United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Colorado State Office
2850 Youngfield Street
Lakewood, Colorado 80215-7093
www.blm.gov/co

TAKE PRIDE IN AMERICA

RECEIVED
JAN 05 2009
Colorado Water Conservation Board

In Reply Refer To:
7250 (CO-932)

DEC 30 2008

Ms. Linda Bassi
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an instream flow enlargement on Bent Creek, located in Water Division 4. The existing instream flow water right on this creek is 2 cubic feet per second, year round, from the headwaters to the confluence with the Lake Fork, a distance of 3 miles. The existing instream flow water right was established in 1980.

Location and Land Status: Bent Creek is tributary to the Lake Fork approximately six miles upstream from Lake San Cristobal. The creek is located within Hinsdale County, approximately 11 miles southwest of Lake City. This recommendation covers the entire stream reach, beginning at the headwaters and extending downstream to the confluence with the Lake Fork. All of the land along 3-mile reach is owned and managed by the BLM.

Biological Summary: Overall, Bent Creek is a very high gradient stream with large substrate size. Most of the creek is confined by steep canyons and supports a spruce-fir riparian community. Near the confluence with Lake Fork, the valley widens and the gradient decreases somewhat. In this section, the stream widens slightly, and an extensive willow riparian community is present. The creek supports a healthy and diverse aquatic insect community including caddisfly, stonefly, and mayfly. Fishery surveys indicate that the creek supports brook trout and rainbow trout.

R2Cross Analysis: BLM's data analysis, coordinated with the Division of Wildlife, indicates that the following flows are needed to protect the fishery and natural environment to a reasonable degree.

- A 1.55 cubic feet per second (cfs) enlargement is recommended during the high temperature period from April 15 through October 31, bringing the total instream flow up to 3.55 cubic feet per second during this time period.

Justification for Instream Flow Enlargement: The BLM was prompted to re-examine the instream flow on Bent Creek because of BLM water quality management objectives in the Henson Creek and Lake Fork watersheds. Both of these stream systems are affected by historic mining activities, and the BLM has begun to initiate projects to treat and minimize acid mine runoff and heavy metals contamination. Within these watersheds, streams that are presently able to support fish are extraordinarily valuable for the habitat they provide and for their ability to dilute runoff originating in more contaminated parts of the watershed. Finally, this creek is located along the very heavily used Alpine Loop backcountry byway. Users of the byway seek opportunities to fish and camp along the uncontaminated streams within these watersheds.

The BLM's cross section analysis revealed that the current instream flow rate is not fully protective for several reasons. First, in locations where the stream widens out and is capable of providing significant riffle and physical habitat, the current 2 cfs water right provides an average of only 0.7 feet per second velocity, which is under the velocity preferred by salmonids. At 2 cfs, a very high percent of the usable habitat would not be at preferred velocities for salmonids in a situation where usable habitat is at a premium. Protecting necessary flows to meet the velocity criteria would result in an average of 75 percent of wetted perimeter, which is a significant advantage in a high gradient stream with limited physical habitat. The BLM's conclusion is that it is prudent to protect a higher flow rate that is capable of making the most of the limited physical habitat available for the fish population.

The BLM also believes that Bent Creek is capable of providing nursery habitat for the Lake Fork of the Gunnison. The BLM plans to undertake further investigations as to why our fish sampling resulted in few fish captured when the creek appears to have excellent water quality, food sources, and pools. It is highly likely that some very modest management actions, such as restocking or removal of small barriers, would result in a robust fish population.

Water Availability: For water availability analysis, the BLM recommends using a combination of methods. First, BLM recommends developing a synthetic hydrograph using the equations provided in *Estimation of Natural Streamflow Characteristics in Western Colorado, USGS Water Resources Investigation Report 85-4086, 1985.* This method incorporates data about basin size and elevation. This synthetic hydrograph should then be reconciled against historic gage data, using a basin apportionment approach. The two most relevant gages are USGS gage 09123500 (Lake Fork at Lake City, CO) and USGS gage 09123400 (Lake Fork Below Mill Gulch Near Lake City, CO). When utilizing these two gages, two factors should be kept in mind. First, the historic gages were likely affected by icing during the winter, and may have underestimated winter flows as a result. Second, the gage near Mill Creek may be more representative of the watershed in this recommendation. The gage near Mill Creek is located higher in the Lake Fork watershed and excludes many square miles of lower elevation and drier terrain in the Lake Fork watershed.

The BLM is not aware of any decreed or historic stream diversion in this stream reach.

Conclusion: The BLM believes that there is strong justification for an additional instream flow appropriation on this highly accessible and relatively pristine creek. Our initial water availability analysis indicates there is sufficient water to support the appropriation without material injury to existing water rights. Accordingly, we urge the board to make an initial appropriation at its regular board meeting in January 2009.

Data sheets, R2Cross output, fishery survey information, and photographs of the cross sections to support this recommendation were provided with the draft recommendation in February 2008. We thank the Colorado Water Conservation Board for its cooperation in this effort.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

for Linda Anania
Deputy State Director, Resources and Fire

cc:
Kenny McDaniel, Gunnison FO
Art Hayes, Gunnison FO
Tom Fresques, Glenwood Springs FO

DRAFT INSTREAM FLOW RECOMMENDATION – BENT CREEK, WD 4

Feb. 13, 2008

Ms. Linda Bassi
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an instream flow enlargement on Bent Creek, located in Water Division 4. The existing instream flow water right on this creek is 2.0 cubic feet per second, year round, from the headwaters to the confluence with the Lake Fork, a distance of 3.0 miles. The existing instream flow water right was established in 1980.

Location and Land Status. Bent Creek is tributary to the Lake Fork approximately six miles upstream from Lake San Cristobal. The creek is located within Hinsdale County, approximately 11 miles southwest of Lake City. This recommendation covers the entire stream reach, beginning at the headwaters and extending downstream to the confluence with the Lake Fork. All of the land along 3.0-mile reach is owned and managed by the BLM.

