

Elk Creek Minimum Stream Flow Water Permit 83-07099 Proof of Beneficial Use

Background

Elk Creek Falls is one of northern Idaho's unique natural features, and is a major scenic attraction within the geographic area encompassing Lewiston-Clarkston, Moscow-Pullman, and other Clearwater Valley communities. Located three miles south of Elk River, Elk Creek Falls is a series of cascades that occurs on Elk Creek below the reservoir, and the Middle Falls are the highest in north Idaho. Rainbow trout and westslope cutthroat trout (Idaho Species of Special Concern) inhabit the lower reaches below the falls. The Idaho Water Resource Board applied for a minimum stream flow within this segment of Elk Creek in 1989 to preserve scenic and recreational purposes, and to provide flushing flows for recruitment of spawning gravels and sediment removal for fish habitat needs.

The minimum stream flow (Permit No. 83-07099) reach commences with the north section line of Section 11 (NWNWNE) and extends downstream to the confluence of Deep Creek with Elk Creek, Section 14 (NESENW), T39N, R2E, B.M., Clearwater County. The amount of water appropriated for the minimum streamflow and its period of use is 120 CFS from March 1 through June 30, and 40 CFS from July 1 through February 29. According to the *Proposed Memorandum Decision and Order* (dated 12/29/1989), the Board is required to "show evidence establishing that 120 cfs or some lesser number is a minimum flow and that a flow duration of March 1 through June 30 is necessary for recruitment of spawning gravels and removal of sediment". Additionally, the Permit Order requires additional flow data showing that the permitted flows are capable of being maintained.

Evidence Required for Proof of Beneficial Use

Additional Flow Data

In a letter from Frank Sherman (Chief, Water Planning Bureau, IDWR) to Rinda Just (Deputy Attorney General, IDPR) dated June 22, 1990 (*Attachment 1*), Mr. Sherman states that, "data collected at the U.S. Forest Service gage [near Elk River] will suffice to demonstrate that the permitted flows are capable of being maintained. If the Forest Service still collects data at the gage, copies of their data for an additional three years [beyond 1984] will be sufficient."

The US Forest Service has continued to operate the gage near Elk River, and those data were obtained to provide the mean hydrograph (*Attachment 2*), flow duration curve for the period March through June, and flow duration curve for the period July through February (*Attachment 3*) for 1980 through September 2001. Due to equipment failure, data obtained for 1986 and 1994 were partially derived, and these years were therefore excluded from the analysis. Flow duration curves demonstrate that flows of 40 CFS from July through February and flows of 120 CFS from March through June are capable of being maintained (based on a 50% exceedance criteria).

Spawning Requirements

According to Cindy Robertson (Staff Biologist, IDFG, refer to *Attachment 4*), optimal spawning conditions for most salmonids require less than 5% fines within spawning gravels, and greater than 30% fines leads to low survival of eggs and sac fry. Gravels in the range of 0.3 to 10cm diameter are suitable for rainbow and cutthroat trout. Fish less than 50 cm in length utilize 1.5-6.0 cm diameter gravel (most rainbow and cutthroat trout in Elk Creek are in this size category) and fish greater than 50 cm in length use 1.5-10 cm diameter gravels. Rainbow and cutthroat trout are spring spawners, with most spawning occurring from early April through late June, though it may extend from March to August. Therefore, early high flows in March are required to flush fines from gravels prior to commencement of spawning. High flows are required not only through the spawning period but through the end of June so that redds are not smothered and eggs aren't stranded. Temperatures of 50-60° F. are preferred. Females dig a redd in the gravel 3 to 6 inches deep, deposit their eggs, then cover them with additional gravel. Eggs hatch in 4 to 7 weeks, and sac fry emerge from the gravel generally from mid June to August (when spawning occurs in April and May). According to the hydrograph, flushing flows are available during this March through June time period (see *Attachment 2*).

Recruitment of Spawning Gravels

Richard Jones, US Forest Service hydrologist with the Clearwater National Forest, provided flow data from the gage above Elk River, and provided cross section and pebble count data for three transects on Elk Creek (*Attachment 5*). Bob Kenworthy, US Forest Service hydrologist with the Boise Adjudication Team, identified the sampling station just above the falls and below the Elk River Reservoir as the best representation of the water over the falls (and within the minimum stream flow segment). Therefore, data from this station was used to model sediment transport. This station (reach) is a riffle/run/pool transect with grain sizes ranging from less than 0.002mm to 512 mm, with 68% within the 32-256mm size class ($d_{50}=32-64\text{mm}$). There is gravel of a optimal size (1.5 to 10 cm) in the system for recruitment, according to the Wohlman pebble count data obtained from the USFS.

Simple model:

Almost all sediment transport equations incorporate the Shields parameter, which is a ratio of the total boundary shear stress as a driving force and the particle weight as a resisting force. Shield's approach considers those forces acting on resistance to initiate grain movement (critical shear stress, or Shields parameter), and is calculated based on submerged weight of the particle, drag force, and turbulent flow. The initiation of sediment (specified particle size) movement occurs when the shear stress is greater than critical Shields parameter. In other words, the critical shear stress is the force needed to initiate movement of particles at rest on the bottom of the stream. Total or basal shear stress of the stream must exceed this critical shear stress value in order to initiate movement.

