loma are appropriate to use for reach #3 even though the Chester gauge is the only gauge currently operating on the Marias River below Tiber Dam. The Chester gauge should be used for reach #2 but not reach #3.

Q. To what objector's testimony does this rebuttal testimony pertain?

A. This pertains to the testimony of Ole M. Ueland, Vice-Chairman of the Headwaters RC&D.

Q. What are Mr. Ueland's concerns?

A. Mr. Ueland states that the only way to supply instream flows is through water storage which would provide multiple benefits. He states there is no water available during the irrigation season, that the DFWP application will not fulfill its stated purpose and will unnecessarily complicate the water planning process in the headwaters region. He states the only way to solve instream flow problems is to increase the amount of water available through conservation and water storage projects in the tributaries. He states DFWP has failed to explore and/or plan for these alternatives and also states that the instream flow request by DFWP will preclude storage on some streams because there is no excess water available in winter and spring.

DFWP knows of no overall comprehensive water management planning process that is ongoing or pending in the Missouri River basin headwaters. DFWP would support and participate in such a planning process, but a comprehensive plan was not contemplated or ongoing at the time DFWP submitted its instream flow requests. It is not DFWP's responsibility to initiate a comprehensive plan. This is better done through the state water planning process. DFWP is simply following an established water reservation process to acquire instream flows.

Mr. Ueland states the only way to solve the problem of low streamflows is to increase the amount of water available. He states one way to do this is through water conservation. We agree with him that there may be opportunities for conservation and are hopeful that streamflows can be improved through conservation measures. In the meantime, we need to preserve the status quo with instream reservations.

Mr. Ueland's other concerns about water availability and storage are similar to those addressed earlier in this testimony.

Q. To which testimony does this rebuttal testimony pertain?

A. To the testimony of Scott V. Hoag, Jr., U.S. Soil Conservation Service.

Q. What part of Mr. Hoag's objector's testimony is addressed in this rebuttal testimony?

A. Mr. Hoag discusses the SCS's small watershed and flood protection program under Public Law 83-566. He discusses the technical assistance and funding available to build small watershed projects and that such projects can be funded by state agencies or irrigation districts. He states that, whenever possible, new storage facilities are designed for multiple purposes and that they can stabilize instream flows. He also says the program can help irrigators become more efficient, thereby increasing instream flows. He discusses a small watershed project on Mill Creek, a tributary of the Yellowstone River. He states that DFWP is participating in this project and that one of the project's benefits is to provide instream flows to flush cutthroat trout fry downstream to the Yellowstone River during critical periods.

At the time his testimony was submitted, the Mill Creek project had recently been completed but had not yet operated during the irrigation season. The project is expected to first operate in the 1992 irrigation season. The Mill Creek project is not a storage project; there is no dam or reservoir. It is a project that will convert a flood irrigation system to a gravity pipeline sprinkler system. Although instream flows were shown as a project benefit in the authorizing documents, no instream flows were actually authorized by Congress and none will occur due to the project itself. They will only be acquired and protected by DFWP through the water leasing program. Mr. Hoag's testimony implies that the benefits are already being provided when, in fact, no leasing agreement had yet been reached with the water users and no instream flows had been provided in Mill Creek. If an agreement is not reached, flows will not be provided. However, DFWP is hopeful current negotiations with water users will result in such benefits becoming a reality. Although new small watershed projects are possible in the Missouri basin under Public Law 83-566, instream flows are not a guaranteed provision of project operation.

Q. To what testimony does this rebuttal testimony relate?

A. This testimony relates to the objector testimony of Gary Elwell, HKM Associates, in which he compares estimates of monthly streamflow characteristics at selected sites in the upper Missouri River basin for the base period water years 1937-86 and 1930-90. Mr. Elwell concludes that, by including the water years 1930-36 and 1987-90, the magnitude of the flows at four stations he analyzed was lower than those shown for the same stations in the USGS analysis. He also concludes that it would be reasonable to assume that other streamflow gauges with similar hydrologic characteristics would yield the same results if monthly streamflow characteristics for water years 1937-86 and 1930-90 were compared.

My rebuttal testimony will simply clarify why the 1937-86 period of record was selected and why the 1987-90 period was not included.

DFWP began formulating the water availability study with the

USGS and DNRC in March 1987. We decided to use 50 years of record ending with Water Year 1986. Water Year 1986 was selected as the ending date because it was the latest complete water year available when the study was begun. (Water year 1986 ended September 30, 1986.) This put the period starting date at water year 1937. Another consideration in this decision was the number of gauging stations available to use as index stations to extend the period of record for those streams which had little or no gauging data available. Prior to about 1937, there were fewer gauging stations operating, and, according to the USGS, using fewer stations (i.e., by including water years prior to 1937) would have produced poorer correlations for estimating flows at ungauged sites than would using the 1937-86 period.

As far as the 1987-90 water years are concerned, streamflow estimates at the sites included in the USGS study were completed prior to July 1, 1989, the date DFWP's application had to be submitted to the Board of Natural Resources and Conservation. Water years 1987 through 1989 were not included because the study was begun before those water years were complete or had even begun. Water year 1990 began October 1, 1989, three months after our application was submitted.

Q. To what objector's testimony does this rebuttal testimony pertain?

A. To the testimony of Roger Perkins, Water Resources Consulting Engineer for the conservation districts whose testimony has also been adopted by other objectors to DFWP's application.

Q. What is your specific testimony in this regard?

A. My testimony will address the parts of Mr. Perkins' testimony concerning the question of standing (page 3), the issue of storage (page 4), and part of his review of DFWP's application (page 23).

The question of DFWP standing has been raised by other objectors and has already been addressed in this testimony. However, there are a few additional points to address in Mr. Perkins' testimony. On Page 3, paragraph 1, he quotes a statement from the DEIS as follows: "Reservations would give reservants legal standing to object to changes in senior and junior rights and applications for new permits and the right to participate in the adjudication process." This statement should not be attributed to DFWP. In our written comments on the draft EIS dated September 12, 1991 (page 10), we specifically take issue with that statement (see Appendix B of this testimony).

Also on page 3, paragraph 1, Mr. Perkins speculates as to

DFWP's actions in the Yellowstone River basin where DFWP already has instream flow reservations. He incorrectly states that DFWP has not actively pursued objections in this basin because we are waiting for the reservation process to be complete on a statewide basis. In fact, since the reservations were granted in 1978, DFWP has had an active program of monitoring applications for new water use permits, changes in existing rights and extensions of water use permit applications to determine if any of those would affect the instream flow reservations. This program is discussed in my direct testimony (Spence Direct - page 7).

Mr. Perkins also speculates (page 3) on what future changes will occur in DFWP's protection of instream flows because of changes in leadership and pressure from those interested in instream flow protection. He quotes an undocumented Colorado case where water right changes are conditioned on the protection of junior instream flow rights. It appears the Colorado situation is no different than that which occurs under Montana water law where changes to existing water rights must not adversely affect the water rights of senior <u>or</u> junior water right holders.

Mr. Perkins' testimony on this issue concludes with the suggestion that the Board condition DFWP's instream reservations so that we "... cannot object to any senior water rights until the adjudication process is complete in the basin." Earlier in this testimony, I addressed the timing of the adjudication process as it relates to the schedule for completing the water reservation process. If the state waits until the adjudication process is completed before any granted reservations can be protected against new consumptive uses and the current water permitting process continues during the expected long period of time before the adjudication is completed, the result will likely be even less water available for instream flows than presently occurs. There will be no instream reservations to protect instream flows from those new water uses, where necessary.

On the issue of storage, Mr. Perkins, throughout this part of his testimony, promotes storage as a means to improve flows. He states that instream flows should not be granted without storage, that the DFWP instream flow requests are unreasonable, that the instream flow requests should be set at a flow level that will not hinder development of new storage, that the instream flows, if granted, would become unreasonable standards for future projects, and that instream flows cannot be set at optimum rates for the fishery and still provide water for other uses. His testimony is inconsistent on these points.

Mr. Perkins goes to considerable length to address the issue of storage that he feels granting of instream flows would preclude. Mr. Perkins would like to improve instream flows by building storage, however, he makes a circular argument. On page 4, paragraph 1 of his testimony, he claims that granting liberal instream flows "can completely negate benefits for those who typically pay for storage," implying that DFWP's requested instream flows cannot be allowed if storage is to be used for other purposes, such as irrigation. At the same time, in the next paragraph, he suggests the use of storage as a means to "augment instream flows." Mr. Perkins is not specific about how granting the instream flows now would preclude new storage projects or what he means by augmenting flows.

Mr. Perkins quotes liberally from Kansas and Wyoming references (no documentation of the references is provided) which outline the instream flow policies of those two states (page 4). Storage is apparently a factor in both states' policies. According to his testimony, the goal of the Kansas instream flow program is "not to have water in the stream all of the time" and "only in cases where reservoir storage is available to supplement stream flows can there be a likelihood of maintaining <u>desirable</u> stream flows at all times" (emphasis added). Mr. Perkins seems to be wanting to improve instream flows but provides no information as to how the "improved" flows from storage would be any different from flows now being requested by DFWP. On page 5, paragraph 2, Mr. Perkins again states that instream flows cannot be set at optimum rates for the fishery and still provide water for other uses. Again, we are confused by his testimony. In that same paragraph, Mr. Perkins states that "many reservoirs never materialized because of the financial constraints imposed by instream flows." However, he provides no examples or supporting data for that statement. We must conclude that Mr. Perkins supports some instream flows below storage, but not necessarily in amounts necessary to provide a healthy fishery.

On page 5, paragraph 2 of his testimony, Mr. Perkins states that reservoirs have a life of 100 to 500 years.

Since the United States has been a country for just over 200 years, and most existing dams are less than 100 years old, we question the reliability of these statistics.

Mr. Perkins concludes his storage discussion by suggesting the Board condition any instream reservations so that if a storage project is built, the instream flows delivered below the project are based on a habitat model other than the Wetted Perimeter Inflection Point Method. This conclusion is reached without any prior discussion of other instream flow methods. We assume he is referring to the Instream Flow Incremental Methodology (IFIM) developed by the U.S. Fish and Wildlife

Service.

DFWP utilized the Wetted Perimeter Inflection Point Method (a standard setting method) to derive most of our instream flow requests. The IFIM can be used when instream flows must be negotiated to allocate a limited water supply amongst different water users (such as building new storage). DFWP has no objection to the use of this model for that purpose as long as all parties understand the model's limitations and agree to the criteria used in the model to determine fishery flows. However, Mr. Perkins implies in this recommendation (page 7), and is perhaps hopeful, that the instream flows derived from a different instream flow habitat model may be less than the flows derived through the Wetted Perimeter Inflection Point Method. This is not necessarily the case. Another model may derive flows equal to or greater than those requested by DFWP.

On page 23, paragraph 2 of his testimony, Mr. Perkins states that instream reservations "should not be used to maintain the status quo or preservation of existing conditions, but as a means of cooperating with other consumptive users to improve the availability of water." Under this current water reservation process, the status quo is all that can be maintained by the reservations. We are not asking for all of the remaining flow, only a portion of it. By starting with maintaining the status quo, we can work towards negotiation and cooperation with other water users to <u>improve</u> streamflows. With the possible exception of Hyalite Reservoir currently being rehabilitated, there are no means to establish instream flows by building new storage projects before the July 1, 1992 deadline established by the legislature for completion of this reservation process.

On page 23, paragraph 3, Mr. Perkins speculates on the future actions of DFWP once instream reservations are granted. He claims DFWP will challenge <u>all</u> new consumptive uses once we receive objector status and will eventually "shoot holes in senior rights." This is contrary to DFWP's history with instream flow protection and he has no basis in fact for such speculation. On page 24, paragraph 1, he again speculates on the actions of DFWP with no substantiation of such speculation.

Mr. Perkins states twice in his testimony (page 6, para. 3 and page 24, para. 2) that water conservation will not significantly improve flows in Missouri basin streams. This is contrary to the belief of Mr. Ole Ueland who states in his testimony (page 2, item 7) that instream flow problems can be solved, at least in part, through conservation measures that make more water available. There are many factors, including return flow, evaporation, and water lost to aquifers not connected to the stream of origin, that must be analyzed on a site specific basis before a conclusion can be reached whether conservation can significantly improve streamflows, especially during the summer low flow period.

Liter E. Spence, being first duly sworn, states that the foregoing testimony is true.

DATED this 17 day of December, 1991.

Liter E. Spence

Liter E. Spence

Subscribed and sworn to before me this 17th day of December, 1991.

Debra K. McRae

Notary Public for the State of Montana
Residing at Helena, Montana
My commission expires May 14, 1994

APPENDIX A

Montana Department of Fish, Wildlife and Parks

Summary of Murphy Right Claims Filed Under S.B. 76

Stream/Reach / Priority Date	Period	Flow (cfs)	Volume (acre-ft)
1) Big Spring Creek (31 miles total)			
Mouth-State Fish Hatchery (31 miles) 12/21/70	1/1 -12/31	110	79,617
2) Blackfoot River (52 miles total)			
Mouth-Clearwater River (34 miles) 1/6/71	9/1 - 3/31	650	273,257
	4/1 - 4/15	700	20,822
	4/16- 4/30	1,130	33,612
	5/1 - 6/30	2,000	241,926
	7/1 - 7/15	1,523	45,302
	7/16- 8/31	700	65,241
Clearwater R-NF of Blackfoot (18 miles) 1/7/71	9/1 - 3/31	360	151,343
	4/1 - 4/30	500	29,745
	5/1 - 5/15	837	24,897
	5/16- 6/15	1,750	107,578
	6/16- 6/30	1,423	42,327
	7/1 - 7/15	848	25,224
	7/16- 8/31	500	46,601
3) Flathead River (56 miles total)			
Flathead Lake-South Fork (46 miles) 12/22/70	8/1 - 4/15	3,500	1,790,649
	4/16- 4/30	6,650	197,804
	5/1 - 7/15	8,125	1,224,502
	7/16- 7/31	5,402	171,395
South Fork-Middle Fork (10 miles) 12/22/70	10/1 - 3/31	1,950	703,767
	4/1 - 4/15	2,100	62,465
	4/16- 4/30	3,597	106,993
	5/1 - 7/15	5,000	753,540
	7/16- 7/31	3,945	125,167
	8/1 - 9/30	2,100	254,022
4) Gallatin River (67 miles total)			
Mouth-E. Gallatin River (12 miles) 12/21/70	9/1 - 4/30	800	383,909
	5/1 - 5/15	947	28,169
	5/16- 5/31	1,278	40,548
	6/1 - 6/15	1,500	44,618
	6/16- 6/30	1,176	34,980
	7/1 - 8/31	850	104,504

Stream/Reach	Period	Flow (cfs	Volume (acre-ft)
Beck and Border Ditch-YNP (55 miles) 12/21/70	7/16- 5/15	400	241,133
	5/16- 7/15	800	96,770
5) Madison River (99 miles total)			
Mouth-Ennis Dam (40 miles) 12/28/70	1/1 - 5/31	1,200	359,320
	6/1 - 6/30	1,500	89,235
	7/1 - 7/15	1,423	42,327
	7/16-12/31	1,300	435,665
Ennis Reservoir-West Fork (44 miles) 12/28/70	1/1 - 5/31	900	269,490
	6/1 - 7/15	1,400	124,929
	7/16-12/31	1,050	351,883
West Fork-Quake Lake (12 miles) 12/21/70	1/1 -12/31	500	361,902
Quake Lake-Hebgen Dam (3 miles) 12/21/70	8/1 - 3/31	500	240,935
	4/1 - 7/31	500	12,096
6) Middle Fork of Flathead River (77 miles total)			
Mouth-Bear Creek (44 miles) 12/22/70	8/1 - 4/15	850	434,872
	4/16- 4/30	1,831	54,463
	5/1 - 7/15	2,325	350,396
	7/16- 7/31	1,904	60,410
Bear Creek-Cox Creek (33 miles) 12/22/70	10/1 - 3/31	75	27,068
	4/1 - 9/30	180	65,320
7) Missouri River (83 miles total)			
Smith River-Holter Dam (62 miles) 12/17/70	1/1 -12/31	3,000	2,171,385
Canyon Ferry Reservoir-Toston Dam (21 miles) 12/17/70 + 12/22/70	9/15-12/31	~~3,000~~ 2,400	~~642,492~~
	1/1 - 1/31	~~1,500~~ 2,400	~~92,210~~
	2/1 - 5/15	~~3,000~~ 2,400	~~618,696~~
	5/16- 6/30	4,000	364,872
	7/1 - 7/15	3,816	113,507
	7/16- 9/14	~~1,500~~ 2,400	~~181,445~~

Stream/Reach	Period	Flow (cfs	Volume (acre-ft)
8) North Fork of Flathead River (59 miles total)			
Middle Fork-Bowman Creek (34 miles) 12/22/70	10/1 - 3/31	987.5	356,395
	4/1 - 4/15	1,400	41,643
	4/16- 4/30	1,766	52,530
	5/1 - 7/15	2,625	395,609
	7/16- 7/31	2,041	64,757
	8/1 - 9/30	1,400	169,348
Bowman Creek-Border (25 miles) 12/22/70	10/1 - 3/31	625	225,566
	4/1 - 4/15	750	22,309
	4/16- 4/30	1,100	32,720
	5/1 - 7/15	1,500	226,062
	7/16- 7/31	1,279	40,580
	8/1 - 9/30	750	90,722
9) Rock Creek (56 miles total)			
Mouth-Ranch Creek (14 miles) 1/6/71	7/16- 4/30	250	143,272
	5/1 - 5/15	454	13,504
	5/16- 5/31	975	30,935
	6/1 - 6/15	926	27,544
	6/16- 6/30	766	22,785
	7/1 - 7/15	382	11,363
Ranch Creek-Headwaters (42 miles) 1/7/71	7/16- 4/30	150	85,963
	5/1 - 5/15	454	13,504
	5/16- 5/31	975	30,935
	6/1 - 6/15	926	27,544
	6/16- 6/30	766	22,785
	7/1 - 7/15	382	11,363
10) Smith River (72 miles total)			
Hound Creek-Cascade County Line (33 miles) 12/17/70	7/1 - 4/30	150	90,425
	5/1 - 5/15	372	11,065
	5/16- 6/15	400	24,589
	6/16- 6/30	398	11,839
Cascade County Line-Sheep Creek (24 miles) 12/22/70	9/1 - 3/31	125	52,550
	4/1 - 4/30	140	8,329
	5/1 - 6/30	150	18,144
	7/1 - 8/31	140	17,212
Sheep Creek-Ft. Logan Bridge (15 miles) 12/22/70	7/1 - 4/30	90	54,255
	5/1 - 6/30	150	18,144

Stream/Reach	Period	Flow (cfs	Volume (acre-ft)
11) South Fork of Flathead River (59 miles total)			
Hungry Horse Reservoir-Powell/ Flathead County Line (43 miles)	10/1 - 3/31	600	216,544
	4/1 - 4/15	700	20,822
	4/16- 4/30	1,180	35,099
	5/1 - 7/15	1,750	263,739
	7/16- 7/31	943	29,920
	8/1 - 9/30	700	84,674
Powell/Flathead County Line- Headwaters (16 miles) 1/7/70	4/1 - 9/30	270	97,980
	10/1 - 3/31	100	36,091
12) Yellowstone River (155 miles total)			
Carbon/Stillwater County Line- Stillwater River (10 miles)	4/16-10/31	2,600	1,026,005
	11/1 - 4/15	1,500	493,769
Stillwater River-Boulder River (43 miles) 12/14/70	11/1 - 4/15	1,300	427,932
	4/16- 4/30	1,800	53,541
	5/1 - 7/31	2,200	401,360
	8/1 -10/31	1,800	328,384
Boulder River-Tom Miner Creek (85 miles) 12/14/70 + 12/23/70	11/1 - 4/15	1,200	395,014
	4/16-10/31	2,000	789,234
Tom Miner Creek-YNP (17 miles) 12/23/70	1/1 -12/31	800	579,033

TOTAL CLAIMS = 106

Montana Department
of
Fish, Wildlife & Parks

1420 East Sixth Avenue
Helena, MT 59620
September 12, 1991

RECEIVED
SEP 16 1991
MONTANA DNRC
HELENA FIELD OFFICE

Larry Dolan
Re: Missouri River Reservations
Department of Natural Resources and Conservation
Water Resources Division
1520 East Sixth Avenue
Helena, MT 59620-2301

Dear Larry:

We have reviewed the draft Environmental Impact Statement for water reservation applications in the Missouri River Basin above Fort Peck Dam. The following are our comments on the draft EIS.

First we would like to compliment the department on the preparation of the DEIS, a voluminous document containing a great deal of information. It is well written and organized and very informative.

We are providing general comments on the contents of the DEIS and also offer specific page by page comments where we feel our comments will clarify or update the information provided. We have also attached some corrected pages from the DEIS to reflect the current situation.

General Comments

1. Although realizing that the four alternatives you provided in the DEIS are only four of several alternatives, we believe that a fifth alternative should be provided that provides for instream flows without any diversionary projects included in the alternative. Particular emphasis in this alternative should be on the maintenance of existing water quality conditions on the streams in the Missouri Basin. The instream flow alternative in the DEIS contains diversionary projects which have the potential to reduce water quality and perhaps negate the effects of providing the instream flow portion of the alternative.

2. The water quantity model used to determine the availability of water on certain streams and the impacts of projects on water availability is limited in that there are not enough nodes on important streams or tributary streams to allow much specificity in quantifying the impacts of projects on the flow regimes. In Chapter 4, the DEIS does, in a narrative fashion, briefly describe where some low flow problems occur in the basin. The description of dewatering is more specific for some streams than it is for others. Even though the dewatering cannot be quantified as it is at points where nodes are established, the DEIS needs to make evident to the Board that such dewatering may be quite significant even on smaller streams. Otherwise it would be easy to overlook the impacts of new water uses on these stream reaches, which do not have the benefit of more specific quantification of flow conditions.

3. Review of the draft EIS raised a number of questions regarding analysis of benefits and costs associated with water use for agriculture, municipalities and recreation.

   The information on Page 109 details the expenditures per day (Table 4-41) while the information for the net economic value (Table 4-43) is for all recreational trips, not a per trip basis or per day basis. Appendix K provides recreational values on an acre foot basis, but does not provide the necessary information on how the net economic value per trip was converted to net economic value per acre foot of water.

   The economic information for recreation is presented by geographical area and not by individual water. This tends to hide the economic value for highly valued waters. Also, the instream values ($ per acre foot) shown in Table K-4 are the same for the Gallatin, Jefferson and Madison rivers. However, the <u>net economic values</u> associated with fishing these waters are not the same and, in fact, are quite different, i.e., Madison River - $160 per day, Jefferson River - $79 per day. The DEIS analysis dilutes the value of instream use on more important waters by presenting the values on a geographical basis and by combining all types of recreation use into one value. Other examples are the recreational values shown in Table 6-40 (pg. 229).

   Chapter 5 discusses various alternatives for granting water reservations. Under the consumptive use alternative, all reservations, whether municipal or irrigation, would be granted no matter if they were economically viable projects or not. We find it disturbing that such projects would be considered where the benefit cost ratio is less than one. Under the instream and combination alternatives, irrigation projects are scrutinized as to their economic viability. We find it difficult to understand why economic viability is not also a requirement in the consumptive use alternative.

Table K-4 (Appendix K) presents an application number GA-201 for irrigation that shows a consumptive value per acre foot of $389.49. This project is for irrigating new ground for seed potato production. While this particular crop does have a high return, the investment required for the project is substantial. Without an analysis of the costs and returns associated with this project, we have some questions about the high net return per acre foot of water used.

The consumptive value of water for municipalities is shown to be $590 per acre foot across the board for all municipalities and for any type of water, whether surface or groundwater (see Table K-4). However, in Table K-6, the cost per thousand gallons of providing this water to each municipality varies considerably between municipalities. We would like to know how the $590 value was derived.

4. Our next general comment concerns the reference in the DEIS to the Montana Rivers Information System (MRIS). We were pleased to see that the data from this system, particularly the recreation information, was used as it was intended to be. We were also pleased to see that further research was done beyond the use of MRIS data and that MRIS data was not used as a sole source. The fisheries data was also appropriately used and, again, with supporting information.

We do have a comment concerning how the MRIS is cited and the need to standardize the citation. On Page 86, under the heading <u>Fisheries and Aquatic Habitat</u>, the second paragraph explains the origin of the data as the "Rivers Study Fisheries Data Base located at the Montana Natural Resources Information System." Three years ago the Montana Rivers Study was renamed the Montana Rivers Information System since a product was finally produced from the study. The Natural Resource Information System (NRIS) disseminates the information contained in MRIS. The "fisheries database" is a portion of MRIS and is not a data set which stands alone. On page 86, the second paragraph under <u>Fisheries and Aquatic Habitat</u>, should be changed to read as follows: "Information presented in the following sections comes primarily from the fisheries portion of the Montana Rivers Information System housed at the Montana Natural Resource Information System at Montana State Library." Also, in Appendix H, the recreation data from MRIS is cited incorrectly. Sources for Columns 4 through 12 should read "Recreation portion of the Montana Rivers Information System" not the Natural Resource Information System (NRIS). NRIS houses and disseminates data from a variety of data bases, including MRIS.

5. An additional table should be added to the DEIS. This table would list those streams and stream reaches where conflicts occur among the applicants. The table should list who is in conflict; for example, instream and irrigation, or instream and municipal, or instream, municipal and irrigation. This addition would make it much easier to identify where conflicts do or do not occur and measure the impacts of the reservation applications.

6. Throughout Chapter 6, there are references to consumptive use projects that, if implemented, would reduce the flows in some streams to zero because those streams are already subject to extremely low flows. In our opinion, streamflows should not be allowed to be reduced any further in these low flow situations and projects which would further reduce current low flows should not be approved.

7. In reviewing the discussion of angler use beginning on page 111 under the Headwaters Sub-basin, we noticed discrepancies in the angler use numbers utilized throughout the section. Attached are the corrections we believe are necessary. This review was compiled by Bob McFarland, DFWP, Bozeman, and any questions can be referred to him.

Page by Page Comments

Page 7, column 2, third paragraph - The four-year pilot program stated in the paragraph is out of date. The pilot program is now for 10 years.

Page 22, column 2, line 8 - The discussion about the variation of the wetted perimeter method developed by Tennant is not correct. Tennant did not use a wetted perimeter method to derive instream flow recommendations. Rather, he used a percentage of the mean annual flow from gauging stations to make his flow recommendations. This sentence should be changed to read "a fixed percentage method that was developed from the results of the wetted perimeter method was used to derive instream flow requests for 27 high quality stream segments."

Page 24, table 3-2, under Jefferson and Boulder River drainages - The reach description for North Willow Creek should read Hollow Top Lake to mouth.

Page 26, table 3-2, under Dearborn River drainage - Sheep Creek is not a tributary to the Dearborn. It should be moved to the section called upper Missouri River and tributaries. Under Smith River #1, the reach description should be North and South Forks to Sheep Creek.

Page 29, map 3-6 - Narrows Creek in the Upper Red Rock drainage is mislocated. It should be shown to enter Elk Lake.

Page 43, column 2, last paragraph - The reference "USGS 1989b" is not shown properly in the bibliography. Also on page 43, column 2, the USGS reference should be USGS 1989b. Also, in that same paragraph, the reference to 341 measuring sites should be 321 sites.

Page 46, table 4-2 - Some stream reaches where low flows occur are identified only as "portions of creek." This is an inadequate description of the location or extent of the dewatering problems on those streams. Even on those stream sections where a reach is identified more specifically, the extent of the dewatering is not shown. What a low flow represents may be a state of mind with different individuals and it may be difficult to convince the Board that new water uses should not be issued on these streams without some better definition of how low the streamflow actually gets. There should be some language in the DEIS that states that, on these stream sections, no new diversionary water uses should be allowed, including reservations of water, until a more specific water availability analysis is made.

Page 46, table 4-2 - The stream reach for the Beaverhead River should read Clark Canyon Dam to mouth. Also Big Sheep Creek and Long Creek (under the Beaverhead River) belong on page 47 under the Red Rock River. They should be eliminated from the Beaverhead River section.

Page 46, under Big Hole River - The following streams should be added to the list: Pintlar Creek; Swamp Creek; Trail Creek; North Fork Bighole River; Governor Creek.

Page 46, under East Gallatin River - We are not certain Thompson Spring Creek has a dewatering problem. Also Baker Creek, South Cottonwood Creek, Camp Creek and Big Bear Creek are not tributaries to the East Gallatin River. They are tributaries to the Gallatin River.

Page 46, under Gallatin River - We believe the stream reach where low flows occur should be changed from that shown to "Shedd's Bridge to mouth."

Page 47, table 4-2 - Under Madison River, change stream reach to Hebgen Dam to Quake Lake.

Page 50, table 4-4 under Missouri River - The Missouri River itself from its headwaters at Three Forks to Canyon Ferry Reservoir should be added to the list as a stream with a dewatering problem due to irrigation.

Pages 46 through 54, tables 4-2, 4-4, 4-6 and 4-8 - The dewatering discussion on these pages should include a caveat that these are <u>some</u> of the low flow problem areas and may not be an all-inclusive list.

Page 54, column 2, last paragraph - The statement that all applicants claim that water is physically available for their reservations... etc. does not apply to the DFWP reservations. We have never claimed that water is physically or legally available <u>all the time</u> to meet our reservation requests. The amount of water available for instream flows will depend on the priority date of the reservation in relating to other water rights and the water available to satisfy those rights.

Pages 50 through 54, tables 4-4 through 4-8 - Same comment as for page 46, table 4-2.

Page 55, column 2, last paragraph - In addition to the discussion in that paragraph, there should be a statement as to how many applications have been received for new water use permits since 1987. That would clarify the confusion in the last sentence of the paragraph in which the phrase "the 75 remaining applications..." is used with no reference to the original number of applications.

Page 61, table 4-12, last column in table - It would appear that the fourth and fifth entries in that column are in error since the same entries in column E are negative numbers which would indicate that, in the last column, the number 20 should be 18 and the number 32 should be -18.

Page 61, under Murphy Rights - There should be some indication of the 1970 and 1971 priority dates of the Murphy Rights. None is listed in the paragraph and there is no reference to priority dates in table 4-13.

Page 62, table 4-13 - Under the West Gallatin River, the reach should be changed from Yellowstone Park to Shedd's Bridge. Also the reach for Big Spring Creek should be changed from state fish hatchery to mouth. There should also be an addition to table 4-13 as follows: Missouri River, Holter Dam to mouth of Smith River, 1/1-12/31, 3,000 cfs.

Page 86, column 2 under fisheries and aquatic habitat - 80 species of fish should be changed to 85 species.

Page 88, under paddlefish - The state record paddlefish weighed 142.5 lbs.

Page 89, under westslope cutthroat trout, column 2 - Although Brown (1971) states that a westslope cutthroat trout can grow as large as 16 lbs., this may be somewhat misleading. A three to four pound maximum weight is more likely to occur.

Page 89, under blue sucker - The state record weight for a blue sucker is 11.5 lbs.

Page 89, under Arctic grayling - Arctic grayling are known to reach lengths of 20 inches. Distribution of grayling in the Sun River is now limited to those found in the Sunny Slope Canal below Pishkun Reservoir. Grayling are no longer found in the Sun River or its tributaries. Grayling found in the Red Rock River may be drifters from the Red Rock Lakes area.

Page 89, column 2, last paragraph - The number 25 should be changed to 24 streams.

Page 90, under Madison River drainage - Reservations have been requested on 29 stream reaches rather than 26 reaches. Also, in that paragraph, beginning with line 7, only <u>one</u> stream supports Arctic grayling.

Page 90, column 1, last paragraph - The first sentence should be changed to read "Stream-dwelling Arctic grayling are found year around in the Madison River. Lake dwelling Arctic grayling spawn in the Madison River and possibly Moore Creek and the South Fork of Meadow Creek."

Page 90, column 2, first full paragraph - Should read "Trout populations in Hebgen, Earthquake, Cliff and Ennis lakes depend on tributary streams for spawning and rearing habitat. Tributaries to the Madison River are also used as reproductive sites for some mainstem trout. Table 4-24 indicates the tributaries that provide this habitat." (Note: We have enclosed an updated Table 4-24.) Also note that Whiskey Spring is a tributary to Hebgen Lake, not the Madison River.

Page 91, under Jefferson and Boulder River drainages, first paragraph, line 1. 11 stream reaches should be changed to 13 stream reaches.

