Final Report

WEST ROSEBUD CREEK MINIMUM FLOW STUDY

Prepared for: The Federal Energy Regulatory Commission In fulfillment of Article 34, Mystic Lake Project, OEPR - DLP No. 2301.

Prepared by: The Montana Power Company
40 East Broadway
Butte, Montana 59701

December, 1979

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INTRODUCTION

The Federal Power Commission (now the Federal Energy Regulatory Commission, FERC) granted on October 5, 1976, to the Montana Power Company, a new license to continue operation of Project No. 2301, Mystic Lake, a hydroelectric power generating plant. The license included a provision which required the Company to determine and recommend a schedule of minimum streamflows in West Rosebud Creek between the project dam and the powerhouse to protect and enhance the fishery resource of the creek. Until the schedule is established, the Company will provide a minimum flow of ten (10) cubic feet per second (cfs) in the above-mentioned portion of the stream during June, July and August and a minimum of two (2) cfs for the remainder of the year. These flows are to be measured at a weir (upper weir) which is located immediately above the powerhouse located 3.2 kilometers downstream from Mystic Lake. If study results demonstrate a need to modify the interim flow levels, the Company must request a change from the FERC.

Other provisions of the license included a requirement to consult with the U.S. Fish and Wildlife Service and the Montana Department of Fish and Game (now called Fish, Wildlife and Parks Department) concerning the stream studies. The license also imposed a minimum water surface elevation of 7663.5 feet to be achieved on Mystic Lake by July 1 of each year.

The original license provision (Article 34) for this study required that a report of the minimum flow study be filed by October 5, 1978. Two extensions of that filing date have been granted by the Federal Energy Regulatory Commission:

(1) On March 1, 1978, The Montana Power Company requested an extension of the filing date to April 1, 1979. The year 1977 was an abnormally dry year resulting in no spill over Mystic Lake Dam, the only year in which this has happened in 50 years of plant operation. This request was reviewed and agreed to by the Montana Department of Fish, Wildlife, and Parks (MDFWP) and the U.S. Fish and Wildlife Service (USFWS). The request was granted by the FERC on July 3, 1978 (Appendix 1).

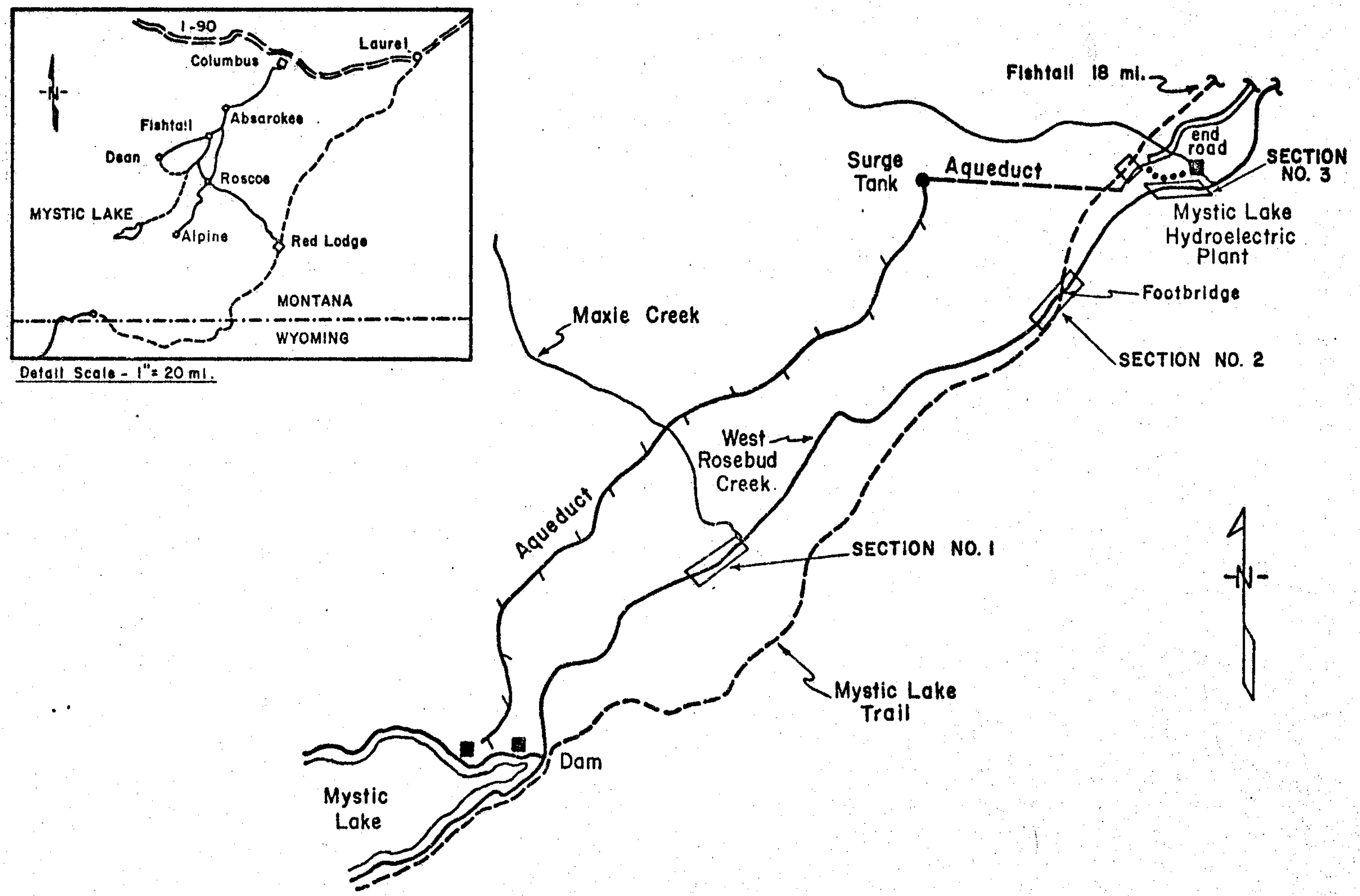
(2) On January 19, 1979, the second extension of report filing to July 1, 1980 was requested. The extension was necessary due to a rupture in the project penstock which created a plant shutdown causing an abnormally high flow regime and greatly increased sediment load in the study area. The request was reviewed and agreed to by the MDFWP and the USFWS. The request was granted by the FERC on February 14, 1979 (Appendix 2).

DESCRIPTION OF THE STUDY AREA

The headwaters of West Rosebud Creek originate in the Beartooth Mountains of southcentral Montana (Figure 1). The stream flows generally north and east to join East Rosebud Creek and finally the Stillwater River in the vicinity of Absarokee, Montana. The Mystic Lake power project consists of a high elevation storage reservoir, Mystic Lake, and a powerhouse located two miles downstream from the storage reservoir. Storage flows from the reservoir pass through a 56 inch, wood stave pipeline on the canyon wall to the turbines in the powerhouse. That portion of the stream above the powerhouse consists of a high gradient, cold water stream fed by a high mountain watershed of 135 square kilometers (52 square miles). The stream descends approximately 343 meters (1,125 feet) in the 3.2 kilometers between the lake and the powerhouse.

Flow through the powerhouse and streamflow from the two mile study section between the dam and the powerhouse are measured at a weir (lower weir) established by the U.S. Geological Survey in 1965. Mean daily discharge at this weir is 130 cubic feet per second (cfs). Streamflow ranges from 50 cfs in April to 419 cfs in July. From plant records, the Mystic Lake mean inflow is 107 cfs and varies from 11 cfs in March to 386 cfs in June. The difference between the calculated Mystic Lake inflow and the lower weir flow is 13 cfs as compared to the measured upper weir flow of 34 cfs. The dissimilarity of

FIGURE - 1 West Rosebud Creek Study Area and Electrofishing Section Locations.



the two estimates of the study area streamflow can be accounted for in part by the age of the USGS (lower) weir, (14 years) and the inaccuracy of the derived Mystic Lake inflow.

The specific area of concern in this study was the two mile reach of stream between the storage reservoir and the powerhouse. Flows in this portion had been measured at a 26 foot wide, broad-crested weir (upper weir) located immediately above the powerhouse. Discharge at the upper weir is recorded daily by the Mystic plant operators. A summary of the available flow data is reported in Table 1. Mean daily flow for all years of record through 1977 is 34 cfs. Discharge in 1977 was extremely low due to a lack of spill flows over the dam yielding a daily average of 6 cfs. At the other extreme, mean flow during 1978 was 86.6 cfs. Excess spill over Mystic dam normally occurs for about a seven week period in mid-summer; however, the plant was inoperative for most of 1978 and spill occurred for about eight months which resulted in higher than normal streamflows over the upper weir.

Flow over the upper weir in March, 1977 was recorded daily as one cfs. Efficient methods for the introduction of supplemental flows had not been implemented at that time. The accuracy of reading very low flows was questionable; therefore, the 26' broad-crested weir was modifed to a sharp-crested weir for more accurate calibration. In addition, further modifications allowed for the installation of boards at each end of the weir, leaving a nine foot width open at the weir center for the measurement of flows less than 7 cfs.

Table 1. West Rosebud Creek Mean Daily Discharge*, cfs (cms), for Individual Years 1974-1978 and for the 25 Year Daily Mean for the Period 1929-1977**.

	1974	1975	1976	1977	1929-1977	1978
Jan.	2 (.06)	2 (.03)	1 (.03)	3 (.08)	3 (.08)	3 (.08)
Feb.	2 (.06)	2 (.06)	1 (.03)	2 (.06)	3 (.08)	2 (.06)
Mar.	2 (.06)	1 (.03)	1 (.03)	1 (.03)	3 (.08)	2 (.06)
Apr.	3 (.08)	2 (.06)	3 (.08)	2 (.06)	3 (.08)	3 (.08)
May	14 (.40)	10 (.28)	20 (.57)	6 (.17)	11 (.31)	16 (.45)
June	542 (15.35)	23 (.65)	62 (1.76)	16 (.45)	95 (2.69)	167 (4.73)
July	500 (14.16)	489 (13.85)	238 (6.74)	14 (.40)	211 (5.97)	527 (14.92)
Aug.	97 (2.75)	64 (1.81)	58 (1.64)	10 (.28)	53 (1.5)	162 (4.59)
Sept.	13 (.37)	4 (.11)	13 (.37)	6 (.17)	10 (.28)	102 (2.89)
Oct.	4 (.11)	3 (.08)	9 (.25)	5 (.14)	7 (.20)	46 (1.30)
Nov.	4 (.11)	1 (.03)	5 (.14)	5 (.14)	5 (.14)	34 (.96)
Dec.	2 (.06)	2 (.06)	5 (.08)	4 (.11)	4 (.11)	37 (1.05)
Mean	99 (2.80)	50 (1.42)	35 (.99)	6 (.17)	34 (.96)	87 (2.46)

* Measured at Mystic Lake Powerhouse Upper Weir
** Records are for years 1929-33, 1956, and 1959-1977

The 3.2 km study section of West Rosebud Creek passes through a deep canyon with steep walls of granitic rock. Numerous small unnamed creeks, many of which are temporary streams, collect snowmelt waters from the high elevations. The watercourse is characterized by numerous small waterfalls and deep pools. Few riffles are present in the upper reaches. The channel contains large angular boulders. Numerous natural barriers exist on the stream which prevent upstream migration of fish. A major barrier occurs about 548 meters above the powerhouse where a long cascading slope prevents upstream movement of fish. Numerous other barriers consisting of 2 to 3 meter waterfalls occur in the upper portion of the stream extending for 1.5 km below the Mystic Dam. Rainbow trout reside in some of the pools between the barricades in the upper reaches and are believed to have been introduced initially during spill flows over the dam. Rainbow trout occur throughout most of the study section, however brown trout are present only in the first 450 to 550 meters above the powerhouse.

A 4.8 km foot trail from the powerhouse to Mystic Lake provides the only public access to the lake which is used heavily by fishermen during the summer months. A total of twelve small boats were inventoried during 1978 at the lake. These boats were brought to the lake by Montana Power Co. on the tram car and small railroad. No additional boats have been brought to the lake for several years, however Montana Power may bring the boats back on request.

Although the foot trail parallels the stream for about 1.5 km above the powerhouse, fishing use of the stream in this area is insignificant. A recreation survey was conducted in 1974 by the Custer National Forest by means of a trail head register. Of 1600 respondents, none indicated their destination and purpose was to fish in the study section (George Schaller, 1977, Personal Communication).

METHODS

Fisheries Study

Three fish capture sections were established between the powerhouse and the storage reservoir. Section No. 1 extends from the upper weir to a point 534 meters (585 yards) upstream (Figure 1). Section No. 2 begins approximately 183 meters below the foot bridge and terminates 269 meters upstream. Section No. 3 begins at the mouth of Maxie Creek and extends upstream a distance of 323 meters.

Fish were collected with a Coffelt Backpack Electroshocker and dip nets. Following anesthesia, the total length of each fish was measured with a measuring board and weighed with a top loading balance.

Collections were taken at all three sections on August 16 and 23, 1977. The first collection was a capture run and the second was a recapture sample to be used for a population estimate. Fin clips were made on each fish, except for the small juveniles. A different fin was used in each shocking section.

Brown trout (*Salmo trutta*) occurred only in Section No. 3. This section was sampled again in October, 1977 in order to determine its use by spawning brown trout. Equipment malfunction prevented the collection of a recapture sample. (The shocker was subsequently returned to the manufacturer for repairs.)

A sample of rainbow trout (*Salmo gairdneri*) was taken in May, 1978 at Section Nos. 1 and 2. The shocker failed before Section 3 was sampled. The equipment was immediately shipped to the manufacturer for repairs and was returned in one week. The shocker still did not perform and a recapture sample was not collected.

A number of events dictated the termination of further fish sampling. First of all, spill flows over the dam did not occur in 1977, a unique event for the Mystic project. In addition, the pipeline to the powerhouse collapsed on May 2, 1978 introducing an unknown quantity of silt to the stream below the break. During the resulting plant outage, higher than normal flows occurred as a result of spill over the dam which began on June 23 (541 cfs) and continued to February, 1979, when pipeline repairs were completed. The unusual flow conditions of 1977 and 1978 caused unknown effects to the trout populations below the reservoir. Further estimates of fish populations would likely be unrepresentative of the normal conditions; therefore, further sampling was not conducted.

The Montana Department of Fish, Wildlife, and Parks and the U.S. Fish and Wildlife Service were asked to review and comment on the study proposal and were kept informed on study progress.