Biological Summary. Overall, Bent Creek is a very high gradient stream with large substrate size. Most of the creek is confined by steep canyons and supports a spruce-fir riparian community. Near the confluence with Lake Fork, the valley widens and the gradient decreases somewhat. In this section, the stream widens slightly, and an extensive willow riparian community is present. The creek supports a healthy and diverse aquatic insect community, including caddisfly, stonefly, and mayfly. Fishery surveys indicate that the creek supports brook trout and rainbow trout.

R2Cross Analysis. BLM's data analysis, coordinated with the Division of Wildlife, indicates that the following flows are needed to protect the fishery and natural environment to a reasonable degree.

> A 1.55 cubic feet per second enlargement is recommended during the high temperature period from April 1 through October 31, bringing the total instream flow right up to 3.55 cubic feet per second during this time period.

Justification for Instream Flow Enlargement. BLM was prompted to re-examine the instream flow on Bent Creek because of BLM water quality management objectives in the Henson Creek and Lake Fork watersheds. Both of these stream systems are affected by historic mining activities, and BLM has begun to initiate projects to treat and minimize acid mine runoff and heavy metals contamination. Within these watersheds, streams that are presently able to support fish are extraordinarily valuable for the habitat they provide

and for their ability to dilute runoff originating in more contaminated parts of the watershed. Finally, this creek is located along the very heavily used Alpine Loop backcountry byway. Users of the byway seek opportunities to fish and camp along the uncontaminated streams within these watersheds.

BLM's cross section analysis revealed that the current instream flow rate is not fully protective for several reasons. First, in locations where the stream widens out and is capable of providing significant riffle and physical habitat, the current 2.0 cfs water right provides an average of only 0.7 feet per second velocity, which is under the velocity preferred by salmonids. At 2.0 cfs, a very high percent of the usable habitat would not be at preferred velocities for salmonids in a situation where usable habitat is at a premium. Protecting flows necessary to meet the velocity criteria would result in an average of 75% wetted perimeter, which is a significant advantage in a high gradient stream with limited physical habitat. BLM's conclusion is that it is prudent to protect a higher flow rate that is capable of making most of the limited physical habitat available for the fish population.

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Water Availability. For water availability analysis, BLM recommends using a combination of methods. First, BLM recommends developing a synthetic hydrograph using the equations provided in *Estimation of Natural Streamflow Characteristics in Western Colorado, USGS Water Resources Investigation Report 85-4086, 1985.* This method incorporates data about basin size and elevation. This synthetic hydrograph should then be reconciled against historic gage data, using a basin apportionment approach. The two most relevant gages are USGS gage 09123500 (Lake Fork at Lake City, CO) and USGS gage 09123400 (Lake Fork Below Mill Gulch Near Lake City, CO). When utilizing these two gages, two factors should be kept in mind. First, the historic gages were likely affected by icing during the winter, and may have underestimated winter flows as a result. Second, the gage near Mill Creek may be more representative of the watershed in this recommendation. The gage near Mill Creek is located higher in the Lake Fork watershed and excludes many square miles of lower elevation, dryer terrain in the Lake Fork watershed.

BLM is not aware of any decreed or historic stream diversion in this stream reach.

Conclusion. BLM believes that there is strong justification for an additional instream flow appropriation on this highly accessible and relatively pristine creek. Our initial water availability analysis indicates there is sufficient water to support the appropriation without material injury to existing water rights. Accordingly, we urge the board to make an initial appropriation at its regular board meeting in January 2009.

Data sheets, R2Cross output, fishery survey information, and photographs of the cross section are enclosed to support this recommendation. We thank the Colorado Water Conservation Board for its cooperation in this effort.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Linda Anania
Deputy State Director
Resources and Fire

4 Enclosures

cc: Kenny McDaniel, Gunnison FO
Art Hayes, Gunnison FO
Tom Fresques, Glenwood Springs FO

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: Bend Creek						CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: 300 ft. downstream from county road						
DATE: 10-11-07	OBSERVERS: R Smith, J. Thompson, J. Roach					
LEGAL DESCRIPTION	¼ SECTION: SE	SECTION: 11	TOWNSHIP: 42 (N)S	RANGE: 5 E(W)	PM: NM	
COUNTY: Hinsdale	WATERSHED: Lake Fork	WATER DIVISION: 4	DOW WATER CODE: 39355			
MAP(S): USGS: Redcloud Peak	GPS Z13	270784				
USFS:		4197937				

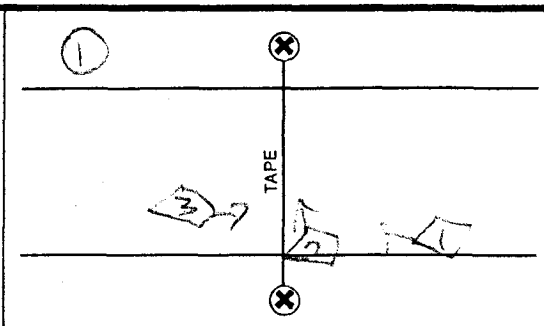
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE: Marsh McBirney			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed ____ lbs/foot	TAPE TENSION: surveyed ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: gravel to 1-foot boulder	PHOTOGRAPHS TAKEN (YES)/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed 4.2 12.7
① WS @ Tape LB/RB	0.0	4.15 / 4.15
② WS Upstream	5.9	4.09
③ WS Downstream	6.3	4.27
SLOPE	0.22/12.2 = .018	

SKETCH



LEGEND:
Stake ⊗
Station ①
Photo ◇①
Direction of Flow

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: (YES)/NO	DISTANCE ELECTROFISHED: ____ ft	FISH CAUGHT: (YES)/NO	WATER CHEMISTRY SAMPLED: YES/NO

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL
see attached																	

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:
mayfly, caddisfly

COMMENTS

TDS = 190
Temp: 7° C
Ph = 8.3

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Bent Creek	CROSS-SECTION NO.: 1	DATE: 10-11-07	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 4:40 pm

Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
LSt G	2.8		3.24								
	3.5		3.56								
W	4.2		4.15								
	4.5		4.25	.1				.14			
RL	5.0		4.20	.05				Ø			
	5.5		4.35	.2				.07			
	[illegible]		4.45	.3				1.06			
	[illegible]		4.45	.3				0.62			
	[illegible]		4.50	.35				0.86			
	[illegible]		4.45	.30				0.37			
	[illegible]		4.35	.20				1.30			
	[illegible]		4.65	.50				0.66			
	[illegible]		4.80	.65				1.09			
	[illegible]		4.75	.60				1.49			
	[illegible]		4.85	.70				0.93			
	[illegible]		4.75	.60				0.72			
	[illegible]		4.75	.60				0.85			
	[illegible]		4.35	.20				Ø			
	[illegible]		4.20	.05				Ø			
	[illegible]		4.20	.05				Ø			
W	12.7		4.15								
	14.7		3.85								
RS	15.2		3.10	< G = 16.0 3.30							
TOTALS:											

End of Measurement	Time:	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Bent Creek						CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: 400 ft. downstream from county road						
DATE: 10-11-07	OBSERVERS: R. Smith, J. Thompson, J. Roach					
LEGAL DESCRIPTION	¼ SECTION: SE	SECTION: 11	TOWNSHIP: 42 (N)/S	RANGE: 5 E(W)	PM: NM	
COUNTY: Hinsdale	WATERSHED: Lake Fork	WATER DIVISION: 4	DOW WATER CODE: 39358			
MAP(S): USGS: Redcloud Peak						
USFS:						

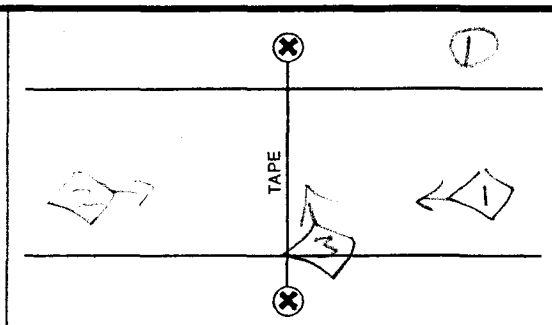
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES)/NO	METER TYPE: Marsh-McBirney			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed ____ lbs/foot	TAPE TENSION: surveyed ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: gravel to 1-foot boulder	PHOTOGRAPHS TAKEN: (YES)/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
(X) Tape @ Stake LB	0.0	surveyed
(X) Tape @ Stake RB	0.0	surveyed
(1) WS @ Tape LB/RB	0.0	4.9 12.4 / 6.16 6.75
(2) WS Upstream	9.2	6.63
(3) WS Downstream	6.2	6.99
SLOPE	0.36	15.4 - .0[illegible]

SKETCH



LEGEND:
Stake (X)
Station (1)
Photo (1)
Direction of Flow

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: YES/NO	DISTANCE ELECTROFISHED: ____ ft	FISH CAUGHT: (YES)/NO	WATER CHEMISTRY SAMPLED: (YES)/NO

LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.)

SPECIES (FILL IN)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL
See attached																	

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:
mayfly, caddisfly

COMMENTS

TDS 190
Temp 7°C
pH = 8.3

FORM #ISF FD 1-85

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Bent Creek	CROSS-SECTION NO.: 2	DATE: 10-11-07	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 5:10 pm

Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
LS/G	3.2		5.80								
W	4.7		6.76								
	5		6.95	.2				.25			
	5.5		7.10	.35				.46			
	6		7.30	.55				.56			
	6.5		7.10	.35				.65			
	7		7.15	.40				1.05			
	7.5		7.15	.40				0.50			
	8		7.[illegible]	.[illegible]				0.[illegible]			
	8.5		7.15	.[illegible]				0.[illegible]			
	9		7.25	.[illegible]				0.62			
	9.5		7.[illegible]	.60				[illegible]			
[illegible]	10	[illegible]	7.25	.[illegible]	[illegible]			2.89	[illegible]		
	10.5		6.95	.20				1.31			
	11		6.80	.05				0			
	11.5		6.85	.10				.08			
	12		6.90	.25				0			
W	12.4		6.75								
G	12.9		5.79								
RS	15.0		3.80								
TOTALS:											

End of Measurement	Time:	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	Bent Creek
XS LOCATION:	300 feet downstream from county road
XS NUMBER:	1
DATE:	11-Oct-07
OBSERVERS:	R. Smith, J. Thompson, J. Roach
1/4 SEC:	SE
SECTION:	11
TWP:	42N
RANGE:	5W
PM:	NM
COUNTY:	Hinsdale
WATERSHED:	Lake Fork Gunnison
DIVISION:	4
DOW CODE:	39358
USGS MAP:	Redcloud Peak 7.5'
USFS MAP:	0.85

SUPPLEMENTAL DATA

		*** NOTE ***
		Leave TAPE WT and TENSION
		at defaults for data collected
TAPE WT:	0.0106	with a survey level and rod
TENSION:	99999	

CHANNEL PROFILE DATA

SLOPE:	0.018

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: ….....……..…….....DATE.....

