

Stream: Maxwell Creek

Executive Summary

Water Division: 2

Water District: 11

CDOW#: 30346

CWCB ID: 09/2/A-001

Segment: Headwaters to the Headgate of O.W. Friskey Ditch

Upper Terminus: HEADWATERS IN THE VICINITY OF
(Latitude 38° 45' 10.62"N) (Longitude 106° 14' 54.52"W)

Lower Terminus: HEADGATE OF O.W. FRISKEY DITCH
(Latitude 38° 46' 25.59"N) (Longitude 106° 11' 2"W)

Watershed: Arkansas Headwaters (HUC#: 11020001)

Counties: Chaffee

Length: 4.0 miles

USGS Quad(s): Buena Vista West

Flow Recommendation: 3.3 cfs (June 1 to July 31)
1.5 cfs (August 1 to September 30)
1.0 cfs (October 1 to October 31)
0.4 cfs (November 1 to May 31)



Staff Analysis and Recommendation

Summary

The information contained in this report and the associated instream flow file folder 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 Colorado Division of Wildlife (CDOW) recommended this segment of Maxwell Creek to the CWCB for inclusion into the Instream Flow Program. Maxwell 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.

Maxwell Creek is approximately 4.0 miles long. It begins on the northeast side of Mount Princeton at an elevation of approximately 13,000 feet and terminates at the O.W. Friskey Ditch at an elevation of approximately 8,690 feet. Of the 4.0-mile segment addressed by this report, approximately 75% of the segment, or 3 miles is located on public lands. Maxwell Creek is located within Chaffee County and has a total drainage area of approximately 2.4 square miles. Maxwell Creek generally flows in an easterly direction.

The subject of this report is a segment of the Maxwell Creek beginning at its headwaters and extending downstream to headgate of the O.W. Friskey Ditch. The proposed segment is located near the Town of Buena Vista. CWCB staff received only one recommendation for this segment, from the CDOW. The recommendation for this segment is discussed below.

Instream Flow Recommendation(s)

The CDOW is recommending 3.3 cfs (June 1 to July 31); 1.5 cfs (August 1 to September 30); 1.0 cfs (October 1 to October 31); and 0.4 cfs (November 1 to May 31) based on their data collection efforts and staff's water availability analyses.

Land Status Review

Upper Terminus	Lower Terminus	Total Length (miles)	Land Ownership	
			% Private	% Public
Headwaters	Headgate of O.W. Friskey Ditch	4.0	25%	75%

100% of the public lands are U.S Forest Service.

Biological Data

CDOW 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.

Field Survey Data

CDOW 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.

Biological Flow Recommendation

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, two data sets were collected. Table 1 shows who collected the data (Party), the date the data was collected, 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. It is believed 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.

Table 1: Data

Party	Date	Q	250%-40%	Summer (3/3)	Winter (2/3)
CDOW	8/9/2006	2.1	5.3 – 0.8	3.8	1.9
CDOW	8/9/2006	2.1	5.2 – 0.8	2.9	1.3

CDOW = Division of Wildlife

The summer flow recommendation, which met 3 of 3 criteria and is within the accuracy range of the R2CROSS model is 3.3 cfs. The recommendation of 1.5 cfs (August 1 to September 30)

which meets 2 of 3 criteria, was reduced as a result of water availability limitations. The winter flow recommendations of 1.0 cfs (October 1 to October 31) and 0.4 cfs (November 1 to May 31) were based on water availability limitations.

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 together 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 **Maxwell Creek** no such gage is available at the LT. In fact, there is no gage on Maxwell creek. It is thus necessary to describe the normal flow regime at Maxwell Creek above the LT through a "representative" gage station. The gage station selected for this purpose was COTTONWOOD C BL HOT SPRINGS, NR BUENA VISTA, CO. (USGS 07089000), a gage with a 49 year period of record (POR) collected between 1910 and 1986. The gage is at an elevation of 8,532 ft above mean sea level (amsl) and has a drainage area of 65.0 mi². The hydrograph (plot of discharge over time) produced from this gage includes the effects of an upstream diversion. However, the existence of this diversion is not a major limitation upon the use of the data from the gage. To make the measured data from Cottonwood Creek transferrable to Maxwell Creek above the LT, the diversions were added back to the measured Cottonwood Creek hydrograph. The resulting "adjusted" hydrograph could then be used on Maxwell Creek above the LT by multiplying the "adjusted" hydrograph by an area ratio; specifically, the area of Maxwell Creek above the LT (2.36 mi² above the LT) to Cottonwood Creek below Hot Springs, near Buena Vista, CO (65.0

mi² above the gage). In this instance, due to the absence of existing significant upstream consumptive irrigation uses or transbasin diversions on Maxwell Creek above the LT, the resulting proportioned “adjusted” hydrograph was not further “adjusted” (decreased). Nevertheless, the final hydrograph represents the existing distribution of flow over time.

