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

TO: Colorado Water Conservation Board Members

FROM: Linda Bassi, Chief
Jeff Baessler, Deputy Section Chief
Stream and Lake Protection Section

DATE: January 26, 2016

AGENDA ITEM: **21. Instream Flow Appropriations in Water Divisions 1, 2, 4 , 5 and 6**

Introduction
This memo provides an overview of the technical analyses that were performed by both the recommending entities and CWCB staff to provide the Board with sufficient information to declare its intent to appropriate instream flow water rights in accordance with the Rules Concerning the Colorado Instream Flow and Natural Lake Level Program ("ISF Rules"). An executive summary for each stream and lake recommendation and appendices of the supporting scientific data, which provides the technical basis for each appropriation, was provided to the Board separately.

Staff Recommendation
Staff recommends that, pursuant to ISF Rule 5d., the Board declare its intent to appropriate an instream flow ("ISF") water right on each stream segment listed and on the attached Tabulation of Instream Flow Recommendations, and direct Staff to publicly notice the Board's declaration of its intent to appropriate.

Background
Pursuant to ISF Rule 5d., staff is requesting the Board to declare its intent to appropriate ISF water rights on the stream segments identified in the attached table. Staff has reviewed each proposed stream segment to ensure that for each ISF recommendation, the data set is complete and standard methods and procedures were followed. In addition, staff has completed its water availability studies. Staff has identified 19 stream segments, in Water Divisions 1, 2, 4, 5 and 6 for which sufficient information has been compiled and analyses performed upon which the Board can base its intent to appropriate. These stream segments and lakes are located in Larimer, Park, Weld, El Paso, Fremont, Teller, Hinsdale, Gunnison, Grand, Mesa, Rio Blanco, and Routt Counties.

Technical Investigations
Staff's executive summary and technical analysis of each stream are contained in the Instream Flow Recommendation Reports and form the basis for staff's recommendations. In addition to the reports, the scientific data and technical analyses performed by the recommending entity are accessible on

the Board's web site at: http://cwcb.state.co.us/environment/instream-flow-program/Pages/2016ProposedISFRecommendations.aspx

Natural Environment Studies
The Bureau of Land Management (BLM), Colorado Parks and Wildlife (CPW), Larimer County Department of Natural Resources, and the City of Fort Collins have conducted field surveys of the natural environment resources on these streams and have found natural environments that can be preserved. To quantify the resources and to evaluate instream flow requirements, the BLM and CPW collected biologic and hydraulic data and performed R2CROSS modeling on all segments. The CWCB staff analyzed and/or reviewed all of the data and models used to support the recommendations, and worked with the recommending entities to prepare final recommendations of the amount of water necessary to preserve the natural environment to a reasonable degree for each of the streams listed on the attached Tabulation of Instream Flow Recommendations.

Water Availability Studies
Staff has conducted an evaluation of water availability for the streams listed. To determine the amount of water physically available for the Board's instream flow appropriations, staff analyzed available USGS gage records, available streamflow models, and/or utilized appropriate standard methods to develop a hydrograph of median daily and/or mean monthly flows for each stream flow recommendation. In addition, staff analyzed the water rights tabulation for each stream to identify any potential water availability problems. Based upon its analyses, staff has determined that water is available for appropriation on each stream to preserve the natural environment to a reasonable degree without limiting or foreclosing the exercise of valid water rights.

On some of the listed streams, CWCB staff suggested modifications to the R2Cross biological recommendation due to water availability limitations. On these streams, staff met with the recommending entities to review the water availability analyses, and discuss whether the modified recommendation would preserve the natural environment to a reasonable degree. After reviewing staff's hydrology, the original R2Cross results, and evaluating the indicator species and other aspects of the natural environment, the recommending entities concluded that the proposed modified recommendations would preserve the natural environment to a reasonable degree on each stream segment.

Stakeholder Outreach
Staff provided public notice of the recommendations in both March and November of 2015 and contacted or met with the County Commissioners for each county where the stream segments are located. In addition, water commissioners and local land owners were contacted when possible to further discuss the recommendations.

Instream Flow Rule 5d.
Rule 5d. provides that the Board may declare its intent to appropriate ISF water rights after reviewing Staff's recommendations for the proposed appropriations. Rule 5d. also sets forth the activities that take place after the Board declares its intent that initiate the public notice and comment procedure for the ISF appropriations. Specifically,

5d. Board's Intent to Appropriate. Notice of the Board's potential action to declare its intent to appropriate shall be given in the January Board meeting agenda and the Board will take public comment regarding its intent to appropriate at the January meeting.

(1) After reviewing Staff's ISF recommendations for proposed ISF appropriations, the Board may declare its intent to appropriate specific ISF water rights. At that time, the Board shall direct the Staff to publicly notice the Board's declaration of its intent to appropriate.

(2) After the Board declares its intent to appropriate, notice shall be published in a mailing to the ISF Subscription Mailing Lists for the relevant water divisions and shall include:
   (a) A description of the appropriation (e.g. stream reach, lake location, amounts, etc.);
   (b) Availability (time and place) for review of Summary Reports and Investigations Files for each recommendation; and,
   (c) Summary identification of any data, exhibits, testimony or other information in addition to the Summary Reports and Investigations Files supporting the appropriation.

(3) Published notice shall also contain the following information:
   (a) The Board may change flow amounts of contested ISF appropriations based on information received during the public notice and comment period.
   (b) Staff will maintain, pursuant to Rule 5e.(3), an ISF Subscription Mailing List for each water division composed of the names of all persons who have sent notice to the Board Office that they wish to be included on such list for a particular water division. Any person desiring to be on the ISF Subscription Mailing List(s) must send notice to the Board Office.
   (c) Any meetings held between Staff and members of the public will be open to the public. Staff may provide Proper Notice prior to any such meetings and may provide notice to persons on the ISF Subscription Mailing List(s).
   (d) Any Notice to Contest must be received at the Board office no later than March 31st, or the first business day thereafter. All Notices of Party status and Contested Hearing Participant status must be received at the Board office no later than April 30th, or the first business day thereafter.
   (e) Staff will announce its Final Staff ISF Recommendation concerning contested appropriations at the September Board meeting and will send notice of the Final Staff Recommendation to all persons on the Contested Hearing Mailing List.
   (f) The Board may take final action on any uncontested ISF appropriations at the May Board meeting.

(4) After the Board declares its intent to appropriate, notice of the Board's action shall be mailed within five working days to the County Commissioners of the county(ies) in which the proposed reach is located.

Attachment

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

Instream Flow Tabulation - Streams

Water Division 1

Case Number	Stream	Watershed	County	Upper Terminus	Lower Terminus	Length (miles)	USGS QUADS	Amount(dates) (CFS)	Approp Date
16/1/A-002	Balm of Gilead Creek	South Platte headwaters	Park	headwaters in the vicinity of lat 38 50 14N long 105 32 41W	BLM property boundary at lat 38 53 38N long 105 31 52W	4.49	Spinney Mountain Thirtynine Mile Mountain	0.24 (11/1 - 3/31) 0.35 (4/1 - 4/30) 0.6 (5/1 - 8/31) 0.35 (9/1 - 10/31)	
15/1/A-005	Boxelder Creek	Cache la Poudre	Larimer	confl S & N Boxelder Creeks at lat 40 57 11N long 105 12 33W	confl unnamed tributary at lat 40 54 51N long 105 10 31W	4.72	Livermore Table Mountain	5 (5/16 - 6/30) 1.3 (7/1 - 5/15)	
13/1/A-005	Lone Tree Creek	Lonetree Creek-Owl Creek	Weld	confl Spotwood Creek at lat 40 58 40N long 104 55 11W	Meadow Springs Ranch boundary at lat 40 57 27N long 104 55 38W	2.17	Carr West	0.3 (1/1 - 12/31)	
16/1/A-001	Pruden Creek	South Platte headwaters	Park	USFS property boundary at lat 38 53 06N long 105 34 14W	BLM property boundary at lat 38 53 24N long 105 33 55W	0.49	Spinney Mountain Thirtynine Mile Mountain	0.24 (11/1 - 3/31) 0.4 (4/1 - 4/31) 1 (5/1 - 8/31) 0.4 (9/1 - 10/31)	
15/1/A-003	Sand Creek	Cache la Poudre	Larimer	Colorado - Wyoming stateline at lat 40 59 54N long 105 12 37W	confl unnamed tributrary at lat 40 56 13N long 105 09 17W	6.59	Table Mountain	5.5 (5/16 - 6/30) 1.5 (7/1 - 5/15)	
16/1/A-007	Unnamed Tributary to Crooked Creek	South Platte headwaters	Park	headwaters in the vicinity of lat 39 19 27N long 105 59 48W	confl Silverheels Ditch at lat 39 16 41N long 105 58 04W	3.86	Como	0.23 (10/1 - 4/31) 0.62 (5/1 - 9/30)	

Totals for Water Division 1

Total # of Stream Miles = 22.32

Total # of Appropriations = 6

(Totals do not include donated/acquired water rights)

Instream Flow Tabulation - Water Division 2

Case Number	Stream	Watershed	County	Upper Terminus	Lower Terminus	Length (miles)	USGS QUADS	Amount(dates) (CFS)	Approp Date
16/2/A-003	East Fork Turkey Creek	Upper Arkansas	Teller El Paso	headwaters in the vicinity of lat 38 40 51N long 104 57 22W	confl WF Turkey Creek at lat 38 38 36N long 104 56 06W	3.43	Mount Big Chief	0.3 (12/1 - 3/31) 0.6 (4/1 - 4/30) 1.35 (5/1 - 8/31) 0.5 (9/1 - 11/30)	
16/2/A-001	Turkey Creek	Upper Arkansas	El Paso	confl EF & WF Turkey Creeks at lat 38 38 36N long 104 56 06W	confl. unnamed tributary at lat 38 37 24N long 104 55 11W	2.38	Mount Big Chief Mount Pittsburg	1 (12/1 - 3/31) 2.7 (4/1 - 4/30) 3.7 (5/1 - 8/31) 1.8 (9/1 - 11/30)	
16/2/A-002	West Fork Turkey Creek	Upper Arkansas	Teller Fremont El Paso	headwaters in the vicinity of lat 38 40 17N long 104 58 30W	confl EF & WF Turkey Creek at lat 38 38 36N long 104 56 06W	3.98	Mount Big Chief	0.5 (12/1 - 3/31) 0.75 (4/1 - 4/30) 2.1 (5/1 - 8/31) 0.75 (9/1 - 11/30)	

Totals for Water Division 2

Total # of Stream Miles = 9.79

Total # of Appropriations = 3

(Totals do not include donated/acquired water rights)

Instream Flow Tabulation - Water Division 4

Case Number	Stream	Watershed	County	Upper Terminus	Lower Terminus	Length (miles)	USGS QUADS	Amount(dates) (CFS)	Approp Date
16/4/A-003	Fourth of July Creek	Upper Gunnison	Hinsdale Gunnison	headwaters in the vicinity of lat 38 08 19N long 107 12 01W	Carris Thompson Ditch hdgt at lat 38 09 30N long 107 17 12W	6.00	Alpine Plateau Powderhorn Lakes	1.1 (4/1 - 7/31) 0.6 (8/1 - 3/31)	
15/4/A-005 (increase)	Little Cimarron River	Upper Gunnison	Gunnison	confl Firebox Creek at lat 38 13 11N long 107 27 57W	confl Van Boxel Creek at lat 38 18 24N long 107 28 08W	7.64	Lost Lake Sheep Mountain	7 (10/1 - 10/31) 4.6 (11/1 - 4/14) 11 (4/15 - 9/30)	

Totals for Water Division 4

Total # of Stream Miles = 13.64

Total # of Appropriations = 2

(Totals do not include donated/acquired water rights)

Instream Flow Tabulation - Water Division 5

Case Number	Stream	Watershed	County	Upper Terminus	Lower Terminus	Length (miles)	USGS QUADS	Amount(dates) (CFS)	Approp Date
16/5/A-002	East Hawxhurst Creek	Colorado Headwaters-Plateau	Mesa	outlet of McCurry Reservoir at lat 39 21 34N long 107 52 51W	confl West Hawxhurst Creek at lat 39 17 27N long 107 54 38W	5.75	Hawxhurst Creek	1.7 (4/15 - 6/30) 0.46 (7/1 - 4/14)	
16/5/A-004	Morgan Gulch	Colorado headwaters	Grand	headwaters in the vicinity of lat 39 56 20N long 106 03 35W	confl Williams Fork River at lat 39 55 14N long 106 06 60W	4.10	Sylvan Reservoir	0.3 (10/1 - 4/30) 2.1 (5/1 - 7/31) 0.8 (8/1 - 9/30)	
16/5/A-003	West Hawxhurst Creek	Colorado Headwaters-Plateau	Mesa	headwaters in the vicinity of lat 39 21 48N long 107 54 01W	confl East Hawxhurst Creek at lat 39 17 27N long 107 54 38W	5.57	Hawxhurst Creek	1.6 (4/15 - 6/30) 0.56 (7/1 - 4/14)	

Totals for Water Division 5

Total # of Stream Miles = 15.42

Total # of Appropriations = 3

(Totals do not include donated/acquired water rights)

Instream Flow Tabulation - Water Division 6

Case Number	Stream	Watershed	County	Upper Terminus	Lower Terminus	Length (miles)	USGS QUADS	Amount(dates) (CFS)	Approp Date
08/6/A-004	Piceance Creek	Piceance Creek-Yellow Creek	Rio Blanco	confl Dry Fork Piceance Creek at lat 40 00 27N long 108 14 45W	confl White River at lat 40 05 22N long 108 14 41W	9.96	Barcus Creek SE White River City	4 (1/1 - 12/31)	
13/6/A-003 (increase)	Willow Creek	Upper Yampa	Routt	outlet of Steamboat Lake at lat 40 47 27N long 106 56 47W	confl Beaver Creek at lat 40 46 07N long 106 54 59W	4.94	Hahns Peak	7 (4/16 - 6/30)	
13/6/A-004 (increase)	Willow Creek	Upper Yampa	Routt	confl Beaver Creek at lat 40 46 7N long 106 54 59W	confl Lester Creek at lat 40 45 44N long 106 53 53W	1.47	Hahns Peak	13 (4/16 - 6/30) 3 (7/1 - 7/31)	
13/6/A-005	Yellow Creek	Piceance Creek-Yellow Creek	Rio Blanco	confl Barcus Creek at lat 40 07 04N long 108 21 40W	confl Lambert Springs at lat 40 08 35N long 108 23 09W	3.66	Barcus Creek Barcus Creek SE Rough Gulch	0.82 (3/1 - 6/15) 0.4 (6/16 - 2/29)	
13/6/A-006	Yellow Creek	Piceance Creek-Yellow Creek	Rio Blanco	confl Lambert Springs at lat 40 08 35N long 108 23 09W	confl White River at lat 40 10 22N long 108 24 11W	3.45	Rough Gulch	1.8 (3/1 - 6/15) 1.2 (6/16 - 2/29)	

Totals for Water Division 6

Total # of Stream Miles = 23.48

Total # of Appropriations = 5

(Totals do not include donated/acquired water rights)

Report Totals

Total # of Stream Miles = 84.65

Total # of Appropriations = 19

(Totals do not include donated/acquired water rights)

January 8, 2016

Colorado Water Conservation Board
1313 Sherman St., Room 721
Denver, CO 80203
Attn: Linda Bassi

Re: Letter of Support for Proposed 2016 Instream Flow Appropriations

Dear Board of Directors:

Western Resource Advocates urges the Board to approve the excellent slate of proposed instream flow appropriations at its upcoming January 2016 meeting.

Western Resource Advocates is a non-profit conservation organization dedicated to protecting the Interior West's land, air, and water. As a participant for many years in water-related matters across the state—many in close partnership with CWCB staff—we understand the importance of Colorado's instream flow program to protect rivers and the species that depend upon them.

The proposals before you would protect existing habitat for a diverse range of important native species including cutthroat trout, northern suckers, mountain suckers, and northern leopard frogs. In addition, they would protect vibrant cold water trout streams that allow angling and help sustain Colorado's $9 billion annual river-related recreation economy.

Western Resource Advocates supports these modest flow protections that would preserve some of the natural values that make Colorado a great place to live.

Sincerely,

Bart P. Miller

Bart Miller
Director, Healthy Rivers Program
Western Resource Advocates

Arizona
P.O. Box 64128
Tucson, AZ 85728

Colorado
2260 Baseline Rd.
Suite 200
Boulder, CO 80302

Nevada
550 W. Musser Street
Suite I
Carson City, NV 89703

New Mexico
409 East Palace Ave.
Unit 2
Santa Fe, NM 87501

Utah
150 South 600 East
Suite 2AB
Salt Lake City, UT 84102

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

2016 Instream Flow Recommendations

Water Division 1

1. Balm of Gilead Creek Executive Summary (Park County)
   Appendices
2. Boxelder Creek Executive Summary (Larimer County)
   Appendices
3. Lone Tree Creek Executive Summary (Weld County)
   Appendices
4. Pruden Creek Executive Summary(Park County)
   Appendices
5. Sand Creek Executive Summary (Larimer County)
   Appendices
6. Unnamed Tributary to Crooked Creek Executive Summary(Park County)
   Appendices

Water Division 2

7. East Fork Turkey Creek Executive Summary (El Paso & Teller Counties)
   Appendices
8. Turkey Creek Executive Summary (El Paso County)
   Appendices
9. West Fork Turkey Creek Executive Summary (El Paso, Fremont, & Teller Counties)
   Appendices

Water Division 4

10. Fourth of July Creek Executive Summary (Hinsdale & Gunnison Counties)
    Appendices
11. Little Cimarron River *Increase* Executive Summary (Gunnison County)
    Appendices

Water Division 5

12. East Hawxhurst Creek Executive Summary (Mesa County)
    Appendices
13. Morgan Gulch Executive Summary (Grand County)
    Appendices
14. West Hawxhurst Creek Executive Summary (Mesa County)
    Appendices

Water Division 6

15. Piceance Creek Executive Summary (Rio Blanco County)
    Appendices
16. Willow Creek (Upper) *Increase* Executive Summary(Routt County)
    Appendices
17. Willow Creek (Lower) *Increase* Executive Summary(Routt County)
    Appendices
18. Yellow Creek (Upper) Executive Summary (Rio Blanco County)
    Appendices
19. Yellow Creek (Lower) Executive Summary (Rio Blanco County)
    Appendices

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

Balm of Gilead Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4298857.94 UTM East: 452727.22
LOWER TERMINUS:	Bureau of Land Management Property Boundary UTM North: 4305120.04 UTM East: 453937.22
WATER DIVISION:	1
WATER DISTRICT:	23
COUNTY:	Park County
WATERSHED:	South Platte Headwaters (HUC#: 10190001)
CWCB ID:	16/1/A-002
RECOMMENDER:	Bureau of Land Management
LENGTH:	4.49 miles
FLOW RECOMMENDATION:	0.24 cfs (11/1 – 3/31) 0.35 cfs (4/1 – 4/30) 0.60 cfs (5/1 – 8/31) 0.35 cfs (9/1 – 10/31)

Balm of Gilead 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Balm of Gilead Creek. This reach is located within Park County (See Vicinity Map). Balm of Gilead Creek originates on the north flank of Thirtynine Mile Mountain at an elevation of 10,500 ft approximately eight miles south of Elevenmile Canyon Reservoir. The creek flows in a northerly direction as it drops to an elevation of 8,600 feet where it joins Elevenmile Canyon Reservoir. The proposed reach extends from the headwaters downstream to the BLM property boundary. One-hundred percent of the land on the 4.49 mile proposed reach is publicly owned and managed by the U.S. Forest Service and the BLM (See Land Ownership Map). The BLM recommended this reach of Balm of Gilead 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.

Balm of Gilead Creek is a cold-water, high gradient stream. The reach flows through a shallow, rolling valley approximately one-fourth mile in width. The stream is confined by bedrock in some locations and travels through alluvium in other locations. The stream generally has medium-sized substrate, ranging from gravels to small boulders. The stream has a good mix of pools, small riffles, and runs.

Fisheries surveys indicate that the stream has supported a limited density rainbow trout population. Intensive macroinvertebrate surveys have not been conducted, but spot samples have revealed various species of black fly, midges, mayfly, caddisfly, and stonefly.

The riparian community is generally comprised of various willow species, alder, river birch, and potentilla. The riparian community is in fair to good condition. The structure of the riparian community provides only limited shading and cover for fish habitat.

Table 1. List of fish species identified in Balm of Gilead Creek.

Species Name	Scientific Name	Status
rainbow trout	*Oncorhynchus mykiss*	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

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 (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). 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 four 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 winter flow of 0.25 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 Balm of Gilead Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	8/17/2009 - 1	0.12	0.05 – 0.3	0.17	Out of range
BLM	8/17/2009 - 2	0.12	0.05 – 0.3	0.21	Out of range
BLM	5/19/2014 - 1	0.24	0.1 – 0.6	0.2	Out of range
BLM	5/19/2014 - 2	0.24	0.1 – 0.6	0.41	0.6*
			Mean	**0.25**	**0.6**

**The flow that meets all three instream flow criteria is outside of the confidence interval for this data set. 0.6 cfs is within the confidence interval, provides 0.72 feet per second average velocity, and meets the instream flow criteria for average depth and wetted perimeter.*

ISF Recommendation Creek

The BLM recommends flows of 0.24 cfs (11/1 – 3/31), 0.35 cfs (4/1 – 4/30), 0.60 cfs (5/1 – 8/31), and 0.35 cfs (9/1 – 10/31) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

0.6 cubic feet per second is recommended during the warm weather period from May 1 to August 31. This recommendation is driven by the average velocity criteria. This creek is very small and steep and has limited physical habitat, so it is important to protect a flow rate that provides usable habitat in riffles when fish are completing critical life history functions during the warm weather months.

0.35 cubic feet per second is recommended during the fall period, from September 1 to October 31. This recommendation is driven by limited water availability. This flow rate meets two of three instream flow criteria.

0.24 cfs is recommended during the winter period from November 1 through March 31. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist. The original BLM recommendation of 0.25 cfs was modified due to water availability issues.

0.35 cfs is recommended during the early portion of the snowmelt runoff period, from the April 1 to April 30. This flow rate meets two of three instream flow criteria, but reflects the fact that snowmelt runoff is not yet sufficient during April to meet all three instream flow criteria.

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 Balm of Gilead Creek is 3.72 square miles, with an average elevation of 9,940 ft and average annual precipitation of 14.93 inches. There are no known surface water diversions within the basin tributary to the proposed ISF. There are also no reservoirs or transbasin import or exports. Hydrology in this drainage basin represents 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 or in nearby drainages that would be representative of streamflow in this reach. In some cases, diversion records can be used to provide an indication of water availability in a stream reach. Balm of Gilead Ditch (1876 appropriation date, 1.1 cfs) was located near the lower terminus. However, while the diversion record provides some information about streamflow, it is not a perfect measure of streamflow because years in which water is available but not taken may be recorded as zero. Balm of Gilead Ditch has just five years with measured diversions and was transferred to the City of Aurora in 1983.

CWCB staff made four streamflow measurements on the proposed reach of Balm of Gilead Creek on 9/25/2015. Due to difficult measurement conditions, the measurements were averaged for inclusion in the water availability analysis.

Data Analysis
The small number of recorded diversions makes use of this record problematic. Most use occurred at different times, for example all in May, or all in June, such that any given day had at most 3 measurements. There are recorded diversions of up to 13 cfs (1980) and two separate years show 5 cfs diversions, but most years are zero or have no data. This record provides supporting evidence, but is too incomplete to use for water availability analyses.

StreamStats provides an estimate of mean-monthly streamflow. It should be noted that average annual precipitation for Balm of Gilead Creek is 14.93 inches, which is below the StreamStats model's suggested precipitation of 18 inches. Therefore, the model results are extrapolations, but remain the best available estimate of streamflow on Balm of Gilead 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 Balm of Gilead 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.

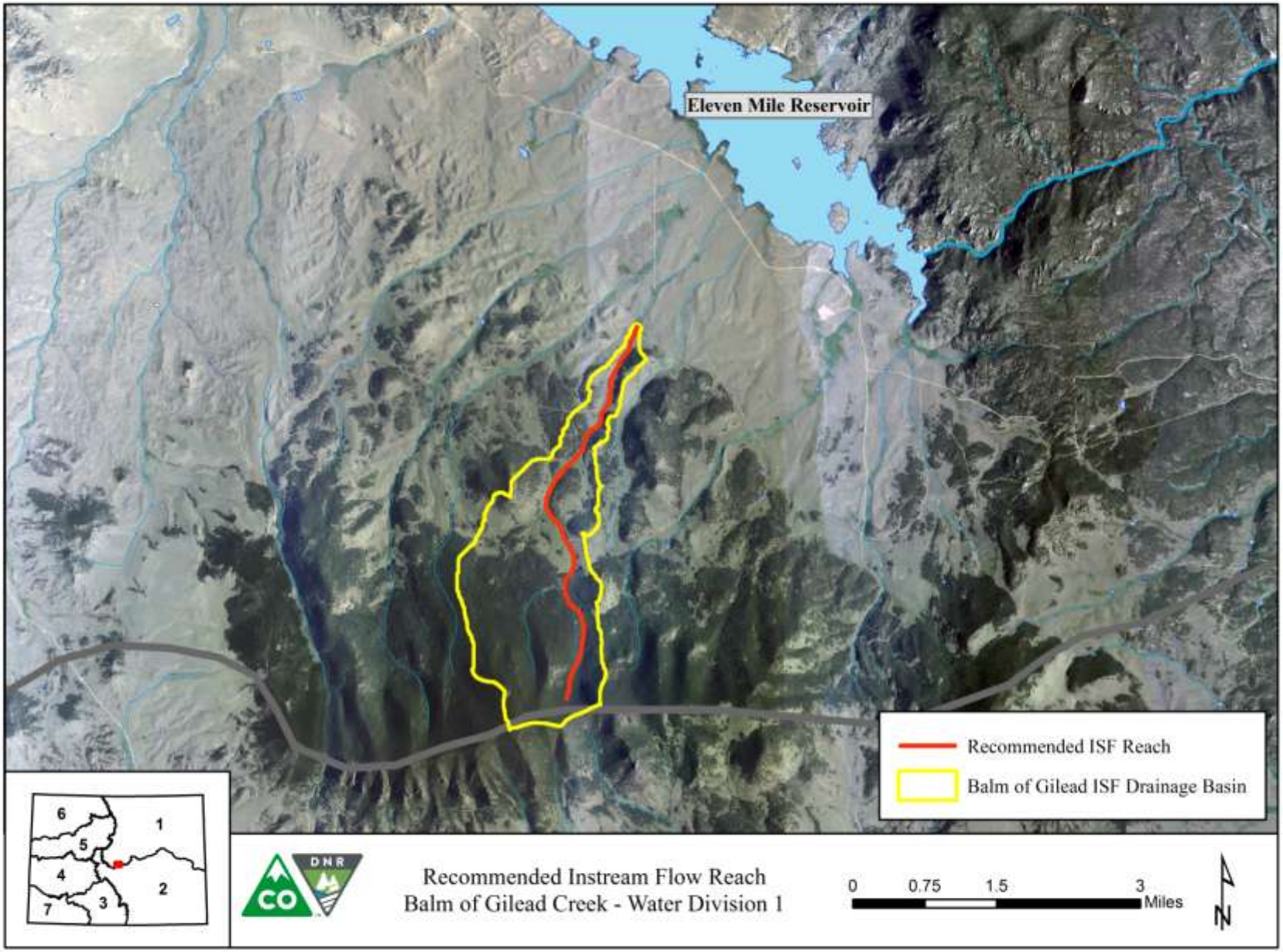
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

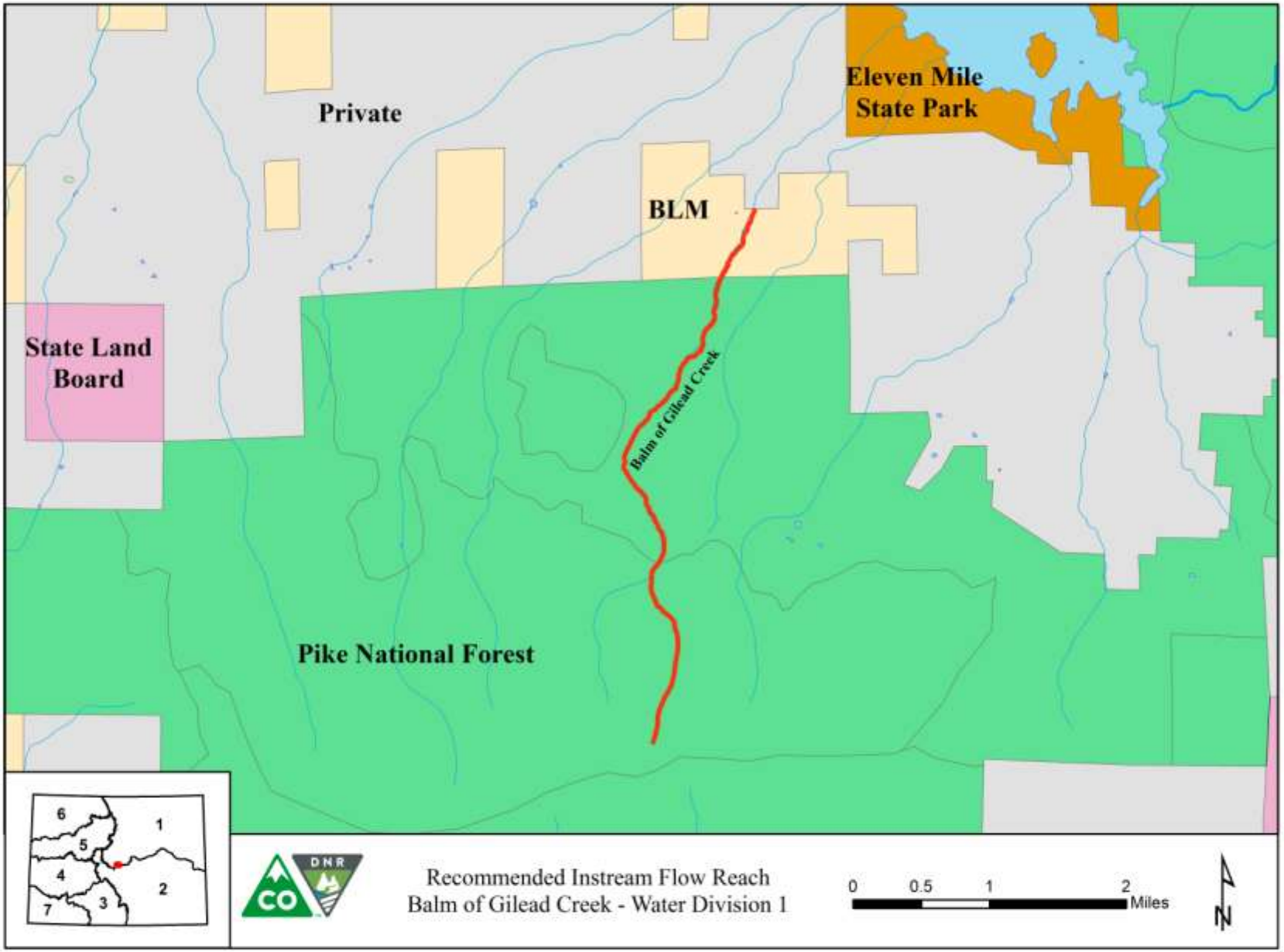
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

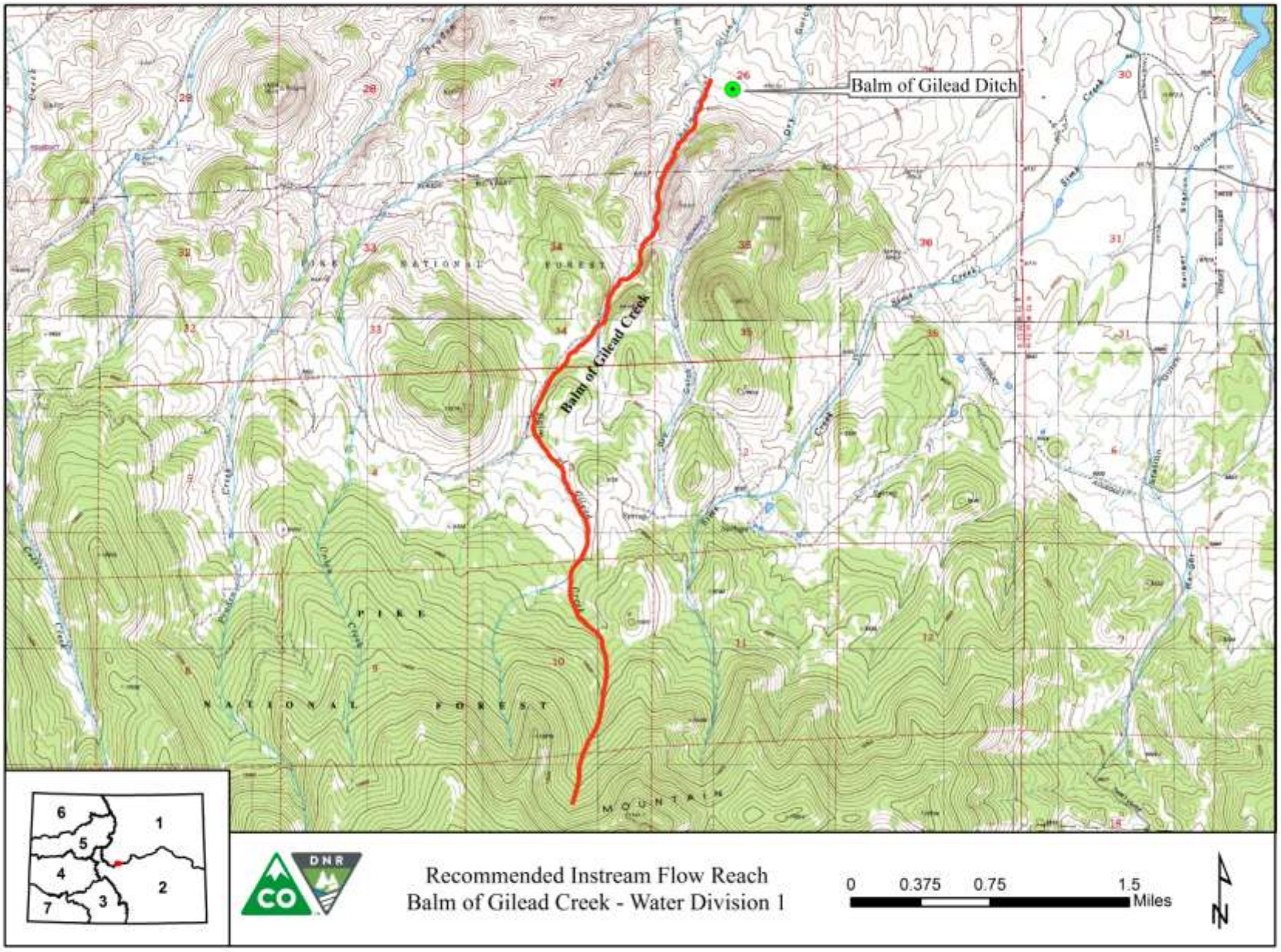
VICINITY MAP



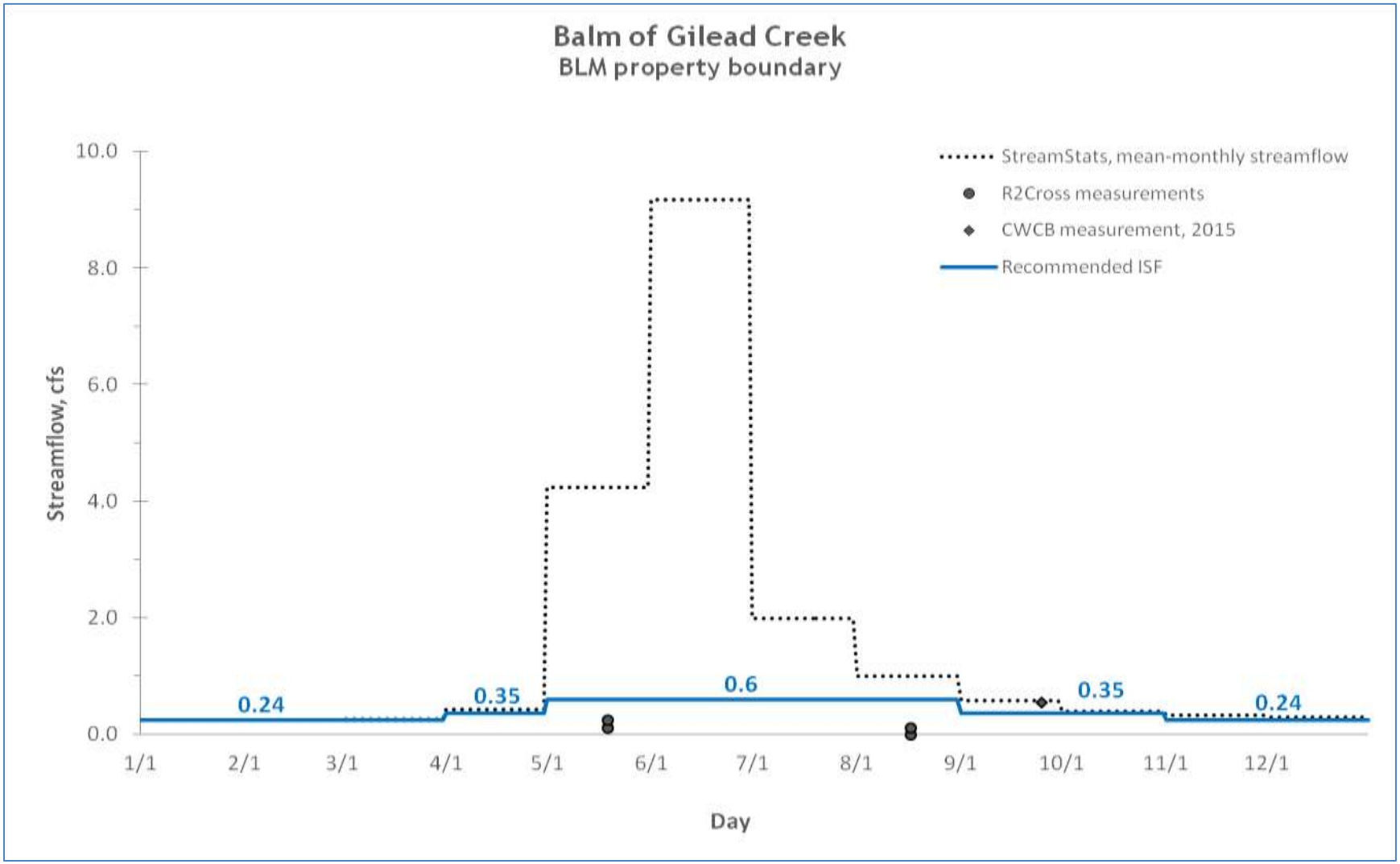
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

Boxelder Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence of South and North Branches of Boxelder Creek UTM North: 4533562.13 UTM East: 482402.33
LOWER TERMINUS:	Confluence with an unnamed tributary UTM North: 4529230.45 UTM East: 485243.56
WATER DIVISION:	1
WATER DISTRICT:	3
COUNTY:	Larimer County
WATERSHED:	Cache la Poudre (HUC#: 10190007)
CWCB ID:	15/1/A-005
RECOMMENDER:	Larimer County Department of Natural Resources & Colorado Parks and Wildlife
LENGTH:	4.72 miles
FLOW RECOMMENDATION:	1.3 cfs (7/1 – 5/15) 5.0 cfs (5/16 – 6/30)

Boxelder 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.