STREAM NAME: Bent Creek
XS LOCATION: 300 feet downstream from county road
XS NUMBER: 1

DATA POINTS= 24

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
1	LS & G	2.80	3.24			0.00		0.00	0.00	0.0%
		3.50	3.56			0.00		0.00	0.00	0.0%
	W	4.20	4.15			0.00		0.00	0.00	0.0%
		4.50	4.25	0.10	0.57	0.32	0.10	0.04	0.02	0.9%
		5.00	4.20	0.05	0.00	0.50	0.05	0.03	0.00	0.0%
		5.50	4.35	0.20	0.07	0.52	0.20	0.10	0.01	0.3%
		6.00	4.45	0.30	1.06	0.51	0.30	0.15	0.16	6.5%
		6.50	4.45	0.30	0.62	0.50	0.30	0.15	0.09	3.8%
		7.00	4.50	0.35	0.86	0.50	0.35	0.18	0.15	6.2%
		7.50	4.45	0.30	0.37	0.50	0.30	0.15	0.06	2.3%
		8.00	4.35	0.20	1.30	0.51	0.20	0.10	0.13	5.3%
		8.50	4.65	0.50	0.66	0.58	0.50	0.25	0.17	6.8%
		9.00	4.80	0.65	1.09	0.52	0.65	0.33	0.35	14.5%
		9.50	4.75	0.60	1.49	0.50	0.60	0.30	0.45	18.3%
		10.00	4.85	0.70	0.93	0.51	0.70	0.35	0.33	13.3%
		10.50	4.75	0.60	0.92	0.51	0.60	0.30	0.28	11.3%
		11.00	4.75	0.60	0.85	0.50	0.60	0.30	0.26	10.4%
		11.50	4.35	0.20	0.00	0.64	0.20	0.10	0.00	0.0%
		12.00	4.20	0.05	0.00	0.52	0.05	0.03	0.00	0.0%
		12.50	4.20	0.05	0.00	0.50	0.05	0.02	0.00	0.0%
	W	12.70	4.15			0.21		0.00	0.00	0.0%
		14.70	3.85			0.00		0.00	0.00	0.0%
1	G	15.00	3.20			0.00		0.00	0.00	0.0%
	RS	15.50	2.10			0.00		0.00	0.00	0.0%
	TOTALS ----------					8.86	0.7 (Max.)	2.86	2.44	100.0%

Manning's n = 0.1098
Hydraulic Radius= 0.322465264

STREAM NAME: Bent Creek
XS LOCATION: 300 feet downstream from county road
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	2.86	2.86	0.0%
3.90	2.86	5.23	83.0%
3.92	2.86	5.02	75.7%
3.94	2.86	4.82	68.5%
3.96	2.86	4.61	61.5%
3.98	2.86	4.42	54.5%
4.00	2.86	4.22	47.7%
4.02	2.86	4.03	41.0%
4.04	2.86	3.84	34.4%
4.06	2.86	3.65	27.9%
4.08	2.86	3.47	21.5%
4.10	2.86	3.29	15.2%
4.11	2.86	3.20	12.1%
4.12	2.86	3.12	9.0%
4.13	2.86	3.03	6.0%
4.14	2.86	2.94	3.0%
4.15	2.86	2.86	0.0%
4.16	2.86	2.77	-3.0%
4.17	2.86	2.69	-5.9%
4.18	2.86	2.61	-8.8%
4.19	2.86	2.52	-11.7%
4.20	2.86	2.44	-14.6%
4.22	2.86	2.29	-19.8%
4.24	2.86	2.15	-24.7%
4.26	2.86	2.02	-29.4%
4.28	2.86	1.89	-34.0%
4.30	2.86	1.76	-38.5%
4.32	2.86	1.63	-42.9%
4.34	2.86	1.51	-47.1%
4.36	2.86	1.39	-51.3%
4.38	2.86	1.28	-55.4%
4.40	2.86	1.17	-59.2%

WATERLINE AT ZERO
AREA ERROR = 4.150

STREAM NAME: Bent Creek
XS LOCATION: 300 feet downstream from county road
XS NUMBER: 1 Constant Manning's n

GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	3.24	12.18	1.05	1.61	12.74	13.24	100.0%	0.96	22.56	1.77
	3.25	12.16	1.04	1.60	12.62	13.21	99.7%	0.96	22.24	1.76
	3.30	12.02	1.00	1.55	12.01	13.03	98.4%	0.92	20.67	1.72
	3.35	11.89	0.96	1.50	11.42	12.86	97.1%	0.89	19.16	1.68
	3.40	11.76	0.92	1.45	10.83	12.68	95.8%	0.85	17.70	1.63
	3.45	11.63	0.88	1.40	10.24	12.50	94.4%	0.82	16.28	1.59
	3.50	11.49	0.84	1.35	9.66	12.33	93.1%	0.78	14.92	1.54
	3.55	11.36	0.80	1.30	9.09	12.15	91.8%	0.75	13.61	1.50
	3.60	11.27	0.76	1.25	8.53	12.01	90.7%	0.71	12.32	1.45
	3.65	11.19	0.71	1.20	7.97	11.88	89.7%	0.67	11.08	1.39
	3.70	11.10	0.67	1.15	7.41	11.75	88.7%	0.63	9.89	1.34
	3.75	11.02	0.62	1.10	6.85	11.61	87.7%	0.59	8.76	1.28
	3.80	10.94	0.58	1.05	6.31	11.48	86.7%	0.55	7.68	1.22
	3.85	10.86	0.53	1.00	5.76	11.35	85.7%	0.51	6.66	1.16
	3.90	10.46	0.50	0.95	5.23	10.93	82.6%	0.48	5.81	1.11
	3.95	10.07	0.47	0.90	4.71	10.52	79.5%	0.45	5.01	1.06
	4.00	9.68	0.44	0.85	4.22	10.11	76.3%	0.42	4.28	1.01
	4.05	9.29	0.40	0.80	3.75	9.69	73.2%	0.39	3.61	0.96
	4.10	8.89	0.37	0.75	3.29	9.28	70.1%	0.35	3.00	0.91
WL	4.15	8.50	0.34	0.70	2.86	8.86	66.9%	0.32	2.44	0.85
	4.20	7.65	0.32	0.65	2.44	8.00	60.4%	0.31	2.01	0.82
	4.25	6.67	0.31	0.60	2.08	6.99	52.8%	0.30	1.69	0.81
	4.30	6.33	0.28	0.55	1.76	6.64	50.2%	0.26	1.32	0.75
	4.35	6.00	0.24	0.50	1.45	6.29	47.5%	0.23	0.99	0.68
	4.40	5.35	0.22	0.45	1.17	5.61	42.3%	0.21	0.74	0.64
	4.45	4.21	0.22	0.40	0.91	4.42	33.4%	0.21	0.58	0.64
	4.50	3.06	0.24	0.35	0.73	3.24	24.4%	0.23	0.49	0.67
	4.55	2.92	0.20	0.30	0.58	3.06	23.1%	0.19	0.35	0.60
	4.60	2.77	0.16	0.25	0.44	2.88	21.8%	0.15	0.23	0.52
	4.65	2.63	0.12	0.20	0.31	2.70	20.4%	0.11	0.13	0.43
	4.70	2.40	0.08	0.15	0.18	2.45	18.5%	0.07	0.06	0.32
	4.75	1.67	0.04	0.10	0.07	1.70	12.8%	0.04	0.01	0.21
	4.80	0.50	0.03	0.05	0.01	0.51	3.9%	0.02	0.00	0.15
	4.85	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!

STREAM NAME: Bent Creek
XS LOCATION: 300 feet downstream from county road
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	2.44	cfs
CALCULATED FLOW (Qc)=	2.44	cfs
(Qm-Qc)/Qm * 100 =	0.0	%
MEASURED WATERLINE (WLm)=	4.15	ft
CALCULATED WATERLINE (WLc)=	4.15	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.70	ft
MAX CALCULATED DEPTH (Dc)=	0.70	ft
(Dm-Dc)/Dm * 100	0.0	%
MEAN VELOCITY=	0.85	ft/sec
MANNING'S N=	0.110	
SLOPE=	0.018	ft/ft
.4 * Qm =	1.0	cfs
2.5 * Qm=	6.1	cfs

RECOMMENDED INSTREAM FLOW:
=============================

FLOW (CFS)	PERIOD
___________	________
___________	________
___________	________
___________	________

RATIONALE FOR RECOMMENDATION:
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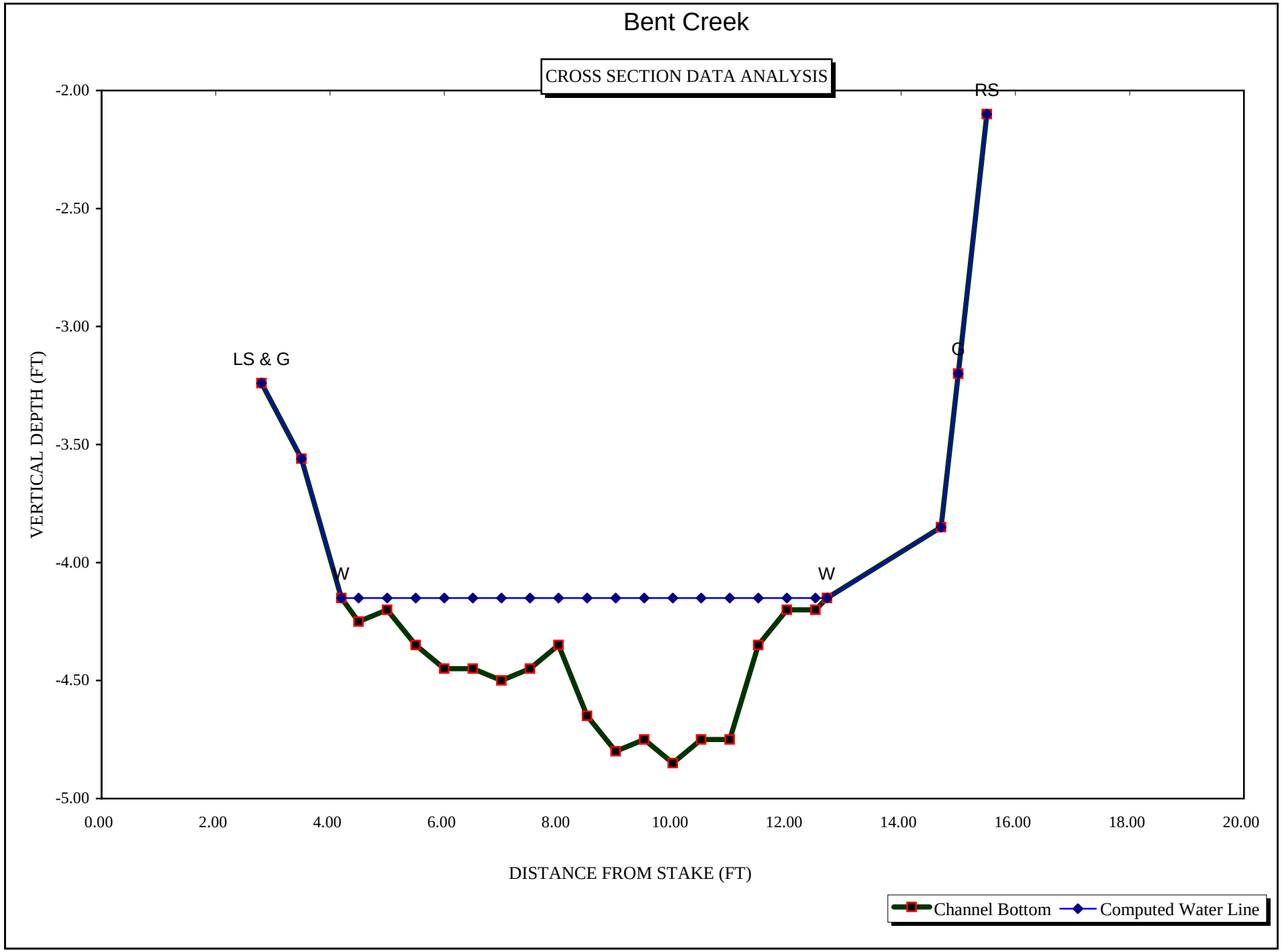
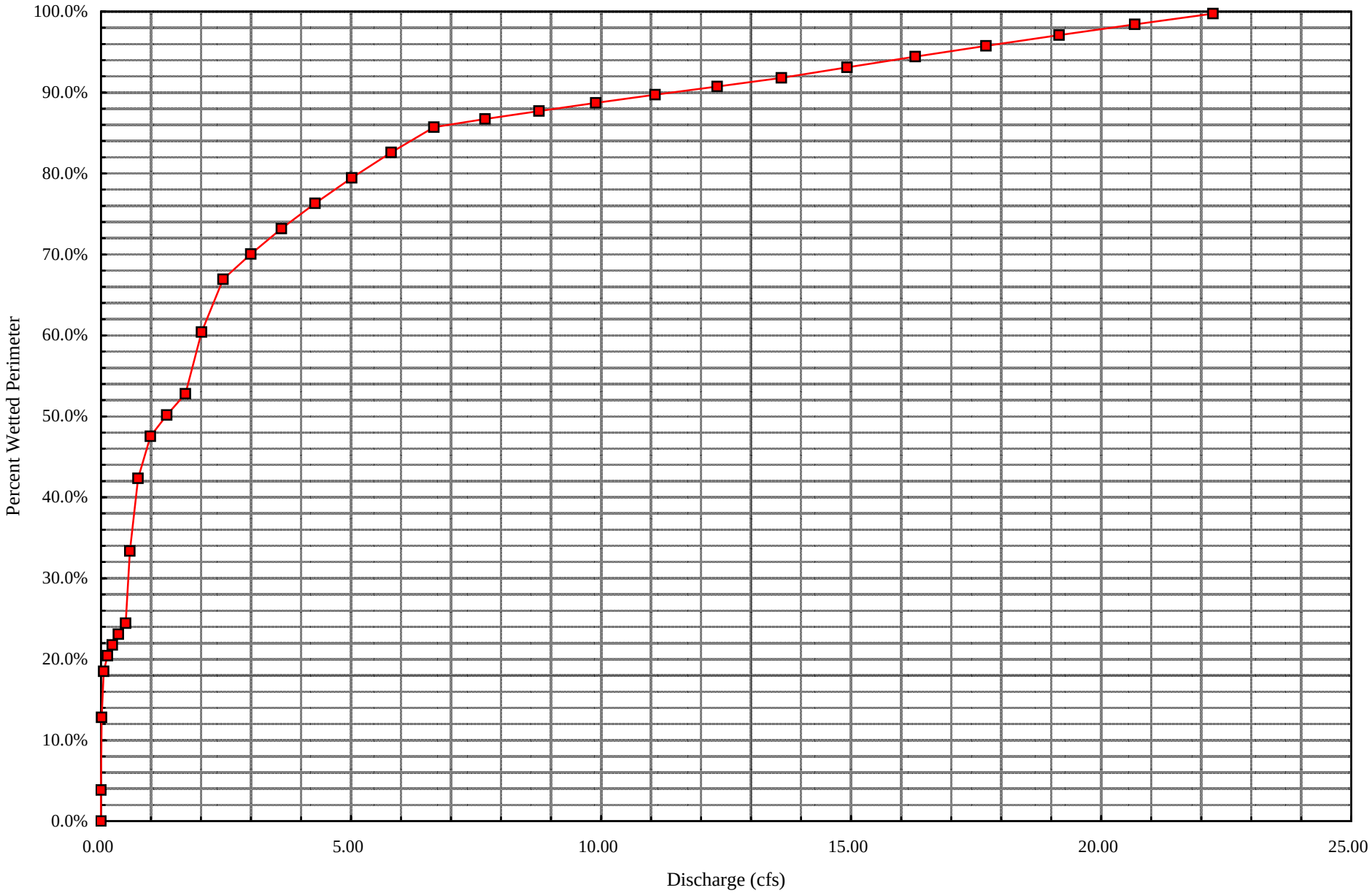
RECOMMENDATION BY: ……………………………………………………… AGENCY…………………………………………………… DATE:…………………………………

