Stream: Battlement Creek

Executive Summary

Water Division: 5
Water District: 45
CDOW#: 19059
CWCB ID: 08/5/A-004

Segment: Outlet of Battlement Reservoir to Headgate Battlement Ditch

Upper Terminus: OUTLET BATTLEMENT RESERVOIR AT
(Latitude 39° 22’ 29.98”N) (Longitude 107° 56’ 15.5”W)

Lower Terminus: HDGT BATTLEMENT DITCH AT
(Latitude 39° 26’10.01”N) (Longitude 107° 58’ 42.44”W)

Watershed: Colorado headwaters-Plateau (HUC#: 14010005)
Counties: Garfield
Length: 5.15 miles
USGS Quad(s): Rulison
Flow Recommendation: 6.3 cfs (April 1 - June 30)
3.5 cfs (July 1 - July 31)
1.5 cfs (August 1 - March 31)

Staff Analysis and Recommendation

Summary

The information contained in this report and the associated instream flow appendices (see CD entitled 2008 Instream Flow Recommendations)forms the basis for staff's instream flow recommendation to be considered by the Board. It is staff's opinion that the information contained in this report is sufficient to support the findings required in Rule 5.40.

Colorado's Instream Flow Program was created in 1973 when the Colorado State Legislature recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3) C.R.S.). The statute vests the CWCB with the exclusive authority to appropriate and acquire instream flow and natural lake level water rights. In order to encourage other entities to participate in Colorado's Instream Flow Program, the statute directs the CWCB to request instream flow recommendations from other state and federal agencies. The Bureau of Land Management (BLM) recommended this segment of Battlement Creek to the CWCB for inclusion into the Instream Flow Program. Battlement Creek is being considered for inclusion into the Instream Flow Program because it has a natural environment that can be preserved to a reasonable degree with an instream flow water right.

Battlement Creek is approximately 8 miles long. It begins on the west flank of Haystack Mountain on the Grand Mesa National Forest at an elevation of approximately 10100 feet and terminates at the confluence the Colorado River at an elevation of approximately 5100 feet. Approximately 50% of the land on the 5.15 mile segment addressed by this report is publicly owned. Battlement Creek is located within Garfield County. The total drainage area of the creek is approximately 10.5 square miles. Battlement Creek generally flows in a northwesterly direction.

The subject of this report is a segment of Battlement Creek beginning at the outlet of Battlement reservoir and extending downstream to the headgate of the Battlement Ditch. The proposed segment is located approximately 13 miles southwest of Rifle. The staff has received only one recommendation for this segment, from the BLM. The recommendation for this segment is discussed below.

Instream Flow Recommendation(s)

BLM recommended 6.3 cfs, high temperature period, 3.5 cfs, late summer and 1.5 cfs, low temperature period, based on its data collection efforts. The modeling results from this survey effort are within the confidence interval produced by the R2Cross model.

Land Status Review

Upper Terminus	Lower Terminus	Total Length (miles)	Land Ownership	
			% Private	% Public
Outlet of Battlement Reservoir	Headgate of Battlement Ditch	5.15	50%	50%

50% of the public lands are managed by the BLM and 50% are managed by the U.S. Forest Service.

Biological Data

The BLM has conducted field surveys of the fishery resources on this stream and have found a natural environment that can be preserved. As reported in the letter from BLM to the CWCB "Battlement Creek is a high gradient stream, with moderate substrate size. The creek is often confined by a narrow canyon, and it has cut down to bedrock in numerous locations. The riparian community is very vigorous in these confined locations and provides substantial shading and nutrient supply for the creek. The creek provides good pool habitat, but rifles for spawning are a limiting factor for the fish population. Fishery surveys indicate that the creek supports a self-sustaining population of Colorado River Cutthroat Trout. Genetic sampling of the trout population has revealed extremely high genetic purity, despite the proximity of roads, campgrounds and reservoirs. These features often attract informal stocking of brook and rainbow trout by visiting fishermen".

Field Survey Data & Biological Flow Quantification

BLM staff used the R2Cross methodology to quantify the amount of water required to preserve the natural environment to a reasonable degree. The R2Cross method requires that stream discharge and channel profile data be collected in a riffle stream habitat type. Riffles are most easily visualized, as the stream habitat types that would dry up first should streamflow cease. This type of hydraulic data collection consists of setting up a transect, surveying the stream channel geometry, and measuring the stream discharge.

The CWCB staff relied upon the biological expertise of the cooperating agencies to interpret output from the R2Cross data collected to develop the initial, biologic instream flow recommendation. This initial recommendation is designed to address the unique biologic requirements of each stream without regard to water availability. Three instream flow hydraulic parameters, average depth, percent wetted perimeter, and average velocity are used to develop biologic instream flow recommendations. The CDOW has determined that maintaining these three hydraulic parameters at adequate levels across riffle habitat types, aquatic habitat in pools and runs will also be maintained for most life stages of fish and aquatic invertebrates (Nehring 1979; Espegren 1996).

For this segment of stream, three data sets were collected with the results shown in Table 1 below. Table 1 shows who collected the data (Party), the date the data was collected (Date), the measured discharge at the time of the survey (Q), the accuracy range of the predicted flows based on Manning's Equation (240% and 40% of Q), the summer flow recommendation based on meeting 3 of 3 hydraulic criteria and the winter flow recommendation based upon 2 of 3 hydraulic criteria.

Table 1: Battlement Creek R2Cross Summary

			Confidence Intervals	Recommended Flows (cfs)	
Party	**Date**	**Q (cfs)**	**250%-40%**	**Summer (3/3)**	**Winter (2/3)**
BLM	6/12/2006	(1)	(1)	(1)	(1)
BLM	7/26/2006	7.98	19.9 – 3.2	9.14	3.15
BLM	7/26/2006	6.77	16.9 – 2.7	3.27	(1)

BLM = Bureau of Land Management
(1) Predicted flow outside of the accuracy range of Manning's Equation.

The high temperature flow recommendation, which meets 3 of 3 criteria and is within the accuracy range of the R2CROSS model is 6.3 cfs (See Table 1). The late summer flow recommendation, which meets 2 or 3 criteria and is within the accuracy range of the R2Cross model is 5.0 cfs. These recommendations were derived by averaging the results of the three data sets. The low temperature flow recommendation is based on water availability limitations is 2.0 cfs. It is our belief that recommendations that fall outside of the accuracy range of the model, over 250% of the measured discharge or under 40% of the measured discharge may not give an accurate estimate of the necessary instream flow required.

Hydrologic Data and Analysis

After receiving the cooperating agency's biologic recommendation, the CWCB staff conducted an evaluation of the stream hydrology to determine if water was physically available for an instream flow appropriation. This evaluation was done through a computation that is, in essence, a "water balance". In concept a "water balance" computation can be viewed as an accounting exercise. When done in its most rigorous form, the water balance parses precipitation into all the avenues water pursues after it is deposited as rain, snow, or ice. In other words, given a specified amount of water deposition (input), the balance tries to account for all water depletions (losses) until a selected end point is reached. Water losses include depletions due to evaporation and transpiration, deliveries into ground water storage, temporary surface storage, incorporations into plant and animal tissue and so forth. These losses are individually or collectively subtracted from the input to reveal the net amount of stream runoff as represented by the discharge measured by stream gages. Of course, the measured stream flow need not be the end point of interest; indeed, when looking at issues of water use to extinction stream flow measurements may only describe intermediate steps in the complex accounting process that is a water balance carried out to a net value of zero.

In its analysis, CWCB staff has attempted to use this idea of balancing inputs and losses to determine if water is available for the recommended Instream Flow Appropriation. Of course, this analysis must be a practical exercise rather than a lengthy, and costly, scientific investigation. As a result, staff has simplified the process by lumping some variables and employing certain rational and scientifically supportable assumptions. The process may be described through the following description of the steps used to complete the evaluation for this particular stream.

The first step required in determining water availability is a determination of the hydrologic regime at the Lower Terminus (LT) of the recommended ISF reach. In the best case this means looking at the data from a gage at the LT. Further, this data, in the best case, has been collected for a long period of time (the longer the better) including wet and dry periods. In the case of **Battlement Creek** such a gage is available at the LT. The gage station is BATTLEMENT CREEK NEAR PARACHUTE, CO (USGS 09092600), a gage with a 9 year period of record (POR) collected between 1956 and 1965. The gage is at an elevation of 6,630 ft above mean sea level (amsl) and has a drainage area of 10.5 mi^2. The hydrograph (plot of discharge over time) produced by this gage includes virtually no upstream consumption through diversions. While this lack of significant upstream diversion and use make this gage attractive for our purposes, the gage does have one drawback; namely, it has a short POR.

To keep the positive values of the Battlement Creek gage while reducing the limitation of its short POR, a statistical procedure called linear regression was employed. The procedure gives us the means to relate characteristics of a limited (short) data set to those of a larger (longer) data set and, if the two data sets are similar enough, to predict the data values "missing" from the short data set. The outcome is a "predicted" (called "Y – Hat" or $\hat{Y}$) set of data that augments the short data set; creating, in effect, a longer POR that is reflective of climate variation (i.e., it includes more wet-dry cycles.) The gage that was selected to provide the longer POR was WEST DIVIDE CREEK NEAR RAVEN, CO (USGS 09089500), a gage with a 50 year POR collected between 1955 and 2005. The West Divide Creek gage is at an elevation of 7050 ft amsl and has a drainage area of 64.6 $mi^{2.}$

Before performing the linear regression described above, the measured hydrographs of both gages must be adjusted to remove the effects of water consumption by upstream irrigation diversion. As mentioned above, the hydrograph of the Battlement Creek gage includes virtually no upstream consumption through diversions. West Divide Creek, however, does have a small number of upstream diversions as well as a trans-basin source of increased discharge. Thus, before performing the linear regression, the West Divide data record must be increased by the amount of consumptive loss due to upstream diversions; it must also be decreased by the amount of trans-basin additions. When the data sets are adjusted in the manner described, then the two gages can be regressed one against the other to produce a "predicted" hydrograph for Battlement Creek that displays the important attributes of a gage that is located nearby, is un-impacted (by irrigation consumption or "foreign water"), and exhibits a long-term POR.

With the creation of the Battlement Creek "predicted" hydrograph we have represented a distribution of flow over time reflective of existing conditions.

The following hydrograph depicts the mean monthly discharge of Battlement Creek (regressed on West Divide Creek near Raven). Included in the hydrograph are the recommended ISF values. The data used in the creation of this hydrograph are displayed

Figure 1 - Battlement Creek Discharge (regressed on West Divide Cr nr Raven) & ISFs

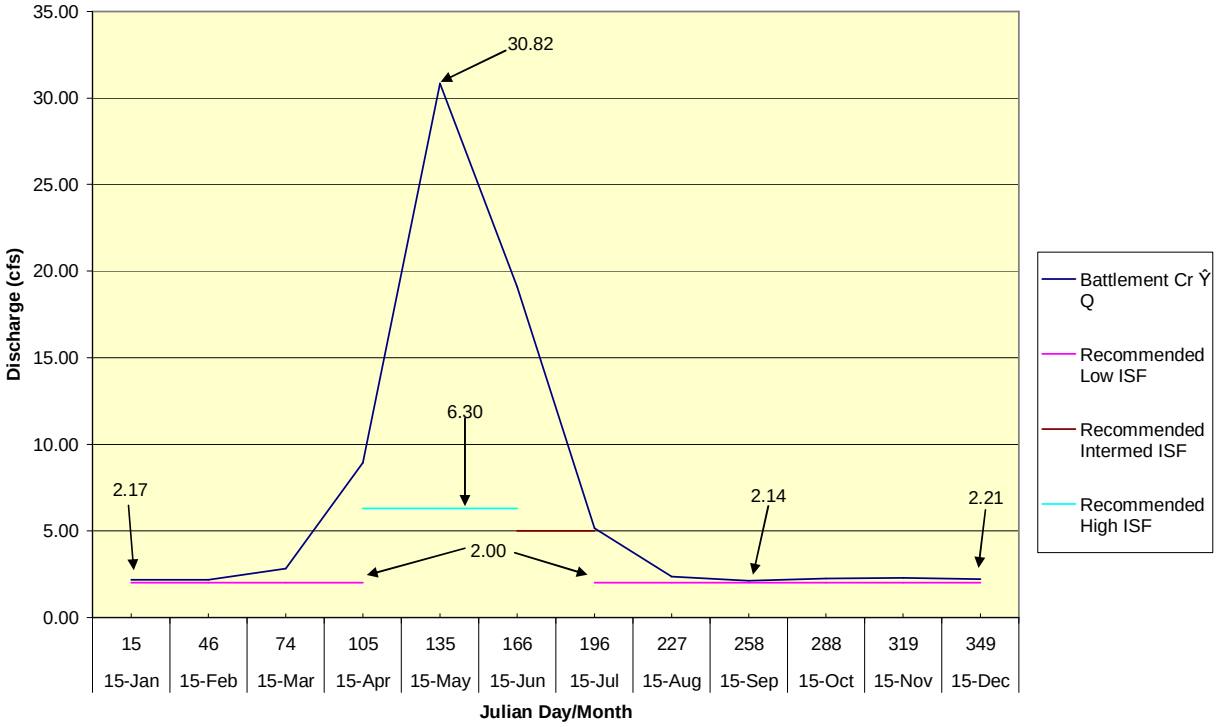


Table 2 – Mean Monthly Discharge and Recommended Instream Flows – Battlement Cr.