Fisheries Computations

A regression of length vs. weight of shocked fish was determined according to the equation: log weight = m log length + log b. Regressions were calculated for each species at each electrofishing section and for each species at all three electrofishing sections on each date. Condition factors were calculated from the formula (Carlander, 1969):

$$K = \frac{W x 10^5}{L^3}$$

where: K = condition factor
W = weight (grams)
L = length (mm)

Because condition factors vary with season, sex, sexual maturity, age, and other factors, condition factors were calculated for length groups within each sample. In this way, condition of the fish could be compared between younger and older fish groups collected on the same date. It also provided an indication of the changes in condition that can be expected during growth.

Estimates of the population size were calculated by the Petersen-type formula (Ricker, 1971):

$$N = \frac{MC}{r}$$

where: N = estimate of the total population number
M = total number of marked fish in the population
C = number of fish in sample
r = number of marked fish recaptured in the sample

Streamflow Analysis

Initial attempts in June 1977 to determine maintenance flows for the study section of the stream were based on a simplification of the Water Surface Profile Program (WSP) developed by the U.S. Bureau of Reclamation (Dooley, 1976) and applied to several Montana rivers and streams (Elser, 1976; Montana Fish and Game Department, 1977). Input to WSP requires measurements from only one or two observed flows. A total of eight transects were established on the study section in June 1977. Streamflow data was recorded for one observed flow at each transect in accordance with methods described by Spence (1975). Analytical results were unreliable and did not agree with subsequent field measurements. The method was discarded as unworkable for West Rosebud Creek. This method and results will be discussed later. The high gradient and turbulent nature of the creek required that measurements be obtained at several observed flows. In order to minimize the amount of error in making predictions, techniques of gathering field data were designed for subsequent analysis with the Oregon method (Thompson, 1972) of minimum flow determination.

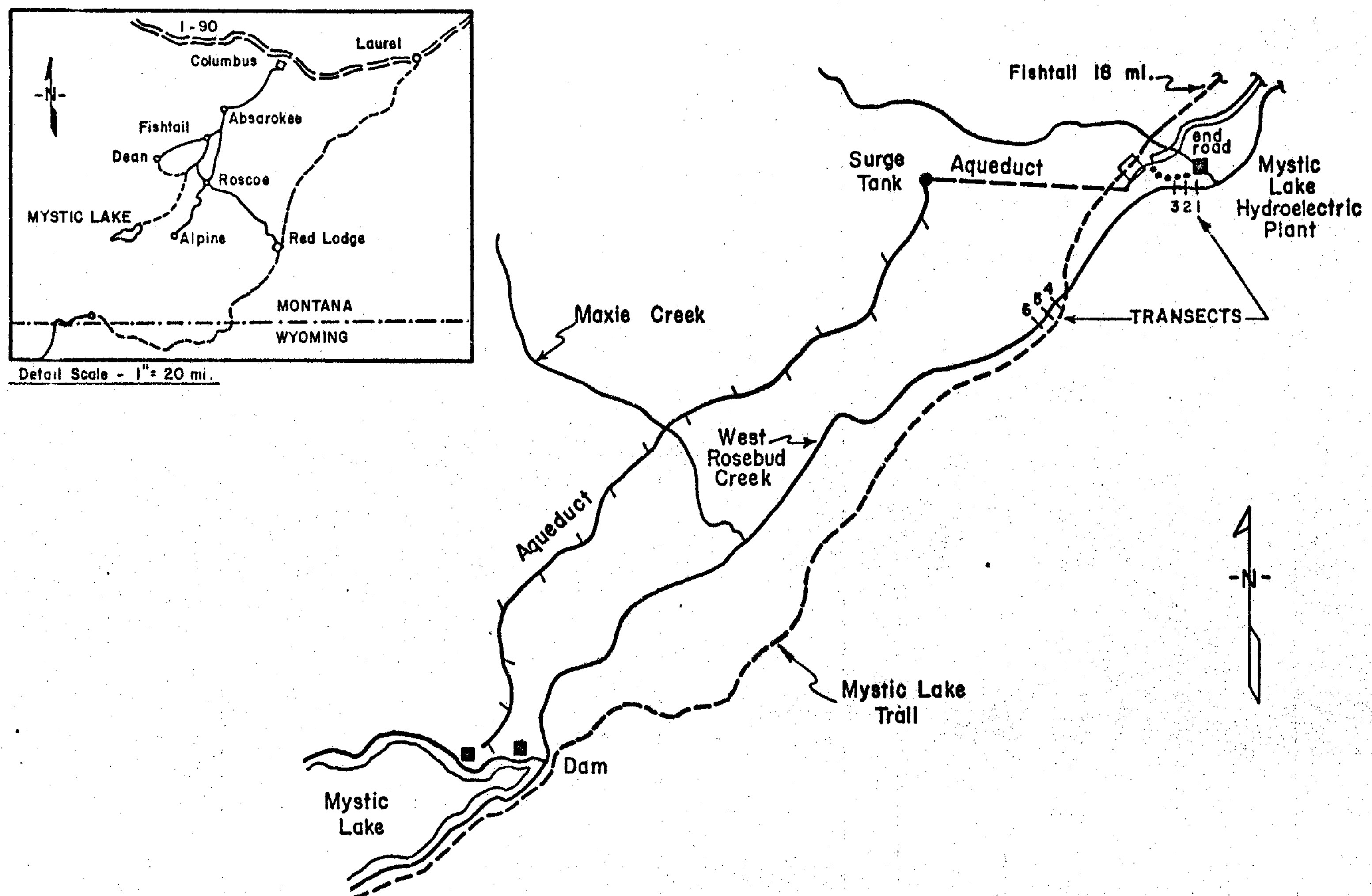
Although depth and velocity criteria exist for fish passage, spawning, incubation and rearing, it was believed that if streamflow was sufficient for fish passage, other requirements would also be met. To determine minimum passage flows, six transects were established in June, 1978. Transects 1, 2 and 3 were located about 365 meters above the upper weir. Transects 4, 5 and 6 were placed immediately above the foot bridge (Figure 2). Transects were located in broad, shallow reaches of the stream which were believed to be critical to passage of large fish and were spaced at least 10 meters apart. Each transect was placed perpendicular to the direction of flow and each end was marked with a permanent stake on the bank, the zero stake being on the right bank. The stream discharge was measured on six occasions from June 1978 through June 1979. The flow was determined only five times for transects 4, 5 and 6 due to the inability to gain access during a period of deep snow. A Gurley Pygmy current meter was used to measure average velocity at each partial segment of the transect. The flow velocities were too high for the Gurley meter at transect No. 1 in June 1978 and other velocity measurements were incorrect for that observed flow; therefore, only the depth and width data were retained.

Following the data collection of June 16, 1978, flows spilled over the dam. Spill flows to the study section did not decrease to workable levels until October 1978 at which time the second set of field measurements was taken.

Streamflow from each transect was calculated by using the mid-section method (Buchanan and Somers, 1969).

The Oregon method defines the minimum streamflow for fish passage as that flow which meets the depth criterion on at least 25% of the total width of the stream and at least 10% of

FIGURE - 2 West Rosebud Creek Study Area and Instream Flow Transect Locations.



the usable width must be continuous. The water depth criterion for trout passage in a stream is 0.4 feet (Thompson, 1972). Usable width is defined as that portion of the channel which meets the depth criterion. Total width is defined here as the wetted width which corresponds with average daily flow. Average flow for the study section was 34 cfs (Table 1). To find wet width at average flow it was necessary to use the transect measurements obtained in October 1978 which provided the only data for flows exceeding 34 cfs.

Ideally, the relationship between wet width and discharge could be determined by plotting discharge against width by using the available field data. However, the varied nature of the stream channel did not allow the plotting of a smooth curve. More data points were required and these were obtained through the use of Manning's equation (Bovee and Milhous, 1978):

$$Q = 1.486\ A\ \frac{s^{1/2}}{n}\ \frac{A}{P}^{2/3}$$

where:
- Q = discharge
- A = cross-sectional area
- P = wetted perimeter, roughly equal to the width + 2 times the mean depth
- s = energy slope
- n = channel roughness coefficient

All factors in Manning's equation were known for measured flows except for the ratio, $s^{1/2}/n$, which was easily calculated.

This ratio is an indirect function of cross-sectional area. This relationship was used to find Q for a given set of channel characteristics. Coefficients of correlation between $s^{1/2}/n$ and cross-sectional area were calculated for each transect using channel measurements from all but the June 1978 data. The least squares equations were used to find the straight line functions for each of the four transects. Statistical methods were described by Mendenhall (1971).

To find $s^{1/2}/n$ for channel measurements other than those obtained in the field it was necessary to simulate decreasing streamflows. This was accomplished by plotting width and depth to obtain a visual profile of each cross-section for each transect. Water surface elevations were subsequently decreased by increments of two inches to simulate decreasing flows. The cross-sectional area of each profile was measured with the use of an electronic digitizer. The wetted width was measured from each increment of the profile and divided into its corresponding area to obtain an average depth.

The straight line equations were used to calculate $s^{1/2}/n$ for each newly determined area. Manning's equation was then used to find the corresponding discharge. These equations were also employed to caluclate the ratio, $s^{1/2}/n$, and Q for transects measured in June 1978.

By plotting Q against width for transect data of October 1978, the stream width that existed when discharge was equal to 34 cfs was derived. These derived widths were defined as total width as used in the Oregon method. All profiles were used to locate the stream width which was necessary to meet the depth criterion on at least 25% of the total width.

Q was plotted against width for all profiles and averaged to produce one curve per transect. The average of the widths which provided the minimum depth requirement were located on each graph to find the corresponding discharge. Derived Q values for each transect were averaged according to Thompson (1972) to become the recommended streamflow.

In order to recommend minimum discharges that will correspond with normal flow in the study section, the flow recommendation generated by the above methods should apply only to the low flow months of September through May.

A flow recommendation for the summer months was based on a judgement of the biological and physical needs of the stream organisms.

RESULTS

Fisheries Study

Species Distribution

The species and numbers of fish collected by electrofishing three sections of West Rosebud Creek are presented in Table 2.

Table 2. Number and Species of Fish Collected by Electrofishing on West Rosebud Creek

Date	Section	Rainbow	Hybrid	Brown	Total
8/16/77	1	98	2	0	100
	2	30	0	0	30
	3	38	0	22	60
8/23/77	1	84	1	0	85
	2	105	0	0	105
	3	39	0	40	79
10/11/77	3	44	0	41	85
5/20/78	1	53	0	0	53
	2	63	0	0	63

Brown trout were found only in Section No. 3 while rainbow trout were found at all three sections. Two fish (one was recaptured on 8-23-77) which were identified as rainbow-cutthroat hybrids were found at Section No. 1. Since these two fish were not distinguishable from rainbow on the basis of length and weight, they were treated as rainbow.

Rainbow trout: Length-frequency

The rainbow trout collected in this study ranged in length from 50mm to 298mm (2 in.-11.7 in.) and in weight from 5g. to 250g. (0.6 lb.). Length-frequency graphs of 10mm length classes are presented in Figures 3, 4, 5 and 6.

Length maxima occurred at approximately 110 mm and 200 mm in August 1977. These peaks appear to be displaced in the October 1977 sample to 120mm and 220mm. Definite age class determinations for these two peaks cannot be reported because age analysis was not performed. Age growth classes may be suggested by comparison of these data with those found in other studies in Western U.S. streams as listed in Table 3 (Carlander, 1969). By comparison with the mean values it seems that the peaks from this study correspond to the Age 0 and Age I-II classes.

Table 3. Mean Length (mm) of Rainbow Trout from Reports of Western U.S. Streams (Carlander, 1969)

Age Class	No.	$\bar{\text{Length}}$ (mm)	Central 50%
0 (Aug)	528	61	-
0 (Sept)	257	89	-
0 (Nov)	96	91	-
I	10,122	173	140-224
II	1,098	231	211-269
III	478	287	254-353

FIGURE 3

LENGTH (10 MM CLASSES) VS. FREQUENCY FOR ELECTRO-FISHED RAINBOW TROUT ON THREE SECTIONS OF WEST ROSEBUD CREEK ON 8-15,16-77.

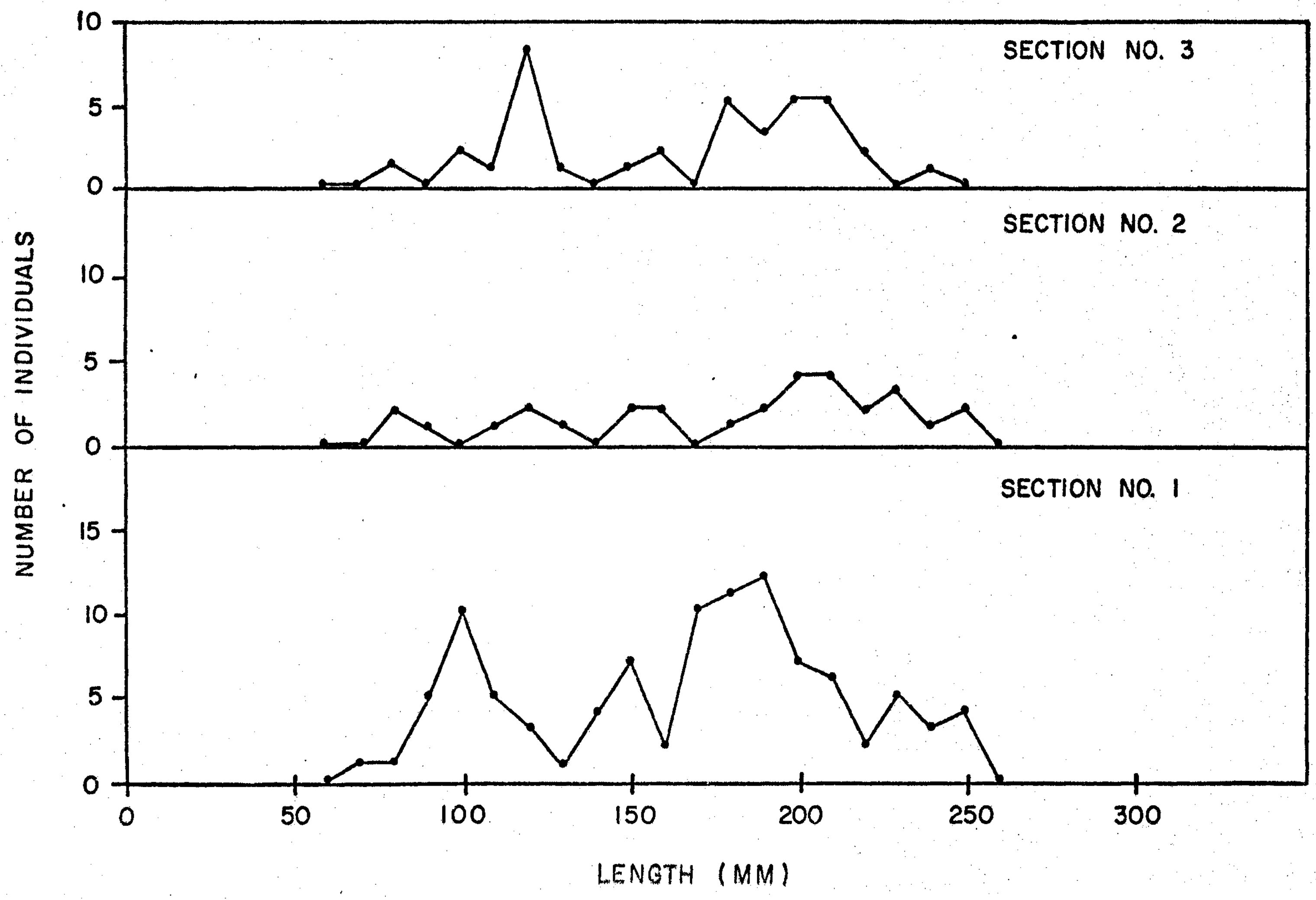


FIGURE 4

LENGTH (10 MM CLASSES) VS. FREQUENCY FOR ELECTRO FISHED RAINBOW TROUT ON THREE SECTIONS OF WEST ROSEBUD CREEK ON 8-22-24-77.