CWCB REVIEW BY: …… DATE:…………………………………


Bent Creek
CROSS SECTION DATA ANALYSIS
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
VERTICAL DEPTH (FT)
LS & G
W
W
G
RS
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line

Percent Wetted Perimeter vs. Discharge



COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	Bent Creek
XS LOCATION:	400 ft. downstream from county road
XS NUMBER:	2
DATE:	11-Oct-07
OBSERVERS:	R. Smith, J. Thompson, J. Roach
1/4 SEC:	SE
SECTION:	11
TWP:	42N
RANGE:	5W
PM:	NM
COUNTY:	Hinsdale
WATERSHED:	Lake Fork Gunnison
DIVISION:	4
DOW CODE:	39358
USGS MAP:	Redcloud Peak 7.5'
USFS MAP:	0

SUPPLEMENTAL DATA

		*** NOTE ***
		Leave TAPE WT and TENSION
		at defaults for data collected
TAPE WT:	0.0106	with a survey level and rod
TENSION:	99999	

CHANNEL PROFILE DATA

SLOPE:	0.023

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: ….....……..…….....DATE.....

STREAM NAME: Bent Creek
XS LOCATION: 400 ft. downstream from county road
XS NUMBER: 2

DATA POINTS= 21

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
1	LS & G	3.20	5.80			0.00		0.00	0.00	0.0%
	W	4.70	6.76			0.00		0.00	0.00	0.0%
		5.00	6.95	0.20	0.25	0.36	0.20	0.08	0.02	0.8%
		5.50	7.10	0.35	0.46	0.52	0.35	0.18	0.08	3.2%
		6.00	7.30	0.55	0.56	0.54	0.55	0.28	0.15	6.1%
		6.50	7.10	0.35	0.65	0.54	0.35	0.18	0.11	4.5%
		7.00	7.15	0.40	1.05	0.50	0.40	0.20	0.21	8.3%
		7.50	7.15	0.40	0.50	0.50	0.40	0.20	0.10	4.0%
		8.00	7.15	0.40	0.36	0.50	0.40	0.20	0.07	2.9%
		8.50	7.45	0.70	0.41	0.58	0.70	0.35	0.14	5.7%
		9.00	7.25	0.50	0.62	0.54	0.50	0.25	0.16	6.2%
		9.50	7.35	0.60	1.53	0.51	0.60	0.30	0.46	18.2%
		10.00	7.25	0.50	2.89	0.51	0.50	0.19	0.54	21.5%
		10.25	7.20	0.45	2.93	0.25	0.45	0.11	0.33	13.1%
		10.50	6.95	0.20	1.81	0.35	0.20	0.08	0.14	5.4%
		11.00	6.80	0.05	0.00	0.52	0.05	0.03	0.00	0.0%
		11.50	6.85	0.10	0.08	0.50	0.10	0.05	0.00	0.2%
		12.00	6.80	0.05	0.00	0.50	0.05	0.02	0.00	0.0%
	W	12.40	6.75			0.40		0.00	0.00	0.0%