Assumptions:

There are numerous stream parameters that must be determined or assumed in order to calculate the flow needed to move a certain particle size. As sediment size increases a higher flow is needed to move the particle. The cobble count was conducted by the USFS determined the average diameter (d_{50}) to range from 3.2 to 6.4 cm. For the modeling purposes d_{50} was assumed

to be 4.8 cm. The gravel diameter of interest (d_i) is 1.5 cm because it is the smallest optimum particle diameter required for spawning gravel.

Mannings n is a resistance factor of water flowing through a channel. As the resistance in the channel increases the flow needed to move a particle increase. Previous studies conducted on Elk Creek found the Mannings n to be 0.07.

The slope is important to the calculations. As slope increases there is more gravity acting on a particle thus requiring a lower flow to move that particle. The slope of the reach was found to be 1.6%.

The wetted parameter of the stream is used to calculate flow. Based on the information collected from previous studies along various reaches of Elk Creek the wetted ~~parameter~~ *perimeter* was estimated to be between 50 and 60ft.

Table: Summary of Assumptions.

Diameter of interest (d_i)	1.5 cm
Mean Diameter (d_{50})	4.8 cm
Manning's n	0.07
Slope (S)	1.6%
Wetted Parameter	50-60 ft

Calculations:

1. Calculate dimensionless shear stress
2. Calculate shear stress
3. Calculate hydraulic radius
4. Calculate velocity
5. Calculate flow

1. Calculation of critical dimensionless shear stress:

$$\tau_{cr}^* = 0.0834 \left(\frac{d_i}{d_{50}} \right)^{-0.872}$$

where:

τ_{cr}^* = Shield's Dimensionless Critical Shear Stress

d_i = grain size of interest, in this case the maximum spawning gravel diameter

d_{50} = mean grain size

2. By determining the dimensionless shear stress based on the particle size of interest, the critical shear stress can be calculated:

$$\tau_{cr} = \tau_{cr}^* * g(\rho_s - \rho_w)d_i$$

where:

τ_{cr}^* = Shield's Dimensionless Critical Shear Stress

τ_{cr} = Sheild's Critical Shear Stress

g = gravity (9.81 m/s²)

ρ_s = sediment density (2.65 g/cm³)

ρ_w = water density (1 g/cm³)

d_i = grain size of interest, in this case the maximum spawning gravel diameter

3. Using the shear stress the hydraulic radius can be calculated, which is essentially the depth required to move a particle. Hydraulic radius is the cross sectional area divided by the wetted perimeter. The hydraulic radius will be used to calculate the velocity.

$$R = \tau_{cr} \cdot \frac{(\rho_s - \rho)}{\rho} \cdot \frac{d}{S}$$

where:

R = Hydraulic radius

τ_{cr} = Sheild's Critical Shear Stress

ρ_s = Density of sediment

ρ = Density of water

d = given grain size

S = channel slope

4. Knowing the channel slope, hydraulic radius, and Manning's n , velocity can be calculated:

$$v = \frac{1}{n} \cdot R^{\frac{2}{3}} \cdot S^{\frac{1}{2}}$$

where:

n = Manning's n , coefficient of roughness

v = water velocity down the channel (ft / sec) = flow (cfs) / cross sectional area (ft²)

R = hydraulic radius (m) = cross sectional area (ft²) / wetted perimeter(ft)

S = gradient of channel (ft / 100ft)

5. Flow is equal to the stream velocity times the cross-sectional area:

$$Q = v \cdot R \cdot WP$$

where:

Q = flow

v = velocity

R = Hydraulic radius

WP = Wetted perimeter

Results:

D _i	D ₅₀	Slope	Manning's n	Wetted Perimeter	τ_{cr}^*	τ_{cr}	R (ft)	Velocity	Flow cfs
1.5	4.8	1.6	0.07	50	0.23	55.83	1.17	2	117
1.5	4.8	1.6	0.07	55	0.23	55.83	1.17	2	129
1.5	4.8	1.6	0.07	60	0.23	55.83	1.17	2	140

Simple Model - Conclusion:

The critical flows required to initiate movement of gravels in the lowest range of appropriate-sized gravels for spawning are 117 to 140. This is not a channel maintenance flow rather a flow needed to mobilize gravel needed for spawning.

Attachment 1: Letter from Frank Sherman to Rinda Just



State of Idaho
DEPARTMENT OF WATER RESOURCES

1301 North Orchard Street, Statehouse Mail, Boise, Idaho 83720 -(208) 327-7900

CECIL D. ANDRUS

GOVERNOR

R. KEITH HIGGINSON

DIRECTOR

June 22, 1990

Ms. Rinda Just
Deputy Attorney General
Idaho Department of Parks and Recreation
Statehouse Mail
Boise, ID 83720

RE: Permit No. 83-7099, Elk Creek Falls

Dear Ms. Just:

As per our earlier telephone conversation, Director Higginson has agreed to explore options with the Natural Resource agencies on ways to reduce the burden on the requesting agency to make proof of beneficial use for minimum streamflows. I shall keep you informed on the results of these discussions.