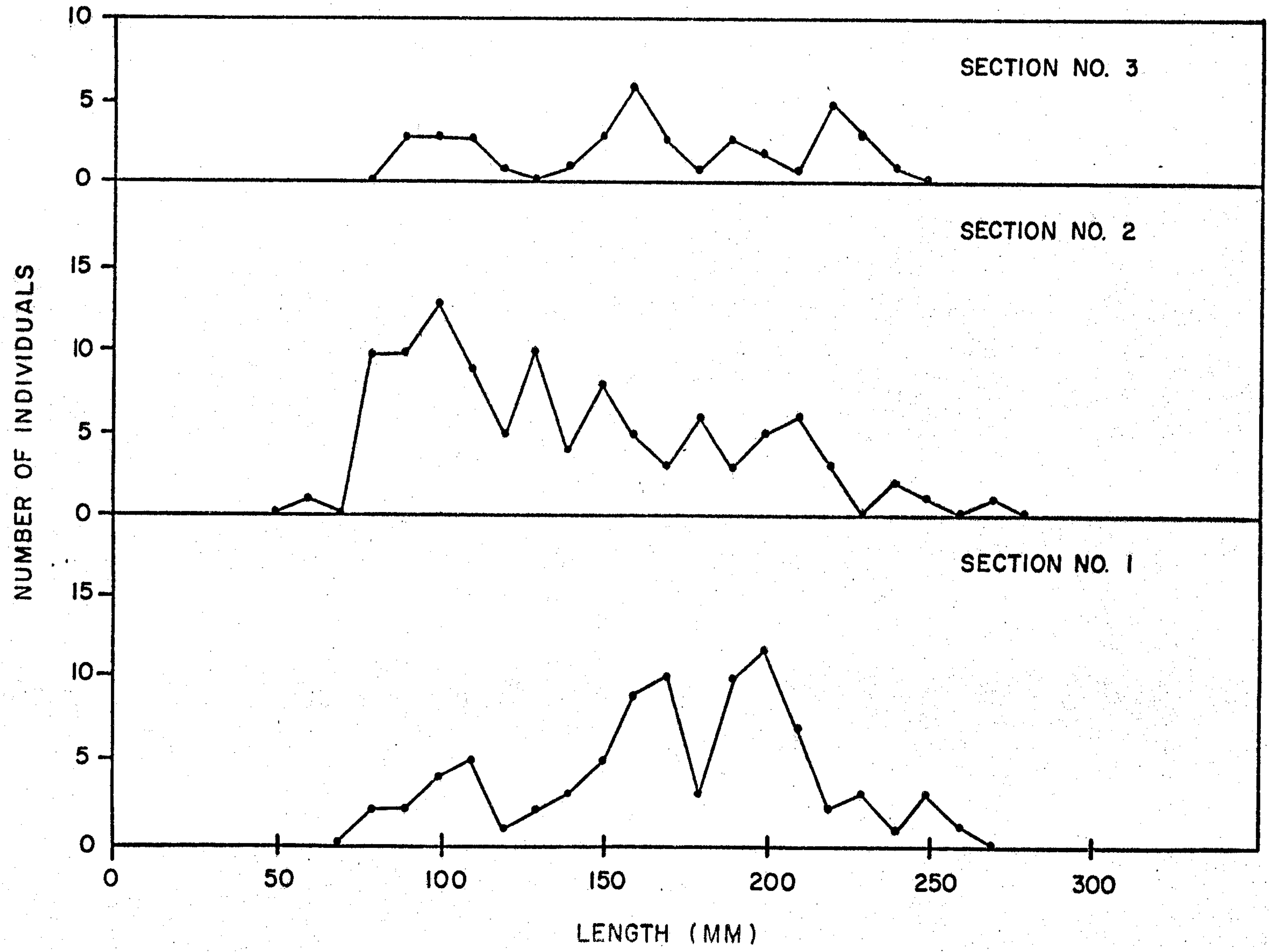


FIGURE 5

LENGTH (10 MM CLASSES) VS. FREQUENCY FOR ELECTRO FISHED RAINBOW TROUT ON ONE SECTION OF WEST ROSEBUD CREEK ON 10-11-77.

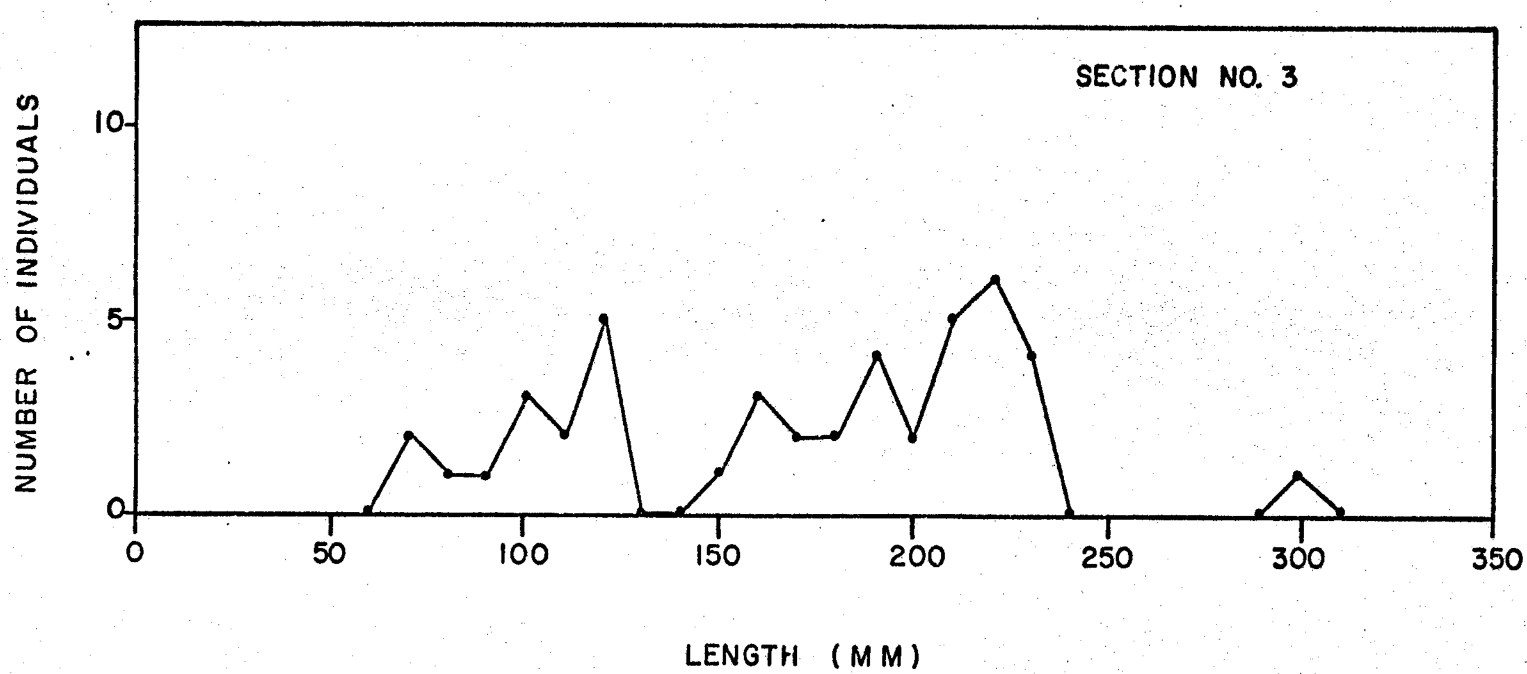
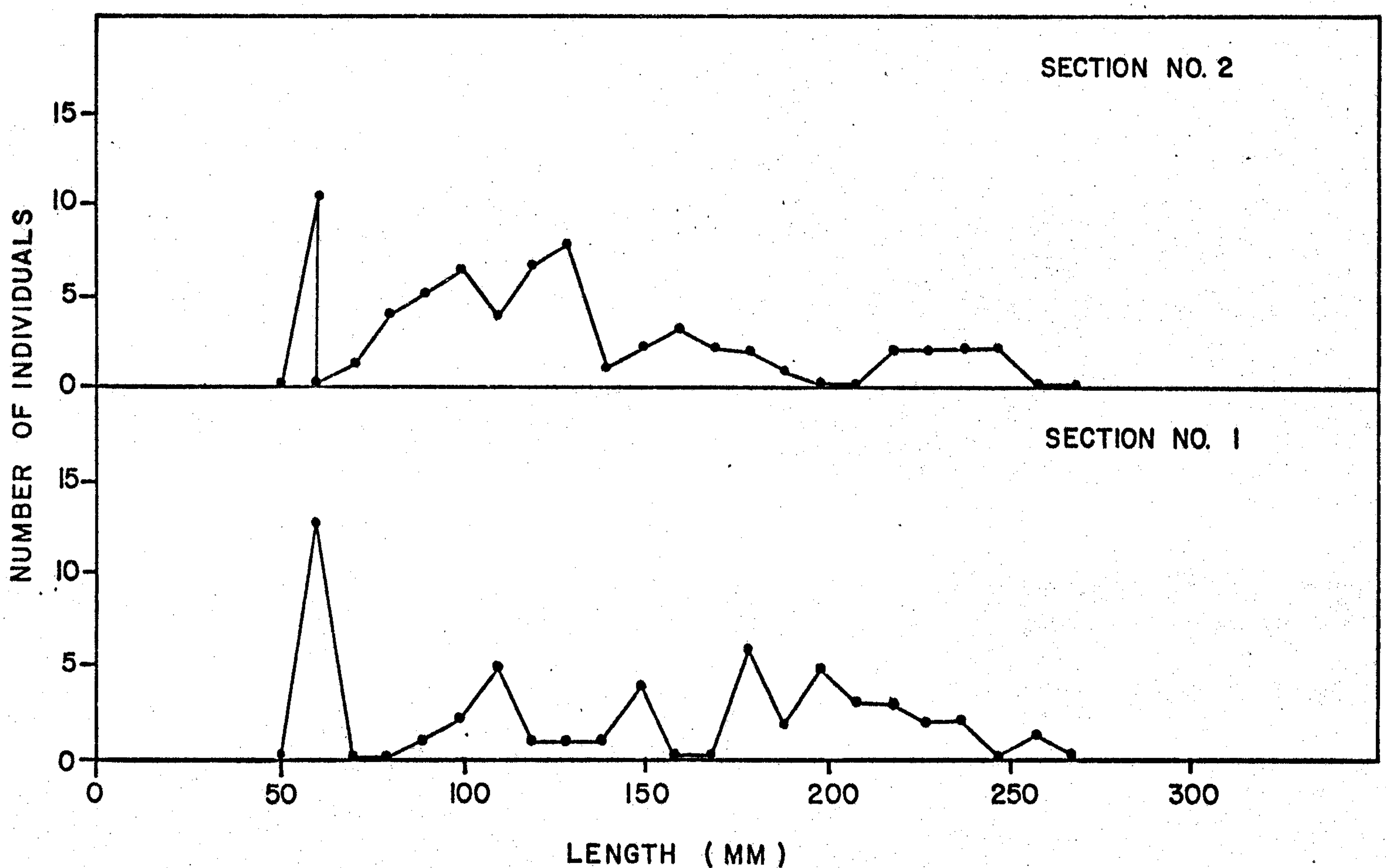


FIGURE 6

LENGTH (10 MM CLASSES) VS. FREQUENCY FOR ELECTRO FISHED RAINBOW TROUT ON SECTIONS 1 & 2 OF WEST ROSEBUD CREEK ON 5-20,21-78.



These data seem to indicate that the rate of growth for rainbow trout is rapid during the first two years (Age 0 and I) but slows abruptly in following years. This type of growth pattern probably results from the limited food available in West Rosebud Creek.

Length-Weight Relationship for Rainbow Trout

The results of the length-weight regression for rainbow trout are presented in Table 4. The slope (m) of the regression line indicates the relationship of length and weight between individual members of the population. A slope value of 3 indicates that larger individuals have maintained the length-weight ratio of the smaller members during growth.

Table 4. The Coefficients of the Length-Weight Regression for Rainbow Trout Collected from West Rosebud Creek (n = number of fish in sample, m = slope, log b = log of y intercept, and r^2 = coefficient of determination)

Date	Section	n	m	log b	r^2
8/15,16/77	1	100	2.74	-4.31	0.971
8/15,16/77	2	30	2.82	-4.47	0.974
8/15,16/77	3	38	2.81	-4.48	0.976
8/15,16/77	1+2+3	168	2.77	-4.39	0.972
8/22,23,24/77	1	85	2.76	-4.35	0.962
8/22,23,24/77	2	105	2.81	-4.46	0.954
8/22,23,24/77	3	39	2.85	-4.58	0.975
8/22,23,24/77	1+2+3	229	2.80	-4.42	0.963
10/11/77	3	44	3.37	-5.828	0.947
5/20,21/78	1	53	1.91	-2.51	0.938
5/20,21/78	2	63	1.97	-2.60	0.910
5/20,21/78	1+2	116	1.93	-2.53	0.924

The slope coefficient for August (2.79) was within the range of slope coefficients (2.59-3.34) aggregated by Carlander

(1969). The coefficient from Section 3 in October (3.37) indicates the larger fish are relatively heavier for their length than the smaller ones.

Condition Factors for Rainbow Trout

The distribution of condition factors, k, for rainbow trout within each sample is presented in Table 5. The most common condition factors found in this study lie in the 1.10-1.49 range.

