COLORADO
Colorado Water Conservation Board
Department of Natural Resources

1313 Sherman Street
Denver, CO 80203

P (303) 866-3441
F (303) 866-4474

John Hickenlooper, Governor

Mike King, DNR Executive Director

James Eklund, CWCB Director

Unnamed Tributary to Crooked Creek

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4353209.68 UTM East: 414098.90
LOWER TERMINUS:	Confluence with the Silverheels Ditch UTM North: 4348065.96 UTM East: 416529.86
WATER DIVISION:	1
WATER DISTRICT:	23
COUNTY:	Park County
WATERSHED:	South Platte Headwaters (HUC#: 10190001)
CWCB ID:	16/1/A-007
RECOMMENDER:	Park County & Colorado Parks and Wildlife
LENGTH:	3.86 miles
FLOW RECOMMENDATION:	0.23 cfs (10/1 – 4/31) 0.62 cfs (5/1 – 9/30)

Unnamed Tributary to Crooked 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 (NLL). 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.

Park County and Colorado Parks and Wildlife (CPW) recommended that the CWCB appropriate an ISF water right on a reach of an unnamed tributary to Crooked Creek. This reach is located within Park County about 5 miles east of the town of Alma (See Vicinity Map). This unnamed tributary to Crooked Creek originates on the west side of Palmer Peak in Pike National Forest at an elevation of 12,200 ft. The creek flows in a southeasterly direction as it drops to an elevation of 9,700 feet where it joins Crooked Creek. The proposed reach extends from the headwaters downstream to the Silverheels Ditch. Sixty-five percent of the land on the 3.86 mile proposed reach is publicly owned and managed by the U.S. Forest Service (See Land Ownership Map). Park County and CPW recommended this reach of the unnamed tributary to Crooked 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/2016ProposedISFRecommendations.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 Crooked Creek drainage has been stocked by the former Colorado Division of Wildlife and CPW with hatchery strain (non-conservation lineage) greenback cutthroat trout since the late 1980s. Periodic stocking and natural reproduction have sustained the population over time. In light of land management protections provided by the US Forest Service, habitat protection and stewardship, and eventual ISF protection, it is likely that this fishery will persist for the foreseeable future.

Table 1. List of fish species identified in Unnamed Tributary to Crooked Creek.

Species Name	Scientific Name	Status
greenback cutthroat	*Oncorhynchus clarkii stomias*	Federally Threatened, State Threatened

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 macro-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 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 0.62 cfs, which meets 3 of 3 criteria, and a winter flow of 0.71 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 Unnamed Tributary to Crooked Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	8/6/2015 – 1	0.66	0.3 – 1.6	0.28	0.62
CPW	8/6/2015 - 2	0.91	0.4 – 2.3	1.13	Out of Range
			Mean	**0.71**	**0.62**

ISF Recommendation
It is relatively rare for a multiple cross section data set to yield summer recommendations that are less than the winter flow recommendations. To protect this natural environment, CPW recommends flows of 0.62 cfs for the entire year based on R2Cross modeling analyses and biological expertise. The CPW recommendation was modified by staff to 0.23 cfs (10/1 – 4/31) and 0.62 cfs (5/1 – 9/30) during the base flow period as a result of water availability.

0.62 cubic feet per second is recommended during the warm weather period from May 1 to September 30.

0.23 cubic feet per second is recommended during the base flow period, from October 1 to April 31. This recommendation is driven by limited water availability.

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 of 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. Statistically, there is 95% confidence that the true value of the median streamflow is located within the confidence interval.

Basin Characteristics
The drainage basin of the proposed ISF on the unnamed tributary of Crooked Creek is 1.35 square mile, with an average elevation of 11,600 ft and average annual precipitation of 29.63 inches. There are no known surface water diversions within the basin tributary to the proposed ISF. There are two

decreed springs and there may be other undecreed spring uses. There are also no known reservoirs or transbasin imports or exports. Hydrology in this drainage basin represents largely natural flow conditions. See the Hydrologic Features Map for more information.