The Larimer County Department of Natural Resources (Larimer County) and Colorado Parks and Wildlife (CPW) recommended that the CWCB appropriate an ISF water right on a reach of Boxelder Creek. This reach is located within Larimer County about 16 miles northwest of the town of Wellington (See Vicinity Map). Boxelder Creek originates where the North Branch and South Branch of Boxelder Creek join together at an elevation of 6,600 feet. The creek flows in a southeasterly direction as it drops to an elevation of 5,000 feet where it joins the Cache la Poudre River. The proposed reach extends from the confluence of the North and South Branches of Boxelder Creeks downstream to the confluence with an unnamed tributary. Seventy-six percent of the land on the 4.72 mile proposed reach is owned by Larimer County (See Land Ownership Map). Larimer County and CPW recommended this reach of Boxelder 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.

Over and understory vegetation on large portions of Boxelder Creek include the following species: Narrowleaf cottonwood (*Populus angustifolia*) is the dominant riparian tree forming a canopy over diverse shrub species, including rocky mountain maple (*Acer glabrum*), wild plum *(Prunus americana)*, sandbar willow (*Salix exigua*), plains cottonwood (*Populus deltoides*), chokecherry (*Prunus virginiana*), bluestem willow (*Salix irrorata*), skunkbush, snowberry (*Symphoricarpos oreophilus*) and cottonwood (*Populus acuminata*). The herbaceous understory in the riparian areas includes Kentucky bluegrass, needle-and-thread, western wheatgrass, lupine (*Lupinus argenteus*), sticky geranium (*Geranium caespitosum*), water sedge (*Carex aquatilus*), field horsetail (*Equisetum arvense*), poison ivy (*Toxicodendron rydbergii*) and field mint (*Mentha arvensis*). Boxelder Creek supports a rare narrowleaf cottonwood/bluestem willow (*Populus angustifolia*/*Salix irrorata*) community.

Boxelder Creek was sampled by CPW for fish composition. Fish species collected were mixed age class, small brook trout with evidence of recruitment and reproduction. The water quality and temperature and native aquatic insect assemblage in Boxelder Creek are very good and have the potential to support introduction of the native state and federally threatened greenback cutthroat trout (*Oncorhynchus clarki stomias)*.

In March 2007 and again in 2012, an aquatic insect survey was completed by Colorado State University (Boris Kondratieff, and others) on Boxelder Creek with excellent results showing that the assemblage of native aquatic insects is intact. During the sampling, over 128 total macroinvertebrate taxa were identified from both qualitative samples and quantitative benthic samples. Species recorded include stoneflies such as the rare snowfly (*Capnura wanica*), mayfly (*Baetis magnus)*, Gunnison snowfly (*Utacapnia poda*), Angulate snowfly (*Paracapnia angulata*), blue-winged olive (*Baetis tricaudatus*), stoneflies (*Sweltsa* sp.), Oregon forestfly (*Zapada oregonensis*)) and alderflies (*Sialis* sp.).

Table 1. List of fish species identified in the vicinity of Boxelder Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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 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 winter flow of 1.3 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 Boxelder Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW & CWCB	3/26/2014	5.16	2.1 – 12.9	1.3	7.2*
CPW & CWCB	7/10/2014	2.88	1.2 – 7.2	Out of range	Out of range
			Mean	**1.3**	**7.2**

**7.2 cfs is within the accuracy range of the model; this rate provides 44% percent of the wetted perimeter and meets the other two habitat criteria.*

ISF Recommendation
The CPW recommends flows of 1.3 cfs (7/1 – 5/15) and 7.2 cfs (5/16 – 6/30) based on R2Cross modeling analyses and biological expertise. The CPW recommendation was modified by staff during the high flow period as a result of water availability.

5.0 cubic feet per second is recommended during the warm weather period from May 16 to June 30. This recommendation is driven by limited water availability.

1.3 cubic feet per second is recommended during the base flow period, from July 1 to May 15.

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 Boxelder Creek is 25 square miles, with average elevation of 7,120 ft and average annual precipitation of 18.14 inches. Two diversion structures are located within the proposed ISF, but there are no diversion records. Approximately 5.4 square miles of the drainage basin is located in Wyoming, which represents approximately 23% of the total basin. Staff identified 14 reservoirs with a total of 15.6 AF in storage capacity and eight surface water diversions with a total of 1.51 cfs in decreed diversions in the portion of the drainage basin located in Wyoming. No large scale diversions were apparent based on review of 2013 National Agricultural Imagery Program aerial photography and 2014/2015 Google Earth imagery.

Available Data

There are no current or historic streamflow gages on Boxelder Creek or any nearby creeks that are likely to be representative. In some cases, diversion records can be used to provide an indication of water availability in a stream reach. The Martin Calloway Ditch (appropriation date 1868, 15.22 cfs) is located approximately 0.9 to 1.25 miles downstream from the proposed lower terminus. The records for this ditch for many years contain the water commissioner comment, “Water taken, but no data available” (1973 through 1980 and 1982 through 1987). Only 1977 provides any daily records, with a maximum daily diversion rate of 1 cfs recorded in that year and a total of 115 AF in diversions. The lack of daily diversion records limits the use of this structure for water availability analysis.

Due to limited available data, CWCB staff installed a temporary streamflow gage on Boxelder Creek at the mouth of the canyon 3/4 mile northeast of Table Mountain. This location has a 16.7 square mile drainage basin, 7,320 ft average basin elevation, and 18.49 average basin annual precipitation. The pressure transducer was installed on 9/4/2014 and is still operating. The pressure transducer recorded water depth every 15 minutes, which was converted to streamflow using a rating curve developed by staff. The 15 minute interval data collected by CWCB staff was used to calculate daily average streamflow values.

CWCB staff made 9 streamflow measurements on the proposed reach of Boxelder Creek between 9/4/2014 and 12/7/2015. These measurements are included in the water availability analysis. In addition, Charles Gindler, resource specialist for the Larimer County Natural Resources Department, estimated that, based upon his observations, streamflow is typically between 1 and 3 cfs on a consistent basis but can be as high as 5 cfs at times. He also stated that streamflow can be significantly higher during rain events.

Data Analysis
Staff used the daily streamflow data from the CWCB temporary gage on Boxelder Creek as is and did not scale the data to the proposed lower terminus, which is located downstream from the measurement location. Median streamflow and 95% confidence interval for median streamflow were not calculated due to the short period of record.

Due to the short period of record for the temporary Boxelder Creek gage, Staff examined nearby climate stations to evaluate the available record. The nearest climate station with a long period of record is located in Cheyenne, Wyoming, roughly 24 miles northeast from the lower terminus (Cheyenne, USW00024018, and accessed 12/7/2015). This station has nearly 100 years of precipitation records (1915 to 2015). The average annual precipitation at the Cheyenne station for years with complete records (1915 to 2014) is 15.24 inches. In 2014, the climate station recorded 17.88 inches of precipitation, which was somewhat above average. During the time the gage operated in 2014 (September through December), precipitation was similar to the average fall precipitation in the climate record. In 2015, the climate record was not complete at the time of analysis and did not contain precipitation values after July. However, 2015 tied 1995 for the highest monthly precipitation recorded in the month of May, and the magnitude and duration of the peak were likely unusually high and long.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show the scaled Boxelder Creek temporary gage data and all measurements on Boxelder Creek. The majority of streamflow measurements are above or near the proposed ISF of 1.30 cfs. The available data and observations made by Charles Gindler form a basis for staff to conclude that the proposed ISF rates are available.

Material Injury
Because the proposed ISF on Boxelder 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.

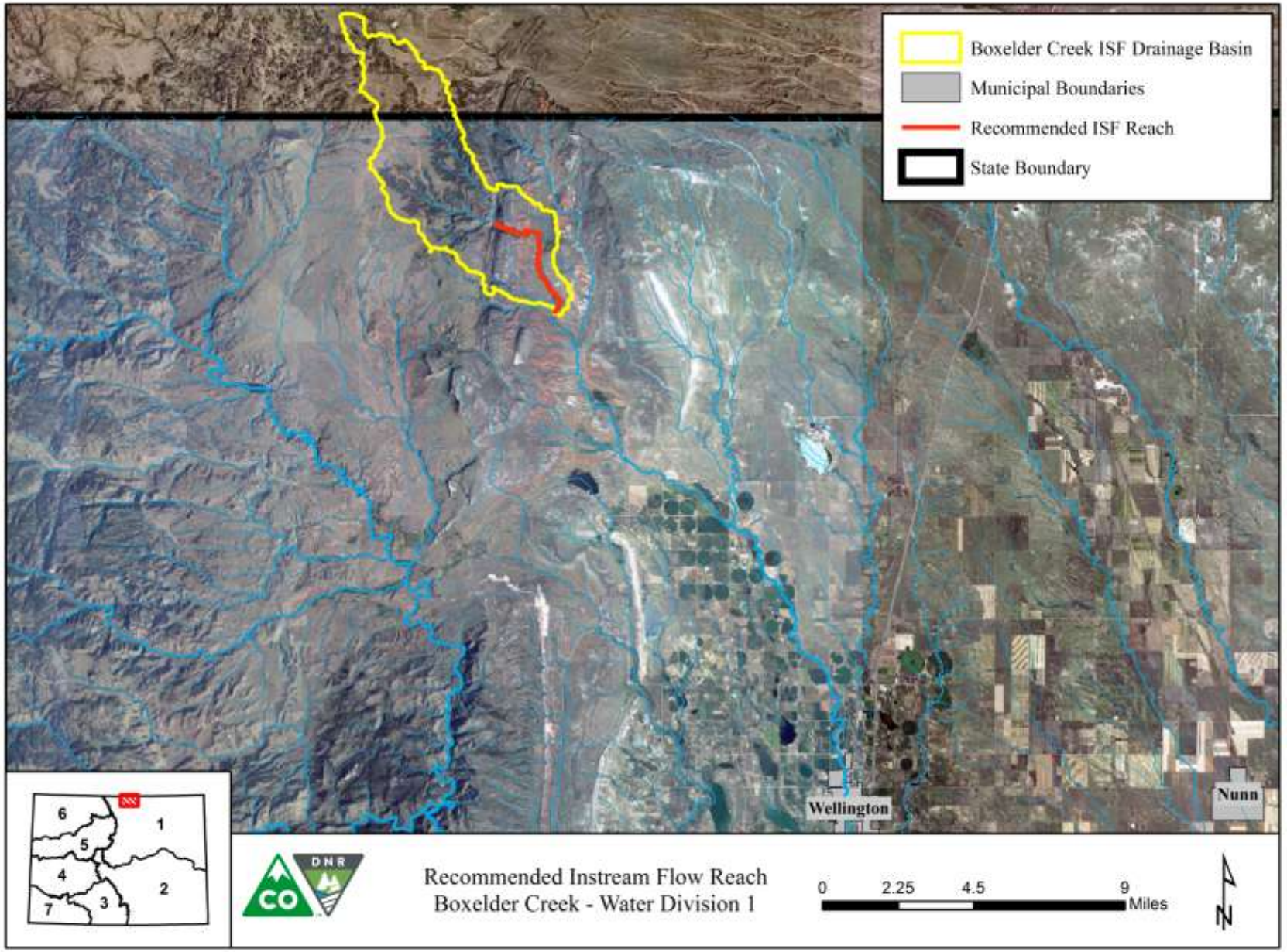
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

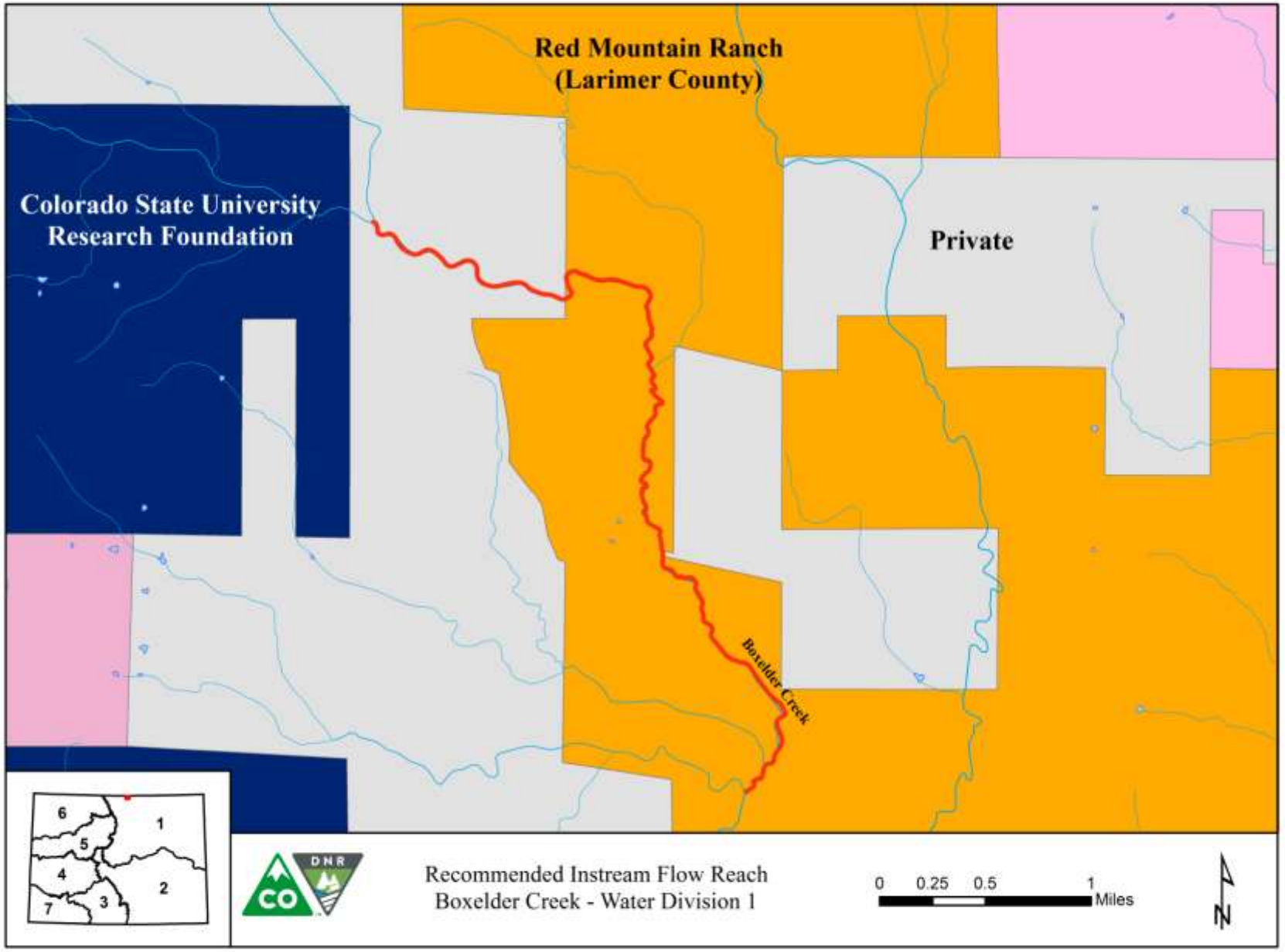
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

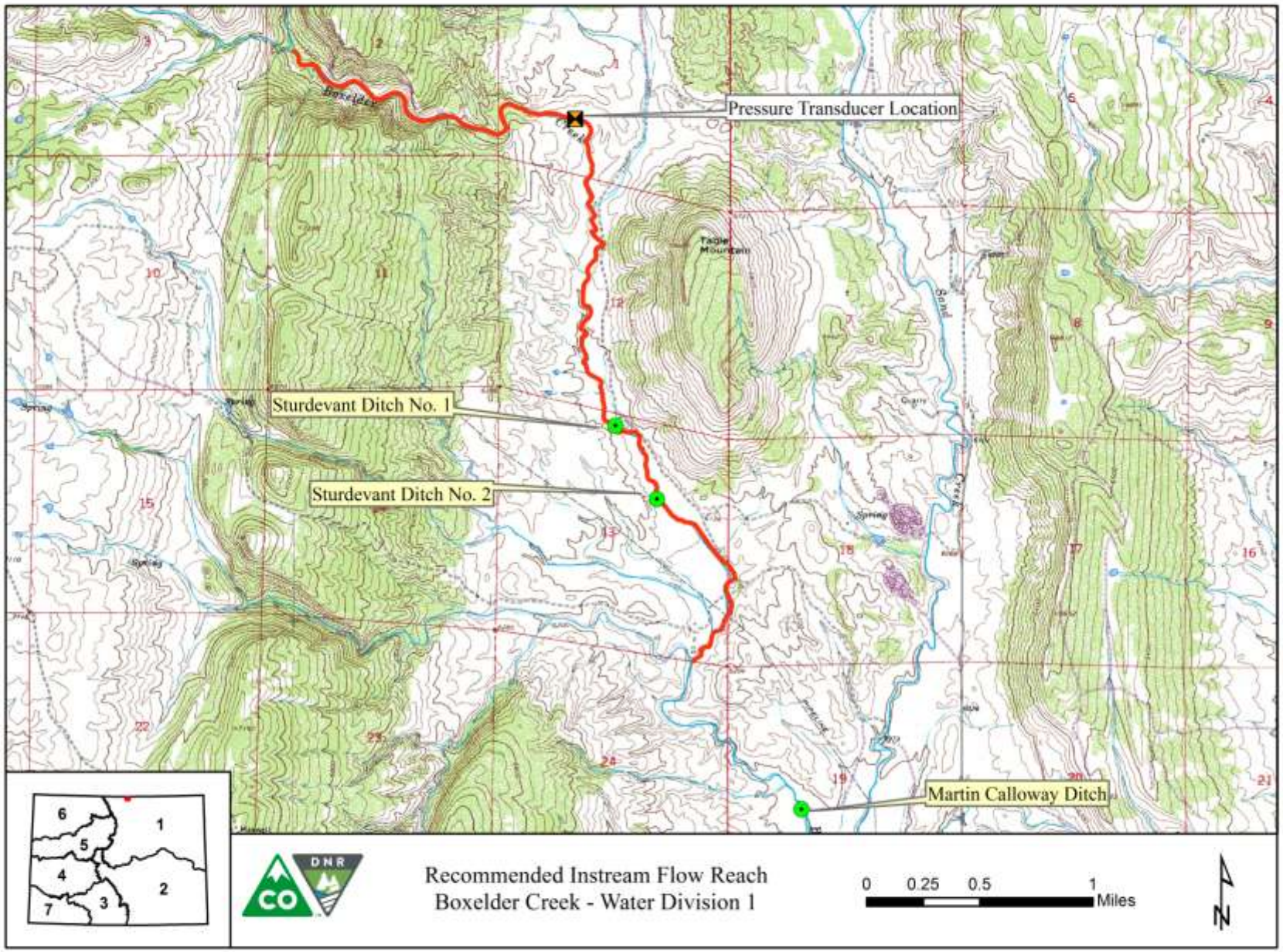
VICINITY MAP



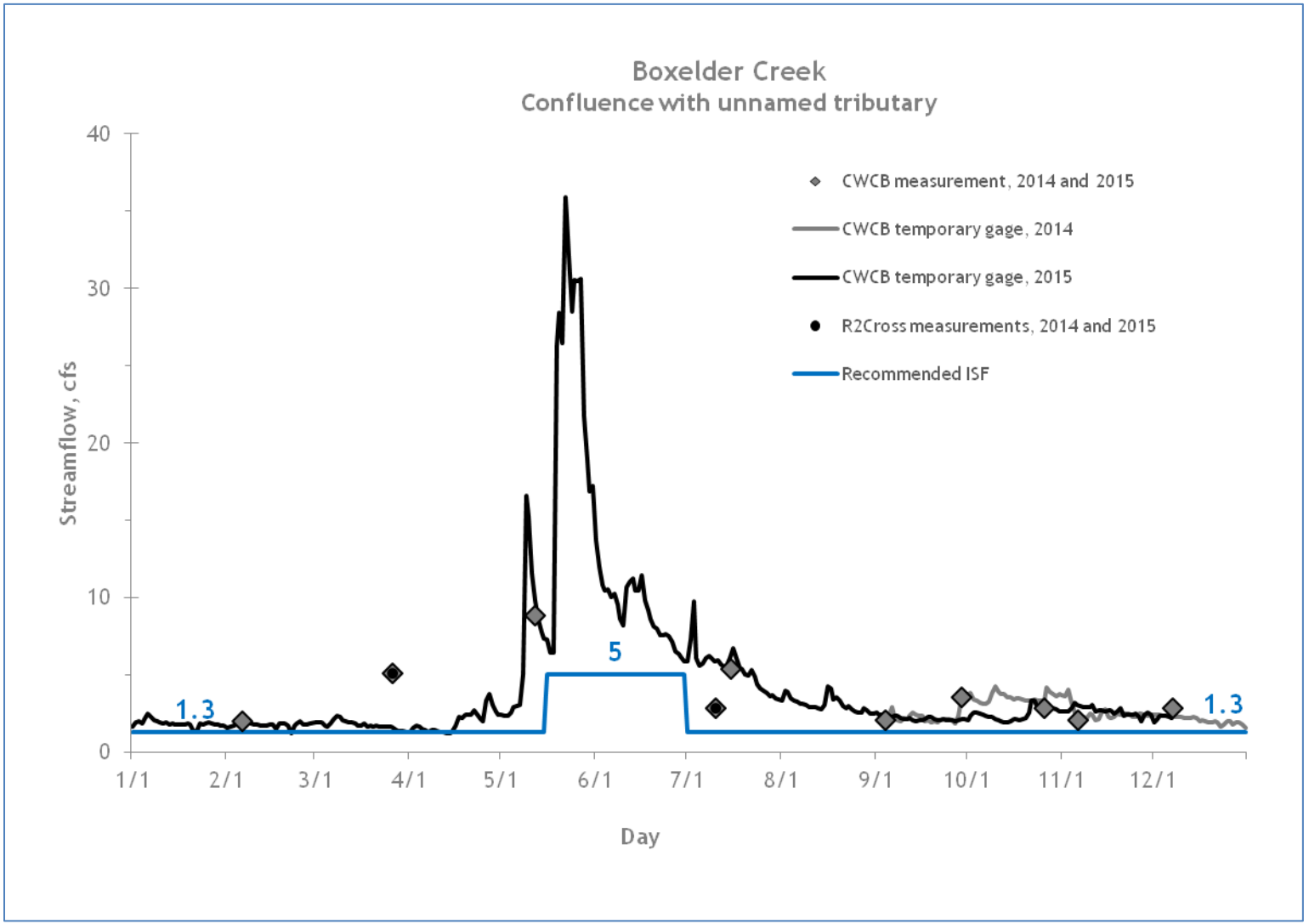
LAND OWNERSHIP MAP



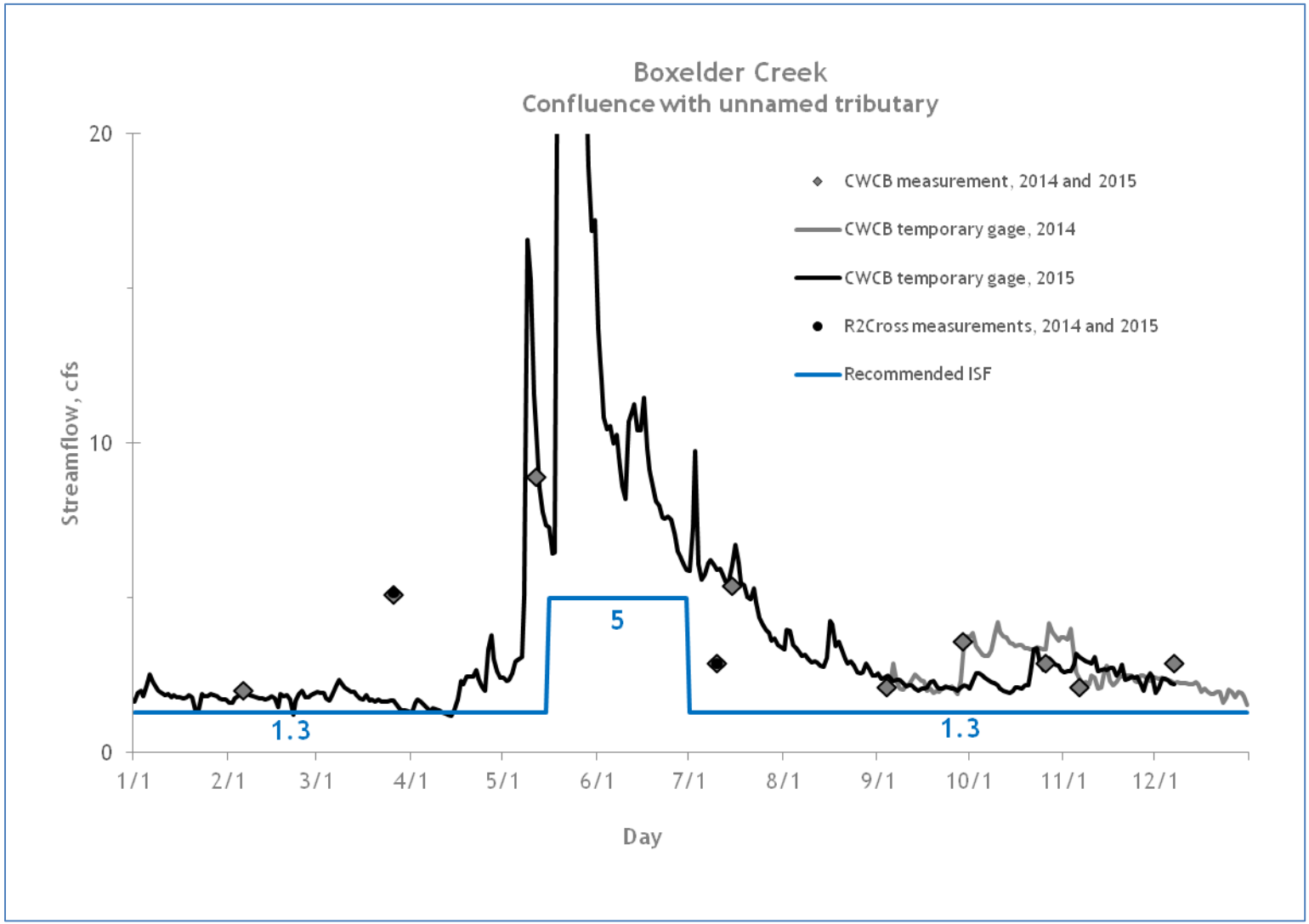
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Lone Tree Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence Spotwood Creek UTM North: 4536307.01 UTM East: 506761.06
LOWER TERMINUS:	Meadow Springs Ranch Property Boundary UTM North: 4534028.44 UTM East: 506135.59
WATER DIVISION:	1
WATER DISTRICT:	1
COUNTY:	Weld County
WATERSHED:	Lone Tree - Owl (HUC#: 10190008)
CWCB ID:	13/1/A-005
RECOMMENDER:	City of Fort Collins & Colorado Parks and Wildlife
LENGTH:	2.17 miles
FLOW RECOMMENDATION:	0.3 cfs (1/1 – 12/31)

Lone Tree 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.

The City of Fort Collins and Colorado Parks and Wildlife (CPW) recommended that the CWCB appropriate an ISF water right on a reach of Lone Tree Creek. This reach is located within Weld County about 16.5 miles northeast of the town of Wellington (See Vicinity Map). Lone Tree Creek originates in Wyoming near the Town of Buford at an elevation of 8,400 ft. The creek flows in a southeasterly direction as it drops to an elevation of 4,600 feet where it joins the South Platte River. The proposed reach extends from the confluence with Spotwood Creek downstream to the Meadow Springs Ranch property boundary. One hundred percent of the land on the 2.17 mile proposed reach is privately owned (See Land Ownership Map). The City of Fort Collins and CPW recommended this reach of Lone Tree 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.

In May 2010, Colorado State University (Nate Cathcart, and William Stacy) performed a fish inventory of Lone Tree Creek. Six species of fish were captured in the electrofishing survey, including brook stickleback (*Culaea inconstans*), white sucker (*Catostomus commersonii*), fathead minnow (*Pimephales promelas*), creek chub (*Semotilus atromaculatus*), central stoneroller (*Campostoma anomalum*), and Iowa darter (*Etheostoma exile*). The respective percentages of each species captured are: fathead minnow (59%), brook stickleback (25%), creek chub (10%), Iowa darter (3%), central stoneroller (2%), and white sucker (1%).

Further, Lone Tree Creek is being studied and investigated as a possible reintroduction site for northern redbelly dace and/or common shiner. Its stable hydrology and temperature regime and its relative isolation make it particularly suitable for active native fishery management activities. Lone Tree Creek also has a diverse community of macro-invertebrates and a productive riparian zone. Due to the relative rarity of water features such as this on the high prairie, it is reasonable to assume that this stream is important to both terrestrial wildlife and avian species.

Table 1. List of fish species identified in Lone Tree Creek.

Species Name	Scientific Name	Status
brook stickleback	*Culaea inconstans*	None
white sucker	*Catostomus commersonii*	None
fathead minnow	*Pimephales promela*	None
creek chub	*Semotilus atromaculatus*	None
central stoneroller	*Campostoma anomalum*	None
Iowa darter	*Etheostoma exile*	State Species of Special Concern

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 one transect for this proposed ISF reach (Table 2). The R2Cross model results in a winter flow of 0.30 cfs, which meets 2 of 3 criteria and is within the accuracy range of the R2Cross model. The summer flow was out of the accuracy range of the model.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW	6/11/2014 - 1	0.21	0.1 – 0.5	0.30	Out of range

ISF Recommendation
CPW recommends flows of 0.3 cfs (1/1 – 12/31) based on R2Cross modeling analyses, biological expertise and staff's water availability analysis. This flow rate meets the criteria for wetted perimeter and average depth in the R2Cross model.

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 hydrology estimate 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 Lone Tree Creek is 134 square miles, with an average elevation of 7,040 ft and average annual precipitation of 17.10 inches. There are two known surface water diversions within the proposed ISF reach. These include the Mantey Ditch 1 (appropriation date

1882, 26 cfs) and the Mantey Ditch 2 (appropriation date 1882, 10 cfs). These structures are listed as active, but there are no daily diversion records available. Approximately 127.5 square miles or 95% of the drainage basin for the proposed reach is located in Wyoming. There are approximately 32 reservoirs with a total of 5,866 AF in storage capacity and approximately 124 surface water rights with diversion rates between zero and 100 cfs (many of these water rights do not state a diversion rate in the Wyoming e-permit database) in the Wyoming portion of the drainage. Based on discussions with DWR and the Wyoming State Engineer's office, there are no known transbasin imports or exports. Hydrology in this drainage basin represents altered flow conditions. See the Hydrologic Features Map for more information.

Available Data

There are no current or historic streamflow gages in the proposed ISF reach. There was a historic gage operated downstream (USGS 06753400 Lone Tree Creek at Carr, CO, 4/1/1993 to 9/30/1995), located approximately 5.1 miles southeast from the proposed lower terminus. The Lone Tree gage is located in a 169 square mile drainage basin, with an average basin elevation of 6,830 ft and average annual precipitation of 16.8 inches. In addition to the diversions located within the proposed reach, the gage may have been affected by intervening decreed diversions. These include two absolute rights that total 0.0138 cfs and two conditional water rights that total 115.77 cfs (the conditional rights have some diversion records that show limited use). None of the intervening diversion structures identified appear to have daily diversion records.

In some cases, diversion records can be used to provide an indication of water availability in a stream reach. The Mantley Ditch 1 has records of annual diversion totals in 1956, 1976, 1987, 1997, 2001, 2005, and 2010. Many years in the record contain the water commissioner comment, "No information available;" however, some years contain the comment, "Water taken, but no data available" (1996, 2001, and 2003). In addition, several years in the record contain the comment, "No water available" (2000, 2002, 2004, 2006, 2008, and 2011). This ditch is located approximately mid-way through the reach, upstream from measurements made by CWCB staff. The lack of daily diversion records limits the use of these diversions to estimate streamflow.

