COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Armstrong Creek
Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Lower Terminus of ISF Case No. 06CW035 at UTM North: 4512573.29 UTM East: 319690.40
LOWER TERMINUS:	Confluence Elkhead Creek at UTM North: 4512684.47 UTM East: 319606.14
WATER DIVISION:	6
WATER DISTRICT:	44
COUNTY:	Routt
WATERSHED:	Upper Yampa (HUC#: 14050001)
CWCB ID:	15/6/A-001
RECOMMENDER	Colorado Parks and Wildlife
LENGTH:	0.1 miles
FLOW RECOMMENDATION:	1.0 cfs (4/1 – 6/30) 0.50 cfs (7/1 – 7/31) 0.22 cfs (8/1 – 3/31)

ARMSTRONG CREEK

Introduction

Colorado's General Assembly created the Instream Flow and Natural Lake Level Program in 1973, recognizing "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 Colorado Water Conservation Board (CWCB or Board) with the exclusive authority to appropriate and acquire instream flow (ISF) and natural lake level water rights. Before initiating a water right filing, the Board must determine that: 1) there is a natural environment that can be preserved to a reasonable degree with the Board's water right if granted, 2) the natural environment will be preserved to a reasonable degree by the water available for the appropriation to be made, and 3) such environment can exist without material injury to water rights.

Colorado Parks and Wildlife (CPW) recommended that the CWCB appropriate an ISF water right on a reach of Armstrong Creek. This reach is located within Routt County about 5.5 miles southeast of Steamboat Lake (See Vicinity Map). Armstrong Creek originates on the west side of Meadan Peak at an elevation of 9,850 feet and it flows in a southwesterly direction as it drops to an elevation of 7,900 feet where it joins Elkhead Creek. The proposed reach extends from lower terminus of CWCB's ISF in Case No. 06CW035 downstream to the confluence with Elkhead Creek. One hundred percent of the land on the 0.1 mile proposed reach is publicly owned and managed by the U. S. Forest Service (USFS) (See Land Ownership Map). CPW recommended this reach of Elkhead Creek because it has a natural environment that can be preserved to a reasonable degree with an ISF water right.

The information contained in this report and the associated supporting data and analyses (located at http://cwcb.state.co.us/environment/instream-flow-program/Pages/2015ProposedISFAppropriations.aspx) form the basis for staff's ISF recommendation to be considered by the Board. This report provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury.

Natural Environment

CWCB staff relies on the recommending entity to provide information about the natural environment. In addition, staff reviews information and conducts site visits for each recommended ISF appropriation. This information is used to provide the Board with a basis for determining that a natural environment exists.

The entire Elkhead Creek basin has been designated (by CPW and the land management agency, USFS) as a prime location for native fish conservation. The entire basin above the North Fork of Elkhead Creek (including all tributaries) is currently being managed and enhanced through a number of interagency projects as Colorado River cutthroat habitat and boreal toad habitat. Armstrong Creek is one of the tributaries where this active fishery management is occurring. Other native species are also present throughout the basin (speckled dace, mountain and longnose suckers, mottled sculpin, and

northern leopard frogs) and these species are water dependant and would benefit from instream flow protection. All non-native salmonids have been chemically removed from the streams and migration barriers have either been constructed or are planned. USFS and CPW biologists have sampled Armstrong Creek in 2009 and 2014 to monitor the ongoing project; this data has been provided to the CWCB.

Table 1. List of species identified in Armstrong Creek.

Species Name	Scientific Name	Status
boreal toad	*Bufo boreas boreas*	State Endangered Federal Sensitive Species
Colorado River cutthroat trout	*Oncorhynchus clarkii pleuriticus*	State Species of Special Concern Federal Sensitive Species
longnose sucker	*Catostomus catostomus*	none
northern leopard frog	*Rana/Lithobates pipiens*	State Species of Special Concern Federal Sensitive Species
mottled sculpin	*Cottus bairdi*	none
mountain sucker	*Catostomus platyrhynchus*	State Species of Special Concern Federal Sensitive Species
speckled dace	*Rhinichthys osculus*	none

ISF Quantification

CWCB staff relies upon the biological expertise of the recommending entity to quantify the amount of water required to preserve the natural environment to a reasonable degree. CWCB staff performs a thorough review of the quantification analyses completed by the recommending entity to ensure consistency with accepted standards.