{The Following discussion is based upon the US Geological Survey’s *Techniques of Water-Resources Investigations Series, Book 4: Hydrologic Analysis and Interpretation, Chapter A3: Statistical Methods in Water Resources* (Chapter 3: Describing Uncertainty) by D.R. Helsel and R. M. Hirsch. This technical reference provides the scientific background and guidance important to the systematic interpretation of hydrologic data. The document is available online and is a valuable aid to understanding and interpreting the analyses described here.}

The next step in producing a representation of the discharge at Maxwell Creek is to compute the Geometric Mean of the area-prorated “adjusted” data values from the Cottonwood Creek below Hot Springs, near Buena Vista, CO hydrograph. This step is of value because of the inherent statistical weaknesses found in any collection of data intended to measure natural stream discharge. Without getting into the details of statistical theory, it is worth noting that a set of discharge measurements is inherently inaccurate, no matter how well collected, due to the difficulties attendant to data collection, especially hydrologic data. To give deference to this fact and to increase the value of the hydrograph product of this analysis, the Geometric Means of the data were computed and plotted along with the 95% Confidence Intervals about the data. The resultant hydrograph, including recommended Instream Flow values, is displayed in figure 1 with an enlargement displayed in figure 2. The data displayed in this hydrograph follow in Table 1.

Fig. 1. Geometric Mean Daily Q Maxwell Cr abv LT (prop on Cottonwood Cr nr Buena Vista - adjusted for irr) & ISFs

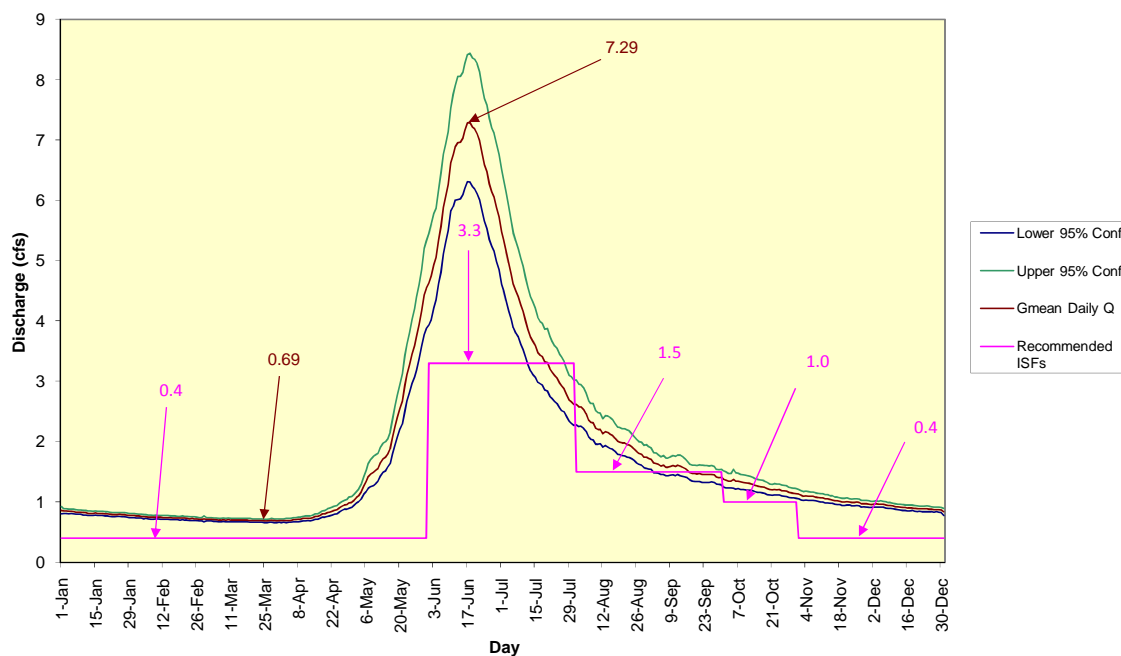


Fig. 2. Geometric Mean Daily Q Maxwell Cr abv LT (prop on Cottonwood Cr nr Buena Vista - adjusted for irr) & ISFs