1	G	12.90	5.79			0.00		0.00	0.00	0.0%
	RS	15.00	3.80			0.00		0.00	0.00	0.0%
	TOTALS ----------					8.14	0.7 (Max.)	2.68	2.52	100.0%

Manning's n = 0.1142
Hydraulic Radius= 0.32906528

STREAM NAME: Bent Creek
XS LOCATION: 400 ft. downstream from county road
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	2.52	cfs
CALCULATED FLOW (Qc)=	2.52	cfs
(Qm-Qc)/Qm * 100 =	0.1	%
MEASURED WATERLINE (WLm)=	6.76	ft
CALCULATED WATERLINE (WLc)=	6.75	ft
(WLm-WLc)/WLm * 100 =	0.1	%
MAX MEASURED DEPTH (Dm)=	0.70	ft
MAX CALCULATED DEPTH (Dc)=	0.70	ft
(Dm-Dc)/Dm * 100	0.0	%
MEAN VELOCITY=	0.94	ft/sec
MANNING'S N=	0.114	
SLOPE=	0.023	ft/ft
.4 * Qm =	1.0	cfs
2.5 * Qm=	6.3	cfs

RECOMMENDED INSTREAM FLOW:
=============================

FLOW (CFS)	PERIOD
___________	________

RATIONALE FOR RECOMMENDATION:
=============================

RECOMMENDATION BY: ………………...………..……............................... AGENCY..……………………......…....…...……...... DATE:......…...……....……………

CWCB REVIEW BY: ...……………………….....…………………………………………………...…............. DATE:..................…………….....

STREAM NAME: Bent Creek
XS LOCATION: 400 ft. downstream from county road
XS NUMBER: 2

WATER LINE COMPARISON TABLE

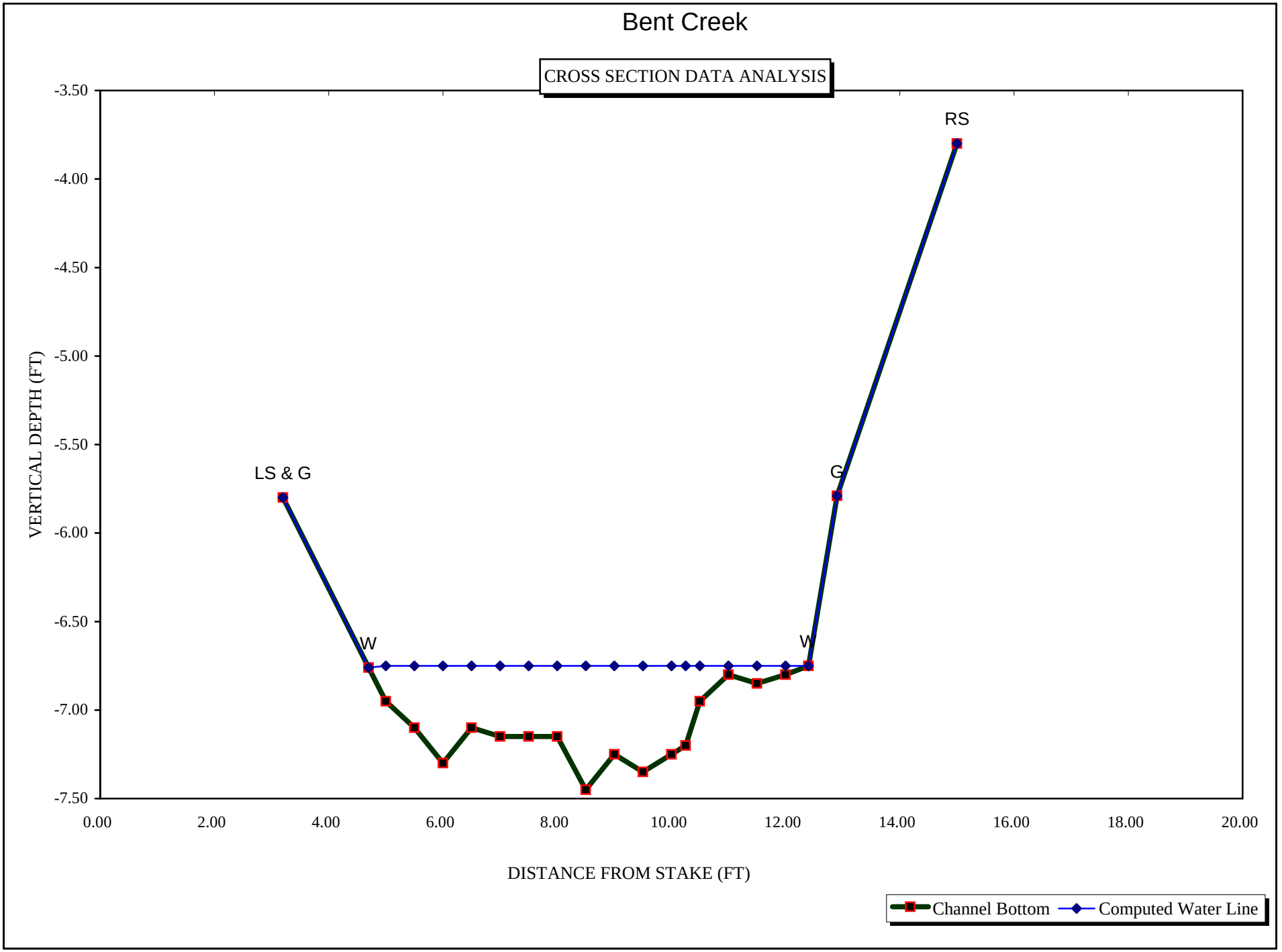
WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	2.68	2.64	-1.4%
6.51	2.68	4.63	73.0%
6.53	2.68	4.47	66.9%
6.55	2.68	4.30	60.8%
6.57	2.68	4.14	54.7%
6.59	2.68	3.98	48.7%
6.61	2.68	3.82	42.7%
6.63	2.68	3.66	36.7%
6.65	2.68	3.50	30.7%
6.67	2.68	3.34	24.8%
6.69	2.68	3.18	19.0%
6.71	2.68	3.03	13.1%
6.72	2.68	2.95	10.2%
6.73	2.68	2.87	7.3%
6.74	2.68	2.80	4.4%
6.75	2.68	2.72	1.5%
6.76	2.68	2.64	-1.4%
6.77	2.68	2.56	-4.2%
6.78	2.68	2.49	-7.0%
6.79	2.68	2.41	-9.8%
6.80	2.68	2.34	-12.5%
6.81	2.68	2.27	-15.2%
6.83	2.68	2.13	-20.4%
6.85	2.68	2.00	-25.1%
6.87	2.68	1.89	-29.6%
6.89	2.68	1.77	-34.0%
6.91	2.68	1.65	-38.3%
6.93	2.68	1.54	-42.5%
6.95	2.68	1.43	-46.7%
6.97	2.68	1.32	-50.8%
6.99	2.68	1.21	-54.8%
7.01	2.68	1.10	-58.8%