CWCB staff made substantial efforts to measure streamflow on Lone Tree Creek. Initially, staff installed a temporary gage consisting of a modified 3 inch Parshall flume and pressure transducer near the bottom third of the reach. This gage was active from 5/30/2012 to 6/8/2012, when a high flow event dislodged the flume. The temporary gage was reinstalled on 6/18/2012 and collected flow data until 7/7/2012, when another high flow event occurred. Unfortunately, a period of high flows in spring and early summer of 2015 precluded installation of a temporary gage that would accurately capture normal base flow conditions. Staff installed a staff plate and time-lapse camera that was used to estimate streamflow from 7/14/2015 to 8/17/2015. When flows receded, a temporary gage consisting of a 90 degree sharp crested v-notch weir and pressure transducer was installed 8/17/2015 and operated until 9/20/2015, when cows damaged the site. The weir was reset on 9/28/2015 and is still in place to date.

CWCB staff made 7 streamflow measurements on the proposed reach of Lone Tree Creek between 6/1/2014 and 10/26/2015. These measurements are included in the water availability analysis.

In addition, staff obtained anecdotal information from Daylan Figgs, the Natural Areas Senior Environmental Planner for the City of Fort Collins Natural Areas Department. According to Mr. Figgs, "Lone Tree Creek appears to have a consistent flow and recent measurements of streamflow verify this observation. Site visits to the Lone Tree over the last 5-7 years have revealed an active stream flow in each occasion and what appears to be a fairly consistent flow. Higher flows do occur during

the spring and in response to storm events. Further, I have not observed periods of no or extremely low flows."

Data Analysis
Due to the short period of record available for the Lone Tree gage, Staff examined nearby climate stations to evaluate how representative the gage data may be. The nearest climate station with a long period of record is located in Cheyenne, Wyoming, roughly 14.5 miles north of the lower terminus (Cheyenne, USW00024018; accessed 12/7/2015). This station has nearly 100 years of precipitation records (1915 to 2015). The average annual precipitation at the Cheyenne station for years with complete records (1915 to 2014) is 15.24 inches. The climate station shows above average precipitation in 1993 and 1995 (18.96 and 20.11 inches respectively), but below average precipitation in 1994 (13.53 inches). Therefore, the Lone Tree gage represents a combination of above and below average precipitation conditions.

The Lone Tree Creek gage was analyzed using the period of record (1993 to 1995). The gage record was scaled by 0.80706 to the lower terminus using the area-precipitation method. Due to the short period of record, median streamflow and 95% confidence intervals for median streamflow were not calculated.

All CWCB staff-installed weir, staff plate, and flume data is shown on the hydrograph. In addition, spot measurements between 5/13/2015 and 7/14/2015 were interpolated to estimate streamflow during the spring and early summer.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show scaled streamflow data from the Lone Tree Creek gage and streamflow measured by CWCB staff. The majority of streamflow measurements are above or near the proposed ISF of 0.3 cfs. However, there is substantial variability in the measurements.

The available streamflow measurements occurred during a relatively unusual period of precipitation conditions. The Cheyenne climate station shows that 2012 had one of the lowest annual precipitation totals on record, with just 5 out of 101 years lower. Conversely, 2015 tied 1995 for the highest monthly precipitation ever recorded in the month of May. Despite this range of precipitation conditions, the measured data on Lone Tree Creek is generally between 0.1 and 1.25 cfs. This data and the observations made by Daylan Figgs form a basis for staff to conclude that 0.3 cfs is typically available year-round.

Material Injury
Because the proposed ISF on Lone Tree 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.

Cathcart, N.C. and Stacy, W.L., 2010, Lone Tree Creek Fish Inventory. Colorado State University Student Subunit of the American Fisheries Society.

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

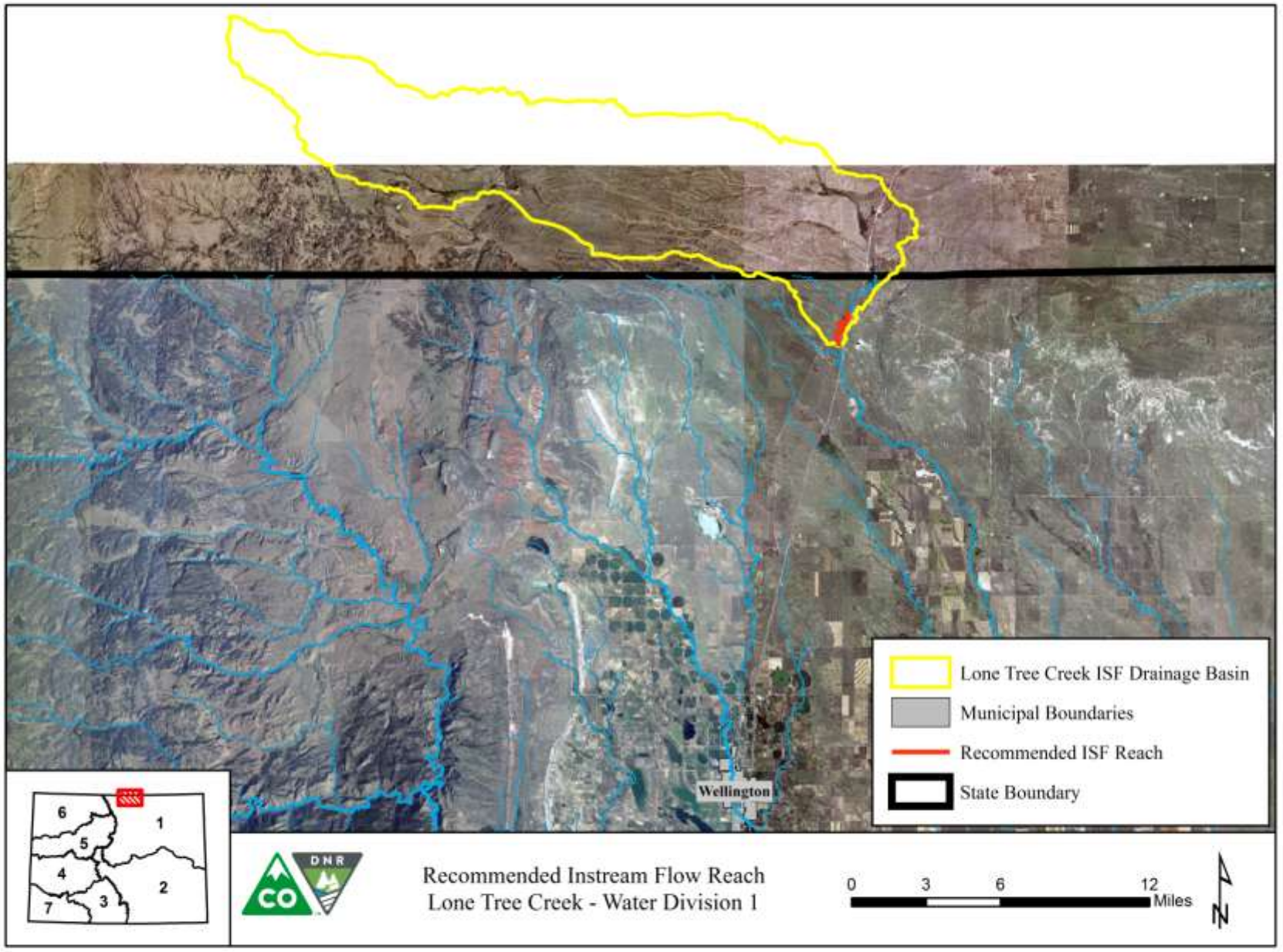
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

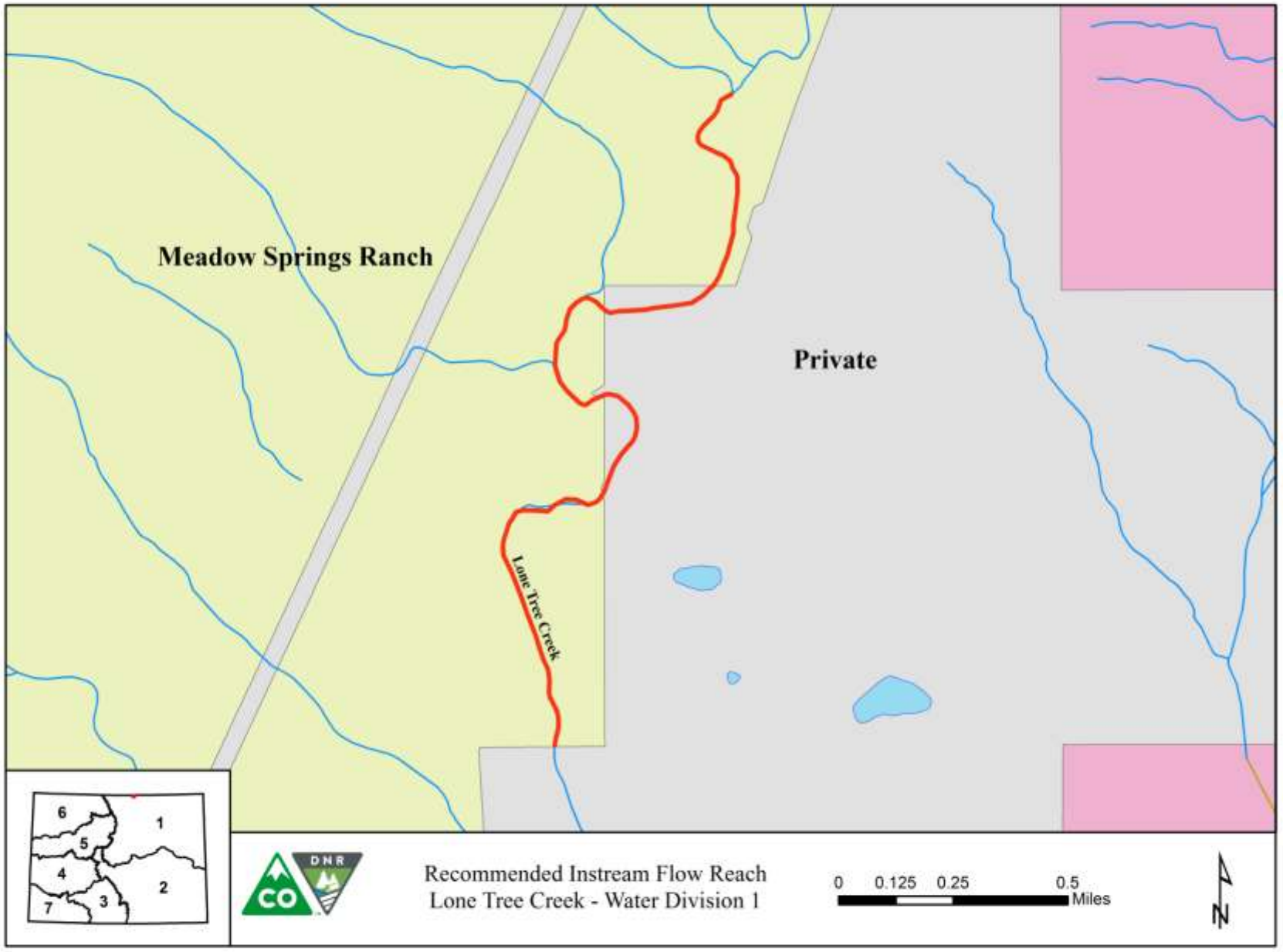
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

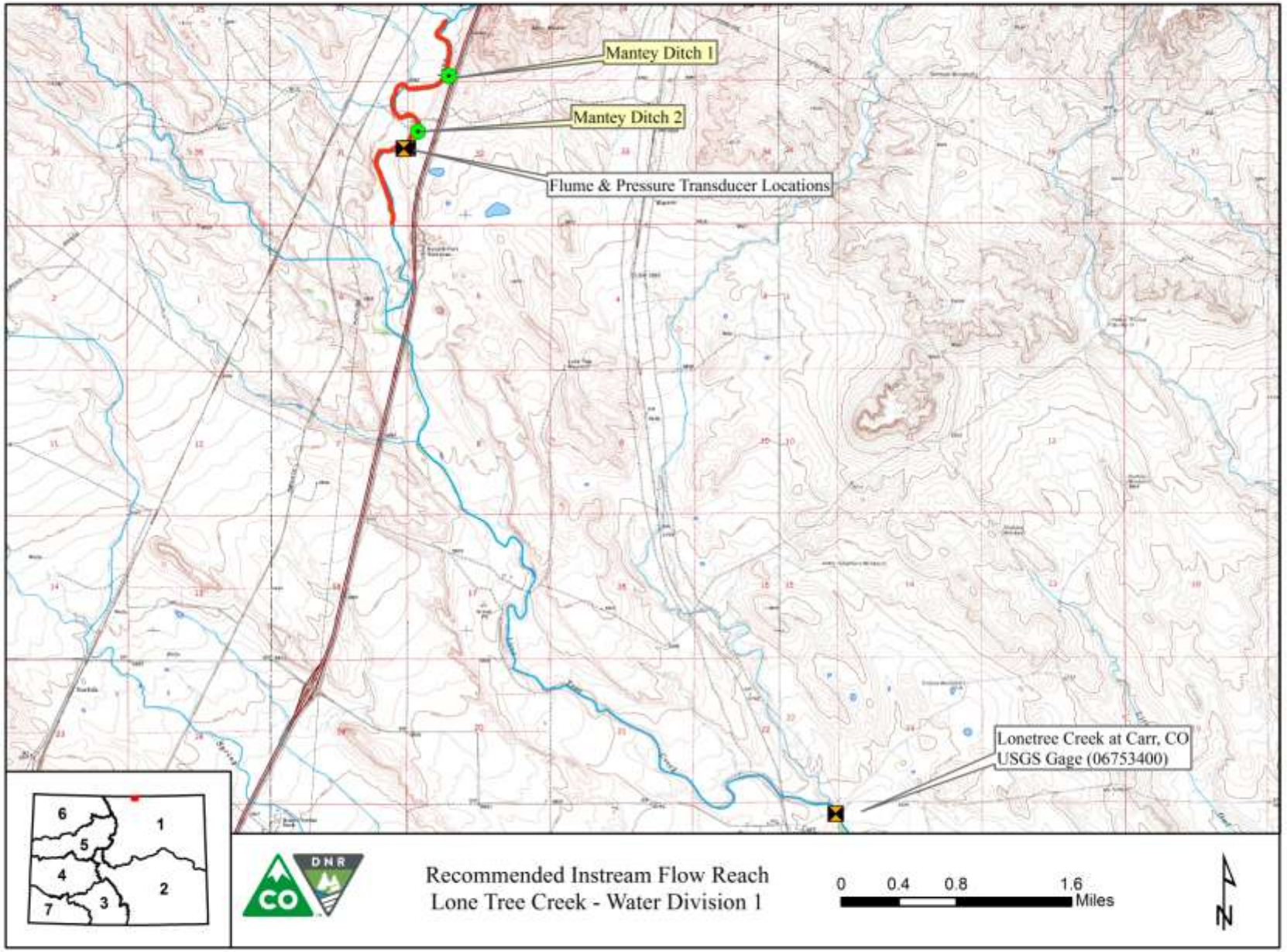
VICINITY MAP



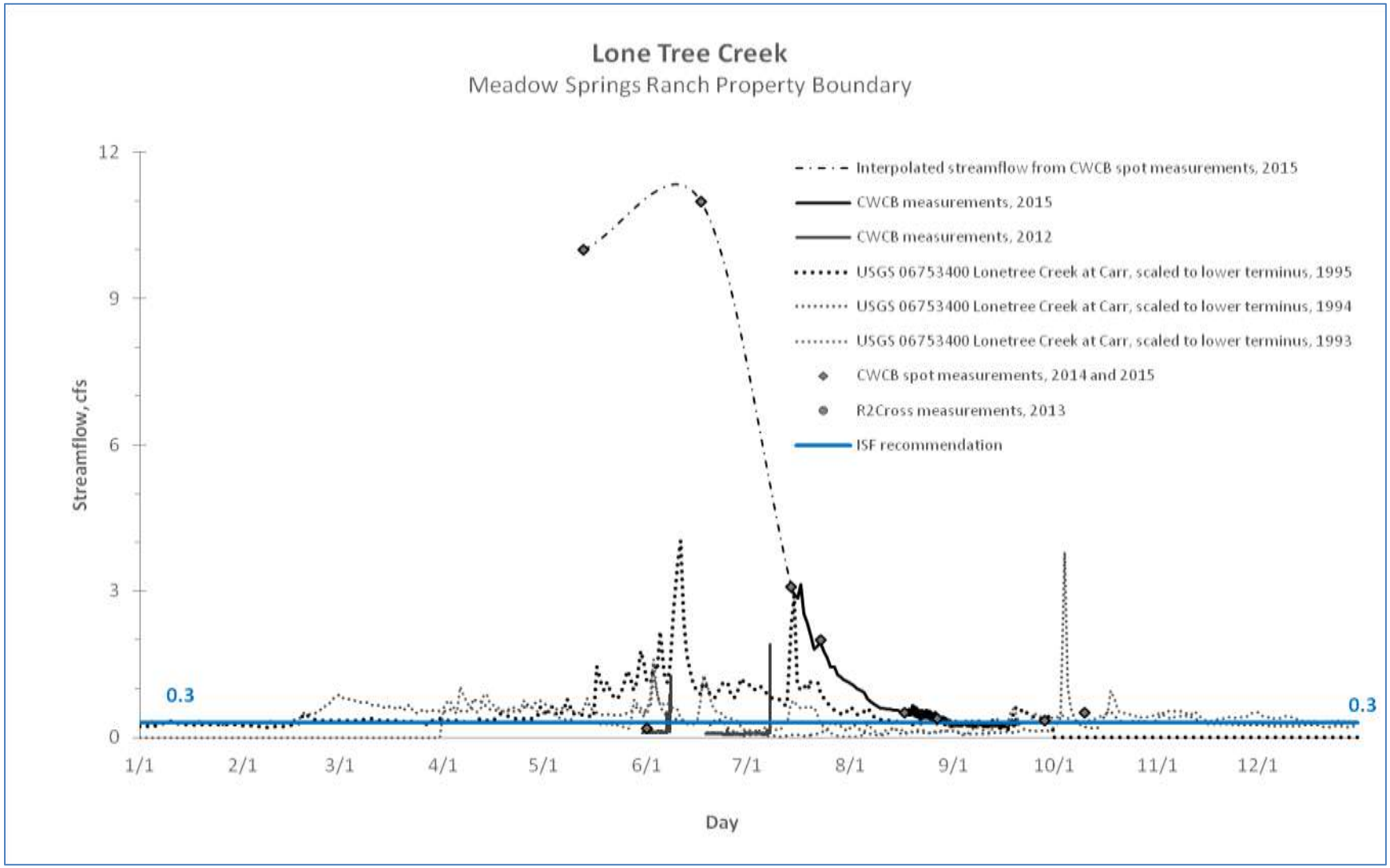
LAND OWNERSHIP MAP



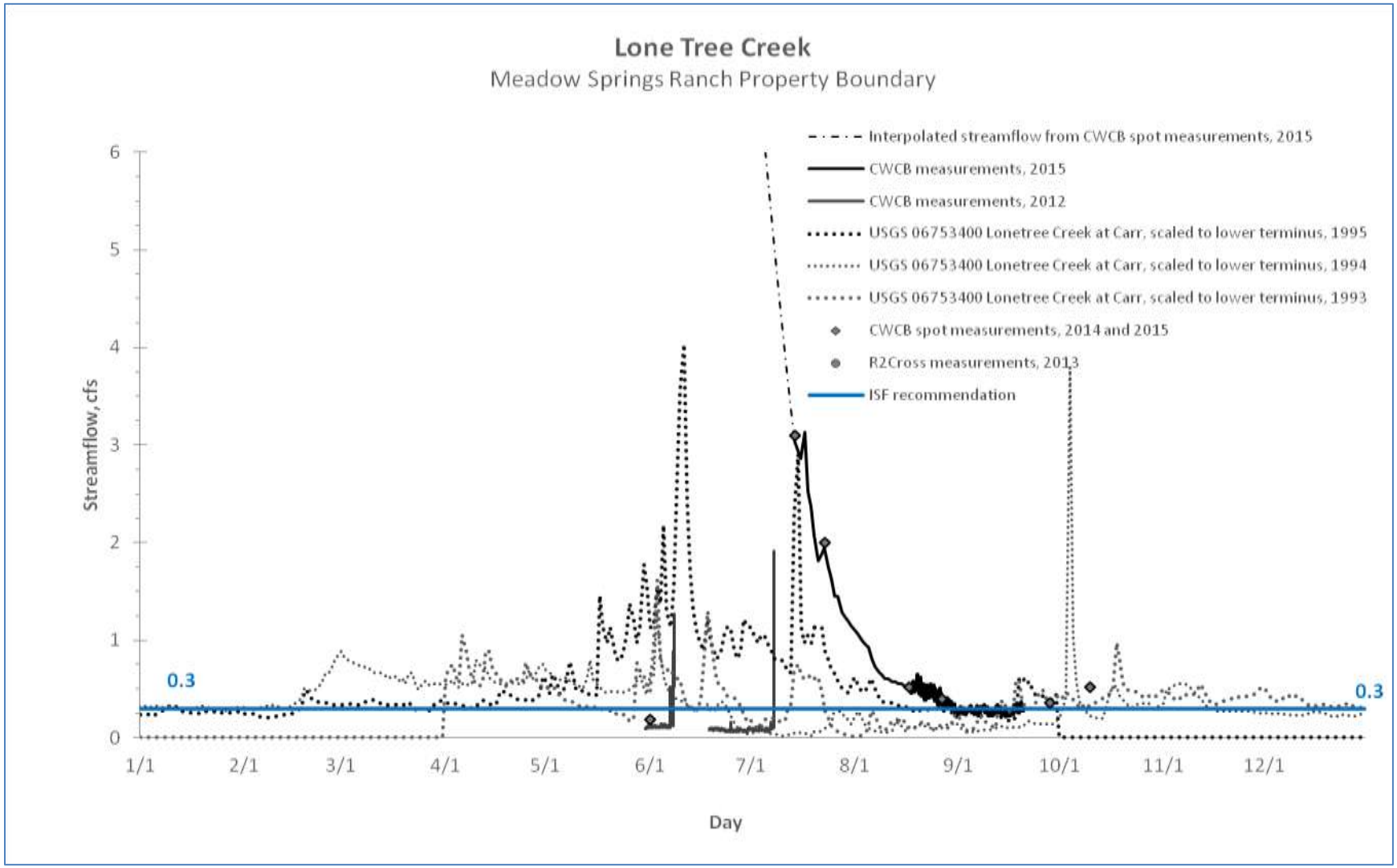
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Pruden Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	United States Forest Service Property Boundary UTM North: 4304180.54 UTM East: 450509.93
LOWER TERMINUS:	Bureau of Land Management Property Boundary UTM North: 4304707.52 UTM East: 450972.97
WATER DIVISION:	1
WATER DISTRICT:	23
COUNTY:	Park County
WATERSHED:	South Platte Headwaters (HUC#: 10190001)
CWCB ID:	16/1/A-001
RECOMMENDER:	Bureau of Land Management
LENGTH:	0.49 miles
FLOW RECOMMENDATION:	0.24 cfs (11/1 – 3/31) 0.40 cfs (4/1 – 4/31) 1.00 cfs (5/1 – 8/31) 0.40 cfs (9/1 – 10/31)

Pruden 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Pruden Creek. This reach is located within Park County (See Vicinity Map). Pruden Creek originates on the north flank of Thirtynine Mile Mountain at an elevation of 10,900 ft approximately eight miles south of Elevenmile Canyon Reservoir. The creek flows in a northerly direction as it drops to an elevation of 8,600 feet where it joins the Elevenmile Canyon Reservoir. The proposed reach extends from the United States Forest Service (USFS) property boundary downstream to BLM property boundary. One hundred percent of the land on the 0.49 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of Pruden 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.

Pruden Creek is a cold-water, high gradient stream. The reach flows through a shallow, rolling valley approximately one-fourth mile in width. The stream is confined by bedrock in some locations and travels through alluvium in other locations. The stream generally has medium-sized substrate, ranging from gravels to small boulders. The stream has a good mix of pools, small riffles, and runs.

Fisheries surveys have revealed a self-sustaining population of brook 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 various willow species, alder, river birch, and potentilla. The riparian community is in fair to good condition. The structure of the riparian community provides only limited shading and cover for fish habitat.

Table 1. List of fish species identified in Pruden Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

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 (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). 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 three 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 1.1 cfs, and a winter flow of 0.51 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 Pruden Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	8/17/2009 - 1	0.27	0.11 – 0.68	0.70	Out of range
BLM	8/17/2009 - 2	0.24	0.10 – 0.60	0.27	Out of range
BLM	5/19/2014 - 1	0.45	0.18 – 1.13	0.55	1.1 *
			Mean	**0.51**	**1.1**

**The flow that meets all three instream flow criteria - 1.16 cfs - is outside of the confidence interval for this data set. 1.1 cfs is within the confidence interval and provides 47% wetted perimeter and meets the instream flow criteria for average depth and average velocity.*

ISF Recommendation

The BLM recommends flows of 0.27 cfs (11/1 – 3/31), 0.40 cfs (4/1 – 4/31), 1.10 cfs (5/1 – 8/31), and 0.40 cfs (9/1 – 10/31) based on R2Cross modeling analyses and biological expertise. However, the ISF rates were adjusted to 0.24 cfs for (11/1 – 3/31) and to 1.0 cfs for (5/1 - 8/31) based on staff's water availability analysis

1.0 cubic feet per second is recommended during the warm weather period from May 1 to August 31. This recommendation is driven by the wetted perimeter criteria. This creek is very small and steep and has limited physical habitat, so it is important to protect a flow rate that provides usable habitat in riffles when fish are completing critical life history functions during the warm weather months.

0.4 cubic feet per second is recommended during the fall period, from September 1 to October 31. This recommendation is driven by limited water availability. This flow rate meets two of three instream flow criteria in some, but not all, of the surveyed cross sections.

0.24 cfs is recommended during the winter period from November 1 through March 31. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

0.4 cfs is recommended during the early portion of the snowmelt runoff period, from the April 1 to April 30. This flow rate meets two of three instream flow criteria in some, but not all, of the surveyed cross sections , but reflects the fact that snowmelt runoff is not yet sufficient during April to meet all three instream flow criteria.

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 Pruden Creek is 3.68 square miles, with an average elevation of 10,100 ft. and average annual precipitation of 15.32 inches. There are no known surface water diversions within the basin tributary to the proposed ISF. There are also no reservoirs or transbasin import or exports. Hydrology in this drainage basin represents natural flow conditions. See the Hydrologic Features Map.

Available Data
There are no current or historic streamflow gages in the vicinity of the proposed ISF reach or in nearby drainages that would be representative of streamflow in this reach. In some cases, diversion records can be used to provide an indication of water availability in a stream reach; however, there are no known surface diversions.

CWCB staff made one streamflow measurement on the proposed reach of Pruden Creek. This measurement is included in the water availability analysis.

Data Analysis
StreamStats provides an estimate of mean-monthly streamflow. It should be noted that average annual precipitation for Pruden Creek is 15.32 inches, which is below the StreamStats Model's suggested precipitation of 18 inches. Therefore, the model results are extrapolations, but remain the best available estimate of streamflow on Pruden 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 Pruden 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.

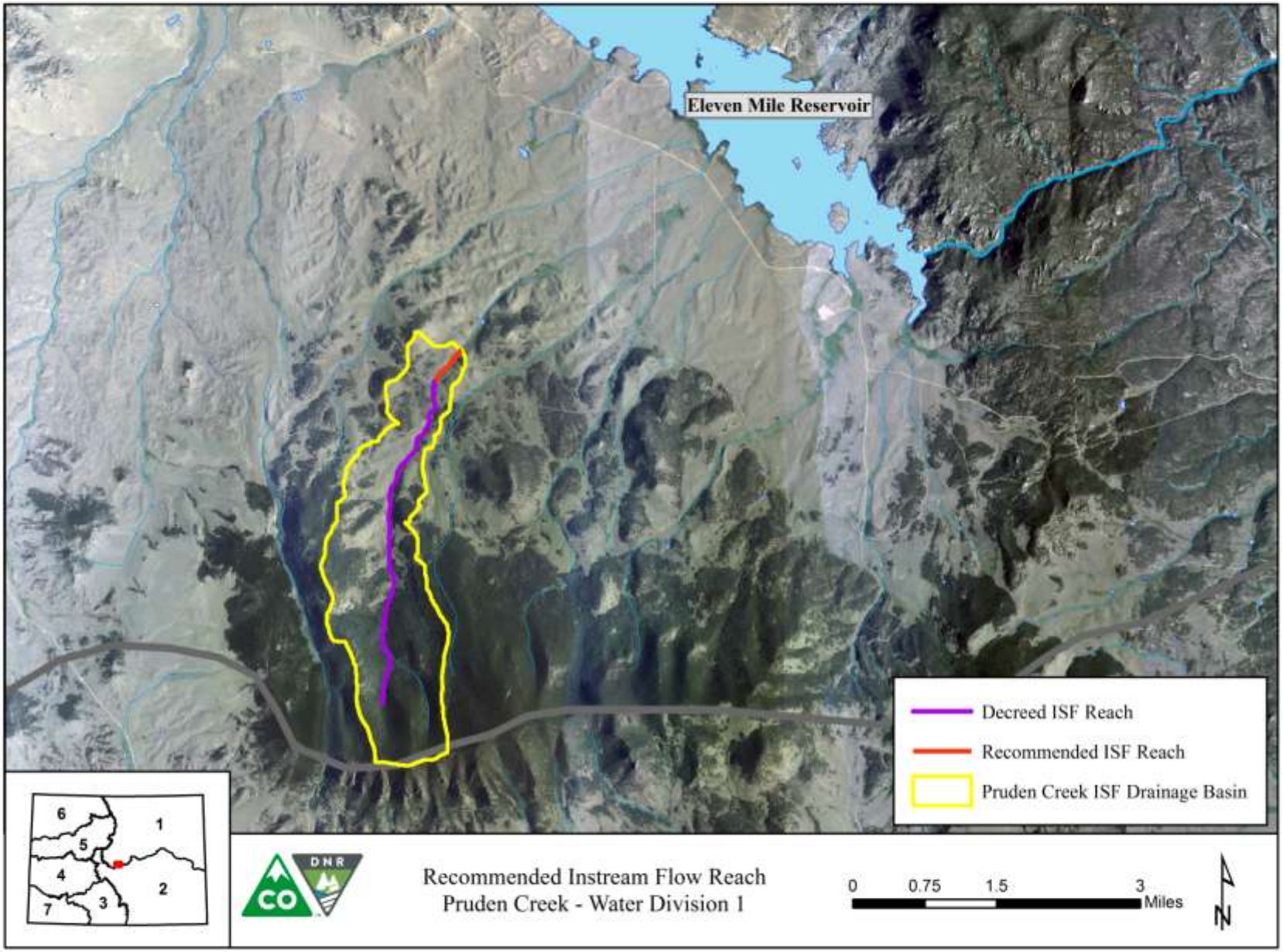
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

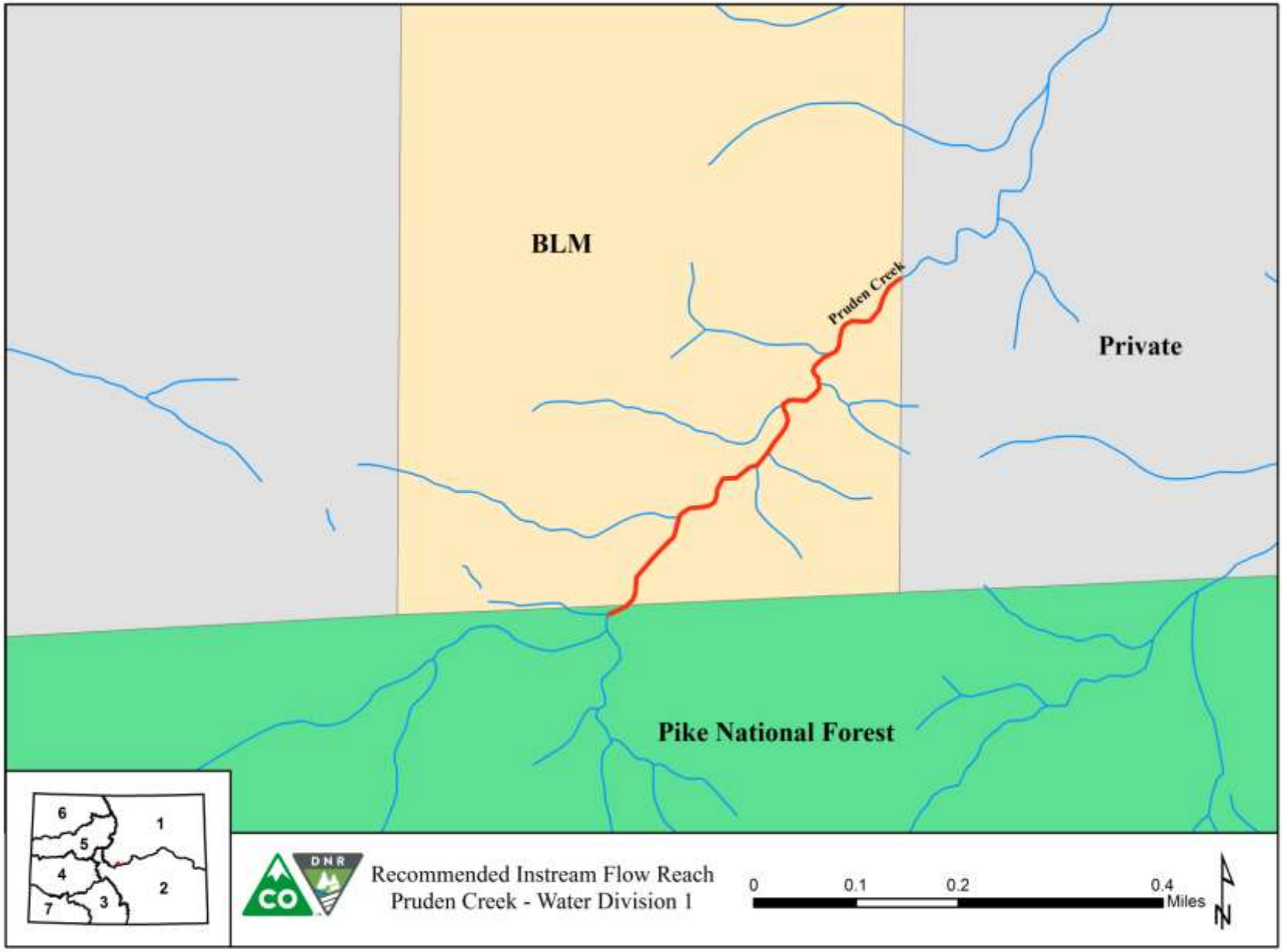
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