Table 5. Condition Factor Frequency and Percentage of Total Numbers for Rainbow Trout

Date	Condition Factor Class	#1 (%)	#2 (%)	#3 (%)
8/15,16/77	0.89	0	0	0
	0.90-1.09	15 (15)	2 (7)	3 (8)
	1.10-1.29	36 (36)	12 (40)	18 (47)
	1.30-1.49	33 (33)	10 (33)	12 (32)
	1.50-1.69	8 (8)	4 (13)	3 (8)
	1.70-1.89	2 (2)	1 (3)	1 (3)
	1.90-2.09	5 (5)	0 (0)	1 (3)
	2.10-	1 (1)	1 (3)	0
		100	30	38
8/22,24/77	0.89	0	1 (1)	0
	0.90-1.09	10 (12)	7 (7)	5 (13)
	1.10-1.29	28 (33)	24 (23)	18 (18)
	1.30-1.49	24 (28)	35 (33)	12 (31)
	1.50-1.69	18 (21)	19 (18)	3 (8)
	1.70-1.89	1 (1)	5 (5)	1 (3)
	1.90-2.09	3 (4)	8 (8)	0
	2.10-	1 (1)	6 (6)	0
		85	105	39
10/11/77	0.89			12 (27)
	0.90-1.09			10 (23)
	1.10-1.29			12 (27)
	1.30-1.49			9 (20)
	1.50-1.69			1 (3)
				44

Mean condition factors, $\bar{k}$, for rainbow trout length classes at each shocking section are listed in Table 6. These values indicate that in August the shorter trout were relatively heavier for their length than the longer trout at each section which indicates that as the fish progress in growth, they continually grow longer relative to weight.

Table 6. Mean Condition Factors ($\bar{k}$) for Length Classes* of Rainbow Trout Collected in West Rosebud Creek

Date	Length Class (mm)	Section #1 (n)	Section #2 (n)	Section #3 (n)	$\bar{k}$ (Length Class)
8/15,16/77	0-130	1.49 (27)	1.48 (7)	1.35 (14)	1.45
	135-160	1.27 (13)	1.37 (4)	1.25 (3)	1.29
	165-250	1.22 (60)	1.31 (19)	1.24 (21)	1.24
	$\bar{k}$ (section)**	1.31	1.36	1.28	1.31
8/22,23,24/77	0-120	1.57 (14)	1.55 (48)	1.28 (10)	1.54
	125-175	1.36 (29)	1.40 (30)	1.34 (14)	1.37
	180-	1.32 (42)	1.35 (27)	1.12 (15)	1.29
	$\bar{k}$ (section)**	1.37	1.44	1.25	1.38
10/11/77	0-120			.87 (14)	
	125-175			.90 (6)	
	180-			1.06 (24)	
	$\bar{k}$ (section)			1.03	
5/20,21/78	0-70	4.81 (13)	4.43 (12)		4.63
	75-160	1.21 (15)	1.96 (38)		1.75
	165-	1.08 (25)	1.19 (13)		1.12
	$\bar{k}$ (section)	2.03	2.27		2.16

*Length classes were selected from peaks of length-frequency Figures.

**These values were computed from individual measurements and may be different from the weighted average computed from the data shown.

Population Estimate for Rainbow and Brown Trout

Estimates of rainbow and brown trout population (no/km and kg/km) at the three electrofishing sections were computed from the August mark and recapture runs and are given in Table 7. Section No. 2 had the highest population in number of fish (all rainbow), 977/km, and Section No. 3 had the highest population in weight of fish (rainbow and brown), 87.8 kg/km.

Table 7. Rainbow and Brown Trout Population Estimates from Three Electrofishing Sections

Section	Section Length	Species	no./km	kg/km
1	535m	Rb	722	52.8
2	269m	Rb	977	58.5
3	323m	Rb	575	39.0
3	323m	Bn	226	48.8
3 (Total)	323m		798	87.8

Table 8 presents the recapture rates for fish recaptured at each section and date. Recapture rates for rainbow trout marked on August 15-16, 1977 and recaptured on August 22-24, 1977 were 22%, 40% and 21% at Sections 1, 2, 3 respectively. The recapture rate for brown trout captured and recaptured on the same dates in August was 55%. The recapture rates for rainbow recaptured on May 20, 21, 1978 were 38 percent and 5 percent at Section 1 and 2. The populations of fish in each section were essentially isolated as no movement of fish between sections was noted from the recapture data.

Table 8. Recapture Rates for Three Recapture Dates

Date	Section	Species	Recapture Rate
8/22/77	1	Rb	22%
	2	Rb	40%
	3	Rb	21%
	3	Bn	55%
10/11/77	3	Rb	25%
	3	Bn	62%
5/21/78	1	Rb	38%
	2	Rb	5%

Brown Trout

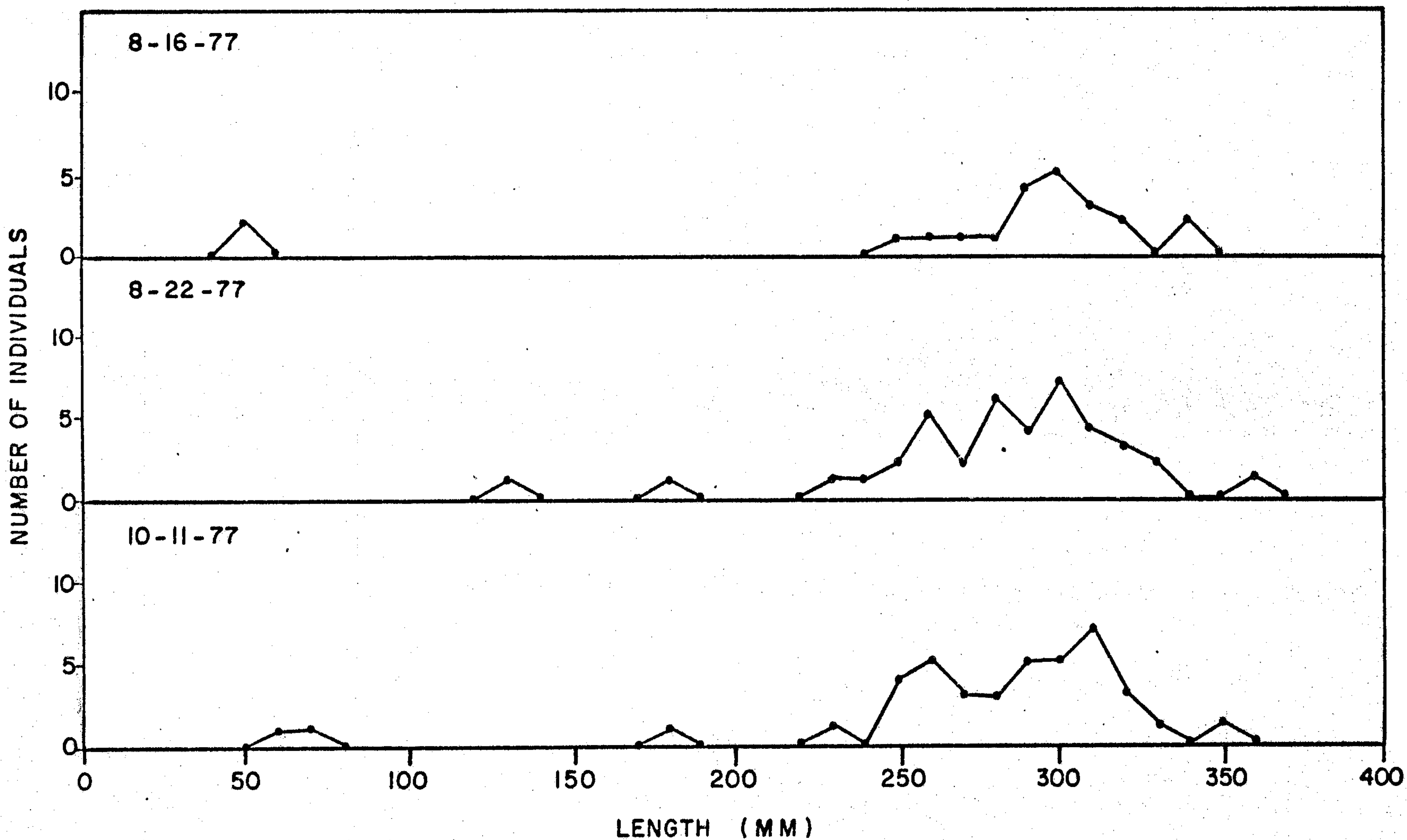
The brown trout collected in this study were all found at Section No. 3. A length-frequency graph of 10mm length classes is presented in Figure 7.

Brown trout length ranged from 50mm to 360mm (2 in.-14 in.) and varied in weight from 3g to 400g (0.9 lb). The length-frequency plot has one peak at approximately 300mm (12 in.) which corresponds to the average length for Age II brown trout collected from Utah, Montana, California, and Wyoming streams (Carlander, 1969).

It is interesting to note that representatives of young-of-the-year or Age 0 brown trout were not collected in appreciable numbers. Although the method of collection, electrofishing, is biased toward collecting larger fish, it should be noted that fingerling rainbow trout, 50mm in length, were collected, and, therefore, fingerling brown trout should have been collected in greater numbers if available at the time of shocking.

F JRE 7

LENGTH (10 MM CLASSES) VS. FREQUENCY FOR ELECTRO FISHED BROWN TROUT AT SECTION NO. 3 OF WEST ROSEBUD CREEK ON THREE DATES.



Length-weight regression coefficients and mean condition factors, $\bar{k}$, are listed in Table 9.

Table 9. Values of Length-weight Regression Coefficients and Mean Condition Factor ($\bar{k}$) for Brown Trout

Date	Section	k	n	m	log b	r^2
8/16/77	3	1.07	22	2.48	-3.74	.997
8/22/77	3	1.00	40	2.77	-4.43	.947
10/11/77	3	1.02	41	2.79	-4.48	.961

The condition of the rainbow trout seemed to be better than the brown trout by virtue of the lower mean condition factors of the brown trout. The slope of the regression line, m, (less than 3) indicates that the larger members of the brown trout population are relatively lighter for their length than the smaller individuals.

Streamflow Analysis

A summary of the transect data and calculations is presented in Table 10. The stream channel at transects 4, 5, and 6 is narrower than the channel at the lower transects; therefore, average depth and velocity are slightly greater upstream. This is true even though discharge upstream is generally less than streamflow at the lower transects. The difference in streamflow between the upper and lower transects is less in fall than during the spring months. The greater difference during spring discharge is attributed to the addition of tributary

Table 10. Summary of Transect Characteristics

Transect	Date	Area (Ft.)	Width (Ft.)	$\bar{d}$ (Ft.)	Q (cfs)	$\bar{v}$ (fps)
1	6/15/8	43.33	42.00	1.03	71.52	1.65
	10/19/8	42.58	53.00	0.80	59.15	1.39
	4/29/9	13.73	29.10	0.47	5.89	0.43
	5/24/9	25.04	40.94	0.61	21.64	0.86
	6/02/9	23.46	41.98	0.56	17.35	0.74
	6/09/9	26.46	42.17	0.63	19.68	0.74
2	6/16/8	36.91	36.70	1.01	59.17	1.60
	10/19/8	39.40	37.25	1.06	64.06	1.63
	4/29/9	9.81	24.50	0.40	6.06	0.62
	5/24/9	18.20	29.84	0.61	17.84	0.98
	6/02/9	16.17	30.92	0.52	12.90	0.80
	6/09/9	18.42	30.46	0.60	17.57	0.95
3	6/16/8	32.82	32.70	1.00		
	10/19/8	34.72	30.50	1.14	56.64	1.63
	4/29/9	8.04	17.50	0.46	7.50	0.93
	5/24/9	17.16	24.00	0.72	27.15	1.58
	6/02/9	12.39	23.41	0.53	19.30	1.56
	6/09/9	13.55	21.66	0.63	19.54	1.44
4	6/16/8	26.50	30.50	0.87	31.20	1.18
	10/19/8	35.33	33.70	1.05	58.47	1.65
	5/24/9	20.55	26.30	0.78	18.11	0.88
	6/02/9	16.94	26.00	0.65	13.68	0.81
	6/09/9	20.78	29.00	0.72	17.34	0.83
5	6/15/8	21.56	30.83	0.70		
	10/19/8	26.25	29.75	0.88	54.55	2.08
	5/24/9	14.76	27.75	0.53	26.98	1.83
	6/02/9	10.68	26.33	0.41	12.51	1.17
	6/09/9	11.92	25.92	0.46	19.24	1.61
6	6/16/8	18.97	19.60	0.97	28.56	1.51
	10/19/8	23.28	20.00	1.16	43.42	1.87
	5/24/9	13.99	18.50	0.76	16.59	1.19
	6/02/9	11.00	17.50	0.63	11.63	1.06
	6/09/9	13.95	16.83	0.83	14.94	1.07

flow to the main channel during snowmelt whereas a significant portion of the fall runoff is probably a result of groundwater recharge to the stream.

Coefficients of correlation between $s^{1/2}/n$ and cross-sectional area are provided in Table 11. High correlations were found for transects 1, 2, 4 and 6. Correlations were negative for transects 3 and 5 which may be due to the extreme roughness of the channel at these two points, and the uneven stage height across the stream. Transects 3 and 5 were excluded from further analysis.

Figures 8 through 11 show the discharge width relationship for the profile data of October 19, 1978 for transects 1, 2, 4 and 6, respectively. These figures were used to determine the wetted width of the stream channel when discharge was equal to the average daily flow of 34 cfs (total width). Table 12 summarizes the stream width data for each profile and shows the usable width which is defined as the width of the stream which meets the depth criterion of 0.4 feet (converted and rounded to 5 inches). The main parameter of concern in this table is the mean wet width which is the width of the channel for each transect which provides a usable width equal to 25% of the total width.