In the specific instance of the Elk Creek minimum streamflow:

1) The Department reserves the right to order installation of measuring devices. I interpret this to mean that data collected at the U.S. Forest Service gage will suffice to demonstrate that the permitted flows are capable of being maintained. If the Forest Service still collects data at the gage, copies of their data for an additional three years will be sufficient. If the Forest Service no longer maintains the gage, weekly readings by your staff or a mutually agreeable person or agency of the old gage or a replacement would be sufficient.

2) With regard to a study to determine flows necessary for the recruitment of spawning gravel, I suggest you seek the cooperation of the Idaho Department of Fish and Game in developing a study plan acceptable to the Department of Water Resources. I assume an examination of substrate conditions at various flows would be the basis of any study with emphasis on the timing of peak flows and their duration.

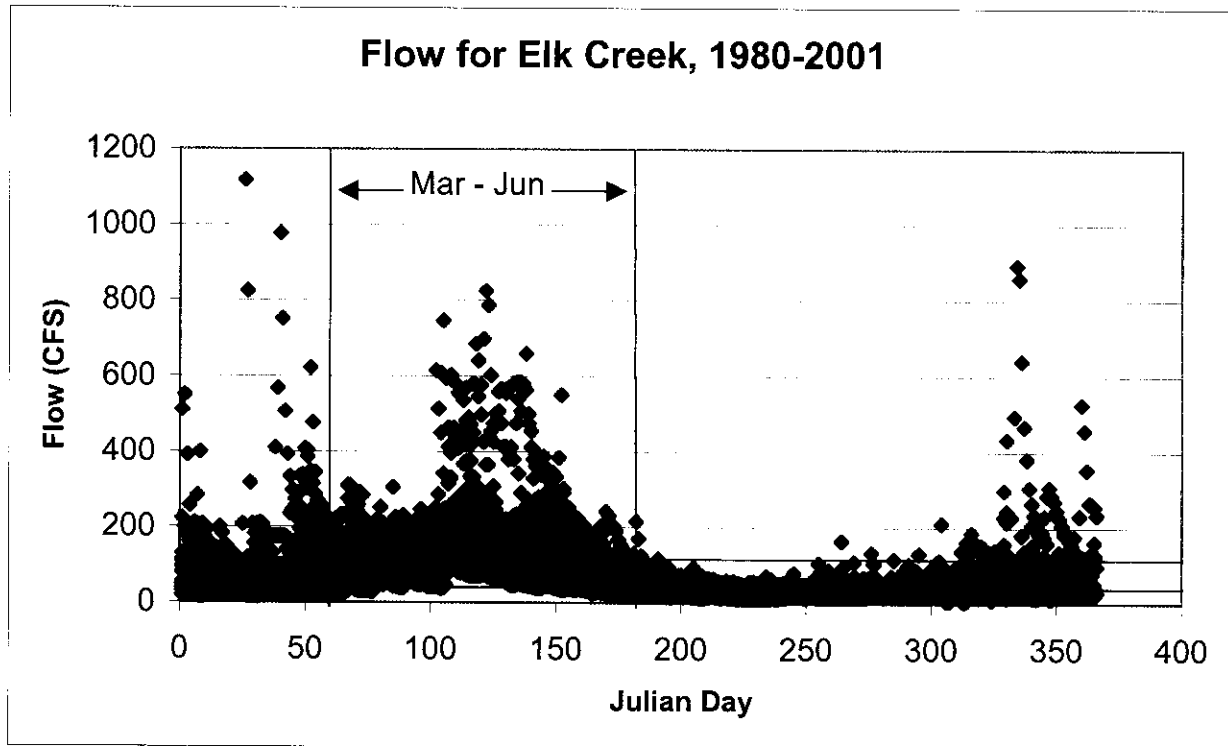
Sincerely,

Frank B. Sherman
Chief
Water Planning Bureau

FBS:cjk

Attachment 2:

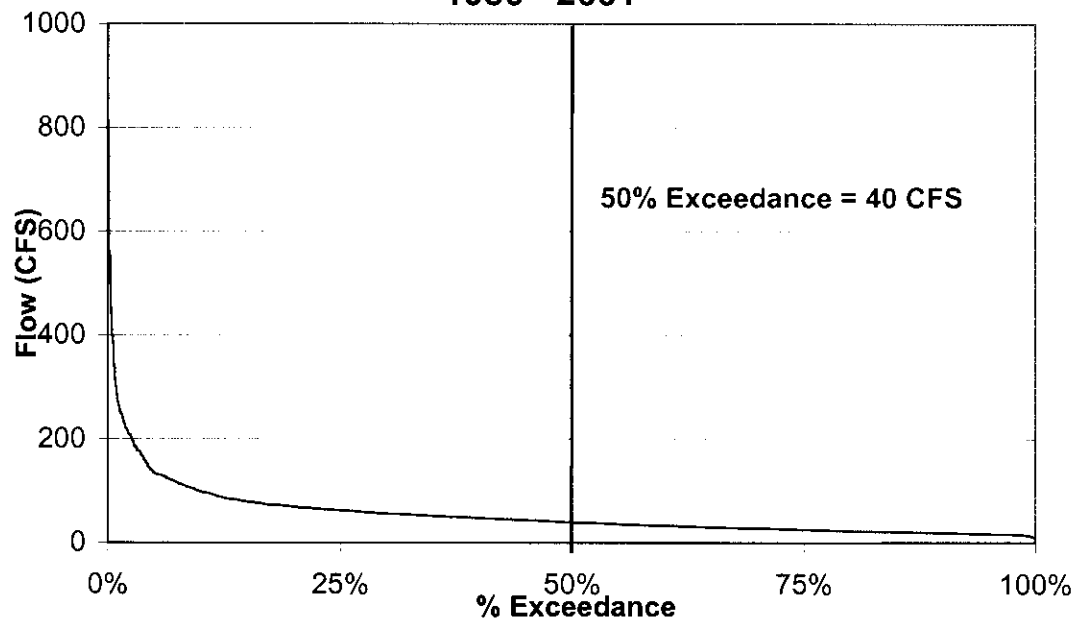
Elk Creek Hydrograph based on the USFS gage near Elk City