WATERLINE AT ZERO
AREA ERROR = 6.750

STREAM NAME: Bent Creek
XS LOCATION: 400 ft. downstream from county road
XS NUMBER: 2 Constant Manning's n

GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	5.80	9.69	1.13	1.65	10.95	10.99	100.0%	1.00	21.56	1.97
	5.80	9.69	1.13	1.65	10.95	10.99	100.0%	1.00	21.55	1.97
	5.85	9.59	1.09	1.60	10.46	10.84	98.6%	0.97	20.18	1.93
	5.90	9.49	1.05	1.55	9.99	10.69	97.3%	0.93	18.84	1.89
	5.95	9.38	1.01	1.50	9.52	10.54	95.9%	0.90	17.55	1.84
	6.00	9.28	0.98	1.45	9.05	10.39	94.6%	0.87	16.29	1.80
	6.05	9.17	0.94	1.40	8.59	10.24	93.2%	0.84	15.07	1.76
	6.10	9.07	0.90	1.35	8.13	10.09	91.9%	0.81	13.90	1.71
	6.15	8.97	0.86	1.30	7.68	9.94	90.5%	0.77	12.77	1.66
	6.20	8.86	0.82	1.25	7.24	9.80	89.1%	0.74	11.67	1.61
	6.25	8.76	0.78	1.20	6.80	9.65	87.8%	0.70	10.62	1.56
	6.30	8.65	0.74	1.15	6.36	9.50	86.4%	0.67	9.61	1.51
	6.35	8.55	0.69	1.10	5.93	9.35	85.1%	0.63	8.64	1.46
	6.40	8.44	0.65	1.05	5.51	9.20	83.7%	0.60	7.72	1.40
	6.45	8.34	0.61	1.00	5.09	9.05	82.4%	0.56	6.84	1.34
	6.50	8.24	0.57	0.95	4.67	8.90	81.0%	0.52	6.00	1.28
	6.55	8.13	0.52	0.90	4.26	8.75	79.6%	0.49	5.21	1.22
	6.60	8.03	0.48	0.85	3.86	8.60	78.3%	0.45	4.46	1.16
	6.65	7.92	0.44	0.80	3.46	8.45	76.9%	0.41	3.76	1.09
	6.70	7.82	0.39	0.75	3.07	8.30	75.6%	0.37	3.11	1.02
WL	6.75	7.71	0.35	0.70	2.68	8.15	74.2%	0.33	2.52	0.94
	6.80	7.23	0.32	0.65	2.30	7.65	69.6%	0.30	2.04	0.89
	6.85	5.99	0.33	0.60	1.97	6.39	58.1%	0.31	1.78	0.90
	6.90	5.74	0.29	0.55	1.68	6.12	55.7%	0.27	1.40	0.83
	6.95	5.50	0.25	0.50	1.40	5.85	53.2%	0.24	1.06	0.76
	7.00	5.28	0.21	0.45	1.13	5.61	51.0%	0.20	0.77	0.68
	7.05	5.07	0.17	0.40	0.87	5.36	48.8%	0.16	0.51	0.59
	7.10	4.85	0.13	0.35	0.62	5.11	46.5%	0.12	0.30	0.48
	7.15	3.05	0.13	0.30	0.40	3.27	29.8%	0.12	0.19	0.49
	7.20	2.66	0.10	0.25	0.26	2.84	25.8%	0.09	0.10	0.40
	7.25	2.08	0.07	0.20	0.14	2.21	20.1%	0.06	0.04	0.31
	7.30	1.12	0.05	0.15	0.06	1.20	10.9%	0.05	0.02	0.26
	7.35	0.42	0.05	0.10	0.02	0.46	4.2%	0.04	0.01	0.25
	7.40	0.21	0.02	0.05	0.01	0.23	2.1%	0.02	0.00	0.16


Bent Creek
CROSS SECTION DATA ANALYSIS
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
-6.50
-7.00
-7.50
VERTICAL DEPTH (FT)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
DISTANCE FROM STAKE (FT)
LS & G
W
W
G
RS
Channel Bottom
Computed Water Line

Percent Wetted Perimeter vs. Discharge