Methodology

CPW staff used the R2Cross methodology to develop the initial ISF recommendation. The R2Cross method is based on a hydraulic model and uses field data collected in a stream riffle (Espegren, 1996). Riffles are most easily visualized as the stream habitat types that would dry up first should streamflow cease. The field data collected consists of streamflow measurements and surveys of channel geometry at a transect and of the longitudinal slope of the water surface.

The field data is used to model three hydraulic parameters: average depth, average velocity, and percent wetted perimeter. Maintaining these hydraulic parameters at adequate levels across riffle habitat types also will maintain aquatic habitat in pools and runs for most life stages of fish and aquatic invertebrates (Nehring, 1979). CPW staff interprets the model results to develop an initial recommendation for summer and winter flows. The summer flow recommendation is based on meeting 3 of 3 hydraulic criteria. The winter flow recommendation is based on meeting 2 of 3 hydraulic criteria. The model's

suggested accuracy range is 40% to 250% of the streamflow measured in the field. Recommendations that fall outside of the accuracy range may not give an accurate estimate of the hydraulic parameters necessary to determine an ISF rate.

The R2Cross methodology provides the biological quantification of the amount of water needed for summer and winter periods based on empirical studies of fish species preferences. The recommending entity uses the R2Cross results and its biological expertise to develop an initial ISF recommendation. CWCB staff then evaluates water availability for the reach typically based on median hydrology (see the Water Availability section below for more details). The water availability analysis may indicate less water is available than the initial recommendation. In that case, the recommending entity either modifies the magnitude and/or duration of the recommended ISF rates if the available flows will preserve the natural environment to a reasonable degree, or withdraws the recommendation.

Data Analysis

R2Cross data was collected at one transect for this proposed ISF reach (Table 2). The R2Cross model results in a summer flow of 1.0 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model. The R2Cross model results in a winter flow of 0.4 cfs, which meets 2 of 3 criteria and is within the accuracy range of the R2Cross model.

Table 2. Summary of R2Cross transect measurements and results for Armstrong Creek.

Entity	Date Measured	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	7/26/2005	0.42	0.2 – 1.0	0.4	1.0
			Mean	**0.4**	**1.0**

ISF Recommendation

CPW's biological flow recommendation is 1.0 cfs (4/1 –7/15) and 0.25 cfs (7/16-3/31). The final recommendation is 1.0 cfs (4/1 – 6/30), 0.50 cfs (7/1 – 7/31), and 0.22 cfs (8/1 – 3/31) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

Water Availability

CWCB staff conducts hydrologic analyses for each recommended ISF appropriation to provide the Board with a basis for making the determination that water is available.

Methodology

Each recommended ISF reach has a unique flow regime that depends on variables such as the timing, magnitude, and location of water inputs (such as rain, snow, and snowmelt) and water losses (such as diversions, reservoirs, evaporation and transpiration, groundwater recharge, etc). Although extensive and time-consuming investigations of all variables may be possible, staff takes a pragmatic and cost-

effective approach to analyzing water availability. This approach focuses on streamflows and the influence of flow alterations, such as diversions, to understand how much water is physically available in the recommended reach.

Staff's hydrologic analysis is data-driven, meaning that staff gathers and evaluates the best available data and uses the best available analysis method for that data. Whenever possible, long-term stream gage data (period of record 20 or more years) will be used to evaluate streamflow. Other streamflow information such as short-term gages, temporary gages, spot streamflow measurements, diversion records, and StreamStats will be used when long-term gage data is not available. StreamStats, a statistical hydrologic program, uses regression equations developed by the USGS (Capesius and Stephens, 2009) to estimate mean flows for each month based on drainage basin area and average drainage basin precipitation. Diversion records will also be used to evaluate the effect of surface water diversions when necessary. Interviews with water commissioners, landowners, and ditch or reservoir operators can provide additional information. A range of analytical techniques may be employed to extend gage records, estimate streamflow in ungaged locations, and estimate the effects of diversions. The goal is to obtain the most detailed and reliable estimate hydrology using the most efficient analysis technique.