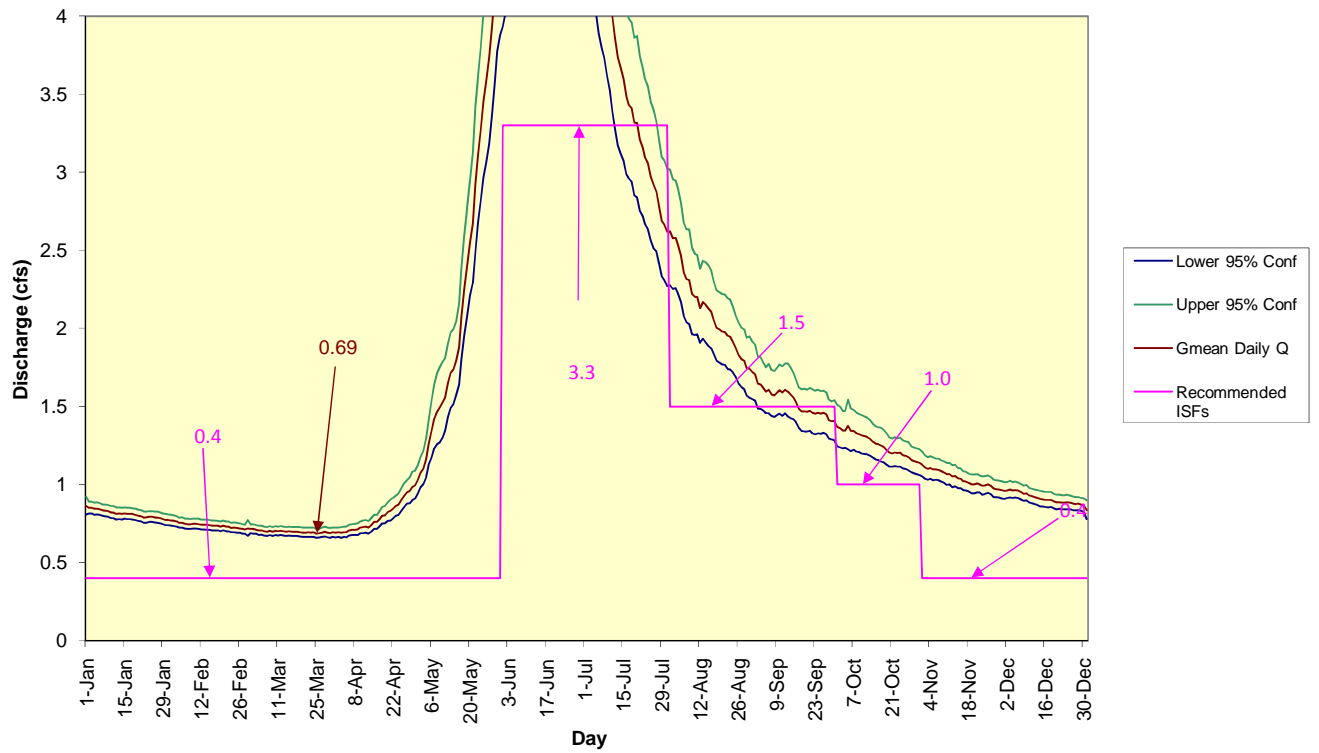


Table 1. Geometric Mean Discharge and Recommended Instream Flows		
Date	Recommended ISF	Proportioned Adjusted GM (abv gage) No Adj (-) for Irr & OoB in Maxwell Cr abv LT
1-Jan	0.4	0.86
2-Jan	0.4	0.85
3-Jan	0.4	0.85
4-Jan	0.4	0.84
5-Jan	0.4	0.85
6-Jan	0.4	0.84
7-Jan	0.4	0.84
8-Jan	0.4	0.83
9-Jan	0.4	0.83
10-Jan	0.4	0.82
11-Jan	0.4	0.82
12-Jan	0.4	0.81
13-Jan	0.4	0.81
14-Jan	0.4	0.81
15-Jan	0.4	0.82
16-Jan	0.4	0.81
17-Jan	0.4	0.81