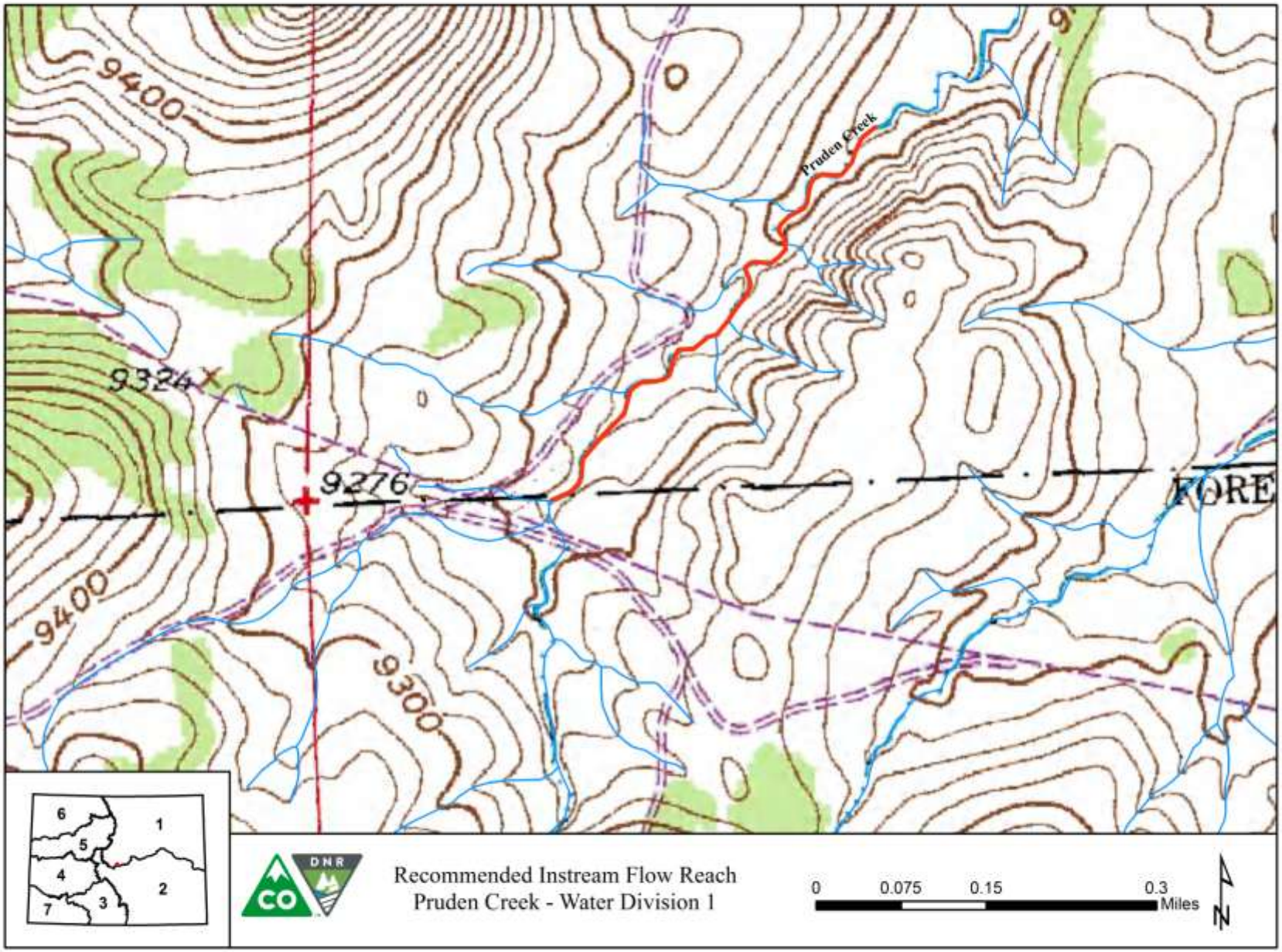
VICINITY MAP



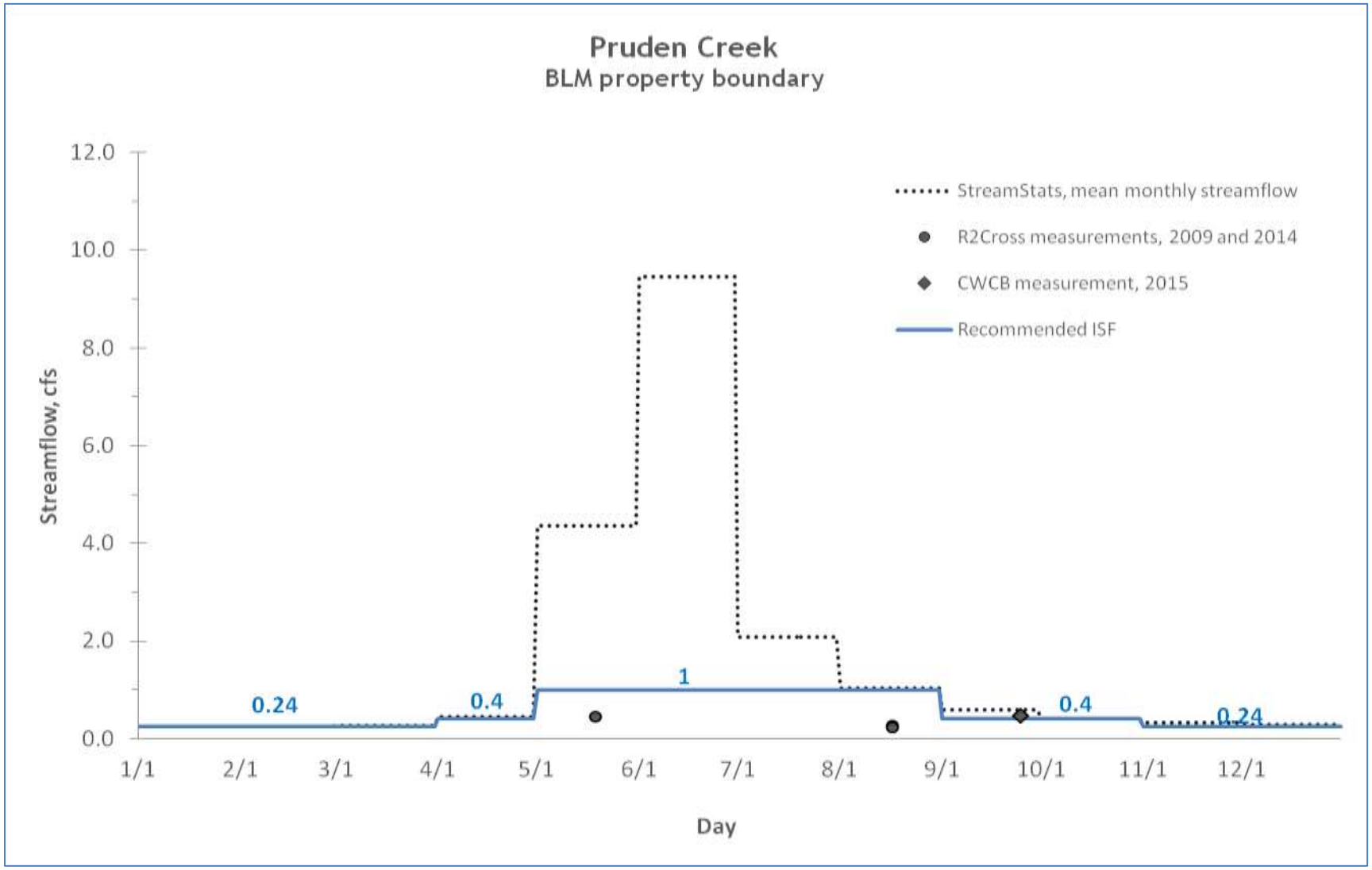
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

Sand Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Colorado - Wyoming Stateline UTM North: 4538599.90 UTM East: 482303.65
LOWER TERMINUS:	confluence with an unnamed tributary UTM North: 4531763.76 UTM East: 486977.39
WATER DIVISION:	1
WATER DISTRICT:	3
COUNTY:	Larimer County
WATERSHED:	Cache la Poudre(HUC#: 10190007)
CWCB ID:	15/1/A-003
RECOMMENDER:	Larimer County Department of Natural Resources & Colorado Parks and Wildlife
LENGTH:	6.59 miles
FLOW RECOMMENDATION:	1.5 cfs (7/1-5/15) 5.5 cfs (5/16-6/30)

Sand 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.

The Larimer County Department of Natural Resources (Larimer County) and Colorado Parks and Wildlife (CPW) recommended that the CWCB appropriate an ISF water right on a reach of Sand Creek. This reach is located within Larimer County about 16 miles northwest of the town of Wellington (See Vicinity Map). Sand Creek originates in Wyoming near the Town of Buford at an elevation of 8,400 ft. The creek flows in a southeasterly direction as it drops to an elevation of 4,600 feet where it joins the South Platte River. The proposed reach extends from the Colorado – Wyoming border downstream to the confluence with an unnamed tributary. Eighty-two percent of the land on the 6.59 mile proposed reach is owned and managed by Larimer County (See Land Ownership Map). Larimer County and CPW recommended this reach of Sand 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.

Over and understory vegetation on large portions of Sand Creek include the following species. Narrowleaf cottonwood (*Populus angustifolia*) is the dominant riparian tree forming a canopy over diverse shrub species including rocky mountain maple (*Acer glabrum*), wild plum *(Prunus americana)*, sandbar willow (*Salix exigua*), plains cottonwood (*Populus deltoides*), chokecherry (*Prunus virginiana*), bluestem willow (*Salix irrorata*), skunkbush, snowberry (*Symphoricarpos oreophilus*) and cottonwood (*Populus acuminata*). The herbaceous understory in the riparian areas includes Kentucky bluegrass, needle-and-thread, western wheatgrass, lupine (*Lupinus argenteus*), sticky geranium (*Geranium caespitosum*), water sedge (*Carex aquatilus*), field horsetail (*Equisetum arvense*), poison ivy (*Toxicodendron rydbergii*) and field mint (*Mentha arvensis*). Haygood Canyon supports a rare narrowleaf cottonwood/chokecherry (*Populus angustifolia/Prunus virginiana*) community.

Sand Creek was sampled by CPW for fish composition. Fish species captured were mixed age class, small brook trout (*Salvelinus fontinalis)* with evidence of recruitment and reproduction. The water quality and temperature and native aquatic insect assemblage in Sand Creek are very good and have

the potential to support introduction of the native state and federally threatened greenback cutthroat trout (*Oncorhynchus clarki stomias)*.

In March 2007 and again in 2012, an aquatic insect survey was completed by Colorado State University (Boris Kondratieff, and others) on Sand Creek with excellent results showing that the assemblage of native aquatic insects is intact. During the sampling, over 128 total macroinvertebrate taxa were identified from both qualitative samples and quantitative benthic samples. Of these, 53 mayfly/stonefly/caddisfly taxa were collected from Sand Creek, a remarkable biodiversity and number for any known Front Range stream. Species recorded include stoneflies such as the rare snowfly (*Capnura wanica*), Gunnison snowfly (*Utacapnia poda*), Angulate snowfly (*Paracapnia angulata*), blue-winged olive (*Baetis tricaudatus*), stoneflies (*Sweltsa* sp.), Oregon forestfly (*Zapada oregonensis*) and alderflies (*Sialis* sp.).

Table 1. List of fish species identified in Sand Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
fathead minnow	*Pimephales promela*	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 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 three 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 5.5 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 3.4 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 Sand Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
CPW & CWCB	3/26/2014 – 1	4.99	2.0 – 12.5	3.5	5.5
CPW & CWCB	3/26/2014 – 2	5.07	2.0 – 12.7	Out of Range	Out of Range
CPW & CWCB	7/10/2014	3.50	1.4 – 8.8	3.3	Out of Range
			Mean	**3.4**	**5.5**

ISF Recommendation
The CPW recommends flows of 3.4 cfs (7/1 – 5/15), and 5.5 cfs (5/16 – 6/30) based on R2Cross modeling analyses and biological expertise. The CPW recommendation was modified by staff during the base flow period as a result of water availability.

5.5 cubic feet per second is recommended during the warm weather period from May 16 to June 30.

1.5 cubic feet per second is recommended during the base flow period, from July 1 to May 15. 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 Sand Creek is 20.3 square miles, with an average elevation of 7,070 ft. and average annual precipitation of 17.97 inches. Three diversion structures are located within the proposed reach, but there are no diversion records. Approximately 9.1 square miles of the drainage basin is located in Wyoming, which represents approximately 44% of the total basin. Staff identified 6 reservoirs with a total of 58.4 AF in storage capacity and one surface water diversion of 0.21 cfs in the portion of the drainage located in Wyoming. No large scale diversions were apparent based on review of 2013 National Agricultural Imagery Program aerial photography and 2014/2015 Google Earth imagery.

Available Data

There are no current or historic streamflow gages on Sand Creek or any nearby creeks that are likely to be representative. There also are no diversion records that provide information about stream flow in the proposed reach. Due to limited available data in the area, CWCB staff installed a temporary streamflow gage on Boxelder Creek at the mouth of the canyon 3/4 of a mile northeast of Table Mountain. The temporary gage on Boxelder Creek measured streamflow on the 16.7 square mile drainage basin adjacent to Sand Creek, which has an average elevation of 7,320 ft. and and average annual precipitation of 18.49 inches, similar to the Sand Creek drainage basin. The pressure transducer was installed on 9/4/2014 and is still operating. The pressure transducer records water depth every 15 minutes, which staff converted to streamflow using a rating curve staff developed. This 15-minute interval data was used to calculate daily average streamflow values.

CWCB staff made 11 streamflow measurements on the proposed reach of Sand Creek between 3/26/2014 and 9/29/2015, including 3 measurements used for R2Cross analysis. The measurements on Sand Creek were made at the mouth of Haywood Canyon, approximately in the top third of the proposed reach. These measurements are included in the water availability analysis.

In addition, Charles Gindler, resource specialist for the Larimer County Natural Resources Department, estimated that based on his observations, streamflow is typically between 1 and 2 cfs on a consistent basis, but can be as high as 5 cfs at times. He also stated that streamflow can be significantly higher during rain events.

Data Analysis

Staff compared and used streamflow measurements on Sand Creek and the Boxelder Creek gage data to develop a regression equation relating the flow in Boxelder Creek to Sand Creek. The two data sets showed good correlation (r^2 value was 0.94) when the highest streamflow measurement taken on

5/12/2015 was excluded. The regression equation was used to estimate streamflow on Sand Creek. The data was not scaled to the proposed lower terminus, which is located downstream from the measurement location on Sand Creek. Median streamflow and 95% confidence interval for median streamflow were not calculated due to the short period of record.

Due to the short period of record for the temporary Boxelder Creek gage, Staff examined nearby climate stations to evaluate the available record. The nearest climate station with a long period of record is located in Cheyenne, Wyoming, roughly 23 miles northeast from the lower terminus (Cheyenne, USW00024018; accessed 12/7/2015). This station has nearly 100 years of precipitation records (1915 to 2015). The average annual precipitation at the Cheyenne station for years with complete records (1915 to 2014) is 15.24 inches. In 2014, the climate station recorded 17.88 inches of precipitation, which was somewhat above average. During the time the gage operated in 2014 (September through December), precipitation was similar to the average fall precipitation in the climate record. In 2015, the climate record was not complete at the time of analysis and did not contain precipitation values after July. However, 2015 tied 1995 for the highest monthly precipitation recorded in the month of May and the magnitude and duration of the peak were likely unusually high and long.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show the scaled Boxelder Creek temporary gage data and all measurements on Sand Creek. All streamflow measurements were above or equal to the proposed ISF rates. The available data and observations made by Charles Gindler form a basis for staff to conclude that the proposed ISF rates are available.

Material Injury
Because the proposed ISF on Sand 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.

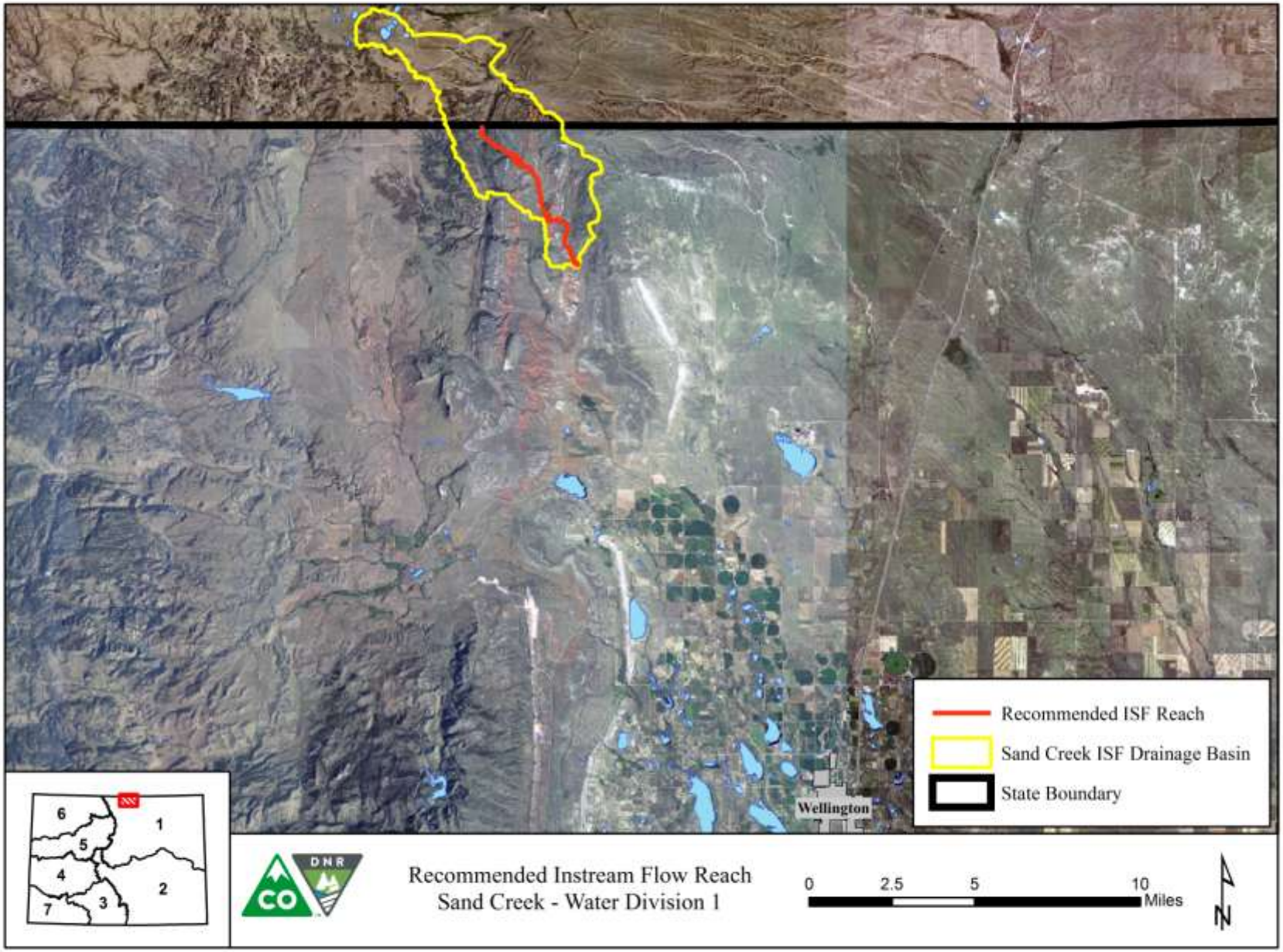
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

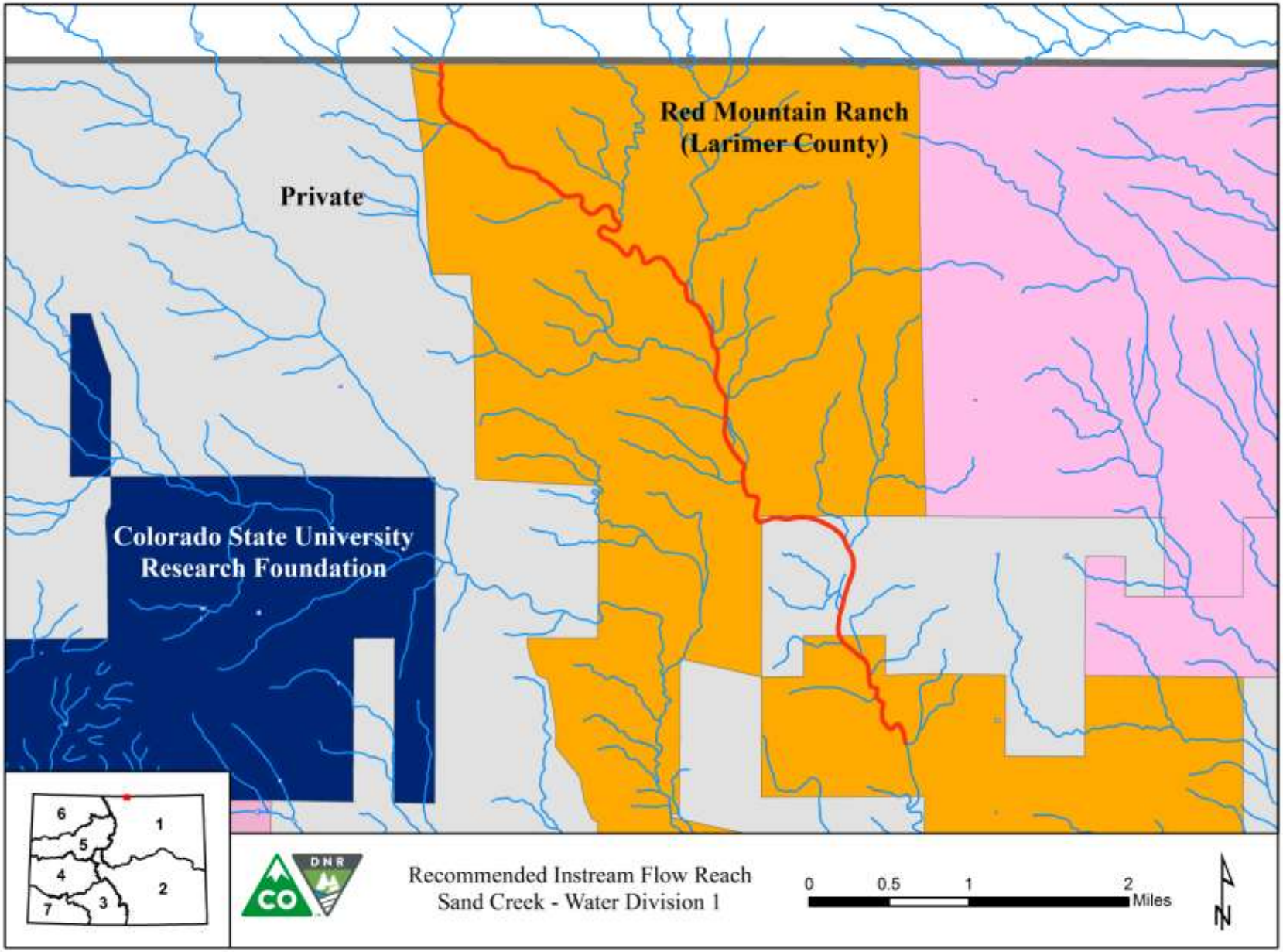
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

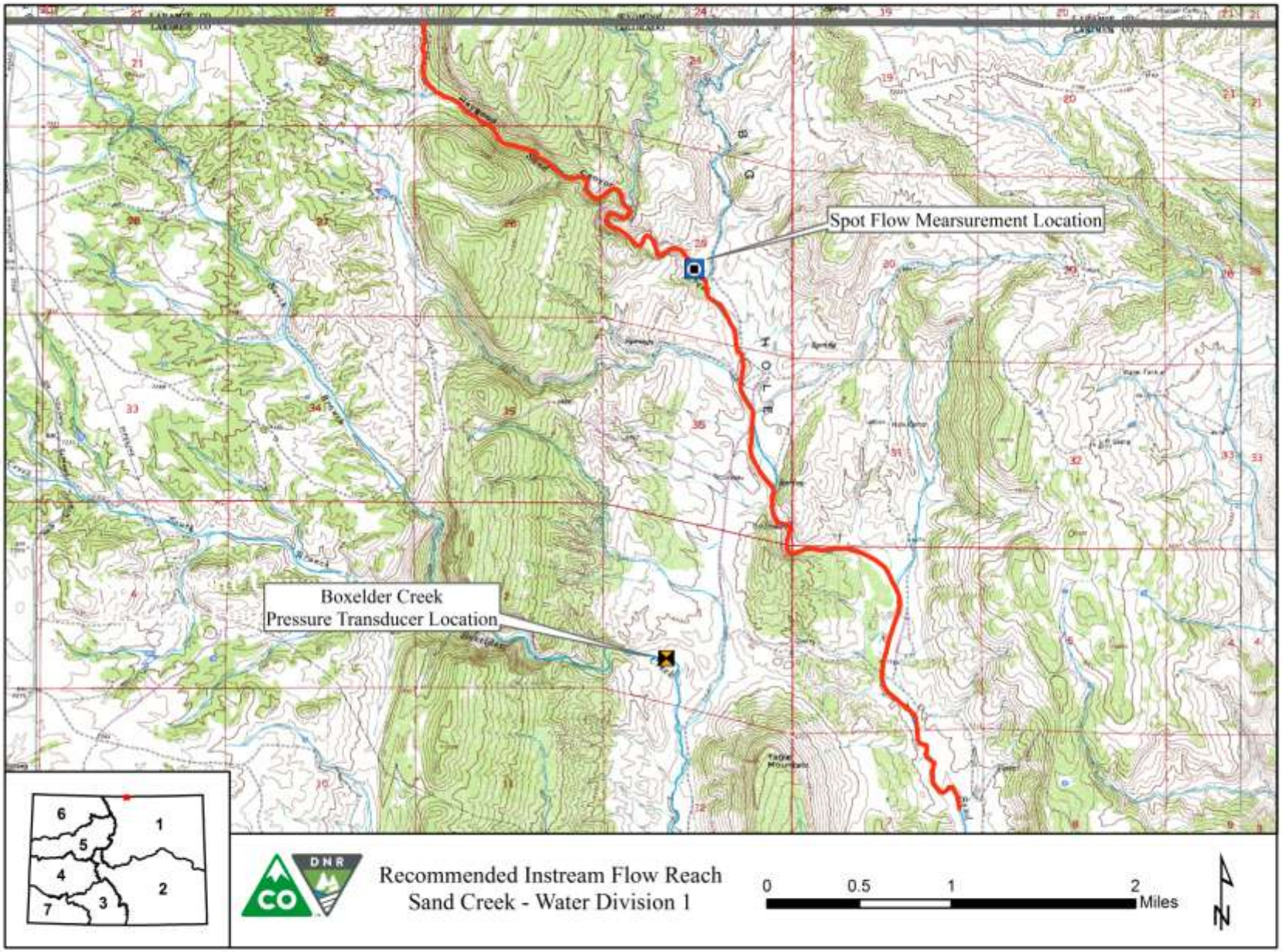
VICINITY MAP



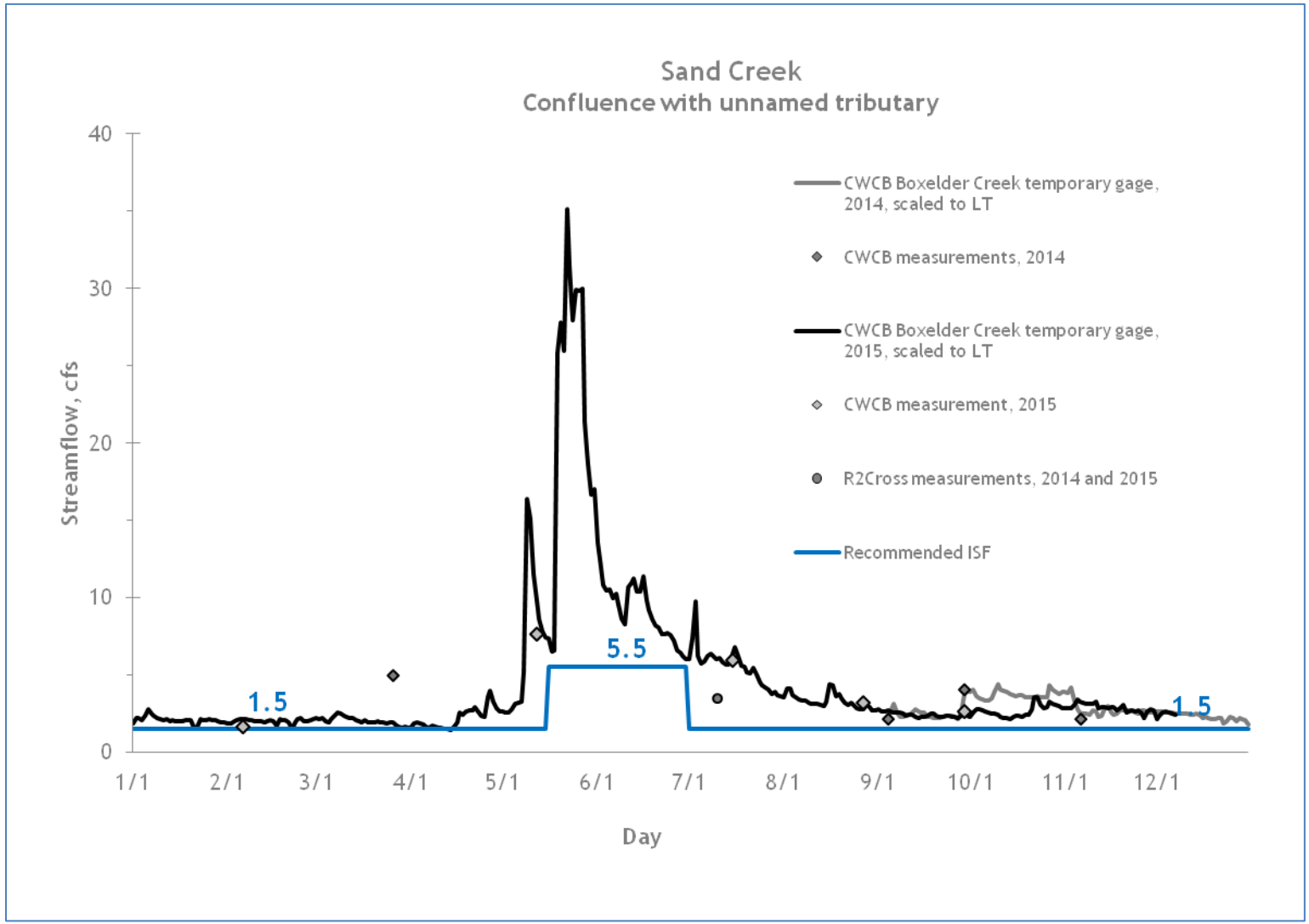
LAND OWNERSHIP MAP



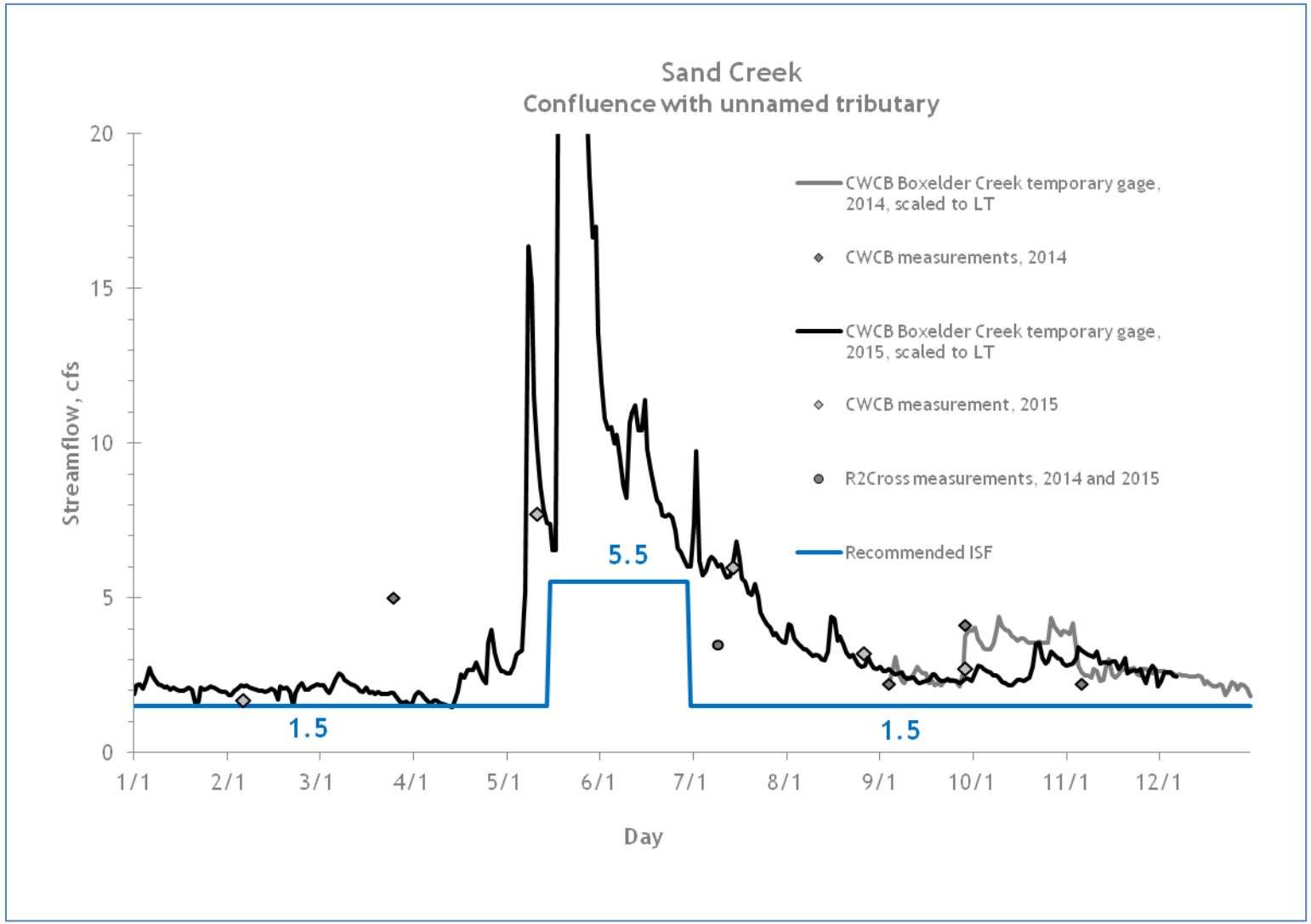
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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.