The final product of the hydrologic analysis used to determine water availability is a hydrograph, which shows streamflow and the proposed ISF rate over the course of one year. The hydrograph will show median daily values when daily data is available; otherwise, it will present mean-monthly streamflow values. Staff will calculate 95% confidence intervals for the median streamflow if there is sufficient data.

Basin Characteristics

The proposed ISF on Armstrong Creek has a 3.31 square mile drainage basin. The average precipitation in the basin is 31.77 inches. The drainage basin tributary to the proposed ISF reach has four reservoir water rights each for 0.5 AF. No other surface water rights were identified. Streamflow in the proposed ISF reach is essentially natural.

Available Data

There is not a current or historical streamflow gage on Armstrong Creek, but there was a historic gage on Elkhead Creek. The Elkhead Creek near Clark gage (USGS 09244500) was located approximately 2.7 miles downstream from the lower terminus. This operated from 1942 to 1944 and 1958 to 1974. This gage has a 44.3 square mile drainage basin. The average elevation of the basin is 8,610 ft and the average precipitation is 31.75 inches. There are several water rights located in the drainage basin tributary to the gage, but none larger than 0.002 cfs. Therefore, streamflow was relatively unaltered at the Elhead Creek near Clark gage location.

Data Analysis

The available record on the Elkhead Creek near Clark gage has 16 to 17 years of record for each day of the year depending on the day. This record is relatively long, but less than the ideal length of 20 or more years. Therefore, staff took additional steps to evaluate the record. Staff examined other gages in the region in an attempt to find a gage that could be used to extend the record through regression analysis. The historic Elkhead Creek near Elkhead gage (USGS 09245000) is located roughly 8.2 miles downstream from the proposed lower terminus. This gage has 15 years of overlap with the Elkhead Creek at Clark gage and the correlation coefficient is 0.96. However, careful review showed that the regression was strong for March, May, June, and July, but poor other times of year. Because water availability is evaluated throughout the year, this gage was not suitable for extending the record at the Elkhead Creek near Clark gage. The Elkhead Creek above Long Gulch, near Hayden, CO gage (USGS 09246200) is located further downstream and did not operate at the same time as the Elkhead Creek near Clark gage; therefore, no analysis was possible.

Staff also examined streamflow gages and climate stations and found that the Hayden climate station (Hayden, Station ID USC00053867, downloaded 12/23/2014) has a relatively long period of record and is located about 18 miles southwest from the lower terminus. The average annual precipitation at the Hayden station for the period of record (1909 to 2014) is 16.3 inches with a standard deviation of 3.9 inches. During the 15 years the Elkhead Creek near Elkhead gage operated with complete water years (1943 and 1958 to 1973), 11 years were within one standard deviation of the average precipitation at the Hayden station, two years were higher, and one year was lower.

Since none of the gages evaluated were found suitable for regression extension, the available record at the Elkhead Creek at Clark gage was analyzed. The gage record was scaled by 0.075 to the lower terminus using the area-precipitation method. The area-precipitation method estimates streamflow based on the ratio of the precipitation weighted drainage area at the lower terminus location to that of the gage location. This ratio is quite small; however, the gage is within close proximity to the proposed ISF reach so that the timing and magnitude of flows should be proportional. Median streamflow and 95% confidence intervals for median streamflow were calculated using the adjusted Elkhead Creek near Clark gage record.

Water Availability Summary

The hydrographs (Figure 1 and Figure 2) show the median streamflow and 95% confidence intervals for the median streamflow calculated from the scaled Elkhead Creek near Clark gage record. The proposed ISF rate is below the median gage data for all but 45 days primarily during late summer and early fall. The proposed ISF rate is below the upper 95% confidence interval from median streamflow at all times. Staff concludes that water is available for appropriation on Elkhead Creek.

Material Injury

Because the proposed ISF on Armstrong Creek is a new junior water right, the ISF can exist without material injury to other water rights. Under the provisions of section 37-92-102(3)(b), C.R.S. (2014), the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.

Citations

Capesius, J.P. and V.C. Stephens, 2009, Regional regression equations for estimation of natural streamflow statistics in Colorado, Scientific Investigations Report 2009-5136.

Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

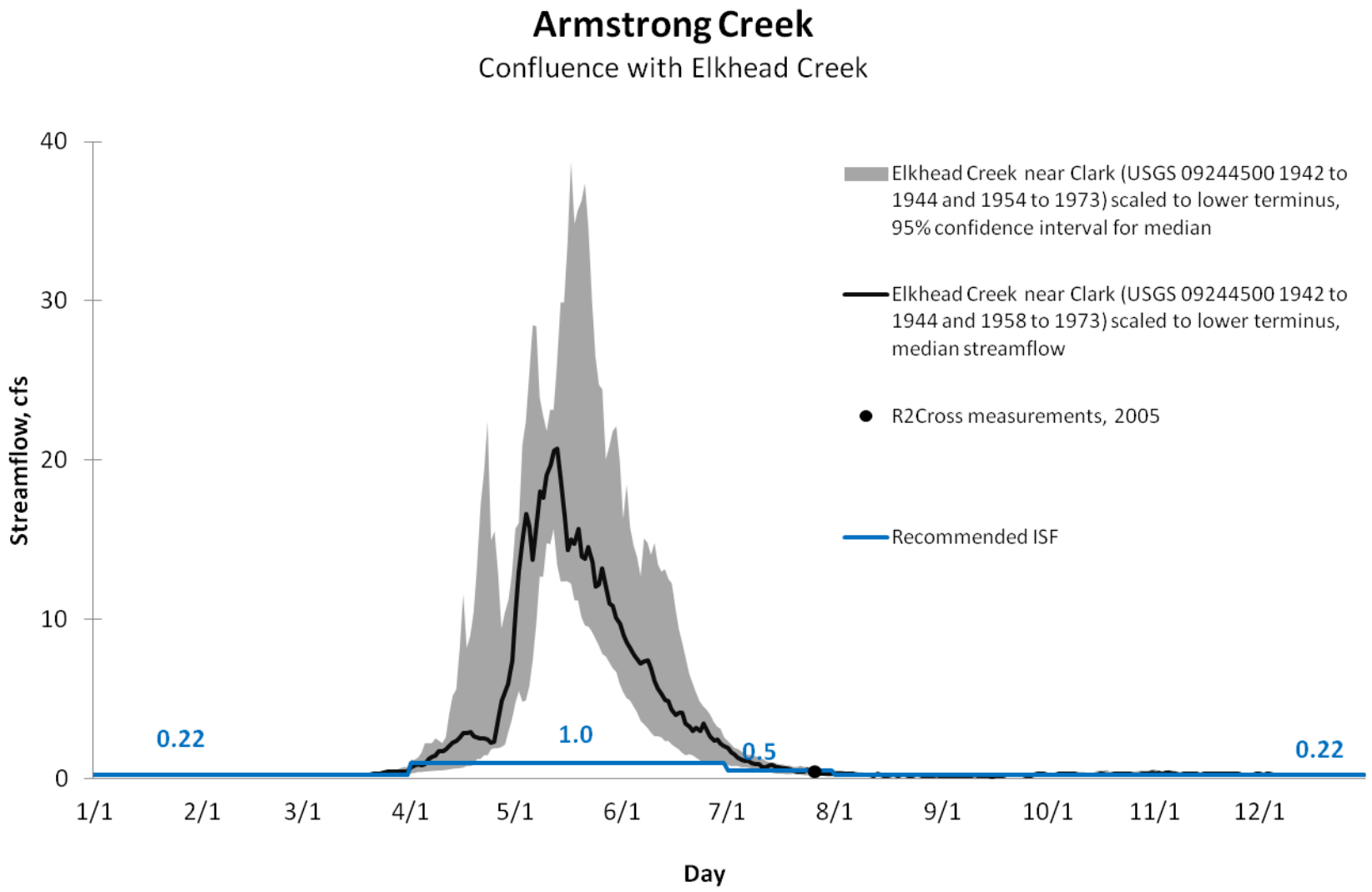


Figure 1. Complete hydrograph showing streamflow data and the proposed ISF rate on Armstrong Creek.

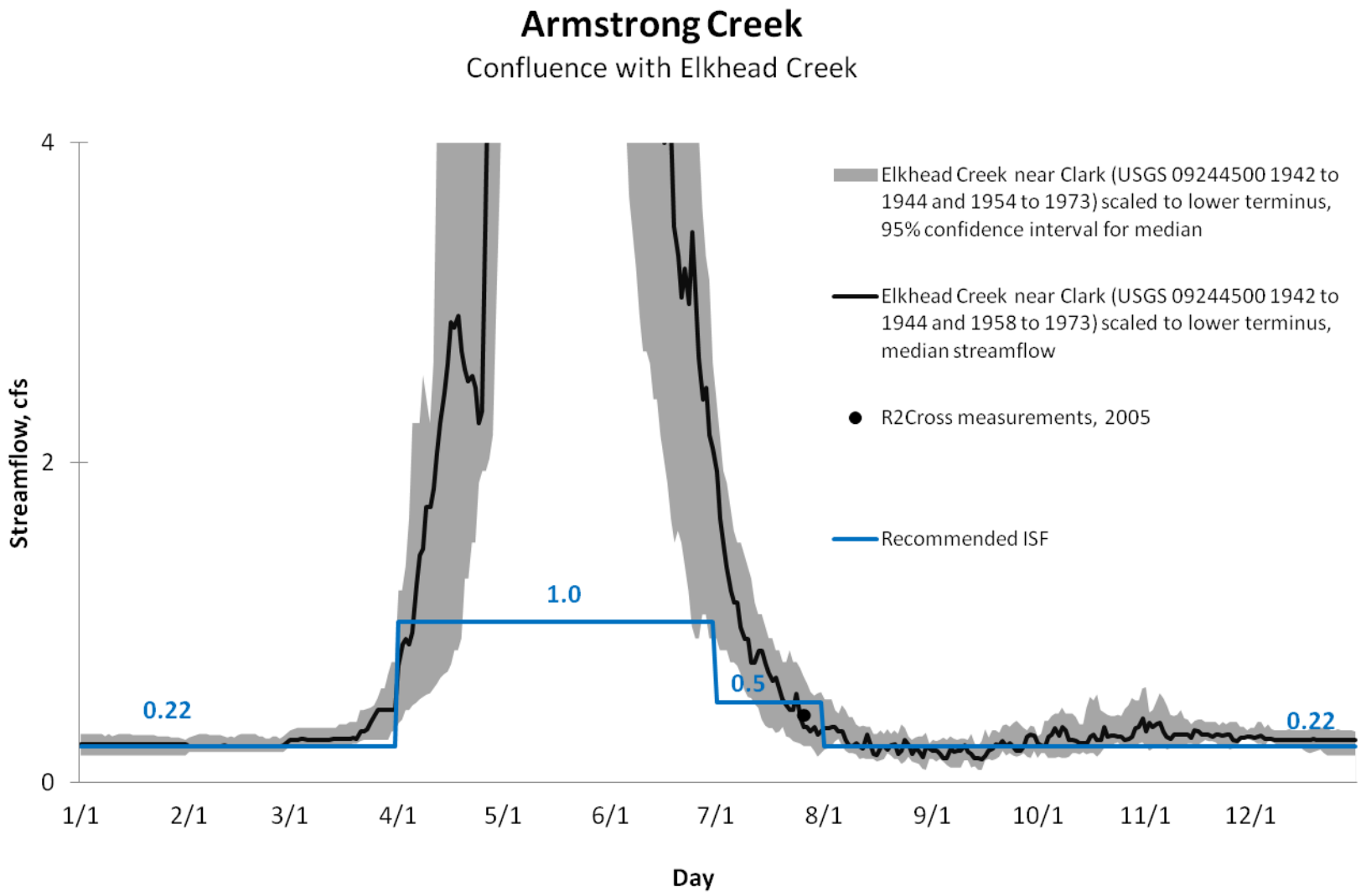
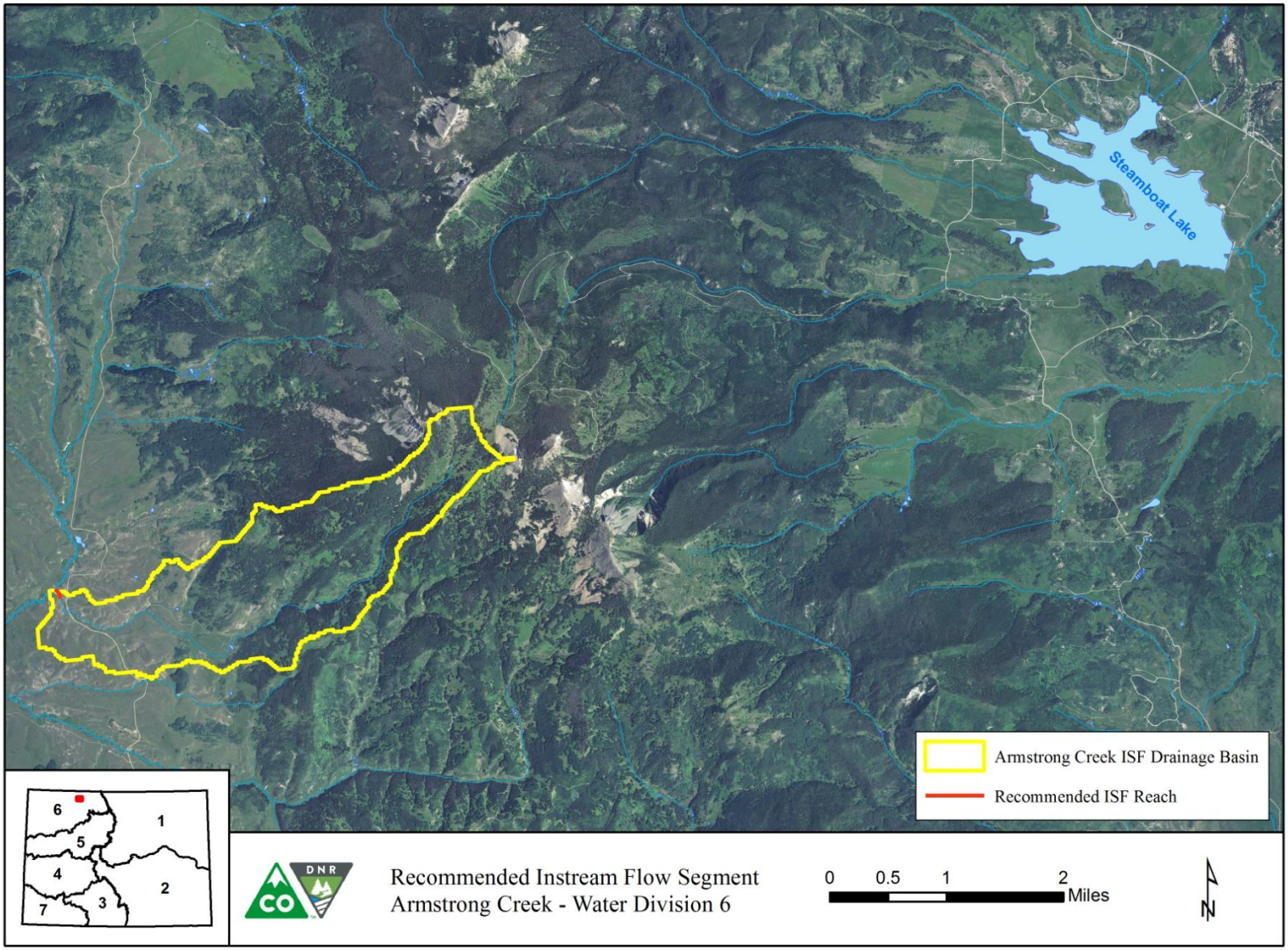
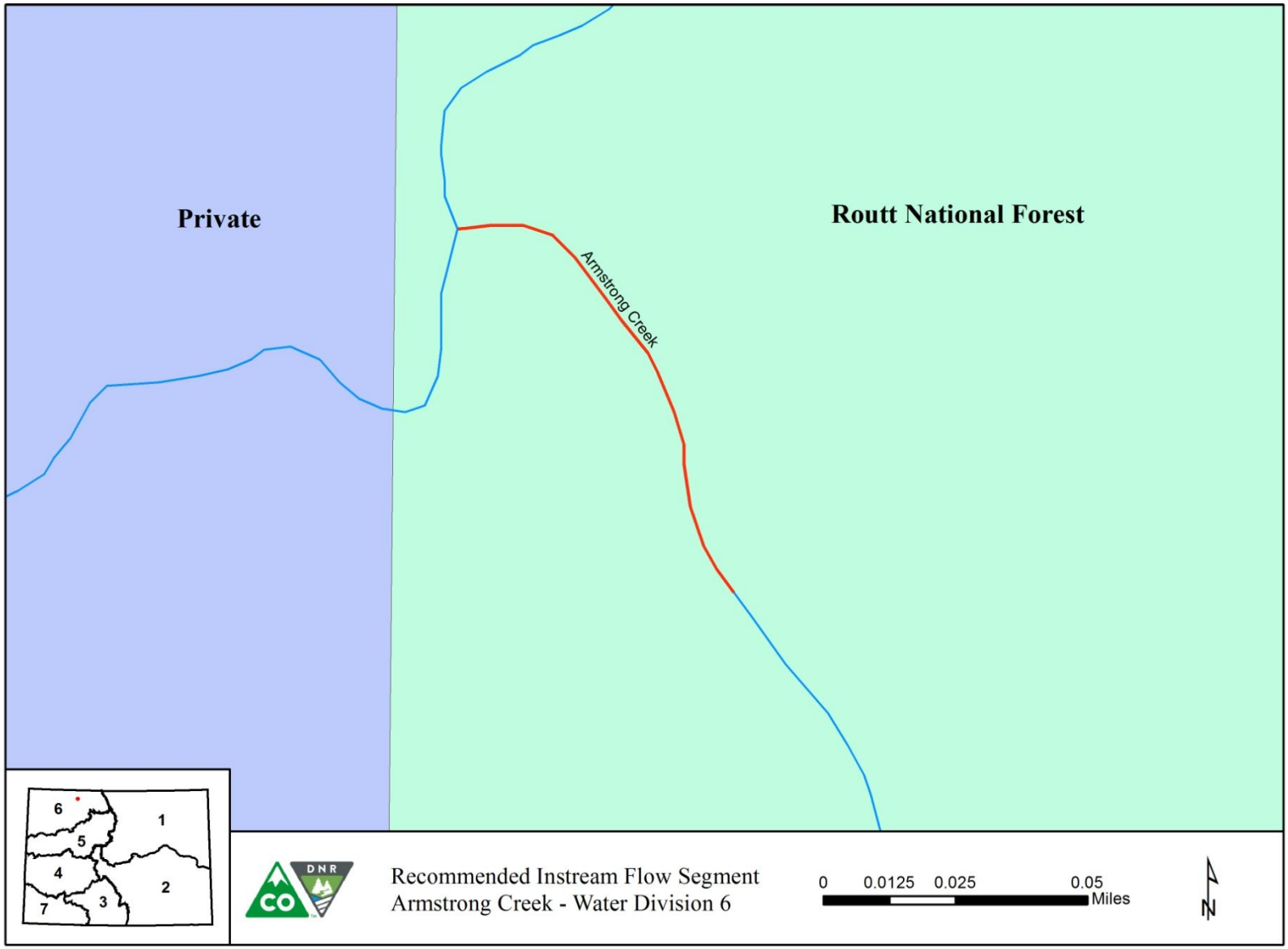


Figure 2. Detailed hydrograph showing streamflow data and the proposed ISF rate on Armstrong Creek.

Vicinity Map



Land Use Map


Private
Routt National Forest
Armstrong Creek
6
1
5
4
2
7
3
DNR
CO
Recommended Instream Flow Segment
Armstrong Creek - Water Division 6
0
0.0125
0.025
0.05
Miles
N

Water Rights Map