Available Data
There are no current or historic streamflow gages in the vicinity of the proposed ISF reach. In some cases, diversion records can be used to provide an indication of water availability in a stream reach. The Crooked Creek Ditch (1877 appropriation date) is decreed for the "entire flow" of Crooked Creek. This diversion structure plots near the proposed ISF reach. However, based on GPS points taken by DWR staff and discussion with the water commissioner, the diversion records are based on a measurement point located downstream on Crooked Creek rather than the unnamed tributary of Crooked Creek (personal communication with Jara Johnson 12/17/2015). Because the measurement location includes water from several different creeks and tributaries, the diversion record does not provide reliable information about streamflow on the proposed ISF reach.

Data Analysis
StreamStats provides the best available estimate of streamflow on the unnamed tributary of Crooked Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean-monthly streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on an unnamed tributary to Crooked 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. (2015), 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.

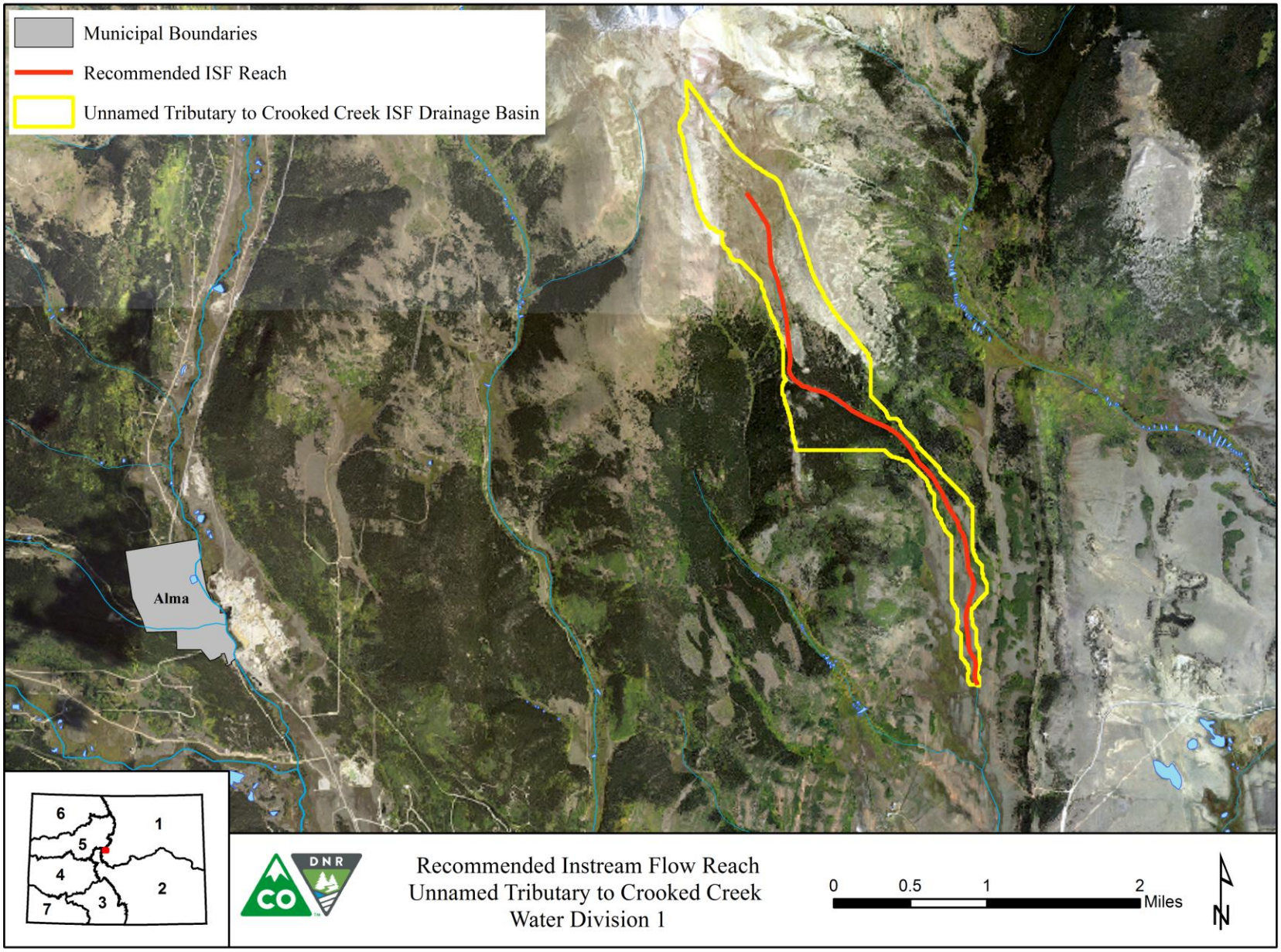
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