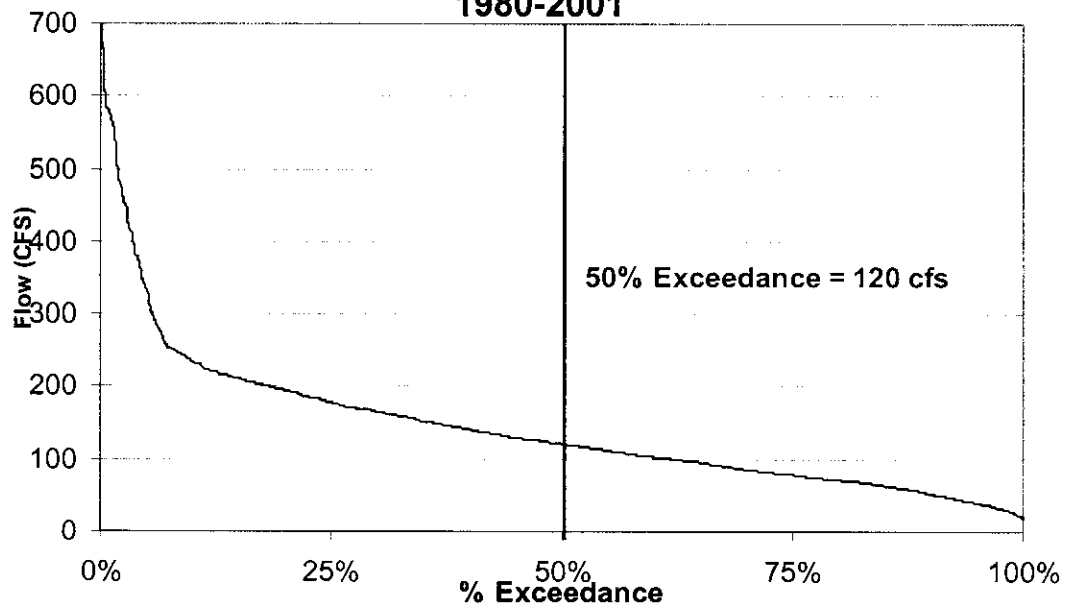
Attachment 3:

Flow Duration Curve for Elk Creek, March through June, based on the USFS gage near Elk City

**Flow-Duration Curve for Jul - Feb
1980 - 2001**



**Flow-Duration Curve for Mar - Jun
1980-2001**



Attachment 4: Rainbow Trout Spawning Requirements

Memorandum

To: David Blew, IDWR
CC: Dee Carlson, IDWR
From: Cindy Robertson, IDFG
Date: 10/29/01
Re: Elk Creek instream flow water right

I have found the following pertinent information regarding rainbow trout spawning requirements. According to Raleigh et al. (1984), the optimal spawning conditions for rainbow trout were described as follows.

Less than or equal 5% fines is optimal and greater than or equal 30% fines results in low survival of eggs and sac fry.

Suitable gravel size is 0.3 to 10.0 cm diameter.

Optimal gravel size is spawner size dependent: for fish less than 50 cm in length, 1.5 to 6 cm diameter; for fish greater than or equal to 50 cm in length, 1.5 to 10.0 cm diameter.

Most authors (Scott and Crossman, 1998; Brown, 1971; Simpson and Wallace, 1982) agree that spawning can occur from March to August, but most spawning occurs between April and late June, depending on regional location, habitat, and water temperature. Temperatures between 50 and 60 degrees Fahrenheit are preferred (Scott and Crossman, 1998). Females dig a redd in the gravel 3 to 6 inches deep, deposit their eggs, then cover them with additional gravel. Eggs hatch in 4-7 weeks and the alevins (sac fry) take 3-7 weeks to absorb the yolk sac and emerge from the gravel. Again, the time in the gravel is dependent upon water temperatures. Fry generally emerge from mid June to mid August when spawning occurs in April and May (Scott and Crossman, 1998).

I think this should give you the parameters we want to look at with the sediment modeling. Let me know if you want additional info.