Discharge width profiles for each transect were combined in Figures 12 through 15 for transects 1, 2, 4 and 6, respectively. The mean wet width from Table 12 is shown in these

Table 11. Statistical Correlation Between $s^{\frac{1}{2}}/n$(y) and Area (x)

Transect	Coefficient of Correlation	y=mx+b
1	r = 0.9645	y = 0.0207x + 0.2264
2	r = 0.9734	y = 0.0115x + 0.6893
3	r = -0.4284	
4	r = 0.9636	y = 0.0232x + 0.2882
5	r = -0.2131	
6	r = 0.7879	y = 0.0213x + 0.6987

FIGURE - 8 Discharge vs. Width for Incremented Depth Reduction of 10/19/78 Data at Transect No. 1

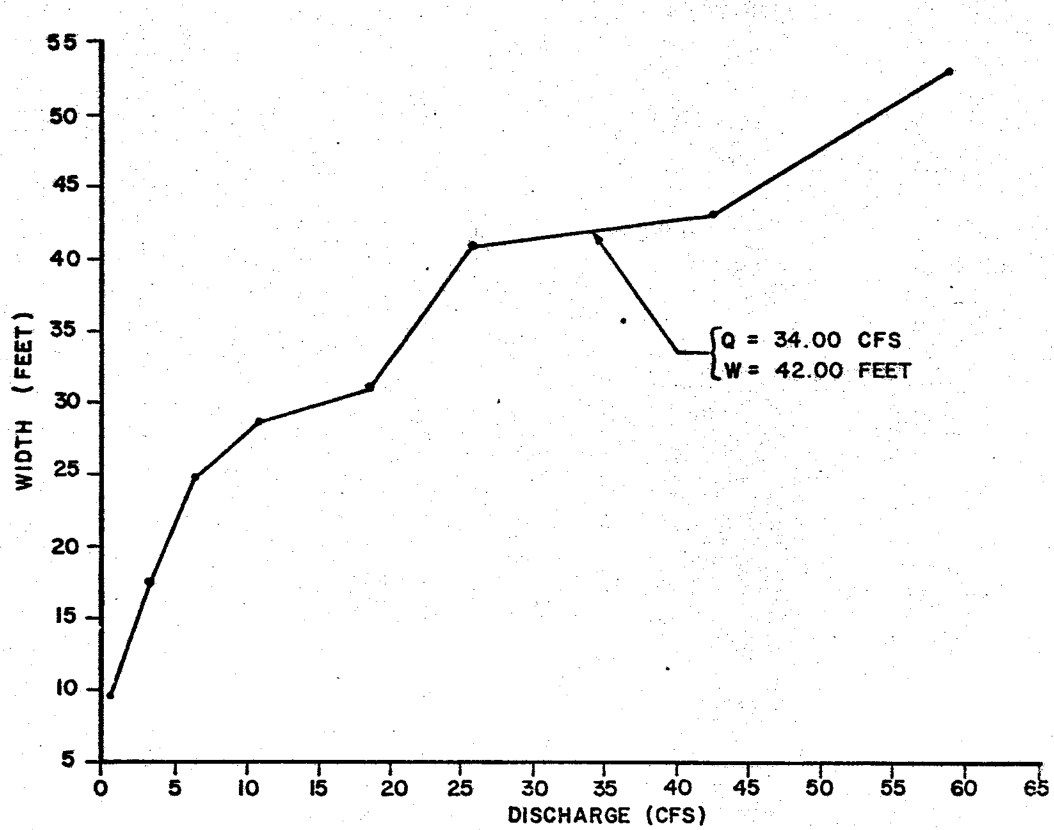


FIGURE - 9 Discharge vs. Width for Incremented Depth Reduction of 10/19/78 Data at Transect No. 2

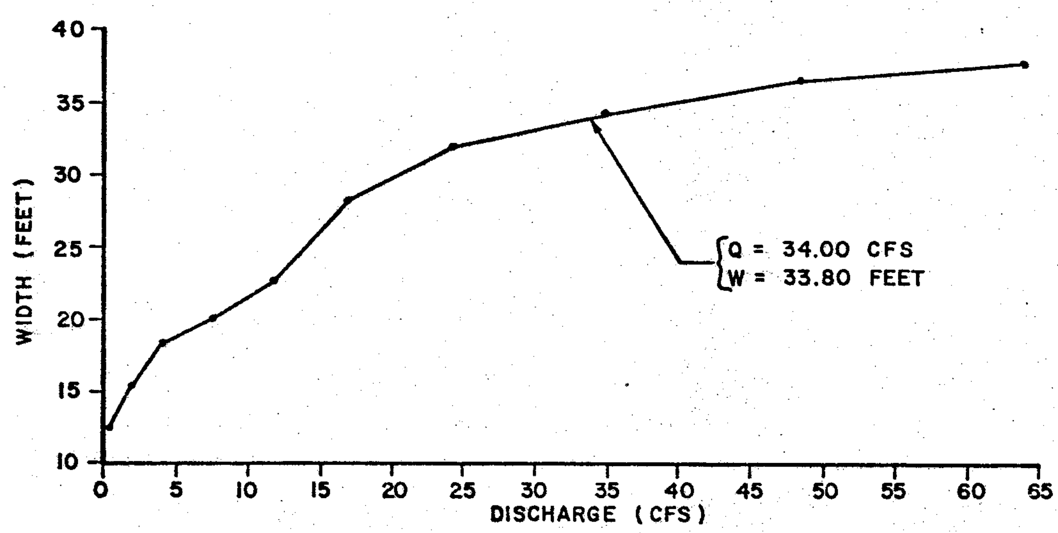


FIGURE-10 Discharge vs. Width for Incremented Depth Reduction of 10/19/78 Data at Transect No. 4

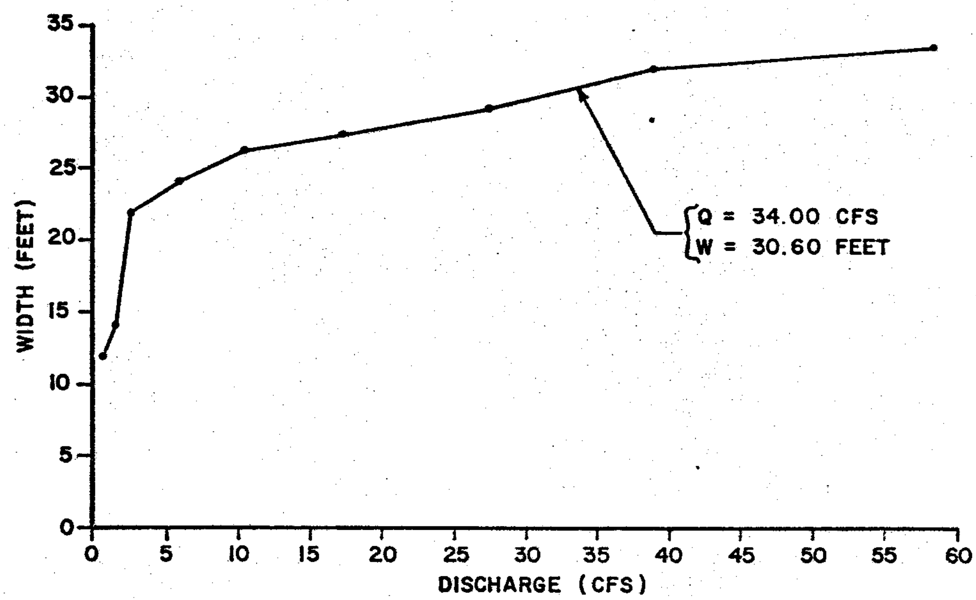


FIGURE-11 Discharge vs. Width for Incremented Depth Reduction of 10/19/78 Data at Transect No. 6

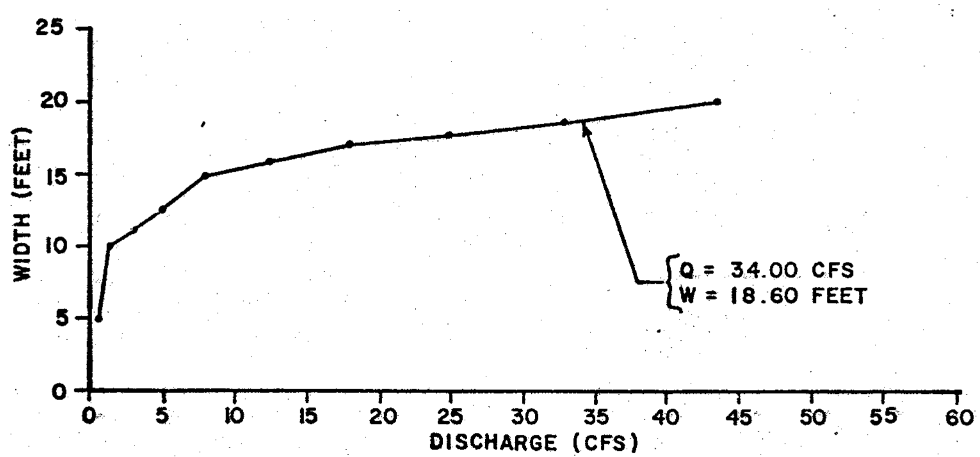


Table 12. Total Width and Usable Width for Each Transect

Transect	Date	Total Width at 34 cfs	Wet Width	Usable Width Feet	Usable Width % of Total Width	Longest Continuous Usable Width Feet	Longest Continuous Usable Width %	Stream Width at Minimum Usable Flow
1	6/15/8	42.00	17.10	10.50	25	6.80	16	
	10/19/8	42.00	23.80	9.70	23	9.70	23	
	4/29/9	42.00	20.30	10.70	25	6.10	15	
	5/24/9	42.00	18.30	10.50	25	7.50	18	
	6/02/9	42.00	21.00	11.70	28	7.40	18	
	6/09/9	42.00	17.10	10.70	25	7.40	18	
	Mean		19.60	10.63	25	7.48	18	
2	6/16/8	33.80	19.15	8.70	26	8.70	26	
	10/19/8	33.80	16.75	8.35	25	7.60	22	
	4/29/9	33.80	23.25	8.45	25	6.20	18	
	5/24/9	33.80	21.10	8.50	25	5.00	15	
	6/02/9	33.80	20.40	8.55	25	5.20	15	
	6/09/9	33.80	20.80	8.35	25	4.60	14	
	Mean		20.24	8.48	25	6.22	18	
4	6/16/8	30.60	19.75	7.70	25	6.05	20	
	10/19/8	30.60	16.50	7.65	25	7.65	25	
	5/24/9	30.60	18.55	7.80	25	5.50	18	
	6/02/9	30.60	20.90	7.50	25	4.90	16	
	6/09/9	30.60	17.90	7.70	25	7.70	25	
	Mean		18.72	7.67	25	6.36	21	
6	6/16/8	18.60	10.50	4.70	25	4.70	25	
	10/19/8	18.60	11.40	4.65	25	4.65	25	
	5/24/9	18.60	9.45	4.65	25	4.65	25	
	6/02/9	18.60	13.75	4.65	25	4.65	25	
	6/09/9	18.60	11.65	4.60	25	4.60	25	
	Mean		11.35	4.65	25	4.65	25	