	Julian Day	Battlement Cr (cfs)	Recommended ISF (cfs)
15-Jan	15	2.17	1.50
15-Feb	46	2.18	1.50
15-Mar	74	2.81	1.50
15-Apr	105	8.95	1.50
30-Apr	120	8.95	1.50
1-May	121	30.82	6.30
15-May	135	30.82	6.30
15-Jun	166	19.11	6.30
15-Jul	196	5.16	6.30
31-Jul	212	5.16	6.30
1-Aug	213	2.35	3.50
15-Aug	227	2.35	3.50
15-Sep	258	2.14	3.50
15-Oct	288	2.27	3.50
31-Oct	304	2.27	3.50
1-Nov	305	2.29	1.50
15-Nov	319	2.29	1.50
15-Dec	349	2.21	1.50

Existing Water Right Information

Staff has analyzed the water rights tabulation to identify any potential water availability problems. The U.S. Forest Service holds water rights Battlement Reservoir 1 through 5, which are located just above the upper terminus of the proposed instream flow reach. In total, these reservoirs are decreed for 669.45 acre feet of storage. The lower terminus of the creek is located at the headgate of the first ditch on the creek, called battlement ditch. This ditch is decreed for 17.84 cfs with 1890s priorities. Based on this analysis staff has determined that water is available for appropriation on Battlement Creek, from the outlet of Battlement Reservoir and the headgate of the Battlement Ditch, to preserve the natural environment to a reasonable degree without limiting or foreclosing the exercise of valid existing water rights.

CWCB Staff's Instream Flow Recommendation

Staff recommends the Board form its intent to appropriate on the following stream reach:

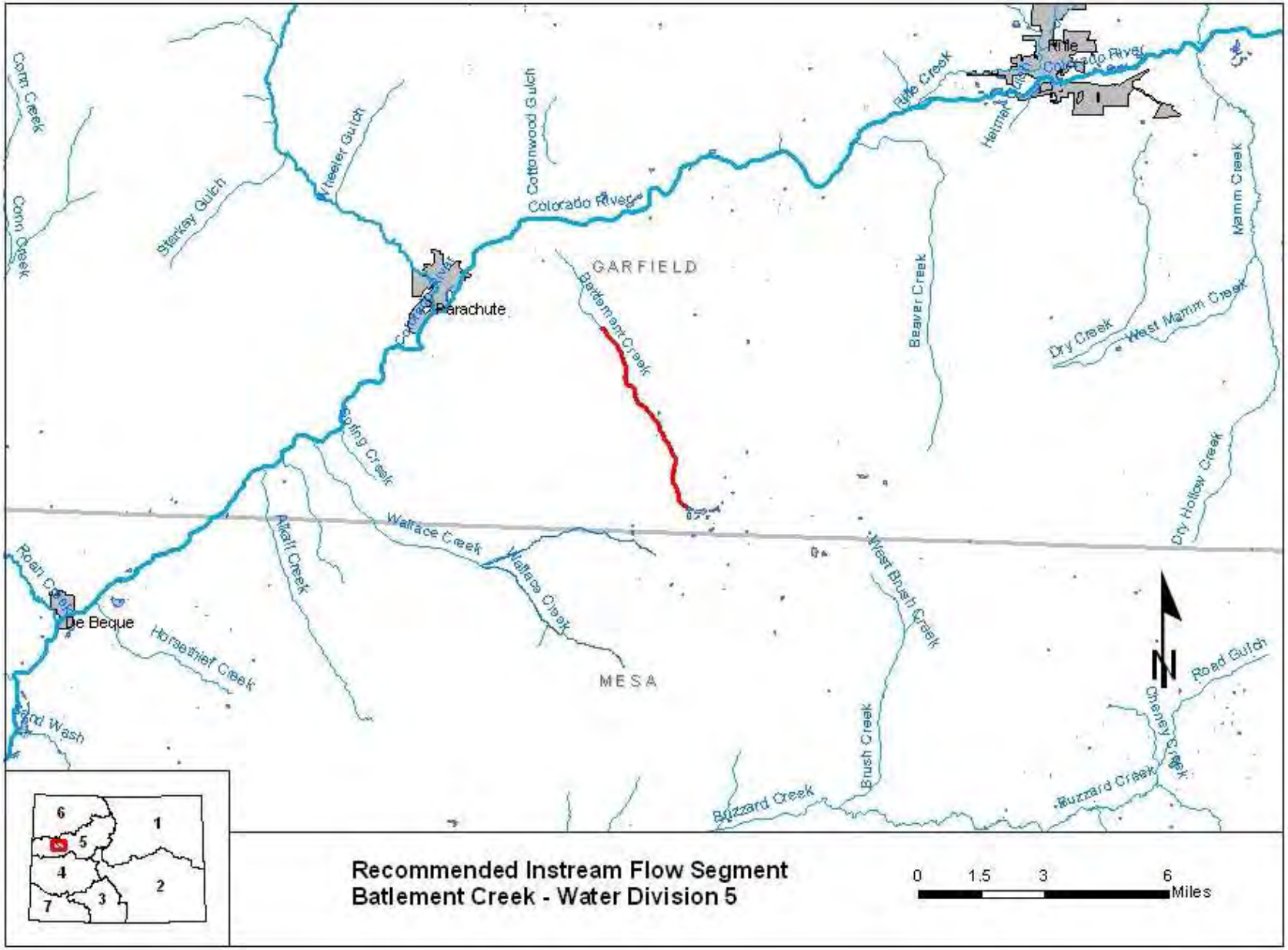
Segment: Outlet of Battlement Reservoir to Headgate Battlement Ditch

Upper Terminus: OUTLET BATTLEMENT RESERVOIR AT
(Latitude 39° 22' 29.98"N) (Longitude 107° 56' 15.5"W)
UTM = 4362508.9 N UTM =246951.1 E
NE SE S12 T8S R95W 6PM
930' West of the East Section Line; 1540' North of the South Section Line

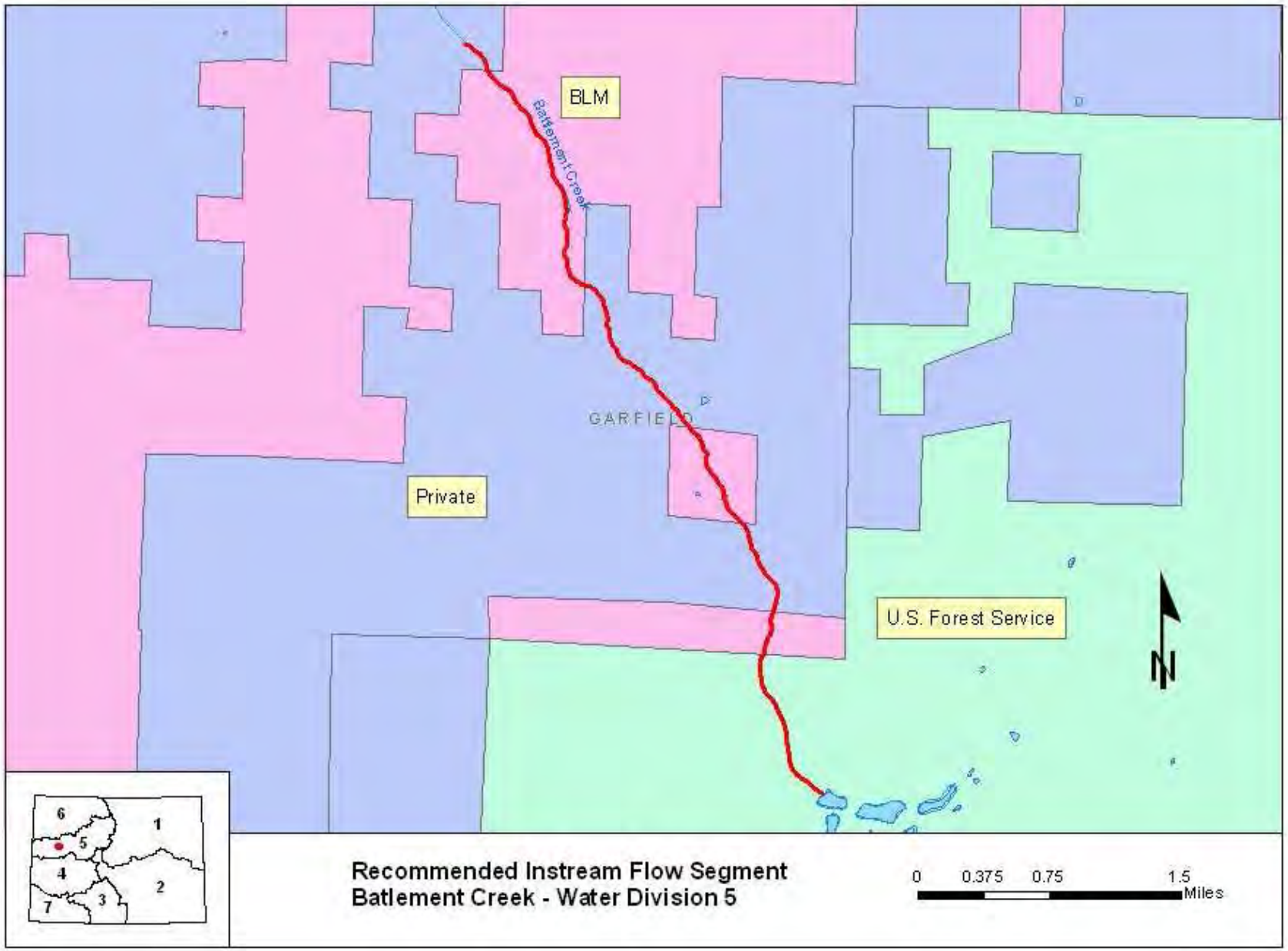
Lower Terminus: HDGT BATTLEMENT DITCH AT
(Latitude 39° 26'10.01"N) (Longitude 107° 58' 42.44"W)
UTM = 4369409 N UTM =243658.5 E
NE SE S15 T7S R95W 6PM
1170' West of the East Section Line; 2160' North of the South Section Line

Watershed: Colorado headwaters-Plateau (HUC#: 14010005)
Counties: Garfield
Length: 5.15 miles
USGS Quad(s): Rulison
Flow Recommendation: 6.3 cfs (April 1- June 30)
3.5 cfs (July 1 - July 31)
1.5 cfs (August 1 - March 31)