Literature Cited:

W. B. Scott and E. J. Crossman. Freshwater Fishes of Canada. 1998. Galt House Publications, LTD. Oakville, Ontario Canada.

James Simpson and Richard Wallace. Fishes of Idaho. 1982. University of Idaho Press. Moscow, ID.

C.J.D. Brown. Fishes of Montana. 1971. Big Sky Books, Montana State University. Bozeman, MT.

October 29, 2001

R.F. Raleigh, T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat Suitability Information: Rainbow trout. U.S. Fish and Wildlife Service. FWS/OBS-82/10.60.

**Attachment 5: Cross-Section Data Obtained from the USFS for Elk
Creek Just Above the Falls**

MAY 29 2002

fax fax fax FAX FAX FAX FAX FAX FAX



12730 Highway 12

Orofino, ID 83544

TELEPHONE: 208-476-4541
TELEFAX: 208-476-8329

DATE: 5/29/02 TIME: 8:00 NUMBER OF PAGES TO FOLLOW: 13
TO: DIC CARLSON FAX NUMBER: 208-327-7866
ORGANIZATION: DWR
FROM: DICK SONG SECTION: _____
SUBJECT: BUL CR ~~BELLO~~ CEDAR ABOVE PAUS
MESSAGE: _____



Elk Cr. abv falls below gage (~1 mi So. of town of Elk River)
8/26/88 (Reach 2) (Ann Gayman camera photos: today)
Gayman

Top of reach:

T₃ riffle

~20 ft wide laminar flow channel; cobble + gravel
bed; silt along banks + ~5 ft willow overhang
on both sides up to banks

T₁ run

Riffle runs into Run. R + L B at transect grass + open
otherwise continuation of willow overhang.
Flow is reasonably laminar w/ small water moss bed
abv. LB. Moss bed runs along parts of both bank
Bed is cobble, gravel, some ^{coarse} sand + a few small bldrs.
Average width ~20-30 ft.

T₂ pool

Run shallows out at top of pool at turn in reach.
Lg moss bed along LB at transect otherwise the same
willow overhang, particularly RB at road bed edge
Profile  even; bed mostly cobbles + coarse sand
w/ some boulders + silt. Many, many minnows 3-6"
~~water~~

General observations — Water very warm (24°C), perhaps because of
Elk Creek reservoir ~ 1/2 mi abv. Many minnows in creek.
Meandering. (Lad rode horse by us)

PEBBLE COUNT

2 1/2 mi
S. Elk River

reach 2

8/26/88

Elk Cr abv falls
below gage

Size Range		Class Name	Dot & Dash Count : = 3, :: = 9	Tot. No.	% of Tot.	Cum. %	Dot & Dash Count : = 3, :: = 9	Tot. No.	% of Tot.	Cum. %
Metric--mm	Inches									
Less .002	//////	Silt/Clay	☒	1	1					
.062 - .125	//////	V. Fine Sand	☒	7	7					
.125 - .25	//////	Fine Sand		1	1					
.25 - .50	//////	Medium Sand								
.50 - 1.0	//////	Course Sand		1	1					
1.0 - 2.0	//////	V. Course Sand								
2.0 - 4.0	//////	V. Fine Gravel		1	1					
4.0 - 8.0	//////	Fine Gravel	:	2	2					
8.0 - 16	.08 - 0.6	Medium Gravel	! :	5	5					
16 - 32	0.6 - 1.3	Course Gravel	• •	3	3					
32 - 64	1.3 - 2.5	V. Course Gravel	☒ ☒ ☒	24	24					
64 - 128	2.5 - 5.0	Small Cobble	☒ ☒ ☒	26	26					
128 - 256	5-10	Large Cobble	☒ . 1	15	15					
256 - 512	10-20	Small Boulders		1	1					
512 - 1024	20-40	Medium Boulders								
1024 - 2048	40-80	Large Boulders								
2048 - 4096	80-160	V. Large Boulders								

Total Number of Samples 100



Elk Ak abr falls
T₃ Riffle ds



Elk Ak abr falls
T₁ nuds

1.36

ELK #22

reach 2

(1 mi S. of
ELK River)below
gage

WRC 1706-03-08-03 00

STREAM ELK Cr abv falls

page 1 of 4

Bm 3.42

Bm 5.42

CLEARWATER NATIONAL FOREST Water Resources Field Measurements

Observer Frank Gayman ATMS
 District D2 Project WRC
 Reach 2 Transect T1 run

Date 8/26/88
8/25/88 Time 1:40

Photo ID Gayman Roll #1

STAGE: Staff ft
 Recorder ft

Turbidity clear

Temperature (water) 24°C
 (air) 30°C

Sediment samples taken?
 Suspended
 Bedload

WEATHER: Hot Sunny clearCONDUCTIVITY 29 Umho

GRADIENT elev chg/distance x 100 = slope
 Water Surface: 0.13 / 84.6 x 100 = 0.15 %
 Bed: 0.59 / 84.6 x 100 = 0.70 %