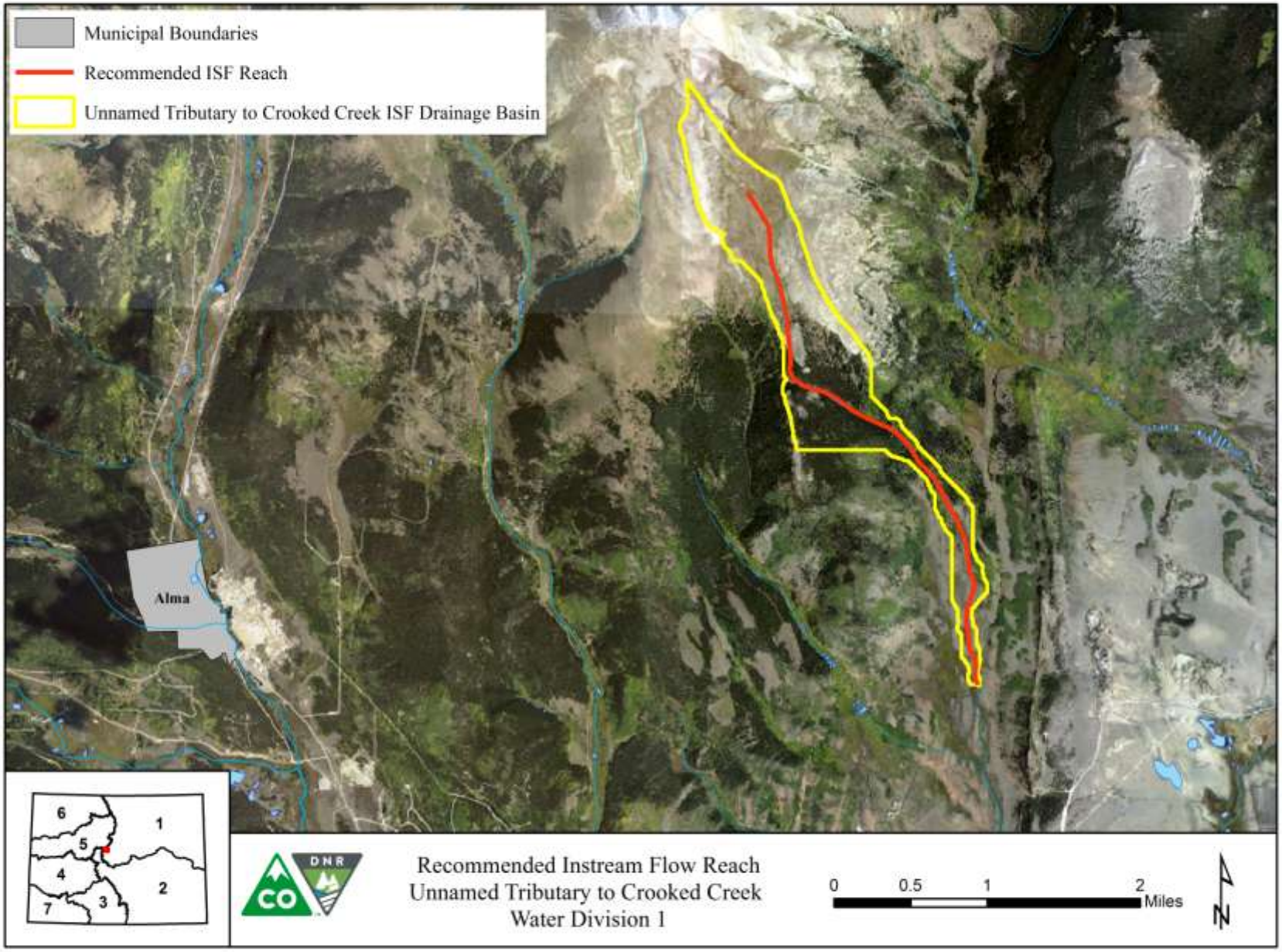
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

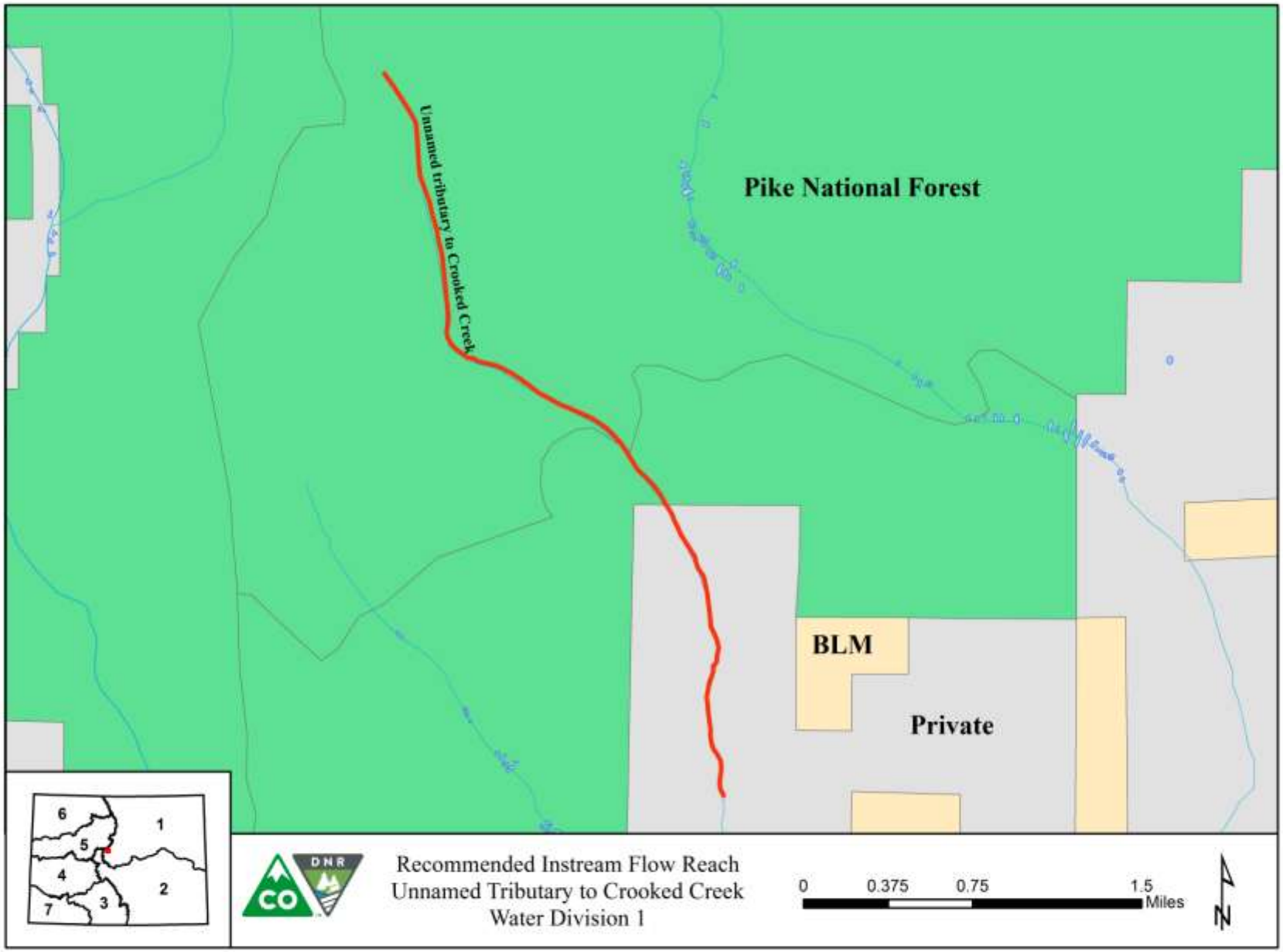
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

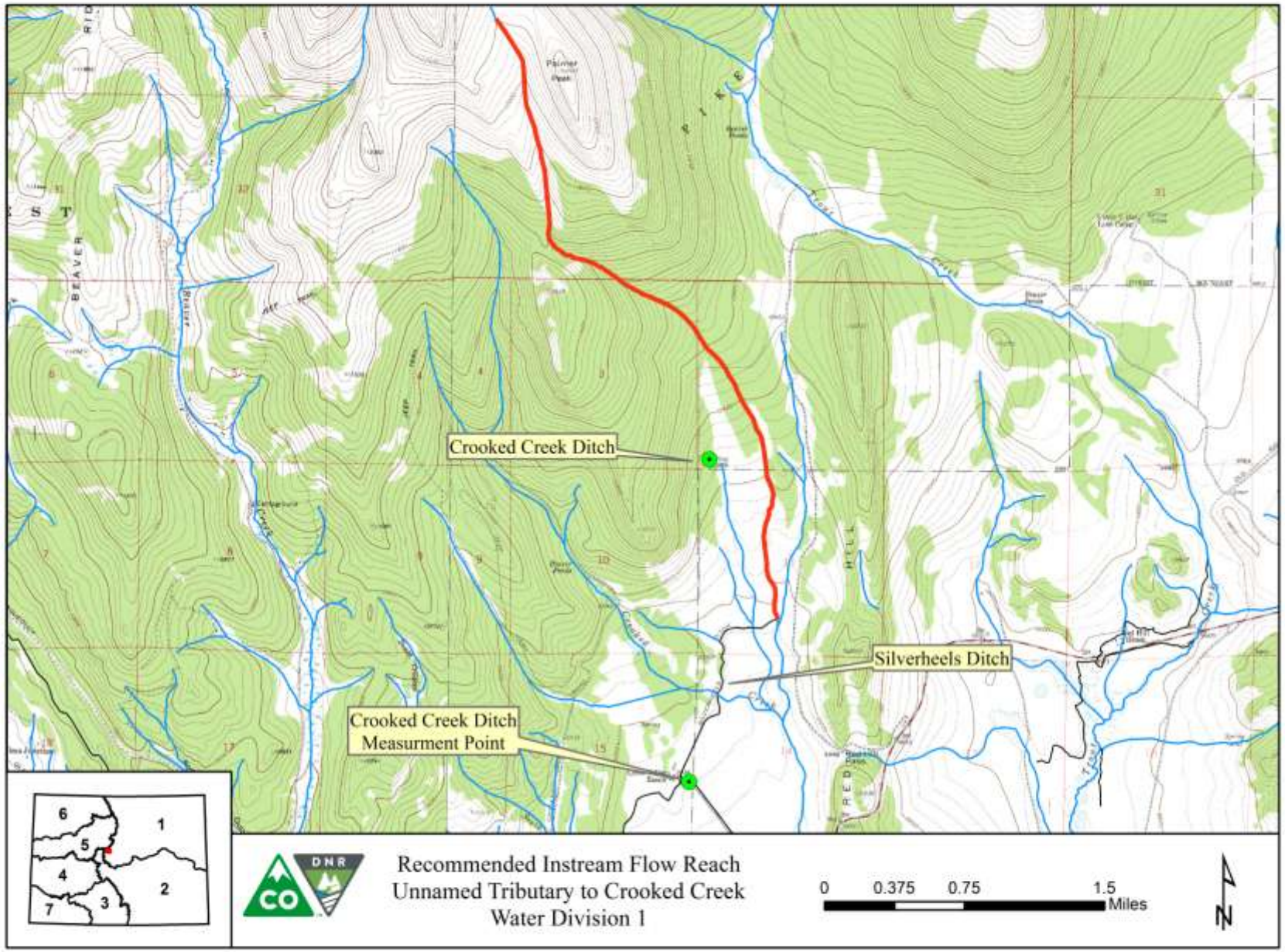
VICINITY MAP



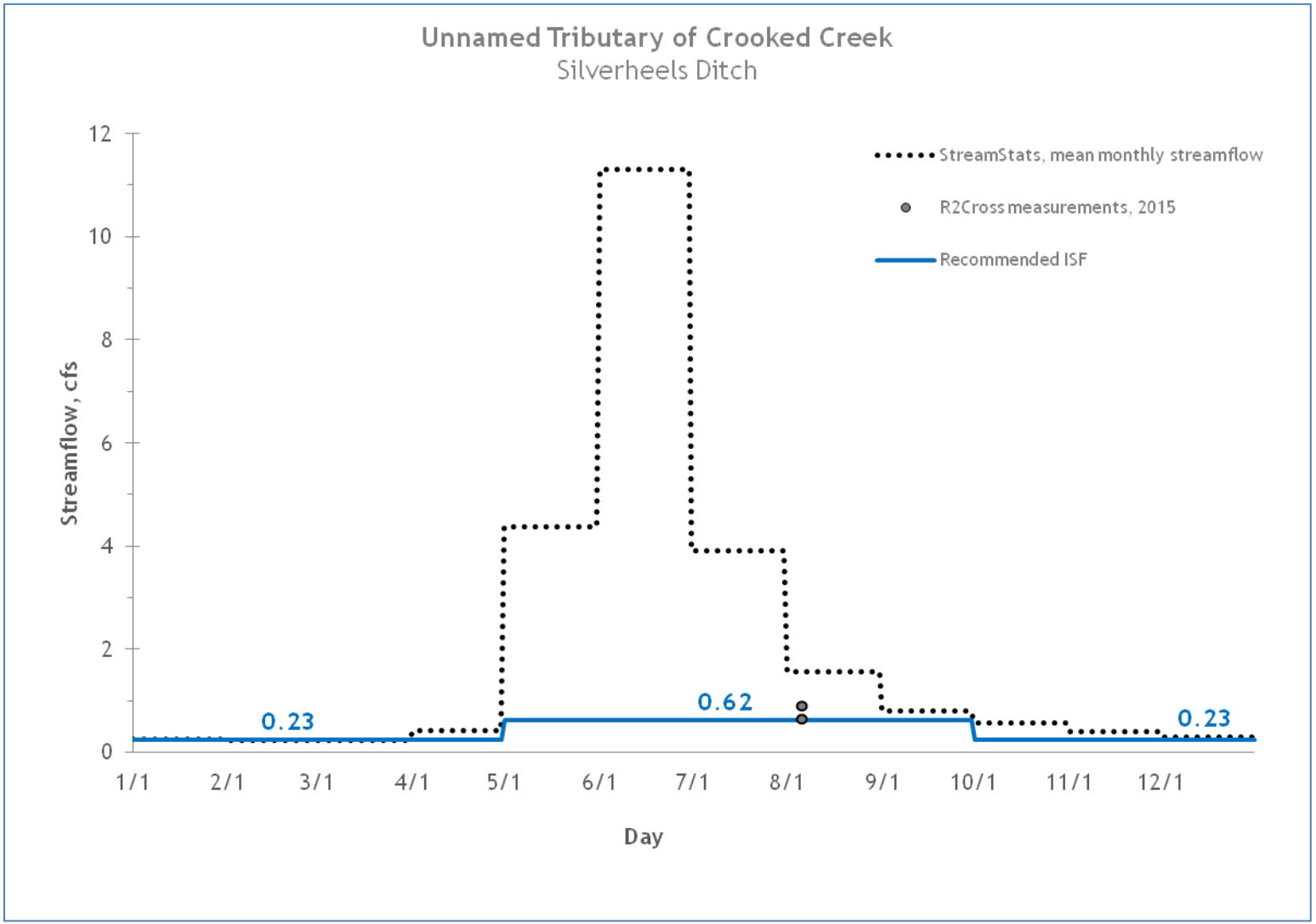
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

East Fork Turkey Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the Vicinity of UTM North: 4281370.35 UTM East: 503824.62
LOWER TERMINUS:	confluence with West Fork Turkey Creek UTM North: 4277192.32 UTM East: 505655.50
WATER DIVISION:	2
WATER DISTRICT:	10
COUNTY:	El Paso, Teller
WATERSHED:	Upper Arkansas (HUC #: 11020002)
CWCB ID:	16/2/A-003
RECOMMENDER	Bureau of Land Management
LENGTH:	3.43 miles
FLOW RECOMMENDATION:	0.3 cfs (12/1 – 3/31) 0.6 cfs (4/1 – 4/30) 1.35 cfs (5/1 – 8/31) 0.5 cfs (9/1 – 11/30)

East Fork Turkey 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of East Fork Turkey Creek. This reach is located within El Paso and Teller Counties about 10 miles southwest of Colorado Springs (See Vicinity Map). East Fork Turkey Creek originates on the east flank of Black Mountain at an elevation of 9,820 feet. The creek flows in an easterly direction as it drops to an elevation of 5,700 feet where it joins West Fork Turkey Creek. The proposed reach extends from the headwaters downstream to the confluence with West Fork Turkey Creek. Sixty-seven percent of the land on the 3.43 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of East Fork Turkey 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.

East Fork Turkey Creek is a cold-water, high gradient stream. The reach flows through a narrow canyon and is confined by bedrock in most locations. The stream generally has large-sized substrate, consisting of cobbles and small boulders. The stream has a good mix of pools, small riffles, and runs.

Fisheries surveys have revealed a self-sustaining population of brook 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 cottonwood, various willow species, and alder. The riparian community is in very good condition, and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in East Fork Turkey Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

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 (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). 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 1.35 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 0.59 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 East Fork Turkey Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	5/27/2014	0.63	0.25 – 1.58	0.58	1.09
BLM	5/27/2014	0.64	0.26 – 1.60	0.59	1.60
			Mean	**0.59**	**1.35**

ISF Recommendation

The BLM recommends flows of 0.3 cfs (12/1 – 3/31), 0.6 cfs (4/1 – 4/30), 1.35 cfs (5/1 – 8/31), and 0.5 cfs (9/1 – 11/30) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

1.35 cubic feet per second is recommended during the warm weather period from May 1 to August 31. This recommendation is driven by the average velocity criteria. This creek is steep and has limited physical habitat, so it is important to protect a flow rate that provides usable habitat in riffles when fish are completing critical life history functions during the warm weather months.

0.5 cubic feet per second is recommended during the fall period, from September 1 to November 30. This recommendation is driven by limited water availability. This flow rates meets the average depth and wetted perimeter criteria.

0.3 cfs is recommended during the winter period from December 1 through March 31. This recommendation is also driven by limited water availability. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

0.6 cfs is recommended during the early portion of the snowmelt runoff period, from the April 1 to April 30. This flow rate meets the average depth and wetted perimeter criteria.

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 East Fork Turkey Creek is 2.62 square miles, with average annual precipitation of 23.96 inches. No surface water rights with diversion records were identified in the drainage basin tributary to the proposed ISF reach. Due to the lack of surface water diversions, hydrology in this drainage basin represents natural flow conditions. See Hydrologic Features Map.

Available Data
There is not a current or historic streamflow gage on East Fork Turkey Creek. There was a historic gage and there is a current seasonally operated gage on Turkey Creek downstream from the proposed ISF reach. These gages are located downstream from the Turkey Creek canyon on an alluvial fan. Because the gages are believed to be in a losing reach (personal communication with water commissioner Doug Hollister on 3/24/2015), the gage records are not suitable for use in water availability analysis.

CWCB staff made one streamflow measurement on the proposed reach of East Fork Turkey Creek. This measurement is included in the water availability analysis.

Data Analysis
StreamStats provides the best available estimate of streamflow on East Fork Turkey Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean monthly streamflow. The proposed ISF rate is below the mean monthly streamflow for the entire year. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on East Fork Turkey 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.

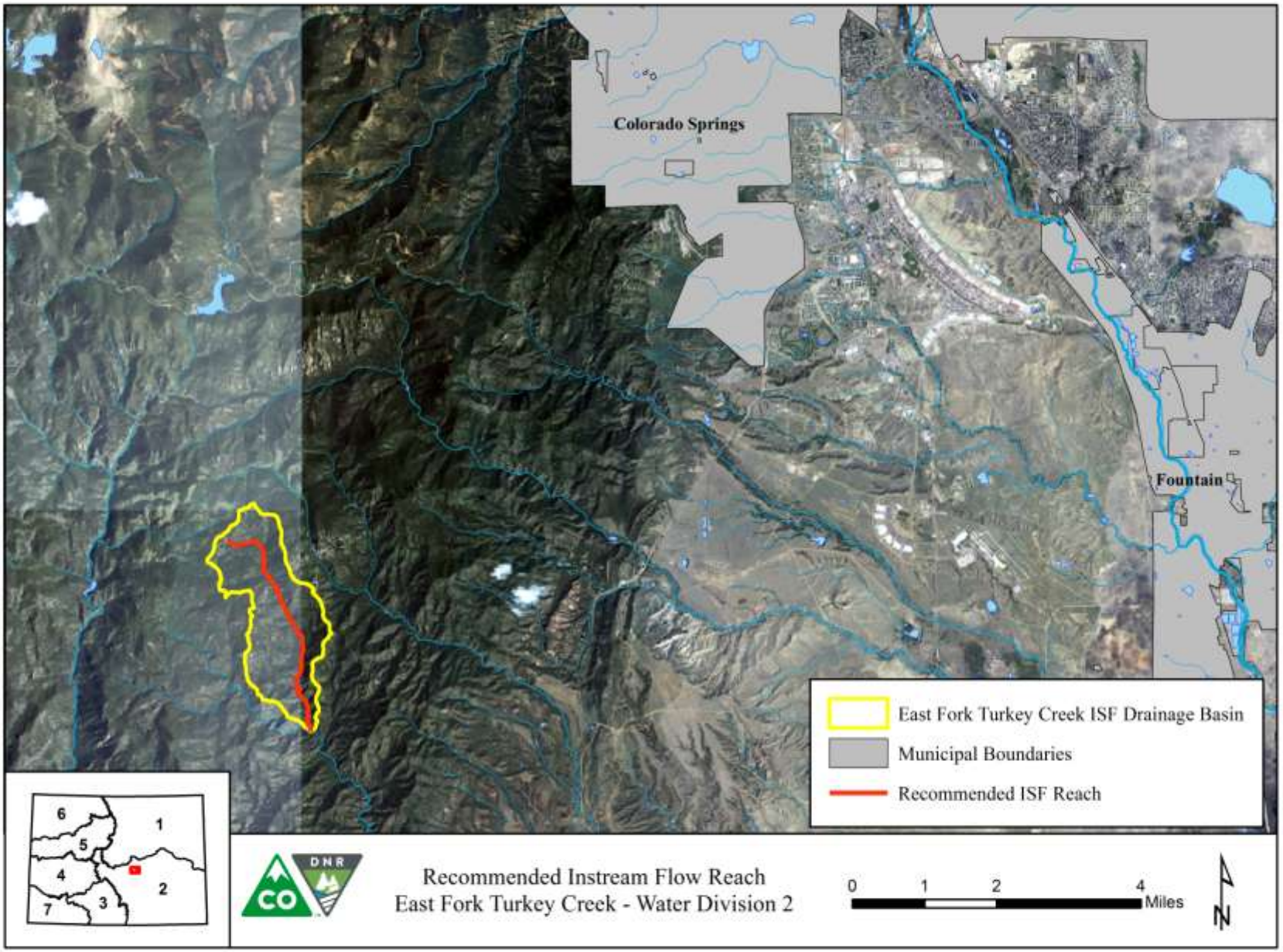
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

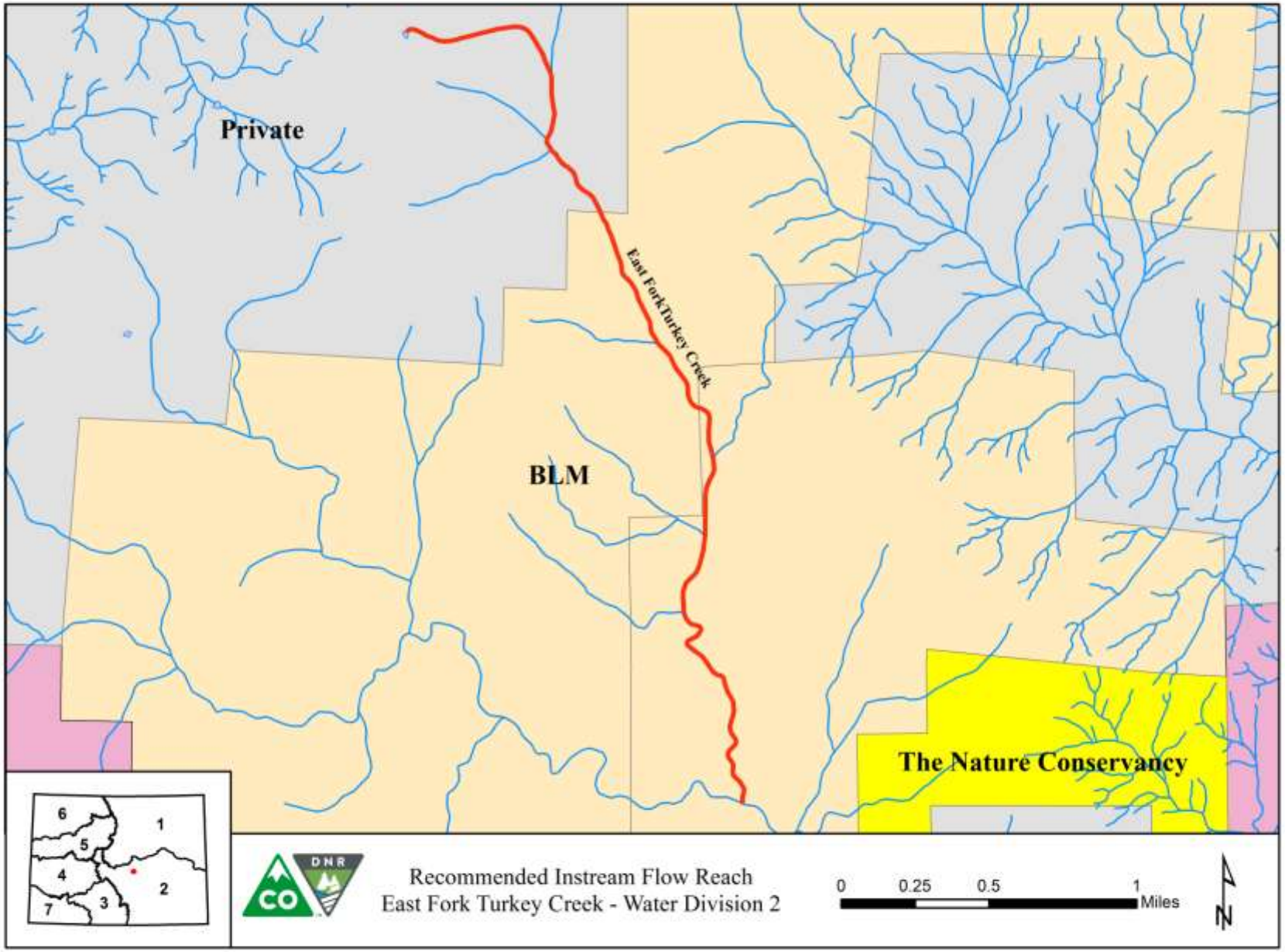
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

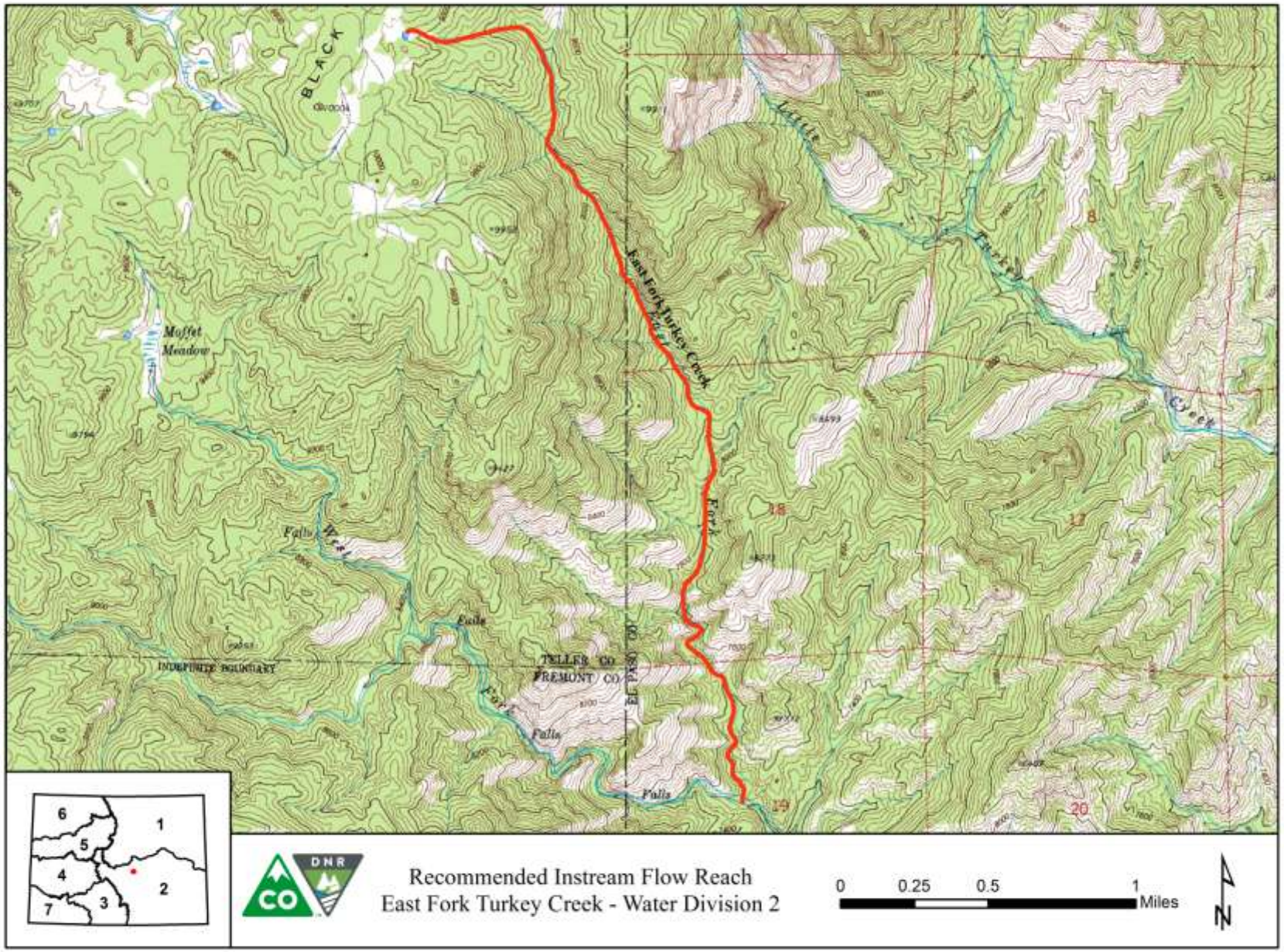
VICINITY MAP



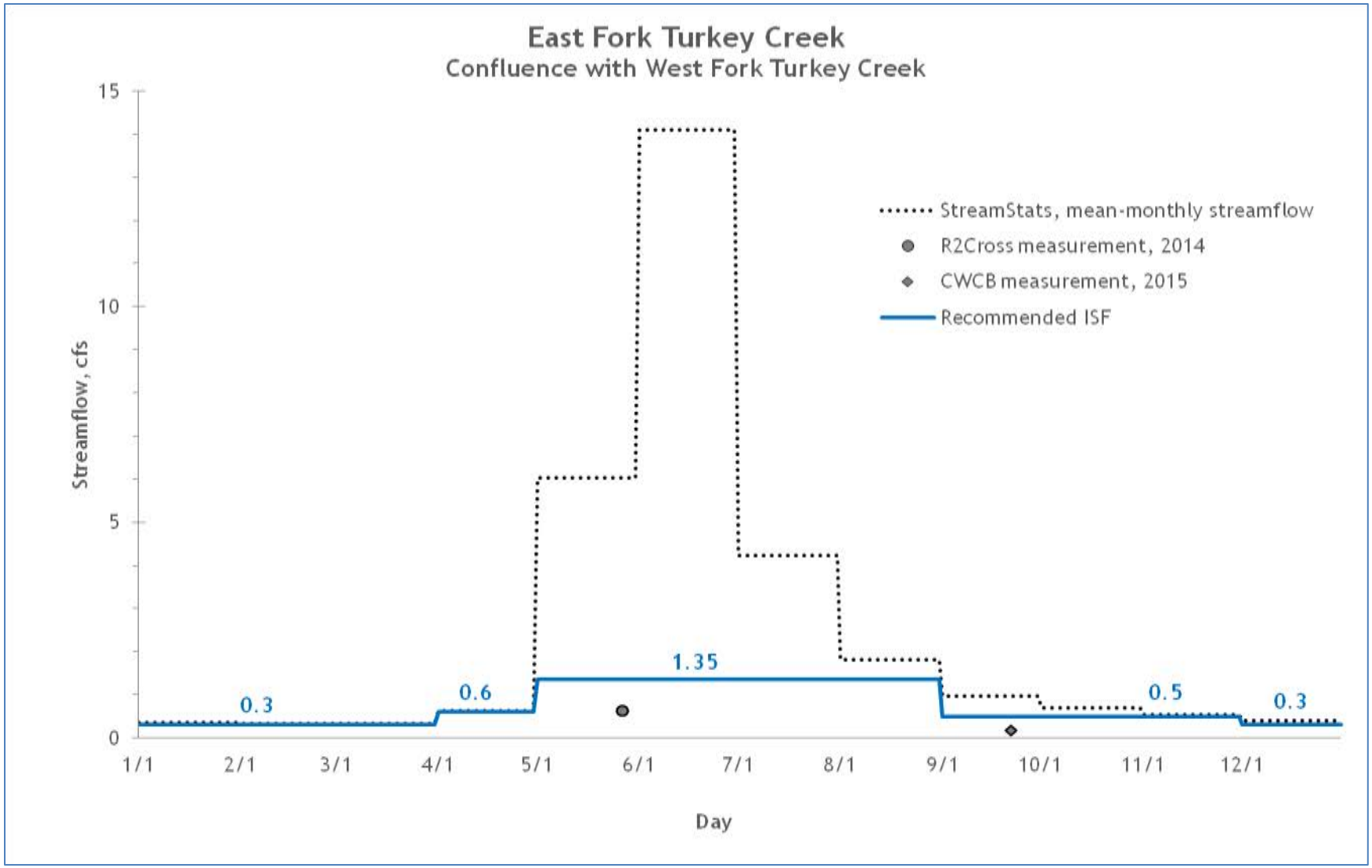
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

Turkey Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence with East Fork and West Fork Turkey Creek UTM North: 4277192.32 UTM East: 505655.50
LOWER TERMINUS:	Confluence with unnamed tributary UTM North: 4274992.02 UTM East: 506998.62
WATER DIVISION:	2
WATER DISTRICT:	10
COUNTY:	El Paso
WATERSHED:	Upper Arkansas (HUC: 11020002)
CWCB ID:	16/2/A-001
RECOMMENDER	Bureau of Land Management
LENGTH:	2.38 miles
FLOW RECOMMENDATION:	3.7 cfs (5/1-8/31) 1.8 cfs (9/1-11/30) 1.0 cfs (12/1-3/31) 2.7 cfs (4/1-4/30)

Turkey 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Turkey Creek. This reach is located within El Paso County about 9 miles southwest of the city of Colorado Springs (See Vicinity Map). Turkey Creek is formed at the confluence of East Fork and West Fork Turkey Creeks at an elevation of 7,400 feet. The creek flows in a southeasterly direction as it drops to an elevation of 4,840 feet where it flows into Pueblo Reservoir. The proposed reach extends from the confluence with East Fork and West Fork Turkey Creeks downstream to an unnamed tributary. Eighteen percent of the land on the 3.45 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of Turkey 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.

Turkey Creek is a cold-water, high gradient stream that flows through a narrow canyon. The stream is confined by bedrock in most locations. The stream generally has large-sized substrate, consisting of cobbles and small boulders. The stream has a good mix of pools, small riffles and runs.

Fisheries surveys have revealed a self-sustaining population of brook 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 cottonwood, various willow species and alder. The riparian community is in very good condition, and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in Turkey Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

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 (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). 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 3.7 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 1.0 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 Turkey Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	5/27/2014	2.11	0.84 – 5.28	0.93	3.72
BLM	5/27/2014	2.05	0.82 – 5.13	1.10	out of range
			Mean	**1.0**	**3.7**

ISF Recommendation

The BLM recommends flows of 3.7 cfs (5/1 – 8/31), 1.8 cfs (9/1 - 11/30), 1.0 cfs (12/1 - 3/31), and 3.0 cfs (4/1 – 4/30) based on R2Cross modeling analyses and biological expertise. However, the ISF rate for the month of April was reduced to 2.7 cfs based on staff's water availability analysis

3.7 cubic feet per second is recommended during the warm weather period from May 1 to August 31. This recommendation is driven by the average velocity criteria. This creek is steep and has limited physical habitat, so it is important to protect a flow rate that provides usable habitat in riffles when fish are completing critical life history functions during the warm weather months.

1.8 cubic feet per second is recommended during the fall period, from September 1 to November 30. This recommendation is driven by limited water availability. This flow rates significantly exceeds the average depth and wetted perimeter criteria, and provides an average velocity of approximately 0.8 feet per second.

1.00 cfs is recommended during the winter period from December 1 through March 31. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

2.7 cfs is recommended during the early portion of the snowmelt runoff period, from the April 1 to April 30. This flow rate comes close to meeting all three instream flow criteria, but reflects the fact that snowmelt runoff is not yet sufficient during April to meet all three instream flow criteria.

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 Turkey Creek is 10.1 square miles, with an average elevation of 8,530 ft and average annual precipitation of 23.02 inches. No surface water rights with diversion records were identified in the drainage basin tributary to the proposed ISF reach. Due to the lack of surface water diversions, hydrology in this drainage basin represents natural flow conditions. See the Hydrologic Features Map.