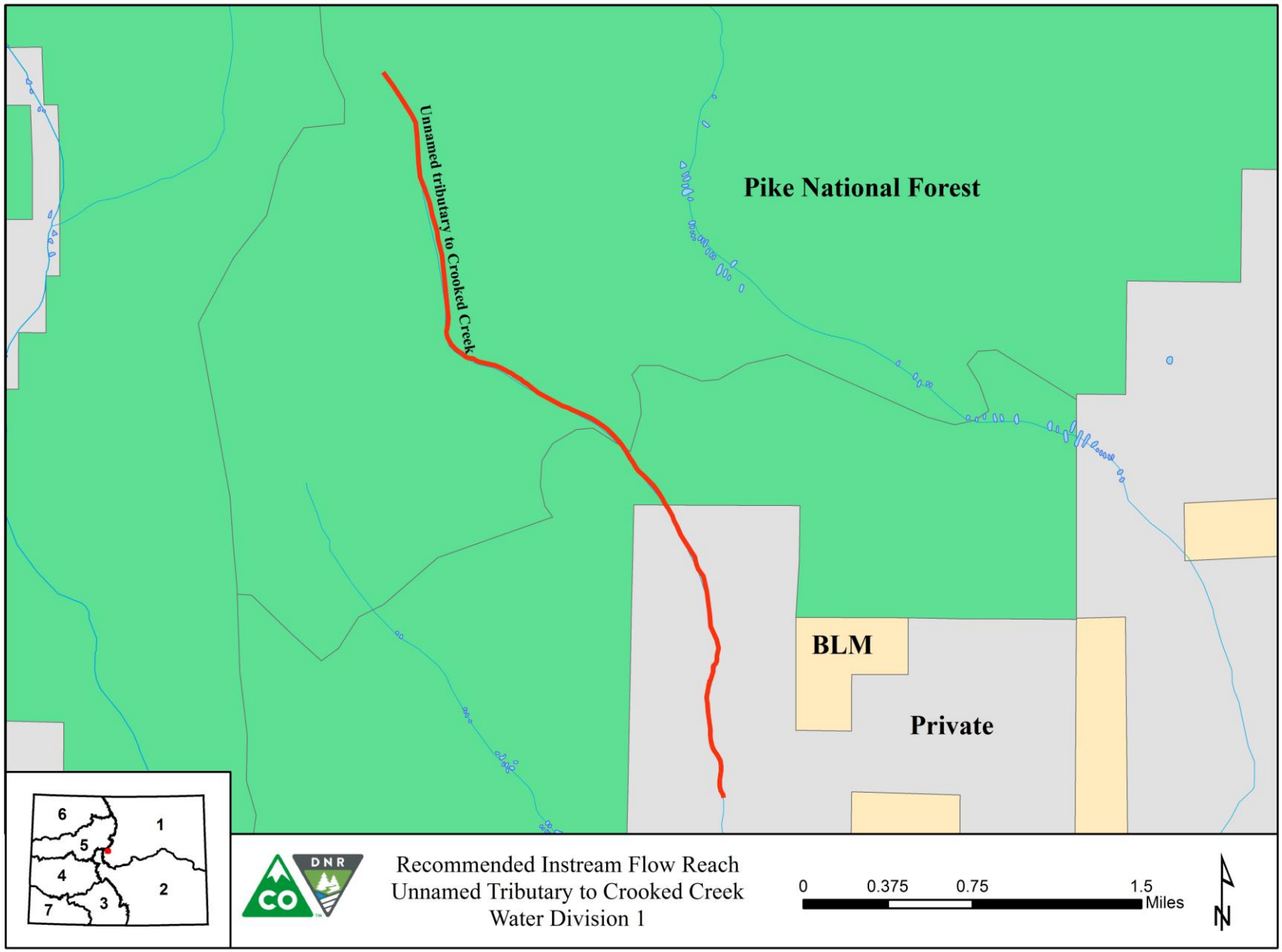
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