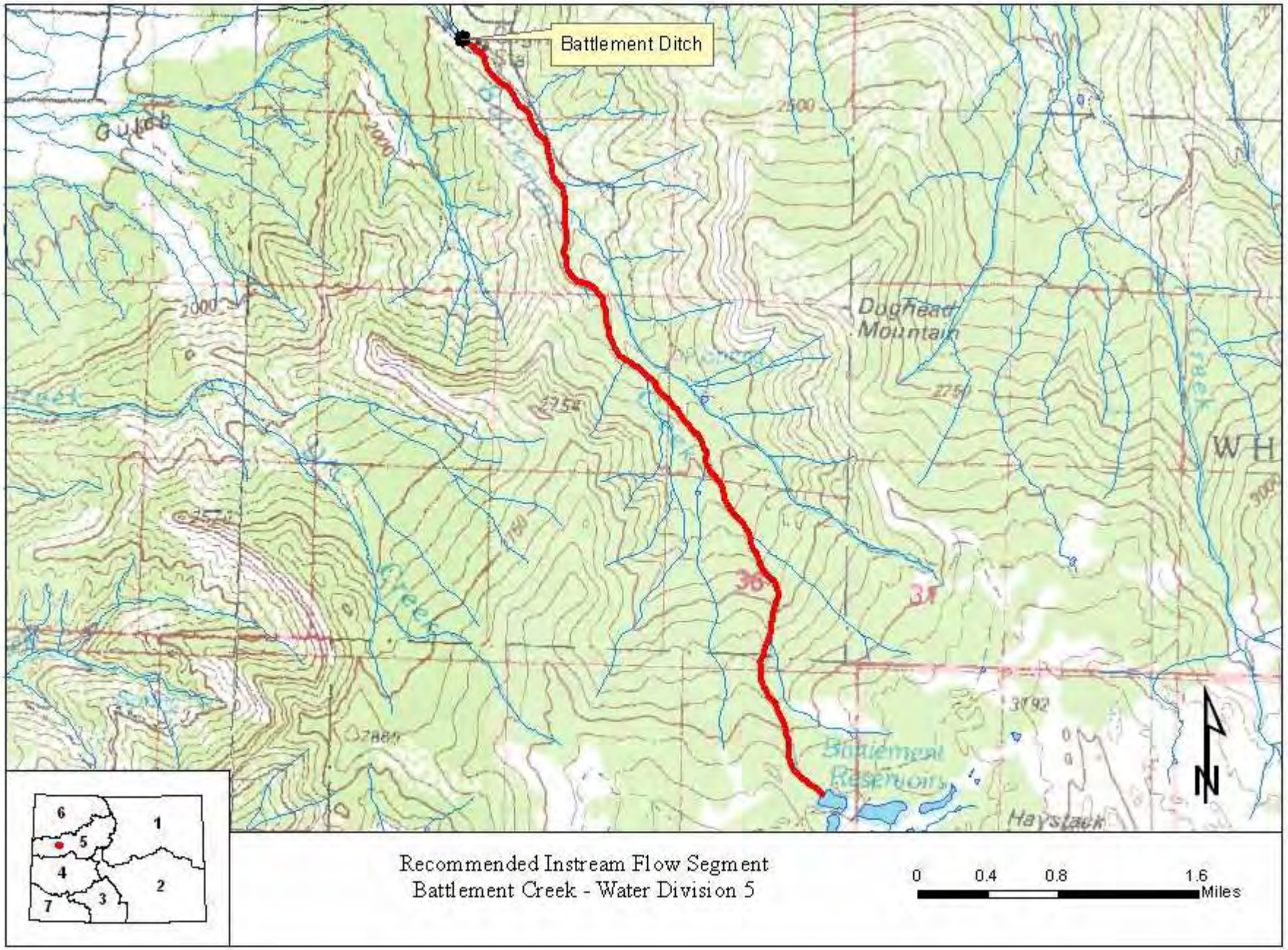
Vicinity Map



Land Use Map


BLM
Batlement Creek
GARFIELD
Private
U.S. Forest Service
N
6
1
5
4
2
7
3
Recommended Instream Flow Segment
Batlement Creek - Water Division 5
0
0.375
0.75
1.5
Miles

Topographic & Water Rights Map



UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
COLORADO STATE OFFICE
2850 YOUNGFIELD STREET
LAKEWOOD, COLORADO 80215-7093

In Reply Refer To:
7250 (CO-932)

DEC 2 6 2007

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 instream flow recommendation for Battlement Creek, located in Water Division 5.

Location and Land Status. Battlement Creek is tributary to the Colorado River approximately 13 miles southwest of Rifle, Colorado. The creek is located within the lower Colorado River watershed. This recommendation covers the stream reach beginning at the outlet of Battlement Reservoirs and extends downstream to the headgate of the Battlement Ditch. Approximately 50 percent of the 5.0-mile reach is located on federal lands, while the remaining 50 percent is located on private lands. Approximately 50% of the federal lands are managed by the U.S. Forest Service, and 50% are managed by the BLM.

Biological Summary. Battlement Creek is a high gradient stream, with moderate substrate size. The creek is often confined by a narrow canyon, and it has cut down to bedrock in numerous locations. The riparian community is very vigorous in these confined locations and provides substantial shading and nutrient supply for the creek. The creek provides good pool habitat, but riffles for spawning are a limiting factor for the fish population. Fishery surveys indicate that the creek supports a self-sustaining population of Colorado River Cutthroat Trout. Genetic sampling of the trout population has revealed extremely high genetic purity, despite the proximity of roads, campgrounds, and reservoirs. These features often attract informal stocking of brook and rainbow trout by visiting fishermen.

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:

- 6.3 cubic feet per second is recommended during the high temperature period from April 1 through June 30. This recommendation is driven by the average depth and average velocity criteria. Because the creek is characterized by short riffles between numerous plunge pools, it is very important to maintain adequate velocity and depth in the limited riffle habitat.

- 5.0 cubic feet second is recommended for the period from July 1 to July 31. It is very important to provide as much physical habitat as possible during this high temperature period, when the fish population is putting on weight for overwintering.

- 2.0 cubic feet per second is recommended for the period from August 1 through March 31. This recommendation is driven by water availability. This flow should provide sufficient water exchange in pools to allow the fish population to successfully overwinter. During late summer and fall months, this flow rate will allow some portions of the stream to meet the wetted perimeter criteria and velocity criteria, allowing fish movement between pools.

Water Availability. The U.S. Forest Service holds water rights Battlement Reservoirs 1 through 5, which are located just above the upper terminus of the proposed instream flow reach. In total, these reservoirs are decreed for 669.45 acre feet of storage. The lower terminus of the creek is located at the headgate of the first ditch on the creek, called Battlement Ditch. This ditch is decreed for 17.84 cfs with 1890s priorities.

BLM recommends using the historic Battlement Creek Gage (U.S. Geological Survey (USGS) 09092600), which was operated for 10 years from 1956 through 1965. This period of record incorporates the operation of the upstream reservoirs, because the reservoirs have been in operation since the 1890s.

Relationship to Management Plans. BLM has placed this creek in its intensive management category because of the high quality Colorado River Cutthroat Trout population. BLM will take actions to prevent unnecessary disturbance and degradation along the creek corridor from any activities authorized on BLM lands. BLM will also work with the U.S. Forest Service to prevent inadvertent introduction of diseases and non-native species. BLM is also working under the three state species conservation agreement for Colorado River Cutthroat Trout to establish this creek as a core genetic population. If a sufficient number of core genetic populations are established, it may be possible to avoid a listing of species under the Endangered Species Act.

The BLM requests that the Board recognize that this recommendation is based only upon the minimum flows necessary to support cold-water and cool-water fishery values. BLM may wish to work with the Board and/or through the Colorado water rights system to appropriate flows to optimally protect fish values and to protect other water-dependent values specified in BLM resource management plans. Data sheets, R2Cross output, fishery survey information, and

photographs of the cross section were included with BLM's draft recommendation in February 2007.

We thank both the Division of Wildlife and the Water Conservation Board for their cooperation in this effort. If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

Dennis D. Zachman (ACTING)

for Linda M. Anañia
Deputy State Director
Resources and Fire

cc: Jamie Connell, Grand Junction FO
Tom Fresques, Glenwood Springs FO

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Battlement Creek					CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: At first campground at BLM land					
DATE: 7-26-06	OBSERVERS: R. Smith, M. Boyum				
LEGAL DESCRIPTION	¼ SECTION: NW	SECTION: 23	TOWNSHIP: 7 N/S	RANGE: 95 E/W	PM: 6th
COUNTY: Garfield	WATERSHED: Colorado	WATER DIVISION: 5	DOW WATER CODE: 19059		
MAP(S): USGS: Hawxhurst Creek 7.5'					
USFS:					

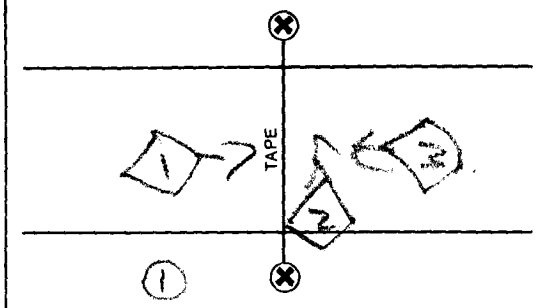
SUPPLEMENTAL DATA

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: 2" cobbles to 1-foot boulders	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
1 WS @ Tape LB/RB	0.0	6.57/6.52
2 WS Upstream	30.0'	5.78
3 WS Downstream	11.0'	6.77
SLOPE	0.99/41.0 =	

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

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

COMMENTS

Temp = 16.5° C
Ph = 8.3
TDS = 160

DISCHARGE/CROSS SECTION NOTES

STREAM NAME:	CROSS-SECTION NO.:	DATE:	SHEET ___ OF ___
Battlement Creek	1	7-26-06	

BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE)	LEFT / RIGHT	Gage Reading: 0.2 ft	TIME: 3:05 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	0.0		4.16								
G	1.3		5.22								
W	1.4		6.57								
	2.0		7.12	0.55				1.32			
	2.5		7.16	0.6				1.80			
	3.0		7.39	0.85				0.83			
	3.5		7.44	0.9				1.96			
	4.0		7.35	0.8				2.08			
	4.5		7.27	0.7				2.13			
	5		7.10	0.55				2.03			
	6		7.01	0.45				0.27			
	7		6.75	0.2				0.79			
	8		6.66	0.1				0.0			
	9		6.71	0.15				0.06			
	10		6.86	0.3				0.95			
	11		6.74	0.2				1.95			
	12		6.91	0.35				1.87			
	13		6.74	0.2				2.23			
	14		6.73	0.2				2.28			
	15		6.72	0.2				0.82			
	16		6.69	0.15				1.08			
	17		6.74	0.2				1.68			
	18		6.68	0.15				1.03			
	19		6.62	0.1				0.54			
	20		6.58	0.05				0.0			
W	20.6		6.52								
	24.6		6.38								
G	29.7		5.19								
RS	34.0		4.55								
TOTALS:											

End of Measurement	Time: 3:40	Gage Reading: 0.3 ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

LOCATION INFORMATION

STREAM NAME: Battlement Creek						CROSS-SECTION NO.:
CROSS-SECTION LOCATION: 1/2 mile upstream from BLM campground at turnoff						
DATE: 7-26-06	OBSERVERS: R. Smith, M. Boyum					
LEGAL DESCRIPTION	¼ SECTION: NW	SECTION: 23	TOWNSHIP: 7 N (S)	RANGE: 95 E (W)	PM: 6th	
COUNTY: Garfield	WATERSHED: Colorado	WATER DIVISION: 5	DOW WATER CODE: 19059			
MAP(S): USGS: Hawxhurst Creek 7.5'	Zone 13	0244287				
USFS:	4368626	6880 ft.				

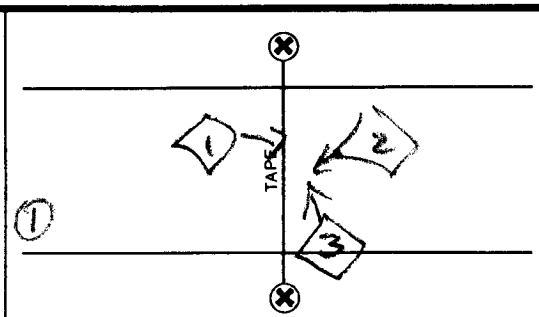
SUPPLEMENTAL DATA

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: 2" cobbles to 2 foot boulders	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	(3.1) (17.7)
(1) WS @ Tape LB/RB	0.0	4.81 / 4.81
(2) WS Upstream	11.0	4.48
(3) WS Downstream	13.0	5.64
SLOPE	1.16 / 24.0 =	

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

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

COMMENTS

TDS = 160
Ph = 8.3
Temp: 16.5°C

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Battlement Creek	CROSS-SECTION NO.: 2	DATE: 7-26-06	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: 0.35 ft	TIME: 4:20 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	0.0		1.62								
G	2.2		4.04								
W	3		4.51								
	3.5		4.90	0.1				0.98			
	4		4.88	0.1				0.0			
	4.5		5.02	0.2				1.46			
	5		5.00	0.2				1.47			
	5.5		5.01	0.2				0.74			
	6		5.13	0.35				0.37			
	6.5		5.24	0.45				1.27			
	7		5.26	0.45				0.87			
	8		5.20	0.4				1.01			
	9		5.15	0.35				1.91			
	10		5.32	0.55				1.58			
	11		5.36	0.55				1.35			
	12		5.26	0.45				0.54			
	13		5.15	0.35				0.99			
	14		5.44	0.65				2.04			
	14.5		5.27	0.45				2.24			
	15		5.27	0.45				2.17			
	15.5		5.19	0.4				1.42			
	16		5.16	0.35				0.54			
	16.5		5.14	0.3				0.45			
	17		4.97	0.15				0.0			
W	17.7		4.81								
G	19.0		3.93								
LS	20.0		2.84								
TOTALS:											