18-Jan	0.4	0.81
19-Jan	0.4	0.81
20-Jan	0.4	0.80
21-Jan	0.4	0.80
22-Jan	0.4	0.79
23-Jan	0.4	0.79
24-Jan	0.4	0.79
25-Jan	0.4	0.79
26-Jan	0.4	0.79
27-Jan	0.4	0.79
28-Jan	0.4	0.78
29-Jan	0.4	0.78
30-Jan	0.4	0.77
31-Jan	0.4	0.77
1-Feb	0.4	0.77
2-Feb	0.4	0.77
3-Feb	0.4	0.76
4-Feb	0.4	0.76
5-Feb	0.4	0.76
6-Feb	0.4	0.75
7-Feb	0.4	0.75
8-Feb	0.4	0.75
9-Feb	0.4	0.75
10-Feb	0.4	0.75
11-Feb	0.4	0.75
12-Feb	0.4	0.74
13-Feb	0.4	0.74
14-Feb	0.4	0.74
15-Feb	0.4	0.74
16-Feb	0.4	0.74
17-Feb	0.4	0.74
18-Feb	0.4	0.74
19-Feb	0.4	0.73
20-Feb	0.4	0.74
21-Feb	0.4	0.73
22-Feb	0.4	0.73
23-Feb	0.4	0.72
24-Feb	0.4	0.73
25-Feb	0.4	0.72
26-Feb	0.4	0.72
27-Feb	0.4	0.72
28-Feb	0.4	0.71
29-Feb	0.4	0.72
1-Mar	0.4	0.72
2-Mar	0.4	0.71
3-Mar	0.4	0.71
4-Mar	0.4	0.71
5-Mar	0.4	0.71
6-Mar	0.4	0.70
7-Mar	0.4	0.70

8-Mar	0.4	0.70
9-Mar	0.4	0.70
10-Mar	0.4	0.70
11-Mar	0.4	0.70
12-Mar	0.4	0.70
13-Mar	0.4	0.70
14-Mar	0.4	0.70
15-Mar	0.4	0.70
16-Mar	0.4	0.70
17-Mar	0.4	0.70
18-Mar	0.4	0.70
19-Mar	0.4	0.70
20-Mar	0.4	0.69
21-Mar	0.4	0.69
22-Mar	0.4	0.69
23-Mar	0.4	0.69
24-Mar	0.4	0.69
25-Mar	0.4	0.69
26-Mar	0.4	0.69
27-Mar	0.4	0.69
28-Mar	0.4	0.70
29-Mar	0.4	0.69
30-Mar	0.4	0.69
31-Mar	0.4	0.69
1-Apr	0.4	0.69
2-Apr	0.4	0.69
3-Apr	0.4	0.69
4-Apr	0.4	0.70
5-Apr	0.4	0.70
6-Apr	0.4	0.71
7-Apr	0.4	0.71
8-Apr	0.4	0.71
9-Apr	0.4	0.71
10-Apr	0.4	0.72
11-Apr	0.4	0.73
12-Apr	0.4	0.73
13-Apr	0.4	0.73
14-Apr	0.4	0.74
15-Apr	0.4	0.76
16-Apr	0.4	0.76
17-Apr	0.4	0.78
18-Apr	0.4	0.80
19-Apr	0.4	0.80
20-Apr	0.4	0.82
21-Apr	0.4	0.83
22-Apr	0.4	0.85
23-Apr	0.4	0.86
24-Apr	0.4	0.87
25-Apr	0.4	0.90
26-Apr	0.4	0.93