OTHER

Meter type: Pygmy Price AA Direct Other

Spin tests: #1 AA Price - 2'45" 1030
 #2 " " 2'40" 1030

CHANNEL FEATURES	STA ft	TAPE- TO-BED ft	WIDTH ft	DEPTH ft	REVS #	TIME sec	VELOCITY fps	AREA ft ²	DISCHARGE cfs	substrate SIZE CLASS	COMMENT
RS.	0.0	4.68								1-veg	
R&F	1.5	6.30								3	
RWF	3.5	7.74		0.2	-	-	0		0	1	
	4.0	8.00								4	
	4.5	7.98		0.4	-	-	0		0	4	
	5.0	9.96		0.5	8	45	0.4		0	4.5	
	5.5	8.01								5.6	
	6.0	8.14		0.6	6	40	0.3		0.2	5.6	
	6.5	8.16								5.6	
	7.0	9.10		0.5	8	43	0.4		0.2	5	
	7.5	9.06								6	
Wt. Average				0.6			0.8				
Total			20.1					11.3	8.9		

CHANNEL FEATURES to note:
 (Reference directions facing downstream)
 L/R stake L/R bankful
 L/R thalweg L/R water edge
 Rock overhangs limits of vegetation

Wetted perimeter 20.5 ft
 Manning n 0.051

fish: brook trout
 classif: C2

WRC 1706-03 08 02⁰⁰

STREAM

ELK Cr abv falls

below gage

page 2 of 4

- Continuation Page -

T₁

CHANNEL FEATURES	STA TION ft	TAPE- to-BED ft	WIDTH ft	DEPTH ft	REVS #	TIME sec	VELOCITY fps	AREA ft ²	DISCHARGE cfs	substrate SIZE CLASS	COMMENT
	8.0	8.15		0.5	5	55	0.2		0.2	5-4	
	8.5	8.14								6-4	
	9.0	8.23		0.6	5	60	0.2		0.1	5-4	
RT	9.5	8.25								6-5	
	10.0	8.21		0.6	16	45	0.8		0.3	6-5	
	10.5	8.28								6	
	11.0	8.35		0.9	23	42	1.2		0.8	5	
	11.5	8.09								6	
	12.0	8.04		0.5	14	42	0.7		0.7	6	
	12.5	8.41								5-4	
	13.0	8.29		0.9	19	41	1.0		0.6	6	
	13.5	8.40								6-5	
	14.0	8.46		0.8	17	41	0.9		0.8	6	
LT	14.5	8.36								6	
	15.0	8.38		0.9	18	41	1.0		0.8	5-6	
	15.5	8.30								5-6	
	16.0	8.18		0.8	25	41	1.3		1.0	6-4	
Wt. Average											
Total											

Gradients: 1.13

E₁ 8.39

E₂ 9.05

E₃ 7.67

elev chg = 1.38

→ T₁ → T₂

L₂₋₁ 94.8

L₃₋₂ 27.2

L = 122.0

T ₁ run	Elev	Depth	L
upper	8.16	0.75	15.3
lower	8.47	1.00	1.00
	8.75	1.21	69.3
			84.6

T ₂ Pool	Elev	Depth	L
upper	8.75	1.21	29.1
lower	9.05	1.21	19.6
	8.77		48.7

T ₃ riffle	Elev	Depth	L
upper	7.36	0.62	51.7
lower	8.16	0.75	11.9
			63.6

(1 mi S of Elk Riv.

below
gauge

WRC 1706-03-0803-00

STREAM ELK Cr abv falls

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CLEARWATER NATIONAL FOREST Water Resources Field Measurements

Observers Franks, Gayman

Date 8/25/88 Time _____

District D2

Project WR

Reach # 2

Transect T₁ L₁

Photo ID _____

STAGE: Staff _____ ft

Turbidity _____ (ftu)

Recorder _____ ft

Temperature (water) _____ ° (f/c)

(air) _____ ° (f/c)

Sediment samples taken?

____ Suspended

____ Bedload

CONDUCTIVITY _____ Umhos

GRADIENT elev chn/distance x 100 = slope

pH _____

Water Surface: 0.13 / _____ x 100 = 1

DO _____

Bed: 0.59 / _____ x 100 = 1

_____ mg/l

OTHER _____

Meter type: Fygn Price AA Direct Other _____

CHANNEL	STA	TAPE-											
FEATURES	TION	TO-BED	WIDTH	DEPTH	REVS	TIME	VELOCITY	AREA	DISCHARGE	SUBSTRATE	SIZE	CLASS	COMMENT
	ft	ft	ft	ft	#	sec	fpm	ft ²	cfs				
	16.5	8.24									5		
	17.0	8.25		0.6	21	41	1.1		0.9		5.4		
	17.5	8.10									6		
	18.0	8.23		0.6	18	42	1.0		0.8		5.6		
	18.5	8.23									5.4		
	19.0	8.14		0.5	16	40	0.9		0.5		6.4		
	19.5	8.15									5.4		
	20.0	8.12		0.6	13	41	0.7		0.4		4.5		
	20.5	8.06									5.6		water veg
	21.0	7.99		0.4	10	44	0.5		0.3		5.1		
	21.5	7.82									5.1		
Wt. Average	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
Total	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

CHANNEL FEATURES to note:

(Reference directions facing downstream)

L/R stake

L/R bankful

L/R thalweg

L/R water edge

Rock overhangs

limits of vegetation

Wetted perimeter _____ ft

Manning n _____

STREAM

page 4 of 5

- Continuation Page - 1

[illegible]

Remarks:

(~1 mi S. Elk River)

WNC 1706-03.08.03.00.