End of Measurement	Time: 5:05	Gage Reading: .35 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: Battlement Creek					CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: At first campground on county road					
DATE: 6-17-98	OBSERVERS: R. Smith, T. Fresques				
LEGAL DESCRIPTION	¼ SECTION: SW	SECTION: 14	TOWNSHIP: 7 N/S	RANGE: 95 E/W	PM: 6th
COUNTY: Garfield	WATERSHED: Colorado	WATER DIVISION: 5	DOW WATER CODE: 19059		
MAP(S): USGS: Parachute 7.5'		zone 13 S 0243992 E			
USFS:		4378999 N			

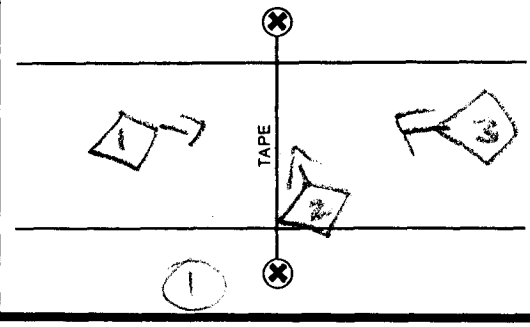
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE: Marsh-McBirney			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: ____ lbs/foot	TAPE TENSION: ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: gravel to 8" cobbles	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
① WS @ Tape LB/RB	0.0	3.08 / 5.02
② WS Upstream	30.0'	4.00
③ WS Downstream	30.0'	6.70
SLOPE	2.7'/60.0 = 0.045	

SKETCH



LEGEND:
Stake ⊗
Station ①
Photo ⟨i⟩
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 previous survey																	

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

caddis fly, caseless caddis, mayfly, mayfly nymph - all abundant

COMMENTS

Ch - 8.0
TDS - 90
Temp - 8° C

FORM #ISF FD 1-85

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Battlement Creek	CROSS-SECTION NO.: 1	DATE: 6-12-06	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: .2 ft	TIME: 10 am

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)
S	0.0		2.83								
	2.0		3.40								
G	2.2		3.62								
W	2.6		5.08								
	3.0		5.99	0.9				2.95			
	4.0		6.36	1.3				4.56			
	5.0		6.20	1.1				3.39			
	6.0		5.98	0.9				[illegible]			
	7.0		5.69	0.6				[illegible]			
	[illegible]		5.51	0.45				[illegible]			
	9.0		5.56	0.5				[illegible]			
	[illegible]		5.51	0.45				[illegible]			
	11.0		5.58	0.5				[illegible]			
	[illegible]		5.57	0.55				[illegible]			
	13.0		5.56	0.55				3.62			
	14.0		5.52	0.45				3.70			
	15.0		5.50	0.45				[illegible]			
	16.0		5.44	0.4				2.72			
	[illegible]		5.47	0.45				[illegible]			
	[illegible]		5.38	[illegible]				1.49			
	[illegible]		5.22	[illegible]				[illegible]			
	[illegible]		5.19	[illegible]				[illegible]			
	21.0		5.13	[illegible]				[illegible]			
	[illegible]		5.11	[illegible]				1.26			
	[illegible]		5.11	0.1				[illegible]			
W	24.4		5.02								
	27.0		4.58								
G	31.0		3.58								
S	33.9		3.37								
TOTALS:											

End of Measurement	Time: 10:30	Gage Reading: .2 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:	Battlement Creek
XS LOCATION:	At first campground on county road
XS NUMBER:	1
DATE:	12-Jun-06
OBSERVERS:	R. Smith, T. Fresques
1/4 SEC:	SW
SECTION:	14
TWP:	7S
RANGE:	95W
PM:	6th
COUNTY:	Garfield
WATERSHED:	Colorado
DIVISION:	5
DOW CODE:	19059
USGS MAP:	Parachute 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:	0.045

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

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

STREAM NAME: Battlement Creek
XS LOCATION: At first campground on county road
XS NUMBER: 1

DATA POINTS= 29

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
	S	0.00	2.83			0.00		0.00	0.00	0.0%
		2.00	3.40			0.00		0.00	0.00	0.0%
1	G	2.20	3.62			0.00		0.00	0.00	0.0%
	W	2.60	5.08			0.00		0.00	0.00	0.0%
		3.00	5.99	0.90	2.93	0.99	0.90	0.63	1.85	6.2%
		4.00	6.36	1.30	4.56	1.07	1.30	1.30	5.93	20.0%
		5.00	6.20	1.10	3.39	1.01	1.10	1.10	3.73	12.6%
		6.00	5.98	0.90	2.87	1.02	0.90	0.90	2.58	8.7%
		7.00	5.69	0.60	2.91	1.04	0.60	0.60	1.75	5.9%
		8.00	5.51	0.45	1.67	1.02	0.45	0.45	0.75	2.5%
		9.00	5.56	0.50	1.90	1.00	0.50	0.50	0.95	3.2%
		10.00	5.51	0.45	2.13	1.00	0.45	0.45	0.96	3.2%
		11.00	5.58	0.50	2.60	1.00	0.50	0.50	1.30	4.4%
		12.00	5.57	0.55	2.38	1.00	0.55	0.55	1.31	4.4%
		13.00	5.56	0.55	3.62	1.00	0.55	0.55	1.99	6.7%
		14.00	5.52	0.45	3.70	1.00	0.45	0.45	1.67	5.6%
		15.00	5.50	0.45	2.88	1.00	0.45	0.45	1.30	4.4%
		16.00	5.44	0.40	2.72	1.00	0.40	0.40	1.09	3.7%
		17.00	5.47	0.45	2.59	1.00	0.45	0.45	1.17	3.9%
		18.00	5.38	0.35	1.49	1.00	0.35	0.35	0.52	1.8%
		19.00	5.22	0.20	1.35	1.01	0.20	0.20	0.27	0.9%
		20.00	5.19	0.20	0.96	1.00	0.20	0.20	0.19	0.6%
		21.00	5.13	0.10	0.99	1.00	0.10	0.10	0.10	0.3%
		22.00	5.11	0.10	1.26	1.00	0.10	0.10	0.13	0.4%
		23.00	5.11	0.10	1.12	1.00	0.10	0.12	0.13	0.5%
	W	24.40	5.02			1.40		0.00	0.00	0.0%
		27.00	4.58			0.00		0.00	0.00	0.0%
1	G	31.00	3.58			0.00		0.00	0.00	0.0%
	S	33.90	3.37			0.00		0.00	0.00	0.0%
	TOTALS ----------					22.58	1.3 (Max.)	10.35	29.65	100.0%

Manning's n = 0.0654
Hydraulic Radius= 0.458277182

STREAM NAME: Battlement Creek
XS LOCATION: At first campground on county road
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.35	10.25	-0.9%
4.80	10.35	15.85	53.1%
4.82	10.35	15.39	48.7%
4.84	10.35	14.93	44.2%
4.86	10.35	14.47	39.8%
4.88	10.35	14.01	35.4%
4.90	10.35	13.56	31.0%
4.92	10.35	13.11	26.7%
4.94	10.35	12.66	22.4%
4.96	10.35	12.22	18.1%
4.98	10.35	11.78	13.8%
5.00	10.35	11.34	9.5%
5.01	10.35	11.12	7.4%
5.02	10.35	10.90	5.3%
5.03	10.35	10.68	3.2%
5.04	10.35	10.47	1.1%
5.05	10.35	10.25	-0.9%
5.06	10.35	10.04	-3.0%
5.07	10.35	9.83	-5.0%
5.08	10.35	9.62	-7.1%
5.09	10.35	9.41	-9.1%
5.10	10.35	9.20	-11.1%
5.12	10.35	8.81	-14.9%
5.14	10.35	8.44	-18.5%
5.16	10.35	8.08	-21.9%
5.18	10.35	7.73	-25.4%
5.20	10.35	7.38	-28.7%
5.22	10.35	7.05	-31.9%
5.24	10.35	6.72	-35.1%
5.26	10.35	6.40	-38.2%
5.28	10.35	6.08	-41.3%
5.30	10.35	5.76	-44.4%

WATERLINE AT ZERO
AREA ERROR = 5.045

STREAM NAME: Battlement Creek
XS LOCATION: At first campground on county road
XS NUMBER: 1

Constant Manning's n

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

STAGING TABLE

	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	3.62	28.64	1.63	2.74	46.62	30.69	100.0%	1.52	296.92	6.37
	4.05	26.82	1.30	2.31	34.82	28.50	92.8%	1.22	191.84	5.51
	4.10	26.61	1.26	2.26	33.49	28.24	92.0%	1.19	180.82	5.40
	4.15	26.39	1.22	2.21	32.16	27.98	91.2%	1.15	170.10	5.29
	4.20	26.18	1.18	2.16	30.85	27.72	90.3%	1.11	159.65	5.18
	4.25	25.97	1.14	2.11	29.55	27.47	89.5%	1.08	149.49	5.06
	4.30	25.75	1.10	2.06	28.25	27.21	88.6%	1.04	139.63	4.94
	4.35	25.54	1.06	2.01	26.97	26.95	87.8%	1.00	130.05	4.82
	4.40	25.33	1.01	1.96	25.70	26.69	87.0%	0.96	120.76	4.70
	4.45	25.11	0.97	1.91	24.44	26.43	86.1%	0.92	111.77	4.57
	4.50	24.90	0.93	1.86	23.19	26.18	85.3%	0.89	103.07	4.45
	4.55	24.68	0.89	1.81	21.95	25.92	84.4%	0.85	94.68	4.31
	4.60	24.44	0.85	1.76	20.72	25.63	83.5%	0.81	86.65	4.18
	4.65	24.13	0.81	1.71	19.51	25.28	82.4%	0.77	79.08	4.05
	4.70	23.82	0.77	1.66	18.31	24.93	81.2%	0.73	71.81	3.92
	4.75	23.51	0.73	1.61	17.12	24.58	80.1%	0.70	64.85	3.79
	4.80	23.20	0.69	1.56	15.95	24.23	78.9%	0.66	58.20	3.65
	4.85	22.90	0.65	1.51	14.80	23.87	77.8%	0.62	51.87	3.50
	4.90	22.59	0.61	1.46	13.67	23.52	76.6%	0.58	45.85	3.36
	4.95	22.28	0.56	1.41	12.54	23.17	75.5%	0.54	40.15	3.20
	5.00	21.97	0.52	1.36	11.44	22.82	74.3%	0.50	34.78	3.04
WL	5.05	21.41	0.48	1.31	10.35	22.22	72.4%	0.47	29.97	2.90
	5.10	20.62	0.45	1.26	9.30	21.39	69.7%	0.43	25.72	2.77
	5.15	18.11	0.46	1.21	8.34	18.85	61.4%	0.44	23.34	2.80
	5.20	17.17	0.43	1.16	7.46	17.87	58.2%	0.42	20.07	2.69
	5.25	16.17	0.41	1.11	6.63	16.84	54.9%	0.39	17.17	2.59
	5.30	15.83	0.37	1.06	5.83	16.47	53.6%	0.35	14.07	2.41
	5.35	15.50	0.33	1.01	5.05	16.10	52.4%	0.31	11.23	2.22
	5.40	15.09	0.28	0.96	4.28	15.65	51.0%	0.27	8.70	2.03
	5.45	14.24	0.25	0.91	3.54	14.77	48.1%	0.24	6.59	1.86
	5.50	12.29	0.24	0.86	2.89	12.78	41.6%	0.23	5.18	1.79
	5.55	8.44	0.28	0.81	2.36	8.89	29.0%	0.27	4.71	1.99
	5.60	4.70	0.44	0.76	2.06	5.11	16.6%	0.40	5.41	2.63
	5.65	4.40	0.42	0.71	1.83	4.77	15.5%	0.38	4.65	2.54
	5.70	4.11	0.39	0.66	1.62	4.45	14.5%	0.36	3.97	2.46
	5.75	3.92	0.36	0.61	1.42	4.21	13.7%	0.34	3.30	2.33
	5.80	3.72	0.33	0.56	1.23	3.98	13.0%	0.31	2.69	2.20
	5.85	3.53	0.30	0.51	1.04	3.74	12.2%	0.28	2.15	2.06
	5.90	3.33	0.26	0.46	0.87	3.51	11.4%	0.25	1.66	1.91
	5.95	3.14	0.23	0.41	0.71	3.28	10.7%	0.22	1.24	1.74
	6.00	2.92	0.19	0.36	0.56	3.02	9.8%	0.19	0.88	1.57
	6.05	2.55	0.17	0.31	0.42	2.64	8.6%	0.16	0.60	1.42
	6.10	2.19	0.14	0.26	0.30	2.26	7.4%	0.13	0.38	1.26
	6.15	1.83	0.11	0.21	0.20	1.88	6.1%	0.11	0.22	1.09
	6.20	1.47	0.08	0.16	0.12	1.51	4.9%	0.08	0.11	0.90
	6.25	1.03	0.06	0.11	0.06	1.06	3.4%	0.06	0.04	0.70
	6.30	0.58	0.03	0.06	0.02	0.59	1.9%	0.03	0.01	0.48
	6.35	0.13	0.01	0.01	0.00	0.13	0.4%	0.01	0.00	0.18