Page 91, column 2, first full paragraph - The following should be added to the paragraph "In 1991, rainbow trout returned to Willow Spring Creek to spawn, indicating that the stocking efforts are proving successful."

Page 92, table 4-25 - The footnote (a) should be deleted. (See our preceding comment.)

Page 92, under Big Hole River drainage - Brown trout should be added to the sentence beginning with line 5. In paragraph 2, line 6, Terry Creek should read Jerry Creek. However, Deep Creek and Jerry Creek should be eliminated from that listing because Deep Creek provides only winter habitat for grayling flows could still be depleted down to the instream flow requests, or, on streams where DFWP has no reservations, flows could be depleted which could affect flows in the reservation streams. Consequently, the 0.0 figure (and perhaps the others as well) is misleading and does not truly reflect possible future streamflows. Also, in table 6-41, the July-August flow reduction for the upper Missouri sub-basin under the combination alternative (20,470.5 acre feet) exceeds the value for the consumptive alternative (20,163.1 acre feet). Is this possible?

We disagree with how the term "professional judgment" is used to describe how instream flows are estimated by the wetted perimeter method. Instream flows are determined from the wetted perimeter/discharge relationship derived by the WETP computer program from field observations. Any professional judgment by the biologists would be in their knowledge of the stream's fisheries, the relative value of each stream and the need for instream flows to maintain those fisheries.

Page 230, table 6-42 - Same comment as for page 229, Table 6-41.

Page 250, under Montana Department of Fish, Wildlife and Parks, column 2, third full paragraph - The second sentence should be changed to read "Desirable flow amounts are assumed to equal a fixed percentage of the estimated <u>average annual</u> flow."

Page B-3, column 1, second paragraph - The second sentence should be changed to read "This method is based on the assumptions that aquatic organisms which make up the majority of food for game fish are produced in riffle areas and that food supply for the fish is a major factor in determining the number and weight of fish a stream can support during the warmer months when fish grow and new fish are recruited into the population."

Page B-4, column 1, under base flow approach - The second sentence in the first paragraph should be changed to read as follows: "On 17 high-quality spring creeks (Table B-3) DFWP is requesting that the lowest average monthly flow for the year (the base flow) <u>which typically occurs in winter</u> be allocated for instream purposes year around." (Emphasis added only to show correction.)

Page B-5, under other approaches - the last sentence in that paragraph should be changed to read as follows: "Lastly, on two intermittent tributaries of the Missouri River (Table B-4) the <u>mean monthly</u> flow was requested during four months each year to protect a rainbow trout spawning run." (Emphasis added only to show correction.)

Page B-5, Table B-4 - Under the request column for Stickney Creek and Wegner Creek mean annual flow should read mean monthly flow.

Page D-3, the following streams are missing from Table D-1: Under Red Rock and Beaverhead drainage, Poindexter Slough; Jefferson drainage, Willow Spring Creek; Madison drainage, Black Sand Spring Creek; Big Hole drainage, Rock Creek at mouth near Wisdom and Delano Creek at mouth near Wise River; Jefferson drainage, Halfway Creek at mouth near Whitehall; Smith River drainage, North Fork Deep Creek at mouth near Milligan; Musselshell River drainage, Collar Gulch at mouth near Maiden; Marias River drainage, Badger Creek below forks near Browning.

Page D-15, under the Dearborn River drainage - Sheep Creek at mouth near Cascade is not a tributary to the Dearborn. It should be listed under the Missouri River drainage - Holter Dam to Belt Creek.

Page E-3, Table E-1 - Corrected copies of this table from the DEIS are attached.

Page G-3, Table G-1 - We have attached copies of Table G-1 with necessary corrections.

Page I-3, Table I-1 - On four streams in the Gallatin River drainage, DFWP requested all the remaining unappropriated flow. The table shows flows remaining on these streams after the instream flows are subtracted. Since DFWP requested all of the remaining flow for each month of the year, the table should show zero remaining flow at the following: Bridger Creek near Bozeman, East Gallatin River at Bozeman, Rocky Creek near Bozeman, Sourdough Creek near Bozeman. Also, in table I-1 under the Madison River drainage, the same comments above apply to the following three streams: Beaver Creek near West Yellowstone; Cabin Creek near West Yellowstone; West Fork Madison River near Cameron.

Page I-4, under Jefferson River drainage - Black Sand Spring Creek is a Madison River tributary, not a tributary to the Jefferson and the flows listed are not correct. Halfway Creek and Willow Spring Creek flows are not correct. Under the Big Hole River drainage, the flows are not correct for Delano Creek or Rock Creek. Under the Beaverhead River and Red Rock River drainage, the flows for Poindexter Slough are not correct. All these flows are too low. DFWP can provide the correct numbers.

Page I-6, under Smith River drainage, the North Fork of Deep Creek is missing from the list.

Page I-7, under Marias River drainage, the flows for Badger Creek are not correct (too low).

Page I-8, under Musselshell River drainage, the flows for Collar Gulch Creek are not correct (too low).

Sincerely,

Liter Spence

Liter Spence
Water Resources Supervisor
Fisheries Division

dl

Table 4-24 Madison River tributaries providing spawning and rearing habitat for game fish.

Lake or Stream where spawning run originates	Tributary Stream	Fish Species spawning in tributary streams
Hebgen Lake	Black Sand Spring Creek	Rainbow trout Brown trout
	South Fork Madison River	Rainbow trout Brown trout Mountain whitefish
	Cougar Creek	Brown trout Rainbow trout
	Duck Creek	Brown trout Rainbow trout
	Red Canyon Creek	Cutthroat trout Rainbow trout
	Watkins Creek Trapper Creek	Rainbow trout Cutthroat trout Rainbow trout
	Grayling Creek	Rainbow trout Brown trout
	Madison River	Rainbow trout Brown trout
Earthquake Lake	Whiskey Spring[a] Cabin Creek[a]	Brown trout Rainbow trout Brown trout
	Beaver Creek[a]	Rainbow trout Brown trout
Cliff Lake	Antelope Creek	Rainbow trout Cutthroat trout (recently introduced)
Ennis Lake	N. Meadow Creek[a]	Brown trout
	Moore Creek[b]	Arctic grayling
Madison River	Cherry Creek	Brown trout Mountain whitefish
	Elk River[a]	Rainbow trout Brown trout
	W. Fk. Madison River[a]	Rainbow trout Brown trout
	Hot Springs Creek	Brown trout

[a]A spawning run is believed to exist but has not been confirmed.

[b]Field work in 1991 failed to confirm grayling spawning.

EIS Corrections - Angling Use

Page 111

Headwaters Subbasin - numbers don't agree with report

1. Rivers and streams in 1985 had 355,090 angler days of use, not 349,820

2. Angler days statewide in 1985 was 2,443,438, not 1,193,000. Statewide stream use in 1985 was 1,324,277 angler days.

3. Angler use is licensed angling pressure. This pressures does not include juveniles which account for 10-25% of the pressure or any pressure on Indian reservations or National Parks.

4. Percent of pressure in headwaters basin is 14.5% if based on total statewide angling pressure or 26.8% if based on total statewide stream/river angling pressure.

5. Map 4-7, percentages are wrong. See my Table 1.

Table 1. Angler use of EIS subbasins for 1985.

Subbasin	Total Angling Use	%	Stream/Rivers Only	
			Use	%
Headwaters	489,522	20.0	355,059	26.8
Upper Missouri	444,159	18.2	205,743	15.6
Kootenai, etc.	558,813	22.9	189,632	14.3
Middle Missouri, etc.	121,603	5.0	50,600	3.8
Marias/Teton	60,328	2.5	9,587	0.7
Upper Clark Fk, etc.	304,764	12.5	201,641	15.2
Upper/Middle Yellowstone	330,545	13.5	244,667	18.5
Lower Missouri, etc.	131,993	5.4	65,637	5.0
	2,441,727*		1,322,566*	
* Statewide total = 2,443,438. The difference is that some pressure could not be assigned to a drainage; it was statewide or regionwide in coding.			* Statewide total = 1,324,277. The difference is the same reason as for statewide total pressure.	

6. Map 4-8 not clear if it is fishing only or total recreation use since the title is recreation but legend says angler days. I didn't check these numbers, but the Boulder basin does not add up if it is fishing pressure.

7. Table 4-47. Corrections made because of coding errors when doing survey (i.e. Clark Canyon and Clark Canyon Reservoir are the same, and Hyalite Lake and Hyalite Reservoir should be added since Hyalite Lake receives very little pressure)

	1982	1983	1984	1985	Average
Clark Canyon Reservoir	58,820	30,162	39,489	35,900	41,093
Hyalite Reservoir	10,775	6,732	4,762	4,482	6,688

Gallatin River Drainage

Coding is hard to get correct section (three possible sections on the Gallatin) since Bozeman is the closest town to all three sections. So pressure between sections is not accurate, total pressure for Gallatin River is accurate. I would not use pressure for any given section. As you can see from the following table, the total pressure remains fairly constant while the sectional pressure fluctuates wildly. This is caused by using different people to code for the different years.

Missouri River Drainage - Three Forks to Holter Dam

The pressure on the river sections below each reservoir (Canyon Ferry, Hauser) is hard to allocate properly when coding. There is some discussion as to whether these are part of the Reservoir and not the river.

Missouri River Drainage - Holter to Belt Creek

Missouri River Sections (Holter to Cascade; Cascade to Morony) are again hard to allocate properly when coding. When an angler says the nearest town was Cascade, which section do you give the pressure?

Sun River Drainage

Again, section coding problems.

Marias/Teton Drainage (P. 119)

Map 4-10 - Same as map 4-8 and 4-9.

Middle Missouri Subbasin

Map 4-11 - same as map 4-8, 4-9, 4-10. Angler use in subbasin 1985, see my Table 1.

	1982	1983	1984	1985	Average
Gallatin River 01	37,523	4,996	6,686	4,552	13,439
Gallatin River 02	9,755	42,158	27,545	34,173	28,408
Gallatin River 03	4,460	9,409	19,392	25,215	14,619
Total	51,738	56,563	53,623	63,940	56,466

Madison River Drainage

Same applies to the sections as in the case of the Gallatin River. Here the problem is not so severe, but the section from Yellowstone National Park to Hebgen should be included with the section from Ennis to Hebgen.

Jefferson River Drainage

First paragraph does not make sense. Angler days averaging from 21,125 angler days too low.

Big Hole River Drainage

Again, sectional pressure is extremely hard to allocate accurately. I would suggest combining sectional pressure.

Upper Missouri Basin Page 115.

1) Angler use (total) is 444,159 Angler Days, 18.2% of total use or using streams/rivers only is 205,743 angler days or 15.5% of that total use. Total should be 1,324,277 angler day for stream use only.

2) Map 4-9 comments same for map 4-8.

le E-1. Water quality classifications and impairments for streams where reservations are requested

llatin Drainage

eam/Reach[a]	Classification	Water Quality Impairments[b]
er Creek	B-1	Critical low flow
Hart Spring Creek	B-1	None
Bear Creek	B-1	Critical low flow
ger Creek	B-1	Critical low flow
ne Creek	B-1	Sediment 7
ork Hyalite Creek	A-1	None
Gallatin River #1 below wastewater eatment plant	B-1	Sediment, nutrients, other
Gallatin River #2 below wastewater eatment plant	B-1	Sediment, pH, nutrients, temperature
allatin River #3	B-1	Sediment, pH, nutrients, temperature
~~atin River #1~~	~~B-1~~	~~Critical low flow~~ NONE
atin River #2	B-1	Critical low flow
allatin River #3	B-1	Critical low flow
ell ~~Raising~~ Rearing Creek	A-1/B-1	None
lor Fork Gallatin River	B-1	Sediment
dle Fork Hyalite Creek #1	A-1/B-1	~~Critical low flow~~ NONE
iddle Fork Hyalite Creek #2	B-1	Sediment, pH, nutrients
iddle Fork of West ork Gallatin River	B-1	None Critical low flow
cupine Creek	B-1	None
eese Creek	B-1	Nutrients
cky Creek	B-1	None
urdough Creek	B-1	Sediment, DO/BOD, pH, nutrients, critical low flow
Fork Cottonwood Creek	B-1	Critical low flow
ork Spanish Creek	A-1/B-1	None
th Fork of West Fork Gallatin River	B-1	Sediment
panish Creek	B-1	None
uaw Creek	B-1	None
ompson Creek	B-1	Sediment
Fork Hyalite Creek	A-1	None
est Fork of Gallatin River	B-1	Sediment

Madison Drainage

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Antelope Creek	B-1	None
Beaver Creek	A-1/B-1	Sediment
Black Sand Spring Creek	B-1	None
Blaine Spring Creek	B-1	Critical low flow
Cabin Creek	B-1	Sediment
Cherry Creek	B-1	None
Couger Creek	B-1	None
Duck Creek	B-1	None
Elk River	B-1	None
Grayling Creek	B-1	None
Hot Springs Creek	B-1	~~None~~ Critical low flow
Indian Creek	A-1/B-1	Critical low flow
Jack Creek	B-1	Sediment, critical low flow
Madison River N. Meadow Cr.	B-1/A-1	Temperature, metals (arsenic?)
Meadow Creek	B-1	Critical low flow
Moore Creek	B-1	Metals, critical low flow
O'Dell Spring Creek	B-1	None
Red Canyon Creek	B-1	~~None~~ Sediment (natural)
Ruby Creek	B-1	Critical low flow
S Fork Madison River	B-1	None
Squaw Creek	A-1/B-1	None
Standard Creek	B-1	None
Trapper Creek	B-1	None
Watkins Creek	B-1	Critical low flow
W Fork Madison River	B-1	Sediment

Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
Source: DHES 1984,1986; DFWP 1985-1989

Jefferson and Boulder Drainages

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Boulder River	B-1	Sediment, pH, nutrients, temperature, metals, critical low flow
Halfway Creek	B-1	None
Hells Canyon Creek	B-1	Critical low flow ?
Jefferson River	B-1	Sediment, temperature, critical low flow
Little Boulder River	B-1	Critical low flow
N Willow Creek	B-1	Critical low flow
S Boulder River	B-1	pH, metals, critical low flow
S Willow Creek	B-1	~~None~~ Critical low flow
Whitetail Creek	B-1	Critical low flow
Willow Creek	B-1	Critical low flow
~~Willow Springs Creek~~	~~B-1~~	~~Critical low flow~~ None

Big Hole and Ruby Drainages

Stream/Reach[a]	Classification	Water Quality Impairments[b]
Alder Creek Not a DFWP stream	B-1	Critical low flow
Big Hole River #1	A-1	Critical low flow
Big Hole River #2	A-1	Critical low flow
Big Hole River #3	B-1	Sediment, temperature, critical low flow
Big Lake Creek	A-1	Critical low flow
Canyon Creek	B-1	Critical low flow
Coal Creek	B-1	None
Cottonwood Creek	B-1	Sediment
Divide Creek	B-1	Critical low flow
E Fork Ruby River	B-1	Sediment, critical low flow ?
Fishtrap Creek	B-1	Critical low flow
Francis Creek	A-1	Critical low flow
Governor Creek	A-1	Sediment, critical low flow
Jerry Creek	B-1	Critical low flow
Johnson Creek	B-1	Critical low flow
M Fork Ruby River	B-1	Sediment
Mill Creek	B-1	Critical low flow
Miner Creek	A-1	Sediment
Moose Creek	B-1	Critical low flow
Mussigbrod Creek	B-1	Critical low flow
N Fork Big Hole River	B-1	Critical low flow
N Fork Greenhorn Creek	B-1	None
Pintlar Creek	B-1	Critical low flow
Rock Creek	A-1	Critical low flow
Rock Creek	B-1	Critical low flow
Ruby Creek	B-1	Critical low flow
Ruby River #1	B-1	Sediment
Ruby River #2	B-1	Sediment, critical low fl
S Fork Big Hole River	A-1	None
Steel Creek ? Duplicate?	A-1	Sediment
Steel Creek	B-1	Critical low flow
Swamp Creek	A-1	Sediment, critical low fl
Trapper Creek	B-1	Critical low flow
Warm Springs Creek (Ruby?)	A-1	None
Warm Springs Creek (Big Hole)	B-1	Sediment, temperature, critical low flow
W Fork Ruby River	B-1	Sediment
Willow Creek	B-1	Critical low flow
Wisconsin Creek	B-1	Critical low flow

[a] Note: Stream/reach locations #1, #2, etc., are described in the DFWP application, June 1989.
[b] Source: DHES 1984,1986; DFWP 1985-1989

Table G-1. Fisheries value class and relative fish abundance by stream

Key to Symbols: 1=outstanding; 2=high-value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=Abundant; C=Common; P=Present; PE=Presence expected but not confirmed; U=Uncommon; R=Rare

Headwaters subbasin

FAMILY		Sturgeon	Sturgeon	Paddlefish	Mooneye	Trout	Trout	Trout	Trout	Trout	Trout	Trout	Trout	Pike
Stream	**Fisheries Resource Value Class**	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
GALLATIN RIVER DRAINAGE														
Baker Creek														
I-90-Mouth	2					U				C	C			
County Road-I-90	4					U				C	C			
Ben Hart Spring Creek	6					P				P	P	P		
Big Bear Creek	6							P				P		
Bridger Creek	4					U		U		C	U	U		
Cache Creek	4							C		U				
EF of Hyalite Creek	2							C				U	C	
East Gallatin River #1	2					C		P		C	C	U		
East Gallatin River #2	2					U				A	A	U		
East Gallatin River #3														
Smith Creek-Mouth	3					C				U	A	U		
Hyalite Creek-Smith Creek	3					C				C	A	U		
Gallatin River #1	2					A		R		C	C	U		
Gallatin River #2														
Baker Creek-East Gallatin River	2					A				C	C	U		
Cameron Bridge-Baker Creek	3					C				U	C	U		
Gallatin Gateway-Cameron Bridge	2					A				U	C	U		
Spanish Creek-Gallatin Gateway	1					A		R		C	C	U		
W. Fk. Gallatin River-Spanish Creek	1					A		R		C	U	U		
Gallatin River #3	2					A				C	A	U		
Hell Roaring Creek	6									P				
Hyalite Creek #1														
Hyalite Reservoir-National Forest	4					U		U		U	C	U		
National Forest-County Road	3							C		A		U		
Hyalite Creek #2	4					U				U	U	P		
MF of the WF Gallatin River	4							U		C		P		
Porcupine Creek	4					U		U		C	U			
Reese Creek	2									C	A	C		
Rocky Creek	2					U				C	C	U		
Sourdough (Bozeman) Creek														
National Forest-Mouth	3									C	U	C		
Mystic Lake-National Forest	3									C		C		
South Cottonwood Creek	6									P	P	P		
SF of Spanish Creek														
Falls Creek-National Forest	4									U		C		
National Forest-Mouth	4									C	P	C		
SF of the WF Gallatin River	4							C		C				
Spanish Creek	1					P				C	P	C		
Squaw Creek	1									C	U	C		
Taylor Fork of the Gal. River														
Source-Lightening Creek	3							C		C				
Lightening Creek-Mouth	3					C		C		C	U			
Thompson Spring Creek														
East/West County Road-Mouth	4					P				C	C	U		
Headwaters-East/West County Road	3									C	C	U		
WF of the Gallatin River	1					U		U		A	U			
WF of Hyalite Creek	2							C				U	C	

FAMILY	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow
Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
GALLATIN RIVER DRAINAGE																	
Baker Creek																	
I-90-Mouth																	
County Road-I-90																	
Ben Hart Spring Creek																	
Big Bear Creek																	
Bridger Creek																	
Cache Creek																	
EF of Hyalite Creek																	
East Gallatin River #1																	
East Gallatin River #2																	A
East Gallatin River #3																	
Smith Creek-Mouth																	PE
Hyalite Creek-Smith Creek																	PE
Gallatin River #1																	U
Gallatin River #2																	
Baker Creek-East Gallatin River																	U
Cameron Bridge-Baker Creek																	U
Gallatin Gateway-Cameron Bridge																	U
Spanish Creek-Gallatin Gateway																	U
W. Fk. Gallatin River-Spanish Creek																	U
Gallatin River #3																	P
Hell Roaring Creek																	
Hyalite Creek #1																	
Hyalite Reservoir-National Forest																	U
National Forest-County Road																	U
Hyalite Creek #2																	U
MF of the WF Gallatin River																	
Porcupine Creek																	
Reese Creek																	
Rocky Creek																	C
Sourdough (Bozeman) Creek																	
National Forest-Mouth																	
Mystic Lake-National Forest																	
South Cottonwood Creek																	
SF of Spanish Creek																	
Falls Creek-National Forest																	
National Forest-Mouth																	
SF of the WF Gallatin River																	
Spanish Creek																	
Squaw Creek																	
Taylor Fork of the Gal. River																	
Source-Lightening Creek																	
Lightening Creek-Mouth																	
Thompson Spring Creek																	
East/West County Road-Mouth																	U
Headwaters-East/West County Road																	U
WF of the Gallatin River																	
WF of Hyalite Creek																	PE

FAMILY	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Catfish	Catfish	Catfish	Codfish
Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot
GALLATIN RIVER DRAINAGE													
Baker Creek													
I-90-Mouth						P	P						
County Road-I-90						P							
Ben Hart Spring Creek													
Big Bear Creek													
Bridger Creek						P							
Cache Creek													
EF of Hyalite Creek													
East Gallatin River #1							C						
East Gallatin River #2						A	A		A				
East Gallatin River #3													
Smith Creek-Mouth						A	A		C				
Hyalite Creek-Smith Creek						A	A		A				
Gallatin River #1						C	C		U				
Gallatin River #2													
Baker Creek-East Gallatin River						C	C		U				
Cameron Bridge-Baker Creek						C	C		U				
Gallatin Gateway-Cameron Bridge						C	C		U				
Spanish Creek-Gallatin Gateway						C	C		U				
W. Fk. Gallatin River-Spanish Creek						C	C		U				
Gallatin River #3						C	C		P				
Hell Roaring Creek													
Hyalite Creek #1													
Hyalite Reservoir-National Forest						U							
National Forest-County Road						PE							
Hyalite Creek #2						U	P		P				
MF of the WF Gallatin River													
Porcupine Creek													
Reese Creek													
Rocky Creek						C	C		P				
Sourdough (Bozeman) Creek													
National Forest-Mouth						U							
Mystic Lake-National Forest													
South Cottonwood Creek													
SF of Spanish Creek													
Falls Creek-National Forest													
National Forest-Mouth													
SF of the WF Gallatin River													
Spanish Creek													
Squaw Creek													
Taylor Fork of the Gal. River													
Source-Lightening Creek													
Lightening Creek-Mouth													
Thompson Spring Creek													
East/West County Road-Mouth													
Headwaters-East/West County Road													
WF of the Gallatin River													
WF of Hyalite Creek						PE							

FAMILY	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Perch	Perch	Perch	Perch	Drum	Sculpin	Stickleback
Stream	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
GALLATIN RIVER DRAINAGE														
Baker Creek														
I-90-Mouth													P	
County Road-I-90													P	
Ben Hart Spring Creek														
Big Bear Creek													P	
Bridger Creek													C	
Cache Creek														
EF of Hyalite Creek													C	
East Gallatin River #1													A	
East Gallatin River #2													C	
East Gallatin River #3														
Smith Creek-Mouth													C	
Hyalite Creek-Smith Creek													C	
Gallatin River #1													C	
Gallatin River #2														
Baker Creek-East Gallatin River													C	
Cameron Bridge-Baker Creek													C	
Gallatin Gateway-Cameron Bridge													C	
Spanish Creek-Gallatin Gateway													C	
W. Fk. Gallatin River-Spanish Creek													C	
Gallatin River #3													A	
Hell Roaring Creek													P	
Hyalite Creek #1														
Hyalite Reservoir-National Forest													U	
National Forest-County Road													C	
Hyalite Creek #2													U	
MF of the WF Gallatin River														
Porcupine Creek													A	
Reese Creek													P	
Rocky Creek													C	
Sourdough (Bozeman) Creek														
National Forest-Mouth													C	
Mystic Lake-National Forest													C	
South Cottonwood Creek													P	
SF of Spanish Creek														
Falls Creek-National Forest													PE	
National Forest-Mouth													PE	
SF of the WF Gallatin River													C	
Spanish Creek													P	
Squaw Creek													C	
Taylor Fork of the Gal. River														
Source-Lightening Creek													P	
Lightening Creek-Mouth													C	
Thompson Spring Creek														
East/West County Road-Mouth													C	
Headwaters-East/West County Road													C	
WF of the Gallatin River													P	
WF of Hyalite Creek													C	

Headwaters subbasin (continued)

Key to Symbols: 1=outstanding 2=high value 3=substantial 4=moderate 5=limited 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike
MADISON RIVER DRAINAGE														
Antelope Creek	2									A				
Beaver Creek	4					C				U	U			
Black Sand Spring Creek	2							U		C	C	P		
Blaine Spring Creek	2									C	C			
Cabin Creek														
6mi. Above Mouth-0.5mi. Above Mouth	4							P		P				
Cub Creek-Mouth	4					U				U	U			
Cherry Creek	4					P				C	U	P		
Cougar Creek	3					A				U	A	U		
Duck Creek	3					A		P		U	A	U		
Elk River	4							P	P	U	C			
Grayling Creek	6					P		P	P	P	P	P		
Hot Springs Creek	4					PE				C	C	P		
Indian Creek	4							U		C	P			
Jack Creek	3					U				C	C			
Madison River #1	1					A		U		A	A	U		
Madison River #2														
Sheep Creek-Varney Bridge	1					A		U		A	A	U		
Hebgen Lake-Sheep Creek	1					A				A	A			
Madison River #3	1					A				A	A	U	U	
Madison River #4														
Greycliff Access-Mouth	1					A		P		A	A	P	P	
Ennis Lake-Greycliff Access	1					A				A	A		P	
Moore Creek														
Source-Hwy. 287 in Ennis	4									U	U			
Hwy. 287 in Ennis-Mouth	2									A			A	
North Meadow Creek														
Sureshot Lakes Fork-National Forest	3							U		U		C		
National Forest-Mouth	3					C		U		C	C	U	U	
O'Dell Spring Creek	6					P				P	P	P		
Red Canyon Creek	6							P		P				
Ruby Creek	3							U		C	U			
SF of the Madison River														
Headwaters-Railroad Line	3									U	C	U		
Railroad Line-Mouth	2					A				U	A	U		
Squaw Creek	4							C		U	P	U		
Standard Creek	4							U	P	U	P		P	
Trapper Creek	6							P		P				
Watkins Creek	6							P		P				
WF of the Madison River														
Meridian Creek-Soap Creek	3							U		U	U	C		
Soap Creek-Mouth	3					U				U	C	U		
Whiskey Spring	6										P	P		
JEFFERSON RIVER DRAINAGE														
Boulder River #1														
Basin-Boulder	4					U				C		U		
Headwaters-Basin	4					C		PE		C		C		
Boulder River #2	4					U				U	C	U		

Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
FAMILY	Minnow																
MADISON RIVER DRAINAGE																	
Antelope Creek																	
Beaver Creek																	
Black Sand Spring Creek																	
Blaine Spring Creek																	
Cabin Creek																	
6mi. Above Mouth-0.5mi. Above Mouth																	
Cub Creek-Mouth																	
Cherry Creek																	
Cougar Creek																	
Duck Creek																	
Elk River																	
Grayling Creek																	
Hot Springs Creek																	P
Indian Creek																	
Jack Creek																	P
Madison River #1				A													PE
Madison River #2																	
Sheep Creek-Varney Bridge																	A
Hebgen Lake-Sheep Creek				A													A
Madison River #3				A													A
Madison River #4																	
Greycliff Access-Mouth	C			U													A
Ennis Lake-Greycliff Access																	A
Moore Creek																	
Source-Hwy. 287 in Ennis																	
Hwy. 287 in Ennis-Mouth																	
North Meadow Creek																	
Sureshot Lakes Fork-National Forest																	
National Forest-Mouth																	
O'Dell Spring Creek																	
Red Canyon Creek																	
Ruby Creek																	
SF of the Madison River																	
Headwaters-Railroad Line																	
Railroad Line-Mouth																	
Squaw Creek																	
Standard Creek																	
Trapper Creek																	
Watkins Creek																	
WF of the Madison River																	
Meridian Creek-Soap Creek																	
Soap Creek-Mouth																	
Whiskey Spring																	
JEFFERSON RIVER DRAINAGE																	
Boulder River #1																	
Basin-Boulder																	U
Headwaters-Basin																	U
Boulder River #2																	U

Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
FAMILY	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
MADISON RIVER DRAINAGE																											
Antelope Creek							P																			P	
Beaver Creek																										C	
Black Sand Spring Creek																											
Blaine Spring Creek						U																				C	
Cabin Creek																											
6mi. Above Mouth-0.5mi. Above Mouth																											
Cub Creek-Mouth						P																				C	
Cherry Creek																										C	
Cougar Creek																										U	
Duck Creek																										U	
Elk River																										C	
Grayling Creek																										P	
Hot Springs Creek						P			P																	C	
Indian Creek																										C	
Jack Creek																										C	
Madison River #1																										A	
Madison River #2																											
Sheep Creek-Varney Bridge																										A	
Hebgen Lake-Sheep Creek																										A	
Madison River #3							P		P																	A	
Madison River #4																											
Greycliff Access-Mouth						A	A		A				A								U					A	
Ennis Lake-Greycliff Access						A	A		A				U													A	
Moore Creek																											
Source-Hwy. 287 in Ennis						P																				P	
Hwy. 287 in Ennis-Mouth																											
North Meadow Creek																											
Sureshot Lakes Fork-National Forest																										C	
National Forest-Mouth																										C	
O'Dell Spring Creek																											
Red Canyon Creek																											
Ruby Creek																										C	
SF of the Madison River																											
Headwaters-Railroad Line																										C	
Railroad Line-Mouth																										C	
Squaw Creek																										C	
Standard Creek																										C	
Trapper Creek																											
Watkins Creek																										P	
WF of the Madison River																											
Meridian Creek-Soap Creek																										C	
Soap Creek-Mouth																										C	
Whiskey Spring																											
JEFFERSON RIVER DRAINAGE																											
Boulder River #1																											
Basin-Boulder						U	U																			C	
Headwaters-Basin						U	U																			A	
Boulder River #2						U	U																			U	

Headwaters subbasin (continued)

Key to Symbols: 1=outstanding 2=high value 3=substantial 4=moderate 5=limited 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Sturgeon: Pallid sturgeon	Sturgeon: Shovelnose sturgeon	Paddlefish: Paddlefish	Mooneye: Goldeye	Trout: Mountain whitefish	Trout: Kokanee	Trout: Cutthroat trout	Trout: Rainbow/cutthroat hybrid	Trout: Rainbow trout	Trout: Brown trout	Trout: Brook trout	Trout: Arctic grayling	Pike: Northern pike
Boulder River #3	3					U				U	A	U		
Hallway Creek														
Headwaters-Hallway Park	1							A						
Finn Cabins-Mouth	4							PE				C		
Hells Canyon Creek														
Source-National Forest	4								A	P	C	U		
National Forest-Mouth	2								A		C			
Jefferson River														
Headwaters-Fish Creek	2					A				C	A			
Fish Creek-Big Pipestone Creek	2					A				C	A			
Big Pipestone Creek-Mouth	2					A				C	A	R		
Little Boulder River														
Headwaters-National Forest	4							U		C		C		
National Forest-Mouth	4					U				C	C	C		
North Willow Creek	3					R	U			C	C	R		
South Boulder River														
Headwaters-National Forest	3									U		A		
National Forest-Hwy 359 Bridge	3									C		C		
Hwy 359 Bridge-Mouth	4					U				U	U	U		
South Willow Creek	3					R	U			C	C	R		
Whitetail Creek														
Whitetail Reservoir-N. Boundary Sec. 4	6											P		
N. Boundary Sec. 4-SE Corner Sec. 36	4							PE			C	U		
SE Corner Sec. 36-Mouth	4										C	U		
Willow Creek														
N & S Willow Creek-Willow Creek Reservoir	3						U			C	U	C		
Willow Creek Dam-Mouth	3					C				U	C	R		
Willow Spring Creek	2									P	U	C		
BIG HOLE RIVER DRAINAGE														
American Creek	6								P	P		P		
Bear Creek	3								U			A		
Big Hole River, #1	1					C		R		U	C	U	R	
Big Hole River, #2	1													
Wise River-Divide	1					A		U		U	C	C	U	
Pintlar Creek-Wise River	1					A		R		C	U	R	R	
Big Hole River, #3	1					A		R		R	R	C	U	
Big Lake Creek	1					C						A	R	
Birch Creek	4													
Beaverhead/Willow Creek Ditch-Mouth	4									C		P		
Headwaters-Beaverhead/Willow Creek Ditch	4							U		R		C		
Bryant Creek	6											P		
California Creek	6					P				P		P		
Camp Creek	4							C	U	U	PE	C		
Canyon Creek	3							R	A	R	PE	C		
Corral Creek	3									R		A		
Deep Creek	3													
French Creek-Mouth	3					U				C		U	P	
Headwaters-French Creek	3					U		P		U		A		

Stream	Minnow: Carp	Minnow: Minnow	Minnow: N. Redbelly x finescale dace	Minnow: Utah chub	Minnow: Flathead chub	Minnow: Sturgeon chub	Minnow: Lake chub	Minnow: Sicklefin chub	Minnow: Emerald shiner	Minnow: Redside shiner	Minnow: Sand shiner	Minnow: Brassy minnow	Minnow: Plains minnow	Minnow: Plains/silvery minnow	Minnow: Silvery minnow	Minnow: Fathead minnow	Minnow: Longnose dace
Boulder River #3																	U
Hallway Creek																	
Headwaters-Hallway Park																	
Finn Cabins-Mouth																	
Hells Canyon Creek																	
Source-National Forest																	
National Forest-Mouth																	
Jefferson River																	
Headwaters-Fish Creek	PE																PE
Fish Creek-Big Pipestone Creek	PE																PE
Big Pipestone Creek-Mouth	C				U					PE							U
Little Boulder River																	
Headwaters-National Forest																	
National Forest-Mouth																	C
North Willow Creek																	C
South Boulder River																	
Headwaters-National Forest																	
National Forest-Hwy 359 Bridge																	
Hwy 359 Bridge-Mouth																	
South Willow Creek																	C
Whitetail Creek																	
Whitetail Reservoir-N. Boundary Sec. 4																	
N. Boundary Sec. 4-SE Corner Sec. 36																	
SE Corner Sec. 36-Mouth																	
Willow Creek																	
N & S Willow Creek-Willow Creek Reservoir																	
Willow Creek Dam-Mouth																	U
Willow Spring Creek																	
BIG HOLE RIVER DRAINAGE																	
American Creek																	
Bear Creek																	
Big Hole River, #1	U																U
Big Hole River, #2																	
Wise River-Divide																	U
Pintlar Creek-Wise River																	U
Big Hole River, #3																	C
Big Lake Creek																	A
Birch Creek																	
Beaverhead/Willow Creek Ditch-Mouth																	
Headwaters-Beaverhead/Willow Creek Ditch																	
Bryant Creek																	
California Creek																	P
Camp Creek																	
Canyon Creek																	
Corral Creek																	
Deep Creek																	
French Creek-Mouth																	A
Headwaters-French Creek																	A

Stream	Sucker: River carpsucker	Sucker: Blue sucker	Sucker: Smallmouth buffalo	Sucker: Bigmouth buffalo	Sucker: Shorthead redhorse	Sucker: Longnose sucker	Sucker: White sucker	Sucker: Largescale sucker	Sucker: Mountain sucker	Catfish: Black bullhead	Catfish: Channel catfish	Catfish: Stonecat	Codfish: Burbot
Boulder River #3						U	U						
Hallway Creek													
Headwaters-Hallway Park													
Finn Cabins-Mouth													
Hells Canyon Creek													
Source-National Forest													
National Forest-Mouth							U						
Jefferson River													
Headwaters-Fish Creek						PE	PE						
Fish Creek-Big Pipestone Creek						PE	PE						
Big Pipestone Creek-Mouth						A	A		U			R	
Little Boulder River													
Headwaters-National Forest													
National Forest-Mouth						U	U						
North Willow Creek						C	C						
South Boulder River													
Headwaters-National Forest													
National Forest-Hwy 359 Bridge													
Hwy 359 Bridge-Mouth													
South Willow Creek						C	C						
Whitetail Creek													
Whitetail Reservoir-N. Boundary Sec. 4													
N. Boundary Sec. 4-SE Corner Sec. 36													
SE Corner Sec. 36-Mouth													
Willow Creek													
N & S Willow Creek-Willow Creek Reservoir						C	C						
Willow Creek Dam-Mouth						U	C		R				
Willow Spring Creek													
BIG HOLE RIVER DRAINAGE													
American Creek													
Bear Creek													
Big Hole River, #1						C	C		U				U
Big Hole River, #2													
Wise River-Divide						C	C		U				U
Pintlar Creek-Wise River						C	C		U				C
Big Hole River, #3						C	U		U				C
Big Lake Creek						C							PE
Birch Creek													
Beaverhead/Willow Creek Ditch-Mouth													
Headwaters-Beaverhead/Willow Creek Ditch													
Bryant Creek													
California Creek						P							
Camp Creek													
Canyon Creek													
Corral Creek													
Deep Creek													
French Creek-Mouth						U							U
Headwaters-French Creek						C			A				U

Stream	Sunfish: Green sunfish	Sunfish: Pumpkinseed	Sunfish: Bluegill	Sunfish: Smallmouth bass	Sunfish: Largemouth bass	Sunfish: White crappie	Sunfish: Black crappie	Perch: Yellow perch	Perch: Sauger	Perch: Walleye	Perch: Iowa darter	Drum: Freshwater drum	Sculpin: Mottled sculpin	Stickleback: Brook stickleback
Boulder River #3													U	
Hallway Creek														
Headwaters-Hallway Park														
Finn Cabins-Mouth														
Hells Canyon Creek														
Source-National Forest													C	
National Forest-Mouth													C	
Jefferson River														
Headwaters-Fish Creek													PE	
Fish Creek-Big Pipestone Creek													PE	
Big Pipestone Creek-Mouth					R		R	R					U	
Little Boulder River														
Headwaters-National Forest													A	
National Forest-Mouth													A	
North Willow Creek													C	
South Boulder River														
Headwaters-National Forest													C	
National Forest-Hwy 359 Bridge													C	
Hwy 359 Bridge-Mouth													C	
South Willow Creek													C	
Whitetail Creek														
Whitetail Reservoir-N. Boundary Sec. 4														
N. Boundary Sec. 4-SE Corner Sec. 36														
SE Corner Sec. 36-Mouth														
Willow Creek														
N & S Willow Creek-Willow Creek Reservoir													C	
Willow Creek Dam-Mouth													C	
Willow Spring Creek														
BIG HOLE RIVER DRAINAGE														
American Creek													P	
Bear Creek													U	
Big Hole River, #1													C	
Big Hole River, #2														
Wise River-Divide													C	
Pintlar Creek-Wise River													C	
Big Hole River, #3													C	
Big Lake Creek													PE	
Birch Creek														
Beaverhead/Willow Creek Ditch-Mouth													P	
Headwaters-Beaverhead/Willow Creek Ditch													A	
Bryant Creek														
California Creek													P	
Camp Creek													U	
Canyon Creek													A	
Corral Creek													P	
Deep Creek														
French Creek-Mouth													C	
Headwaters-French Creek													A	

Headwaters subbasin (continued)

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FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
COMMON NAME		Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
Stream	Fisheries Resource Value Class																																																									
Delano Creek	6							P																																																		
Divide Creek	3									C	PE	A																									C																				A	
Fishtrap Creek	3																																																									
E Fk Fishtrap Creek-Mouth	3									U		A	P																		C						C							C													C	
W & M Fk Fishtrap Creek-E Fk Fishtrap Creek	5							PE				PE																																													PE	
Francis Creek	2					U						A	R																								A	R						C													A	
French Creek	4					U				P		U																			A						C							R													A	
Governor Creek	1					C				R		C	U																		A						R							U													A	
Jacobsen Creek	6					P			P			P																																														
Jerry Creek	4							PE	U	C		C																																													PE	
Johnson Creek	3					R						A	R																		A						U							C													A	
Joseph Creek	3											A																																C													A	
LaMarche Creek	3																																																									
National Forest boundary-Mouth	3							PE		U		A	U																								U							R													A	
W Fk LaMarche Creek-National Forest	3							PE		U		A	U																								U							R													A	
Miner Creek	1																																																									
National Forest-Mouth	1											A	U																															PE													PE	
Ridge Lakes Fk-National Forest	1							PE		P		A	U																								P							C													C	
Moose Creek	3							A	R	U		A																																													A	
Mussigbrod Creek	2											A	R																								R							R													A	
NF Big Hole River	1					C				P		A	U																		A						C							C													A	
Oregon Creek	6									P		P																																													P	
Pattengail Creek	3							P	P	U		C																																													A	
Pintlar Creek	3																																																									
National Forest-Mouth	3							R				C	R																								C							C													C	
Headwaters-National Forest	4							C				C																																													PE	
Rock Creek	1					C		PE				A	U																								C							C													C	
Ruby Creek	3							PE	P	R		A																									R							R													A	
Sevenmile Creek	6								P	P		P																									P																				P	
Seymour Creek	3											C																																														
Sixmile Creek	6							P	P	P		P																																													P	
SF Big Hole River	6					P				P		P																									P							P													P	
Steel Creek	1					U			C			A	U																		C						U							R													A	
Sullivan Creek	6											P																																													P	
Swamp Creek	1					R		PE				C	U																		C						C							C													A	
Tenmile creek	6									P		P																																P													P	
Trail Creek	3					C		PE				C																			C						C																				A	
Trapper Creek																																																										
National Forest-Mouth	4									PE	PE	U																																														
Sappington Creek-National Forest	4							C	C	U	R	A																																													A	
Twelvemile Creek	6								P			P																																													P	
Warm Springs Creek																																																										
National Forest-Mouth	3											A	PE																		C						R							U													A	
Little Milk Creek-National Forest	3							PE				A	PE																															PE													PE	
Willow Creek	3								C	P		A																																													A	
Wise River																																																										
Lacy Creek-Mouth	3					P				U		U																			C						C							U													C	
Source/Jacobson & Mono Creeks-Lacy Creek	3							C				C																																														
Wyman Creek	4							PE		PE		C	P																																												U	

Headwaters subbasin (continued)

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FAMILY		Sturgeon		Paddlefish	Mooneye	Trout								Pike
Stream	Fisheries Resource Value Class	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
RUBY RIVER DRAINAGE														
Coal Creek	6							P						
Cottonwood Creek														
4km Above Mouth-Mouth	4							R		R				
4.8km Above Mouth-4.0km Above Mouth	4							R						
EF Ruby River	4							U	U	C				
MF Ruby River	6							P	P	P				
Mill Creek														
National Forest-BN RR Bridge	4									U		C		
Leggat Creek-National Forest	4									R		C		
NF of Greenhorn Creek	1							U				C		
Ruby River #1														
National Forest-Ruby River Reservoir	3					U				A	U	R		
Warm Springs Creek-National Forest	3					C				C	C			
Three Forks Ruby River-Warm Springs Creek	4					C			C		R			
Coal Creek-Three Forks Ruby River	4							U	C	R				
Ruby River #2	2					C				R	A			
Warm Springs Creek														
Still Creek-Mouth	3					R		U		C	C			
Road-Buckskin Creek	4							A		U	C			
Headwaters-Road	3							C						
WF Ruby River	4							U	U	R		P		
Wisconsin Creek	5							P				P		
RED ROCK-BEAVERHEAD DRAINAGE														
Bear Creek	2							C				A		
Beaverhead River #1														
Clark Canyon Dam-Grasshopper Creek	1					A				C	A	U		
Beaverhead River #2														
Anderson Lane-Mouth	3					U				U	C	R		
Stodden Ditch-Anderson Lane	3					U				U	C	R		
Big Sheep Creek														
Irrigation Diversion-Mouth	4					PE			PE	PE	PE			
Shearing Pen Gulch-Irrigation Diversion	3					U			U	A	C			
Source-Shearing Pen Gulch	2									A	C			
Black Canyon Creek	6											P		
Blacktail Deer Creek														
East Bench Canal-Mouth	3					P				U	C			
Above E. Bench Canal-East Bench Canal	5									PE		PE		
W Fk. Blacktail Creek-2.4km Above E. Bench Canal	3					A				U		C		
Bloody Dick Creek														
National Forest-Mouth	3					U				C		A		
Park Creek-National Forest	3					C				A		A		
Browns Canyon Creek	6							P						
Cabin Creek	2							C						
Corral Creek	2							U				A	U	
Deadman Creek	3							P	A	P				

FAMILY	Minnow																	
Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
RUBY RIVER DRAINAGE																	
Coal Creek																	
Cottonwood Creek																	
4km Above Mouth-Mouth																	
4.8km Above Mouth-4.0km Above Mouth																	
EF Ruby River																	PE
MF Ruby River																	
Mill Creek																	
National Forest-BN RR Bridge																	
Leggat Creek-National Forest																	
NF of Greenhorn Creek																	
Ruby River #1																	
National Forest-Ruby River Reservoir																	P
Warm Springs Creek-National Forest																	P
Three Forks Ruby River-Warm Springs Creek																	P
Coal Creek-Three Forks Ruby River																	PE
Ruby River #2	P																P
Warm Springs Creek																	
Still Creek-Mouth																	A
Road-Buckskin Creek																	
Headwaters-Road																	PE
WF Ruby River																	
Wisconsin Creek																	
RED ROCK-BEAVERHEAD DRAINAGE																	
Bear Creek																	
Beaverhead River #1																	
Clark Canyon Dam-Grasshopper Creek	R																U
Beaverhead River #2																	
Anderson Lane-Mouth	U																A
Stodden Ditch-Anderson Lane	U																A
Big Sheep Creek																	
Irrigation Diversion-Mouth																	
Shearing Pen Gulch-Irrigation Diversion																	
Source-Shearing Pen Gulch																	A
Black Canyon Creek																	
Blacktail Deer Creek																	
East Bench Canal-Mouth																	P
Above E. Bench Canal-East Bench Canal																	
W Fk. Blacktail Creek-2.4km Above E. Bench Canal																	A
Bloody Dick Creek																	
National Forest-Mouth																	
Park Creek-National Forest																	
Browns Canyon Creek																	
Cabin Creek																	
Corral Creek																	
Deadman Creek																	

FAMILY	Sucker									Catfish			Codfish
Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot
RUBY RIVER DRAINAGE													
Coal Creek													
Cottonwood Creek													
4km Above Mouth-Mouth													
4.8km Above Mouth-4.0km Above Mouth													
EF Ruby River							PE						
MF Ruby River													
Mill Creek													
National Forest-BN RR Bridge													
Leggat Creek-National Forest													
NF of Greenhorn Creek													
Ruby River #1													
National Forest-Ruby River Reservoir							C	P	P				
Warm Springs Creek-National Forest							U						
Three Forks Ruby River-Warm Springs Creek													
Coal Creek-Three Forks Ruby River							PE						
Ruby River #2							P	P					
Warm Springs Creek													
Still Creek-Mouth						A			U			A	
Road-Buckskin Creek													
Headwaters-Road							PE						
WF Ruby River													
Wisconsin Creek													
RED ROCK-BEAVERHEAD DRAINAGE													
Bear Creek													
Beaverhead River #1													
Clark Canyon Dam-Grasshopper Creek						C	U		U				U
Beaverhead River #2													
Anderson Lane-Mouth						C	U		R				U
Stodden Ditch-Anderson Lane						C	U		R				U
Big Sheep Creek													
Irrigation Diversion-Mouth						PE	PE						
Shearing Pen Gulch-Irrigation Diversion						C	C						
Source-Shearing Pen Gulch													
Black Canyon Creek													
Blacktail Deer Creek													
East Bench Canal-Mouth							C	C					
Above E. Bench Canal-East Bench Canal													
W Fk. Blacktail Creek-2.4km Above E. Bench Canal													
Bloody Dick Creek													
National Forest-Mouth													
Park Creek-National Forest													
Browns Canyon Creek													
Cabin Creek						P							
Corral Creek													
Deadman Creek													

FAMILY	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
RUBY RIVER DRAINAGE														
Coal Creek														
Cottonwood Creek														
4km Above Mouth-Mouth													U	
4.8km Above Mouth-4.0km Above Mouth													U	
EF Ruby River													P	
MF Ruby River													P	
Mill Creek														
National Forest-BN RR Bridge														
Leggat Creek-National Forest														
NF of Greenhorn Creek														
Ruby River #1														
National Forest-Ruby River Reservoir													P	
Warm Springs Creek-National Forest													P	
Three Forks Ruby River-Warm Springs Creek														
Coal Creek-Three Forks Ruby River													PE	
Ruby River #2													P	
Warm Springs Creek														
Still Creek-Mouth														
Road-Buckskin Creek														
Headwaters-Road													PE	
WF Ruby River													P	
Wisconsin Creek														
RED ROCK-BEAVERHEAD DRAINAGE														
Bear Creek													C	
Beaverhead River #1														
Clark Canyon Dam-Grasshopper Creek													A	
Beaverhead River #2														
Anderson Lane-Mouth													A	
Stodden Ditch-Anderson Lane													A	
Big Sheep Creek														
Irrigation Diversion-Mouth														
Shearing Pen Gulch-Irrigation Diversion														
Source-Shearing Pen Gulch													A	
Black Canyon Creek													P	
Blacktail Deer Creek														
East Bench Canal-Mouth														
Above E. Bench Canal-East Bench Canal														
W Fk. Blacktail Creek-2.4km Above E. Bench Canal													A	
Bloody Dick Creek														
National Forest-Mouth													PE	
Park Creek-National Forest													A	
Browns Canyon Creek														
Cabin Creek														
Corral Creek													A	
Deadman Creek													A	

Headwaters subbasin (continued)

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Stream	Fisheries Resource Value Class	Sturgeon		Paddlefish	Mooneye	Trout								Pike
		Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
EF Blacktail Deer Creek														
Headwaters-National Forest	4							C	U	U		A		
National Forest-Mouth	3					C		C	U	C		A		
EF Clover Creek	4							C				A		
EF of Dyce Creek	6								P			P		
Frying Pan Creek	6							P						
Grasshopper Creek														
Reservoir Creek-Mouth	4					U				U	U	P		
National Forest-Reservoir Creek	4								P	P		P		
Hell Roaring Creek														
Hell Roaring Canyon-New Mouth	1							U				U	U	
0.8km Above Lillian Lake-Hell Roaring Canyon	4							U				U		
Horse Prairie Creek														
Bloody Dick Creek-Clark Canyon	3									C	C	C		
Maiden Creek-Bloody Dick Creek	4									C	U	C		
Indian Creek	2							C						
Jones Creek														
RD. End 2.4km Above RD. Xing at Wolfe Corrals	3							C						
280m Up Right FK Above Forks-Road End/Conifer Edge	3							C						
Long Creek	3							C				R		
Medicine Lodge Creek	3									C	PE	A		
Narrows Creek	2							A	P	P			A	
Odell Creek														
Refuge-Lower Red Rock Lake	2					PE		U	U	U		U	C	
County Road-Refuge	2					PE		PE	U	U		C	A	
0.4km Above Spring Creek-County Road	2							C						
Headwaters-0.4km Above Spring Creek	2							C						
Peet Creek	2							A						
Poindexter Slough	1					P				C	A	P		
Rape Creek	1							A						
Red Rock Creek														
Upper Red Rock Lake-Lower Red Rock Lake	3							PE				PE	U	
Hell Roaring Creek Orig. Mouth-Upper Red Rock Lake	1							A				C	A	
Source-Hell Roaring Creek Original Mouth	4									PE		PE	U	
Red Rock River #1	4													
Red Rock River #2														
Big Sheep Creek-Mouth	2					P				C	A	P		
Lima Reservoir-Big Sheep Creek	3					P				C	C	U		
Reservoir Creek	6							P						
Shenon Creek	4							U	U			U		
Simpson Creek	2							U						
Tom Creek	3											C	U	
Trapper Creek	6							P				P		
WF Blacktail Deer Creek	4									U		A		
WF of Dyce Creek	6							P				P		

Stream	Minnow																
	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
EF Blacktail Deer Creek																	
Headwaters-National Forest																	
National Forest-Mouth																	
EF Clover Creek																	
EF of Dyce Creek																	
Frying Pan Creek																	
Grasshopper Creek																	
Reservoir Creek-Mouth																	A
National Forest-Reservoir Creek																	
Hell Roaring Creek																	
Hell Roaring Canyon-New Mouth																	
0.8km Above Lillian Lake-Hell Roaring Canyon																	
Horse Prairie Creek																	
Bloody Dick Creek-Clark Canyon																	
Maiden Creek-Bloody Dick Creek																	
Indian Creek																	
Jones Creek																	
RD. End 2.4km Above RD. Xing at Wolfe Corrals																	
280m Up Right FK Above Forks-Road End/Conifer Edge																	
Long Creek																	
Medicine Lodge Creek																	
Narrows Creek																	
Odell Creek																	
Refuge-Lower Red Rock Lake																	
County Road-Refuge																	
0.4km Above Spring Creek-County Road																	
Headwaters-0.4km Above Spring Creek																	
Peet Creek																	
Poindexter Slough																	
Rape Creek																	
Red Rock Creek																	
Upper Red Rock Lake-Lower Red Rock Lake																	
Hell Roaring Creek Orig. Mouth-Upper Red Rock Lake																	
Source-Hell Roaring Creek Original Mouth																	
Red Rock River #1																	
Red Rock River #2																	
Big Sheep Creek-Mouth	U																
Lima Reservoir-Big Sheep Creek																	P
Reservoir Creek																	
Shenon Creek																	
Simpson Creek																	
Tom Creek																	
Trapper Creek																	
WF Blacktail Deer Creek																	
WF of Dyce Creek																	

Stream	Sucker									Catfish			Codfish
	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot
EF Blacktail Deer Creek													
Headwaters-National Forest													
National Forest-Mouth													
EF Clover Creek													
EF of Dyce Creek													
Frying Pan Creek													
Grasshopper Creek													
Reservoir Creek-Mouth						C	C						
National Forest-Reservoir Creek													
Hell Roaring Creek													
Hell Roaring Canyon-New Mouth													
0.8km Above Lillian Lake-Hell Roaring Canyon													
Horse Prairie Creek													
Bloody Dick Creek-Clark Canyon													P
Maiden Creek-Bloody Dick Creek													
Indian Creek													
Jones Creek													
RD. End 2.4km Above RD. Xing at Wolfe Corrals													
280m Up Right FK Above Forks-Road End/Conifer Edge													
Long Creek						C							
Medicine Lodge Creek													
Narrows Creek													
Odell Creek													
Refuge-Lower Red Rock Lake						A	A						
County Road-Refuge						A	A						
0.4km Above Spring Creek-County Road													
Headwaters-0.4km Above Spring Creek													
Peet Creek													
Poindexter Slough						P	P						
Rape Creek													
Red Rock Creek													
Upper Red Rock Lake-Lower Red Rock Lake						PE	PE						U
Hell Roaring Creek Orig. Mouth-Upper Red Rock Lake													
Source-Hell Roaring Creek Original Mouth													
Red Rock River #1							C						U
Red Rock River #2													
Big Sheep Creek-Mouth						A	A						U
Lima Reservoir-Big Sheep Creek						PE	PE						C
Reservoir Creek													
Shenon Creek													
Simpson Creek													
Tom Creek						PE	PE						
Trapper Creek													
WF Blacktail Deer Creek													
WF of Dyce Creek													

Stream	Sunfish							Perch				Drum	Sculpin	Stickleback
	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
EF Blacktail Deer Creek														
Headwaters-National Forest													C	
National Forest-Mouth													C	
EF Clover Creek													A	
EF of Dyce Creek														
Frying Pan Creek														
Grasshopper Creek														
Reservoir Creek-Mouth													C	
National Forest-Reservoir Creek														
Hell Roaring Creek														
Hell Roaring Canyon-New Mouth														
0.8km Above Lillian Lake-Hell Roaring Canyon														
Horse Prairie Creek														
Bloody Dick Creek-Clark Canyon													PE	
Maiden Creek-Bloody Dick Creek													PE	
Indian Creek														
Jones Creek														
RD. End 2.4km Above RD. Xing at Wolfe Corrals													P	
280m Up Right FK Above Forks-Road End/Conifer Edge														
Long Creek													A	
Medicine Lodge Creek													C	
Narrows Creek														
Odell Creek														
Refuge-Lower Red Rock Lake														
County Road-Refuge														
0.4km Above Spring Creek-County Road														
Headwaters-0.4km Above Spring Creek														
Peet Creek													C	
Poindexter Slough													P	
Rape Creek														
Red Rock Creek														
Upper Red Rock Lake-Lower Red Rock Lake														
Hell Roaring Creek Orig. Mouth-Upper Red Rock Lake													PE	
Source-Hell Roaring Creek Original Mouth														
Red Rock River #1														
Red Rock River #2														
Big Sheep Creek-Mouth													P	
Lima Reservoir-Big Sheep Creek													P	
Reservoir Creek														
Shenon Creek													U	
Simpson Creek														
Tom Creek													U	
Trapper Creek														
WF Blacktail Deer Creek													A	
WF of Dyce Creek														

Upper Missouri subbasin

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

Stream	Fisheries Resource Value Class	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike
FAMILY		Sturgeon	Sturgeon	Paddlefish	Mooneye	Trout	Trout	Trout	Trout	Trout	Trout	Trout	Trout	Pike
UPPER MISSOURI RIVER DRAINAGE														
Avalanche Creek	4								C					
Beaver Creek														
Town of Nelson-Mouth	3							U	R	U	U	U		
Headwaters-Town of Nelson	3							U	U	U	R	U		
Beaver Creek														
National Forest-Mouth	4									P		A		
S.Fk. Beaver Creek-National Forest	4								U			A		
1920 Meter Elevation-S.Fk. Beaver Creek	4								C			C		
Canyon Creek	4									C	R	C		
Confederate Gulch														
National Forest-Ditch Head in Section 16	4							C				A		
Cement Gulch-National Forest	4								U	P	P	A		
Cottonwood Creek	4									U	P	C		
Crow Creek														
Radersburg-Mouth	4					U				U				
National Forest-Radersburg	3									C	R	C		
Hall Creek-National Forest	3									A		C		
Crow Creek Falls-Begin Gorge	4									U		C		
Jct. Wilson/Tizer Creeks-Crow Creek Falls	4									U		C		
Deep Creek														
Headwaters-National Forest	3							R		C		C		
National Forest-County Road	4							PE		C	C	U		
County Road-Mouth	4							PE		U	U	U		
Dry Creek														
Source-National Forest	3							U		C		C		
National Forest-Mouth	4							U	P	C		C		
Duck Creek														
Gold Mines-Irrigation Ditch	4							R		U		C		
Irrigation Ditch-Mouth	4							U		C	C	A		
Little Prickly Pear Creek #1	2					U				C	C	U		
Little Prickly Pear Creek #2	2					U				C	C	U		
Lyons Creek	4									U	P	U		
McGuire Creek	6									P			R	P
Missouri River #1														
Canyon Ferry Reservoir-Toston Dam	1					A		P		C	C	P		
Toston Dam-Three Forks	3					A		PE		C	C	PE		
Missouri River #2	1					C	U	R		A	A			
Prickly Pear Creek #1														
Begin Private Land-End Private Land	4											C		
4.8km Above National Forest-National Forest	2							C				C		
National Forest-Clancy Creek	3									C		C		
Prickly Pear Creek #2														
Clancy Creek-County Road Crossing	3							P		A	A	U		
County Road Crossing-Mouth	4									U	U	U		
Sevenmile Creek	4									C	U	U		
Silver Creek	3						P	C		P	P	P		

Stream	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace
FAMILY	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow	Minnow
UPPER MISSOURI RIVER DRAINAGE																	
Avalanche Creek																	
Beaver Creek																	
Town of Nelson-Mouth																	
Headwaters-Town of Nelson																	
Beaver Creek																	
National Forest-Mouth																	
S.Fk. Beaver Creek-National Forest																	
1920 Meter Elevation-S.Fk. Beaver Creek																	
Canyon Creek																	
Confederate Gulch																	
National Forest-Ditch Head in Section 16																	
Cement Gulch-National Forest																	
Cottonwood Creek																	
Crow Creek																	
Radersburg-Mouth																	
National Forest-Radersburg																	
Hall Creek-National Forest																	
Crow Creek Falls-Begin Gorge																	
Jct. Wilson/Tizer Creeks-Crow Creek Falls																	
Deep Creek																	
Headwaters-National Forest																	
National Forest-County Road																	
County Road-Mouth																	
Dry Creek																	
Source-National Forest																	
National Forest-Mouth																	
Duck Creek																	
Gold Mines-Irrigation Ditch																	
Irrigation Ditch-Mouth	U																
Little Prickly Pear Creek #1																	
Little Prickly Pear Creek #2																	
Lyons Creek																	
McGuire Creek																	
Missouri River #1																	
Canyon Ferry Reservoir-Toston Dam	R			PE	R												U
Toston Dam-Three Forks	R			PE	U												U
Missouri River #2	U																
Prickly Pear Creek #1																	
Begin Private Land-End Private Land																	
4.8km Above National Forest-National Forest																	
National Forest-Clancy Creek																	
Prickly Pear Creek #2																	
Clancy Creek-County Road Crossing																	
County Road Crossing-Mouth																	
Sevenmile Creek																	
Silver Creek																	

Stream	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker
FAMILY	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker	Sucker
UPPER MISSOURI RIVER DRAINAGE									
Avalanche Creek									
Beaver Creek									
Town of Nelson-Mouth							U		
Headwaters-Town of Nelson									
Beaver Creek									
National Forest-Mouth									
S.Fk. Beaver Creek-National Forest									
1920 Meter Elevation-S.Fk. Beaver Creek									
Canyon Creek									
Confederate Gulch									
National Forest-Ditch Head in Section 16									
Cement Gulch-National Forest									
Cottonwood Creek									
Crow Creek									
Radersburg-Mouth									
National Forest-Radersburg									
Hall Creek-National Forest									
Crow Creek Falls-Begin Gorge									
Jct. Wilson/Tizer Creeks-Crow Creek Falls									
Deep Creek									
Headwaters-National Forest									
National Forest-County Road									
County Road-Mouth									
Dry Creek									
Source-National Forest									
National Forest-Mouth									
Duck Creek									
Gold Mines-Irrigation Ditch									
Irrigation Ditch-Mouth							PE		
Little Prickly Pear Creek #1						U	U		
Little Prickly Pear Creek #2						U	U		
Lyons Creek									
McGuire Creek									
Missouri River #1									
Canyon Ferry Reservoir-Toston Dam						U	U		U
Toston Dam-Three Forks						U	U		U
Missouri River #2						C	C		
Prickly Pear Creek #1									
Begin Private Land-End Private Land									
4.8km Above National Forest-National Forest									
National Forest-Clancy Creek									
Prickly Pear Creek #2									
Clancy Creek-County Road Crossing						A	U		
County Road Crossing-Mouth						C	C		
Sevenmile Creek									
Silver Creek									

Stream	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
FAMILY	Catfish	Catfish	Catfish	Codfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Sunfish	Perch	Perch	Perch	Perch	Drum	Sculpin	Stickleback
UPPER MISSOURI RIVER DRAINAGE																		
Avalanche Creek																	C	
Beaver Creek																		
Town of Nelson-Mouth																	U	
Headwaters-Town of Nelson																	U	
Beaver Creek																		
National Forest-Mouth																	C	
S.Fk. Beaver Creek-National Forest																	U	
1920 Meter Elevation-S.Fk. Beaver Creek																		
Canyon Creek																	C	
Confederate Gulch																		
National Forest-Ditch Head in Section 16																	C	
Cement Gulch-National Forest																		
Cottonwood Creek																	C	
Crow Creek																		
Radersburg-Mouth																		
National Forest-Radersburg																	A	
Hall Creek-National Forest																	C	
Crow Creek Falls-Begin Gorge																	U	
Jct. Wilson/Tizer Creeks-Crow Creek Falls																		
Deep Creek																		
Headwaters-National Forest																	U	
National Forest-County Road																	U	
County Road-Mouth																	U	
Dry Creek																		
Source-National Forest																	C	
National Forest-Mouth																	C	
Duck Creek																		
Gold Mines-Irrigation Ditch																	C	
Irrigation Ditch-Mouth																		
Little Prickly Pear Creek #1																	C	
Little Prickly Pear Creek #2																	C	
Lyons Creek																	C	
McGuire Creek																	P	
Missouri River #1																		
Canyon Ferry Reservoir-Toston Dam			C	U					R			P					C	
Toston Dam-Three Forks				U					R			PE					C	
Missouri River #2												U		R			C	
Prickly Pear Creek #1																		
Begin Private Land-End Private Land																		
4.8km Above National Forest-National Forest																		
National Forest-Clancy Creek																	C	
Prickly Pear Creek #2																		
Clancy Creek-County Road Crossing																	C	
County Road Crossing-Mouth																		
Sevenmile Creek																	R	
Silver Creek																	C	

Upper Missouri subbasin (continued)

Key to Symbols: 1=outstanding; 2=high value; 3=substantial; 4=moderate; 5=limited; 6=insufficient information to classify stream

A=abundant; C=common; P=present; PE=presence expected but not confirmed; U=uncommon; R=rare

	FAMILY	Sturgeon		Paddlefish	Mooneye	Trout								Pike	Minnow																	Sucker									Catfish			Codfish	Sunfish							Perch				Drum	Sculpin	Stickleback
Stream	Fisheries Resource Value Class COMMON NAME	Pallid sturgeon	Shovelnose sturgeon	Paddlefish	Goldeye	Mountain whitefish	Kokanee	Cutthroat trout	Rainbow/cutthroat hybrid	Rainbow trout	Brown trout	Brook trout	Arctic grayling	Northern pike	Carp	Minnow	N. Redbelly x finescale dace	Utah chub	Flathead chub	Sturgeon chub	Lake chub	Sicklefin chub	Emerald shiner	Redside shiner	Sand shiner	Brassy minnow	Plains minnow	Plains/silvery minnow	Silvery minnow	Fathead minnow	Longnose dace	River carpsucker	Blue sucker	Smallmouth buffalo	Bigmouth buffalo	Shorthead redhorse	Longnose sucker	White sucker	Largescale sucker	Mountain sucker	Black bullhead	Channel catfish	Stonecat	Burbot	Green sunfish	Pumpkinseed	Bluegill	Smallmouth bass	Largemouth bass	White crappie	Black crappie	Yellow perch	Sauger	Walleye	Iowa darter	Freshwater drum	Mottled sculpin	Brook stickleback
Sixteenmile Creek																																																										
Headwaters-Higgins Reservoir	3									A	U	A																																													C	
Higgins Reservoir-Sixteen	3									A	U	A																																													C	
Sixteen-Maudlow	3					C		C		A	A																										PE	PE																			C	
Maudlow-Mouth	3					A				A	A																										C	C																			C	
Spokane Creek	3								P	P			C	C																																											PE	
Stickney Creek	3							R		C		U																																													C	
Tenmile Creek																																																										
National Forest-Road 356	4									C		U																									U	U																			A	
Below Rimini-National Forest	4									U		U																																													C	
National Forest - Mouth	6									P	P	P																																													P	
Trout Creek	3						C		P	U	C																										U																				C	
Unnamed Tributary of Tenmile Creek	6									R																																																
Virginia Creek	4									P	P	C																																													C	
Warm Springs Creek	6										PE																																															
Wegner Creek	6									C																																																
Whiskey Springs	6																	P																																								
Willow Creek	3							P	P	U		C																																													C	
Wolf Creek	3					U		R		C	R	C																										U																			C	
MISSOURI RIVER DRAINAGE - Holter Dam to Belt Creek																																																										
Missouri River #3																																																										
Sand Coulee Creek-Black Eagle	3					C				U	U				C																	P					C	C				C		C	P			R		R		R	C				C	
Smith River-Sand Coulee Creek	3					C				U	U				C																	P					C	C				P		C	U					R		R	C		U		C	
Cascade Bridge-Smith River	3					C				C	U				C																						C	C						U	U										U		C	
Sheep Creek-Cascade Bridge	1					C				A	U				U							C									C	A					C	C							R		R			R			U		R		C	
Dearborn River-Sheep Creek	1					A		R		A	U				U							U									U	A					C	C							U								U		R		C	
Holter Dam-Dearborn River	1					A	R	R		A	U				U																	A					C	C							U								U		U		C	
Missouri River #4																																																										
Black Eagle Dam-Morony Dam	3					U				U	U				U					C											C	C					C	C				U		U			R						U				C	
DEARBORN RIVER DRAINAGE																																																										
Dearborn River																																																										
National Forest-Mouth	3					C				C	C	U																				C					C	C																			C	
Near Headwaters-National Forest	3							U		C		U																																													C	
Flat Creek	4					P				U	U	U																																														
Middle Fork Dearborn River	4									U		U																										P																			C	
Sheep Creek	3					C				C	U	U																									C	C																			C	
South Fork Dearborn River	4									U		U																																														
SMITH RIVER DRAINAGE																																																										
Big Birch Creek																																																										
National Forest-Mouth	4					C		U		U	R	A																																													C	
Near Forks-National Forest	4							U		U		C																																														
Eagle Creek	4							R		C		C																																														
Hound Creek	3					C				C	C	U																																													C	
Newlan Creek																																																										
National Forest-Mouth	4					C		P		U		C																																													C	
Jct Sec 11/12-National Forest	4									U		C																																													C	

PREFILED REBUTTAL TESTIMONY OF RICHARD A. OSWALD
ON BEHALF OF THE MONTANA DEPT. OF FISH, WILDLIFE, AND PARKS

My name is Richard A. Oswald, business address 730 N. Montana St. Dillon, Montana. I am a fisheries biologist employed by the Department of Fish, Wildlife, and Parks and have been responsible for the fisheries management of the Red Rock, Beaverhead, Ruby, and Big Hole River drainages since 1983. I have been employed with the Department since 1980 and prior to my present position worked on the assessment of fisheries resources, water quality, and instream flow characteristics on numerous streams on the Mt. Haggin WMA near Anaconda; worked on an assessment of the fish populations and instream flow characteristics of numerous streams in the Big Hole, Red Rock, and Beaverhead drainages in the Dillon area; and worked on the assessment of fish populations and cutthroat trout spawning migration in Bear Creek near Jardine prior to mining development. I hold a B.S. degree in zoology from the University of Wisconsin, an M.S. degree in zoology from Montana State University, and certification as a professional fisheries scientist from the American Fisheries Society.

The purpose of this testimony is rebuttal to testimony filed by Mr. Richard H. Kennedy in opposition to the DFWP instream flow reservation applied for on the Beaverhead River, by Mr. Lowell K. Sauerbier in opposition to the instream flow reservation applied for on the Ruby River, and by Mr. Chad G. Holland in opposition to the instream flow reservation applied for on Grasshopper Creek.

BEAVERHEAD RIVER

Mr. Kennedy's testimony suggests that no unappropriated water exists for reservation or new permits. This suggestion fails to recognize the variation in water availability to the Beaverhead River dependant upon annual variation in reservoir storage and inflows to the reservoir. It further suggests that no reasonable liklihood exists for the issuance of new permits on the Beaverhead River. These statements ignore the occasional sale of additional water for irrigation beyond contracted allotments and fail to show why additional water use permits will not be granted in the future. The reservation request does not interfere with prior appropriations and merely seeks to avoid additional stream dewatering due to increased future withdrawal.

Mr. Kennedy's testimony suggests that the stream fishery, angling, and other forms of water born recreation are fully protected and maintained under normal operating conditions. However, conditions in Reach 2 downstream from Dillon often evidence flows approaching the 25 cfs minimum authorized by the Clark Canyon Project. Trout populations within this reach decline rapidly from Dillon to Anderson Lane to the observed minimum of

200 to 300 per mile near Beaverhead Rock. Irrigation season flows within Reach 2 exhibit periodically dewatered conditions under present operating levels. The reservation merely seeks to avoid an increase in the frequency of such minimal flow conditions.

Mr. Kennedy notes that DFWP agreed upon winter releases of 35 cfs from Clark Canyon Dam during the 1989 - 1990 and 1990 - 1991 nonirrigation periods. It should be noted that this was agreed upon as a temporary measure to conserve stored water under record low reservoir storage conditions. DFWP recognizes that releases of 35 cfs are far below the optimal minimum to maintain quality trout populations within Reach 1.

RUBY RIVER

Mr. Sauerbier's testimony suggests that no unappropriated water exists for reservation or new permits. This suggestion fails to recognize the variation in water availability to the Ruby River dependant upon annual variation in reservoir storage or inflows to the reservoir. It further suggests that no reasonable liklihood exists for the issuance of new permits on the Ruby River. These statements ignore the potential for occasional sale of additional water for irrigation beyond contracted allotments and fail to show why additional water use permits will not be granted in the future. The reservation request does not interfere with prior appropriations and merely seeks to avoid additional stream dewatering due to increased future withdrawal.

Mr. Sauerbier's testimony suggests that the trout fishery of the Ruby River has prospered under present management and requires no further protection under the reservation. Reaches of the Ruby River currently undergo periodic dewatering. This is particularly evident in the Alder - Laurin reach and the reach from Harrington Bridge to the mouth. Fish population data indicate strong brown trout populations upstream from Alder and in the Silver Spring area where streamflow is relativly constant and abundant. The lowest trout populations observed have been surveyed in two study sections downstream from the Harrington Bridge. The reservation merely seeks to avoid an increase in the frequency of dewatered conditions within these critical reaches.

GRASSHOPPER CREEK

Mr. Holland's testimony suggests that no unappropriated water exists for reservations or new permits in Grasshopper Creek. It further suggests that no new permits are likely to be granted in the future. The objection fails to fully demonstrate why new permits could not be issued. The reservation request does not interfere with prior appropriations and merely seeks to avoid additional stream dewatering due to increased future withdrawal.

Mr. Holland's testimony suggests that fish populations in Grasshopper Creek are presently doing well without flow reservations. Current trout population data for most of Grasshopper Creek, particularly the upper basin (upstream from Bannack), are presently lacking. Low streamflows and dewatering have been observed periodically in the reach between the Grasshopper - Wise River road and Highway 278 and in stream segments west of the Grasshopper road. It is most probable that such low streamflows are well below optimal conditions for the maintainence of trout populations within this reach. The reservation request merely seeks to avoid an increase in the frequency of low flow events in Grasshopper Creek.

Richard A. Oswald, being first duly sworn, states that the foregoing testimony is true.

Dated December 16, 1991

Richard A. Oswald

RICHARD A. OSWALD

Subscribed and sworn to before me this 16th day of December, 1991.

ROSALEE B. RICHARDSON
Clerk & Recorder Beaverhead County
By Lee Diedreah, Deputy
Notary Public for the State of Montana
Residing at Dillon, Montana
My Commission Expires N/A

PRE-FILED REBUTTAL TESTIMONY OF BILL HILL
ON BEHALF OF THE MONTANA DEPARTMENT
OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. What is your name and address?

A. Bill Hill, Box 296, Choteau, Montana 59422

Q. What is your occupation and by whom are you employed?

A. I am a Fisheries Biologist employed by the Montana Department of Fish, Wildlife and Parks.

Q. Have you provided previous testimony in this proceeding?

A. Yes. I provided pre-filed direct testimony on behalf of DFWP which was filed on November 1, 1991. That testimony contained a statement of my qualifications and work experience and a biography.

Q. What is the purpose of your rebuttal testimony?

A. The purpose is to respond to the objector testimony of Thomas A. Wesche, Leonard Blixrud, Herbert L. Tangen and Les Otness in regard to DFWP's instream flow reservation requests on the Teton River and Cut Bank Creek. I have reviewed their testimony and have the following responses to make.

Q. What is your response to Mr. Wesche's testimony?

A. Regarding Cut Bank Creek, Mr. Wesche questioned the "high fishery value" because of the put-and-take rainbow trout fishery and the preclusion of natural reproduction.

Cut Bank Creek is considered to have a high fishery value to people in the Cut Bank vicinity because it is the only trout stream readily available. Catchable-size rainbow trout are stocked annually to supplement a limited wild rainbow trout population. Reproduction of these wild rainbow does occur. Brown trout introduced in 1965 also reproduce in this stream reach. These fishery values need preservation through an instream flow reservation.

Q. What is your response to Mr. Blixrud's testimony?

A. Mr. Blixrud said the Farmers' Cooperative Canal Company runs Teton River water into offstream reservoirs and this is an example where offstream storage provides recharge flows to the river system throughout the year. He also said these reservoirs contain fisheries and provide cover for birds and other wildlife.

Flows in the Teton River are greatly reduced when water is diverted to Harvey and Farmers reservoirs. Once water is removed from the river and placed into the storage reservoirs, there is no opportunity for this water to find its way back to the dewatered portion of the river. The Farmer's Ditch ends up on the Farmington Bench northeast of Choteau. Any excess water or recharge would be to Spring Coulee or Muddy Creek and not the Teton River. The reservoirs do provide resting and nesting for waterfowl and other water oriented species of birds. The reservoirs do not provide year-round fisheries. Surveys conducted in the early 1980's indicate these waters fluctuate drastically and are too shallow to overwinter game fish. For this reason, they are not managed by DFWP. Rough fish (suckers) inhabit the reservoirs because they can tolerate lower dissolved oxygen levels. A few trout enter the reservoirs from the Teton River via the canal headworks but the majority will die during the winter due to the marginal habitat.

Q. What is your response to Mr. Tangen's testimony?

A. Mr. Tangen said that after the 1964 flood, the Army Engineers and the Fish and Game Department cooperated in a debris removal program in the Teton River from Choteau into the mountains which caused damage to the river.

Fish and Game (now DFWP) objected to the debris removal program because it would eliminate the fishery in this stretch of river (refer to attached correspondence dated May 13 and 14, 1965, in Appendix A). Similar debris removal projects were undertaken by Teton County following the 1975 flood. I tried to convince the county that trees anchored into the river should be left for fish habitat and stabilization. After many discussions, some trees were left intact. DFWP has not caused or encouraged any damage to the Teton River. In fact, we earnestly try to protect and improve habitat through the stream preservation laws. Also, since the early 1960's, we have cooperated with the Forest Service on habitat improvement projects on the river.

Q. What is your response to Les Otness' testimony?

A. Mr. Otness said that the Teton County Conservation District Designated a portion of the Teton River between Eureka Reservoir and the town of Choteau as an intermittent stream and that this designation demonstrates that there is no unappropriated water in the river for instream flow reservations. Mr. Otness also said that public entities filing on Teton River water want control of the river and that DFWP contaminates the river with water released from Freezeout Lake.

Mr. Otness failed to mention that the Conservation District reconsidered its designation and on January 20, 1981, they declared the Teton River to be perennial from the Highway 89 north-south section line (where the Teton Canyon road takes off) downstream to the Choteau-Fairfield Bridge. Presently, the Conservation District uses USGS maps to determine whether streams are perennial. The 1981 decision agrees with USGS determinations. AT times, portions of this stretch of river will dry up due to the many upstream diversions pulling water throughout the summer. After irrigation ceases, the river begins to flow again.

DFWP is not trying to get control of the river. We only want to ensure that river flows will not get any worse with new water appropriations which would further affect fish and other aquatic life in this part of the river.

It is not known what Mr. Otness means by "contaminated" water. Water released into the Teton River from Freezeout Lake must pass through Priest Butte Lake. According to information we have on Priest Butte Lake, this water is not contaminated. We introduced rainbow trout into the lake in 1969 and carried on this practice through 1972. Appendix B shows creel census and netting dam on rainbow trout sampled in the lake.

In the late 1970's, interest grew in developing warmwater fisheries. Yellow perch and black crappie were stocked into the lake from 1981 through 1985. Surveys conducted in 1989 and 1991 show these species are surviving in the lake (Appendix C).

Bill Hill, being first duly sworn, states that the foregoing testimony is true.

DATED this 16th day of December 1991

Bill Hill

Bill Hill

Subscribed and sworn to before me this 16th day of December, 1991.

Jonnie Ruth Carabuck

Notary Public for the State of Montana
Residing at Choteau, Montana
My Commission Expires 5/31/94

HILL REBUTTAL - 3

APPENDIX A

MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

Notes from Meeting on Teton River Emergency Channel Rehabilitation
Teton County Courthouse, Choteau, Montana
May 11, 1965

Participants:

U. S. Army Corps of Engineers

Jim Kelly, Omaha Dist. C. E., Omaha, Nebraska
Don Beckman, Fort Peck Area C. E., Fort Peck, Montana

Teton County

Martin Shannon,	County Commissioner
Roy Godell,	" "
Homer Royland,	" "
Robert Riggs,	County Road Foreman

Montana Fish and Game Department

George D. Holton

Choteau was flooded in the 1964 flood and had been flooded several times previously. At the behest of local residents, the County Commission appealed to the Federal Office of Emergency Planning for action to prevent recurrence. The request was referred to the Corps of Engineers. It is the opinion of the Engineers that streambank damage caused by last year's flood coupled with snags left in the streambed will result in the river escaping its banks at even a lower water level than before.

At this meeting the Corps of Engineers presented their plan (Refer to C. E. Invitation CIVENG-25-066-111 and C. E. aerial photos in Habitat Evaluation file, Fish Div, Helena). Briefly, 6 miles of the Teton River in vicinity of Choteau will be affected. In the upper 4 miles the stream channel will be reshaped - referred to by C. E. as "channel cleanout". The new channel will have a 40-foot minimum width bottom. For the most part the previous natural channel will be followed, however, it was mentioned that two natural stream meanders will be cut off. Subsequent examination of aerial photos furnished by the C. E. indicates (if interpreted correctly) this will result in the loss of 4,200 feet of natural streambed which will be replaced with 700 feet of straightened streambed. Material removed from the stream bottom will be placed in a continuous pile on the north bank. Corps of Engineers representatives admitted this would afford only limited flood protection and carefully refrained from referring to these piles as dikes.

In addition the channel will be cleared: "all standing and fallen trees, limbs, timbers, stumps, snags and flood debris and fallen trees only shall be removed from a width of 10 feet on each creek bank". Live trees to be removed are those with a diameter of 3 inches or greater measured 2 feet above the ground.

The lower two miles of the project area will not involve channel cleanout but will be subjected to clearing to the same extent at the upper 4 miles.

During his discussion of the Corps of Engineers proposal, Mr. Kelly made several comments which substantiate the Fish and Game Department philosophy that government agencies should restrict their stream channel work to substantial projects rather than temporary expediencies. In effect he said the channel work involved in this project cannot be correctly called flood protection, its purpose is to open the river channel and allow free passage of water downstream. The stream is not going to stay put, instead the work will deteriorate in a relatively short time. The anticipated life of the project is 10 years.

The project will cost approximately $18,000 and this will be entirely borne by the Federal Government. Mr. Beckman explained that the C. E. would prefer a more substantial undertaking - one that would involve standard dikes or levees. This would be a true flood protection project. The problem is local participation would be required to the extent of providing the land and borrow material. Also local sponsors would have to fence the levees and maintain them, except when extraordinary maintenance was required, in which case the C. E. would bear the expense. A full-scale levee project would require congressional approval.

After the emergency project was described by the C. E. representatives, I was permitted to express Fish and Game Department views. I explained we had no jurisdiction over federal projects, but that we did not like the work being undertaken, since it would eliminate what stream fishery there is in this stretch of Teton River. I further pointed out that we would much prefer the more substantial levee project which, by eliminating the need for periodic stream rechanneling and clearing, would be much more compatable with a stream sport fishery.

The County Commission is concerned about the possibility of floods again this spring and felt something must be done. Therefore it approved the Emergency Channel Rehabilitation Project as presented. However, at least limited interest was expressed in a future substantial levee project for long range flood protection.

prepared by George D. Holton
May 13, 1965

Teton River
14-6046-1

Helena, Montana
May 14, 1965

Mr. Cecil S. Gubser, Supervisor
Missouri River Basin Studies
Bureau of Sport Fisheries and Wildlife
P. O. Box 1381
Billings, Montana

Dear Cecil:

Enclosed are notes from a meeting on Teton River Emergency Channel Rehabilitation. Although Teton River has only local value as a sport fishery, we are appalled at the complete destruction of fish habitat which will result from the project.

The invitation to bid on this project is dated Arpil 14, however, we did not receive detailed information until May 7. We are writing this letter to ask if you can arrange with the Corps of Engineers to be notified of all projects at an early enough date to permit you to fulfill your responsibility under the Coordination Act.

Sincerely,

FRANK H. DUNKLE
STATE FISH AND GAME DIRECTOR

FHD/eb
Enc.

APPENDIX B

Page ______ of ______

ELECTROFISHING SHEET

~~"Rite in the Rain~~

1st page only:
Date __ __ __ (mo. da. yr.)

Water name ____________ Priest Lake

Name or designation of ~~shocking~~ section ____ 5-17-89

Collection code _ _ _ _ _ _ (from Helena)   Trip type ____ (1 = mark; 2 = recovery)   Species code _ _ _ _ (Prefix: W = wild; H = hatchery) U = unknown or undesigna

~~L~~ Sp.	~~W1/~~ L	~~Mark code2/~~ W	~~Do Not~~ sex	Punch	L	W1/	Mark code2/	Do Not	Punch	L	W1/	Mark code2/	Don Pun
YP	10.8	.56	♂										
CR	9.0	.47	♀										
CR	9.1	.46	♀										
CR	8.6	.39	♂										
CR	9.1	.45	♀										
CR	8.7	.40	♂			Scales							
CR	9.6	.63	♀										
CR	9.4	.52	♀										
WS	16.6												
	15.4												
	19.6												
	18.2												
	10.1												
	18.6												
	17.3												
	14.9						2-1	" TRAP NETS					
	10.9												
	12.8						1	CR IN 1 TRAP NW END					
	18.9						6	CR IN 1 TRAP (11 TO [illegible])					
	12.7							+ WSu + LnSu + CHUB					
	16.6												
	15.9						1	YP IN GILL NET					
	11.7							+WSu					
	16.3												
	15.7												
	11.1												
	15.3												
	17.2												

1/ Weigh all "new" game fish or dub in weight.   2/ Mark code: 0 = unmarked; 1 = marked

PRIEST BUTTE LAKE
1-1-72
(OPENING DAY - ANGLING)

FISHERMEN CONTACTED BETWEEN
9:30 AM + 1100 PM.
NUMBER OF VEHICLES VARIED FROM 18-24

APPENDIX B

Sp	L	W	#Rb
Rb	10.8	.50	
	10.9	.52	
	10.3	.46	
	11.3	.74	
	9.1	.40	
	10.9	.50	
	10.7	.52	
	13.3	1.04	
	12.9	.91	
(9) avg	11.1	0.62	
	15.8	1.73	
	14.1	1.38	
	14.1	1.26	
	14.4	1.32	
	17.5	-	
	17.3	2.34	
	17.6	2.32	
(6) avg	16.1	1.80	
	18.5	2.80	
	18.5	3.38	
	20.4	3.84	
	19.5	3.36	
	18.8	2.92	
	20.2	3.80	
	19.2	3.18	
	19.9	3.12	
	18.7	2.69	
(9) avg	19.3	3.23	
	16.1	1.89	x
	13.5	1.26	x
	17.0	2.38	x
	13.8	1.40	x
	13.6	1.14	x

PLANT		No.	L	W
OCT	1969	9	19.3	3.23
June	1970	6	16.1	1.80
APR	1971	9	11.1	0.62

APPENDIX C

Continuation Sheet for .... Page ______ of ______

EXPERIMENTAL NET SET RECORD

SET 2PM

SET NO. ________ LAKE PRIEST LAKE PULLED 8AM DATE OF LIFT 5-24-91

1-125' SINKER

	SPECIES	L	W	SPECIES	L	W	SPECIES	L	W	SPECIES	L	W
1	YP	12.9	1.16									
2	CARP	13.3	1.26									
3		13.8	1.50									
4	WSu.	15.3	1.58									
5		12.9	0.91									
6							1" TRAP					
7							CR	12.5	1.21			
8				1/4" TRAP				18.1	1.48			
9								11.1	0.82			
10				@ 2500				10.1	0.63			
11				STICKLEBACKS				9.8	0.62			
12				FATHEADS				10.1	0.59			
13				BRASSY M.				9.9	0.62			
14				LAKE CHUB				10.8	0.70			
15												
16							PLUS	WSu	20			
17								CARP	6			
18								SALAMANDERS				

Priest Lake

Nets Set 4:00 AM 8/21/73
Pulled 8:00 AM 8/22/73

125' Sinker

Sp.	Lth	WT
Rb	19.3	3.25
	20.6	4.20
	17.0	1.85
	16.5	2.02
	15.3	1.81
	14.6	1.26

2 FSu
30 CSu

8-21-73 3:30 PM

TDS 3800 ppm

Depth	Temp
Surface	68.5° F.
1m	68.0°
2m	68.0°
3m	68.0°
4m	67.5°
(Bottom) 4.5m	66.5°

125' Floating

Sp	Lth	WT
Rb	18.6	1.80
	20.8	2.70
	20.1	3.52
	15.4	1.80
	16.7	2.19
	15.3	1.64
	14.2	1.38
	14.3	1.25
	15.0	1.58
	15.2	1.56
	15.4	1.67
	15.0	1.61
	14.7	1.71

+1 FH Chub

Sp	No	Ave Lth	Ave WT	Range L	Range W
Rb	8	18.7	2.69	16.5-20.8	1.80-4.20
Rb	11	14.9	1.57	14.2-15.4	1.25-1.81

Σ 19 16.5 2.04

313.5
38.79

PREFILED REBUTTAL TESTIMONY OF WADE FREDENBERG
ON BEHALF OF
THE MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. Please state your name and business address.

A. My name is Wade Fredenberg and I work at the Montana Department of Fish, Wildlife and Parks Region 3 Headquarters, 1400 So. 19th St. Bozeman.

Q. What is your employment history with the Department of Fish, Wildlife and Parks?

A. I am currently employed as a fishery program specialist. In this position I am considered the regional biologist in charge of the fishery program in the Gallatin and Madison River drainages. In addition, I have statewide responsibility for overseeing certain aspects of the Department's electrofishing program. I have been in this position nearly three years. Prior to that time, I was a regional fishery biologist in the Billings office of DFWP. For six years there, I was in charge of the fishery program in the Bighorn and Upper Musselshell River drainages.

Q. Have you provided previous testimony in this proceeding?

A. Yes, I provided pre-filed direct testimony on behalf of DFWP which was filed on November 1, 1991. That testimony contained a statement of my education and work experience and a biography.

Q. What is the purpose of your rebuttal testimony?

A. The purpose is to comment on certain objector's testimony by individuals from the Big Hole basin who criticize the reliability of DFWP's fisheries data and take issue with the effects dewatering has on cutthroat trout, Arctic grayling and other fish species.

Several objectors to the Department of Fish, Wildlife and Parks' instream flow reservation application in the Upper Big Hole River basin have questioned the accuracy of the Departments' fish distribution data on grayling and cutthroat trout (see Direct Testimony of Dale Strodtman, D.L. Smith, Gaylon Zohner, et. al.). All fish distribution data as presented in the department's reservation application is substantiated with field records of observations by trained biologists in the department. I wish to point out that fish distribution and abundance is oftentimes not accurately perceived by the angling public. The data on fish species and numbers we have collected utilizing our electrofishing equipment is of greater accuracy and reliability than the information that can be obtained by anglers.

Mr. Zohner states that there are no cutthroat trout in Bear Creek based on DFWP's statement on page 2-84 of its application that "no estimate of cutthroat trout could be devised (sic) due to a lack of sufficient recaptured fish to insure statistical reliability". Estimating the size of a population requires that a certain number of fish be captured. Thirty-six (36) cutthroat trout were actually caught in Bear Creek on August 4, 1982. These fish were marked, released and some of them recaptured on August 10, 1982. However, not enough marked fish were recaptured to estimate the actual size of the cutthroat population.

There are also statements in the testimony of objectors that the drought and low water conditions experienced in 1988 actually benefitted the fisheries of the areas and improved the fishing. The attached 9-page excerpt (Attachment A) from a Job Progress Report prepared by MDFWP in 1989 clearly states that "The recent period of low streamflow has resulted in marked effects on populations of gamefish, particularly rainbow and brown trout, in the Big Hole River." It goes on to say that the drought cycle had a profoundly negative effect on survival and recruitment of young trout. Thus, the full effects would likely be manifested over the course of several years. The complete report with figures is available upon request (Vincent, et.al. 1989. Montana Department of Fish, Wildlife and Parks' Job Progress Report F-46-R-2, Job 1-f. Helena).

There is conjecture in some of the testimony of the objectors to the Departments' instream flow reservation that the decline of the fluvial Arctic grayling is due to stocking of brook trout into the Big Hole River by DFWP and is not related to instream flow depletion (see Direct Testimony of S. J. Seidensticker, Dale Strodtman, et. al.). The most recent scientific analysis of the causes for decline of the Big Hole grayling point to a likely scenario including fishing, competition with non-native species, and habitat degradation as a result of dewatering. (Kaya, Calvin M., 1990. Status Report on Fluvial Arctic Grayling in Montana. Montana Department of Fish, Wildlife and Parks, Helena). Attached as Attachment B is the discussion section of that report which deals with these issues. It is clear that it is not a simple problem.

However, in considering the objector's testimony, one may be left with an erroneous conclusion as to the source of the competing species, especially brook trout. Brook trout appeared in the Big Hole system around the turn of the century and there are no Department of Fish, Wildlife and Parks records regarding those very early fish plants. Fish stocking at the turn of the century was an activity often conducted by well-meaning but ill-informed members of the public with no connection to any official State of Montana program. Since 1931, when the first Department records exist, the State has stocked about 2.4 million rainbow trout, 792,000 brown trout, 306,000 cutthroat trout, 900 kokanee salmon, and nearly 9 million grayling into the Big Hole River. There has been no stocking of brook trout during that period.

Wade A. Fredenberg, being first duly sworn, states the foregoing testimony is true.

DATED this 16th day of December, 1991.

Wade A. Fredenberg

Wade A. Fredenberg

Subscribed and sworn to before me this 16th day of December, 1991.

Joan Buhl

(NOTARIAL SEAL)

NOTARY PUBLIC for the State of Montana
Residing at Bozeman
My Commission expires 8-21-92

Attachment A

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION

JOB PROGRESS REPORT

State: Montana

Project Number: F-46-R-2
Job Number: I-f

Project Title: Statewide Fisheries Investigations
Study Title: Survey and Inventory of Cold Water Streams
Job Title: Southwest Montana Major River Fisheries Investigation

Period Covered: July 1, 1988 through June 30, 1989

BIG HOLE RIVER

Fish Population Estimates

Wisdom - McDowell Sections

The Wisdom and McDowell study sections were established to monitor and research arctic grayling populations in the upper Big Hole drainage. Population estimate work was conducted in these sections in 1986 but no estimates were collected in 1987 and 1988 due to extremely low streamflow. The 1986 population data will be presented with future data in a subsequent report due to previously discussed out-migration problems (Oswald 1986) and a need for a broader span of current data.

In addition to population estimate work, the arctic grayling research was expanded to include work on migration, winter habitat and spawning requirements. Since 1986, all captured grayling in excess of 7.0 inches in length have been implanted with numbered floy anchor tags. Subsequent tag return information has shown that the Big Hole grayling population requires a large expanse of river, migrating up to 60 river miles between spawning, summer and winter habitats. This data has been collected and will be presented in more detail in a subsequent report. Winter habitat has been located in three large pools downstream from the Wisdom vicinity. The age and length composition of grayling collected in these habitats has been analyzed as well as the migration of these tagged fish between habitats which has confirmed the importance of grayling migration between summer, winter and spawning habitats. These data will be presented in more detail in a subsequent report. All major components of the grayling spawning migration were analyzed in 1988 and 1989 by sampling large reaches of the Big Hole River between Jackson and Wise River, MT. Migration, length, age, and sex composition of the spawning run as well as descriptions of spawning habitat have been documented and summarized (Shepard and Oswald 1989). This data will be summarized in a subsequent report.

Jerry Creek Section

The Jerry Creek study section was instituted in 1986 to monitor wild rainbow and brown trout populations in a portion of the river dominated by rainbow trout and to provide fisheries management data for the reach in order to formulate a river management plan. The Jerry Creek section heads at the Jerry Creek bridge and continued downstream to a common use boat launch downstream from Dewey, MT for a distance of 4.73 miles in 1986 and 1987. In 1988, the section was shortened to 4.30 miles to end at the newly developed Dewey Fishing Access Site FWP. Because of the predominance of rainbow trout in the section, it is sampled in the fall (Sept.-Oct.). Gamefish collected in the study section include, rainbow trout, brown trout, mountain whitefish, arctic grayling, brook trout, cutthroat trout, and burbot. Non-game species occupying the section include white, longnose, and mountain sucker, longnose dace and mottled sculpin.

During the 1986-87 sampling period, fishing regulations which applied to the Jerry Creek section included the standard bag limit of five brown , rainbow, or cutthroat trout, only one of which may exceed 18 inches in length (Limit A) and legal terminal gear included the use of bait. In 1988, a coalition of local sportsmen succeeded in including the reach of river under the special regulations that have applied to the Divide to Melrose reach since 1981. This special regulation, extended from Divide upstream to Dickie Bridge, allows the harvest of three trout under 13 inches and one in excess of 22 inches and restricts gear to the use of artificial lures and flies. Future trout population analysis for the Jerry Creek section will consequently include an evaluation of the special regulations.

Rainbow trout density and standing crop within the Jerry Creek section is presented in Figure 15. The section supports the highest average rainbow trout densities found in the Big Hole River. The large increase in population between 1986 and 1987 was due to superior recruitment of yearlings from 1986 which supplied the best summer flow regime of the 1985-88 period. The sudden drop in population between 1987 and 1988 was due to the extremely low summer flow regime of 1988. Standing crops of rainbow trout follow density trends within the section, however the 1987 density peak was much more marked than the biomass peak due to a predominance of age 1 fish in the population. This is further demonstrated in the analysis of the population by age class (Figure 16.) which depicts the superior recruitment of yearlings in 1987. This figure also depicts the affects of low 1988 streamflow on the population as the strong class of yearlings present in 1987 was rapidly reduced in 1988. The data suggest that age classes in both 1986 and 1988 were affected by low streamflows in 1985, 1987, and 1988. Size distributions of rainbow trout within the sample (Figure 17.) and within the population (Figure 18.) indicate the the rainbow trout population of the Jerry Creek section was dominated by fish under 13 inches in length however, numbers of 16 inch and larger fish exceeded those observed in the Maiden Rock section which has been under special regulation since 1981.

Brown trout densities and standing crops for the Jerry Creek section are presented in Figure 19. The apparent population increase between 1987 and 1988 is probably an artifact of sampling date and due to estimate inflation resulting from spawning movement. It is apparent that the section supports low densities of brown trout relative to downstream study sections and relative to the rainbow trout population within the section. The relationship between standing crop and density indicates a dominance of the population by large fish. This is further supported by length - frequency distribution within the sample (Figure 20.) and estimated densities of selected length groups within the population (Figure 21.) Distribution of brown trout density among age classes (Figure 22.) suggests that this is due, in part, to limited recruitment which probably results from an observed scarcity of brown trout mainstem spawning habitat in the section. The scarcity of spawning habitat is due to the steep gradient and large substrate of the section. The predominance of large brown trout is also partially due to superior brown trout growth concomitant with low densities within the species.

Melrose and Maiden Rock Sections

Comparison of the Melrose and Maiden Rock sections have provided an evaluation of the special regulation "slot limit" since its initiation in 1981 (Oswald 1984, 1986). The Melrose section was not sampled in 1987 and 1988 due to a reorganization of work plan however sampling in the Maiden Rock section has been continuous since 1981. Both sections were sampled in spring and fall in all sample years.

Estimated numbers and standing crops of brown trout are presented in Figures 23 and 24 for the Melrose and Maiden Rock sections. Numbers and biomass of brown trout in the Melrose section were matched quite closely over the period indicative of an average weight of on pound per fish. Brown trout populations within the section have shown a tendency to increase over the sample period reaching observed maxima in 1985 and 1986 following a period of abundant streamflow in 1982-84. In contrast with the Melrose section, brown trout biomass in the Maiden Rock section exhibited a trend to exceed numbers indicative of a dominance of the population by larger fish. Exceptions to this trend included 1981, prior to the inception of special regulations, 1985 when exceptional recruitment similar to that observed in the Melrose section occurred, and 1988 when populations of large brown trout declined giving way to younger fish. The recruitment peak in 1985 in the Maiden Rock section did not carry over into 1986 as it did in the Melrose section indicating a continued dominance of the population by larger mature fish.

Estimated densities of 13 inch and larger brown trout have been compared for the two sections to determine the affect of the special regulations in increasing numbers of fish within the protected slot (Figure 25.). It is apparent from this graph that no significant increase in numbers of 13 inch and larger brown trout can be attributed to the special regulations. Comparison of densities of mature larger brown trout between the two sections (Figure 26.) indicates a substantial increase in the number of these 18 inch and larger brown trout due to special regulations. The numbers of 18 inch and larger brown trout in the Maiden Rock section increased more than five fold in the 1981-86 period while numbers of these large fish increased only slightly in the Melrose section. Some of the slight increase in the Melrose section may be attributable to out migration from the Maiden Rock section immediately upstream. The decline in the number of large brown trout in the Maiden Rock section in 1987 and 1988 is believed to be due to the dominance of the population by the older larger fish which suppressed recruitment and numbers of young fish. This can be seen in declines in numbers of brown trout in the 1981-84 and 1985-87 period and is corroborated by recruitment data. As the dominant year classes aged and began to suffer from mortality, the population of 18 inch and larger fish began to decline in 1987 which opened more habitat for younger fish which increased in number. The 1989 data indicates an upward trend in the numbers of larger fish. This is further demonstrated in Figure 27, which depicts the percentage of the brown trout standing crop that is accounted for by 18 inch and larger fish and shows the domination of the brown trout production by this segment of the population. The growth, maturation, and decline of the 18 inch and larger segment of the brown trout population of the Maiden Rock section can be seen in Figure 28, which splits the density of these larger fish into inch groups. The data indicate a slower growth in the number of fully mature (19 and 20+ inch fish) until they attained maximum numbers after four to five years of regulation. These maximum numbers of large fish then underwent a rapid decline in 1987 and 1988 as mortality eroded the population. It is possible that the special regulation of the brown trout in the Maiden Rock section may result in cycles in which the 18 inch and larger fish dominate the population while inhibiting recruitment until mortality of old fish causes short term declines and an opportunity for younger fish to enter the population. It is also possible that the population is still adjusting to regulated harvest and will merely seek a level modified by recruitment and mortality rates and attain a relative degree of stability. It will be important to continue future monitoring to determine the mechanisms by which the population responds to the special regulation.

Estimated numbers and standing crops of rainbow trout are presented for the Maiden Rock and Melrose sections in Figures 29 and 30. Total numbers and biomass of rainbow trout have risen markedly in the Maiden Rock section since the inception of the special regulations while numbers in the Melrose section declined or fluctuated. Comparative densities of 13 inch and larger rainbow trout (Figure 31) have also shown marked increases in the Maiden Rock section while densities of these fish have increased slightly and fluctuated in the Melrose section. Fluctuations in the density of these fish under special regulations may be indicative of a cyclic process as was speculated upon for brown trout or may be a function of low streamflow in the 1985-88 period. Densities of 16 inch and larger rainbow trout in the Maiden Rock section increased rapidly to achieve a maximum in 1983 that was triple the observed density in 1981. This was followed by a decline and stabilization at approximately 50 per mile that has persisted since 1984. While populations of these larger rainbow trout have increased under the special regulation, a similar increase was noted in the Melrose section over the 1981-86 period. It is possible that out migration of some of these fish from the Maiden Rock section has contributed to this increase. It is also possible that the special regulation has had the opposite affect that it has had on brown trout and is most effective in increasing numbers of 13 inch and larger rainbow as well as overall rainbow trout density. Limited increases in the

16 inch and larger rainbow trout in the Maiden Rock section also may be a function of limited growth potential due to higher densities within the species (Figure 32). Some of the data suggest that this factor may be in operation and future analysis of this data will be presented in a subsequent report.

Hog Back Section

The Hog Back study section was established in the lower Big Hole River in 1987 in order to monitor brown trout populations and provide data necessary to formulate a river management plan. The section originates at the mouth of the Garrison diversion channel (T4S, R8W, NE Sec. 31) and continues downstream 4.52 miles to the Notch Bottom Fishing Access Site (MDFWP). Because the primary component of the fishery of the section is brown trout, the section is sampled in the spring. Gamefish occupying the section include brown trout, mountain whitefish, rainbow trout, burbot, and occasional arctic grayling. Nongame species occupying the section include white and longnose sucker, longnose dace, and mottled sculpin.

Density and standing crop of age 2 and older brown trout are reported in Figure 33. This figure demonstrates that the reach supports high densities of brown trout ranging between 1052 and 1885 per mile. While standing crop closely approximated density levels in 1987 and 1989, the two parameters were widely divergent in 1988. This was due to excellent recruitment of age 2 fish from 1986, the same observation made for rainbow trout in the Jerry Creek section in upper reaches of the river. This is demonstrated in greater detail in Figure 34 which presents estimated densities of age classes of brown trout. Age data from the spring sample of 1989 has not been included in this graph since it has not been analyzed. This figure also depicts poor recruitment into the population from 1985, as evidenced by the low density of age 2 brown trout in 1987. The length distribution of the 1988 sample (Figure 35) and the densities of selected length groups of brown trout (Figure 36) demonstrate the length composition of the brown trout population of the section. These distributions indicate that brown trout growth is somewhat limited in the section relative to other study sections upstream. This is probably due to chronic low summer streamflow within the reach coupled with high brown trout density. Numbers of 18 inch and larger brown trout (15 - 20 per mile are the lowest observed for any section supporting a viable brown trout population in the Big Hole River.

Estimated populations of rainbow trout in the Hog Back section (Figure 37) are low, ranging between 165 and 204 per mile. This represents a downward trend in rainbow trout density from highs observed in the Jerry Creek section downstream to minimum densities observed in the Hog Back section. It is believed that this is due to a change in habitat from high gradient rubble cobble substrate to a lower gradient cobble gravel substrate as well as a gradual decline in tributary spawning habitat. The length distribution of the rainbow trout in the 1987 is shown in Figure 38 in order to depict the length composition of the sample. The rainbow trout population of the Hog Back section represents a relatively minor component of the fishery of the reach.

Sampling was conducted within the reach in the early 1970's. During this era, the Big Hole River still received annual plants of hatchery rainbow trout. It has been demonstrated that wild trout populations have responded favorably to the cessation of of these plants in in the Big Hole River in 1974 (Oswald, 1984). As was the case in the Melrose section, both brown and rainbow trout populations in the Hog Back Section have increased markedly over densities observed in the Reichle section in 1972 and 1973 Figures 39 and 40. Modern day wild populations of both species are approximately double those observed during the era of hatchery plants.

Discharge

Summer streamflows in the Big Hole River were somewhat below average in 1986 and markedly below average in 1987 and 1988 (Figure 41). This is representative of a drought condition which has persisted in southwest Montana since 1985 and has limited area streamflow. Flows in 1988 dropped to an instantaneous recorded minimum of 51 cfs, only 2 cfs above the record minimum of 49 cfs observed in 1931. Figure 41 demonstrates that August and September flows in 1987 and 1988 were well below the minimum recommended streamflow of 300 cfs for this reach of the Big Hole River. This drought regime streamflow in the Big Hole River is in sharp contrast to the abundant streamflows observed in the 1982-84 period.

The recent period of low streamflow has resulted in marked effects on populations of gamefish, particularly rainbow and brown trout, in the Big Hole River. Preliminary analysis of population data indicate that the affects of low streamflow have been manifest most severely in declines in survival of young rainbow trout between age 1 and age 2 and declines in recruitment of both brown and rainbow trout. This data is being analyzed and will be presented in a subsequent report.

Water Temperatures

Mean summer water temperatures in the Big Hole River were above average in 1987 and 1988 concomitant with low streamflow and warm climatic conditions (Figure 42). Maximum instantaneous water temperatures recorded over the period were 71.6 F in 1986, 72.5 F in 1987, and 74.3 F in 1988. For the July - August period, temperatures in excess of 70 F were recorded on three days in 1986, 10 days in 1987, and 21 days in 1988. Temperatures as high as 80 F were recorded in lower segments of the river near Twin Bridges and were associated with thermal stress kills of mountain whitefish and brown trout. High water temperatures coupled with low streamflow resulted in effects on the trout populations which will be analyzed in detail in a subsequent report.

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Prepared by: E.R. Vincent, Chris Clancy, Wade Fredenberg, Richard Oswald, and Bruce Rehwinkel.

Date: August 29, 1989.

Attachment B

Status Report on Fluvial Arctic Grayling (Thymallus arcticus) in Montana

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Attachment B. (Frelenberg)

Prepared for:

Montana Department of Fish, Wildlife and Parks

Helena, Montana

September 1990

POSSIBLE CONTRIBUTING FACTORS ON THE BIG HOLE RIVER

Fishing Pressure and Harvest

Before the adoption of more restrictive angling regulations, grayling may have been caught and harvested at disproportionately high ratios from the Big Hole River. Grayling accounted for a much higher proportion of anglers' catches than obtained through electrofishing surveys in 1959. Grayling made up 6% of 500 salmonids reported in MDFWP warden creel census of the Big Hole River above Pintlar (Wipperman 1965), in contrast to 1% in the electrofishing surveys that same year in a similar portion of the river (Heaton 1960). In the nine years from 1954 to 1962, the average percentage of grayling among salmonids caught in the Big Hole River was about 10% between Divide Dam and Pintlar Creek (annual range 2.6-22.4%) and about 13%

from Pintlar Creek upstream (annual range 1.1-44.9%) (Wipperman 1965). Varley (1977) reported that grayling made up only about 0.5% of fish sampled by electrofishing in the upper river, but were the predominant fish in catches of fishermen interviewed in the same area.

These figures suggest that grayling were easier to catch than trout and were being removed from the fish community at a disproportionately high rate. However, it is possible that the actual proportion of grayling in the salmonid community was higher than indicated by electrofishing, if they were concentrating in the larger, deeper pools that could not be effectively electrofished (Wipperman 1965). Regulations on angler harvest of grayling from the Big Hole River have become increasingly more restrictive in recent years: five fish (in combination with trout) up to 1983, one grayling from 1983-84 to 1987-1988, and catch and release since 1988-89. Thus far the grayling population of the Big Hole River has not responded to the more restrictive regulations and has apparently continued to decline between 1983 to 1989 (Shepard and Oswald 1989).

Habitat Alteration

Among the factors most commonly cited as being detrimental to Big Hole River grayling is the partial dewatering of the river and its tributaries during the summer by irrigation diversions (Heaton 1960; Liknes 1981; Shepard and Oswald 1989). In addition to reduction in available habitat for grayling of all ages, other possible effects of dewatering include stranding of incubating eggs or young fish, increased predation on young through their being concentrated in remnant waters with adults and other fishes, reduced food availability through habitat reduction for aquatic invertebrates, and increased maximum daily temperatures. The mechanisms through which reductions in stream discharge volume may influence Big Hole

River grayling have not been investigated, but it appears that weak year classes are associated with lower flows and strong year classes with flows normal to slightly above average (Shepard and Oswald 1989).

In addition to stream dewatering, the diversions are also causing loss of grayling, especially young fish. Grayling fry and juveniles are found in the ditches and may be carried into irrigated fields or left stranded in the ditches when headgates are closed at the end of the irrigation season (Shepard and Oswald 1989). While the magnitude of this loss is not known, an earlier study of trout in irrigation diversions from Montana streams indicates that such loss can be substantial (Clothier 1953).

Another major alteration on the river is the presence of Divide Dam near the town of Divide. The dam was originally built in 1899 (M. Patterson, Butte Water Company, pers. comm.) by the Butte Water Company to divert water into its municipal supply system. A second, hydroelectric dam built a short distance upstream a few years later by the Montana Power Company was destroyed by a flood in 1927. The migrations of grayling between upstream spawning and downstream wintering areas in the Big Hole River (Shepard and Oswald 1989) and in Alaskan rivers (Armstrong 1986) have been previously mentioned. It is possible that migrations up and down the Big Hole River were originally more extensive than at present and included movements between the lower and upper reaches now separated by a dam. Although grayling may be able to swim over the dam during periods of high water flow, it is a general barrier to upstream migration (Heaton 1960; Wippperman 1965). Rainbow and brown trout replaced grayling in the lower river sometime after construction of these dams, perhaps because grayling declined from having their access to upstream spawning areas restricted, and/or through interspecific interactions with non-native salmonids.

The Divide dams could have had two contrasting effects on grayling in the upper river. Without the fish being able to move between upper and lower sections of the river, each section of river alone may represent marginal quality habitat for fluvial grayling. On the other hand, it is possible that the Divide dams have had a role in preserving the grayling population by inhibiting free upstream movement of non-native trout, especially brown trout, into the upper river. These two roles are not necessarily mutually exclusive; the dams could have confined the grayling within marginal quality habitat but helped to save them there by inhibiting upstream colonization by brown trout.

Information is not available to determine whether other habitat parameters such as stream temperatures or turbidities of the Big Hole River have been degraded through human activities and have contributed to the decline of grayling. Present midsummer water temperatures in the upper Big Hole River may be at times marginal for grayling, and stream dewatering may be contributing to elevated temperatures. Liknes (1981) suggested that higher numbers of grayling in the Wisdom area than in areas further downstream could be related to cooler temperatures. However, temperatures may also become marginal in the Wisdom section. For example, continuous recordings by the U.S. Geological Survey (1989) indicate that maximum daily water temperatures in the Wisdom area consistently exceeded 20 °C during July 1988 and reached a maximum of 24.5 °C. Although 24.5 °C is below levels that would produce a thermal kill of grayling (Feldmeth and Eriksen 1978), temperatures above 20 °C may be higher than optimum for the species (Hubert et al. 1986).

Feldmeth and Eriksen (1978) hypothesized that warmer temperatures may favor non-native salmonids over native grayling and cutthroat trout in

Montana. They measured upper critical thermal maxima of 26.9 °C for adult grayling and 28.7 °C for grayling fry acclimated to about 13 °C, compared to critical thermal maxima of 29.8, 29.6, and 31.6 for brook, rainbow, and brown trout, respectively. They concluded that the lower thermal tolerance of grayling would make them susceptible to being replaced by the non-native salmonids at warmer temperatures.

In an earlier and more intensive study, however, McCauley (1958) derived lower short-term lethal temperatures for brook trout than Feldmeth and Ericksen. Upper lethal temperatures in his study were about 27.0 and 25.5 °C for brook trout (juveniles?) acclimated to 20 and 10 °C, respectively. These values indicate that brook trout may have lower, rather than higher, tolerance for warm temperature than do grayling. This suggests that brook trout would be more adversely affected than grayling by warm summer temperatures. If so, then warm summer temperatures of the upper Big Hole River would not account for the dominance of brook trout over grayling (and over rainbow and brown trout) in the salmonid community of the upper Big Hole River.

Interactions with Non-Native Species

The best evidence for detrimental effects of interactions with non-native fishes in the Big Hole River is provided by the lower river below Divide Dam. Grayling have become rare in these lower reaches, which are dominated by brown trout and in which rainbow trout are also abundant (Oswald 1984, 1986). Very limited information suggests that grayling were largely replaced in these reaches by rainbow trout before brown trout were introduced. According to S. J. Seidensticker of Twin Bridges (pers. comm.), grayling were abundant and easily caught in his grandparents' time, in the 1890's, near the family ranch in waters around the confluence of the

Big Hole River and the Jefferson River. By his boyhood in the late 1920's, grayling had become relatively uncommon and the main sportfish caught was rainbow trout. He also related that in the late 1920's to early 1930's, a local sportmen's club introduced brown trout into the lower Beaverhead River near its confluence with the Big Hole River, and that this may have been their first introduction into these waters. Brown trout had become the predominant salmonid at least by the 1950's (Heaton 1961; Wipperman 1965). Thus it appears that species interactions in the lower river have followed a pattern consistent with other former grayling streams in the upper Missouri drainage; establishment of brown or rainbow trout associated with disappearance of grayling. It is not known whether the few grayling present in the lower river originate locally or whether they represent fish which have moved down from reaches further upstream.

Interactions with non-native salmonids may also be important in the upper Big Hole River. According to a personal account cited by Liknes (1981), brook trout have been in the river since about 1929. Since at least the 1950's and continuing to the present, brook trout have been the dominant salmonid in the upper river and small numbers of rainbow trout are also present (Heaton 1961; Wipperman 1965; Oswald 1984, 1986). A recent upstream expansion of brown trout distribution in the Big Hole River represents obvious additional concern. Brown trout were not seen above Divide Dam in electrofishing surveys in 1959 and 1964 (Heaton 1961; Wipperman 1964), but started being seen in small numbers in later surveys (Wells and Rehwinkel 1980; Liknes 1981).

If species interactions are contributing to the low densities and apparent continuing decline of fluvial grayling in the upper Big Hole River, only the brook trout appears sufficiently numerous to be exerting such an effect. However, data are lacking on mechanisms of possible interactions between grayling and brook trout and the relations between the two species are not understood. Nelson (1954) reported finding a few grayling fry in the stomachs of brook trout in the spawning tributary of Upper Red Rock Lake, but this observation did not necessarily indicate that grayling fry are particularly vulnerable to predation. McMichael (1990) found sucker fry (unidentified Catostomus species), longnose dace (Rhinichthys cataractae), and young mountain whitefish, but no grayling in the stomachs of 35 brook trout collected from the upper Big Hole River. Skaar (1989) found differences in habitat occupied by brook trout and grayling in the upper Big Hole River. Age-1+ brook trout were most abundant in higher gradient sections and faster flowing water, while grayling were more typically found in slow runs or pools with depths of 0.6 m or greater. It is not known whether this difference in habitat use results from difference in preference between the two species or from competitive displacement of one by the other.

It is interesting to speculate on possible reasons for the persistence of fluvial grayling in the upper Big Hole River despite the long presence of non-native salmonids, contrary to their disappearance from all other streams in Montana and Michigan. One possibility is that the present situation represents the final stages of the complete replacement of this fluvial grayling population by the non-natives. Vincent (1962) concluded that it takes about 40 years for fluvial grayling to be replaced by introduced species. Grayling have persisted in the Big Hole River longer than this prediction, however, since brook trout appear to have been present in the river for about 60 years.

Another possibility is that the upper Big Hole River is marginal quality habitat for salmonids in general, and that fluvial grayling have persisted there because they are as able or better able to withstand certain unfavorable conditions, such as partial stream dewatering, than brown or rainbow trout. This hypothesis is indirectly supported by the situation previously described for the Sunny Slope Canal, where grayling persist despite severe seasonal dewatering and where rainbow trout are present in only small numbers. Marginal habitat conditions may thus have a dual effect on grayling in the upper river, serving both to depress the grayling population while preventing their replacement by non-native salmonids. As with other potential factors, however, evidence is lacking for the role or mechanisms of interactions between grayling and non-native salmonids in the upper Big Hole River.

REBUTTAL TESTIMONY OF JOHN DUFFIELD
UPPER MISSOURI RIVER BASIN WATER RESERVATION APPLICATION

PART I. OVERVIEW

Q. Please state your name and business address.

A. John Duffield, Department of Economics, University of Montana, Missoula, MT 59812 and Bioeconomics, Inc., 250 Station Drive, Missoula, MT 59801.

Q. What is your present employment?

A. I am a Professor of Economics at the University of Montana. I also work for Bioeconomics, Inc., a natural resource economics research firm.

Q. Please state your educational background and experience.

A. I was educated in Montana public schools through high school. I am a 1968 graduate of Northwestern University with a B.A. in economics. I received a Ph.D. in economics at Yale University in 1974, with a specialization in natural resource economics and market organization. I have been employed at the University of Montana since 1974, where I teach courses in resource and environmental economics, microeconomic theory and mathematical economics. I have attached a copy of my resume as Exhibit 1.

Q. What is the purpose of your testimony?

A. The purpose of this testimony is to offer a rebuttal to objector testimony filed in these proceedings by Randal Rucker and Roger Perkins.

Q. How is your rebuttal testimony organized?

A. I will examine the testimony of each individual in the order named. For purposes of clarity, I will use subsection headings to indicate the focus of the testimony. For purposes of brevity, all page number references unless otherwise indicated are to the respective objector's testimony. Rucker's testimony is the most extensive and is organized in three parts; I will examine each part of his testimony sequentially.

Q. What are the parts of Rucker's testimony?

A. There are three parts. Rucker first lists major issues, then provides a list of specific comments and closes with a series of questions.

II. RUCKER - MAJOR ISSUES

Q. What are the points in the first part of Rucker's testimony?

A. Rucker states (p. 2) that "Seven basic flaws in..Duffield's analysis are listed below." Only six are actually listed. I will take these in turn. The first point is basically that "The correct approach to determining the value of DFWP instream flow requests is to base the calculation on the <u>actual</u> [Rucker's emphasis] effect on water flow levels of granting (or not granting) the DFWP' requests." (p.3). If this view is accepted, the implication is obvious. For example, for DFWP's requests for which there are no known competing uses, it can be argued that granting the requests will <u>not</u> change stream flow levels and therefore yield no benefit. This would imply that the value of all DFWP reservations with no competing uses is zero, rather than on the order of $34 million dollars per year as I have estimated (Duffield Direct - 19).

Q. Is Rucker's approach valid?

A. No. It is inconsistent with the policy and decision criteria specified in the Administrative Rules of Montana for the issues at hand. I have previously discussed these (Duffield Direct - 4 to 6 and Duffield Direct Exhibit 1). The essential points are the explicit definition in the ARM (36.16.102) that direct benefits "mean all benefits to the reservant derived from applying reserved water to the use for which it is granted". This implies that the "without" case point of reference is not a before/after/actual change in flows but the change if the water was <u>not applied</u> to the beneficial use in question. In fact, as my direct testimony describes, (Duffield Direct-19) the water in question <u>is</u> being applied to a legally described "beneficial use" including fish and wildlife and recreational use and in fact supports valuable fish and wildlife populations and provides the opportunity for many hundreds of thousands of days of recreational use. In the absence of the water being "applied" to these uses, the uses would not exist.

Q. Does the ARM specifically describe maintaining flow levels as a beneficial use?

A. Yes. Implicit in Rucker's point #1 is the status quo as a point of reference. From this follows the view that in the absence of changes from the status quo there are no benefits. This view is overly narrow and explicitly rejected by the ARM where it states: "Montana must be responsive to the need..for maintaining stream flows for the protection of existing water rights, acquatic life and water quality" (ARM 36.16.101 (1)) and "For the purposes of these rules, the term beneficial use includes the maintenance of a minimum flow, level or quality of water." (ARM 36.16.101 (3)). Presumably "beneficial" use would entail a point of reference and definition of benefits such that positive benefits are associated with maintaining status quo flow levels. In fact, the definition of "direct benefits" described above, from the ARM, provides just such a definicion.

Q. What is the underlying basis for the definitions in the ARM?

A. In my view, these rules are explicitly designed to put instream uses on an equal footing with diversionary uses, consistent with the Montana consitution. The economic point here is that one could just as well argue that no water rights should be allocated (for example, historically) to irrigators unless there was evidence that another irrigator would want the water. What is the value of a policy that protects or establishes rights in the absence of known conflicting use? The point is that rights of use need to be established to provide security of supply, otherwise the irrigator would not risk investment in locating his ranch, buiding ditches or laying pipe or seeding multi-year crops like alfalfa. The same security of supply is needed for instream rights. This is obvious for hydropower uses entailing major investments in generation facilities. However, the same argument holds for fish and wildlife and recreational uses. Without the security of supply of instream uses, the substantial public investment in management and improvement of fisheries and outdoor recreation is at risk. Investing in a recreation access site is conceptually no different than the investment in an irrigation ditch, and deserves the same level of protection under the law. Similarly recreational users, outfitters and guides invest in physical property (equipment, boats, shoreline property and improvements, etc.) and "human capital" in the sense of committing to getting to know how to fish a given stream.

Q. Does Rucker's point #1 lead to illogical conclusions with regard to water allocation?

A. Yes. Rucker is suggesting that the benefits of establishing instream flow water reservations in the absence of known conflicts is zero, yet argues that there may be benefits to establishing instream flow for cases of competing consumptive uses. This leads to rejecting all reservations where the opportunity cost to society is zero and accepting only reservations where the opportunity cost is positive.

Q. How does Rucker suggest analyzing cases where there are competing consumptive use requests?

A. For these cases he suggests that the appropriate reference is the change in actual amount of flow due to the consumptive requests. Implicitly, the consumptive requests provide the measure of the change in flow being analyzed. He states: "The amount of the <u>current</u> consumptive use requests is the correct quantity on which to base the estimates of the current benefits and costs of granting the DFWP request."

Q. Do you agree with this for cases where there are competing uses?

A. As a practical approach to the problem, yes. In fact in my direct testimony (Duffield Direct-5) I note the symmetry of approaching the valuation of the water allocations in question from either the standpoint of a positive increase in the diversionery use (such as irrigation) or from the standpoint of an increase in instream flows. I in fact choose to analyze this set of cases from the standpoint of the consumptive change, as Rucker suggests, because of the accounting problem that arises from specific irrigation projects affecting flows in many river sections. As a practical matter, it is much more convenient to analyze the change from the standpoint of the diversionery use. This understates the benefits of the DFWP reservations in the cases where the DFWP reservation exceeds the diversionery change.

Q. Does Rucker recognize that you distinguish between 1) cases with no competing uses and 2) cases with competing uses?

A. No. Rucker states "Prof. Duffield makes no attempt to distinguish the situations described above." In fact, (Duffield Direct-12), I explicitly deal with these cases separately stating: "I have organized this part of my testimony in two parts. First I will discuss the consumptive use reservations, including municipal and irrigation. Secondly, I will discuss the net benefits associated with DFWP's reservations for which there are no competing consumptive uses."

Q. Does Rucker understand how you analyzed the second type of case?

A. No. He states that my analysis "seems again to be based on the assumption that the effect of granting DFWP instream flow requests will be to increase stream flow by the amount of the request" (p.4). This is obviously not the case. I clearly define the issue of symmetry and base the entire analysis for the competing use cases on the consumptive requests (Duffield Direct-12 to 18).

Q. Does Rucker suggest a third type of situation?

A. Yes. The first two cases presume that water is available to be appropriated. A third possibility is that there is no water available to be appropriated. He argues that in this case there are no benefits to instream flow. One can add that there are no benefits to diversionery requests. I have proceeded in my analysis on the assumption that the hydrological issue of water availability has been taken into account and that the diversionery requests by the conservation districts and municipalities and the instream flow requests by DFWP are for available water.

Q. What is the second issue raised by Rucker?

A. Rucker is concerned that [my numbering]: 1) "the value of water is constant over the entire range of the reservation requests (see Duffield Direct, p. 8)" and notes that 2) "This assumption is inconsistent with the most fundamental law of economics -- the First Law of Demand." Rucker further states that 3) "An important consequence of this assumption is that Prof. Duffield's analysis <u>always</u> [Rucker's emphasis] suggests that <u>only one</u> [Rucker's emphasis] reservation request should be granted. His analysis does not allow for the possibility that an efficient allocation of water on any given project might involve granting a fraction of the irrigation requests and a fraction of the DFWP request. His analysis therefore can not provide any insights into this important issue." (p.5)

Q. Are these points significant in this context?

A. No. I will discuss them sequentially beginning with the last point. I do not consider the intra-project allocation issue an important one. As a practical accounting matter for the projects with competing uses, we chose to use the diversionery reservation requests or projects as the unit of analysis (as previously noted) since these were generally smaller than the DFWP requests and cut across several DFWP requests. We also chose this approach because it had already been used by DNRC in their project level analysis (see Duffield Direct Exhibit 16) and provided us with some economies in our analysis. In fact the guidance in the ARM concerning water reservations is very clear that the unit of analysis is <u>the reservation</u>. For example, under the public interest criteria it is stated that the question is whether "the reservation is in the public interest". Rucker is suggesting that we should additionally examine whether <u>some part</u> of a given reservation is in the public interest. There is no guidance in the ARM for this requirement and, perhaps more importantly, this would add considerable complication to an already complicated undertaking. He would also have these proceedings investigate the appropriate scale of each reservation. As a practical matter, DNRC has, for the irrigation requests, accepted the scale of diversion put forward on each project. The irrigators should have the responsibility for identifying the optimal scale on each project and in fact have an incentive for identifying it in the sense that it minimizes costs and maximizes the net return. Similarly, DFWP has investigated the scale of its requests through the wetted perimeter method. In short, reservation level rather than intra-reservation (or intra-project) allocation is the allocation level required by the relevant Administrative Rules for Montana.

Q. Is there any other reason why you think the intra-project level of allocation is unimportant for these cases?

A. Yes. Most fundamentally, as I will develop below, the relevant values associated with irrigation <u>are likely to be constant</u> over the scale of a given diversionery project, which is our unit of analysis. A similar argument can be made for the hydropower values (as it turns out, for the same technical reasons). While recreation values will vary with the level of flow, the impact of many of the individual projects on flow levels is likely to be small. These facts tend to suggest that if a project does not show positive net benefits at the proposed scale, it is unlikely to be show positive net benefits at any scale.

Q. Turning to Rucker's second point on this issue, does the "First Law of Demand" apply for all of the values you utilize?

A. No. Invoking the "First Law of Demand" makes a nice argument; however, in economics it seems one has to qualify just about everything with an "it depends". Unfortunately, this applies to the law of demand. While Rucker does not define the latter, it is a reference to the generally observed inverse relationship of price and quantity demanded. The law derives from consumption theory but actually requires a specific assumption that the amount demanded of a commodity increases when income increases. The law is therefore more of an empirical law rather than one that holds in all cases. Declining quantity demand with increasing price is the common case, but does not hold for all commodities. In other words, there are exceptions to the law even for commodities. More importantly, there are different types of demand relationships. The law of demand is generally formally derived for the individual consumer and applies to most final consumption goods. However, there are several important types of demand relationships for which price or value is constant over the relevant range of quantity demanded. For example, this is the case for the demand curve faced by the perfectly competitive firm which, by definition, is too small to influence market price. Another important class of demand relationships is the derived demand for inputs on the part of firms. Here the shape of the demand curve for a given input depends on the nature of the production relationship. For example, if output increases linearly over the relevant range of input variability, this implies that the incremental contribution of the input to the firm's output (technically, the "marginal product") is constant at all levels. For a firm that is small relative to the market served, the value of this input to the firm is also constant. In short, invoking the (to use Rucker's words) "most fundamental law of economics" should be done cautiously with an examination of whether the law applies to the case at hand.

Q. Does the law of demand apply to all of the water values you have referenced, for example in your (Duffield Direct) Exhibit 4 (hydropower and recreation) and 7 (irrigation)?

A. No. For example it does not hold for hydropower, which is the specific value discussed on the page of my direct testimony (p. 8) which Rucker references. In fact both the hydropower related water values and the irrigation related water values are explicitly based on derived demand for water as an input in the production of commodities, electricity and alfalfa respectively. The hydropower production technology described by Larry Gruel in his testimony as well as DNRC's approach to characterizing this technology implies, in fact, a linear production relationship. The same is true of the production technology underlying DNRC's model of irrigated aflalfa production. The latter is based on extensive agricultural experiment station data that shows a linear relationship between the water input and output within the relevant range of water use. This relationship is described in the paper by Dan Dodds and others referenced in Duffield Direct-10 and is explicitly used by Dodds in his computation of alfalfa related water values. Alfalfa production is likely to approximate the conditions of a competitive market from the standpoint of the irrigator. These two conditions taken together lead to constant values for irrigation water <u>at the project level</u> as displayed in both DNRC's analysis (Exhibit 16, Duffield Direct) and our version of that analysis (Exhibit 7, Duffield Direct).

Q. Do you also use constant values for recreation over the range of all reservations?

A. No. The recreation values are specific at the basin level and reflect a continuous nonlinear relationship of flow and value derived in DFWP Exhibit 9. In a sense these relationships could also be conceived of as based on a production relationship in the sense that streamflow is an essential "input" from the standpoint of the recreator "producing" a recreational experience. This model is in fact one commonly appealed to in the recreation literature and is termed a "household production" model. In this case, however, the production technology is nonlinear in the sense that streamflow changes at some levels (eg. at the level where "boatability" or survival of the fish stock changes dramatically) have greater influence on the experience than, for example, small changes at normal streamflow levels.

Q. What is Rucker's third issue?

A. He suggests that there is "methodological inconsistency" in valuing nonmarket goods because I have not used the same methodology for irrigation water and recreation water. Specifically, Rucker suggests that we ought to use a contingent valuation (or direct survey approach, see the discussion in Duffield Direct-30 to 31) noting "the task of asking irrigators the question 'What is the minimum payment you would accept for your water rights' would not seem prohibitive." (p.5) But instead, "Prof. Duffield, however, uses a totally different methodology for obtaining the value of irrigation water.." (p.5)

Q. Is this a valid point?

A. No. The class of "nonmarket" goods is a very broad one and includes anything that is not generally traded in established markets. Because both irrigation water and recreation happen to be nonmarket commodities, it does not follow that the best method for estimating value for recreation is the best method for irrigation. One important difference is that irrigation water is an input for a priced agricultural commodity; it makes sense to this relationship. This is not an option for beneficial use of instream flows for recreation in most settings. As noted in Duffield Direct-30, a commonly used recreation value methodology is the travel cost model. This approach is in fact the basis of the analysis in DFWP Exhibit 7, which is the source of the values for the noncompeting set of cases (Duffield Direct-19 and 20). This model makes use of the "weak complementarity" connection of recreation to an existing market, the market for travel services.

Q. Why doesn't Rucker suggest this approach to evaluating irrigation values?

A. Presumably because he recognizes that it would be impossible to apply.

Q. Is it a general practice to use different methods for different nonmarket uses of water?

A. Yes. The standard references on methods for valuing water in different uses, such as the U.S. Water Resources Council Principles and Standards (1983), suggest different methods for different uses. The methods we have used are among those suggested by these guidelines as explicitly noted for recreation, for example Duffield Direct-31.

Q. What about the specific approach of using contingent valuation for irrigation water as Rucker suggests of "What is the minimum payment you would accept for your water rights?"

A. This is an approach that could be conceivably used in this application, though its use would be novel and perhaps hard to justify given the opportunity to use observed market information and carefully developed production relationships. In addition the specific question that Rucker suggests is naive in that it is a "willingness to accept" question. The latter actually is inconsistent with our application of contingent valuation (CVM) in this case (eg. DFWP Exhibit 9) in the sense that we used "willingness to pay" questions. It is commonly found in empirical applications of these methods that "willingness to pay" measures and "willingness to accept" measures may differ by two to five fold. Additionally, the use of "willingness to accept" questions of the type Rucker proposes are explicitly not recommended in the federal guidelines for this method.

Q. Could there be an argument for using a "willingness to accept" measure for foregone recreation values that would accompany new irrigation diversions?

A. This depends on the point of reference. The choice of willingness to pay versus a willingness to accept depends on the implicit or actual entitlement. For example, the new proposed irrigation diversions will reduce instream flows. If it could be argued that recreationist's have a right to at least the existing flow levels, then a willingness to accept measure may be appropriate in the sense that recreationists should be compensated for their loss. However, one could also argue that irrigators have an equal right to divert additional water. Another perspective on this issue is that the appropriate benefit-cost test is that the proposed change lead to a potential Pareto improvement. The latter means that gainers (here irrigators) can more than compensate loosers (here recreationists and hydroelectric users). The only direction of a real change in flow levels actually proposed in these proceedings is a reduction of status quo flows. This suggests that we can only be sure of a potential Pareto improvement for proposed diversions if irrigation benefits exceed the amount needed to compensate recreationists and other instream flow beneficiaries for their loss. If this test is accepted, the willingness to pay measures used here for recreation benefits understand the compensation that would be demanded. To avoid the emprical problem of implementing willingness to accept CVM studies, one could compute willingness to accept from the willingness to pay measures using theoretical relationships. Note that a similar argument could be made for actually using a willingness to accept measure for irrigators if one was considering a change from the status quo that led to increased streamflow and reductions in existing levels of irrigation diversions.

Q. As a point of clarification, why do you use the travel cost model results for the DFWP reservations for which there are no competing requests?

A. I did this for reasons of efficiency. Recall that the analysis of the DFWP reservations with competing uses is fairly complicated and justifies being concerned with marginal values for the recreational value of instream flow. Accordingly the analysis of these cases is based on DFWP Exhibit 9. For the cases with no competing uses, a much simpler approach is taken to merely indicate the approximate magnitude of the values of DFWP's reservation requests applied to the fish and wildlife and recreation beneficial use. For these cases the logical unit of analysis is the DFWP reservation requests. When these are aggregated at the stream or even sub-basin level, it is convenient to have recreation values that also are aggregated at this level. These are conveniently available in the travel cost model study (DFWP Exhibit 7) and were accordingly used.

Q. What is Rucker's fourth issue?

A. There are three points made here. All relate to the specific form of the question used in the contingent valuation approach we used to value recreational use of water. The first point is that we did not supply a copy of the actual questionnaire used in the study described in Exhibit 8 and therefore "..it is not possible to comment in detail on the fishing survey used by Prof. Duffield.." (p.6). (This point is revisited in connection with issue number six below.)

Q. Is this an important point?

A. No. It indicates that Rucker did not understand from which studies the recreation values used in our analysis are derived. In fact they are derived from the studies in DFWP Exhibits 7 and Exhibit 9, not from Exhibit 8. The study described in Exhibit 8 is cited for two reasons in my direct testimony. (The studies in these exhibits are generally described Duffield Direct-32). First, on Duffield Direct-31, results from the study in Exhibit 8 for the Madison River (also Duffield Direct Exhibit 21) are presented as a means of describing the general method. In fact, the specific CVM question used is actually listed here (Duffield Direct-31). Secondly, the CVM study in Exhibit 8 is used as a basis for comparison and validation of the results in Exhibit 7, which is a travel cost model study.

Q. Were the CVM questions actually used as a basis for estimating the recreational values of instream flows in your direct testimony in fact available?

A. Yes. The complete survey instrument is provided as Appendix A of DFWP Exhibit 9.

Q. What is the second point on this issue raised by Rucker?

A. He suggests that the approach is unnecessarily complex in that values were derived by "splicing estimates of the value of fishing trips from one study (DFWP Exhibit #8) with estimates of changes in use rates in response to changes in water flow levels from another study (DFWP Exhibit #9)". (p. 6)

Q. Is this true?

A. No. The recreational values referred to are based on Exhibit 9.

Q. Does Rucker suggest another approach?

A. Yes. He recommends a contingent valuation question, stating: "A more straightforward approach to estimating the value of increased instream flows would have been to ask fishermen by how much their willingness to pay would change in response to a specified change in water levels."

Q. Would this be a good approach for the problem at hand?

A. No. This approach would not have been feasible within the budgetary constraints of the sponsoring agency (DNRC). This is because to make such a question meaningful it is necessary to be able to anchor the response to something specific, such as changes from 1200 CFS or changes from the flow level you experienced. The first is implausible because "1200 CFS" would be a meaningless description to most users;

the second is infeasible given the very large number of river reaches at issue and the inadequacy of secondary data on actual flows. Additionally, a separate question would have to be asked for each reach and flow increment. We have actually implemented a study of this type but did it with on-site surveys; the cost of doing two river segments (totaling 60 stream miles) was equivalent to our budget available for evaluating stream flows in the study in Exhibit 9 for the entire Upper Missouri River Basin. Our judgement was that the only feasible methodology for the problem at hand was Narayanan's approach (as described in Duffield Direct 37-38).

Q. Does Rucker make any other points on this issue?

A. Yes. He comments that we "did not specify the condition of other similar water systems in the area" and "it is impossible to say what assumptions concerning this issue were made by fishermen in their answers to the surveys". (p.6)

Q. Have you considered this problem?

A. Yes. The natural assumption is that the angler would have no reason to anticipate a change in the absence of specific guidance in our survey. From a practical survey research standpoint it is necessary to avoid burdening the respondent in these types of surveys with an overload of information. For example, it would be burdensome to specify changed conditions at the site of interest and a number of other sites. The standard approach has been to <u>not</u> specify the conditions at all other sites. <u>Our</u> assumption is that changes are evaluated with conditions constant at all other sites. Actual cash transaction experiment results have tended to validate this approach to the problem in that the cash results are for unchanged other conditions and the responses are consistent with CVM responses where conditions at other sites are assumed unchanged (by the researcher) and not specified.

Q. What is the fifth issue raised by Rucker?

A. Rucker suggests that omitted indirect benefits and costs may influence the results. He first mentions (p. 6) the "pro-instream flow biases in his analysis that were discussed above" as part of issue number one. This is an odd way to view the basic point he raises in issue number one. The argument there has to do with the point of reference with the outcome either zero or $32 million per year. He did not under issue one raise the argument that the estimate of $32 million was "biased" (i.e., high or low) but that it was zero. He secondly states that my analysis "fails to mention some important indirect benefits from irrigation and at least one important indirect cost associated with granting the DFWP's instream flow request.

Q. What are the indirect benefits?

A. Rucker states that "additional irrigated aflalfa acreage will result in a reduction in the price of hay" (p.6) and then goes on to explain that this will "encourage expansion of both the cattle industry and the recreational horseback-riding industry in the state". There is no evidence provided that the latter are possibly significant or even necessarily beneficial. Is the market for beef such that an expansion of industry supply will actually benefit Montana ranchers? Moreover, Rucker ignores the direct impact a reduction in hay prices will have on project economics for the irrigation reservation requests (see Duffield Direct-17). A reduction in the expected price of alfalfa means that the net values associated with irrigated agriculture in the DNRC model are overestimated. Rucker also notes that "increased storage of water during periods of high flows for later use in irrigation may actually increase the value of recreational fishing". This point does not seem particularly relevant given that few of the proposed projects are storage projects. Rucker makes an additional unsubstantiated assertion that "additional alfalfa acreage has the potential to reduce impacts of drought on the cattle industry in the state". (p.6). In the absence of any empirical evidence, these "indirect benefits" seem quite speculative. I would expect that they would be outweighed by the direct effect of reduced alfalfa prices on project net benefits and the unquantified indirect benefits I have mentioned in my Direct Testimony (16-17) on the instream flow side. The latter include dilution of arsenic concentrations in the Missouri, existence values associated with protecting unique environments and species, benefits of adequate flow levels to existing irrigators in the operation of diversions and headgates, and the failure to incorporate a plausible trend of increasing amenity, energy, and recreation values relative to the value of agricultural products.

Q. What is the indirect cost that Rucker mentions?

A. Rucker suggests that if DFWP is an owner of water rights in most of the Upper Missouri River Basin "DFWP will have the right to challenge almost any water transfers or requests for change in use in the entire basin" which will increase the transaction costs associated with transferring water in Montana. Rucker contends that this will reduce the likelyhood of efficient transfers occuring.

Q. Does this concern seem well founded?

A. No. DFWP already has significant water rights on many streams in the basin, the so-called Murphy rights. There is no evidence that this has led to burdensome transaction costs. In fact, some water transfers may be in DFWP's interest. For example, a change in point of diversion may increase the flow in a given reach.

Q. What is the sixth issue Rucker raises?

A. Rucker states that the documentation accompanying my direct testimony was incomplete and incorrect on several points.

Q. What are the specific concerns?

A. Rucker notes that the wrong survey (an elk survey instrument) is included in our fishing study provided as DFWP Exhibit 8). This survey was incorrectly included in the original printing of the document and has never been revised. It was an oversight to not correct this for purposes of exhibits in these proceedings. However, as noted, the results of this study are only used for purposes of explaining methods and for comparison to the travel cost model results (DFWP Exhibit 7) that are used to value the DFWP reservations with no competing uses. A copy of the angler survey that was used in the study described in DFWP Exhibit 8 is provided as Exhibit 2 to this rebuttal testimony. Additionally, Rucker notes that footnotes are missing to Duffield Direct Exhibit 4 and referenced municipal values are also missing from Exhibit 4. These are oversights. A corrected Duffield Direct Exhibit 4 is provided as Exhibit 3 to this testimony. It may be noted that the municipal value per acre-foot is provided and described at Duffield Direct-12. Finally, Rucker notes that variable definitions are not provided for Exhibits 7, 8, and 9. Exhibit 4 to this testimony provides variable definitions. I would note that the key exhibit is Exhibit 7. We do provide terse variable names that are fairly descriptive. Additionally, we note in the discussion (Duffield Direct-18) that these exhibits are derived from the DNRC Appendix K-4 (Duffield Direct Exhibit 16). We have also in Exhibit 5 of this testimony provided an annotated computer code to facilitate interpretation of Duffield Direct Exhibit 9.

Q. Have you made other corrections or changes to your previous testimony?

A. Yes. We noticed that Duffield Direct Exhibit 7 did not list the measure of irrigation project value that was actually used in computing the net values. The irrigation values listed were VALUE rather than VALUE2 (defined in Exhibit 4 this testimony). We provide a corrected Duffield Direct

Exhibit 7 as Exhibit 6 to this testimony. The net values are unchanged. We also noted that several words had been transposed into the wrong columns in Duffield Direct Exhibit 11; we provide a corrected copy as Exhibit 7 to this testimony.

III. RUCKER - SPECIFIC COMMENTS

Q. Are you now going to address the specific comments that Rucker makes in the last two parts of his testimony?

A. Yes. It is tedious to repeat all of these comments here in narrative. In Exhibit 8, I provide a complete copy of Rucker's testimony part II and III with each comment sequentially numbered on the left side with circled penciled numbers. In Exhibit 9, I provide correspondingly numbered replies to each of Rucker's comments.

IV. PERKINS

Q. Do you have any comments on the testimony by Roger Perkins?

A. Yes. Perkins briefly discusses "Instream and Recreational Values" on pages 21-22 of his testimony.

Q. What issues does Perkins raise?

A. Many of his comments address issues similar to those discussed above with respect to Rucker's testimony. The general theme is that the analysis reported in the DNRC Draft EIS generally overstates instream values and understates irrigation water values. However, the points argued are often unsubstantiated or, where examples are given, the facts described may actually counter the general point presented. His first comment is that "Recreational values are assumed to be perfectly elastic, which we believe to not be the case. Several examples follow. In the above average water years, the marginal value of an acre foot will be much less than in the dry, below average years." In fact, as described earlier and as shown in Duffield Direct Exhibits 31 and 32, marginal recreation values are presented. These, as Perkins suggests they should, show higher values at lower flow levels.

Q. What other points does Perkins make?

A. One of his next comments is "If a consumptive diversion is located in a historically dewatered area, we believe the recreational value of water to be overstated. This is no documentation of the maximum extent that fishing or other activities can expand without overcrowding or over-use." Does this mean that Perkins concedes that the recreational value of water is not overstated in other situtations? In any case, there is no basis provided for the assertion. The concern about overcrowding is beside the point. Our analysis used current levels and only evaluated streamflow changes that would reduce recreational use. Perhaps Perkins means that the trend in recreational use is, other things equal, for increased use. This would suggest that our computation of recreational value (which assumed no increase in future use levels or willingness to pay) leads to an underestimate.

Q. Does Perkins distinguish cases of DFWP instream flow reservation requests where there are no competing irrigation or municipal requests?

A. Yes. He states that "In those streams with no expected consumptive competition for the water, we believe that the marginal value is nonexistent". His meaning is not entirely clear, because in this case if "marginal value" refers to the nonexistent consumptive competition, the value of the latter is indeed nonexistent. However, if the point of reference is instream flow value, he is in error on this point for the reasons presented above with respect to Rucker's first issue.

Q. Does Perkins raise the issue of indirect benefits?

A. Yes. Perkins mentions the value of water storage in headwaters reservoirs as having instream benefits, but does not identify any such reservation requests at issue in these proceedings. He states generally that "It is not clear whether instream or consumptive indirect benefits would be greater. Ag spends considerable dollars to support irrigation and contributes tax dollars to state and local government. The extent of recreational indirect benefits is unkown." (p. 21).

Q. Are the latter business expenditures and tax dollars indirect benefits as the term is used in the ARM?

A. No. Economic measures of expenditures, for example, do not provide unique measures of net benefits for use in benefit-cost analysis but provide "benefits" in another metric - the jobs and income economic impacts usually examined in regional economic analysis. In fact recreationists also make substantial expenditures and contribute in this way to the local economy.

Q. Does Perkins make the same argument as Rucker concerning the stability an expanded hay resource would provide for the livestock industry?

A. Yes. Again it is unsubstantiated.

Q. Does Perkins demonstrate an understanding of the comparability of economic measures used in both recreation and fisheries valuation and agriculture?

A. No. He states: "Apparently there is a difference in what DFWP is willing to pay for instream leasing of water, compared to the rancher's perception of the value of the water. Market value is a better measure than marginal value for fisheries. This reaction demonstrates that the water for fisheries is valued equal to or less than the water for agriculture in the real world." These assertions do not demonstrate anything having to do with relative value.

Q. Does Perkins offer any quantitative evidence concerning the economics of irrigated agriculture?

A. Yes. Several points of fact are mentioned. Perkins first argues that the amount of water per acre foot that the DNRC EIS believes will be diverted for the Conservation Districts (1.9 acrefeet per acre) is much too high and suggests values of 0.71 AF/acre to 0.98 AF/acre with the latter being his preferred estimate for current use. He notes that "With sprinkler irrigation, closed pipelines and high power costs leading to the common practice of deficit irrigation, we believe the depletion for the new acreage should be closer to 0.75 AF/acre." He concludes that "Thus, reductions to both power and recreation benefits may be considerably over-estimated in the EIS and the Duffield analysis".

Q. Is this a valid point?

A. The point that irrigators may actually be diverting less water than DNRC assumed may be valid and it certainly may be important. However, the full implications are not examined by Perkins. The tradeoff that determines whether irrigation projects past a benefit-cost test (which includes the opportunity cost of foregone insteam flows) is not extremely sensitive (not at all for hydropower) to the range of flow changes Perkins considers. On the other hand, irrigation benefits are quite sensitive because of the high fixed costs (investment costs) associated with the types of projects being considered by the Conservation Districts. Relatively lower utilization of the fixed irrigation capital will reduce net returns. In fact, the DNRC analysis of the net benefits of irrigation rests heavily on the assumption that crops will be efficiently and adequately watered. Does "deficit irrigation" mean the opposite? DNRC is predicting 4 to 5 tons per acre of alfalfa production, much of which is tied to irrigation water. If Perkins' 11 numbers are really diversion per acre, the contribution of irrigation to a given alfalfa crop will be fairly small. For example, assume that conversion efficiency is 100 percent; this may not be realistic. Assume that application efficiency is 65%, which is achievable with center pivot, sidewheel or handline. If only .75 AF/acre are diverted at 65% application efficiency, is this not only a maximum contribution to evapotransporation of about 6 inches? Using the marginal physical product that is established in agricultural experiment station studies for alfalfa of .19 tons per ET this implies a contribution to production of only 1.14 tons. At 1986 to 1989 alfalfa prices in Montana ($65 per ton), this implies a gross value (ignoring all costs) to the irrigation of about $75 per acre.

Q. Does Perkins provide any information on costs?

A. He provides only the anecdotal statement that "We have visited with three irrigation dealers in the Headwaters subbasin and they are all busy installing irrigation equipment on new land at a cost of $400 to $800 an acre. This is the true test of the value of irrigation water." Actually, this may indicate the true cost of irrigation investments. Investments of this scale, amortized at say 9% for 20 years would imply per acre costs on the order of up to $87 a year. This does not sound like too good an investment if the gross return is really $75 an acre and we haven't even identified operating and maintenance and power costs.

Q. Do Perkins' estimates have implications for the interpretation of the DNRC irrigation net benefit estimates?

A. Yes. Presumably Perkins is well acquainted with the facts of water useage levels and investment costs. The range of numbers he cites for these key parameters would suggest that the net benefits to irrigation water (absent even adjustments for variable and opportunity costs) developed by DNRC are overestimated.

Q. Does Perkins provide any other quantitative information?

A. Yes. Perkins notes that "Generally, the Duffield testimony and analysis under-values agricultural water and over-values recreational water. We are aware of several water purchases in the Bozeman area of agricultural water valued at $30 to $50 per AF."

Q. Is this useful information?

A. Yes. It would be very interesting to see documentation of these values. To the extent there are widespread market transactions for irrigation water rights, this contradicts the testimony of Rucker, who suggests (as noted above) that these are nonmarket resources.

Q. Do these values indicate that you have under-valued irrigation water?

A. Although both Perkins and Rucker seem to give me credit for the irrigation values we use, they are totally based on the DNRC analysis. In fact, as reported in Duffield Direct Exhibit 4, the <u>average</u> DNRC "gross benefits" for irrigation water at 40 mill power is $41.68 across all projects. This "gross benefit" is net of costs to the irrigator, for somewhat subsidized power, and excludes opportunity costs and therefore may provide at least a rough approximation to what an irrigator might be willing to pay for water rights. In fact, the values Perkins cites bracket the DNRC average. Perkins' values therefore do not seem to support his assertion that irrigation water is being undervalued in these analysis. Of course one needs to look more closely at the particulars of the the cash transactions to really evaluate the comparison.

Q. Does Perkins have any other comments?

A. Yes. He states that "We are aware of several other studies that value fishing days and recreational days at a value much less than Duffield derived".(p.22)

Q. Is this a valid point?

A. Yes. I think it is appropriate to look at the values that have been derived by other researchers. However, one should be careful in such a comparison to be aware of differences in methodology, assumptions, and particularly the nature of the experience valued. Resources like the Madison, Big Hole and Gallatin are viewed as unique and important fisheries by anglers from across the United States. This is reflected in the very high proportion of nonresident anglers among those who fish these streams. On the Madison (and Big Horn) nonresident use in some summer months is over 70%. These are destination fisheries and are likely to have values in excess of those associated with more local or lower quality fisheries.

Q. Does this complete your testimony?

A. Yes.

I, John Duffield, being first duly sworn, state that the foregoing testimony is true.

Dated this 16th day of December, 1991.

John Duffield

John Duffield

Subscribed and sworn to before me this 16th day of December, 1991.

Patricia R. Schmid

Notary Public for the State of Montana
Residing at Missoula, Montana.
My commission expires 3-3-92.

REBUTTAL EXHIBIT 1

RESUME OF JOHN W. DUFFIELD

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EDUCATION

Ph.D. Economics, Yale University, 1974
B.A. Economics, Northwestern University, 1968

AWARDS AND HONORS

Phi Beta Kappa
Woodrow Wilson Fellow
National Science Foundation Fellowship in Economics, Yale University 1970-73.
Resources for the Future Dissertation Fellowship 1973-74.
Research Sabbatical, Inst. of Economics, University of Oslo 1983.

PERSONAL

Born September 28, 1946 in Great Falls, Montana. Primary and secondary education at Mystic Lake and Thompson Falls public schools. Married. Avid skier, angler and boater.

PROFESSIONAL EXPERIENCE

Dr. Duffield is currently Professor of Economics at the University of Montana where he has taught since 1974. His areas of specialization are environmental and natural resource economics. His teaching responsibilities include microeconomic theory and mathematical economics. Duffield is also the owner of a natural resource economics consulting firm, Bioeconomics Associates, based in Missoula, Montana.

In the last fifteen years, Dr. Duffield has participated in research examining a wide range of environmental and natural resource issues including air pollution standards, energy forecasting, benefit/cost analysis of hydroelectric projects, and optimization of residential energy systems. His current and most recent research is largely in the area of nonmarket valuation. Dr. Duffield recently directed a two-year study for the U.S. Forest Service Rocky Mountain Experiment Station aimed at developing economic methodologies for valuing instream flows. Duffield is currently directing a study for the U.S. Environmental Protection Agency field-testing option and existence values in a simulated market context. Duffield also has a contract with the State of Montana to undertake natural resource damage assessments on Montana "Superfund" sites. Another current project is using contingent valuation methods to evaluate proposed wolf recovery in Yellowstone National Park.

During his graduate and undergraduate education, Dr. Duffield worked in a part-time consulting capacity with a variety of organizations including the Association of American Medical Colleges, Southern Railway System, and Metrecon Division of Larry Smith and Co.

MEMBERSHIP

Association of Environmental and Resource Economists

RECENT GRANTS AND CONTRACTS

1991-1992. Director, research project for the Liz Claiborne and Art Ortenberg Foundation. "Wolves and People in Yellowstone: A Case Study in the New Resource Economics". Assessment of the economics of wolf recovery in Yellowstone National Park based on a national random-digit dialed contingent valuation survey.

1990-1992. Co-Director, research project for the Northwest Area Foundation. "An Economic Evaluation of Montana Sustainable Agricultural Practices". Evaluate environmental benefits and economic viability of sustainable small-grain/legume rotations on Montana farms.

1989-1991. Director, research project for U.S. Environmental Protection Agency Cooperative Agreements in Environmental Economics. "Field Testing of Option/Existence Values". Project in cooperation with The Nature Conservancy to apply simulated and hypothetical valuation measures to instream flows in Montana.

1989-present. Contract with Montana Department of Health and Environmental Sciences to conduct natural resource damage assessments on selected Montana National Priority List "Superfund" sites.

1990. Director, research project for the National Park Service. "An Economic Analysis of Wolf Recovery in Yellowstone National Park". Contingent valuation assessment of direct recreational benefits and existence values for wolf recovery.

1990. Contract with U.S. Forest Service to provide a literature review of nonconsumptive recreation including wildlife viewing and the literature on wildlife preservation or existence values.

1990. Contract with Montana Department of Fish, Wildlife and Parks to estimate fair market price for leased water to augment instream flows on select Montana streams.

1990. Contract with Montana Department of Fish, Wildlife and Parks to conduct contingent valuation assessment of waterfowl hunting in Montana.

1989-1990. Contract with Montana Department of Natural Resources and Conservation to evalute the recreational benefits of instream flows in the Upper Missouri River Basin of Montana. Large scale contingent valuation household mail survey.

1989-1990. Contracts with Montana Department of Fish, Wildlife and Parks to conduct socio-economic assessments of proposed habitat acquisitions including elk winter range adjoining Yellowstone National Park. Contingent valuation of changed environmental conditions in a total valuation framework.

1988-1990. Director, research project for Montana Water Resources Center (U.S. Geological Survey support), "Net Economic Values of Instream Flows: A Regional Travel Cost Model of Montana Trout Streams". Develop pooled time-series/cross-sectional travel cost application.

1988-1989. Contract with Montana Department of Fish, Wildlife and Parks to direct contingent valuation studies of wilderness lake fishing and deer hunting in Montana.

1988. Contract with Montana Department of Fish, Wildlife and Parks to analyze fishery regulations on Rock Creek. Contingent valuation analysis of bank angler/float fisherman conflict.

1987-1989. Director, research project for U.S. Forest Service Rocky Mountain Experiment Station. "Economic Value of Recreation and Preservation Benefits of Instream Flows". Application of contingent valuation methods to instream flows; empirical study of Big Hole and Bitterroot Rivers.

1985-1987. Director, Montana Bioeconomics Study for Montana Department of Fish, Wildlife and Parks, with John Loomis, Stewart Allen and Rob Brooks. Comprehensive contingent valuation and travel cost modeling of stream and lake fishing and elk, deer and antelope hunting in Montana.

PUBLICATIONS AND REPORTS

Ph.D. Dissertation: Wilderness: A Political and Economic Analysis (Yale, 1974).

Projections of Northern Great Plains Coal Mining. Report to the National Science Foundation. (May 1976) (co-author).

"Defining the Market for Great Plains Coal", 14 Montana Business Quarterly 3 (Summer 1976) pp. 18-25 (co-author).

"Toward Planet Terrarium: A Household Production Function for Solar Energy" (Paper presented at the Western Economics Association Meetings, Anaheim, California, June 20-23, 1977).

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Jan. 20, 1977.

"Regional Electricity Models: A Case Study of Montana" (Paper presented at the Western Social Science Association meetings in Denver,Colorado, April, 1977).

"The Costs of Congestion: An Econometric Analysis of Wilderness Recreation, by Charles Cicchetti and V. Kerry Smith" (Book Review) 1 Environmental Management 5 (June 1977).

Economic Critique of the Auburn-Folsom South Unit Central Valley Project. Report for the Audubon Society. March 17, 1978.

"The Lands Nobody Wanted: Policy for National Forests in the Eastern United States" (Book Review) 2 Environmental Management 4. (July 1978).

Review of The Economics of Solar Home Heating, 4 Journal of Energy & Development 1 (Autumn, 1978).

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Thanks again. If you would like to receive a copy of the survey results, please write "Results requested" and your address on the back of the return envelope (not on this questionnaire).

REBUTTAL EXHIBIT 2

ANGLER SURVEY

Summer 1986

Montana Department of Fish, Wildlife & Parks

FIRST, WE HAVE SOME GENERAL QUESTIONS ABOUT YOUR FISHING.

How many years have you been fishing? ______ Years

About how many days a year do you fish for trout? ______ Days

About how many of these days are spent in Montana? ______ Days

How would you rate trout fishing compared to other outdoor recreation activities you do? (please check one)

1 ___ It's my favorite outdoor recreation activity

2 ___ It's one of my favorite outdoor recreation activities

3 ___ It's just one of several outdoor recreation activities that I do

4 ___ I prefer to participate in other outdoor recreation activities

About what percent of your fishing time do you spend at each of these types of water?