FIGURE-12 Discharge vs. Mean Width for Six Dates at Transect No. 1

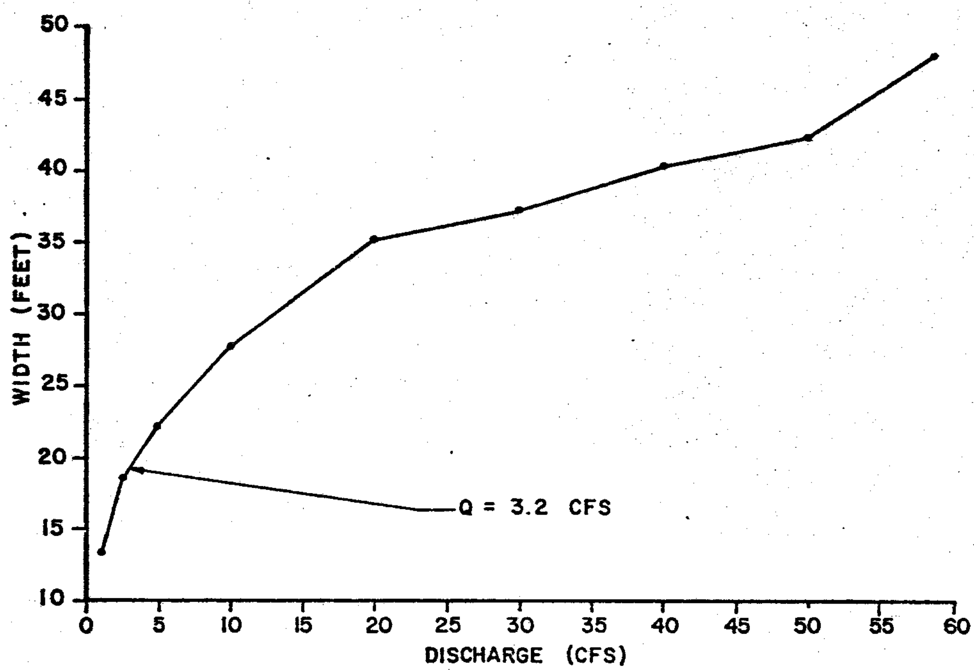


FIGURE-13 Discharge vs. Mean Width for Six Dates at Transect No. 2

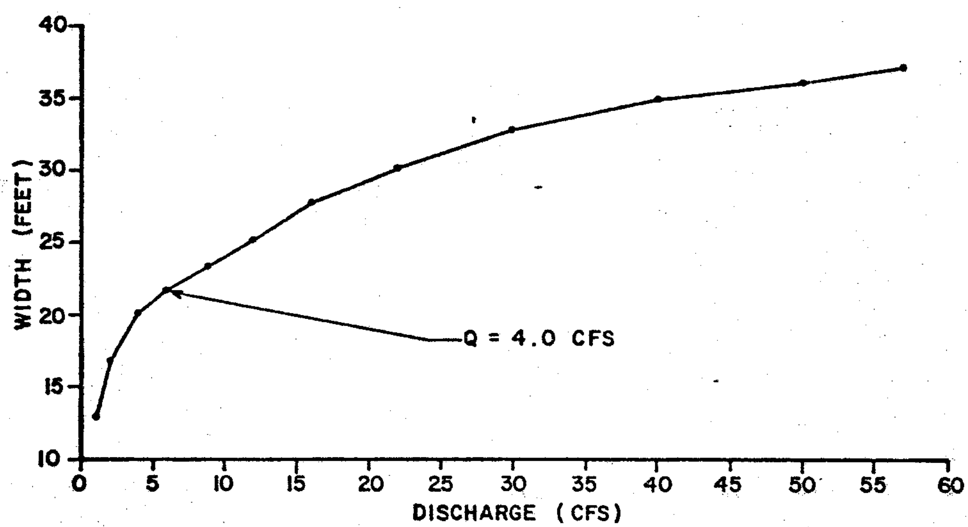


FIGURE-14 Discharge vs. Mean Width for Five Dates at Transect No. 4

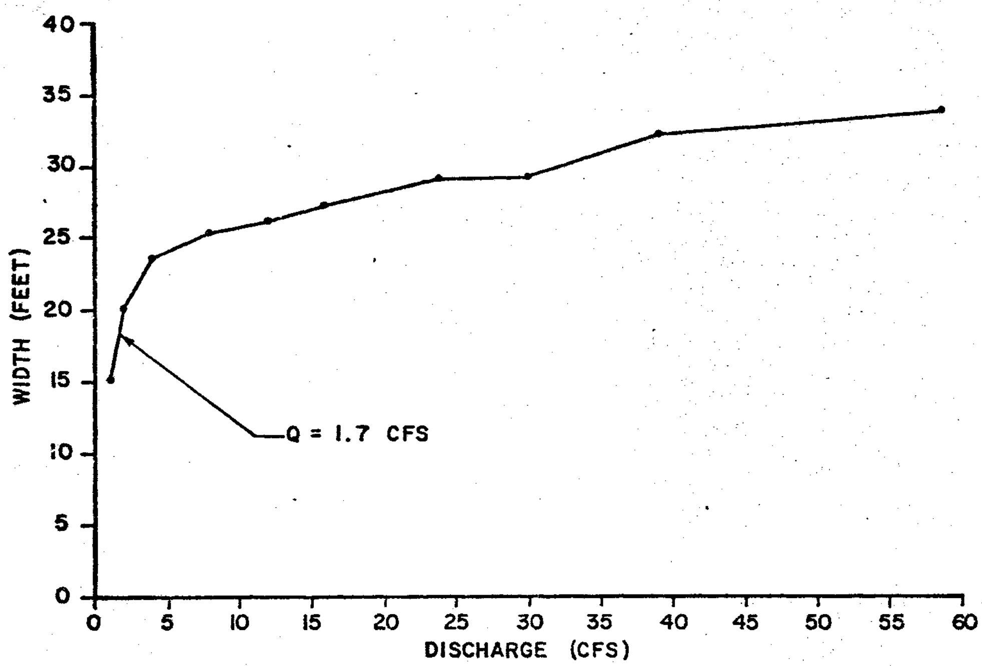
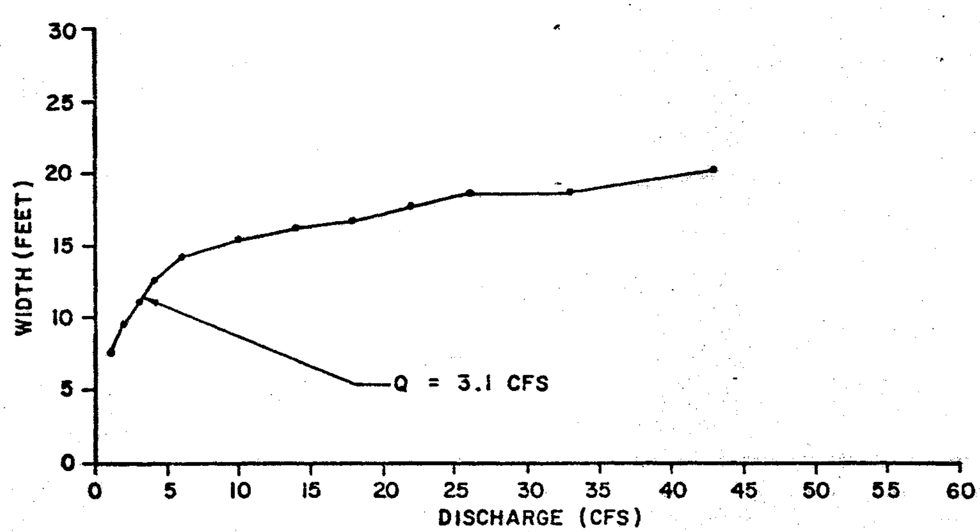


FIGURE-15 Discharge vs. Mean Width for Five Dates at Transect No. 6



figures along with its corresponding discharge. The streamflow which provides the minimum depth criterion for transects 1, 2, 4 and 6 are 3.2, 4.0, 1.7 and 3.1, respectively. In accordance with the Oregon method, the four flow values were averaged to 3.0 cfs to become the minimum streamflow recommendation.

Profiles were averaged for each transect for depth and water velocity and plotted against discharge. The results of these analyses appear in Figures 16 through 19. At streamflow of 3.0 cfs at the four transects, mean velocity ranges from 0.34 fps to 0.63 fps and average depth varies from 0.30 to 0.44 feet.

A discharge of 3.0 cfs is recommended as the minimum flow only for the months of September through May. Greater streamflows are desired for the summer months. Much of the annual growth of trout fry and aquatic insects, the food supply of the salmonids, takes place during the summer months in response to warm water temperatures. To enhance the productive capability of the stream ecosystem, additional flows are necessary to increase the amount of available habitat. An increase in the stream width at the riffles will provide additional habitat for the aquatic insects. A minimum streamflow of 10 cfs is recommended for the summer months which will greatly increase available habitat. The average stream width at the four transects at a streamflow of 3.0 cfs is 23.2 feet. An increase of 75% of the stream width is realized by increasing flow to 10 cfs (Figures 12 through 15).

FIGURE - 16 Mean Depth and Velocity vs. Discharge at Transect No. 1 for Six Dates

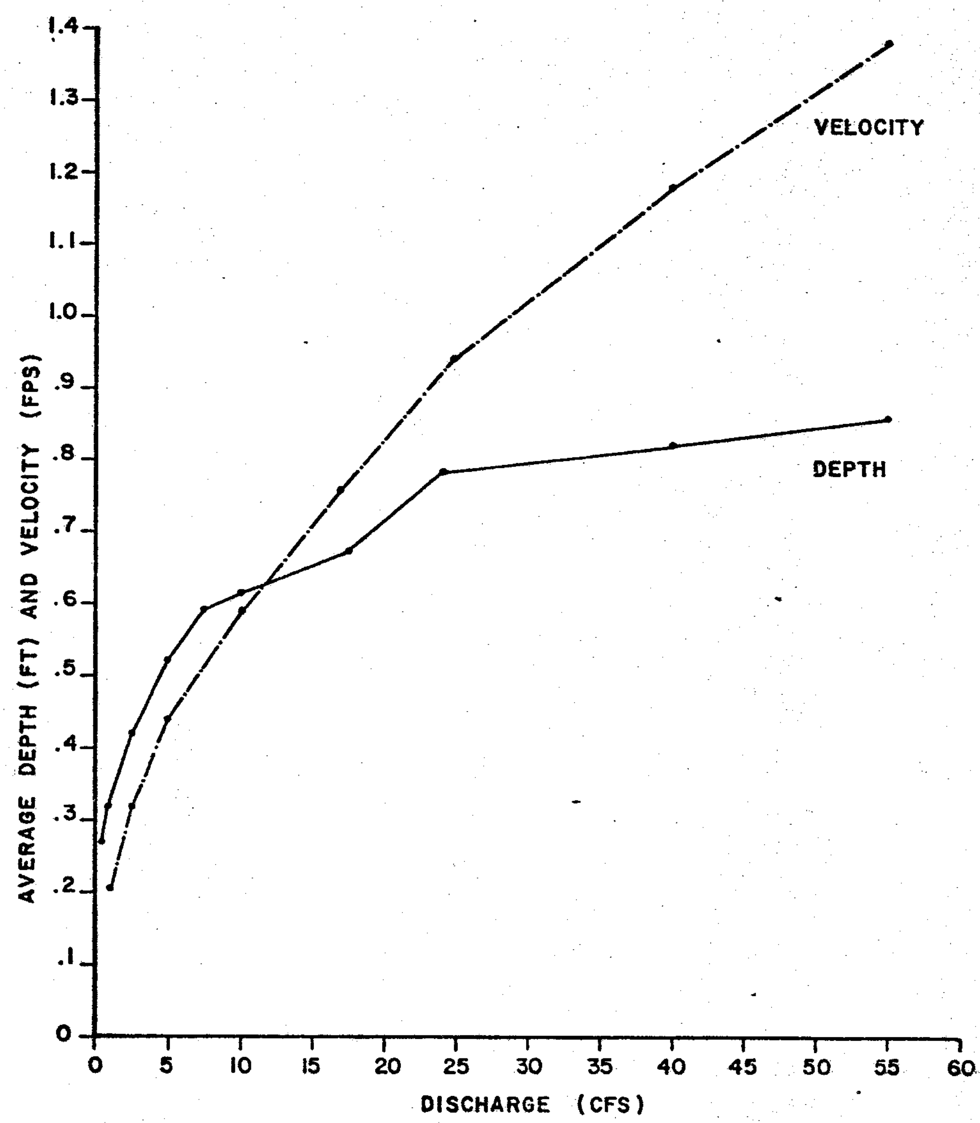


FIGURE 17. Mean Depth and Velocity vs. Discharge at Transect No. 2 for Six Dates

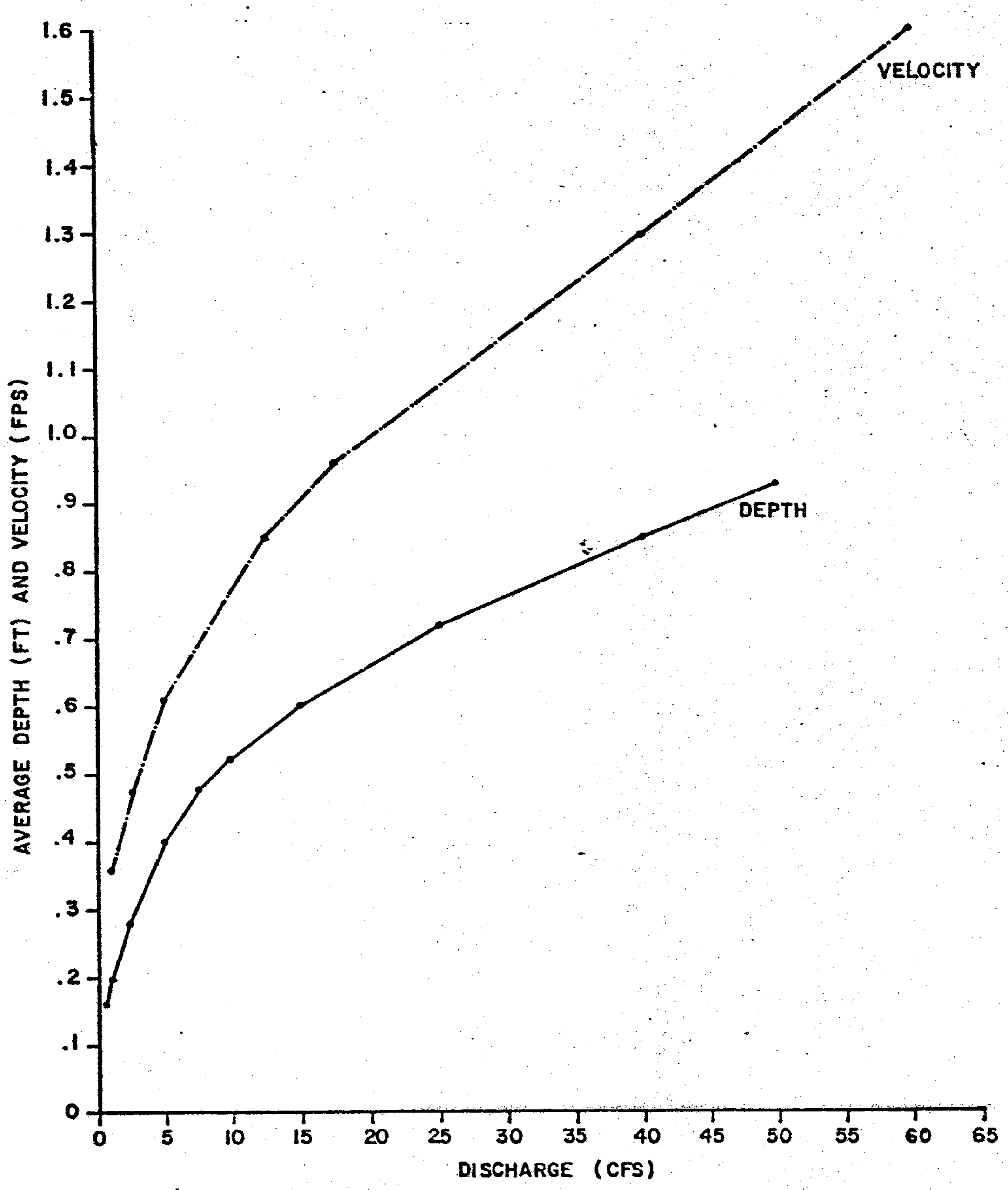


FIGURE - 18 Mean Depth and Velocity vs. Discharge at Transect No. 4 for Five Dates