Available Data
There was a historic streamflow gage and there currently is a seasonally operated gage on Turkey Creek downstream from the proposed ISF reach. These gages are located downstream from the Turkey Creek canyon on an alluvial fan. Because the gages are believed to be in a losing reach (personal communication with water commissioner Doug Hollister on 3/24/2015), the gage records are not suitable for use in the water availability analysis.

CWCB staff made two streamflow measurements on the proposed reach of Turkey Creek. These measurements are included in this water availability analysis.

Data Analysis
StreamStats provides the best available estimate of streamflow on Turkey Creek.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show StreamStats results for mean monthly streamflow for Turkey Creek. The proposed ISF rate is below the mean monthly streamflow at all times. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Turkey 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.

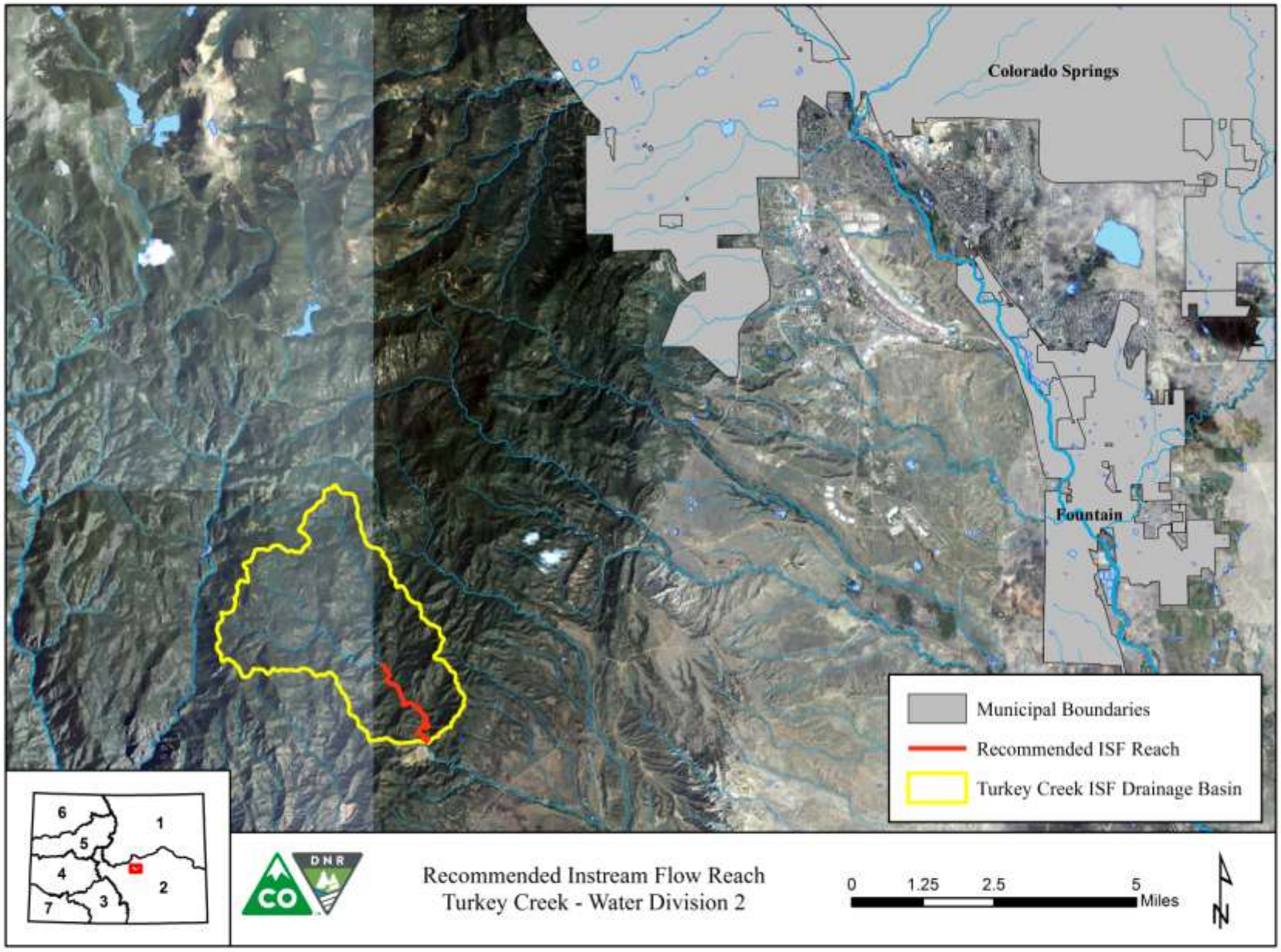
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

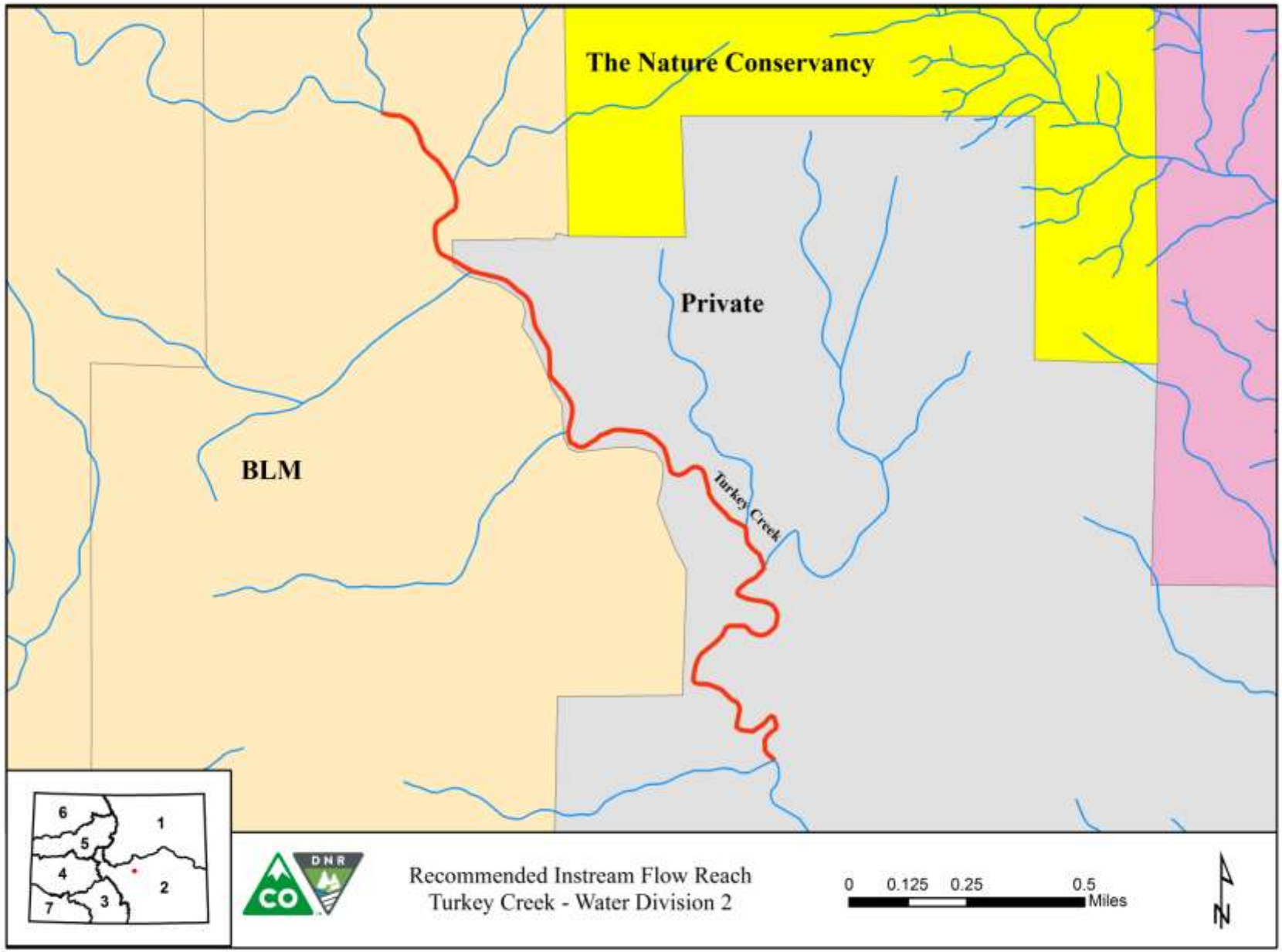
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

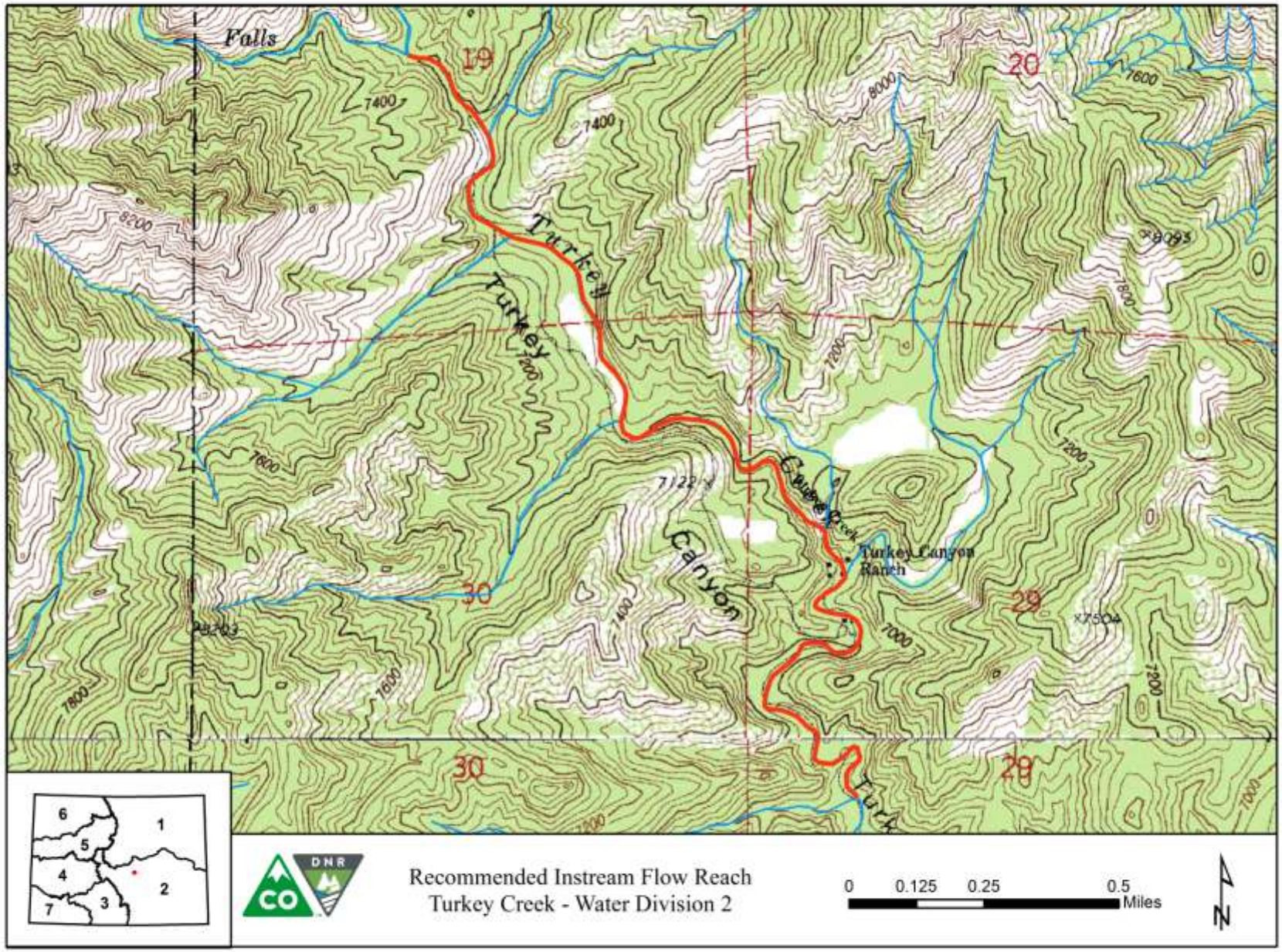
VICINITY MAP



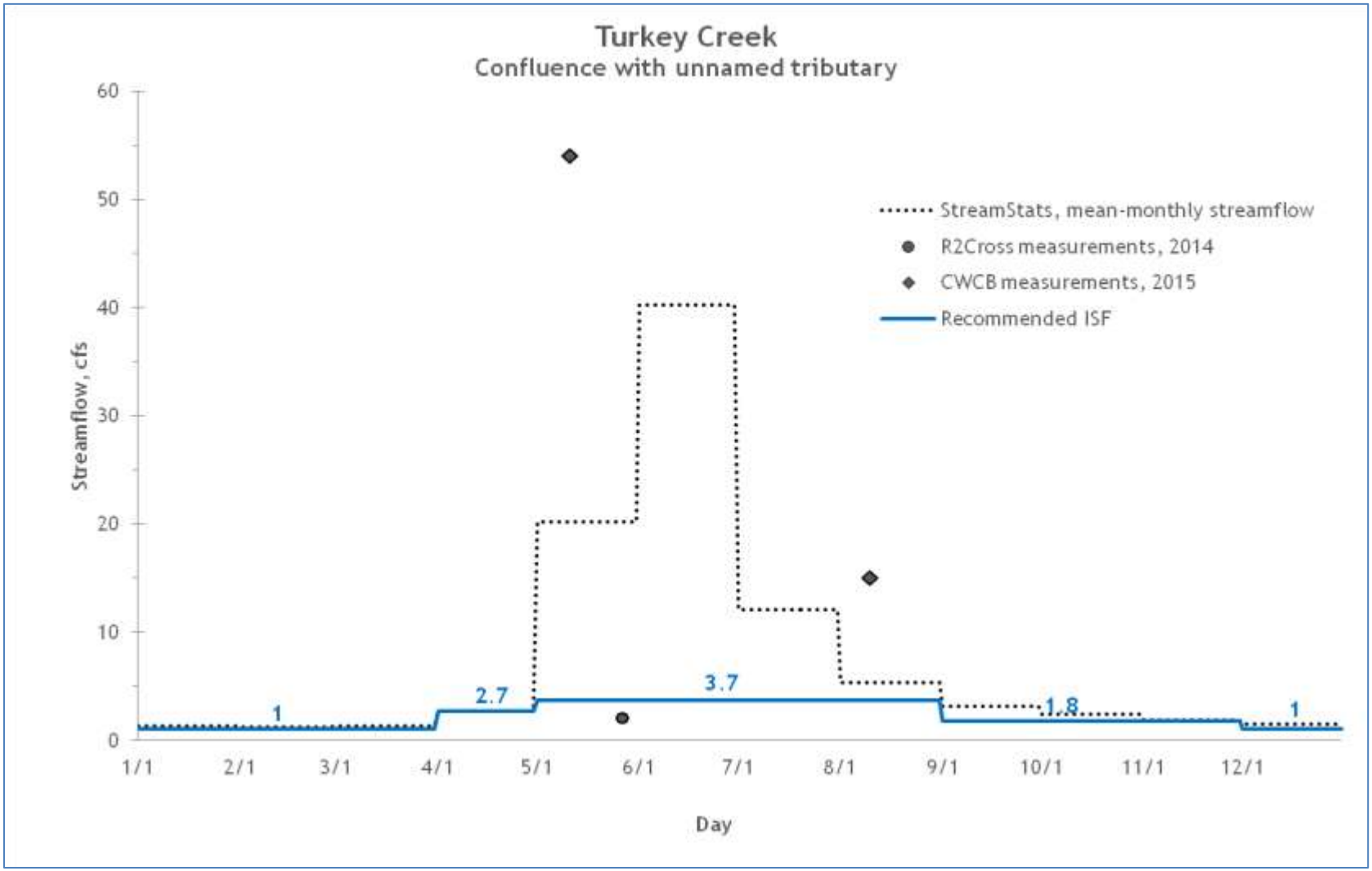
LAND OWNERSHIP MAP



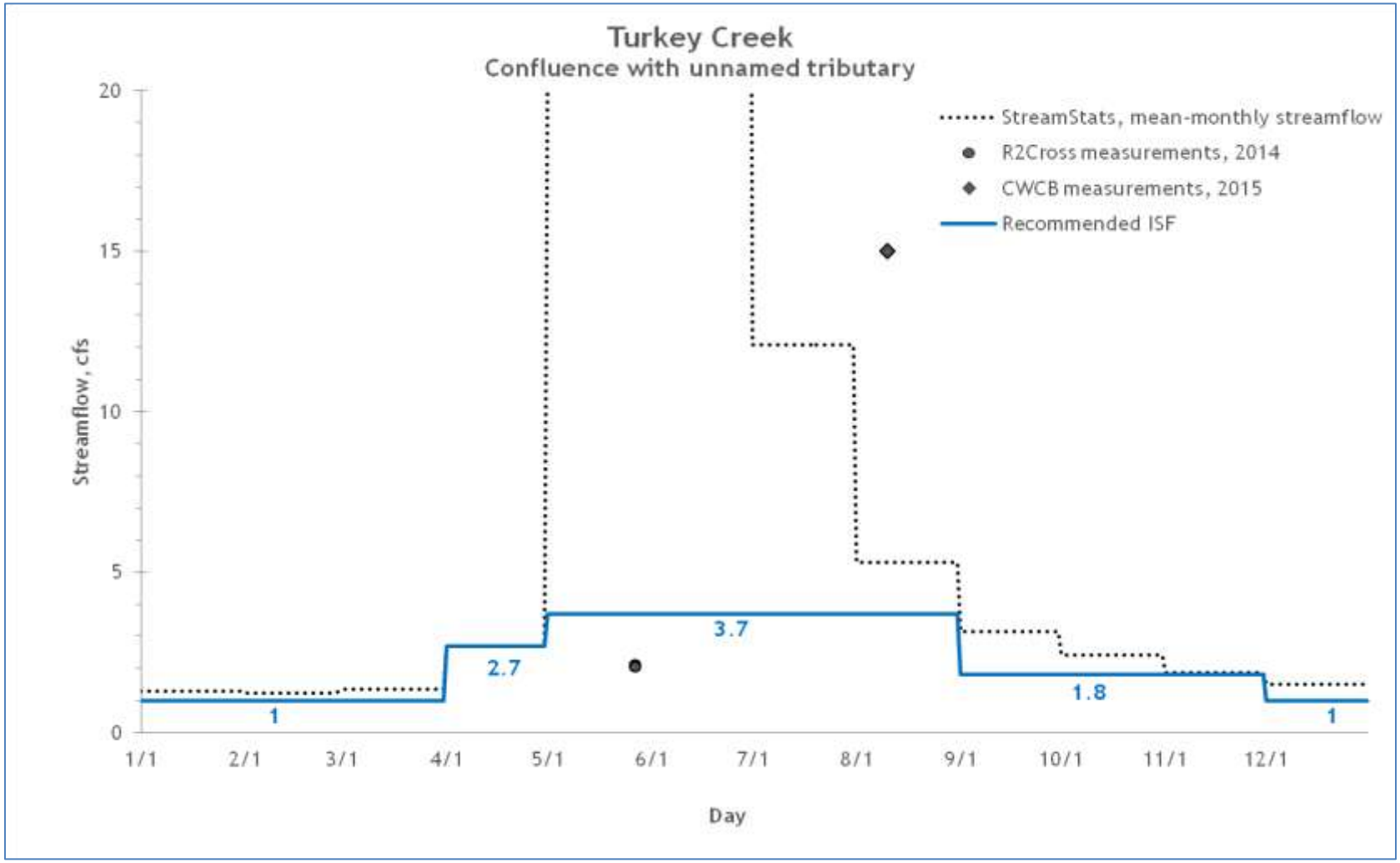
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

West Fork Turkey Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4280317.03 UTM East: 502182.46
LOWER TERMINUS:	Confluence with East Fork Turkey Creek UTM North: 4277192.32 UTM East: 505655.50
WATER DIVISION:	1
WATER DISTRICT:	10
COUNTY:	El Paso, Fremont, & Teller
WATERSHED:	Upper Arkansas (HUC #: 11020002)
CWCB ID:	16/2/A-003
RECOMMENDER	Bureau of Land Management
LENGTH:	3.98 miles
FLOW RECOMMENDATION:	2.1 cfs (5/1 – 8/31) 0.75 cfs (9/1-11/30) 0.5 cfs (12/1-3/31) 0.75 cfs (4/1 – 4/30)

West Fork Turkey 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of West Fork Turkey Creek. This reach is located within El Paso, Fremont and Teller Counties about 8 miles southwest of Colorado Springs (See Vicinity Map). The West Fork Turkey Creek headwaters originate off of the south flank of Black Mountain at an elevation of 9,300 feet. The creek flows in a southeasterly direction as it drops to an elevation of 7,400 feet where it joins East Fork Turkey Creek to form Turkey Creek. The proposed reach extends from the headwaters downstream to the confluence with East Fork Turkey Creek. Seventy-eight percent of the land on the 3.98 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of West Fork Turkey 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.

West Fork Turkey Creek is a cold-water, high gradient stream. The reach flows through a narrow canyon and is confined by bedrock in most locations. The stream generally has large-sized substrate, consisting of cobbles and small boulders. The stream has a good mix of pools, small riffles, and runs.

Fisheries surveys have revealed a self-sustaining population of brook 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 cottonwood, various willow species, and alder. The riparian community is in very good condition, and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in West Fork Turkey Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

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 (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). 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 one transect for this proposed ISF reach (Table 2). The R2Cross model results in a summer flow of 2.12 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 0.73 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 West Fork Turkey Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	5/27/2014	1.29	0.52 – 3.23	0.73	2.12
			Mean	**0.73**	**2.12**

ISF Recommendation

The BLM recommends flows of 2.1 cfs (5/1 – 8/31), 0.75 cfs (9/1 - 11/30), 0.5 cfs (12/1 - 3/31) and 0.75 cfs (4/1 – 4/30) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

2.1 cubic feet per second is recommended during the warm weather period from May 1 to August 31. This recommendation is driven by the average velocity criteria. This creek is steep and has limited physical habitat, so it is important to protect a flow rate that provides usable habitat in riffles when fish are completing critical life history functions during the warm weather months.

0.75 cubic feet per second is recommended during the fall period, from September 1 to November 30. This recommendation is driven by limited water availability. This flow rates meets the average depth and wetted perimeter criteria.

0.5 cfs is recommended during the winter period from December 1 through March 31. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

0.75 cfs is recommended during the early portion of the snowmelt runoff period, from the April 1 to April 30. This flow rate meets the average depth and wetted perimeter criteria.

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 West Fork Turkey Creek is 4.14 square miles, with an average elevation of 9,080 ft and average annual precipitation of 23.34 inches. No surface water rights with diversion records were identified in the drainage basin tributary to the proposed ISF reach. Due to the lack of surface water diversions, hydrology in this drainage basin represents natural flow conditions. See the Hydrologic Features Map.

Available Data
There is not a current or historic streamflow gage on West Fork Turkey Creek. There was a historic gage and there currently is a seasonally operated gage on Turkey Creek downstream from the proposed ISF reach. These gages are located downstream from the Turkey Creek canyon on an alluvial fan. Because the gages are believed to be in a losing reach (personal communication with water commissioner Doug Hollister on 3/24/2015), the gage records are not suitable for use in the water availability analysis.

CWCB staff made two streamflow measurements on the proposed reach of West Fork Turkey Creek. These measurements are included in the water availability analysis.

Data Analysis
StreamStats provides the best available estimate of streamflow on West Fork Turkey Creek.

Water Availability Summary
The hydrograph (See Complete Hydrograph) shows StreamStats results for mean monthly streamflow for West Fork Turkey Creek. The proposed ISF rate is below the mean monthly streamflow at all times. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on West Fork Turkey 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.

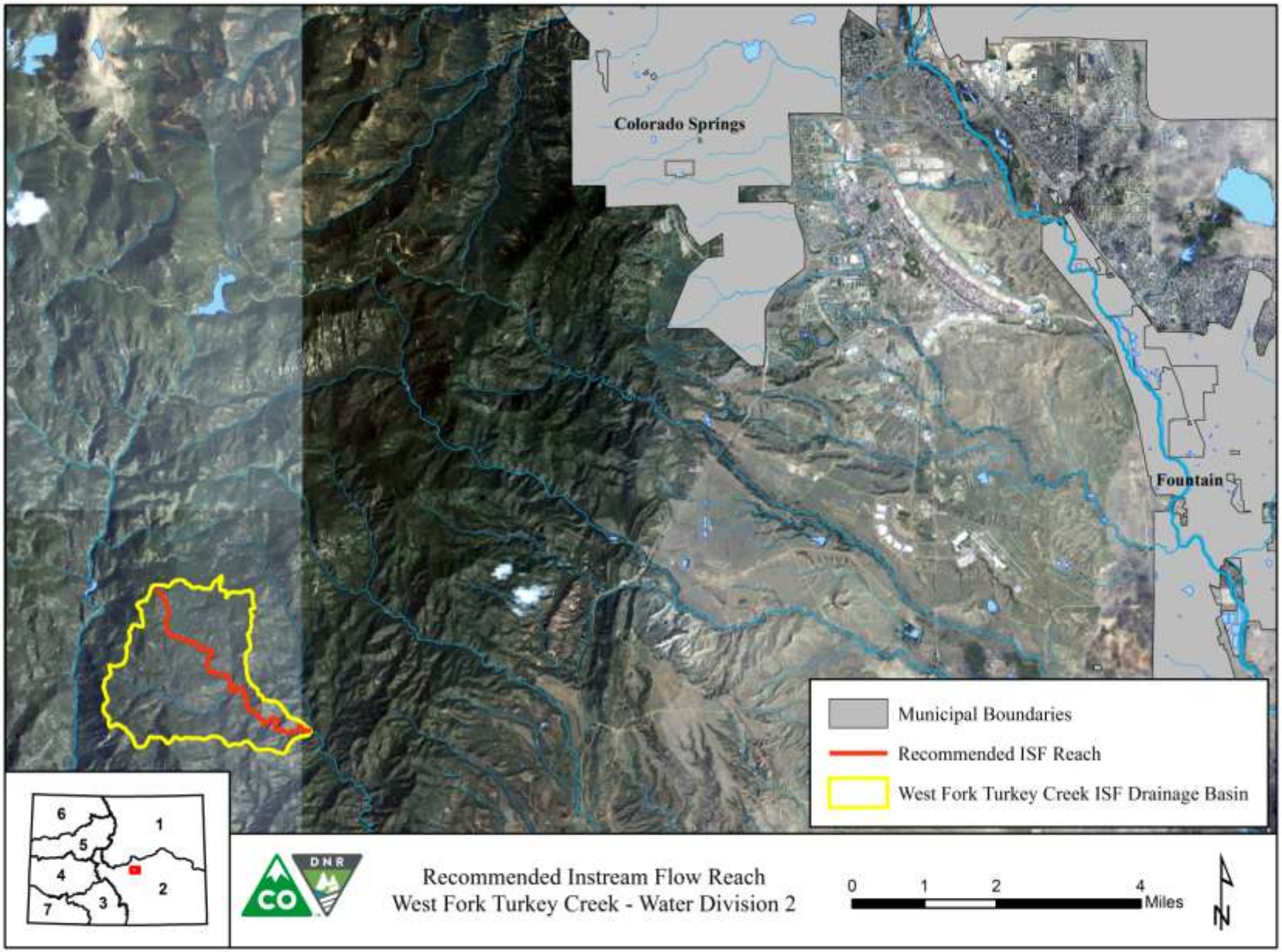
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

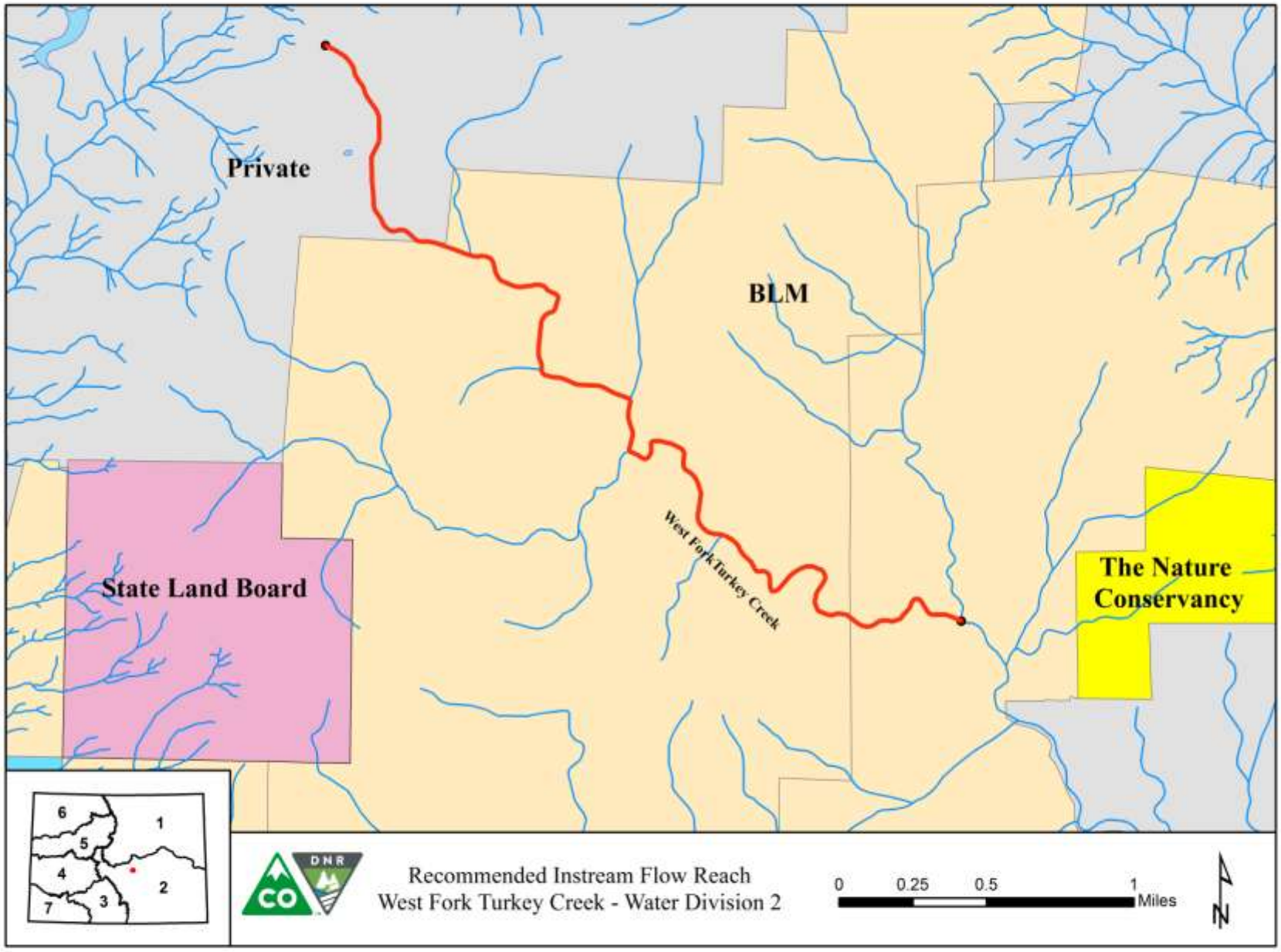
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

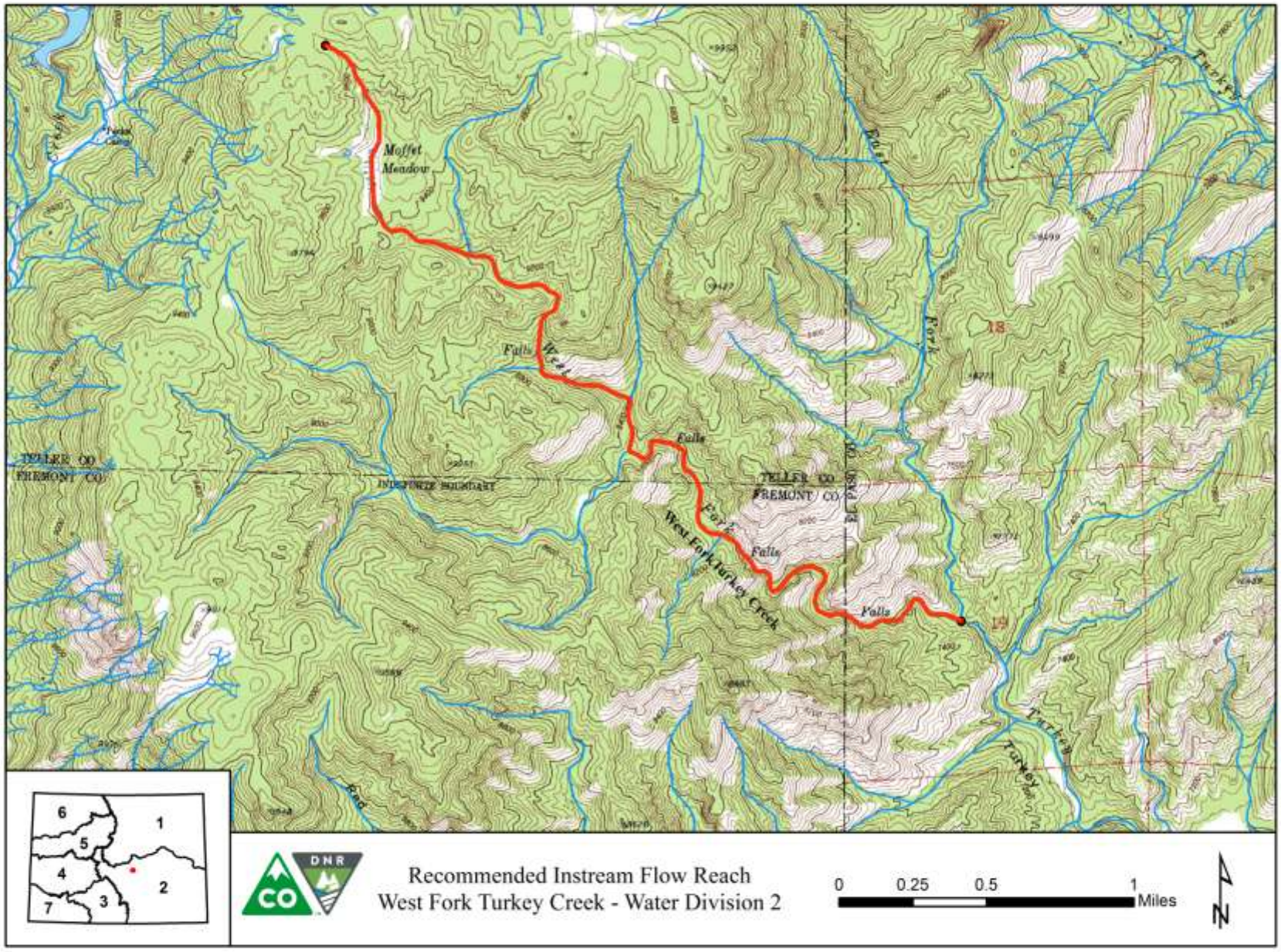
VICINITY MAP



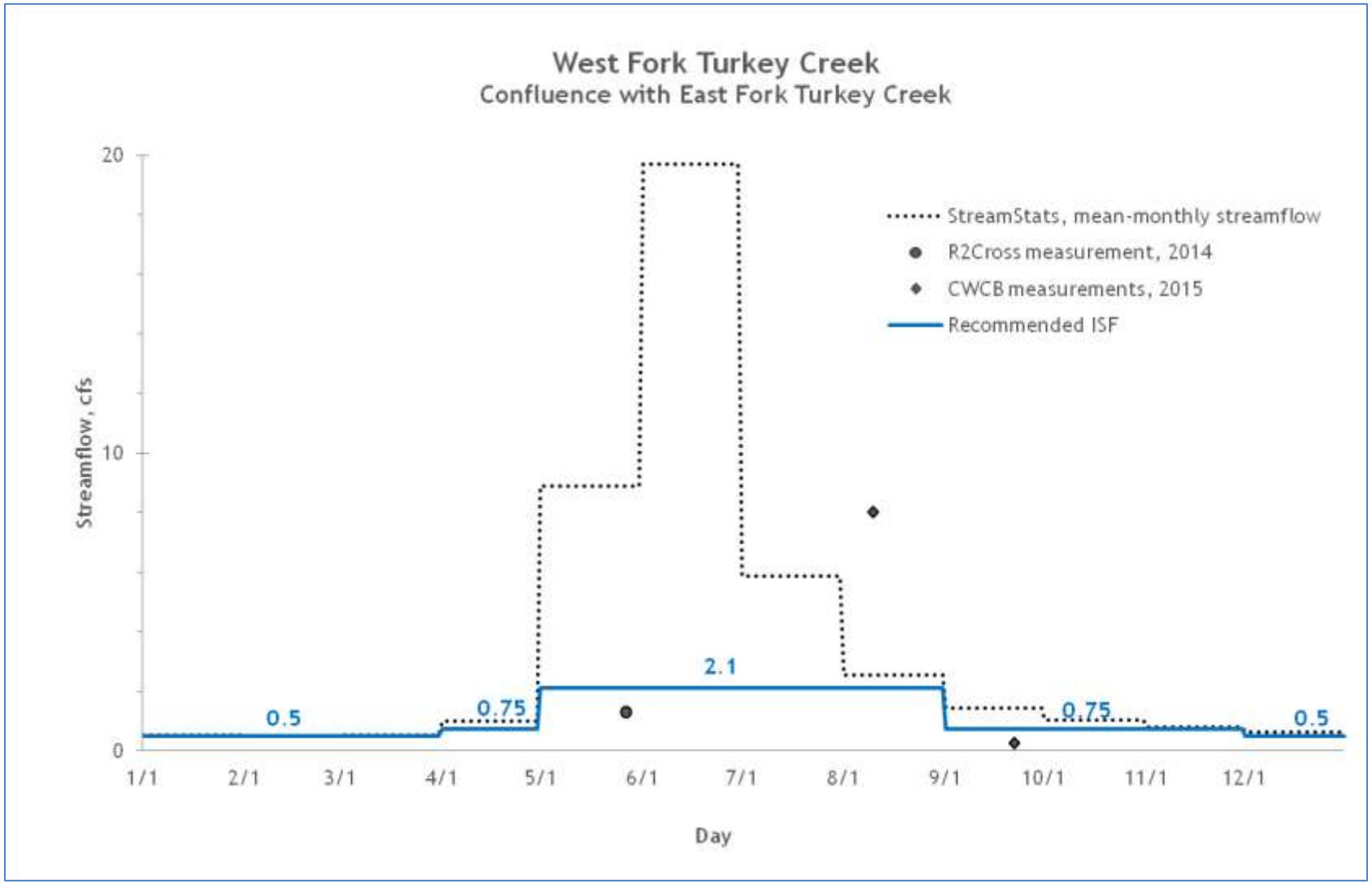
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

Fourth of July Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4223472.28	UTM East: 307162.58
LOWER TERMINUS:	Carris Thompson Ditch headgate UTM North: 4225851.27	UTM East: 299652.37
WATER DIVISION:	4	
WATER DISTRICT:	62	
COUNTY:	Gunnison, Hinsdale	
WATERSHED:	Upper Gunnison (HUC#: 14020002)	
CWCB ID:	16/4/A-003	
RECOMMENDER:	Bureau of Land Management	
LENGTH:	6.0 miles	
FLOW RECOMMENDATION:	1.1 cfs (4/1-7/31) 0.6 cfs (8/1-3/31)	

Fourth of July 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Fourth of July Creek. This reach is located within parts of Gunnison and Hinsdale Counties about 8 miles northeast of Lake City (See Vicinity Map). Fourth of July Creek originates on the north flank of the Calf Creek Plateau at an elevation of 12,200 ft in the Powderhorn Wilderness Area. The creek flows in a northwesterly direction as it drops to an elevation of 8,240 feet where it joins the Lake Fork Gunnison River. The proposed reach extends from the headwaters downstream to the Carris Thompson Ditch headgate. Eighty percent of the land on the 6.0 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of Fourth of July 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.