STREAM NAME: Battlement Creek
XS LOCATION: At first campground on county road
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	29.65	cfs
CALCULATED FLOW (Qc)=	29.97	cfs
(Qm-Qc)/Qm * 100 =	-1.1	%
MEASURED WATERLINE (WLm)=	5.05	ft
CALCULATED WATERLINE (WLc)=	5.05	ft
(WLm-WLc)/WLm * 100 =	0.1	%
MAX MEASURED DEPTH (Dm)=	1.30	ft
MAX CALCULATED DEPTH (Dc)=	1.31	ft
(Dm-Dc)/Dm * 100	-1.1	%
MEAN VELOCITY=	2.90	ft/sec
MANNING'S N=	0.065	
SLOPE=	0.045	ft/ft
.4 * Qm =	11.9	cfs
2.5 * Qm=	74.1	cfs

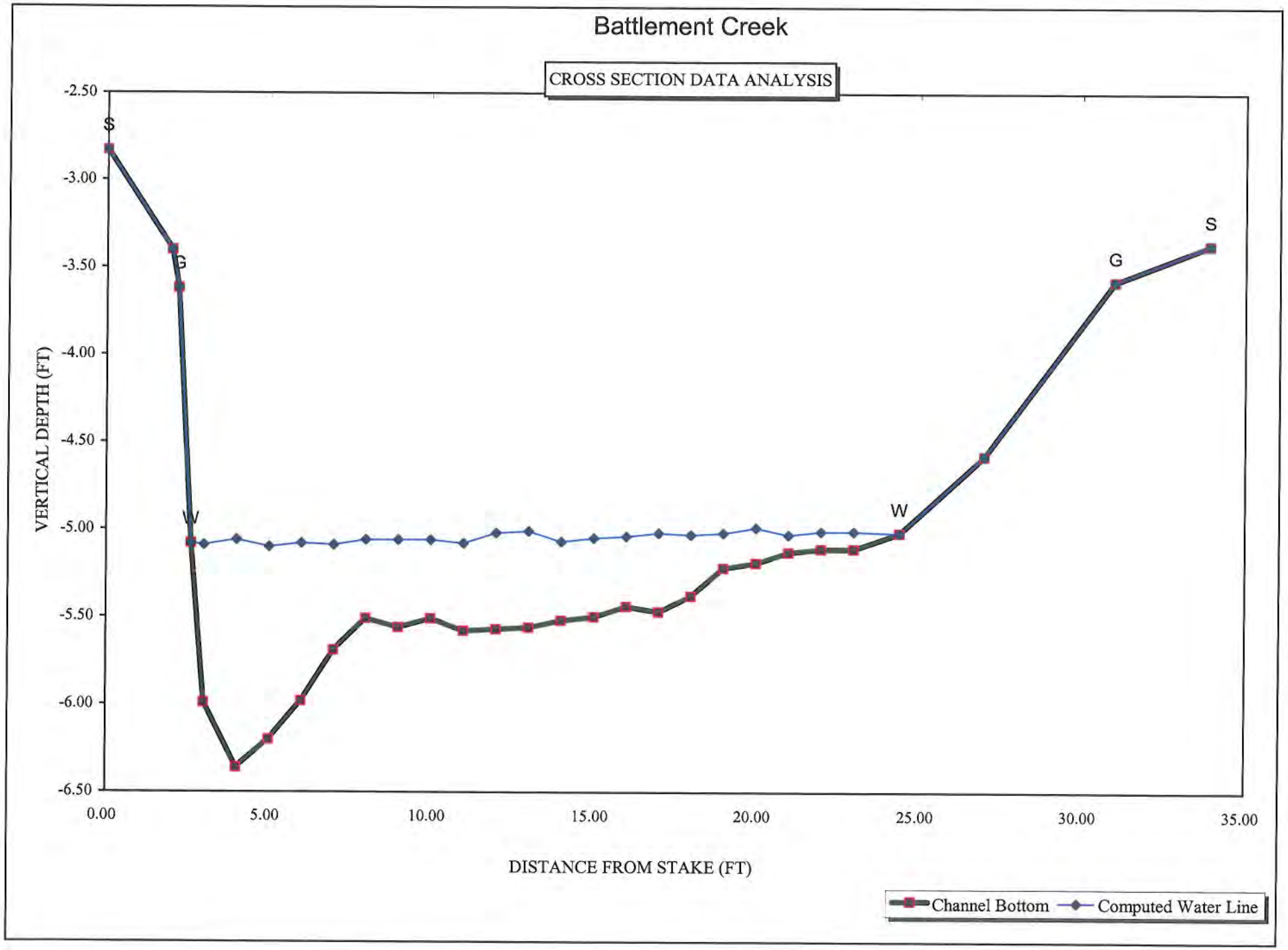
RECOMMENDED INSTREAM FLOW:

FLOW (CFS)	PERIOD

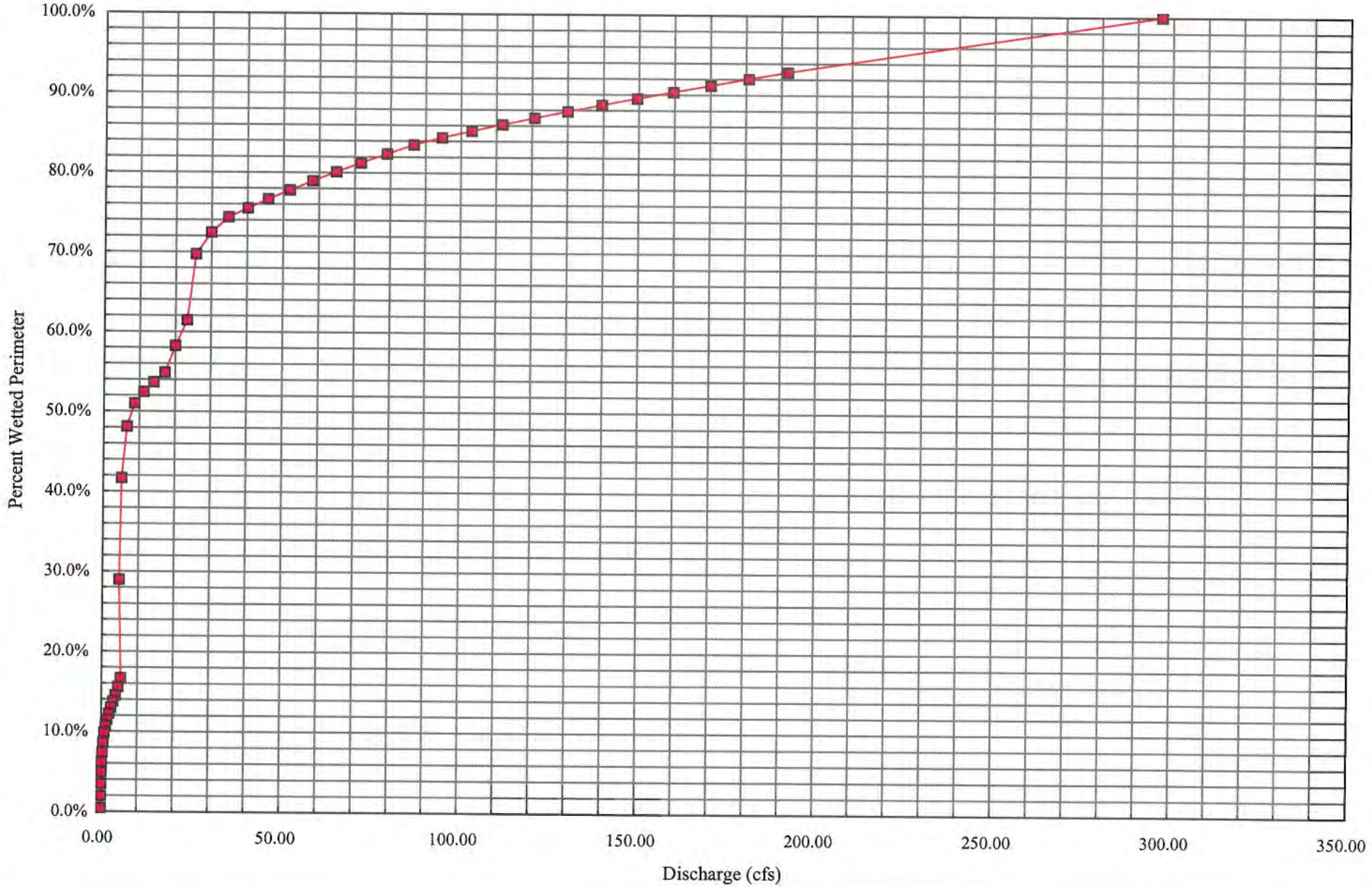
RATIONALE FOR RECOMMENDATION:

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

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


Battlement Creek
CROSS SECTION DATA ANALYSIS
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
-6.50
VERTICAL DEPTH (FT)
S
G
W
W
G
S
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
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:	Battlement Creek
XS LOCATION:	At first campground at BLM land
XS NUMBER:	1
DATE:	26-Jul-06
OBSERVERS:	R. Smith, M. Boyum
1/4 SEC:	NW
SECTION:	23
TWP:	7S
RANGE:	95W
PM:	6th
COUNTY:	Garfield
WATERSHED:	Colorado
DIVISION:	5
DOW CODE:	0
USGS MAP:	Hawxhurst Creek 7.5'
USFS MAP:	0

SUPPLEMENTAL DATA

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

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE:	0.0241

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

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

STREAM NAME: Battlement Creek
XS LOCATION: At first campground at BLM land
XS NUMBER: 1

DATA POINTS= 29

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL
	LS	0.00	4.16		
1	G	1.30	5.22		
	W	1.40	6.57		
		2.00	7.12	0.55	1.32
		2.50	7.16	0.60	1.80
		3.00	7.39	0.85	0.83
		3.50	7.44	0.90	1.96
		4.00	7.35	0.80	2.08
		4.50	7.27	0.70	2.13
		5.00	7.10	0.55	2.03
		6.00	7.01	0.45	0.27
		7.00	6.75	0.20	0.79
		8.00	6.66	0.10	0.00
		9.00	6.71	0.15	0.06
		10.00	6.86	0.30	0.95
		11.00	6.74	0.20	1.95
		12.00	6.91	0.35	1.87
		13.00	6.74	0.20	2.23
		14.00	6.73	0.20	2.28
		15.00	6.72	0.20	0.82
		16.00	6.69	0.15	1.08
		17.00	6.74	0.20	1.68
		18.00	6.68	0.15	1.03
		19.00	6.62	0.10	0.54
		20.00	6.58	0.05	0.00
	W	20.60	6.52		
		24.60	6.78		
1	G	29.70	5.19		
	RS	34.00	4.88		

TOTALS ----------

VALUES COMPUTED FROM RAW FIELD DATA

WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.81	0.55	0.30	0.40	5.0%
0.50	0.60	0.30	0.54	6.8%
0.55	0.85	0.43	0.35	4.4%
0.50	0.90	0.45	0.88	11.1%
0.51	0.80	0.40	0.83	10.4%
0.51	0.70	0.35	0.75	9.3%
0.53	0.55	0.41	0.84	10.5%
1.00	0.45	0.45	0.12	1.5%
1.03	0.20	0.20	0.16	2.0%
1.00	0.10	0.10	0.00	0.0%
1.00	0.15	0.15	0.01	0.1%
1.01	0.30	0.30	0.29	3.6%
1.01	0.20	0.20	0.39	4.9%
1.01	0.35	0.35	0.65	8.2%
1.01	0.20	0.20	0.45	5.6%
1.00	0.20	0.20	0.46	5.7%
1.00	0.20	0.20	0.16	2.1%
1.00	0.15	0.15	0.16	2.0%
1.00	0.20	0.20	0.34	4.2%
1.00	0.15	0.15	0.15	1.9%
1.00	0.10	0.10	0.05	0.7%
1.00	0.05	0.04	0.00	0.0%
0.60		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
19.61	0.9 (Max.)	5.63	7.98	100.0%

Manning's n = 0.0708
Hydraulic Radius= 0.287102449

STREAM NAME: Battlement Creek
XS LOCATION: At first campground at BLM land
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	5.63	6.15	9.2%
6.30	5.63	12.23	117.3%
6.32	5.63	11.74	108.5%
6.34	5.63	11.24	99.7%
6.36	5.63	10.75	91.0%
6.38	5.63	10.26	82.3%
6.40	5.63	9.77	73.6%
6.42	5.63	9.28	64.9%
6.44	5.63	8.80	56.2%
6.46	5.63	8.31	47.6%
6.48	5.63	7.83	39.0%
6.50	5.63	7.34	30.4%
6.51	5.63	7.10	26.2%
6.52	5.63	6.86	21.9%
6.53	5.63	6.62	17.6%
6.54	5.63	6.38	13.4%
6.55	5.63	6.15	9.2%
6.56	5.63	5.92	5.1%
6.57	5.63	5.69	1.0%
6.58	5.63	5.46	-3.0%
6.59	5.63	5.24	-6.9%
6.60	5.63	5.02	-10.8%
6.62	5.63	4.60	-18.3%
6.64	5.63	4.19	-25.6%
6.66	5.63	3.80	-32.5%
6.68	5.63	3.42	-39.2%
6.70	5.63	3.08	-45.3%
6.72	5.63	2.77	-50.8%
6.74	5.63	2.52	-55.2%
6.76	5.63	2.32	-58.7%
6.78	5.63	2.15	-61.9%
6.80	5.63	1.99	-64.6%

WATERLINE AT ZERO
AREA ERROR = 6.568

STREAM NAME: Battlement Creek
XS LOCATION: At first campground at BLM land
XS NUMBER: 1

Constant Manning's n

STAGING TABLE

GL = lowest Grassline elevation corrected for sag
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	5.22	28.30	1.44	2.22	40.76	30.21	100.0%	1.35	162.10	3.98
	5.57	27.16	1.15	1.87	31.12	28.70	95.0%	1.08	107.00	3.44
	5.62	27.00	1.10	1.82	29.77	28.48	94.3%	1.05	99.86	3.35
	5.67	26.83	1.06	1.77	28.42	28.26	93.5%	1.01	92.92	3.27
	5.72	26.67	1.02	1.72	27.09	28.04	92.8%	0.97	86.19	3.18
	5.77	26.51	0.97	1.67	25.76	27.82	92.1%	0.93	79.67	3.09
	5.82	26.34	0.93	1.62	24.44	27.61	91.4%	0.89	73.36	3.00
	5.87	26.18	0.88	1.57	23.12	27.39	90.6%	0.84	67.27	2.91
	5.92	26.01	0.84	1.52	21.82	27.17	89.9%	0.80	61.38	2.81
	5.97	25.85	0.79	1.47	20.52	26.95	89.2%	0.76	55.72	2.72
	6.02	25.69	0.75	1.42	19.23	26.73	88.5%	0.72	50.29	2.61
	6.07	25.52	0.70	1.37	17.95	26.52	87.8%	0.68	45.08	2.51
	6.12	25.36	0.66	1.32	16.68	26.30	87.0%	0.63	40.10	2.40
	6.17	25.19	0.61	1.27	15.42	26.08	86.3%	0.59	35.36	2.29
	6.22	25.03	0.57	1.22	14.16	25.86	85.6%	0.55	30.87	2.18
	6.27	24.87	0.52	1.17	12.91	25.64	84.9%	0.50	26.62	2.06
	6.32	24.70	0.47	1.12	11.67	25.42	84.2%	0.46	22.63	1.94
	6.37	24.54	0.43	1.07	10.44	25.21	83.4%	0.41	18.90	1.81
	6.42	24.37	0.38	1.02	9.22	24.99	82.7%	0.37	15.45	1.68
	6.47	24.21	0.33	0.97	8.01	24.77	82.0%	0.32	12.28	1.53
	6.52	24.05	0.28	0.92	6.80	24.55	81.3%	0.28	9.41	1.38
WL	6.57	22.67	0.25	0.87	5.63	23.12	76.5%	0.24	7.15	1.27
	6.62	20.63	0.22	0.82	4.54	21.04	69.7%	0.22	5.33	1.17
	6.67	18.55	0.19	0.77	3.56	18.94	62.7%	0.19	3.80	1.07
	6.72	13.81	0.20	0.72	2.74	14.16	46.9%	0.19	2.98	1.09
	6.77	8.61	0.26	0.67	2.21	8.92	29.5%	0.25	2.84	1.29
	6.82	6.79	0.27	0.62	1.83	7.06	23.4%	0.26	2.42	1.32
	6.87	5.32	0.29	0.57	1.53	5.55	18.4%	0.28	2.11	1.38
	6.92	4.58	0.28	0.52	1.28	4.77	15.8%	0.27	1.74	1.36
	6.97	4.33	0.25	0.47	1.06	4.49	14.9%	0.24	1.32	1.24
	7.02	4.03	0.21	0.42	0.85	4.17	13.8%	0.20	0.96	1.13
	7.07	3.42	0.19	0.37	0.66	3.54	11.7%	0.19	0.71	1.07
	7.12	2.95	0.17	0.32	0.51	3.05	10.1%	0.17	0.50	0.99
	7.17	2.28	0.17	0.27	0.38	2.37	7.8%	0.16	0.36	0.96
	7.22	2.03	0.13	0.22	0.27	2.09	6.9%	0.13	0.22	0.83
	7.27	1.77	0.10	0.17	0.17	1.82	6.0%	0.10	0.12	0.68
	7.32	1.36	0.07	0.12	0.10	1.39	4.6%	0.07	0.05	0.55
	7.37	0.95	0.04	0.07	0.04	0.96	3.2%	0.04	0.01	0.38
	7.42	0.35	0.01	0.02	0.00	0.35	1.2%	0.01	0.00	0.16

STREAM NAME: Battlement Creek
XS LOCATION: At first campground at BLM land
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	7.98	cfs
CALCULATED FLOW (Qc)=	7.15	cfs
(Qm-Qc)/Qm * 100 =	10.4	%
MEASURED WATERLINE (WLm)=	6.55	ft
CALCULATED WATERLINE (WLc)=	6.57	ft
(WLm-WLc)/WLm * 100 =	-0.3	%
MAX MEASURED DEPTH (Dm)=	0.90	ft
MAX CALCULATED DEPTH (Dc)=	0.87	ft
(Dm-Dc)/Dm * 100	3.1	%
MEAN VELOCITY=	1.27	ft/sec
MANNING'S N=	0.071	
SLOPE=	0.0241	ft/ft
.4 * Qm =	3.2	cfs
2.5 * Qm=	19.9	cfs

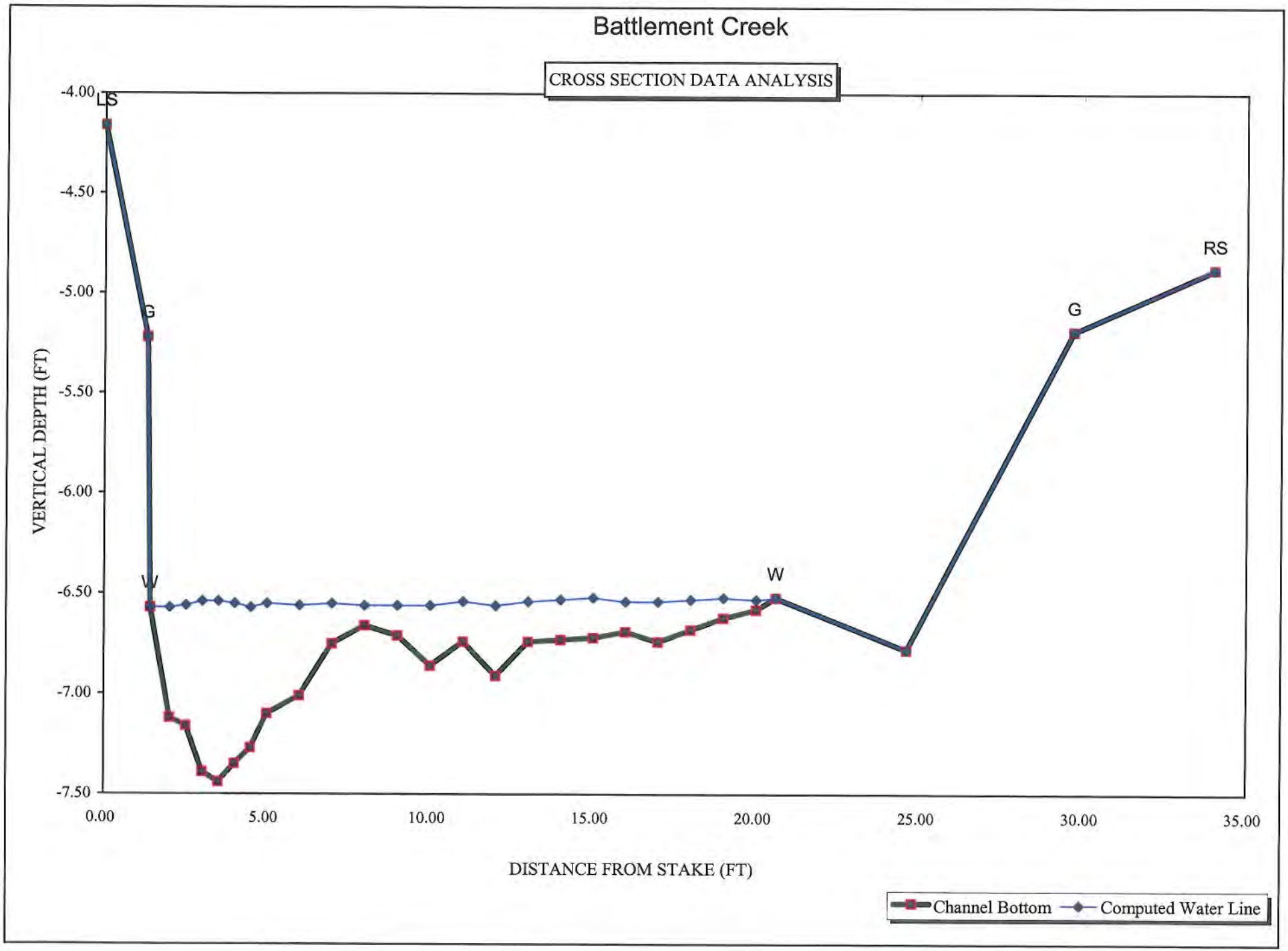
RECOMMENDED INSTREAM FLOW:

FLOW (CFS)	PERIOD

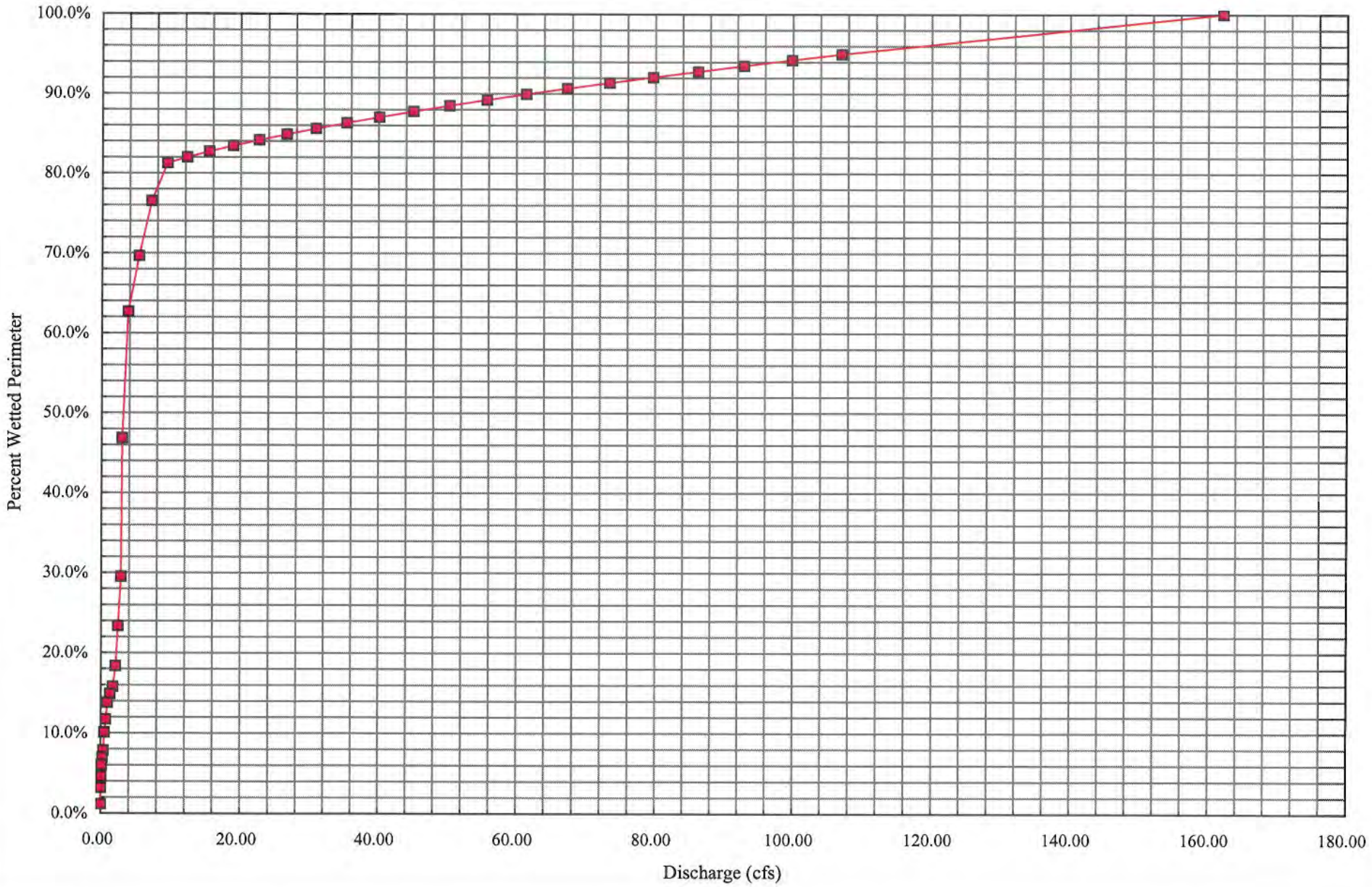
RATIONALE FOR RECOMMENDATION:

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

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


Battlement Creek
CROSS SECTION DATA ANALYSIS
LS
G
W
W
G
RS
-4.00
-4.50
-5.00
-5.50
-6.00
-6.50
-7.00
-7.50
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
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:	Battlement Creek
XS LOCATION:	1/2 mile upstream from BLM campground at turnoff
XS NUMBER:	2
DATE:	26-Jul-06
OBSERVERS:	R. Smith, M. Boyum
1/4 SEC:	NW
SECTION:	23
TWP:	7S
RANGE:	95W
PM:	6th
COUNTY:	Garfield
WATERSHED:	Colorado
DIVISION:	5
DOW CODE:	19059
USGS MAP:	Hawxhurst Creek 7.5'
USFS MAP:	0

SUPPLEMENTAL DATA

TAPE WT:	0.0106
TENSION:	99999

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

CHANNEL PROFILE DATA

SLOPE:	0.0483

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

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

STREAM NAME: Battlement Creek
XS LOCATION: 1/2 mile upstream from BLM campground at turnoff
XS NUMBER: 2

DATA POINTS= 27

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL
	LS	0.00	1.62		
1	G	2.20	4.04		
	W	3.00	4.81		
		3.50	4.90	0.10	0.98
		4.00	4.88	0.10	0.00
		4.50	5.02	0.20	1.46
		5.00	5.00	0.20	1.47
		5.50	5.01	0.20	0.74
		6.00	5.13	0.35	0.37
		6.50	5.24	0.45	1.27
		7.00	5.26	0.45	0.87
		8.00	5.20	0.40	1.01
		9.00	5.15	0.35	1.91
		10.00	5.32	0.55	1.58
		11.00	5.36	0.55	1.35
		12.00	5.26	0.45	0.54
		13.00	5.15	0.35	0.99
		14.00	5.44	0.65	2.04
		14.50	5.27	0.45	2.24
		15.00	5.27	0.45	2.17
		15.50	5.19	0.40	1.42
		16.00	5.16	0.35	0.54
		16.50	5.14	0.30	0.45
		17.00	4.97	0.15	0.00
	W	17.70	4.81		
1	G	19.00	3.93		
	RS	20.00	2.84		

TOTALS ----------

VALUES COMPUTED FROM RAW FIELD DATA

WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.51	0.10	0.05	0.05	0.7%
0.50	0.10	0.05	0.00	0.0%
0.52	0.20	0.10	0.15	2.2%
0.50	0.20	0.10	0.15	2.2%
0.50	0.20	0.10	0.07	1.1%
0.51	0.35	0.18	0.06	1.0%
0.51	0.45	0.23	0.29	4.2%
0.50	0.45	0.34	0.29	4.3%
1.00	0.40	0.40	0.40	6.0%
1.00	0.35	0.35	0.67	9.9%
1.01	0.55	0.55	0.87	12.8%
1.00	0.55	0.55	0.74	11.0%
1.00	0.45	0.45	0.24	3.6%
1.01	0.35	0.35	0.35	5.1%
1.04	0.65	0.49	0.99	14.7%
0.53	0.45	0.23	0.50	7.4%
0.50	0.45	0.23	0.49	7.2%
0.51	0.40	0.20	0.28	4.2%
0.50	0.35	0.18	0.09	1.4%
0.50	0.30	0.15	0.07	1.0%
0.53	0.15	0.09	0.00	0.0%
0.72		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
0.00		0.00	0.00	0.0%
14.91	0.65 (Max.)	5.34	6.77	100.0%

Manning's n = 0.1300
Hydraulic Radius= 0.358219367

STREAM NAME: Battlement Creek
XS LOCATION: 1/2 mile upstream from BLM campground at turnoff
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	5.34	5.23	-2.0%
4.56	5.34	8.98	68.3%
4.58	5.34	8.68	62.5%
4.60	5.34	8.37	56.8%
4.62	5.34	8.07	51.1%
4.64	5.34	7.77	45.4%
4.66	5.34	7.46	39.8%
4.68	5.34	7.16	34.1%
4.70	5.34	6.86	28.5%
4.72	5.34	6.56	22.9%
4.74	5.34	6.27	17.3%
4.76	5.34	5.97	11.8%
4.77	5.34	5.82	9.0%
4.78	5.34	5.67	6.2%
4.79	5.34	5.53	3.5%
4.80	5.34	5.38	0.7%
4.81	5.34	5.23	-2.0%
4.82	5.34	5.08	-4.8%
4.83	5.34	4.94	-7.5%
4.84	5.34	4.79	-10.2%
4.85	5.34	4.65	-12.9%
4.86	5.34	4.51	-15.6%
4.88	5.34	4.23	-20.9%
4.90	5.34	3.95	-26.0%
4.92	5.34	3.69	-30.9%
4.94	5.34	3.43	-35.8%
4.96	5.34	3.17	-40.6%
4.98	5.34	2.92	-45.3%
5.00	5.34	2.67	-50.0%
5.02	5.34	2.43	-54.4%
5.04	5.34	2.21	-58.6%
5.06	5.34	1.99	-62.8%

WATERLINE AT ZERO
AREA ERROR = 4.803

STREAM NAME: Battlement Creek
XS LOCATION: 1/2 mile upstream from BLM campground at turnoff
XS NUMBER: 2

Constant Manning's n

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

STAGING TABLE

	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	4.04	16.64	1.04	1.40	17.30	17.39	100.0%	0.99	43.29	2.50
	4.05	16.61	1.03	1.39	17.09	17.35	99.8%	0.98	42.49	2.49
	4.10	16.48	0.99	1.34	16.26	17.19	98.8%	0.95	39.36	2.42
	4.15	16.35	0.94	1.29	15.44	17.03	97.9%	0.91	36.33	2.35
	4.20	16.23	0.90	1.24	14.62	16.87	97.0%	0.87	33.41	2.28
	4.25	16.10	0.86	1.19	13.82	16.71	96.1%	0.83	30.58	2.21
	4.30	15.98	0.81	1.14	13.01	16.54	95.1%	0.79	27.86	2.14
	4.35	15.85	0.77	1.09	12.22	16.38	94.2%	0.75	25.24	2.07
	4.40	15.73	0.73	1.04	11.43	16.22	93.3%	0.70	22.73	1.99
	4.45	15.60	0.68	0.99	10.65	16.06	92.3%	0.66	20.33	1.91
	4.50	15.47	0.64	0.94	9.87	15.90	91.4%	0.62	18.04	1.83
	4.55	15.35	0.59	0.89	9.10	15.74	90.5%	0.58	15.86	1.74
	4.60	15.22	0.55	0.84	8.33	15.58	89.6%	0.54	13.80	1.66
	4.65	15.10	0.50	0.79	7.58	15.41	88.6%	0.49	11.85	1.56
	4.70	14.97	0.46	0.74	6.82	15.25	87.7%	0.45	10.03	1.47
	4.75	14.84	0.41	0.69	6.08	15.09	86.8%	0.40	8.33	1.37
WL	4.80	14.72	0.36	0.64	5.34	14.93	85.9%	0.36	6.76	1.27
	4.85	14.28	0.32	0.59	4.61	14.48	83.2%	0.32	5.41	1.17
	4.90	13.21	0.30	0.54	3.92	13.40	77.0%	0.29	4.34	1.11
	4.95	12.82	0.26	0.49	3.27	12.99	74.7%	0.25	3.27	1.00
	5.00	12.27	0.21	0.44	2.64	12.43	71.5%	0.21	2.36	0.89
	5.05	11.08	0.19	0.39	2.07	11.22	64.5%	0.18	1.68	0.81
	5.10	10.72	0.14	0.34	1.52	10.85	62.4%	0.14	1.03	0.68
	5.15	9.98	0.10	0.29	1.00	10.10	58.1%	0.10	0.54	0.54
	5.20	7.08	0.08	0.24	0.58	7.17	41.2%	0.08	0.27	0.47
	5.25	4.53	0.06	0.19	0.28	4.60	26.4%	0.06	0.11	0.39
	5.30	2.55	0.05	0.14	0.12	2.60	15.0%	0.04	0.04	0.31
	5.35	0.82	0.03	0.09	0.03	0.85	4.9%	0.03	0.01	0.24
	5.40	0.24	0.02	0.04	0.00	0.25	1.4%	0.02	0.00	0.17

STREAM NAME: Battlement Creek
XS LOCATION: 1/2 mile upstream from BLM campground at turnoff
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	6.77	cfs
CALCULATED FLOW (Qc)=	6.76	cfs
(Qm-Qc)/Qm * 100 =	0.1	%
MEASURED WATERLINE (WLm)=	4.81	ft
CALCULATED WATERLINE (WLc)=	4.80	ft
(WLm-WLc)/WLm * 100 =	0.2	%
MAX MEASURED DEPTH (Dm)=	0.65	ft
MAX CALCULATED DEPTH (Dc)=	0.64	ft
(Dm-Dc)/Dm * 100	1.9	%
MEAN VELOCITY=	1.27	ft/sec
MANNING'S N=	0.130	
SLOPE=	0.0483	ft/ft
.4 * Qm =	2.7	cfs
2.5 * Qm=	16.9	cfs