Large lakes	______	%
Small lakes	______	%
Large rivers	______	%
Small rivers	______	%
Creeks	______	%
Spring creeks	______	%
Total:	100	

THE NEXT FEW QUESTIONS ASK ABOUT YOUR MOST RECENT FISHING TRIP TO THE BITTERROOT AND YOUR EVALUATION OF THE FISHING THERE.

Approximate date(s) of this last trip: ____________

trip could be anything from an hour to several or more days)

2. On this trip, did you fish a section of the Bitterroot th[at] has special fishing regulations? (Please check one)

1 ___ Yes

2 ___ No

3 ___ I'm not sure

3. How many days did you fish the Bitterroot on this trip?

___ Days

verbatim

4. About how many hours per day were you fishing?

___ Hours per day

5. What type of fishing equipment did you use?

1 ___ Bait

2 ___ Lures

3 ___ Flies (6. Did you tie your own? 1 ___Yes 2 ___N[o]

4 ___ Combination

7. About how many trout did you catch on this most recent trip?

___ Trout caught

8. How many of these trout did you keep?

___ Trout kept

9. Did you use a fishing guide or outfitter on the Bitterroot?

1 ___ Yes 2 ___ No

10. Did you fish from shore, from a boat, or both?

1 ___ Shore 2 ___ Boat 3 ___ Both

11. How many other anglers were in your party?

___ Other anglers came with me

2. Was the Bitterroot the main (or only) river you fished on this trip, or did you fish other rivers? (Please check one)

main

1 ___ The Bitterroot river was the main (or only) river I fished on this trip away from home

2 ___ Fishing at other rivers was just as important as fishing on the Bitterroot on this trip.

3 ___ Fishing at other rivers was more important than fishing the Bitterroot this trip.

3. Was fishing the main purpose of your trip away from home when you fished the Bitterroot or did you make the trip for other reasons such as business or a family vacation?

reason

1 ___ Fishing was the main purpose of this trip

2 ___ Fishing was one of several reasons for making the trip

3 ___ The main purpose of this trip was not to fish, but for other reasons.

4. Was this your first visit to the Bitterroot?

1 ___ Yes

2 ___ No

15. If not, how many years have you been fishing the Bitterroot ?

___ Years

6. How many separate trips did you make from your home to the Bitterroot this year?

___ Separate trips from home this year

17. People fish for many reasons. We'd like to know some of the reasons you fished the Bitterroot this trip, to help us understand different types of anglers and their preferences.

Following is a list of possible reasons for fishing. Please check the box that says whether that reason was a very important reason, an important reason, not an important reason, or not at all important a reason you fished the Bitterroot this trip.

	1 Very Important	2 Important	3 Not very Important	4 Not at all Important	5
1. To catch wild trout	☐	☐	☐	☐	
2. To experience solitude	☐	☐	☐	☐	
3. To catch many trout	☐	☐	☐	☐	
4. To learn more about trout	☐	☐	☐	☐	
5. To get away from it all	☐	☐	☐	☐	
6. To catch large trout	☐	☐	☐	☐	
7. It's close to home	☐	☐	☐	☐	
8. To be outdoors	☐	☐	☐	☐	
9. To catch trout to eat	☐	☐	☐	☐	
10. To view the scenery	☐	☐	☐	☐	
11. Because of the special regulations	☐	☐	☐	☐	
12. To test my fishing skills	☐	☐	☐	☐	
13. To be with my family	☐	☐	☐	☐	
14. It's where my friends were going	☐	☐	☐	☐	
15. To get away from other anglers	☐	☐	☐	☐	
16. I've had good fishing here before	☐	☐	☐	☐	
17. To fish somewhere new	☐	☐	☐	☐	

18. Could you please look back over this list and circle the numbers of the three most important reasons you fished the Bitterroot?

. Based on your experience fishing the Bitterroot, do you feel that there are any major problems with how it is managed?

1 ___ Yes 1   2 ___ No 2   3 ___ Not sure 3

20. If you said yes, please check any of the following problems you feel exist on the river:

___ Too many anglers	___ Access not adequate
___ Too many boats	___ Poor fish habitat
___ Too few fish	___ Poor scenic quality
___ Fish are too small	___ Too much access
___ Water levels	___ Water quality

___ Other: ______________________

omitted   1 if checked
missing if Not

. About how many other anglers did you see while you were fishing the Bitterroot on this trip?

___ Other anglers seen while fishing the Bitterroot

. Was this number more than you expected to see, less than you expected to see, or about as many as you expected?

1 ___ More than I expected to see

2 ___ About as many as I expected to see

3 ___ Fewer than I expected to see

4 ___ I didn't have any expectations

. Did other anglers present affect your fishing?

1 ___ Yes   2 ___ No

24. If yes, please explain how:

missing here
complete
missing on 23

1

...

1 ___ Yes   2 ___ No

26. If yes, about how frequently do you plan to fish the Bitterroot? (please check one)

1 ___ As frequently as I do now

2 ___ More frequently than I do now

3 ___ Less frequently than I do now

4 ___ I'm not sure

27. How does the Bitterroot compare to other trout streams in Montana? (please check one)

1 ___ It's my favorite place to fish

2 ___ It's one of my favorite places to fish

3 ___ It's one of many places where I fish

4 ___ I prefer to fish other places

28. Are there any other rivers or streams in Montana that you feel provide a fishing experience comparable to the Bitterroot?

1 ___ Yes   2 ___ No

# of Possible subst.

29. If yes, please name them: numeric pertaining to the number on list

30. If you could not have fished the Bitterroot, where might you have fished instead?

Alpha
Subwa?

______________ Name of stream or river

31. About how far is it from your home to this alternative fishing location?

Sub dist

___ Miles

32. How does it compare to fishing the Bitterroot?

Blank no response & no subst. ?

PEOPLE PLACE ON FISHING THE BITTERROOT.

WE REALIZE YOU AREN'T USED TO CONSIDERING FISHING THIS WAY, BUT PLEASE THINK ABOUT IT AND GIVE US YOUR BEST ESTIMATE!

1. About how far is it from your home to where you fished the Bitterroot this trip?

_____ Miles (one-way)

2. How long did it take to travel from your home to the Bitterroot?

___ Hours (include any stops made en route)

3. If you drove, how many anglers were in the vehicle with you?

___ Other anglers

4. About how much did you personally spend on this trip? Include expenses such as gas and oil, food and beverages, any lodging or camping fees, car rentals, airfares, equipment purchased just for this trip, fishing access fees, and other trip expenses. If you can't recall the exact amount, please give your best estimate.

__________ Total amount I spent on this trip

9. Was this trip worth more than you actually spent? TRPEXP

___ Yes 1

___ No 2

6. If YES, would you still have made the trip if your share of the expenses had been $500 more?

___ Yes 1

___ No 2

7. What is the maximum increase in your actual trip cost you would have paid to fish the Bitterroot instead of having to fish elsewhere?

________ Dollars

8. If your answer was zero, could you briefly explain why? (mult proxies)

Coded

9. About how big would a trout you caught on this trip have to be before you would consider it to be large?

_______ Inches

10. How many large trout did you catch on this trip to the Bitterroot?

___ Large trout caught

CVM

11. Imagine that everything about this last trip were the same, except that your chance of catching a large trout was twice as great AND that your trip costs were $300 more than your actual costs. Would you still have made the trip under these circumstances? (Please check one)

1 ___ Yes, I would still have made the trip

2 ___ No, I would not have made the trip

12. What is the maximum increase in actual trip costs you would pay to double your chances of catching a large trout?

________ Dollars increase in trip cost

13. If your answer was zero, could you briefly explain why?

Coded

CVM

14. If you caught at least one trout, imagine that everything about this last trip were the same, except that you caught twice as many trout as you actually did AND that your trip costs were $400 more than your actual cost. Would you still have made the trip under these circumstances?

___ Yes, I would still have made the trip

___ No, I would not have made the trip

15. What is the maximum increase in actual trip costs you would pay to catch twice as many trout as you actually did?

________ Dollars increase in trip cost

16. If your answer was zero, could you briefly explain why?

Coded

1. In general, which <u>two</u> of the following management programs do you favor the most for managing Montana trout streams? (Please rank your top two choices)

if checked diff from Rank

___ Stocking rivers with hatchery trout

___ Protecting trout habitat

___ Special fishing regulations

___ Improving fishing access

___ Would need more information

0 if no Response
1 if 1st choice
2 if 2nd choice
3 if just checked

2. If restrictions are needed to increase the number of larger trout in a stream, which <u>two</u> of the following regulations would you prefer? (Please rank your top two choices)

___ Gear restriction (such as artificial lures only)

___ Reduce limit on number of trout kept

___ Reduce limit on size of trout kept

___ Shorten fishing season

___ Limit fishing access sites

___ Would need more information

Same as above

3. If special regulations are needed to increase the number of larger trout in a stream, which <u>two</u> of the following regulations would you prefer? (Please rank your top two choices)

___ Catch and release all trout

___ Keep only small trout

___ Reduce total limit

___ Slot limit (catch and keep trout under a minimum size and one trout over a maximum size)

___ Would need more information

Same as above

...ck ...gain in ...ged file

V. THESE LAST FEW QUESTIONS WILL HELP UNDERSTAND YOUR RESPONSES BY KNOWING SOME BASIC INFORMATION ABOUT YOU.

1. Where are you from? City: ______________ State: ______

2. What is your age? ________ Years

3. Are you: ___ Male ___ Female

4. Are you a member of any fishing, conservation, or sport organizations?

___ Yes ___ No

5. If so, which ones?

6. What is the highest year of formal education you completed?

1 ___ Some grade school
2 ___ Finished grade school
3 ___ Finished junior high school
4 ___ Finished high school
5 ___ Some college
6 ___ Finished college
7 ___ Some postgraduate work
8 ___ Finished postgraduate

7. If you had not gone fishing this trip, would you have been working instead?

___ Yes 1 ___ No 2

8. During the fishing season this year, were you: (check one)

1 ___ Employed full time
2 ___ Employed part time
3 ___ Unemployed
4 ___ Retired
5 ___ Homemaker
6 ___ Other: ______ Not coded

9. Please check your household's income before taxes last year:

1 ___ Under 5,000	5 ___ 20,000 - 24,999	9 ___ 40,000 - 49,000
2 ___ 5,000 - 9,999	6 ___ 25,000 - 29,999	10 ___ 50,000 - 74,999
3 ___ 10,000 - 14,999	7 ___ 30,000 - 34,999	11 ___ 75,000 - 100,00
4 ___ 15,000 - 19,999	8 ___ 35,000 - 39,999	12 ___ over 100,000

may use mean w/in Bracket or median

REBUTTAL EXHIBIT 3

Exhibit 4. Values per acre-foot.

Item	(Dollars/AF)		
(A) Hydropower values per acre foot.			
	Replacement power cost		
	50 mills[1]	75 mills	100 mills
Headwaters	69.16	103.74	138.32
Upper Missouri Above Canyon Ferry	65.16	97.74	130.32
Below Canyon Ferry	59.07	88.61	118.14
Marias/Teton	30.38	45.57	60.76
Middle Missouri	30.38	45.57	60.76
(B) Recreation[2]	July & Aug	Rest of Yr	Average[3]
Headwaters	60.67	14.62	50.37
Upper Missouri	25.27	6.39	11.73
Marias/Teton	5.81	1.63	4.33
Middle Missouri	5.81	1.63	4.07
(C) Summary of instream values for 75 mill power			
	Hydropower + Recreation average		
Headwaters Madison	154.11		
Headwaters, other	148.11		
Upper Missouri Above Canyon Ferry	109.47		
Below Canyon Ferry	100.34		
Marias/Teton	49.90		
Middle Missouri	49.64		

Exhibit 4 continued.

Item	(Dollars/AF)	
(D) Irrigation (all projects)	Average value	Range
(a) Gross benefits of DNRC; 40 mill power, 50% return flows	41.68	-27.39 - 398.49
(b) Gross benefits return flows at 21% for most sprinklers, 0% for some sprinklers, 43% for flood, actual use for GA-201, GA-46	25.55	-13.69 - 168.22
Net benefits		
(1) 50 mill power	-38.36	-105.23 - 99.22
(2) 75 mill power	-68.67	-147.13 - 78.69
(3) 100 mill power	-98.98	-189.03 - 58.16
	Dollars/AF	
(E) Municipal	590.00	

[1] Table K-2, DNRC EIS (June 1991).
[2] Corrected Table K-1.
[3] Based on Table 6-41, DNRC EIS p.229.

REBUTTAL EXHIBIT 4

Variable definitions for exhibits 7 and 8.

Variable	Definition
OBS	Observation number
CODE	DNRC code for reservation request
ID	sequential ID number added to table K-4, DNRC EIS
RETURN	Return flow dummy variable, 0=some return flows can be expected and 1=no return flows from project
VALUE	Consumptive value per acre foot from column A table K-4 DNRC EIS
VALUE2	Consumptive value (as above) adjusted for return flows
VALREC	Recreational value of instream flows
VALHY	Hydropower value of instream flows
REPLACE	Value of replacement power
NET	VALUE2 - (VALREC + VALHY + REPLACE)
DIVERSN2	Proposed level of water diversion adjusted for anticipated return flows
REC	Indicator for which subbasin proposed project is in and hence what recreational value of instream flows should be assigned
HYDRO	Indicator variable for which subbasin the proposed project is in and hence what hydropower value for instream flows should be assigned
ARSENIC1	Dummy for analysis of arsenic contamination, not used in final analysis
ARSENIC2	Dummy for analysis of arsenic contamination not used in final analysis
DIVERSN	Proposed level of water diversion from table 3-1 DNRC EIS
SPRINK	Dummy variable, 1=sprinkler irrigated, 0=flood irrigated
POWER	Estimated annual power usage of project in Kwh
FUEL	Estimated annual diesel usage of project in gallons

REBUTTAL EXHIBIT 5

```
oname missouri 'c:\sas2\missouri\';
ta missouri.main;
set missouri.irgate;

ET SPRINK=9 TO MISSING

 SPRINK=9 THEN SPRINK=.;

SSIGN DIVERSION LEVELS TO MUNICIPAL REQUESTS

 id=1 then diversn=6000;
 id=2 then diversn=645;
 id=19 then diversn=2550;
 id=21 then diversn=81;
 id=37 then diversn=202;
 id=62 then diversn=7071;
 id=63 then diversn=258;
 id=64 then diversn=10642;
 id=102 then diversn=467;
 id=123 then diversn=62;
 id=124 then diversn=100;
 id=136 then diversn=890;
 id=139 then diversn=302;
 id=156 then diversn=1322;
 id=159 then diversn=435;
 id=169 then diversn=482;
 id=193 then diversn=124;
 id=214 then diversn=60;
 id=233 then diversn=2906;
 ID=74 THEN DIVERSN=287;

ORRECT DATA ENTRY ERRORS

 rec=4 and hydro=2 then do;
:=2; hydro=4;
d;
 value=590 and rec=2 and hydro=2 then rec=1;

SSIGN USE CATEGORY 1=MUNICIPAL 2=IRRIGATION

 value=590 then use=1;else use=2;

SSIGN RECREATION AND HYDROPOWER VALUES TO MUNICIPAL AND IRR. REQUESTS

 value=590 then do;
if rec=1 then valrec=22.30;
if rec=2 then valrec=9.54;
if rec=3 then valrec=2.33;
if hydro=1 then valhy=69.16;
if hydro=2 then valhy=65.16;
if hydro=3 then valhy=59.07;
if hydro=4 then valhy=30.38;
d;
 rec=1 and valrec lt 1 then valrec=50.37;
 rec=2 and valrec lt 1 then valrec=11.73;
 rec=3 and valrec lt 1 then valrec=4.07;
 hydro=1 then valhy=69.16;
 hydro=2 then valhy=65.16;
 hydro=3 then valhy=59.07;
 hydro=4 then valhy=30.38;

TLE1 'SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWE
```

```
VALHY=VALHY*1.5;                * SETS POWER COST AT 75 MILLS
RUN=3;                          * SETS HOW RETURN FLOWS ARE TREATED
X=.075;                         * SETS POWER COST AT 75 MILLS

IF USE=2 THEN DO;

*IN RUN=1 RETURN FLOWS ARE 50%

IF RUN=1 THEN DIVERSN2=DIVERSN/2;

*IN RUN=2 RETURN FLOWS ARE 50% FOR FLOOD AND 0% FOR SPRINKLERS

IF RUN=2 THEN DO;
   IF SPRINK IN(1,.) THEN VALUE2=VALUE/2 AND DIVERSN2=DIVERSN;
   ELSE DIVERSN2=DIVERSN/2 AND VALUE2=VALUE;
END;
END;
IF USE=2 THEN DO;

*IN RUN=3 ADDITIONAL INFO ON % OF EXPECTED RETURNS IS ADDED

IF RUN=3 THEN DO;
   IF RETURN=0 AND SPRINK IN(1,.) THEN DO;
      VALUE2=(VALUE/2)*1.269; DIVERSN2=DIVERSN*.7875;END;
   ELSE DO;
      VALUE2=(VALUE/2)*1.739; DIVERSN2=DIVERSN*.575;END;
END;
END;
   IF RETURN=1 THEN DO;VALUE2=VALUE/2;DIVERSN2=DIVERSN;END;

*DIVERSION FOR MUNICIPAL REQUEST IS SET

IF USE=1 THEN DO; VALUE2=VALUE;DIVERSN2=DIVERSN;END;

*WATER INFO FOR 2 SPECICIC REQUESTS IS SET

IF CODE='GA46' THEN DO; VALUE2=(VALUE/2)*.813;DIVERSN2=123;END;
IF CODE='GA201' THEN DO; VALUE2=(VALUE/2)*.8442928;DIVERSN2=14508;END;

*CALCULATION OF REPLACEMENT POWER COST

IF POWER=. THEN POWER=0;
REPLACE=((POWER*1000)*(X-.04))/DIVERSN2;

* CALCULATION OF NET INDIVIDUAL AND GROSS VALUES

INSTREAM=VALREC+VALHY;
NET=VALUE2-INSTREAM-REPLACE;
IF NET GE 0 THEN PASS=1;
GREPLACE=REPLACE*DIVERSN2;
grec=valrec*diversn2;
ghydro=valhy*diversn2;
GVALUE=VALUE2*DIVERSN2;
GNET=GVALUE-GHYDRO-GREC-GREPLACE;

*OUTPUT OF CASE LEVEL RESULTS

count=1;
IF USE=2 ;
PROC PRINT;VAR CODE VALUE VALREC VALHY INSTREAM NET DIVERSN2;RUN;/*
```

```
AGGREGATION OF CASE LEVEL RESULTS

' NET GE 0 THEN CLASS=1;ELSE CLASS=2;
oc sort;by use CLASS ;

oc summary nway;
lass count;
ar gvalue grec ghydro GREPLACE PASS;
y use CLASS;
utput out=out1 sum=sumval sumrec sumhydro SUMREPL  SPASS;

MULTIPLYING AGGREGATED RESULTS BY NET PRESENT VALUE FACTOR

TA STUFF;
 SET WORK.OUT1;
IMREC=(SUMREC*22.109708);
IMHYDRO=(SUMHYDRO*22.109708);
IMVAL=(SUMVAL*22.109708);
IMGNET=(SUMGNET*22.109708);
IMREPL=(SUMREPL*22.109708);

OUTPUT OF FINAL RESULTS

oc print;
r sumval sumrec sumhydro SUMREPL  SPASS;
' use CLAss;
n;
```

S	CODE	VALUE2	VALREC	VALHY	REPLACE	NET	DIVERSN2
1	BR101	14.0250	50.37	97.74	13.0486	-147.134	11515.00
2	BR103	25.5800	11.73	97.74	5.2058	-89.096	5066.00
3	BR104	-13.6950	11.73	97.74	12.0859	-135.251	22491.00
4	BR106	22.5850	11.73	97.74	12.6140	-99.499	676.00
5	BR107	19.5550	11.73	97.74	12.2613	-102.176	278.00
6	BR108	25.1050	11.73	97.74	9.3094	-93.674	229.00
7	BR109	10.1600	11.73	97.74	16.5246	-115.835	258.00
8	BR11	26.8700	11.73	97.74	16.1235	-98.724	119.00
9	BR110	17.7000	11.73	97.74	15.9771	-107.747	467.00
0	BR111	4.4150	11.73	97.74	15.9862	-121.041	80.00
1	BR12	-13.3000	11.73	97.74	16.0890	-138.859	159.00
2	BR14	17.9350	11.73	97.74	17.1453	-108.680	746.00
3	BR28	20.3300	11.73	97.74	13.0751	-102.215	249.00
4	BR29	11.7035	11.73	97.74	17.6522	-115.419	48.30
5	BR34	43.3871	11.73	97.74	8.9130	-74.996	391.39
6	BR35	18.5591	11.73	97.74	16.6367	-107.548	391.39
7	BR38	58.6976	11.73	97.74	8.8930	-59.665	85.84
8	BR40	31.3000	11.73	97.74	13.2472	-91.417	126.00
9	BR41	32.8050	11.73	97.74	14.4330	-91.098	506.00
0	BR42	37.6005	11.73	97.74	9.8162	-81.686	63.79
1	BR44	18.1750	11.73	97.74	16.8383	-108.133	1243.00
2	BR5	17.5250	11.73	97.74	14.7222	-106.667	362.00
3	BR50	31.9725	11.73	97.74	13.6257	-91.123	469.35
4	BR52	32.1565	50.37	97.74	13.5333	-129.487	63.00
5	BS31	1.8527	4.07	45.57	0.0000	-47.787	58.28
6	BS32	7.8900	4.07	45.57	19.1152	-60.865	1506.00
7	BSS2	0.2300	4.07	45.57	20.0735	-69.484	44608.00
8	BUREC	18.9116	4.07	45.57	.	.	0.00
9	CH181	0.0000	.	.	0.0000	.	29.92
0	CH201	27.1550	4.07	45.57	0.0000	-22.485	77.00
1	CH21	45.2145	4.07	45.57	6.3831	-10.809	319.72
2	CH211	10.0505	4.07	45.57	0.0000	-39.590	300.82
3	CH371	1.4086	4.07	45.57	7.3333	-55.565	23.62
4	CH381	3.4700	4.07	45.57	13.6577	-59.828	1912.00
5	CH511	6.0300	4.07	45.57	24.1529	-67.763	1577.00
6	CH541	6.2625	4.07	45.57	0.0000	-43.377	29.14
7	CH551	33.9200	4.07	45.57	0.0000	-15.720	86.00
8	CH641	-6.4021	4.07	45.57	0.0000	-56.042	41.74
9	CHI10	23.5653	4.07	45.57	11.4112	-37.486	247.28
0	CHI21	29.1743	4.07	45.57	11.9060	-32.372	592.20
1	CHI22	25.6972	4.07	45.57	12.2148	-36.158	306.34
2	CHI30	32.0930	4.07	45.57	7.5604	-25.107	506.36
3	CHI40	30.8938	4.07	45.57	0.0000	-18.746	228.37
4	CHI51	25.0627	4.07	45.57	0.0000	-24.577	192.15
5	CHI52	9.6507	4.07	45.57	0.0000	-39.989	200.81
6	CHI53	34.2503	4.07	45.57	0.0000	-15.390	227.59
7	CHI61	26.4840	4.07	45.57	0.0000	-23.156	194.51
8	CHI72	26.4840	4.07	45.57	0.0000	-23.156	84.26
9	CHI74	24.3585	4.07	45.57	0.0000	-25.282	83.47
0	CHI80	29.4218	4.07	45.57	0.0000	-20.218	96.07
1	CHS1	0.3000	11.73	45.57	22.8897	-79.890	3117.00

OBS	CODE	VALUE2	VALREC	VALHY	REPLACE	NET	DIVERSN2
52	CHS3	13.2700	4.07	45.570	6.3990	-42.769	19654.00
53	CHS5	14.5650	4.07	45.570	27.5071	-62.582	9058.00
54	CHS6	-2.3100	4.07	45.570	19.7476	-71.698	35814.00
55	CS101	50.5950	11.73	88.605	5.7822	-55.522	239.40
56	CS102	35.3734	11.73	88.605	10.6452	-75.607	146.47
57	CS111	42.0483	11.73	88.605	10.6533	-68.940	629.21
58	CS159	21.3446	11.73	45.570	7.4074	-43.363	89.77
59	CS171	17.6201	11.73	88.605	9.5873	-92.302	55.13
60	CS21	0.9010	11.73	88.605	0.0000	-99.434	110.25
61	CS231	3.7753	11.73	88.605	8.6667	-105.226	20.47
62	CS241	24.9930	11.73	88.605	9.7497	-85.092	149.62
63	CS251	17.9350	11.73	88.605	10.8914	-93.291	245.00
64	CS252	26.8711	11.73	88.605	9.2006	-82.665	60.64
65	CS271	33.6666	11.73	88.605	9.9138	-76.582	105.52
66	CS31	9.9363	11.73	88.605	8.6572	-99.056	74.02
67	CS32	5.7866	11.73	88.605	9.1341	-103.682	68.51
68	CS331	24.3331	11.73	88.605	8.8421	-84.844	44.89
69	CS351	32.7656	11.73	88.605	9.2550	-76.824	290.59
70	CS42	33.6583	11.73	45.570	3.3252	-26.967	254.72
71	CS43	40.7412	11.73	45.570	11.6602	-28.219	471.71
72	CS44	27.8545	11.73	45.570	0.0000	-29.445	65.36
73	CS471	14.7331	11.73	88.605	13.5344	-99.136	99.22
74	CS51	4.7905	11.73	88.605	8.6102	-104.155	139.39
75	CS52	15.2343	11.73	88.605	11.0667	-96.167	70.87
76	CS541	39.2629	11.73	88.605	8.8374	-69.909	54.34
77	CS61	44.7513	11.73	88.605	4.8780	-60.462	128.36
78	CS62	26.6744	11.73	88.605	7.9496	-81.610	111.04
79	CS63	20.7735	11.73	88.605	2.4048	-81.966	101.59
80	CS64	21.2938	11.73	88.605	9.6133	-88.655	78.75
81	CS71	15.7356	11.73	88.605	14.7619	-99.361	33.07
82	CSI101	47.9872	11.73	88.605	5.8515	-58.199	175.61
83	CSI102	35.9000	11.73	88.605	9.0708	-73.506	134.66
84	CSI103	43.2348	11.73	88.605	7.2428	-64.343	438.64
85	CSI11	33.2288	11.73	88.605	9.6973	-76.803	226.01
86	CSI111	28.2670	11.73	88.605	10.3883	-82.456	663.86
87	CSI12	23.6288	11.73	88.605	8.4364	-85.143	86.62
88	CSI120	13.1849	11.73	88.605	10.2757	-97.426	104.74
89	CSI21	29.7834	11.73	88.605	10.3949	-80.946	123.64
90	CSI22	33.7808	11.73	88.605	10.0859	-76.640	128.36
91	CSI23	22.3090	11.73	88.605	10.4167	-88.443	113.40
92	CSI31	23.2671	11.73	88.605	7.3517	-84.420	85.84
93	CSI32	9.9426	11.73	88.605	15.2403	-105.633	67.72
94	CSI33	13.6481	11.73	88.605	11.6089	-98.296	118.12
95	CSI34	19.0604	11.73	88.605	8.7967	-90.071	129.15
96	CSI35	28.2670	11.73	88.605	5.7022	-77.770	199.24
97	CSI41	23.9207	11.73	88.605	9.7284	-86.143	141.75
98	CSI51	35.4685	11.73	88.605	11.0151	-75.882	196.87
99	CSI52	46.5533	11.73	88.605	6.1105	-59.892	551.25
100	CSI71	18.9525	11.73	88.605	14.5814	-95.964	155.92
101	CSI81	20.3865	11.73	88.605	9.6111	-89.560	75.60
102	CSI82	19.9043	11.73	88.605	7.8021	-88.233	107.89

OBS	CODE	VALUE2	VALREC	VALHY	REPLACE	NET	DIVERSN2
103	CSI83	29.612	11.73	88.605	7.3580	-78.081	77.96
104	CSI91	18.972	11.73	88.605	8.2102	-89.574	101.59
105	CSI92	17.119	11.73	88.605	6.3951	-89.611	56.70
106	CSS200	-0.210	11.73	88.605	26.3816	-126.927	11885.00
107	FE111	0.400	4.07	45.570	0.0000	-49.240	19.69
108	FE141	40.919	4.07	45.570	0.7514	-9.473	295.31
109	FE161	20.710	4.07	45.570	4.6437	-33.574	205.54
110	FE401	19.430	4.07	45.570	6.2836	-36.494	64.00
111	FE41	0.755	4.07	45.570	19.2330	-68.118	103.00
112	FE42	-4.441	4.07	45.570	0.0000	-54.082	34.65
113	FE431	27.049	4.07	45.570	11.0280	-33.619	84.26
114	FE561	0.000	4.07	45.570	18.0204	-67.660	382.00
115	FE671	31.167	4.07	45.570	13.8550	-32.328	589.05
116	FE672	39.218	4.07	45.570	7.8749	-18.296	349.65
117	FE673	32.740	4.07	45.570	8.1900	-25.090	103.16
118	FE81	0.500	4.07	45.570	9.4787	-58.619	403.00
119	FEI10	36.490	4.07	45.570	0.0000	-13.150	151.20
120	FEI20	6.592	4.07	45.570	0.0000	-43.048	206.32
121	FEI30	9.625	4.07	45.570	0.0000	-40.015	70.87
122	FEI40	17.906	4.07	45.570	23.6055	-55.340	1253.70
123	FEI50	5.063	4.07	45.570	30.3452	-74.922	5812.54
124	GA102	39.015	50.37	97.740	5.7067	-114.801	196.87
125	GA110	12.766	50.37	97.740	7.1032	-142.447	88.99
126	GA124	72.193	50.37	97.740	9.5000	-85.417	44.10
127	GA13	69.345	50.37	97.740	11.7065	-90.472	83.47
128	GA130	16.491	50.37	97.740	8.4474	-140.067	119.70
129	GA14	46.001	50.37	97.740	10.6400	-112.749	39.38
130	GA143	25.323	50.37	97.740	12.1857	-134.973	373.27
131	GA151	60.836	50.37	97.740	14.7800	-102.054	40.16
132	GA201	168.221	50.37	97.740	38.3878	-18.277	14508.00
133	GA24	51.363	50.37	97.740	9.7139	-106.461	114.97
134	GA35	50.214	50.37	97.740	14.5401	-112.436	40.82
135	GA40	35.386	50.37	97.740	14.1807	-126.905	59.06
136	GA41	42.067	50.37	97.740	12.4089	-118.452	78.75
137	GA44	69.662	50.37	97.740	10.1308	-88.579	137.81
138	GA46	53.312	50.37	97.740	4.5415	-99.339	123.00
139	GA79	53.932	50.37	97.740	9.8721	-104.050	400.84
140	GA81	38.546	50.37	97.740	6.4422	-116.006	307.12
141	GA92	28.368	50.37	97.740	12.3181	-132.060	80.32
142	GL11	23.195	4.07	45.570	9.9350	-36.380	472.00
143	GL201	22.607	4.07	45.570	0.0000	-27.033	126.50
144	GL221	26.975	4.07	45.570	7.9515	-30.616	579.00
145	HI269	4.830	4.07	45.570	18.6477	-63.458	2708.00
146	JB111	20.304	4.07	45.570	4.0780	-33.414	103.16
147	JB21	16.357	4.07	45.570	7.2642	-40.547	21.26
148	JB231	12.696	4.07	45.570	11.2077	-48.151	72.45
149	JB232	12.696	4.07	45.570	11.2077	-48.151	72.45
150	JB261	18.997	4.07	45.570	0.0000	-30.643	44.10
151	JB281	39.432	11.73	45.570	0.0000	-17.868	16.10
152	JB309	1.903	4.07	45.570	7.2000	-54.936	35.44
153	JB61	29.821	11.73	45.570	7.8545	-35.333	216.56