Fourth of July Creek is a cold-water, high gradient stream. It flows through a canyon with a valley floor approximately one eighth mile in width. The stream cuts through alluvial deposits in the narrow valley and is confined by bedrock in many locations. The stream generally has small-sized substrate, consisting of gravels, small cobbles and small boulders. The stream has a good mix of pools, small riffles and runs. While deep pool habitat is absent, the existing pools are sufficient for overwintering fish.

Fisheries surveys have revealed a self-sustaining population of brook 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 blue spruce, aspen, willow species and alder. The riparian community is in very good condition and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in Fourth of July Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

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 (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). 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 four 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 winter flow of 0.67 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 Fourth of July Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	7/18/2013 - 1	0.42	0.2 – 1.1	0.83	1.10*
BLM	7/18/2013 - 2	0.37	0.1 – 0.9	0.40	Out of range
BLM	7/25/2014 - 1	0.40	0.2 – 1.0	0.65	Out of range
BLM	7/25/2014 - 2	0.39	0.2 – 1.0	0.81	Out of range
			Mean	**0.67**	**1.10**

Note: 1.1 cubic feet per second is within the confidence interval for the data set collected on 07/18/2013. 1.1 cubic feet per second provides 0.94 feet per second average velocity, which is very close to the 1.0 foot per second criteria used in the R2Cross program.

ISF Recommendation

The BLM recommends flows of 1.1 cfs (4/1 – 7/31), and 0.6 cfs (8/1 – 3/31) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

1.1 cubic feet per second is recommended during the snowmelt runoff period from April 1 to July 31. This recommendation is driven by the average velocity criteria. This creek is narrow and has limited physical habitat, so it is important to protect a flow rate that makes most of this habitat available to the fish population while they are completing critical life history functions during the warm weather months.

0.6 cubic feet per second is recommended from August 1 to March 31. This recommendation is driven by the average velocity criteria. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

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 Fourth of July Creek is 5.52 square miles, with an average elevation of 10,700 ft and average annual precipitation of 21.26 inches. There is one known surface water diversion used to fill and refresh a 1.8 AF pond within the basin tributary to the proposed ISF (Fourth of July Feeder PL, 1985 appropriation date, 2 cfs until pond is full, then 0.2 cfs). There are no known transbasin imports or exports. Hydrology in this drainage basin represents essentially 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 or in nearby drainages that would be representative of streamflow in this reach. In some cases, diversion records can be used to provide an indication of water availability in a stream reach. The Carris Thompson ditch, (1912 appropriation date, 4 cfs) is located at the lower terminus. However, while the diversion record provides some information about streamflow, it is not a perfect measure of streamflow because years in which water is available but not taken may be recorded as zero.

CWCB staff made two streamflow measurements on the proposed reach of Fourth of July Creek. These measurements are included in the water availability analysis.

Data Analysis

The Carris Thompson ditch has daily records from 11/1/1973 through 10/31/2014. However, many years have no records or record zero flow diverted. Several years of the record include the water commissioner comment, “water available but not taken” (1994, 1995, 1999, 2000, 2001, and 2002). These years were omitted from the analysis of median diversions. The remaining 18 to 20 years of data, depending on the day of the year, were used to estimate median diversions and 95% confidence intervals for the median diversion.

StreamStats was also used to estimate of mean-monthly streamflow.

Water Availability Summary

The hydrographs (See Complete and Detailed Hydrographs) show StreamStats results for mean-monthly streamflow as well as median and the upper 95% confidence interval for median diversions

for the Carris Thompson Ditch. The proposed ISF rates are below the StreamStats estimates at all times and below the upper 95% confidence interval for the median diversion during most of the typical irrigation season. Staff has concluded that water is available for appropriation.

Material Injury

Because the proposed ISF on Fourth of July 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.

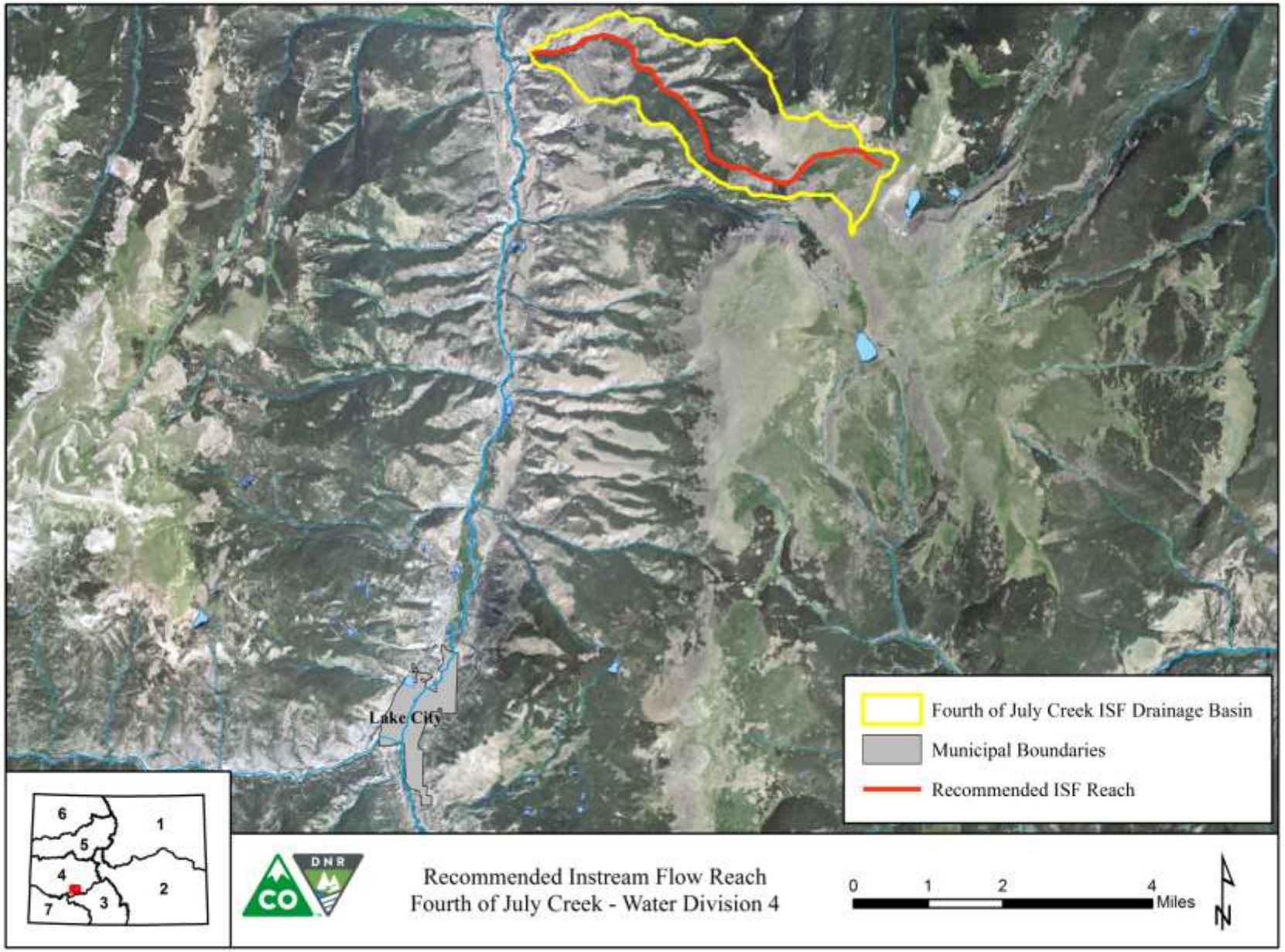
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

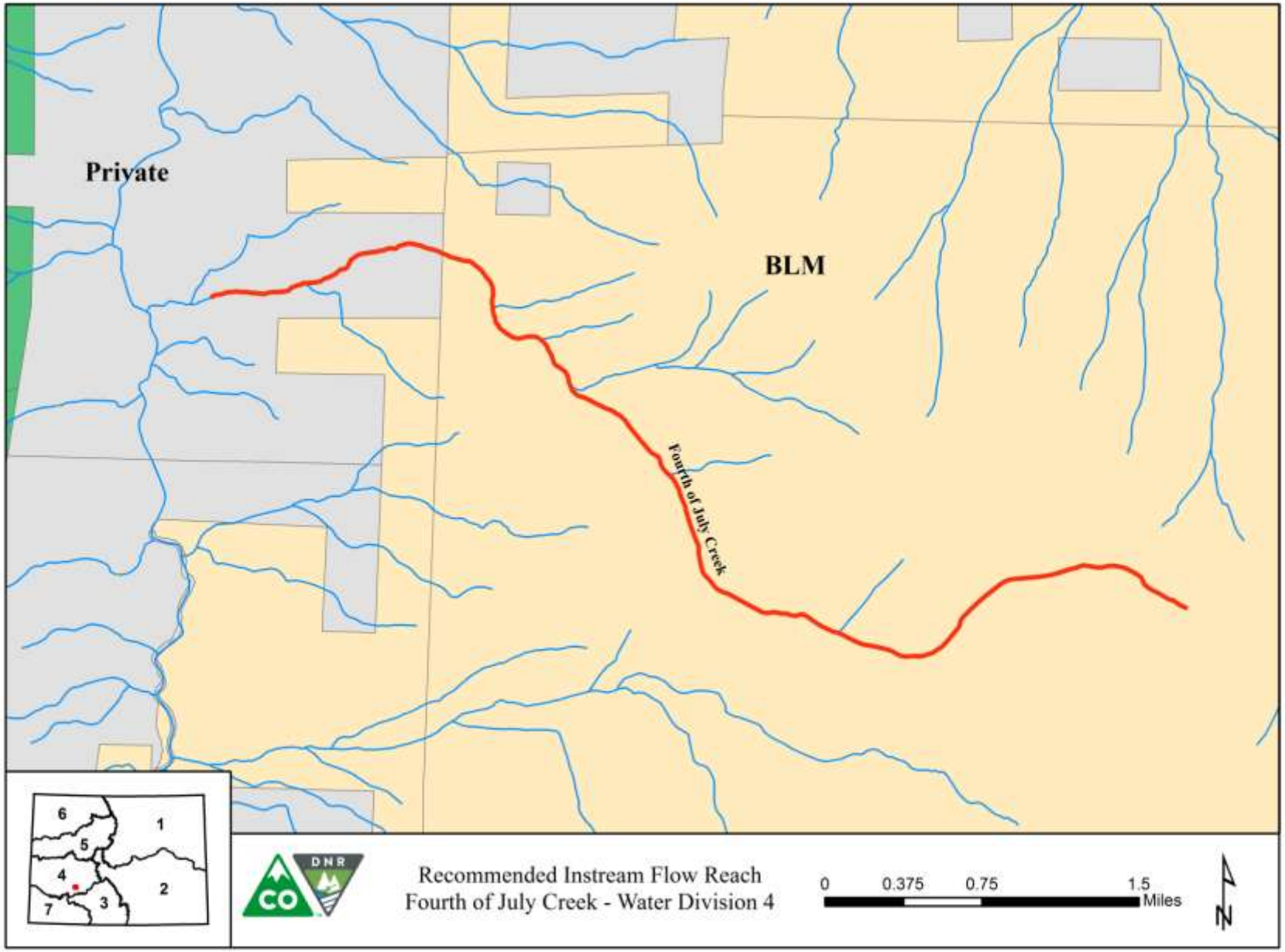
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

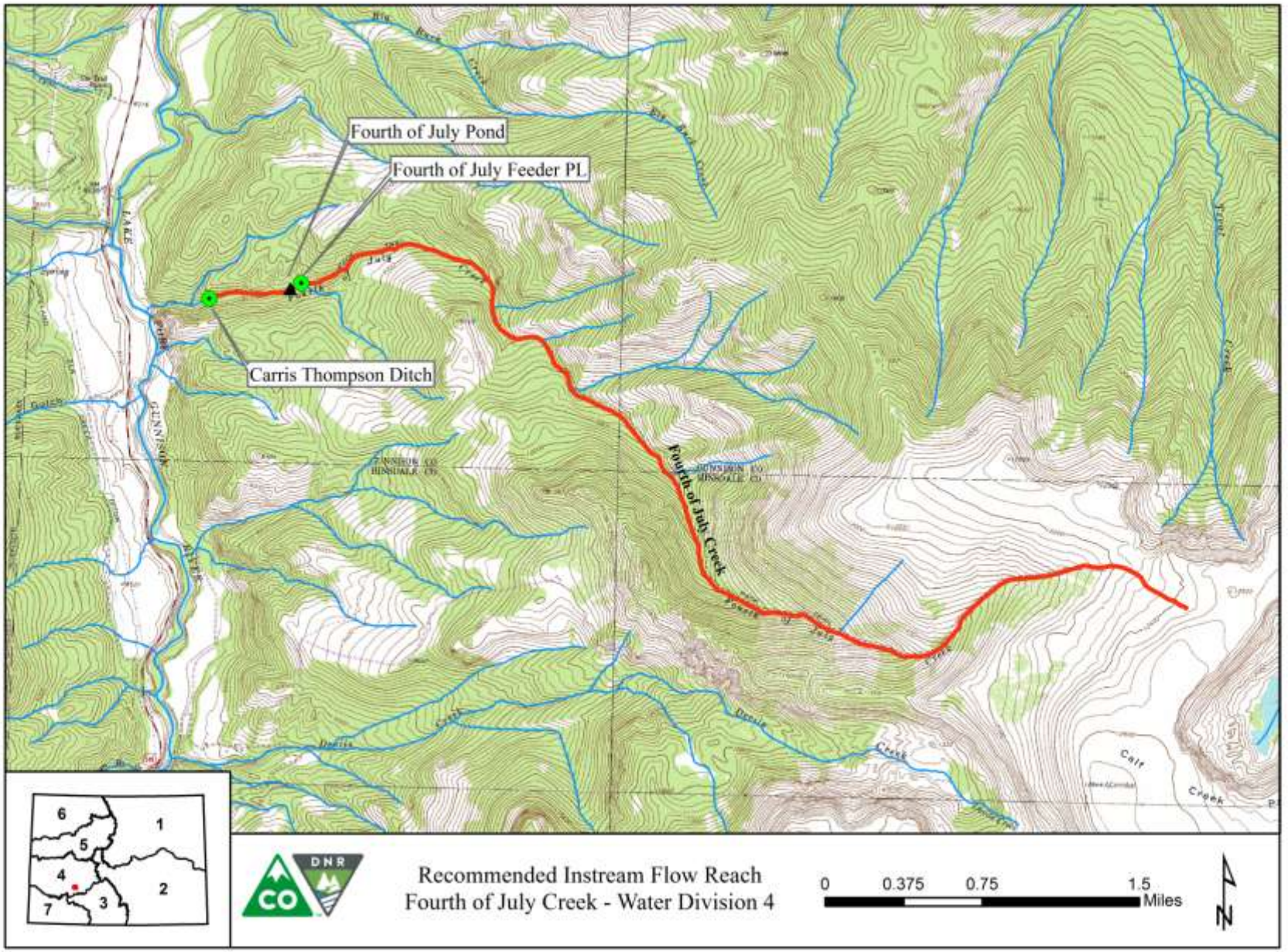
VICINITY MAP



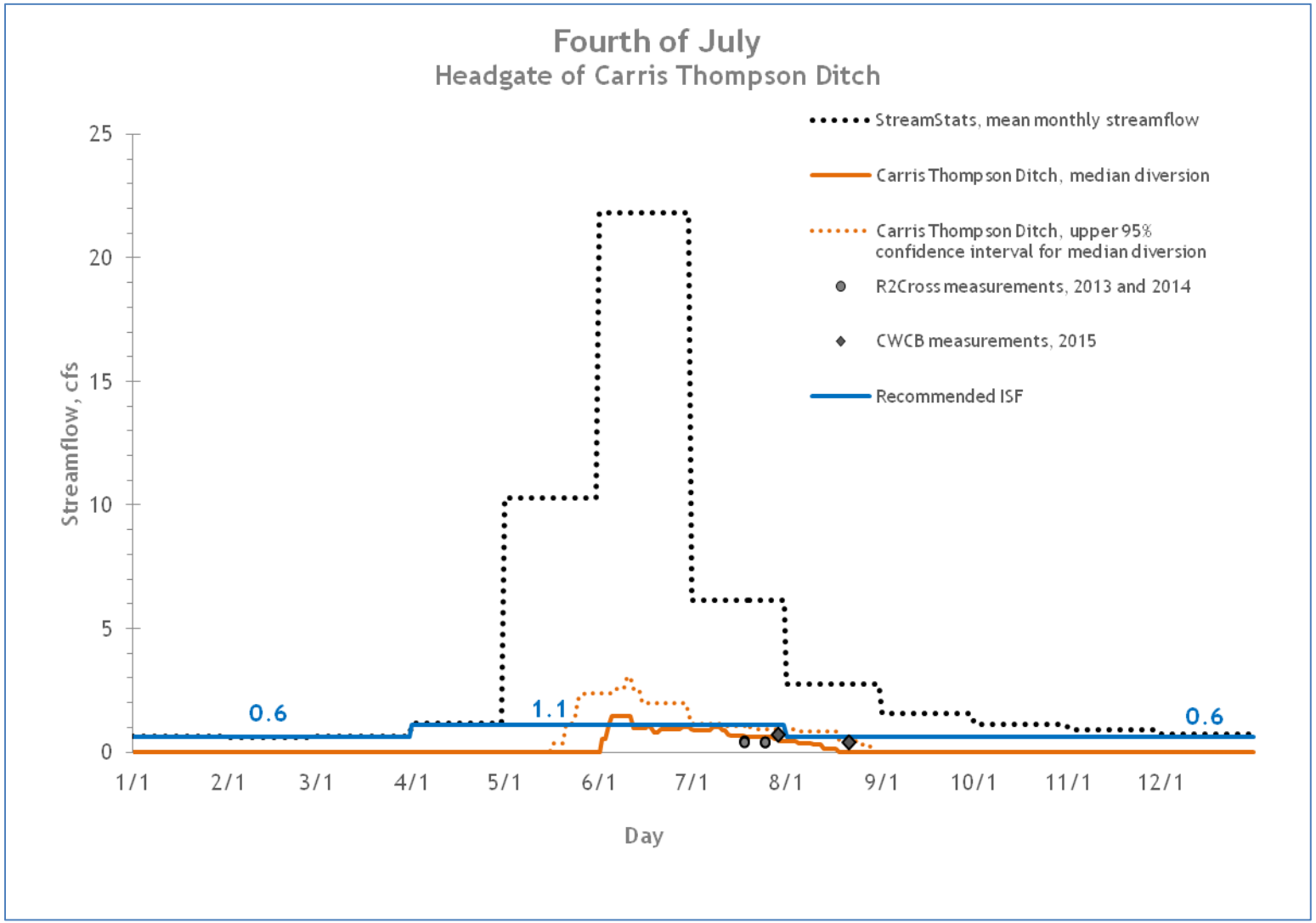
LAND OWNERSHIP MAP



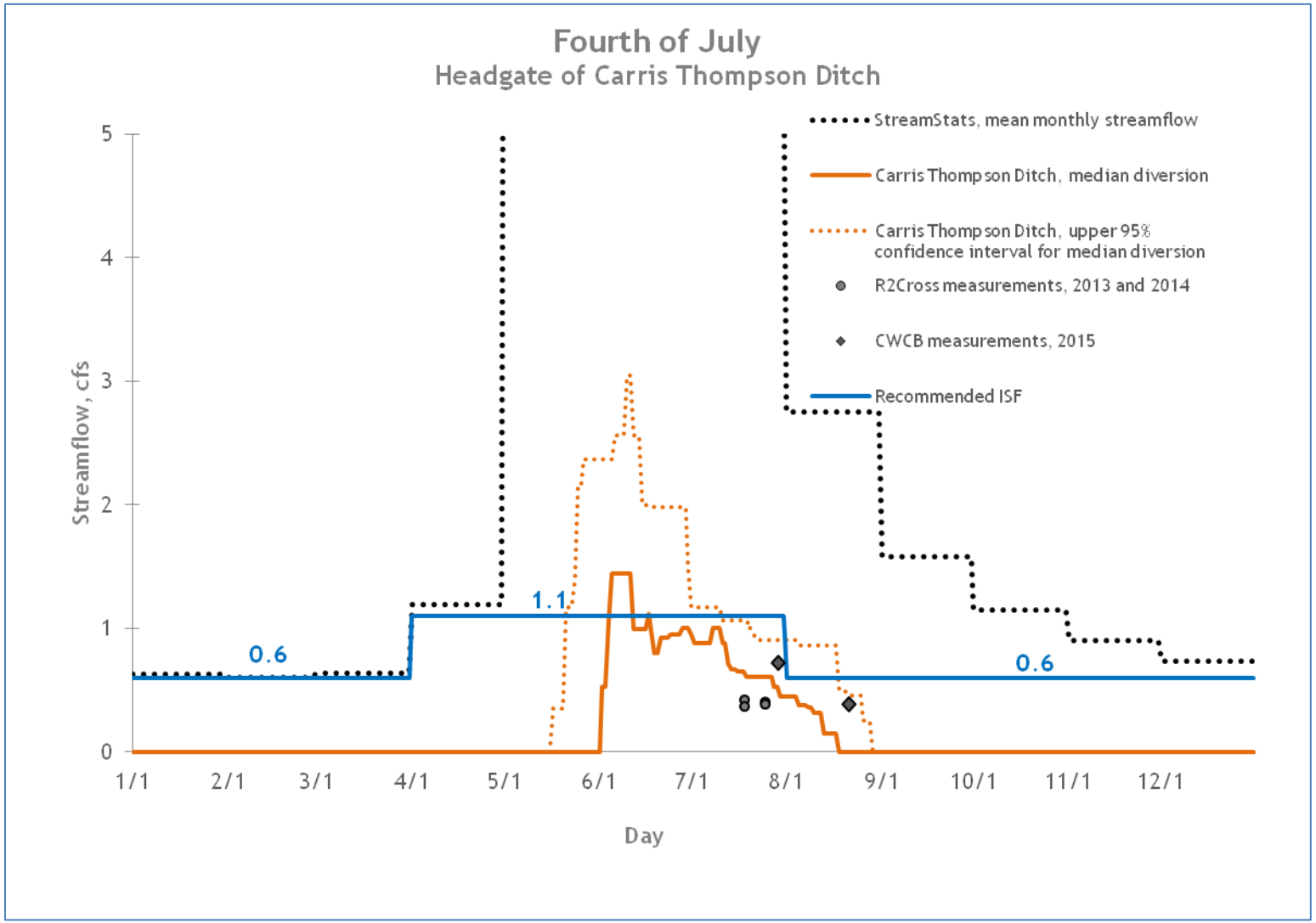
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Little Cimarron River
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence Firebox Creek UTM North: 4233064.75	UTM East: 284126.66
LOWER TERMINUS:	Confluence Van Boxel Creek UTM North: 4242731.81	UTM East: 284132.66
WATER DIVISION:	4	
WATER DISTRICT:	62	
COUNTY:	Gunnison	
WATERSHED:	Upper Gunnison (HUC#: 14020002)	
CWCB ID:	15/4/A-005	
RECOMMENDER:	Bureau of Land Management	
LENGTH:	7.64 miles	
FLOW RECOMMENDATION:	11.0 cfs (4/15-9/30) 7.0 cfs (10/1-10/31) 4.6 cfs (11/1-4/14)	
EXISTING ISF:	4-84CW396; 2.0 cfs (1/1-12/31)	

Little Cimarron River

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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an increase to the existing ISF water right on the Little Cimarron River. The CWCB currently holds an instream flow water right on the Little Cimarron River for 2.0 cfs (1/1-12/31), decreed in Case No. 4-84CW396. The BLM does not consider the current ISF water right to be sufficiently protective of the natural environment in the Little Cimarron River, in light of CWCB's current application of R2Cross. 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.

This reach is located within Gunnison County and is about 10 miles southeast of the Town of Cimarron (See Vicinity Map). The Little Cimarron River originates near Silver Mountain within the Uncompahgre Wilderness Area at an elevation of about 12,960 feet. The creek flows in a northerly direction as it drops to an elevation of 7,035 feet where it joins the Cimarron River. The proposed reach extends from the confluence with Firebox Creek downstream to confluence with Van Boxel Creek. Forty-six percent of the land on the 7.64 mile proposed reach is publicly owned and managed by the BLM and U.S. Forest Service (See Land Ownership Map).

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 Little Cimarron River is a cold-water, high 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 confined by bedrock in many locations. The stream generally has large substrate, consisting of mostly small cobbles and boulders of up to three feet in size. The stream has a good mix of large pools in meander bends, riffles and runs with some large woody debris.

Fisheries surveys have revealed a self-sustaining population of brook trout, with small numbers of lake 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 blue spruce and willow species. The riparian community is in very good condition and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in the Little Cimarron River.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
lake trout	*Salvelinus namaycush*	None

Justification for Increase

The R2Cross data summarized below clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing and spawning. When the existing instream flow rates are applied to the cross sections that were collected, the stream would exhibit between 20 percent and 45 percent wetted perimeter, so a significant portion of the potential habitat is not available.

The available habitat is further reduced when the existing instream flow rates are applied to the cross sections collected, because 2.0 cfs produces average depths ranging from 0.16 to 0.28 feet. These depths occur in a stream that averages 35 feet in width. While 0.28 feet is sufficient for fish passage, 0.16 feet is not. In many portions of the channel, depths may not be usable by the fish population. During the warm weather season, the fish population needs to have access to as much of the stream channel as possible for feeding, resting and spawning if it is to survive the pronounced cold winters in this location.

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 (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). 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 four 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 13.08 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 9.89 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 the Little Cimarron River.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	7/24/2014 - 1	20.7	8.3 – 51.7	9.64	10.26
BLM	7/24/2014 - 2	22.38	9.0 - 56.0	Out of range	12.34
BLM	7/27/2015 - 1	17.89	7.2 – 44.7	8.35	11.53
BLM	7/27/2015 - 2	17.52	7.0 – 43.8	11.69	18.20
			Mean	**9.89**	**13.08**

ISF Recommendation

The BLM recommends increased flows of 11.0 cfs (4/15 - 9/30), 7.0 cfs (10/1 - 10/31), and 4.6 cfs (11/1 - 4/14) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

13.00 cubic feet per second is recommended during the warm weather period from April 15 to September 30. Protecting this flow rate would require an increase of 11.0 cfs to the existing instream flow water right. This recommendation is driven by the average depth criteria and wetted perimeter. This portion of the river is at high altitude and within a dark canyon; it therefore experiences significant icing during the winter months. It is important to protect a flow rate that makes a majority of this habitat available to the fish population while they are completing critical life history functions during the warm weather months.

9.0 cubic feet per second is recommended from October 1 to October 31. This recommendation is driven by limited water availability. Protecting this flow rate would require an increase of 7.0 cfs to

the existing instream flow water rights. This flow rate will provide a transitional flow rate for the fish community between the higher flows during the warmer part of the year and low base flows during winter, allowing the population to adjust to gradually reduced physical habitat.

6.6 cubic feet per second is recommended during cold weather period from November 1 to April 14. Protecting this flow rate would require an increase of 4.6 cfs to the existing instream flow water right. This recommendation is driven by limited water availability. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter.

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 Little Cimarron Creek is 32.7 square miles, with an average elevation of 10,700 ft and average annual precipitation of 30.5 inches. There are no known transbasin imports or exports. Other than spring rights and instream flow water rights on Firebox Creek and Little Cimarron Creek, there is only one decreed absolute surface water diversion for

0.077 cfs decreed to the Stanfield Pipeline. Hydrology in this drainage basin represents essentially natural flow conditions. See the Hydrologic Features Map for more information.

Available Data

There is not a current or historic streamflow gage on Little Cimarron Creek. Little Cimarron Creek is tributary to the Cimarron River, which has a number of historical and current gages. Of these, the Cimarron River near Cimarron, CO gage (USGS 09126000) is the closest in proximity and drainage basin characteristics to the proposed reach on Little Cimarron Creek. The gage is located approximately 5.4 miles southwest from the proposed lower terminus. The gage has operated since 1954; however, Silver Jack Reservoir was constructed upstream from the gage and began regulating streamflow in late 1970. The average elevation of the Cimarron basin is 10,900 ft and the average annual precipitation is 32.64 inches. The Cimarron Feeder Garnet Ditch (appropriation date 1890, 50 cfs) is located upstream from Silver Jack Reservoir and exports water to water district 68. Therefore, hydrology in the basin tributary to the Cimarron River gage does not represent natural flow conditions and the gage underestimates natural streamflow.

CWCB staff made three streamflow measurements on the proposed reach of Little Cimarron Creek. These measurements are included in the water availability analysis.

Data Analysis

Staff examined climate stations to evaluate the gage record. The Cimarron climate station (Cimarron, Station ID USC00051609) has a relatively long period of record and is located about 13.8 miles north from Cimarron Gage (and about 10 miles north from the proposed lower terminus on Little Cimarron Creek). The average annual precipitation at the Cimarron station for the period of record (1951 to 2014, excluding incomplete years) is 13.4 inches. During the years the Cimarron Creek gage operated (1954 to 1970, excluding incomplete years), the average annual precipitation was 12.3 inches, with three years experiencing above average precipitation at the Cimarron Station and all others below average. Therefore, the Cimarron Creek gage record likely represents average or below average streamflow conditions.

Only Cimarron River gage data collected prior to Silver Jack Reservoir flow regulation was used to estimate streamflow (1/1/1954 to 12/22/1970). This time period is influenced by the Cimarron Feeder Garnet Ditch, but does not reflect later reservoir operations. The Cimarron River gage was scaled to the proposed lower terminus of Little Cimarron Creek using a proration factor of 0.46 based on 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. It should be noted that the Cimarron River gage was originally located approximately 0.4 miles downstream from the current location and was moved in 1972. The current gage location was used to determine the proration factor, but any differences in location are negligible given a less than 1 percent difference in drain basin characteristics between the two locations. Median streamflow and 95% confidence intervals for the median were calculated using scaled Cimarron River gage record.

StreamStats was also evaluated at the lower terminus of the proposed Little Cimarron Creek reach.

Water Availability Summary

The hydrographs (See Complete and Detailed Hydrographs) show StreamStats results for mean-monthly streamflow and median and 95% confidence intervals for median streamflow for the prorated Cimarron River gage data. The proposed ISF is below the StreamStats and median

streamflow estimates the majority of the time and below the upper 95% confidence interval at all times. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Little Cimarron 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.