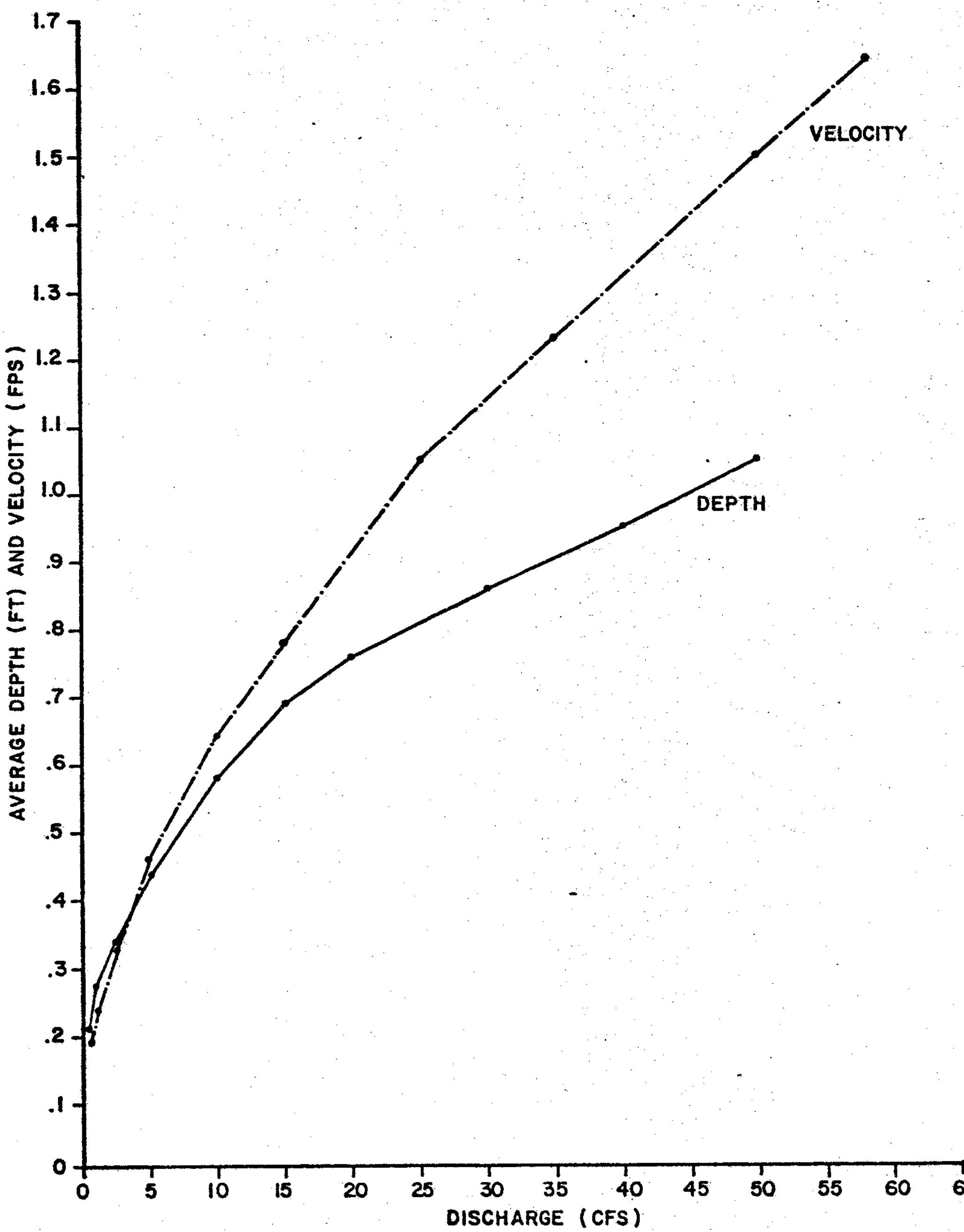
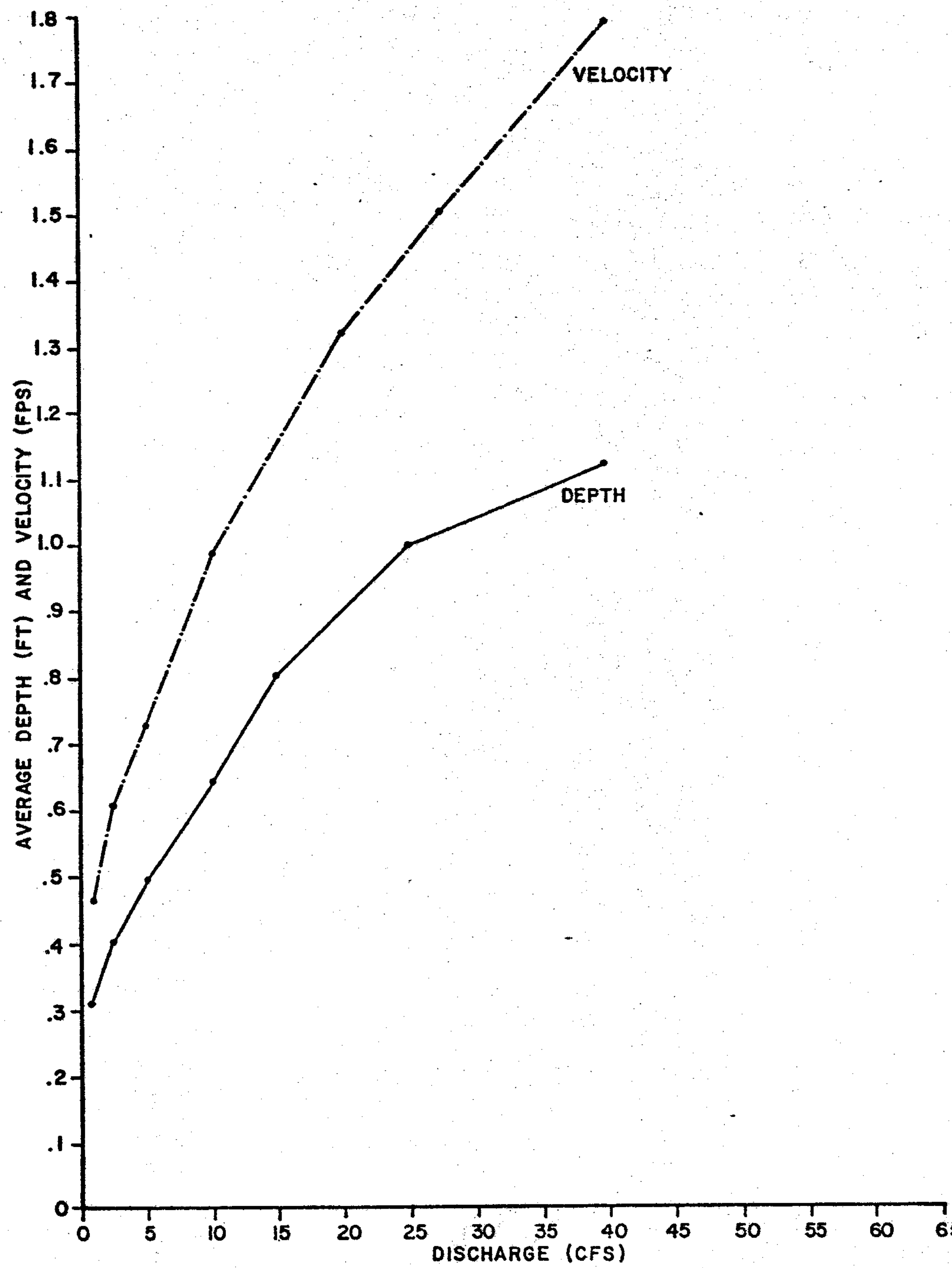


FIGURE - 19 Mean Depth and Velocity vs. Discharge at Transect No. 6 for Five Dates



The recommended flow of 3.0 cfs agrees closely with the recommended minimum flow of 3.4 cfs calculated from the Montana Method (Tennant 1975) which recommends 10% of mean flow as a "minimum flow to sustain short term survival habitat for most aquatic life forms".

DISCUSSION

Several techniques for hydraulic simulation were discussed by Bovee and Milhous (1978). Most currently used analytical procedures include Manning's equation. Bovee and Milhous described the degree of error that results when the stage-discharge relationship for a stream channel is determined. They demonstrated the change that occurs in the energy slope (S) and roughness coefficient (n) with discharge. Analytical methods such as WSP, which was initially used in this study, employ only one or two field determinations of these variables and calibration of Manning's equation results in a greater degree of error. The error can be minimized by obtaining additional stream width measurements at different flow rates; however, sufficient correlation between stream width at transects and upper weir flows did not exist, due to influences of ground water and tributaries. The degree of error is significantly reduced by obtaining more measurements at each transect and placing reasonable limits on extrapolation of curves of discharge versus channel characteristics. These two points were adhered to in this study and provided a more reliable result than was to be expected by using WSP. Predictions for the range of flows studied are expected to be fairly accurate.

A September to May minimum flow of 3.0 cfs will undoubtedly require the introduction of supplemental flows during some winters. The benefits to the fish community are unquantifiable at this time; however, they are expected to be substantial in view of the fact that riffle areas in the upper reaches have previously experienced total dewatering in some winter months. Winter survival of fish and production of food organisms are expected to be greatly enhanced.

Spring runoff usually does not influence the stream appreciably until mid June. In years of late snowmelt, streamflow may have to be supplemented to attain 10 cfs by June 1. Increased flow and higher water temperature during this period will provide greater assurance that habitat conditions necessary for summer growth of age 0 fish and the food organisms are met.

The difference between winter and summer flows is extreme for the study section as it is for many alpine streams; however, the sudden high flows caused by spill over the dam creates an unknown degree of stress for the stream organisms. The first spill creates, on the average, a sudden 800% increase in streamflow. It comes at a time when trout fry are present. It can dislodge riffle insects and destroys the beaver dams and lodges present in the study area. Such surges are mimicked in other unimpounded streams of the area on very warm spring days, perhaps to a lesser degree. It was not within the scope of this study to quantify these effects and these occurrences cannot be avoided. Efficient plant operation can; however, tend to reduce the peak of the spill discharge, by increasing generation in advance of snowmelt. This is common practice, but its success is limited by unpredictable changes in snow pack and weather conditions. The storage reservoir can fill at a rate of 2 to 3 feet per day in the period prior to spill even if the plant is generating at maximum capacity.

A possible hindrance to attempts at reduction of peak spill is the imposition of the recreation level of 7663.5 feet to be met by July 1. In years of late snowmelt, the surface elevational level of 7663.5 feet does not occur until after July 1. If this condition were anticipated, it would be necessary to operate the plant at reduced capacity in June until the recreational level is attained. As rapidly as the reservoir fills, spill occurs within a few days after reaching that level; therefore, the generation would probably be increased, perhaps to maximum capacity immediately after the required level is met, in order to reduce the magnitude of spill. An operation such as this may tend to increase the magnitude of the peak spill flow, thus placing greater stress than necessary on the fish and insects below the dam. This potential problem could be eliminated by delaying the date of attaining the recreational surface elevation.

The recreational level is assumed to provide a benefit for persons launching boats from docks. There are currently only 12 boats at Mystic and in a year of delayed runoff, access to the lake by the foot trail may be limited by deep snow as late as the first week of July. The benefits of a recreational level for boating are insignificant at Mystic Lake, relative to the potential damage to the stream community from excessive spill flows.

The presence of young rainbow trout of 50 mm length at the upper two sections in May 1978 indicates successful hatching in the spring of 1977 and favorable conditions for survival in the winter of 1977-1978. The decrease in condition factor with the increase in size of rainbow trout and the slope of the length-weight regression line indicate that fish become progressively thinner during growth. This growth trend does not indicate an unhealthy population because condition factors remained relatively high, even in the larger rainbow collected. Body confirmation of the larger fish, as determined by the relative size of the head and body of each fish, did not indicate that fish remained in the study area after attaining their present size. The absence of larger rainbow suggests the upper limits on growth which can be expected in this reach of West Rosebud Creek. Because of the cold water temperatures, high stream gradient, and the size of the stream, it is not expected that the rainbow population can be significantly benefitted by a large flow augmentation.

The May, 1978 collections of rainbow trout in Section Nos. 1 and 2 did not include a recapture sample and winter mortality could not be determined. Thirty eight percent of the fish marked in August, 1977, in Section 1 were recaptured in May, 1978. This compares with a recapture rate of 22% for fish marked on August 16, 1978 and recaptured five days later. This indicates poor efficiency in collecting, but it also suggests that winter survival was probably fairly high in Section No. 1. Section 1 contains numerous large deep pools which comprise more than half of the section; the remainder of this section is composed of shallow reaches and riffles. Flows in this section may have been reduced below one cfs during the winter; however, the fish apparently endured the low flows by taking refuge in the pools.

The recapture rate in Section No. 2 was only 5% for fish marked in August, 1977, and recaptured in May, 1978. The majority of Section 2 consists of broad riffle areas of fast flowing water. Capture efficiency is significantly lower in this habitat than in slow pools. This fact may explain the low recapture rate or the low rate may be a result of winter mortality. The riffles of Section 2 are the longest, continuous reaches of shallow water in the entire study section and are interspersed only occasionally by large pools. These reaches may have been seriously dewatered in the winter of 1977-1978 and mortality may have been high.

Brown trout were found only at the lower Section, No. 3. The brown trout captured in October, 1977, were ripe for spawning; however, the absence of significant numbers of young indicate that hatching and/or rearing was unsuccessful.

The high recapture rates for brown trout prior to spawning indicates the population is isolated from spawning browns downstream. Although fish have been sighted jumping the 4.5 feet high lower weir, the recapture rate indicates the numbers of fish passing the weir is not significant. Therefore, the portion of the stream above the powerhouse is probably not available to brown trout for spawning runs from downstream of the powerhouse.

RECOMMENDATIONS

1. The minimum flow of the portion of West Rosebud Creek between Mystic Lake and the powerhouse should be 3.0 cfs as measured at the upper weir, for the nine months of September through May. For June through August the minimum flow should be 10 cfs.

2. Frequent adjustment of supplemental flows should be avoided. It should be remembered that rapid fluctuations of flow can be detrimental to young fish and riffle insects. Therefore, a certain amount of leeway should be present in the recommended minimum. It is suggested that the streamflow may vary between 2 cfs and 6 cfs for a three (3) day period before adjustments in supplemental streamflow are made.

3. To facilitate the introduction of supplemental flows, it is recommended that water be introduced to the stream at a point near the upper reaches of the study section. This can be accomplished by releasing water via a valve from the wood pipeline near the dam. A calibrated valve which could be operated remotely from the powerhouse will be considered for this purpose.

4. The FERC license provision for attainment of the recreational water level in Mystic Lake on July 1 can indirectly

influence the peak flow in West Rosebud Creek during the summer spill period. By delaying the date of attainment of the recreational water level, the abnormally high peak flow in the summer months may be reduced. It is recommended that the date of attainment of the recreational water level be delayed to July 10.

5. Investigate measures to improve weir gauge reading accuracy at low flow. The amount of error introduced in reading the weir gauge at flow values circa 3 cfs may be large depending upon operator experience. Installment of a stilling well should be considered for this purpose.

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APPENDIX 1

THE MONTANA POWER COMPANY
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59707 · TELEPHONE 406 / 723-5421
SERVING YOU IS OUR BUSINESS

February 3, 1978

Mr. Don Tennant
U. S. Fish and Wildlife Service
Federal Building
Room 3025
Billings, MT 59101

Dear Don:

Enclosed is a brief proposal for continued in-stream flow studies on West Rosebud Creek. Feel free to comment.

On another matter, I intend to request additional time to complete this project. The Federal Power Commission stated in the project license that the fish study report is to be submitted to the FPC by October, 1978. Due to the exceptional flow conditions of 1977, it is necessary to continue field work in 1978. The final field sampling should be completed in September or October which will not allow sufficient time to analyze the data or write a report. I wish to request a time extension until April 1, 1979. Your support for this request would be valuable. I would appreciate a letter from you indicating your support for a six-month time extension as we discussed previously. Your letter will be forwarded to the FPC.

Sincerely,

/s/ Dennis J. Schwehr

Dennis J. Schwehr
Ecologist

DJS/sa/2:2

Enclosure

THE MONTANA POWER COMPANY
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59707 · TELEPHONE 406/723-5421
SERVING YOU IS OUR BUSINESS

February 3, 1978

Mr. Clint Bishop
Montana Fish & Game Department
1125 Lake Elmo Drive
Billings, MT 59101

Dear Clint:

Enclosed is a brief proposal for continued in-stream flow studies on West Rosebud Creek. Feel free to comment.

On another matter, I intend to request additional time to complete this project. The Federal Power Commission stated in the project license that the fish study report is to be submitted to the FPC by October, 1978. Due to the exceptional flow conditions of 1977, it is necessary to continue field work in 1978. The final field sampling should be completed in September or October which will not allow sufficient time to analyze the data or write a report. I wish to request a time extension until April 1, 1979. Your support for this request would be valuable. I would appreciate a letter from you indicating your support for a six-month time extension as we discussed previously. Your letter will be forwarded to the FPC.

Sincerely,

/s/ Dennis J. Schwehr

Dennis J. Schwehr
Ecologist

DJS/sa/2:2

Enclosure

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Billings Area Office
Federal Building, Room 3035
316 North 26th Street
Billings, Montana 59101

February 7, 1978

Mr. Dennis Schwehr
Ecologist
Montana Power Company
40 East Broadway
Butte, MT 59707

Dear Dennis:

We received your letter of February 3, 1978 regarding the in-stream flow studies on West Rosebud Creek. Mr. Tennant, a member of our Ecological Services staff, reviewed your letter and will continue to work closely with you and Clint Bishop of the Montana Fish and Game Department on this project.