27-Apr	0.4	0.95
28-Apr	0.4	0.96
29-Apr	0.4	0.99
30-Apr	0.4	1.00
1-May	0.4	1.03
2-May	0.4	1.08
3-May	0.4	1.10
4-May	0.4	1.17
5-May	0.4	1.26
6-May	0.4	1.34
7-May	0.4	1.42
8-May	0.4	1.47
9-May	0.4	1.49
10-May	0.4	1.53
11-May	0.4	1.56
12-May	0.4	1.65
13-May	0.4	1.72
14-May	0.4	1.74
15-May	0.4	1.79
16-May	0.4	1.88
17-May	0.4	2.07
18-May	0.4	2.25
19-May	0.4	2.40
20-May	0.4	2.55
21-May	0.4	2.68
22-May	0.4	2.93
23-May	0.4	3.11
24-May	0.4	3.27
25-May	0.4	3.45
26-May	0.4	3.59
27-May	0.4	3.74
28-May	0.4	3.94
29-May	0.4	4.17
30-May	0.4	4.43
31-May	0.4	4.54
1-Jun	3.3	4.63
2-Jun	3.3	4.75
3-Jun	3.3	4.94
4-Jun	3.3	5.05
5-Jun	3.3	5.34
6-Jun	3.3	5.57
7-Jun	3.3	5.88
8-Jun	3.3	6.06
9-Jun	3.3	6.26
10-Jun	3.3	6.62
11-Jun	3.3	6.76
12-Jun	3.3	6.89
13-Jun	3.3	6.96
14-Jun	3.3	6.97
15-Jun	3.3	7.03

16-Jun	3.3	7.16
17-Jun	3.3	7.29
18-Jun	3.3	7.29
19-Jun	3.3	7.21
20-Jun	3.3	7.18
21-Jun	3.3	7.11
22-Jun	3.3	6.99
23-Jun	3.3	6.77
24-Jun	3.3	6.60
25-Jun	3.3	6.48
26-Jun	3.3	6.28
27-Jun	3.3	6.14
28-Jun	3.3	6.06
29-Jun	3.3	5.88
30-Jun	3.3	5.73
1-Jul	3.3	5.48
2-Jul	3.3	5.35
3-Jul	3.3	5.16
4-Jul	3.3	4.96
5-Jul	3.3	4.78
6-Jul	3.3	4.61
7-Jul	3.3	4.50
8-Jul	3.3	4.41
9-Jul	3.3	4.27
10-Jul	3.3	4.16
11-Jul	3.3	4.01
12-Jul	3.3	3.86
13-Jul	3.3	3.74
14-Jul	3.3	3.67
15-Jul	3.3	3.60
16-Jul	3.3	3.48
17-Jul	3.3	3.43
18-Jul	3.3	3.41
19-Jul	3.3	3.32
20-Jul	3.3	3.32
21-Jul	3.3	3.21
22-Jul	3.3	3.16
23-Jul	3.3	3.10
24-Jul	3.3	3.06
25-Jul	3.3	2.97
26-Jul	3.3	2.92
27-Jul	3.3	2.88
28-Jul	3.3	2.78
29-Jul	3.3	2.69
30-Jul	3.3	2.66
31-Jul	3.3	2.62
1-Aug	1.5	2.62
2-Aug	1.5	2.58
3-Aug	1.5	2.58
4-Aug	1.5	2.54

5-Aug	1.5	2.47
6-Aug	1.5	2.36
7-Aug	1.5	2.32
8-Aug	1.5	2.31
9-Aug	1.5	2.22
10-Aug	1.5	2.20
11-Aug	1.5	2.20
12-Aug	1.5	2.13
13-Aug	1.5	2.17
14-Aug	1.5	2.15
15-Aug	1.5	2.13
16-Aug	1.5	2.11
17-Aug	1.5	2.06
18-Aug	1.5	2.01
19-Aug	1.5	2.00
20-Aug	1.5	1.98
21-Aug	1.5	1.98
22-Aug	1.5	1.95
23-Aug	1.5	1.95
24-Aug	1.5	1.92
25-Aug	1.5	1.88
26-Aug	1.5	1.83
27-Aug	1.5	1.80
28-Aug	1.5	1.79
29-Aug	1.5	1.75
30-Aug	1.5	1.74
31-Aug	1.5	1.72
1-Sep	1.5	1.71
2-Sep	1.5	1.65
3-Sep	1.5	1.64
4-Sep	1.5	1.62
5-Sep	1.5	1.60
6-Sep	1.5	1.61
7-Sep	1.5	1.58
8-Sep	1.5	1.57
9-Sep	1.5	1.59
10-Sep	1.5	1.60
11-Sep	1.5	1.59
12-Sep	1.5	1.61
13-Sep	1.5	1.60
14-Sep	1.5	1.58
15-Sep	1.5	1.56
16-Sep	1.5	1.53
17-Sep	1.5	1.49
18-Sep	1.5	1.47
19-Sep	1.5	1.47
20-Sep	1.5	1.47
21-Sep	1.5	1.47
22-Sep	1.5	1.46
23-Sep	1.5	1.46