S	CODE	VALUE2	VALREC	VALHY	REPLACE	NET	DIVERSN2
4	JBI2	15.082	4.07	45.570	18.5313	-53.089	1271.81
5	JBS3	47.600	4.07	45.570	6.9039	-8.944	315.79
6	JV17	99.836	50.37	97.740	6.5399	-54.814	74.17
7	JV18	94.071	50.37	97.740	5.5503	-59.589	43.70
8	JV201	16.535	50.37	97.740	9.8471	-141.422	11022.00
9	JV202	42.710	50.37	97.740	12.1251	-117.525	12177.00
0	JV203	21.710	50.37	97.740	8.5105	-134.911	5313.00
1	JV204	46.858	50.37	97.740	5.8511	-107.103	553.61
2	JV25	62.428	50.37	97.740	8.5198	-94.201	46.46
3	JV55	39.428	50.37	97.740	8.3981	-117.080	151.20
4	JV63	50.132	50.37	97.740	10.9360	-108.914	77.96
5	JV80	79.029	50.37	97.740	6.3686	-75.450	38.53
6	JV81	56.382	50.37	97.740	17.0259	-108.754	125.21
7	JV95	31.357	50.37	97.740	3.5807	-120.334	1377.34
8	LC11	18.546	11.73	88.605	8.0222	-89.811	63.00
9	LC131	16.310	11.73	88.605	7.0788	-91.104	151.00
0	LC210	26.363	11.73	88.605	9.2763	-83.248	116.55
1	LC251	3.000	11.73	88.605	6.7696	-104.105	281.00
2	LCI10	14.900	11.73	88.605	13.9773	-99.412	185.00
3	LCI20	33.032	11.73	88.605	0.0000	-67.303	279.56
4	LI161	26.190	4.07	45.570	12.4591	-35.909	1043.00
5	LI162	23.200	4.07	45.570	15.0363	-41.476	690.00
6	LI261	7.765	4.07	45.570	14.1763	-56.051	3241.00
7	LI262	10.240	4.07	45.570	17.5967	-56.997	1401.00
8	LI263	14.900	4.07	45.570	15.1775	-49.918	269.00
9	LI91	4.665	4.07	45.570	19.0002	-63.975	503.00
0	LM20	135.807	4.07	45.570	7.4761	78.691	4686.25
1	MEI11	9.240	11.73	88.605	10.1211	-101.216	1247.00
2	MEI12	21.243	11.73	88.605	11.2282	-90.320	206.32
3	MEI20	9.650	11.73	88.605	11.1134	-101.798	303.00
4	PO171	34.630	4.07	45.570	5.9292	-20.939	252.00
5	PO211	17.131	4.07	45.570	12.2667	-44.775	102.37
6	PO251	19.669	4.07	45.570	6.6383	-36.609	74.02
7	PO271	22.988	4.07	45.570	0.0000	-26.652	88.20
8	PO411	18.305	4.07	45.570	12.9272	-44.262	200.81
9	PO421	16.790	4.07	45.570	12.9014	-45.751	425.00
0	PO91	2.000	4.07	45.570	7.6761	-55.316	117.00
1	POI10	36.357	4.07	45.570	0.0000	-13.283	556.76
2	TE101	35.938	4.07	45.570	0.0000	-13.702	151.20
3	TE181	29.587	11.73	88.605	11.0840	-81.832	348.86
4	TE183	17.350	11.73	88.605	14.0900	-97.075	1353.00
5	TE281	10.412	4.07	45.570	0.0000	-39.228	84.26
6	TE282	14.194	4.07	45.570	10.4936	-45.940	163.80
7	TE321	44.764	4.07	45.570	6.1704	-11.046	729.23
8	TE361	26.014	4.07	45.570	8.6926	-32.318	256.72
9	TE401	10.500	4.07	45.570	4.9728	-44.113	380.00
0	TE411	18.426	4.07	45.570	0.0000	-31.214	92.14
1	TE571	20.390	11.73	88.605	8.8994	-88.844	1593.00
2	TE581	33.032	4.07	45.570	7.3191	-23.927	233.89
3	TE591	73.037	4.07	45.570	3.8610	19.536	1968.75
4	TE81	3.008	4.07	45.570	7.5979	-54.230	16.54

OBS	CODE	VALUE2	VALREC	VALHY	REPLACE	NET	DIVERSN2
205	TEI10	20.2050	4.07	45.570	10.4423	-39.8773	358.00
206	TEI100	24.3775	11.73	88.605	0.0000	-75.9575	136.24
207	TEI20	15.6468	4.07	45.570	0.0000	-33.9932	187.42
208	TEI30	19.3950	4.07	45.570	9.8122	-40.0572	3194.00
209	TEI40	34.1551	4.07	45.570	5.4215	-20.9064	99.22
210	TEI50	26.8330	4.07	45.570	10.2429	-33.0499	371.70
211	TEI60	27.4041	4.07	45.570	12.8207	-35.0566	1185.19
212	TEI70	14.3016	4.07	45.570	12.9341	-48.2724	472.50
213	TEI80	33.5651	11.73	88.605	0.0000	-66.7700	196.87
214	TEI90	16.9650	11.73	88.605	0.0000	-83.3700	119.00
215	TO211	-1.3500	4.07	45.570	22.2072	-73.1972	1476.00
216	TO221	14.1430	4.07	45.570	10.5418	-46.0388	120.49
217	TO341	24.5100	4.07	45.570	9.3259	-34.4559	488.00
218	TO342	8.9500	4.07	45.570	15.1785	-55.8685	561.00
219	TO421	4.0000	4.07	45.570	0.0000	-45.6400	112.00
220	VAS1	8.1650	4.07	45.570	9.1533	-50.6283	92000.00

REBUTTAL EXHIBIT 7

EXHIBIT 11

Summary of Corrections to DNRC Draft EIS on Missouri Basin Water Reservation (June 1991) to Achieve Valid Public Interest (Benefit-Cost) Analysis

Issue	Correctly Handled In: Site specific[1] analysis	Correctly Handled In: Aggregate[2] analysis	Effect on Results
1. Arithmetic	NA	No	Wrongly indicates "combination" alternative with highest net benefits
2. Replacement cost of power included	No	Yes	Overstate irrigation benefits at project level
3. Sensitivity shown, of hydropower, replacement costs to 50 mill and 100 mill power	No	No	Only 50 mill overstates range of irrigation net benefit.
4. Instream use net benefits shown and efficient allocation identified	No	No	Net benefits of all alternatives not compared
5. Include effects upstream withdrawals downstream for:			
-hydropower	Yes	Yes	
-recreation	No	No	Understate recreation loss and overstate irrigation net benefit

[1] Montana DNRC Draft EIS, Table K-4

[2] Id. Tables S-1, S-2

6. Irrigation return flow assumption consistent with project-level assumption of 50% return			
-hydropower	Yes	N/A	
-recreation	No	N/A	Overstate recreation loss by factor of 2
7. Return flow assumption consistent with DNRC hydrology model	No	No	Understates hydro-power and rec. loss by a factor of about 1.58
8. Unquantified costs of consumptive withdrawals to water quality and Fish and Wildlife uses noted in summary	No	No	Inconsistent with ARM 36.16.107B public interest criteria and overstates consumption use

different alternatives for water use. The text of the table indicates there are at least three explanatory footnotes. These footnotes, which presumably provide insights into the construction of the estimates, are not included as part of the exhibit. Further, on p. 9 of his direct testimony, Prof. Duffield refers to the values of municipal withdrawals shown in exhibit 4. Exhibit 4 contains estimates of the values of hydropower, recreation, and irrigation, but does not contain estimates of the value of municipal uses.

- Exhibits 7, 8, and 9 appear to be the computer output and computer code that are the basis for Prof. Duffield's estimation of the efficient allocation of water on individual projects. None of these exhibits contain variable definitions and Prof. Duffield's direct testimony contains only a very brief discussion of these exhibits. A much more detailed explanation of these exhibits is required for an evaluation of his approach.

II. SPECIFIC COMMENTS, QUESTIONS AND REQUESTS CONCERNING THE DIRECT TESTIMONY OF JOHN DUFFIELD

PAGE	COMMENT/QUESTION/REQUEST
3	In Prof. Duffield's calculation of the present value of net benefits associated with his estimated efficient allocation of water, he uses a discount rate of 4.3%. Clearly, the appropriate discount rate to use is a topic that has been widely debated among economists and policy makers. What effect does the use of different discount rates have on his estimated net benefits?
6	This discussion is unclear. Did Prof. Duffield not determine the efficient use on a project-by-project basis? Why did he have to worry about "aggregation"?
8	Prof. Duffield appears to have assumed in his calculations that the value per acre foot for a given use is the same for all of the reservation. For example, if an irrigator requested a reservation of 100 acre feet, Prof. Duffield seems to assume that the value of the 1st acre foot and the 100th acre foot were the same. As indicated in section I of this document (see discussion of FLAW #2), this assumption is flawed. Further, it is not clear whether the value per acre foot used by Prof. Duffield is a marginal value or an average value.
8	Prof. Duffield needs to elaborate on his second step. What does he mean by "the amounts of water that would be applied to each beneficial use in a given reservation"? Did he, for example, use the DFWP instream flow requests

shown in table 3-2 (pp. 23-28) of the DNRC Draft EIS as the amounts of water to be applied to instream flow use? Because Prof. Duffield does not demonstrate anywhere in his testimony or the accompanying exhibits what quantities (acre feet) he used for individual projects, it is not possible to determine with certainty how he obtained his reported estimates.

5) 8 In his third step, Prof. Duffield says that to calculate his estimates of the dollar value of the benefits for each use, he "multiplied the values per acre-foot of water times the acre-foot quantities at issue". Were the "acre-foot quantities at issue" the quantities specified in the reservation requests? Again, this is unclear.

6) 8 For irrigation reservation requests, when calculating the cost of the value of electric energy lost, did Prof. Duffield assume that an acre-foot diverted represented one less acre-foot available for generating electric energy?

7) 8 In his discussion of the value of lost hydropower, Prof. Duffield uses the cost of replacing that power as his estimate of value. There is a problem with this approach. The actual social cost of a unit of lost hydropower is the difference between the marginal cost of electricity from the alternative source and the marginal cost of electricity from hydropower.

8) 9 Where are the footnotes for Exhibit 4?

9) 9 In Exhibit 4, how are the average recreation values calculated?

0) 9 On the second page of Exhibit 4, what do the two columns of numbers represent? These columns have no labels.

1) 9 In Prof. Duffield's discussion of Exhibit 4 in the text, is he suggesting that the average recreation values he obtained (e.g., 50.37 for the Headwaters) are comparable to the fees charged at Nelson's Spring Creek and Red Rocks River?

12) 9 At the bottom of p. 9, Prof. Duffield discusses how the average value of a municipal diversion might be calculated using the values in Exhibit 4. Exhibit 4 doesn't contain any values for municipal diversions. Again such information is necessary to evaluate Prof. Duffield's analysis.

13) 9 Are the values in Exhibit 4 in units of dollars per acre foot <u>per year</u>?

4) 11 Prof. Duffield goes through considerable discussion of the efficiency of different irrigation systems. He then suggests that many of the projects are distant from the river where the diversion occurs, that it will take many years

before there will be any return flows, and that "In a present value setting, it is appropriate to take these return flows at zero." Does it take 70 years for there to be return flows? Did he make this assumption for all of the irrigation projects? If not, then which ones?

5) 12 Prof. Duffield says that "Where there are competing uses for water, it is most convenient to base the analysis on the consumptive use project water reservation amount." His immediately preceding statement suggests that at this point in his testimony, he is referring to his approach to determining the values of the consumptive use reservations. Is this interpretation correct?

6) 13 In many cases, the DFWP instream flow reservation request is in competition with more than one consumptive use reservation request from Conservation Districts. In such a case, when Prof. Duffield calculates the value of the instream flow and the irrigation reservation requests, does he compare the total value of all the competing irrigation projects with the single instream flow request? Or did he compare each competing irrigation request with the instream flow request? In his calculations, it is again unclear whether Prof. Duffield assumes that the entire reservation request will be available each year.

7) 14 In exhibit 6, what is the difference between "replacement power" and "foregone hydro generation"? Also, it is unclear from this exhibit whether the values presented are annual flow values or discounted values of future benefits and costs.

17 Did Prof. Duffield attempt to obtain any information on market prices for irrigation water? While he goes to considerable lengths to try to "validate" his estimates of recreation values, he seems to make no effort to "validate" his estimates of the value of water in irrigation uses. It is important to keep in mind that Prof. Duffield's estimates of irrigation water values are constructed artificially from technical information. It is entirely possible that these values are not accurate. The prices paid for farmland (which include the value of the water rights that accompany the land), may well be based on factors other than the commercial profitability of farming operations. The "style of life" that goes with the purchase of a farm may have considerable value.

17 What does Prof. Duffield mean by his statement that "Alternatively, perhaps these aggregate market effects fit better under the criteria of 'need'"?

17 What are the distinguishing characteristics of the two projects LM-20 and TM-591 that make them so valuable?

18 Prof. Duffield needs to provide us with definitions of and sources for the variables in exhibits 7 and 8. Further discussion of exhibits 7-9 is also required for us to determine how he obtained his estimates. Expecting someone else to be able to decipher his computer code with no accompanying

discussion of the code is ludicrous.

29 Prof. Duffield seems to suggest that the price at Nelson's Spring Creek may represent a quality differential rather than a difference in the value of the experience. Does this imply that an increase in quality does not increase the value of the experience? Also, given that the owners of Nelson's Spring Creek sometimes allow six rods per day, it is unlikely that the quality differential is due to lower congestion (as suggested by Prof. Duffield).

31 How good is the statistical fit between the actual and predicted values shown in Exhibit 22?

32 Why does Prof. Duffield expect the CVM estimates to be slightly smaller than the TCM estimates? In exhibit 23, for ten of the seventeen streams, the TCM estimates are smaller than the CVM estimates. Is this a problem? If not, why not?

32 Also, why are the differences between the CVM and the TCM estimates "likely to be small for goods like recreation"? In exhibit 23, the average difference between the TCM and CVM estimates is 29% and several of the estimates differ by 40% or more. Are these differences large enough to cause concern? If not, why not?

32 Other questions on exhibit 23 include the following:

- What is the definition of a trip?
- Is the CVM estimate for the Madison ($228) derived from exhibit 22? Given the small number of bid values in exhibit 22 in excess of $228 and the low probability of a "yes" response for these bid values, the estimate of $228 seems too high.
- How exactly are these values "derived from Duffield and Allen"?
- Why are the CVM values expressed in 1985 dollars and the TCM values expressed in 1986 dollars? How would conversion of these values to the same base year affect the values in this table and the test results reported in exhibit 24?

32 The study by Duffield and Allen (DFWP Exhibit #8) is described as a study of 17 of Montana's better trout streams. There are 283 DFWP applications. It is unclear whether most of these applications are for streams of lower quality than the streams for which value estimates are derived in the Duffield and Allen study. If many of the 283 DFWP applications are for lower quality streams, then are not Prof. Duffield's estimates of the value of recreation biased upward?

32 As Prof. Duffield indicates, the purpose of the projects that resulted in DFWP Exhibits 7 and 8 was to "estimate average willingness to pay . . . under current conditions". To what extent does Prof. Duffield use these estimates to estimate values under very different conditions? That is, the applications under consideration have the potential to have major impacts on the entire Upper Missouri River Basin.

33 In exhibit #24, Prof. Duffield shows the results of a test of the null hypothesis that there is no correlation between the TCM and CVM estimates. The question being asked, however, is whether the estimates are the same. Can Prof. Duffield use his data to test the null hypothesis that the estimates are the same? If so, then what is the result? The p-values listed in this exhibit suggest that this null hypothesis may also be rejected.

33 Why does Prof. Duffield pick 80 observations as the level for splitting the sample? Are his results sensitive to splitting sample size at 50 or 100 observations?

34 What does Prof. Duffield mean by the phrases "fair consistency" and "quite similar"?

35 What is Exhibit Rec-8? No such exhibit seems to accompany this testimony.

36 Is the "study undertaken in 1989 for DNRC" one of the DFWP exhibits that accompany this testimony?

37 Prof. Duffield says that "This model, plus a baseline recreational value estimate, can be used to compute marginal recreational values per acre-foot of stream flow." Prof. Duffield needs to explain just how he did this computation.

38 Why are the recreational values per acre-foot in exhibit 32 (table 6-40) different from the values per acre-foot shown in exhibit 4?

38 What is the "Combination" alternative in exhibit 32 (tables 6-41 and 6-42)?

35 Prof. Duffield indicates that the estimated net economic value of river-related trips in the Upper Missouri River Basin is between $110 and $175 million. He then states that "one can be 95% sure that the true value is within this range." It is important to note that this confidence level only applies if the underlying methods and implicit assumptions are appropriate. It is also important to keep in mind that although these estimates seem large, they are not particularly relevant for the issue being addressed in Prof. Duffield's

testimony.

35 Does Prof. Duffield think that it would be appropriate to compare the estimates in exhibit 25 (table 38) to the prices charged at Nelson's Spring Creek?

35 In exhibit 25, what do the numbers in table 37 represent in terms of the demand curve for a typical site??

35 In the survey conducted in DFWP Exhibit #8, Prof. Duffield finds a few people who say they would pay $500 more for one trip to a particular Montana river or stream. What implicit assumption about the condition of other fisheries was made when fishermen answered this question? Given the surplus of other high quality fishing streams in Montana, it difficult to believe anybody would pay $500 to fish a particular stream if substitute streams are still available at a zero access price. There is a distinction between the value of fishing at a particular site and the value of fishing in general -- the latter is probably much higher than the former. How does Prof. Duffield know that he is indeed getting estimates of the former?

36 Does Prof. Duffield have any information on either the short run or the long run relationship between fish stocks and water levels?

37 Prof. Duffield indicates that his estimated model of the relationship between changes in visitation and changes in flow levels "plus a baseline recreational value estimate, can be used to compute marginal recreational values per acre-foot of stream flow." It is not clear exactly how Prof. Duffield does this. Does he divide his baseline recreation value by the total acre feet of stream flow to obtain value per acre foot? Or does he use some other approach? Is the estimate of the value per acre foot obtained by Prof. Duffield a marginal or an average value?

37 Rather than go through this complicated approach of combining the results from two separate studies, why did Prof. Duffield not include a question like "How would an X% change in the river flow affect the maximum bid you would pay?" in the survey used in DFWP Exhibit #8?

38 In exhibit 32 (table 44) what is the appropriate interpretation of the numbers? How, for example, does one interpret the value $50.28? Is it the marginal value per year of an additional acre foot of flow throughout the entire basin during July and August to all fishermen on the river basin? Or is it something else? Exactly how are these numbers calculated? What was used for a baseline recreational value? Also, what do the 50%, 75%, 100% represent? They are not described adequately either in this testimony or in DFWP Exhibit #9 (pp. 76-81).

45 39 In exhibit 32 (table 6-41) why do instream flow reservations result in reductions in stream flows?

46 39 DFWP Exhibit 9, pp 43-45 does not seem to contain the comparison of values per acre foot indicated by Prof. Duffield.

The Duffield testimony contains a large amount of information and a variety of empirical estimates presented primarily through numerous exhibits. To determine the validity of the information and estimates presented in the Duffield testimony it is critical that we be able to understand how they were obtained. To this point, we have found it almost impossible, using the information provided, to determine how some of Prof. Duffield's estimates were obtained. Answers to the above questions will make it possible to evaluate the estimates presented in his testimony.

III. COMMENTS AND QUESTIONS CONCERNING DFWP EXHIBITS 8 AND 9 ACCOMPANYING THE DIRECT TESTIMONY OF JOHN DUFFIELD

DFWP EXHIBIT #8

- A copy of the fishing survey used in this study is required before this study can be evaluated in detail.

- What sort of introductory comments were made by the people in the field who administered the survey used in this report? Did the people being surveyed have any idea of the purpose of this survey?

- Did the survey (which is not included with this report) specify the conditions of other streams and rivers in the region?

- There are a number of widely acknowledged problems with survey approaches like the one used in this study. Types of biases that have been discussed in the literature include hypothetical bias, strategic bias, payment vehicle bias, starting point bias, information bias, and interviewer bias What approaches were taken in this study to reduce or eliminate these potential biases?

DFWP EXHIBIT #9

(51) - What sort of introductory comments were made by the people in the field who administered the survey used in this report? Did the people being surveyed have any idea of the purpose of this survey?

2) - It appears that the survey used in this report did not specify the conditions of other streams and rivers in the region. Is this correct?

) - On p. 71, Prof. Duffield indicates that 40% of the respondents said they would have made the trip regardless of the water level. These observations were then dropped from the sample. What would be the effects on the estimated model of including the observations in the sample? Would this reduce the estimated recreation value per acre foot? By how much?

4) - On p. 73, what proportion of the predictions from the OLS regressions were less than zero or greater than one?

5) - On p. 75 (table 41), how many degrees of freedom are there in these regressions? Is it not possible to get estimates at a less aggregated level? Also, why isn't the actual level of the flow included as an explanatory variable in this regression?

56) - On p. 79 (table 43), how does Prof. Duffield get "Nonresident" estimates for three subbasins? Table 41 suggests that he only ran two regressions for nonresidents. How did he get these estimates?

7) - On pp. 79-80 (tables 42-45), what do 50%, 75%, and 100% represent?

EXHIBIT 9. RESPONSE TO RUCKER COMMENTS AS NUMBERED IN EXHIBIT 8.

1. We have not computed this sensitivity as it would entail reestimating Dan Dodds' model.

2. We did determine efficient use on a project by project basis. We do not "worry" about aggregation but present the results by way of providing an overview.

3. As our discussion of Rucker's issue 2 indicates, Flaw #2 is flawed. When values are constant, average and marginal are equal.

4. Duffield Direct Exhibit 7 provides the quantities used for the cases with competing uses. The diversion amounts are labeled DIVERSN2 in this exhibit and are derived from DNRC DEIS Table 3-1. The reservation amounts for the DFWP requests are based on Tables K-3 and K-5 in the DNRC DEIS. The noncompeting amounts are aggregated at the sub-basin level and reported in Duffield Direct Exhibit 10.

5. Yes.

6. No.

7. Good point. We are assuming that the marginal cost of electricity from hydropower is negligable.

8. See Exhibit 3 this testimony.

9. See Duffield Direct-9 and -38. The estimates come from Table 6-40 in Duffield Direct Exhibit 32.

10. See Exhibit 3 this testimony.

11. These are not strictly comparable in terms of the relevant economic measures.

12. See Duffield Direct-12 and Exhibit 3 this testimony.

13. Yes.

14. We do not know if it takes 70 years. We make this assumption (zero return flows) for the projects coded "1" under the RETURN variable in Duffield Direct Exhibit 8.

15. Yes.

16. The competing irrigation request is compared to the value for recreation at the sub-basin level. It is assumed that the reservation request is available each year, both for irrigation and instream flow.

17. These are discounted values. Replacement power is defined DNRC DEIS pp. 232-233. Foregone hydro generation is the value of hydro generation lost due to reduced instream flows.

18. No.

19. Is there a "need" for increased alfalfa production when many farm programs are designed to reduce agricultural production, though these programs are not all aimed at alfalfa production?

20. These were among the projects that were not typical irrigation projects.

21. See Exhibit 3 this testimony.

22. I would expect that an increase in quality would increase the value of the experience. I have the impression that six rods per day is experienced as "uncongested" by these anglers.

23. We have estimated the deviance (a goodness of fit statistic) for this model to be 27.2 with a P-value of .35 based on a chi-square distribution with degrees of freedom equal to the number of bid levels minus 2.

24. Usual relationship of Hicksian willingness to pay measure and ordinary consumer surplus. This may be a problem, depending on the precision of the estimates.

25. Expect small income effects. These differences are not surprising given the sample sizes.

26. A trip is a possibly multi-day event that is presumed to begin and end at the usual place of residence and include time at the given recreational site. No. This is a truncated mean as listed in Table 26 of Duffield and Allen; the procedure is described in the latter report. The year dollars are TCM 1985 and CVM 1986 corresponding to the years of survey. We have not investigated the effect of using same year dollars.

27. We do not use DFWP Exhibit 8 in our estimated instream flow values.

28. We have not used these estimates under very different conditions.

29. There are several ways to test whether the estimates are the same across sites. One approach is to use a paired t-test on the differences. The mean difference is 5.00 and the t-statistic with 16 degrees of freedom is .473 with a P-value of .643. Note that the ratios of the CVM and TCM values are also shown in Duffield Direct Exhibit 24. One can do a t-test for the null hypothesis that the ratio is one. The mean ratio is 1.010 with a t-statistic of .11, accordingly one cannot reject the null hypothesis in either of these tests.

30. We have not investigated this issue.

31. The cash experiments for willingness to accept differed by about 60%, with cash being lower. The willingness to pay experiments were within 10% for some cases. Quite similar is within 20%.

32. Reference is to Exhibit 26, specifically Table 4-43.

33. DFWP Exhibit 9.

34. See DFWP Exhibit 9.

35. The values in Exhibit 4 are based on aggregating instream values (from Table 6-40) over all subbasins below the subbasin in question.

36. See DNRC DEIS p. S-2.

37. No comment seems to be requested here.

38. No.

39. These represent average individual welfare measures based on a Hicksian compensated demand curve.

40. One piece of evidence we have is the consistency with cash transaction experiments.

41. There are several sites listed in the DFWP instream flow application that discuss this issue.

42. It is marginal. See DFWP Exhibit 9.

43. See the discussion <u>supra</u> with respect to your issue number four.

44. The numbers in Duffield Direct Exhibit 32 (Table 44) are computed based on equation 24 on page 76 of DFWP Exhibit 9. The intent was to meet DNRC's desire for sub-basin average estimated marginal flow values by time of year. These numberof the marginal value of an additional acre foot of flow distributed in any way among the major basin streams. The specific headwaters subbasin July-August value of $50.28 reported in Table 44 is the sum of resident and nonresident marginal value for these waters provided in Tables 42 and 43 of DFWP Exhibit 9. As an example, the resident value was computed using 1) total resident river-based recreational value in the basin of $21,734,550 for July-August (from Table 39 p.67, DFWP Exhibit 9), 2) total flows based on the discharge at the mouth of each of the Missouri's major tributaries in the subbasin (Big Hole, Jefferson, Madison, Gallatin, Beaverhead, Boulder, Ruby, and Red Rock) which totals 432,130 acre feet in 1989 as discussed p. 77 of DFWP

Exhibit 9, 3) and the observed average share of July-August angler use to the year total on 19 major Montana streams (discussed p. 76 DFWP Exhibit 9) of .3656. Note that the 1989 discharge levels used in all such computations are provided in Exhibit 10 of this testimony. These factors alone can be used to compute an average flow value in the subbasin for residents in July-August of $18.39 (eg. Table 46). These factors are used in Equation 24 along with the derivative of the first flow value relationship listed in Table 41, to derive the marginal value at any flow level (such as at 50% of actual experienced flows, the value of $20.24 in Table 42). Nonresident values are computed in a similar way. Because of a smaller sample, subbasin level net values per day were not computed (Table 38) but only a basin wide value. This was used with estimated nonresident subbasin use levels (Table 15) to generate the aggregated estimate in Table 39. Given the subbasin level total value estimates and discharge, average and marginal values are computed symmetric to the resident case. Note that only a basin-wide flow value relationship was estimated for nonresidents. The permutation of subbasin values for nonresidents in Table 43 is based on differences in total value and discharge by subbasin, not on differences in flow-value response. The 50% marginal flow level accordingly has the interpretation of being the marginal value of an acre-foot of flow through the subbasin when flows are at 50% of actual experienced flows. Since these are by definition subbasin averages, the interpretation of these values is that they represent the value of an extra acrefoot of flow distributed in any way among the eight guaging points.

45. The DNRC "instream" alternative includes some diversions such as municipal. See DNRC DEIS p. S-2.

46. This reference should be DFWP Exhibit 9, pp. 84-87.

47. See Exhibit 2, this testimony.

48. This was a mail, not a field survey. The individuals who received the surveys were provided with a cover letter.

49. No.

50. We generally tried to minimize hypothetical bias by valuing a concrete, easily described commodity. The choice of payment vehicle was based on our experience and the literature. Starting point bias was avoided by not using an iterative bid procedure. We had no interviewers as it was a mail survey. We did not experiment with information levels as the good was an easily described one.

51. Another mail survey. The cover letters are provided in Exhibit 11.

52. Yes.

53. The effect of including the observations in the model depend on how they are used. If it is assumed that all of these respondents would continue to visit even at zero flow levels, values would be reduced. We investigated this subsample and found that 57% were participating in activities that would be precluded by zero flow levels, eg. fishing from shore, fishing from boats and floaters. This suggests that the respondents had difficulty answering the question and that the ambivalence might rather indicate distributing the subsample over all possible sample points. We chose to instead drop these observations.

54. The model we used was the logit. It is impossible to have values less than zero or greater than one in such a model.

55. Three. No, there were fixed response percentages. The number of actual river guaging stations in the basin is quite limited. It would not have been possible to get meaningful flow data for many of the visited sites. The collection and tabulation of this data would have been too costly given the resources available for this study.

56. See note 44 <u>supra</u>.

57. See note 44 <u>supra</u>.

REBUTTAL EXHIBIT 10

Calculation of total discharge figures used in marginal flow value calculations

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Upper Subbasin

River	July/August Discharge	1989 year total
Big Hole	56,840	486,700
Jefferson	60,450	851,900
Beaverhead	64,930	190,990
Ruby	34,640	101,200
Gallatin	90,170	486,200
Boulder	5,290	65,200
Madison	104,290	689,400
Red Rock	15,520	64,289
Total discharge	432,130 July-August	2,935,879 Entire year
	2,503,749 Sept.-July	

Middle Subbasin

	July-Aug. discharge	1989 year discharge
Missouri at Ft. Benton	562,600	4,020,000
- Sun River	-83,520	-496,300
Totals	479,080 July-August	3,523,700 Entire year
	3,044,620 Sept.-July	

Lower Subbasin

	July-Aug. discharge	1989 year discharge
Missouri at Ft. Benton	562,600	4,020,000
Teton	16,850	88,510
Musselshell	10,650	36,050
Marias	134,190	487,000
Totals	724,290 july-august	4,631,560 entire year
	3,907,270 Sept.-July	

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

REBUTTAL EXHIBIT 11

STAN STEPHENS, GOVERNOR

1520 EAST SIXTH AVENUE

STATE OF MONTANA

DIRECTOR'S OFFICE (406) 444-6699
TELEFAX NUMBER (406) 444-6721

HELENA, MONTANA 59620-2301

September 14, 1989

Dear Montanan:

Water allocation is one of the main issues facing Montana and the western United States. The State of Montana is now in the process of deciding how unallocated water in the Missouri River basin will be used. Cities, conservation districts, and state and federal agencies are asking to reserve water for drinking, irrigation projects, protecting water quality, and for instream flows for fish, boating, and other recreation uses.

We are asking you to complete and return the enclosed survey to help Montana make decisions about water reservations in the Missouri Basin. Your responses will be an important source of information about recreation uses and values in the basin. They will be combined with other studies we are conducting.

The survey takes about 15 minutes and we think you will enjoy completing it. We have included a stamped, addressed return envelope for your convenience. Your opinions will be completely confidential. Each survey is stamped with a number so we know which have been returned.

We need to hear from you even if you don't visit rivers for recreation. You are one of a small number of people scientifically selected to receive this survey. For our results to be accurate and representative, we need your opinions.

Thanks for your help. If you would like a summary of the results of this study, please write your name and address on the return envelope (not on the questionnaire), and I will make sure you get one. Because of the importance of this survey, we've established a toll-free number. Please call my survey staff at (800) 448-0664 with any questions you have.

Sincerely,

Karen L Barclay

Karen L. Barclay
Director

NJ/jb
Encs.

CENTRALIZED SERVICES DIVISION | CONSERVATION DISTRICTS DIVISION | ENERGY DIVISION | OIL AND GAS DIVISION | WATER RESOURCES DIVISION

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

STAN STEPHENS, GOVERNOR 1520 EAST SIXTH AVENUE

STATE OF MONTANA

DIRECTOR'S OFFICE (406) 444-6699
TELEFAX NUMBER (406) 444-6721
HELENA, MONTANA 59620-2301

September 14, 1989

Dear Angler:

Water allocation is one of the main issues facing Montana and the western United States. The State of Montana is now in the process of deciding how unallocated water in the Missouri River basin will be used. Cities, conservation districts, and state and federal agencies are asking to reserve water for drinking, irrigation projects, protecting water quality, and for instream flows for fish, boating, and other recreation uses.

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The survey takes about 15 minutes and we think you will enjoy completing it. We have included a stamped, addressed return envelope for your convenience. Your opinions will be completely confidential. Each survey is stamped with a number so we know which have been returned.

You are one of a small number of anglers selected to receive this survey. For our results to be accurate and representative, we need your opinions.

Thanks for your help. If you would like a summary of the results of this study, please write your name and address on the return envelope (not on the questionnaire), and I will make sure you get one. Because of the importance of this survey, we've established a toll-free number. Please call my survey staff at (800) 448-0664 with any questions you have.

Sincerely,

Karen L. Barclay

Karen L. Barclay
Director

NJ/jb
Encs.