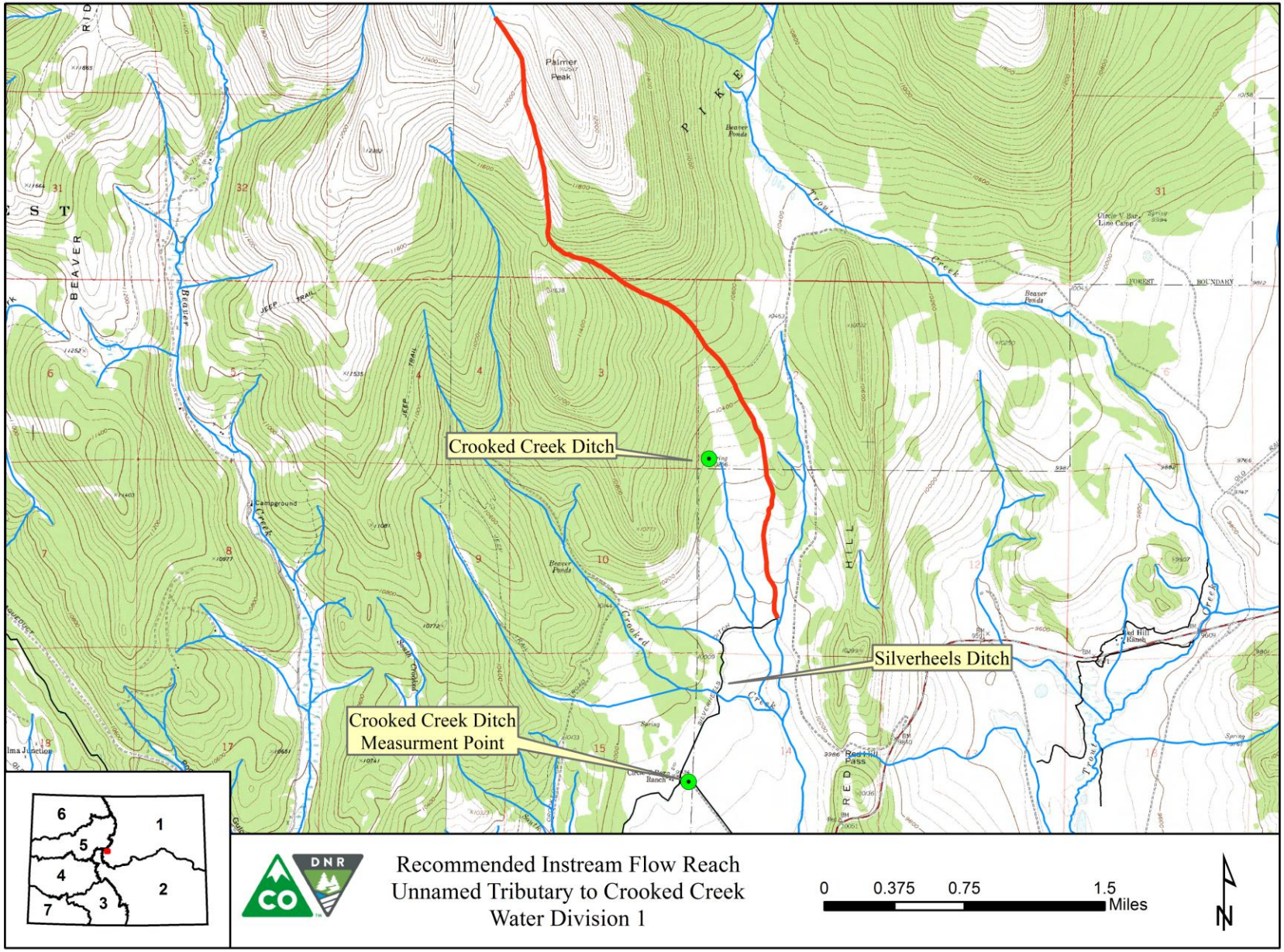
VICINITY MAP



LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH