



COLORADO

**Colorado Water
Conservation Board**

Department of Natural Resources

Soldier Creek Executive Summary



CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS: Confluence Right Fork Soldier Creek and Middle Fork Soldier Creek at
UTM North: 4402321.62 UTM East: 193527.82

LOWER TERMINUS: Confluence Cathedral Creek at
UTM North: 4407196.87 UTM East: 194744.74

WATER DIVISION: 6

WATER DISTRICT: 43

COUNTY: Rio Blanco

WATERSHED: Lower White (HUC#:14050007)

CWCB ID: 15/6/A-010

RECOMMENDER Bureau of Land Management

LENGTH: 3.67 miles

FLOW

RECOMMENDATION: 0.4 cfs (4/1-9/30)

EXISTING ISF: 5-85CW256; 1.5 cfs (1/1-12/31)

SOLDIER 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an increase to the existing ISF water right on Soldier Creek. The CWCB currently holds an instream flow water right on Soldier Creek for 1.5 cfs (1/1-12/31) in Case No. 5-85CW256. The BLM does not consider the current instream flow water right to be fully protective of the natural environment in Soldier Creek, pursuant to modern analytical procedures used by the CWCB. The current instream flow water right does not meet all three instream flow criteria during the spring and summer, which is a critical growth and spawning period for the fish population. Since the stream supports native cutthroat trout, the BLM considers a fully protective instream flow water right to be essential.

Soldier Creek is located within Rio Blanco County about 24 miles southeast of the town of Rangely (See Vicinity Map). Soldier Creek originates with the joining of Right Fork Soldier Creek and Middle Fork Soldier Creek at an elevation of 7,480 feet. It flows in a northerly direction as it drops to an elevation of 6,700 feet where it joins Cathedral Creek. The proposed reach extends from the confluence of Right Fork Soldier Creek and Middle Fork Soldier Creek downstream to the confluence with Cathedral Creek. Thirty-six percent of the land on the 3.67 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of Soldier Creek because it has a natural environment that can be preserved to a reasonable degree with an increased 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/2015ProposedISFAappropriations.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.

Soldier Creek is a cold-water, moderate gradient stream. It flows through a canyon with a valley floor approximately one-fourth mile in width. The stream cuts through alluvial deposits in the narrow valley and is not confined by bedrock in most locations. The stream generally has medium-sized substrate, consisting of gravels, cobbles, and small boulders. While riffle habitat is abundant, parts of the stream lack extensive pool habitat.

Fisheries surveys have revealed a self-sustaining population of native cutthroat trout. See Table 1 for a list of species identified in this stream. The BLM is considering implementation of a project to create better habitat connectivity between this stream and other streams in the watershed that support native cutthroat trout. Intensive macro-invertebrate surveys have not been conducted, but spot samples have revealed various species of mayfly, caddisfly, and stonefly.

The riparian community is generally comprised of willow species, cattails, rushes, and sedges. In general, the riparian community is in good condition, and provides adequate shading and cover for fish habitat.

Table 1. List of species identified in Soldier Creek.

Species Name	Scientific Name	Status
native cutthroat trout	<i>Oncorhynchus clarkii</i> *	State Species of Special Concern BLM Sensitive Species

**Identification of subspecies / lineage of native cutthroat trout in Colorado is ongoing through genetic testing and research.*

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

BLM 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 (Espégren, 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). BLM 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 two transects for this proposed ISF reach (Table 2). Results obtained at more than one transect are averaged to determine the R2Cross flow rate for the reach of stream. The R2Cross model results in a summer flow of 1.90 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 1.17 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 Soldier Creek.

Entity	Date Measured	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	7/27/2009	0.82	0.3 – 2.0	0.82	2.00
BLM	7/27/2009	0.80	0.3 – 2.0	1.52	1.79
			Mean	1.17	1.90

ISF Recommendation

BLM recommends flows of 0.4 cfs (4/1 – 9/30), based on R2Cross modeling analyses, biological expertise and staff's water availability analysis.

1.9 cfs is recommended for the snowmelt runoff period from April 1 through September 30. Protecting 1.9 cfs will require an increase of 0.4 cfs to the existing instream flow water right. This recommendation is driven by the average depth criteria. This creek experiences consistently low flows

during late summer and fall, so it is important to protect as much physical habitat as possible during the limited time when snowmelt runoff flows and monsoon-related flows are available.

The BLM recommends that the existing instream flow water right remain unchanged for the time period between October 1 and March 31. It appears that the existing water right will meet two of three instream flow criteria used by the CWCB.

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

Soldier Creek is a headwater stream with a relatively small 9.94 square mile drainage basin. The average elevation of the basin is 8,060 ft and the average precipitation is 22.18 inches. There is one relatively small diversion structure with records within the drainage basin tributary to the proposed ISF. Soldier Creek Ditch (appropriation date 1916, 4.3 cfs; appropriation date 1920, 2.7 cfs; total 7 cfs) is located approximately 0.7 miles upstream from the proposed lower terminus. Consequently, streamflow may represent natural flow condition or altered flow conditions depending on operation of the diversion structures.

Available Data

Soldier Creek is a tributary in the headwaters of the Douglas Creek basin. There is not a current or historic gage on Soldier Creek, but there is a historic gage on Douglas Creek. The Douglas Creek gage (USGS 09306380 Douglas Creek at Rangely, CO) is located near the confluence with the White River. This gage has a short and intermittent record from 10/1/1976 to 9/30/1978 and 3/9/1994 to 9/30/1995. The drainage basin tributary to the Douglas Creek gage is 425 square miles, the average elevation of the basin is 6,940 ft, and the average precipitation is 16.3 inches. The proration factor between the proposed lower terminus and the Douglas Creek gage is 3.2%. The proration factor is based on the area-precipitation method which estimates streamflow using the ratio of the precipitation weighted drainage area at the lower terminus location to that of the gage location. Large differences in drainage basin size may produce inaccurate results when scaling streamflow (Archfield and Vogel, 2009). Due to the short period of record and small proration factor, the Douglas Creek gage was not used to estimate streamflow at the lower terminus.

The Corral Gulch gage (USGS 09306242 Corral Gulch near Rangely, CO) is located approximately 21 miles east of the proposed lower terminus. This gage has a long period of record, 1974 to present. The drainage basin tributary to the Corral Gulch gage is 31.7 square miles, the average elevation of the basin is 7,540 ft, and the average precipitation is 19.22 inches. The proration factor between the proposed lower terminus and the Corral Gulch gage is 36.2%. The Corral Gulch drainage is lower in elevation and has less average annual precipitation, which may result in an underestimation of streamflow on Soldier Creek. USGS personnel familiar with Corral Gulch did not think it would be representative of conditions on East Douglas Creek or its tributaries (Mark Henneberg, personal communication). Due to differences in drainage basin characteristics and statements by USGS personnel, the Corral Gulch gage was not used to estimate streamflow at the lower terminus.

In some cases, diversion records can be used to provide an indication of water availability in a stream reach. The diversion record from Soldier Creek Ditch represents some of the only data available for analysis. According to retired Water Commissioner, Bill Dunham, Soldier Creek Ditch may sweep the river at times, particularly during low flows. However, this area has not historically been under administration and the Water Commissioner had not spent a lot of time in the area in recent years. Mr. Dunham stated that none of the diversion structures in the area have measuring devices so all diversion

records are based on visual estimates. Therefore, the diversion record is not a perfect indicator of streamflow because of the nature of the measurements and the fact that the diversion structure does not reliably sweep the creek.

CWCB staff attempted to contact the relevant land owner numerous times, but was unable to gain access to Soldier Creek. Therefore, there are no additional streamflow measurements available for inclusion in the water availability analysis.

Data Analysis

Staff used information from the Soldier Creek Ditch diversion record and StreamStats in the water availability analysis. Soldier Creek Ditch has fairly continuous records from 1967 to 2012 based on data available through HydroBase on 6/18/2014. There are some limited data gaps. Before 1980, the diversion record shows that 4 - 5 cfs was regularly diverted. After about 1980, the record shows that diversions of 2 cfs were more common. The entire diversion record was used to calculate the median diversion and 95% confidence intervals for the median diversion. In addition, the maximum recorded diversion rate was determined. Staff also used StreamStats to estimate the natural streamflow of Soldier Creek.

Water Availability Summary

The hydrograph (Figure 1) shows the median diversion, the 95% confidence interval for the median diversion, and the maximum diversion based on the Soldier Creek Ditch diversion record. The proposed ISF is less than the median diversion rate from about mid-May to mid-June and less than the upper 95% confidence interval from early May to late July. The proposed ISF is below the maximum diversion at all times, indicating that flows have been sufficient for the proposed increase. Given the limitations associated with using the diversion record, StreamStats estimates of mean-monthly streamflow provide the best available estimate of streamflow throughout the year. The proposed increase to the existing ISF is less than the StreamStats estimate. Staff has concluded that water is available for appropriation.

Material Injury

Because the proposed ISF on Soldier 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

Archfield, S.A., and R.M. Vogel, 2009, Map correlation method: selection of reference streamgage to estimate daily streamflow at ungaged catchments, Water Resources Research, vol 46, W10513, doi:10.1029/2009WR008481.

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.

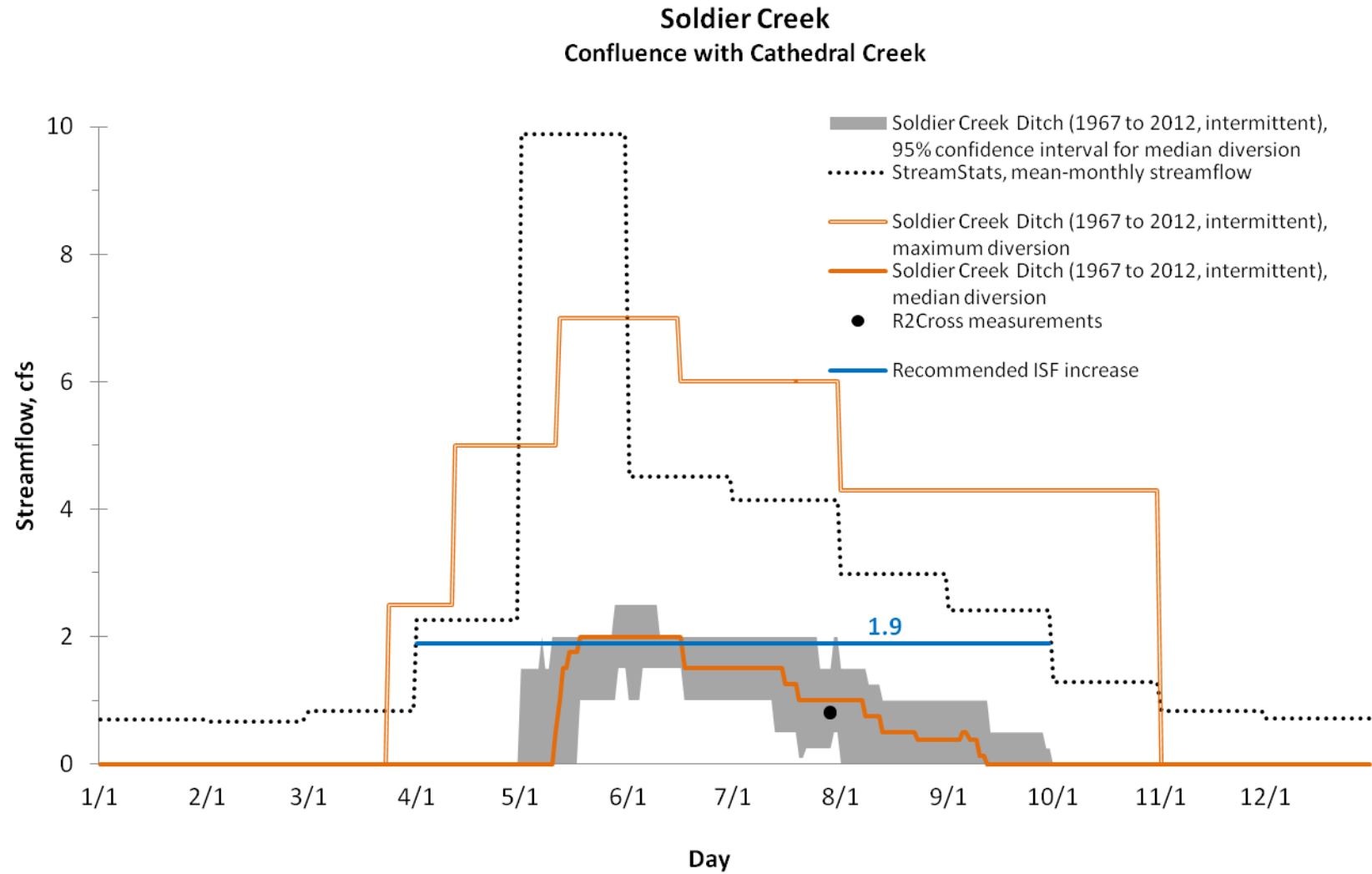
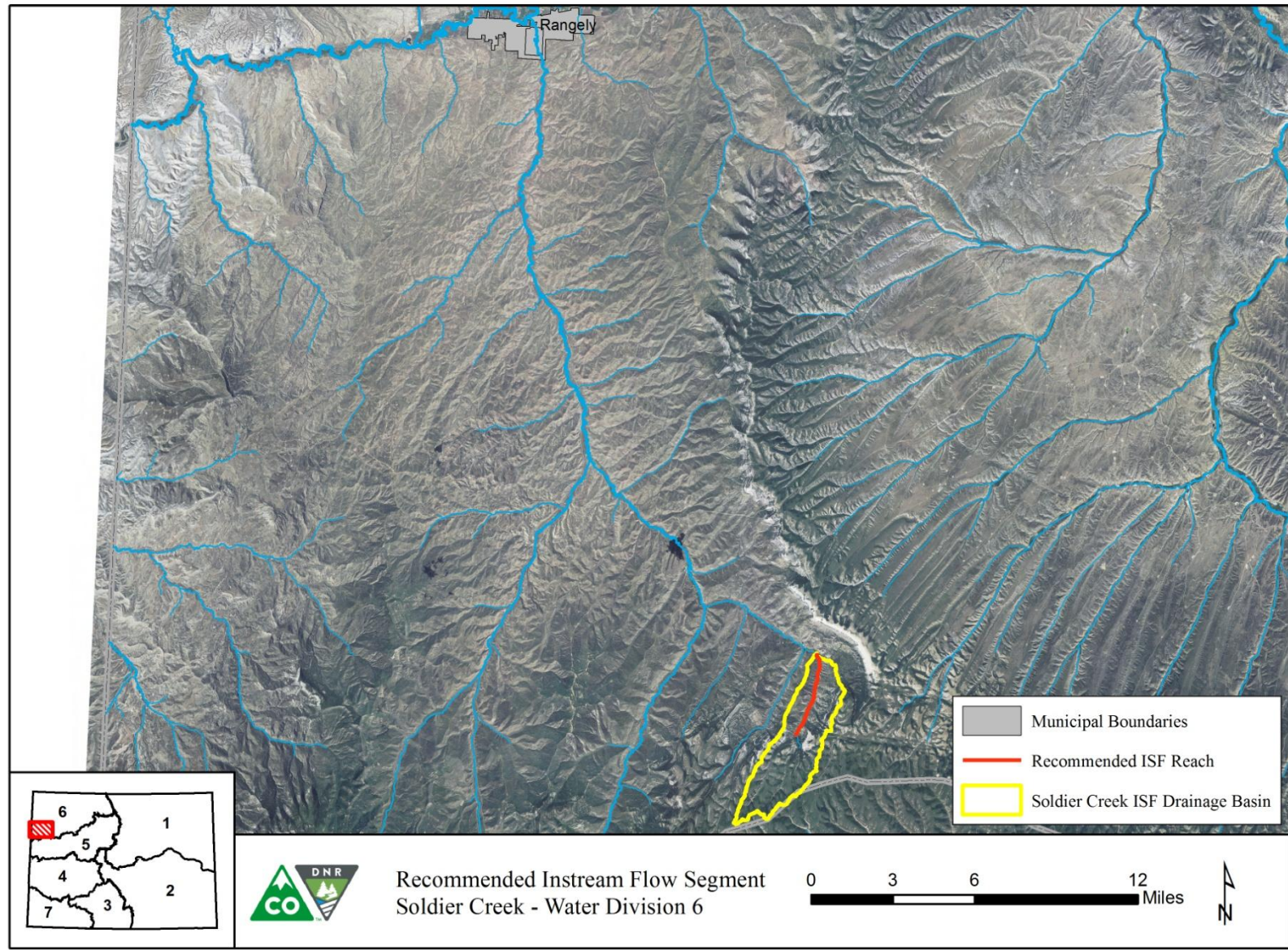
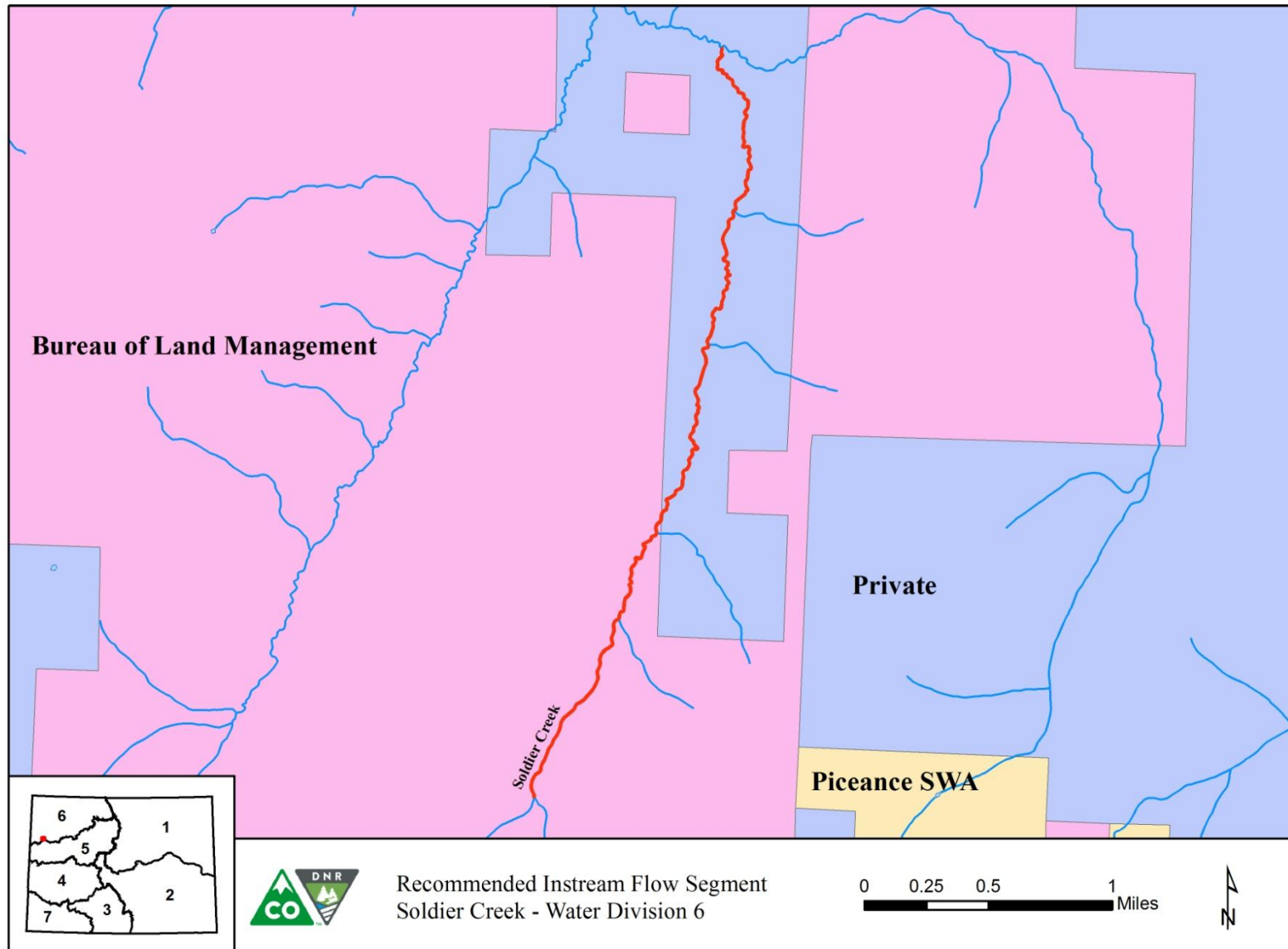


Figure 1. Complete hydrograph showing streamflow data and the proposed ISF rate on Soldier Creek.

Vicinity Map



Land Use Map



Water Rights Map