24-Sep	1.5	1.46
25-Sep	1.5	1.46
26-Sep	1.5	1.46
27-Sep	1.5	1.45
28-Sep	1.5	1.41
29-Sep	1.5	1.41
30-Sep	1.5	1.41
1-Oct	1.0	1.37
2-Oct	1.0	1.36
3-Oct	1.0	1.35
4-Oct	1.0	1.35
5-Oct	1.0	1.38
6-Oct	1.0	1.34
7-Oct	1.0	1.34
8-Oct	1.0	1.33
9-Oct	1.0	1.32
10-Oct	1.0	1.32
11-Oct	1.0	1.31
12-Oct	1.0	1.30
13-Oct	1.0	1.29
14-Oct	1.0	1.28
15-Oct	1.0	1.26
16-Oct	1.0	1.26
17-Oct	1.0	1.25
18-Oct	1.0	1.24
19-Oct	1.0	1.22
20-Oct	1.0	1.20
21-Oct	1.0	1.20
22-Oct	1.0	1.21
23-Oct	1.0	1.20
24-Oct	1.0	1.21
25-Oct	1.0	1.19
26-Oct	1.0	1.19
27-Oct	1.0	1.18
28-Oct	1.0	1.16
29-Oct	1.0	1.15
30-Oct	1.0	1.15
31-Oct	1.0	1.14
1-Nov	0.4	1.13
2-Nov	0.4	1.11
3-Nov	0.4	1.10
4-Nov	0.4	1.11
5-Nov	0.4	1.10
6-Nov	0.4	1.10
7-Nov	0.4	1.10
8-Nov	0.4	1.08
9-Nov	0.4	1.08
10-Nov	0.4	1.07
11-Nov	0.4	1.07
12-Nov	0.4	1.05

13-Nov	0.4	1.05
14-Nov	0.4	1.04
15-Nov	0.4	1.04
16-Nov	0.4	1.02
17-Nov	0.4	1.02
18-Nov	0.4	1.01
19-Nov	0.4	1.00
20-Nov	0.4	1.00
21-Nov	0.4	1.01
22-Nov	0.4	1.00
23-Nov	0.4	0.99
24-Nov	0.4	1.00
25-Nov	0.4	1.00
26-Nov	0.4	0.99
27-Nov	0.4	0.97
28-Nov	0.4	0.97
29-Nov	0.4	0.97
30-Nov	0.4	0.97
1-Dec	0.4	0.96
2-Dec	0.4	0.96
3-Dec	0.4	0.97
4-Dec	0.4	0.96
5-Dec	0.4	0.97
6-Dec	0.4	0.96
7-Dec	0.4	0.95
8-Dec	0.4	0.94
9-Dec	0.4	0.95
10-Dec	0.4	0.93
11-Dec	0.4	0.93
12-Dec	0.4	0.92
13-Dec	0.4	0.91
14-Dec	0.4	0.91
15-Dec	0.4	0.91
16-Dec	0.4	0.90
17-Dec	0.4	0.90
18-Dec	0.4	0.90
19-Dec	0.4	0.89
20-Dec	0.4	0.89
21-Dec	0.4	0.89
22-Dec	0.4	0.88
23-Dec	0.4	0.89
24-Dec	0.4	0.89
25-Dec	0.4	0.88
26-Dec	0.4	0.88
27-Dec	0.4	0.88
28-Dec	0.4	0.88
29-Dec	0.4	0.87
30-Dec	0.4	0.87
31-Dec	0.4	0.84

Existing Water Right Information

Staff has analyzed the water rights tabulation and contacted the Division Engineer Office (DEO) to identify any potential water availability problems. There are no decreed surface diversion within this reach of stream. Staff has determined that water is available for appropriation on Maxwell Creek, from the headwaters to the headgate of the O.W. Friskey 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: Headwaters to the Headgate of O.W. Friskey Ditch

Upper Terminus: HEADWATERS IN THE VICINITY OF

(Latitude 38° 45' 10.62"N) (Longitude 106° 14' 54.52"W)

UTM North= 4290101.6 UTM East: 391515.3

SE SW S8 T15S R79W 6th PM

2230' East of the West Section Line; 210' North of the South Section Line

Lower Terminus: HEADGATE OF O.W. FRISKEY DITCH

(Latitude 38° 46' 25.59"N) (Longitude 106° 11' 2"W)