We fully support your proposal for a time extension until April 1, 1979 to complete a final report. A comparison between the drouth year of 1977 and a probable, more normal runoff this year, with spills over the Mystic Lake Dam would be very valuable in determining the most appropriate in-stream flows for the reach of the West Rosebud River under study.

If we can be of further help on the study and project of mutual interest, please let us know.

Sincerely,

Burton W. Rounds,
Area Manager

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME
1125 Lake Elmo Drive
Billings, Montana 59101
February 10, 1978

Mr. Dennis J. Schwehr
The Montana Power Company
40 East Broadway
Butte, Montana 59707

Dear Dennis:

I support your request to the Federal Energy Regulatory Commission to extend the time period for the fish study report to April 1, 1979 for the studies on West Rosebud Creek. This additional time will allow inclusion of field work in 1978 as 1977 was an atypical dry year and could not be considered representative of conditions normally occurring in the stream.

I approve your study proposals as submitted to me.

Sincerely,

Clinton G. Bishop

Clinton G. Bishop
Regional Fishery Manager

CGB:f

cc Don Tennant

THE MONTANA POWER COMPANY
GENERAL OFFICES 40 EAST BROADWAY, BUTTE, MONTANA 59701 • TELEPHONE 406 / 723 5421

ROBERT J. LABRIE
VICE PRESIDENT AND CHIEF ENGINEER

March 1, 1978

Federal Energy Regulatory Commission
825 N. Capitol Street N.E.
Washington, D.C. 20426

Gentlemen:

RE: Project No. 2301
Mystic Lake

The Montana Power Company is licensee of the above project, pursuant to ORDER, ISSUING NEW LICENSE (MAJOR), issued October 5, 1976.

Article 34(b) of the license provides in part:

> "Within two (2) years of issuance of this Order, the Licensee shall file with the Commission the results of such [mininum flow] studies."

We request an extension of time for filing the required studies from October 5, 1978 to April 1, 1979.

The basis for the request is as follows:

Field studies were conducted in 1977 which was an exceptionally low flow year. Flows over the upper weir located immediately above the powerhouse averaged 6.1 cfs during the calendar year 1977. In previous years, the average flow was about 45 cfs. The reason for the large difference was the fact that flows did not spill over the dam in 1977, the only year in which this has happened since plant operation began 50 years ago. As a result, the field data obtained in 1977 concerning fish populations and flows are not representative and, in fact, are unique. A schedule of minimum flows cannot be determined solely on the basis of unique data. The information gathered during these unusual conditions is of course valuable, but only if it is followed by continued investigations.

The Soil Conservation Service has determined current snowpack to be near normal in the West Rosebud drainage. Their estimate was made from measurements obtained in late January, 1978. It appears that stream flow may be normal in 1978 and spill flows over Mystic Dam can be expected.

Spill flows are a major contributor of the stream discharge and must be considered in the fish studies. We therefore plan to monitor changes in the population of fishes marked last fall by sampling again in the spring of 1978. To account for the effects of spill flows, it will be necessary to sample the populations again in late summer or early fall, possibly as late as October.

In addition, further flow and channel measurements are needed to expand on measurements taken during low flows in 1977.

The necessity of continuing field work late into 1978 will prevent completion of a study, analysis and report by October.

We have solicited and received the concurrence and support of the U.S. Fish and Wildlife Service and the Montana Department of Fish and Game. Copies of the relevant correspondence are attached.

Very truly yours,

R. J. Labrie
Vice President and
Chief Engineer

RJL/JC/llm/C:1

Attachments

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

OEPR-DLP
Project No. 2301 -
Montana Power Company
Montana

JUL 3 1978

Mr. R.J. Labrie
Vice President and Chief Engineer
Montana Power Company
40 East Broadway
Butte, Montana 59707

Dear Mr. Labrie:

This acknowledges receipt of an application filed on March 1, 1978, requesting an extension of time until April 1, 1979, for filing results of minimum flow studies required by Article 34 of the license for Mystic Lake Project No. 2301. The application contained letters from the U.S. Fish and Wildlife Service and the State of Montana Department of Fish and Game, supporting the request for an extension of time.

Based on a review of the application and supporting letters from the fish and wildlife agencies, Staff concludes that the additional time requested is essential to allow appropriate study of minimum flows, and that the extension would not adversely affect the aquatic habitat downstream from the project.

You are hereby granted approval for an extension of time until April 1, 1979, to complete minimum flow studies at the project and to file with the Commission study results and appropriate recommendations as required by Article 34 of the license for Project No. 2301.

Very truly yours,

Kenneth F. Plumb

Secretary

APPENDIX 2

THE MONTANA POWER COMPANY
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59707 · TELEPHONE 406/723-5421
SERVING YOU IS OUR BUSINESS

May 25, 1978

Mr. Don Tennant
U. S. Fish and Wildlife Service
Federal Building 3025
Billings, MT 59101

Dear Don:

We have started field investigations at West Rosebud Creek for this season and I wanted to keep you up to date on the present status.

An attempt was made to get to Mystic May 6, 1978, to sample the fish population at a flow of approximately 6 cfs. However, 40 inches of snow fell that weekend and we were unable to do anything. We sampled the creek May 20-21, at flows exceeding 20 cfs but efficiency was low due to the high water. We hope to conduct a recapture run May 27-28, if flows permit access.

It was our intention to obtain a population estimate this spring to determine winter survival and obtain another estimate this fall to assess the effects of summer spill flows. Unfortunately, recent events may have an adverse effect on the stream and the study. A rock slide has removed a 50-foot section of the penstock from the canyon wall. Large amounts of silt have been deposited in the stream below the break, jeopardizing the survival of brown trout eggs and fry. Rainbow trout are spawning now as siltation continues.

Repairs to the penstock may not be completed until late summer. This will cause the reservoir to fill at a higher than normal rate and the spill flow over the dam is expected to be excessive in terms of magnitude and duration. Our hydrologist estimates a total spill of 25,000 cfs days. The velocity induced by extreme discharge may be as detrimental to the fish population as excessively low winter flows. Autumn sampling may reveal the effects of excessive flow. The point of concern, however, is that we do not have normal conditions with which to conduct the fish study. We have gone from one extreme to the other, from drought in 1977 to flood in 1978. Information obtained under such conditions is valuable but delays the determination of suitable minimum flows for the salmonids.

It is our intention to request another time extension from the Federal Energy Regulatory Commission in order to continue investigation through 1979. Assuming a more normal flow regime next year, we wish to extend our submittal date to April 1, 1980. The scientific interest alone, makes it desirable to investigate the fishery through the unusual circumstances of low, high and average flow conditions. I would appreciate any comments you may have, and if you are in concurrence with this proposal, please so advise.

Sincerely,

Dennis J. Schwehr, Ecologist
Environmental Protection Department

DJS/lh/5:6

cc: John Carl
Chuck Duffield

THE MONTANA POWER COMPANY
GENERAL OFFICES: 40 EAST BROADWAY, BUTTE, MONTANA 59707 - TELEPHONE 406/723-5421
SERVING YOU IS OUR BUSINESS

May 25, 1978

Mr. Clint Bishop
Montana Department of
Fish and Game
1125 Lake Elmo Drive
Billings, MT 59102

Dear Clint:

We have started field investigations at West Rosebud Creek for this season and I wanted to keep you up to date on the present status.

An attempt was made to get to Mystic May 6, 1978, to sample the fish population at a flow of approximately 6 cfs. However, 40 inches of snow fell that weekend and we were unable to do anything. We sampled the creek May 20-21, at flows exceeding 20 cfs but efficiency was low due to the high water. We hope to conduct a recapture run May 27-28, if flows permit access.

It was our intention to obtain a population estimate this spring to determine winter survival and obtain another estimate this fall to assess the effects of summer spill flows. Unfortunately, recent events may have an adverse effect on the stream and the study. A rock slide has removed a 50-foot section of the penstock from the canyon wall. Large amounts of silt have been deposited in the stream below the break, jeopardizing the survival of brown trout eggs and fry. Rainbow trout are spawning now as siltation continues.

Repairs to the penstock may not be completed until late summer. This will cause the reservoir to fill at a higher than normal rate and the spill flow over the dam is expected to be excessive in terms of magnitude and duration. Our hydrologist estimates a total spill of 25,000 cfs days. The velocity induced by extreme discharge may be as detrimental to the fish population as excessively low winter flows. Autumn sampling may reveal the effects of excessive flow. The point of concern, however, is that we do not have normal conditions with which to conduct the fish study. We have gone from one extreme to the other, from drought in 1977 to flood in 1978. Information obtained under such conditions is valuable but delays the determination of suitable minimum flows for the salmonids.

It is our intention to request another time extension from the Federal Energy Regulatory Commission in order to continue investigation through 1979. Assuming a more normal flow regime next year, we wish to extend our submittal date to ~~April 1~~, 1980. The scientific interest alone, makes it desirable to investigate the fishery through the unusual circumstances of low, high and average flow conditions. I would appreciate any comments you may have, and if you are in concurrence with this proposal, please so advise.

Sincerely,

Dennis J. Schwehr, Ecologist
Environmental Protection Department

DJS/lh/5:6

cc: John Carl
Chuck Duffield

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Billings Area Office
Federal Building, Room 3035
316 North 26th Street
Billings, Montana 59101

IN REPLY REFER TO:

ES

June 12, 1978

Montana Power Company
40 E. Broadway
Butte, MT 59707

Attn. Mr. Dennis J. Schwehr, Ecologist

Gentlemen:

Mr. Tennant of our Ecological Services Staff has reviewed your letter dated May 25, 1978, concerning field investigations at West Rosebud Creek between Mystic Lake and the power plant.

We agree that another year of field work would be very desirable considering the low runoff without a spill last year and the predicted high spills for this spring due to damage to the penstock and a good snowpack.

Thank you for keeping us advised of your studies on this project. If we can be of further assistance please let us know.

Sincerely,

John G. Wood
John G. Wood
Acting Area Manager

cc: Regional Director, USFWS, Denver, CO (ENV)
Montana Department of Fish & Game, Billings, MT (Attn Clint Bishop)

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME

1125 Lake Elmo Drive
Billings, MT 59101

July 12, 1978

Montana Power Company
40 E. Broadway
Butte, MT 59707

Attn: Mr. Dennis J. Schwehr, Ecologist

Gentlemen:

Your letter dated May 25, 1978, concerning field investigations at West Rosebud Creek between Mystic Lake and the power plant, has been reviewed. We agree that another year of field work would be very desirable considering the low runoff without a spill last year and the predicted high spills for this spring due to damage to the penstock and a good snowpack.

Thank you for keeping us advised of your studies on this project. If we can be of further assistance, please let us know.

Sincerely,

Clinton G. Bishop
Regional Fishery Manager

CGB/kb

January 19, 1979

Federal Energy Regulatory Commission
825 N. Capitol Street N.E.
Washington, D.C. 20426

Re: OEPR-DLP
Project No. 2301

Gentlemen:

Article 34(b) of the license for the above project issued October 5, 1976 provides in part:

> "Within two years of issuance of this order, the Licensee shall file with the commission the results of such [minimum flow fishery] studies."

The Licensee has heretofore applied for and has been granted an extension of the time of completion of the studies to April 1, 1979. The purpose of this letter application is to seek a further extension of time to July 1, 1980, for the reasons stated below.

On May 2, 1978, the 56" wood stave pipeline which is part of the conduit for water from the storage lake to the powerhouse was damaged with the result shown in the photograph which accompanies this application.

Apparently, a boulder on the hillside some distance above the pipeline was dislodged by natural forces, and tumbled down the mountain with sufficient force to penetrate the pipeline. The stream of water from the ruptured area resulted in the erosion and landslide conditions apparent in the picture. Approximately 200 feet of the pipeline must be reconstructed as a result.

The eroded material carried into the stream below as a result of the area may jeopardize the survival of trout eggs, fry and food organisms in the creek, and most certainly has not provided a representative environment for study.

Because the plant has been off the line for an extended period, the storage lake is full, and current inflows are

Re: OEPR-DLP
Project No. 2301

being discharged through the study area via two valves - one at the dam and one on the pipeline upstream from the break. This volume of water exceeds the normal late fall-early spring flows substantially, is difficult to work in, and is not representative of expected conditions.

Repairs to the pipeline have been under way for some time, but have been seriously hampered by severe weather conditions. At this writing, a repair crew is digging its way through snowdrifts as much as fourteen feet deep to resume work. Weather permitting, the repairs will be completed in mid- or late February, and the normal flow regime of the stream re-established before next spring.

The concurrence of the Montana Department of Fish and Game and the United States Fish and Wildlife Service has been solicited and obtained, as shown by the attached correspondence.

It appears reasonably certain that a fairly normal season will occur next year. Our Ecologist, Dennis Schwehr, has indicated that an extension of the report time to July 1, 1980 should provide an adequate data base for development of a recommended minimum flow regime for the Project. Although an April 1, 1980 date was suggested to the fishery agencies, we are applying for an extension to July 1, 1980 as a precaution, in the event normal operation cannot be resumed this Spring.

Very truly yours,

Robert J Labrie

RJL/em
Enclosures

A

E.V. [illegible]

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

OEPR-LP
Project No. 2301-
Montana

FEB 14 1979

Mr. R. J. Labrie
Vice President and Chief Engineer
The Montana Power Company
40 East Broadway
Butte, Montana 59701

Dear Mr. Labrie:

By letter dated January 19, 1979, the Montana Power Company requested a further extension of time (the initial extension expires April 1, 1979) until July 1, 1980, for filing the results of minimum flow studies required by Article 34 of the license for Mystic Lake Project, FERC No. 2301. The request included supporting letters from the U.S. Fish and Wildlife Service and the State of Montana Department of Fish and Game.

The extension became necessary due to a rupture in the project penstock which produced an atypical flow regime and greatly increased sediment load in the study area. The study, as outlined, could not resume before completion of repair work, which would allow the resumption of controlled flows below the project required by the study design.

Staff has reviewed the request for an extension of time, and the supporting letters from the fish and wildlife agencies, and concludes that the additional time would be essential to allow an appropriate study of minimum flow requirements. Further, Staff believes that the extension would not adversely affect the aquatic habitat downstream from the project.

By delegation of authority under Section 3.5(g) of the Commission's regulations, 18 CFR 3.5(g) as amended August 14, 1978, the request for further extension of time, until July 1, 1980, for filing the minimum flow study results is hereby approved.

Sincerely,

William W. Lindsay
Director, Office of Electric
Power Regulation