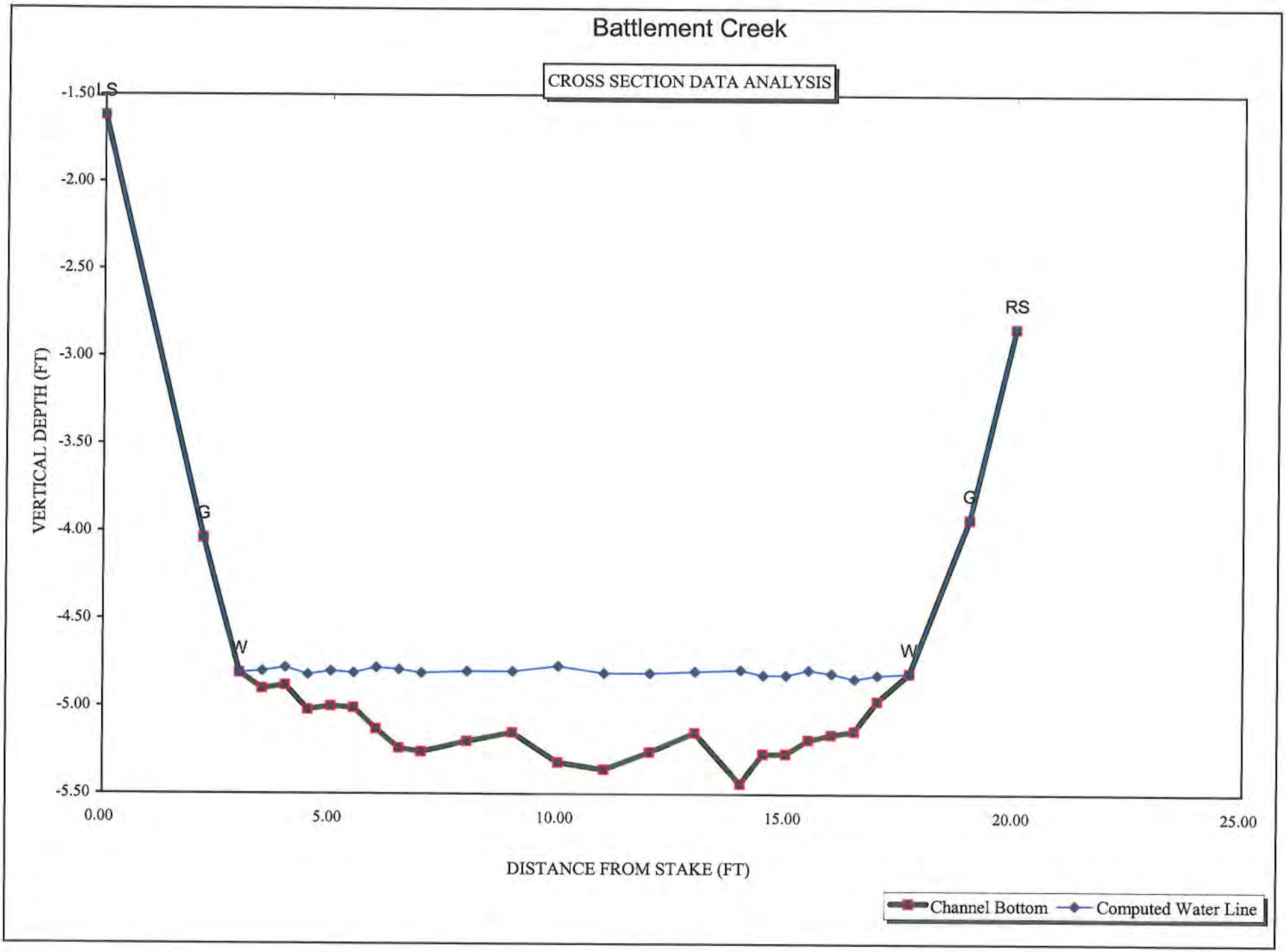
RECOMMENDED INSTREAM FLOW:

FLOW (CFS)	PERIOD

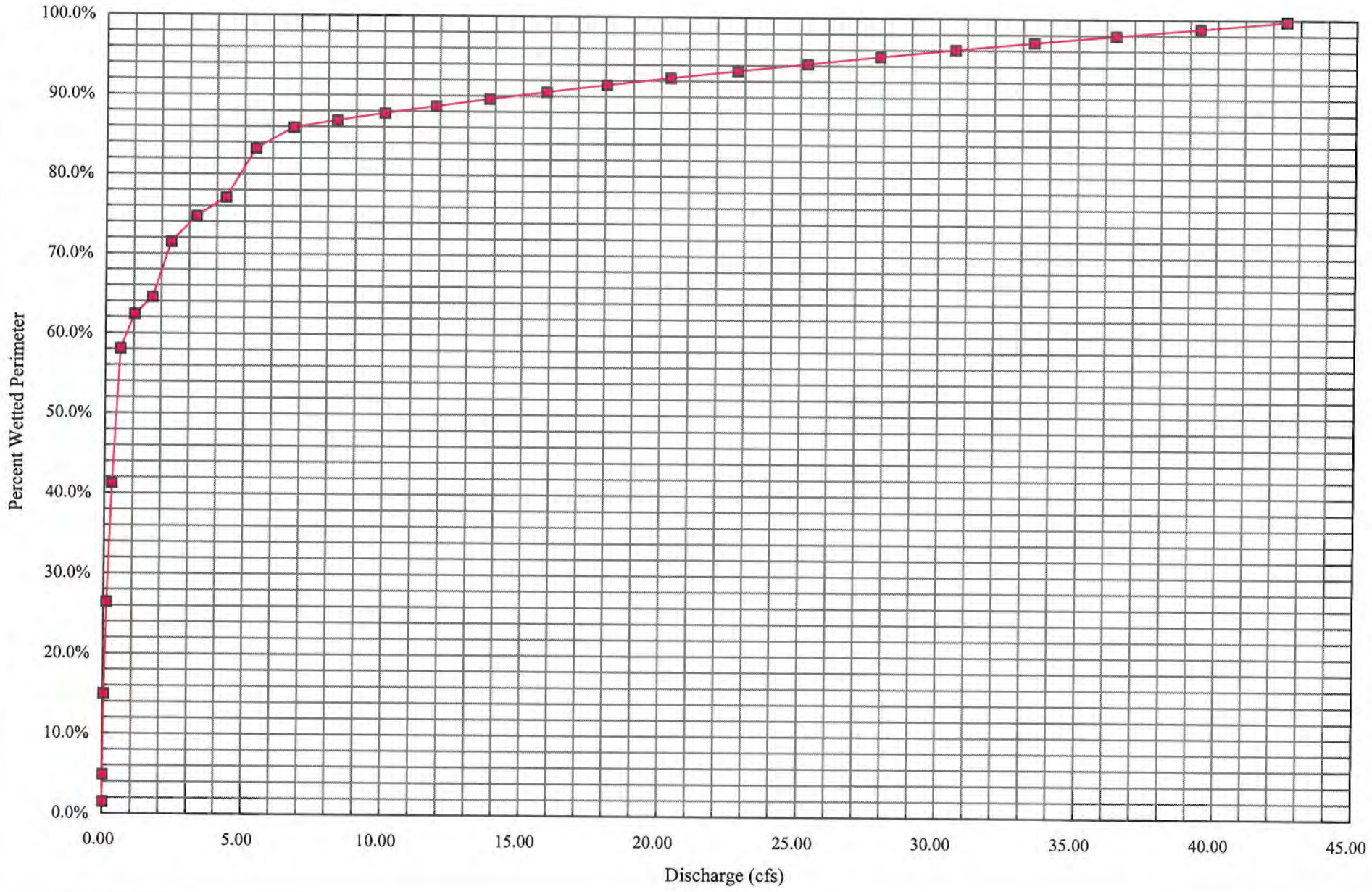
RATIONALE FOR RECOMMENDATION:

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

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


Battlement Creek
CROSS SECTION DATA ANALYSIS
LS
G
W
W
G
RS
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line

Percent Wetted Perimeter vs. Discharge



Glenwood Springs Field Office Stream Surveys
October 2004

Battlement Creek - Water Code #19059

Battlement Creek, located east of Battlement Mesa, CO and located on BLM lands managed by the GSFO was sampled on October 25, 2004. Battlement Creek is tributary to the Colorado River. Fish sampling was conducted to collect fin clips for genetic analysis of Colorado River cutthroat trout present in the stream. Sampling was conducted via backpack electro-shocker. Personnel present were Bill Elmblad, Colorado Division of Wildlife Fish Biologist, and Tom Fresques, BLM West Slope Fisheries Biologist.

A total of 25 adult fish were collected and fin clips taken. Genetic samples were sent to and analyzed by Dennis Shiozawa, BYU, and the following results were emailed to Bill Elmblad on May 15, 2006. A copy of the formal report alluded to below has not been obtained by BLM regarding the Battlement Creek Fish:

From: Dennis Shiozawa [mailto:shiozawa@byu.edu]
Sent: Monday, May 15, 2006 11:34 AM
To: Elmblad, Bill
Subject: cuthroat trout analyses

Bill,

We are finally getting organized and the dust is settling (from Paul's travels to Egypt and England, a number of workers leaving, and a new one starting). Sorry for the delay in this, but hopefully it has gotten to you in time.

So here are the results, a formal report will be sent to you soon. We will also send copies of the report to the BLM and USFS.

Collier Creek Colorado River cutthroat trout, no Yellowstone, no rainbow trout

Fortification Creek Colorado River cutthroat trout, no Yellowstone, no rainbow trout

Fourmile Creek Colorado River cutthroat trout, no Yellowstone, no rainbow trout

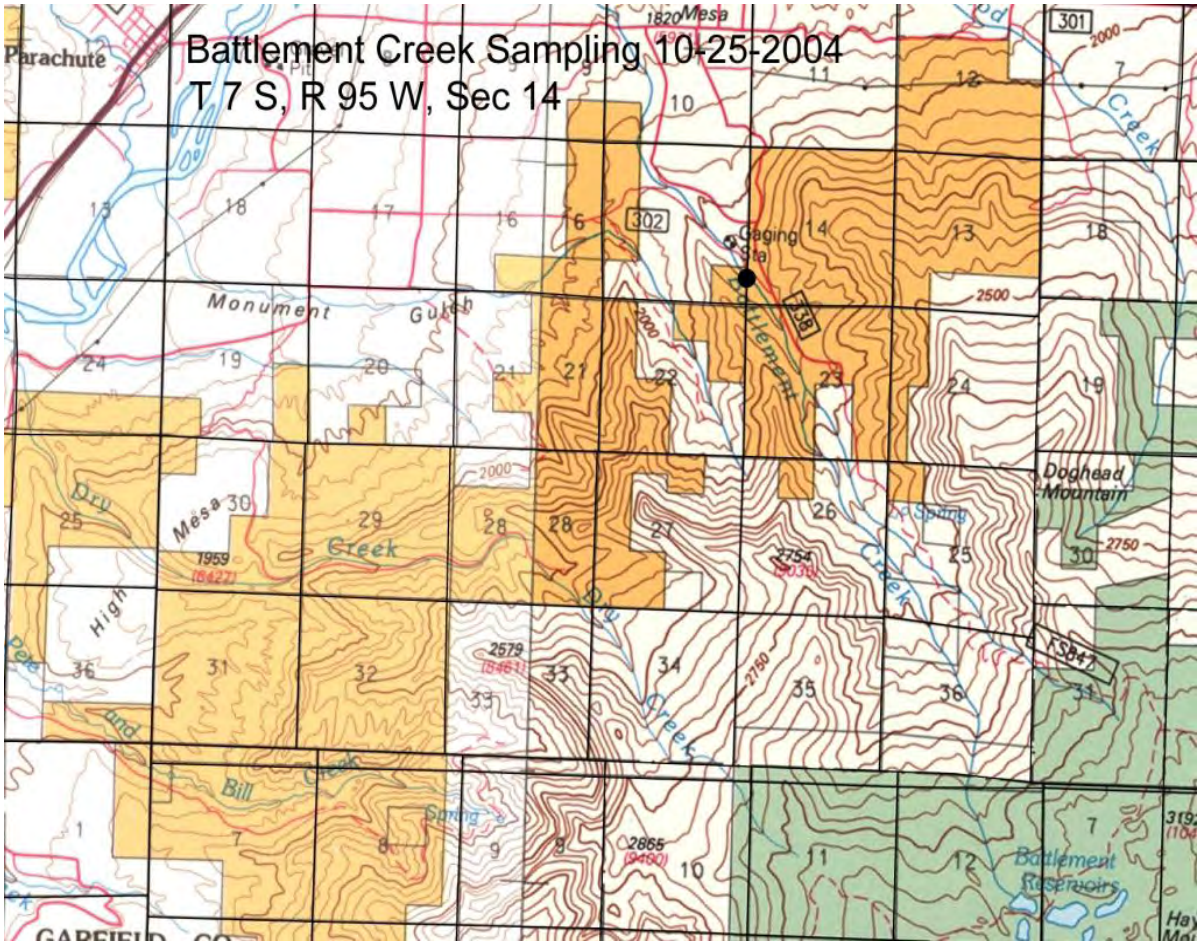
West Prong Creek Colorado River cutthroat trout, no Yellowstone, no rainbow trout

Battlement Creek Colorado River cutthroat trout, no Yellowstone, no rainbow trout

Canyon Creek About 50% Yellowstone Cutthroat trout, 50% Colorado River Cutthroat trout, no rainbow

I hope all is going well for you.

Dennis


Battlement Creek Sampling 10-25-2004
T 7 S, R 95 W, Sec 14
Parachute
Mesa
Monument Gulch
Dry Mesa
Creek
High Pete and Bill Creek
Gaging Sta
Battlement
Creek
Spring
Doghead Mountain
Battlement Reservoirs
301
302
330
CSR47
1820
2000
2500
2750
1959
2579
2754
2665