UTM North= 4292338.0 UTM East: 39157.8

NW SW S1 T15S R79W 6th PM

35' East of the West Section Line; 2400' North of the South Section Line

Watershed: Arkansas Headwaters (HUC#: 11020001)

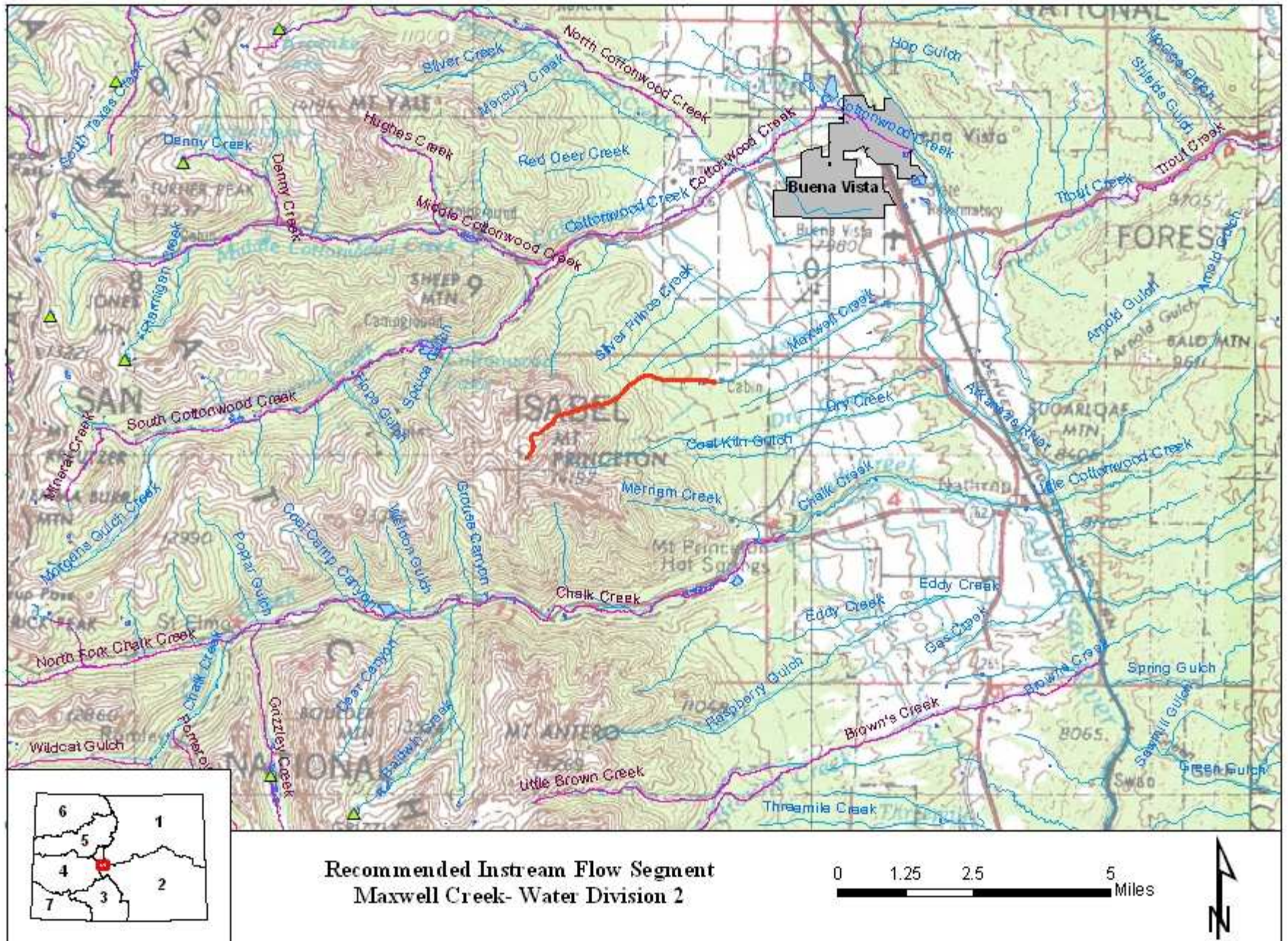
Counties: Chaffee

Length: 4.0 miles