STREAM ELK CR. abv falls below gage

page 1 of 3

CLEARWATER NATIONAL FOREST Water Resources Field Measurements

Observers Abrams Date 8/25/88 Time 1045
District R1 Project WNR
Reach 2 Transect 1.73 Photo ID Gayman roll #1

STAGE: Staff — ft
Recorder — ft

Turbidity — (ftu)

Sediment samples taken?
— Suspended
— Bedload

Temperature (water) — °(f/c)
(air) — °(f/c)

GRADIENT elev chg/distance x 100 = slope
Water Surface: 0.02/48.7 x 100 = 0.04 %
Bed: 0.02/48.7 x 100 = 0.04 %

CONDUCTIVITY — Umho
pH —
DO — mg/l

OTHER —

Motor type: Pygmy Price AA Direct Other —

CHANNEL FEATURES	STA TION	TAPE- TO-BED	WIDTH	DEPTH	REVS	TIME	VELOCITY	AREA	DISCHARGE	substrate SIZE	COMMENT
	ft	ft	ft	ft	#	sec	fps	ft ²	cfs	CLASS	
RS	0	0.3								1.5	
RBF	1.0	1.6								1.3	
	2.0	2.1								1.3	
	2.4	2.3		0	—	—	0		0	5.3	Alcor
	3.0	2.4		0.1	—	—	0		0	5.3	11
	4.0	2.8		0.4	—	—	0		0	6.3	11
	5.0	2.9		0.6	—	—	0		0	5.3	11
	6.0	3.0		0.7	—	—	0		0	5.3	11
CN Rock	7.0	2.5		0.2	5	90	0.07		0	7	4
	8.0	3.1		0.8	5	41	0.3		0.1	6	
	9.0	3.2		0.9	5	54	0.2		0.2	6	
Wt. Average		0.8		0.3							
Total		27.6						23.4		7.9	

CHANNEL FEATURES to note:

(Reference directions facing downstream)
L/R stake L/R bankful
L/R thalweg L/R water edge
Rock overhangs limits of vegetation

Wetted perimeter 27.2 ft

Manning n 0.077

VRC 1706-0308-0300

STREAM

ELK CR. abt falls below gage

page 2 of 3

- Continuation Page - T2 point

CHANNEL FEATURES	STA TION	TAPE- to-BED	WIDTH	DEPTH	REVS	TIME	VELOCITY	AREA	DISCHARGE	substrate SIZE	COMMENT
	ft	ft	ft	ft	#	sec	fps	ft ²	cfs	CLASS	
	10.0	3.4		1.1	5	66	0.2		0.2	5.4	
	11.0	3.4		1.1	5	97	0.1		0.2	5.7	
	12.0	3.2		0.9	5	42	0.3		0.2	6.7	
PTH	13.0	3.5		1.2	10	44	0.5		0.4	6	
	14.0	3.6		1.3	10	55	0.4		0.6	6	
	15.0	3.5		1.2	10	45	0.5		0.6	6.7	
	16.0	3.6		1.3	8	41	0.4		0.6	6	
	17.0	3.5		1.2	13	42	0.7		0.7	6	
	18.0	3.4		1.1	9	41	0.5		0.7	6	
	19.0	3.7		1.4	8	42	0.4		0.6	5.6	
	20.0	3.6		1.3	12	41	0.7		0.7	6	
	21.0	3.7		1.3	7	45	0.4		0.7	6.5	
	22.0	3.5		1.1	7	42	0.4		0.4	5.6	
	23.0	3.4		1.1	7	43	0.4		0.4	5.6	
LTH	24.0	3.2		0.9	6	47	0.3		0.3	5.4	
	25.0	3.0		0.7	—	—	0		0.1	1	water m25
	26.0	3.0		0.6	—	—	0		0	1	Bed cov
Wghted Average											
Total											

Remarks:

WRC 1706-03 08 03 00

STREAM

ELK CR. abv. Falls bcbw gauge

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CLEARWATER NATIONAL FOREST Water Resources Field Measurements

Observer

Abdains

Date

8, 26, 88

Time

1100

District

D1

Project

WR

Reach #

2

Transsect

MT2 pool

Photo ID

STAGE: Staff

ft

Recorder

ft

Turbidity

(ftu)

Temperature (water)

(°C)

(air)

(°C)

Sediment samples taken?

Suspended

Bedload

CONDUCTIVITY

Umhos

GRADIENT

elev chg/distance x 100 = slope

pH

Water Surface:

x 100 = 1

DO

mg/l

Bed:

x 100 = 1

OTHER

Meter type: Pymy Price AA Direct Other

CHANNEL FEATURES	STA TION	TAPE- TO-RED	WIDTH	DEPTH	NEWS	TIME	VELOCITY	AREA	DISCHARGE	substrate SIZE	COMMENT
	ft	ft	ft	ft	#	sec	fpm	ft ²	cfs	CLASS	
	27.0	2.9		0.4	-	-	0		0	1	water-ma: Bed cover
	28.0	2.7		0.3	-	-	0		0	1	11
	29.0	2.6		0.2	-	-	0		0	1	11
LWE	29.3	2.5		0.1	-	-	0		0	1	11
	30.0	2.3								3	
	31.0	1.8								1.3	
	32.0	1.6								1.3	
LBF	33.0	1.2								1	
	34.0	1.0								1	
	35.0	0.6								1	
LS	35.5	0.4								1	
Wt. Average	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
Total	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

CHANNEL FEATURES to note:

(Reference directions facing downstream)

L/R stake L/R bankful

L/R thalweg L/R water edge

Rock overhangs limits of vegetation

Wetted perimeter

ft

Manning n

WVC 1706-03-08 0300

STREAM

ELK Cr abv falls below

gage page 2 of 2

- Continuation Page -

T₂

(2.1 mi S of ELK River)

WVC 1706-03-08 0300

STREAM

ELK Cr abv falls below

gage page 1 of 2

CLEANWATER NATIONAL FOREST Water Resources Field Measurements

Observers Gayman^Q Date 8/25/88 Time 1045
 District D2 Project WR
 Reach # 2 Transect T3 riffle Photo ID Gayman roll #1
DS-10 LB-11 WS-12
 STAGE: Staff _____ ft Turbidity _____ (ftu)
 Recorder _____ ft
 Sediment samples taken?
 _____ Suspended _____ (s/c)
 _____ Bedload _____ (s/c)
 GRADIENT $\frac{\text{elev chg/distance} \times 100 = \text{slope}}$
 Water Surface: $\frac{0.67}{63.6} \times 100 = 1.05 \%$ pH _____
 Bed: $\frac{0.80}{63.6} \times 100 = 1.26 \%$ DO _____ mg/l
 CONDUCTIVITY _____ Umho
 OTHER _____
 Meter type: Pygmy Price AA Direct Other _____

CHANNEL	STA	TAPE-	WIDTH	DEPTH	REVS	TIME	VELOCITY	AREA	DISCHARGE	substrate	COMMENT
FEATURES	TION	TO-BED	ft	ft	#	sec	fps	ft ²	cfs	SIZE	
	ft	ft								CLASS	
RS	0	1.1								1	veg
	2.0	1.7								1	
LOW RBF	35	3.1								1	
RWE	38	3.3		0.01	-	-	0		0	1	roots
on bank	4.2	3.5		0.2	6	42	0.3		0	5.6	silt
	5.0	3.6		0.3	5	50	0.2		0.1	5.6	
	6.0	3.6		0.4	6	46	0.3		0.1	6.5	
Rtn	7.0	3.6		0.3	38	43	1.9		0.4	6	
on bank	8.0	3.4		0.2	17	44	0.9		0.4	6	
	9.0	3.6		0.4	21	42	1.1		0.3	6.4	
	10.0	3.6		0.4	26	41	1.5		0.5	5.6	
Wt. Average				0.3			1.0				
Total			19.8					6.5	6.5		

CHANNEL FEATURES to note:

(Reference directions facing downstream)

L/R stake L/R bankful

L/R thalweg L/R water edge

Rock overhangs limits of vegetation

Wetted perimeter 20.1 ft
 Manning n 0.073

VNC 1706-03 08 03 00

STREAM

EIK Cr abv falls below gage

page 2 of 2

- Continuation Page - T3

CHANNEL FEATURES	STA TION ft	TAPE- to-BED ft	WIDTH ft	DEPTH ft	REVS #	TIME sec	VELOCITY fps	AREA ft ²	DISCHARGE cfs	substrate SIZE CLASS	COMMENT
on cob	11.0	3.4		0.2	26	41	1.4		0.4	6	
I	12.0	3.3		0.1	21	41	1.1		0.2	6.5	
	13.0	3.6		0.4	28	40	1.5		0.3	5.6	
	14.0	3.6		0.4	24	41	1.3		0.6	5	
LTH on cob	15.0	3.5		0.3	30	40	1.7		0.5	6	
	16.0	3.8		0.6	25	44	1.3		0.7	5.4	
	17.0	3.6		0.3	21	41	1.1		0.5	5	
on cob	18.0	3.5		0.3	21	41	1.1		0.3	6.5	
	19.0	3.6		0.4	17	43	0.9		0.4	5	
	20.0	3.7		0.4	13	42	0.7		0.3	5.6	
	21.0	3.6		0.4	12	42	0.6		0.3	5	
	22.0	3.8		0.5	5	59	0.2		0.2	5.1	branches
LWE	23.6	3.2		0.01	-	-	0		0	1	Silt willow roots
Willow tower	25.0	2.5								1	Willow mass
	27.0	2.6								1	Silt
	29.0	3.0								1	
	31.0	2.5								1	Silt
Weighted Average:											
Total:											
BF	32.0	2.2									log
DV Remarks:	33.0	1.1									Silt
S	34.2	0.3									veg grass

* heavy (4-5') willow overhang both banks