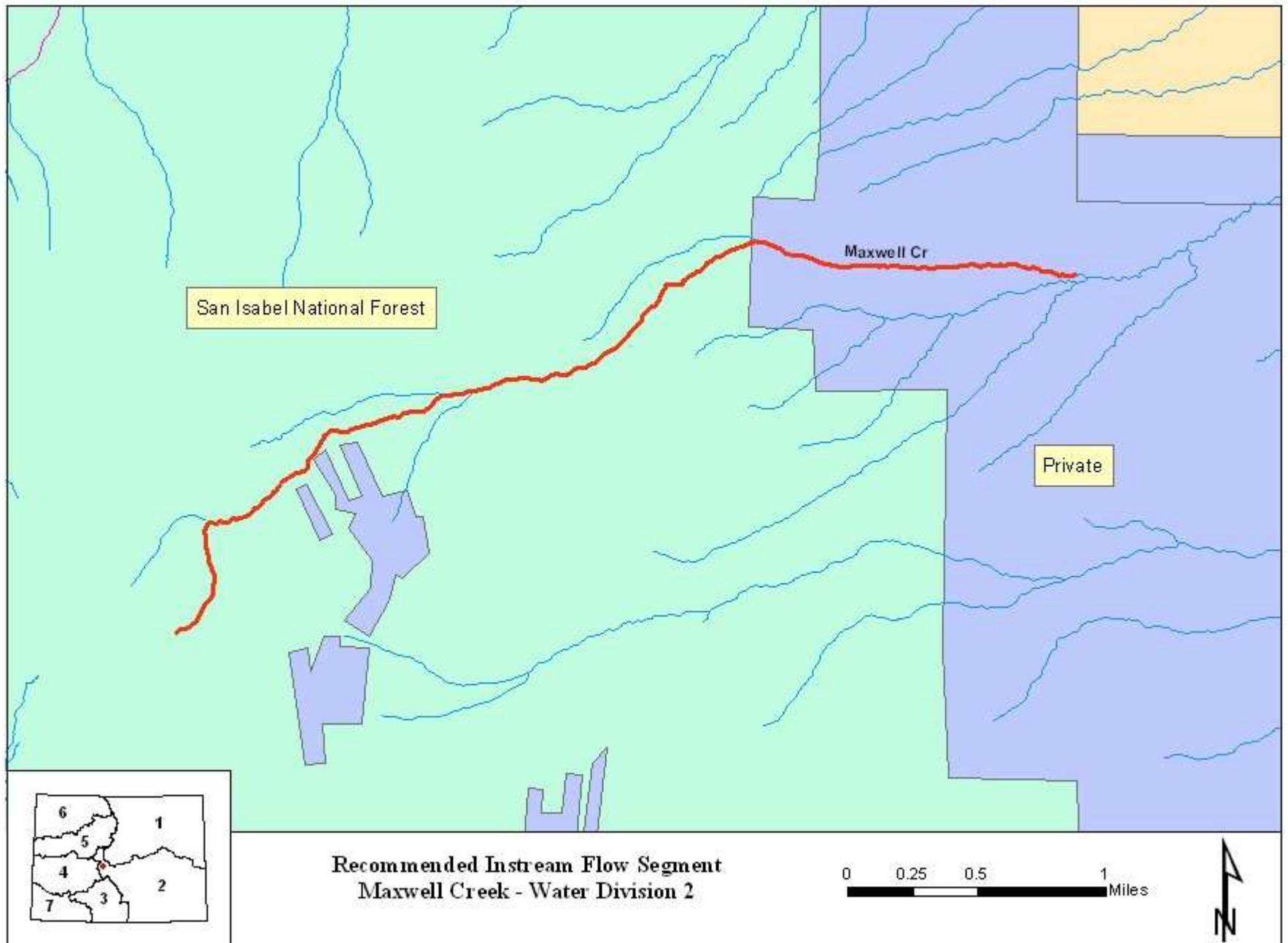
USGS Quad(s): Buena Vista West

Flow Recommendation: 3.3 cfs (June 1 to July 31)
1.5 cfs (August 1 to September 30)
1.0 cfs (October 1 to October 31)
0.4 cfs (November 1 to May 31)

Vicinity Map



Land Use Map



Topographic & Water Rights Map