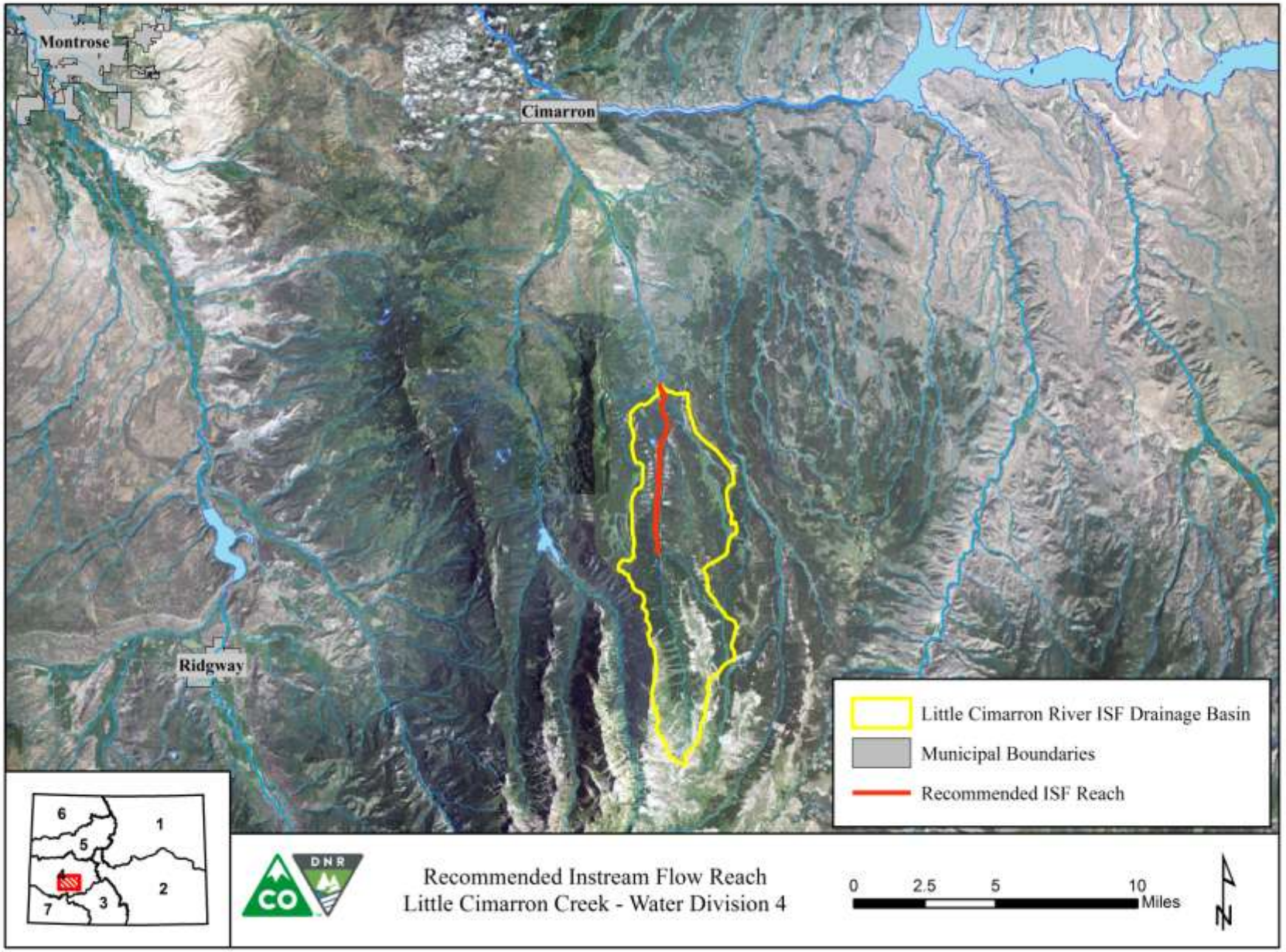
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

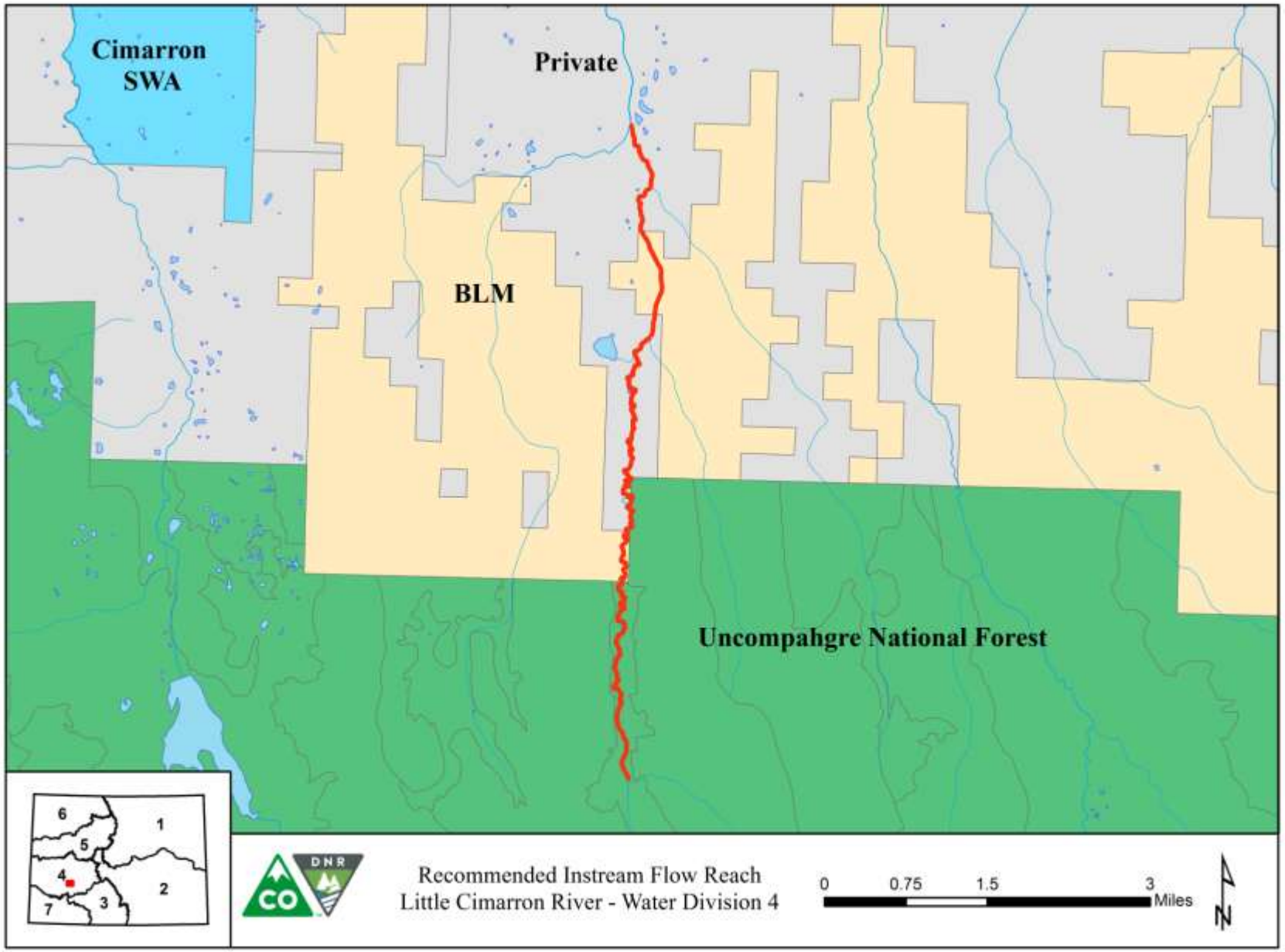
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

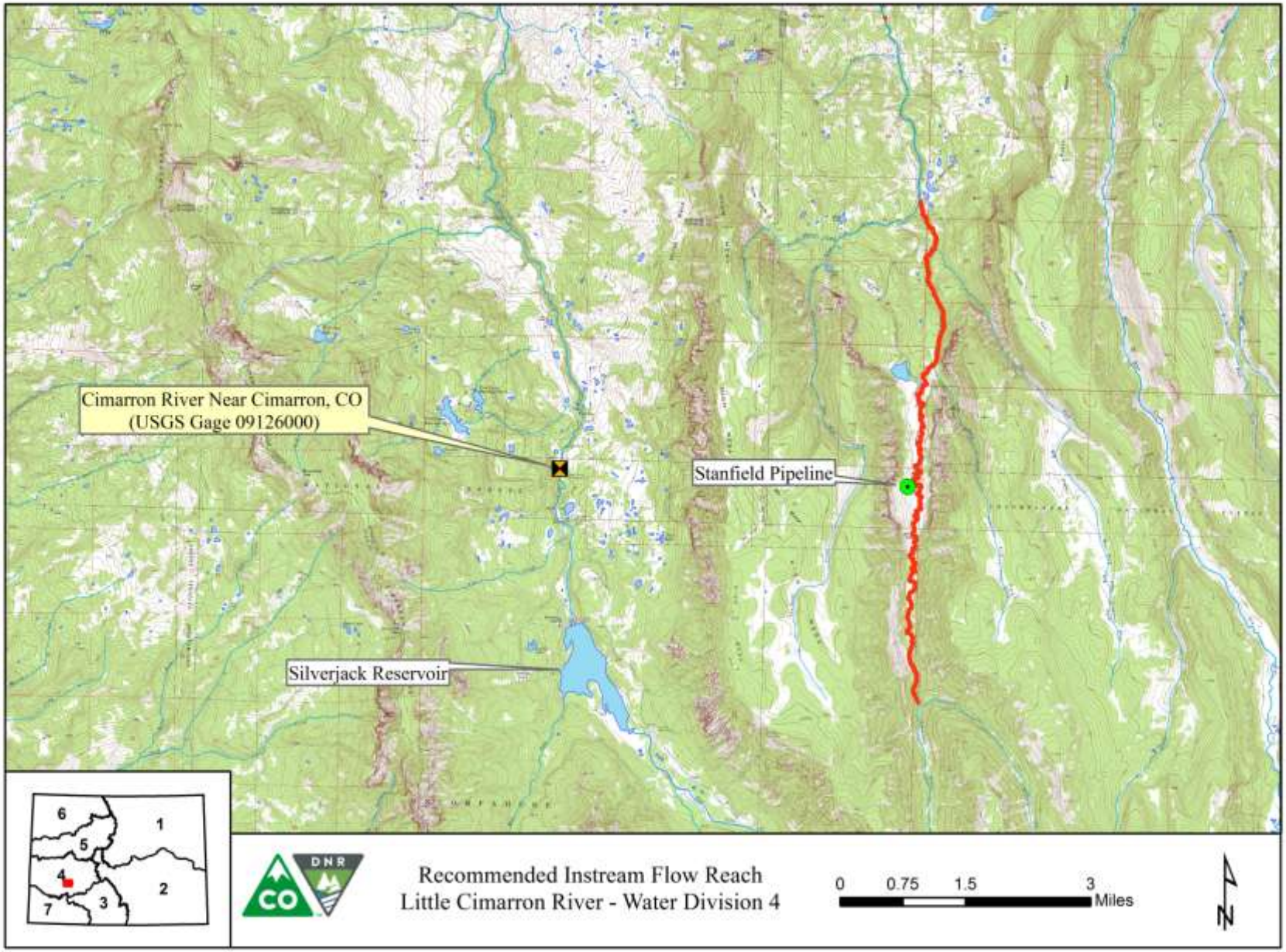
VICINITY MAP



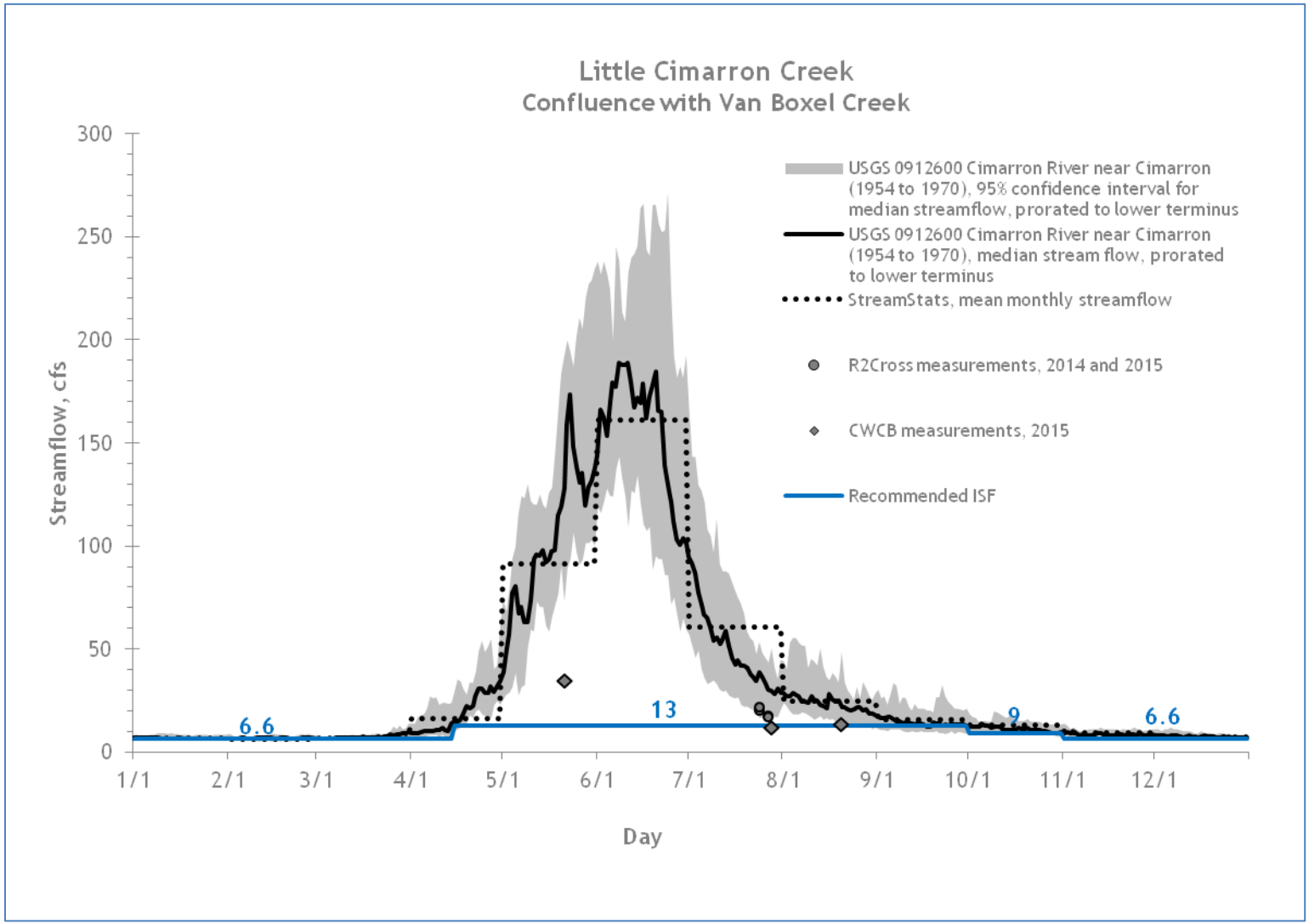
LAND OWNERSHIP MAP



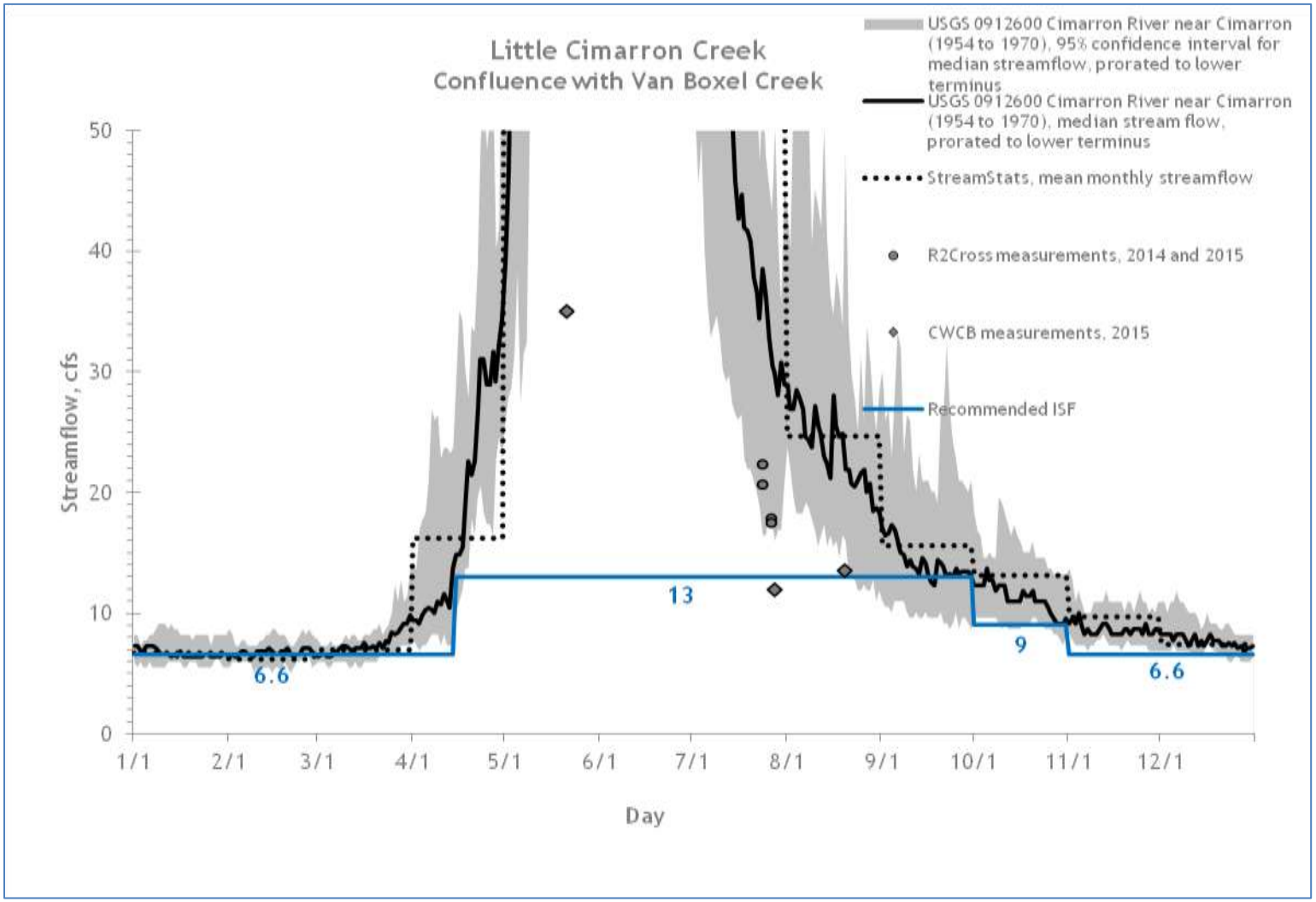
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

East Hawxhurst Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Outlet of McCurry Reservoir UTM North: 4360638.30 UTM East: 251782.92
LOWER TERMINUS:	Confluence with West Hawxhurst Creek UTM North: 4353102.99 UTM East: 248989.35
WATER DIVISION:	5
WATER DISTRICT:	72
COUNTY:	Mesa
WATERSHED:	Colorado Headwater-Plateau (HUC#: 14010005)
CWCB ID:	16/5/A-002
RECOMMENDER:	Bureau of Land Management
LENGTH:	5.75 miles
FLOW RECOMMENDATION:	1.70 cfs (4/15 – 6/30) 0.46 cfs (7/1 – 4/14)

East Hawxhurst 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of East Hawxhurst Creek. This reach is located in Mesa County about 4 miles northeast of Collbran (See Vicinity Map). East Hawxhurst Creek originates on the south flank of Battlement Mesa at an elevation of 10,680 ft. The creek flows in a southerly direction as it drops to an elevation of 8,600 feet where it joins West Hawxhurst Creek to form Hawxhurst Creek, a tributary to Plateau Creek. The proposed reach extends from the outlet of McCurry Reservoir downstream to the confluence with West Hawxhurst Creek. Ninety-nine percent of the land on the 5.75 mile proposed reach is publicly owned and managed by a combination of the BLM, Colorado Parks and Wildlife, and the U.S. Forest Service (See Land Ownership Map). The BLM recommended this reach of East Hawxhurst 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.

East Hawxhurst Creek is a cold-water, high gradient stream. The stream is confined by bedrock in most locations. The stream generally has medium-sized substrate, consisting of gravels and small cobbles, and small boulders. The stream has a good mix of pools, small riffles, and runs. While deep pool habitat is absent, the existing pools are sufficient for overwintering fish.

Fisheries surveys have revealed a self-sustaining population of native cutthroat trout and rainbow 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 very diverse and is comprised of box elder, red osier dogwood, birch, willow species, and alder. The riparian community is in very good condition, and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in East Hawxhurst Creek.

Species Name	Scientific Name	Status
native cutthroat trout	*Oncorhynchus clarki*	None
rainbow trout	*Oncorhynchus mykiss*	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

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 (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). 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 1.67 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 1.31 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 East Hawxhurst Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	10/1/2011 - 1	0.69	0.28 – 1.73	1.19	Out of range
BLM	7/22/2014 - 1	1.09	0.44 – 2.73	1.44	1.67
			Mean	**1.31**	**1.67**

ISF Recommendation
The BLM recommends flows of 1.7 cfs (4/1 – 7/31), and 0.65 cfs (8/1 – 3/31) based on R2Cross modeling analyses and biological expertise. Staff recommends 1.7 cfs (4/15 – 6/30) and 0.46 cfs (7/1 – 4/14) due to water availability limitations.

1.70 cubic feet per second is recommended during the snowmelt runoff period and summer, from April 15 to June 30. This recommendation is driven by the wetted perimeter criteria. This creek is very steep and has limited usable habitat, so it is important to protect a flow rate that makes a high percentage of this habitat available to the fish population while they are completing critical life history functions during the warm weather months.

0.46 cubic feet per second is recommended during the cold weather period from August 1 to April 14. This recommendation is driven by limited water availability. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

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 East Hawxhurst Creek is 5.73 square miles, with an average elevation of 8,910 ft and average annual precipitation of 28.57 inches. There are no known surface water diversions within the basin tributary to the proposed ISF. Hawxhurst Reservoir (also known as McCurry Reservoir, appropriation date 1911, 283 AF) is a small reservoir located near the headwaters of the basin. There are no known transbasin imports or exports. Hydrology in this drainage basin represents somewhat altered conditions due to Hawxhurst Reservoir. See the Hydrologic Features Map for more information.

Available Data

There is not a current or historic streamflow gage on Hawxhurst Creek. The closest gage identified was the historic Brush Creek near Collbran, CO gage (USGS 09097600). The gage was located in a drainage basin approximately 4.3 miles northeast from the proposed lower terminus. The gage has a continuous short period of record from 1955 to 1967. The Brush Creek gage has a 9.29 square mile drainage basin with an average elevation of 9,590 ft and average precipitation of 30.96 inches. Brush Creek drains the southern edge of Battlement Mesa and is oriented similar to Hawxhurst Creek. The Brown No 1 Ditch (appropriation date 1928, 0.78 cfs) has absolute decreed water rights with diversion records in the drainage basin tributary to the historic gage. This structure irrigates land upstream from the Brush Creek gage and return flows may accrue to the stream above the gage.

Hawxhurst Reservoir has daily reservoir release records for 7 years (1976, 1982, 1985, 1987, 1988, 1989, and 1990). There are infrequent records that report annual or monthly total release volumes for a number of other years, but there was insufficient information to estimate daily values from these records. A number of years have no data, or incomplete data. In addition, Hawxhurst Reservoir has not been usable due to a breach since 2006.

CWCB staff made one streamflow measurement on the proposed reach of East Hawxhurst Creek. This measurement is included in the water availability analysis.

Data Analysis

Due to the short period of record available for the Brush Creek gage, 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. However, none of the gages evaluated produced a reasonable regression coefficient and none were found suitable for regression extension.

Staff also examined climate stations and found that the Collbran climate station (Collbran, Station USC00051741, downloaded 1/10/2015) had a long, nearly continuous period of record and is located about 4.5 miles southwest from the lower terminus. The average annual precipitation at the Collbran station for the period of record (1893 to 1999, excluding years with incomplete records) was 14.89

inches. During the complete years the Brush Creek gage operated (1956 to 1966), the average precipitation was 13.41 inches, with five years above average precipitation at the Collbran station and six years below average. Therefore, the Brush Creek gage record likely represents average precipitation conditions.

The Brush Creek gage was analyzed using the period of record available (1955 to 1967). The effects of the Brown No. 1 diversion were assumed to be included in the gage data. The gage record was scaled by 0.57 to the lower terminus on East Hawxhurst Creek 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 analysis was not adjusted by the Hawxhurst reservoir releases due to the small number of years with daily release records. Median streamflow was calculated using the scaled Brush Creek gage record. 95% confidence intervals were not calculated due to the short period of record at the Brush Creek gage.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median streamflow calculated from the scaled Brush Creek gage record. Median streamflow is above the proposed ISF at all times. Staff concludes that water is available for appropriation.

Material Injury
Because the proposed ISF on East Hawxhurst 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.

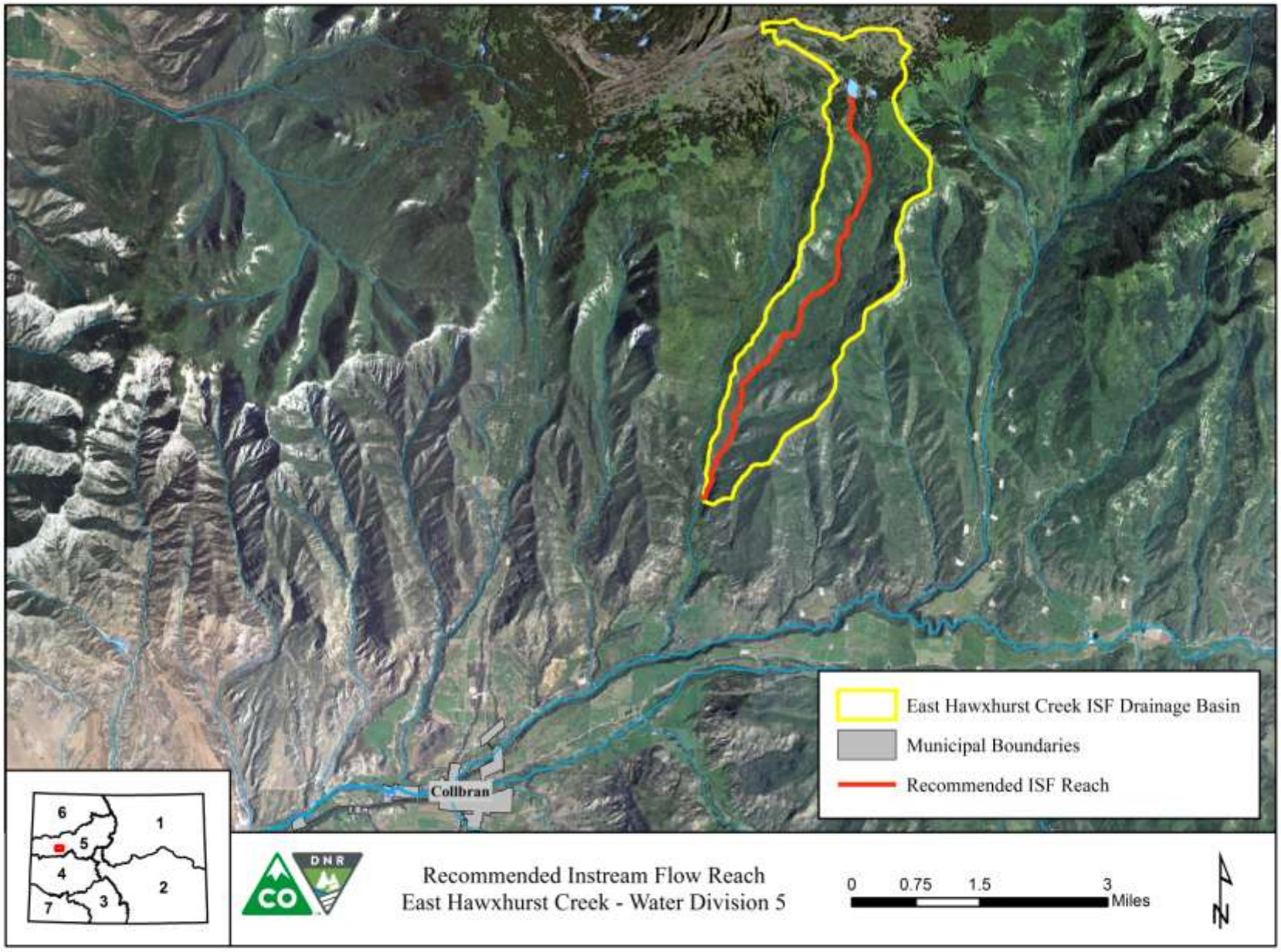
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

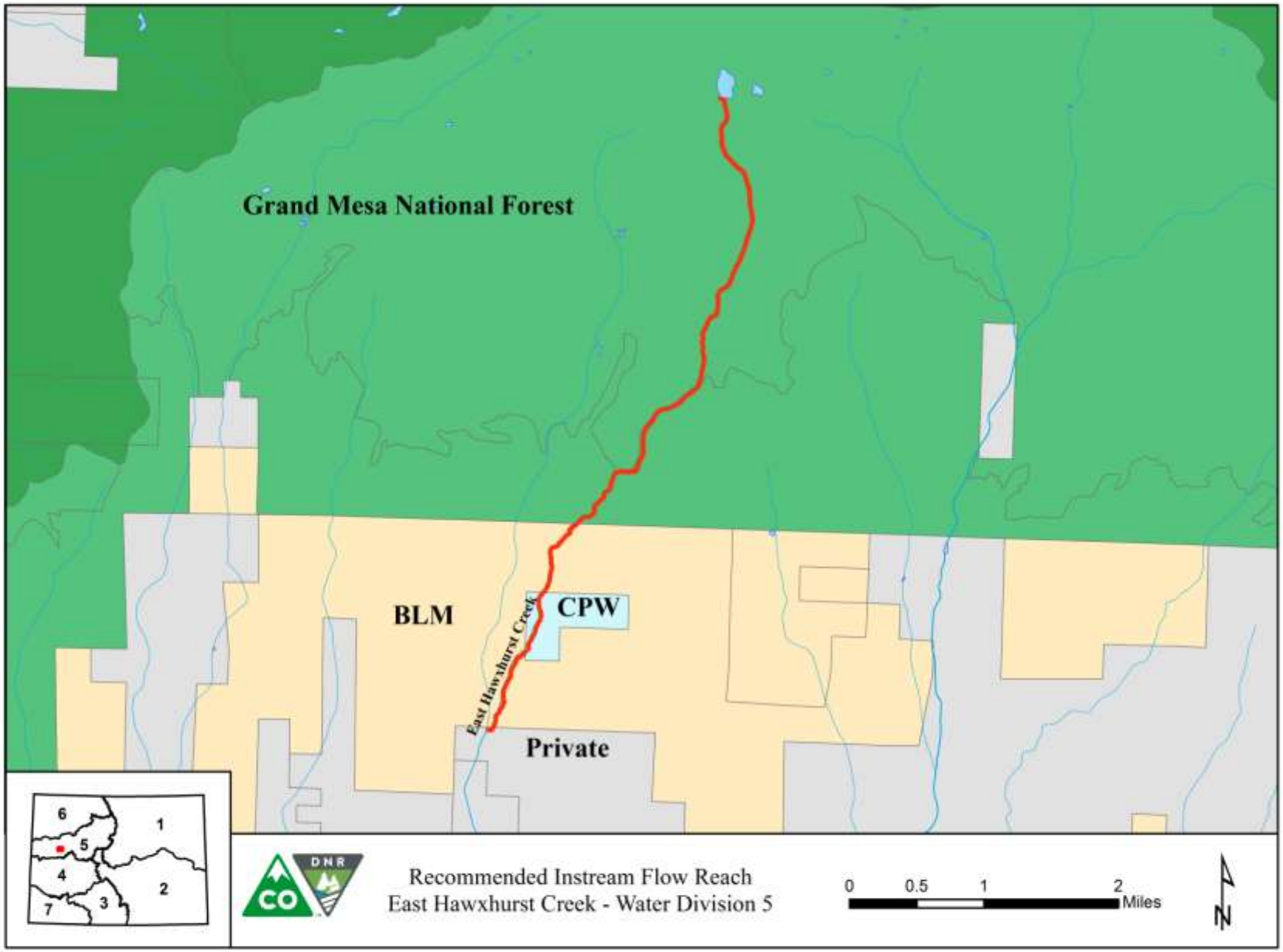
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

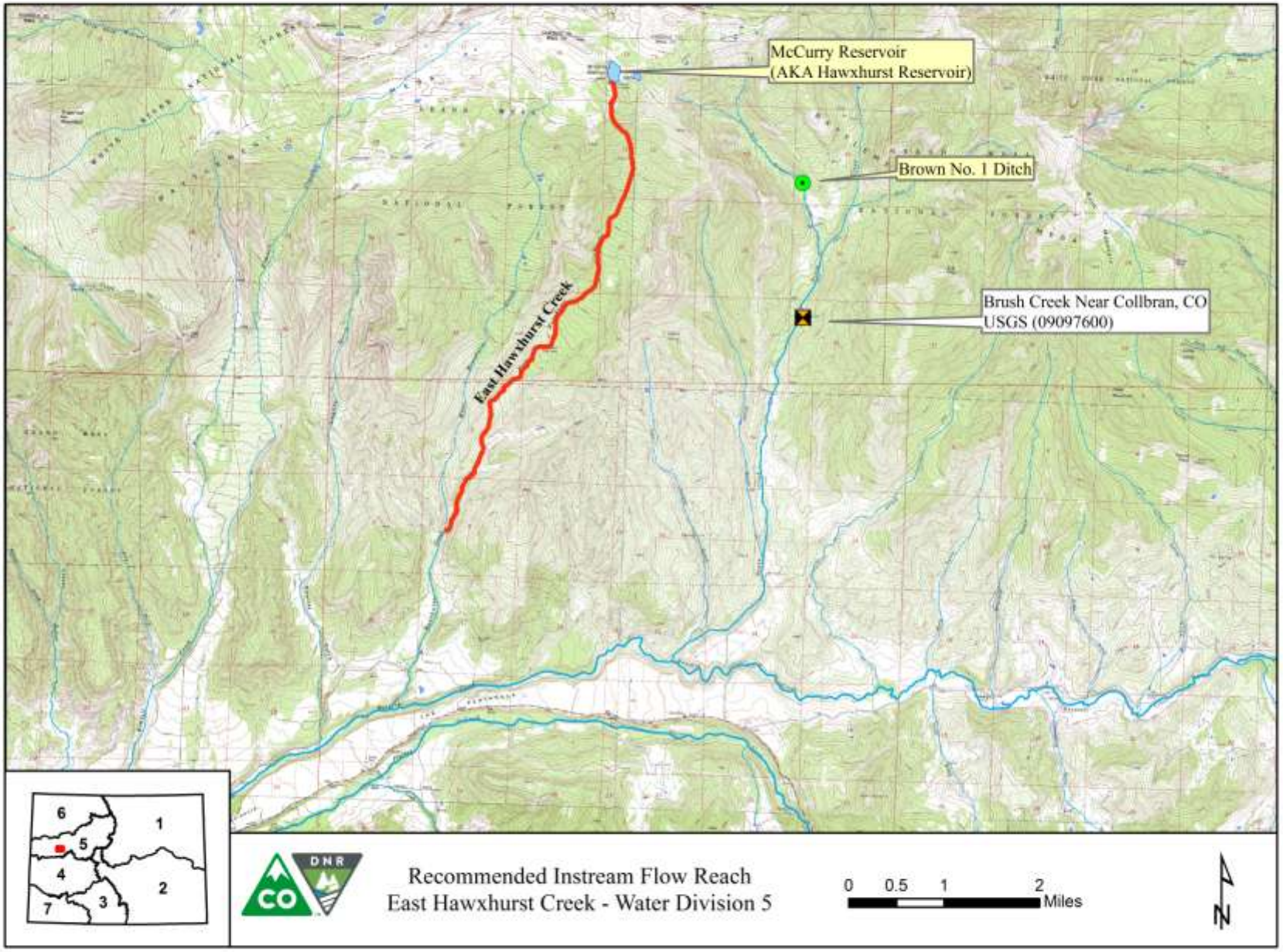
VICINITY MAP



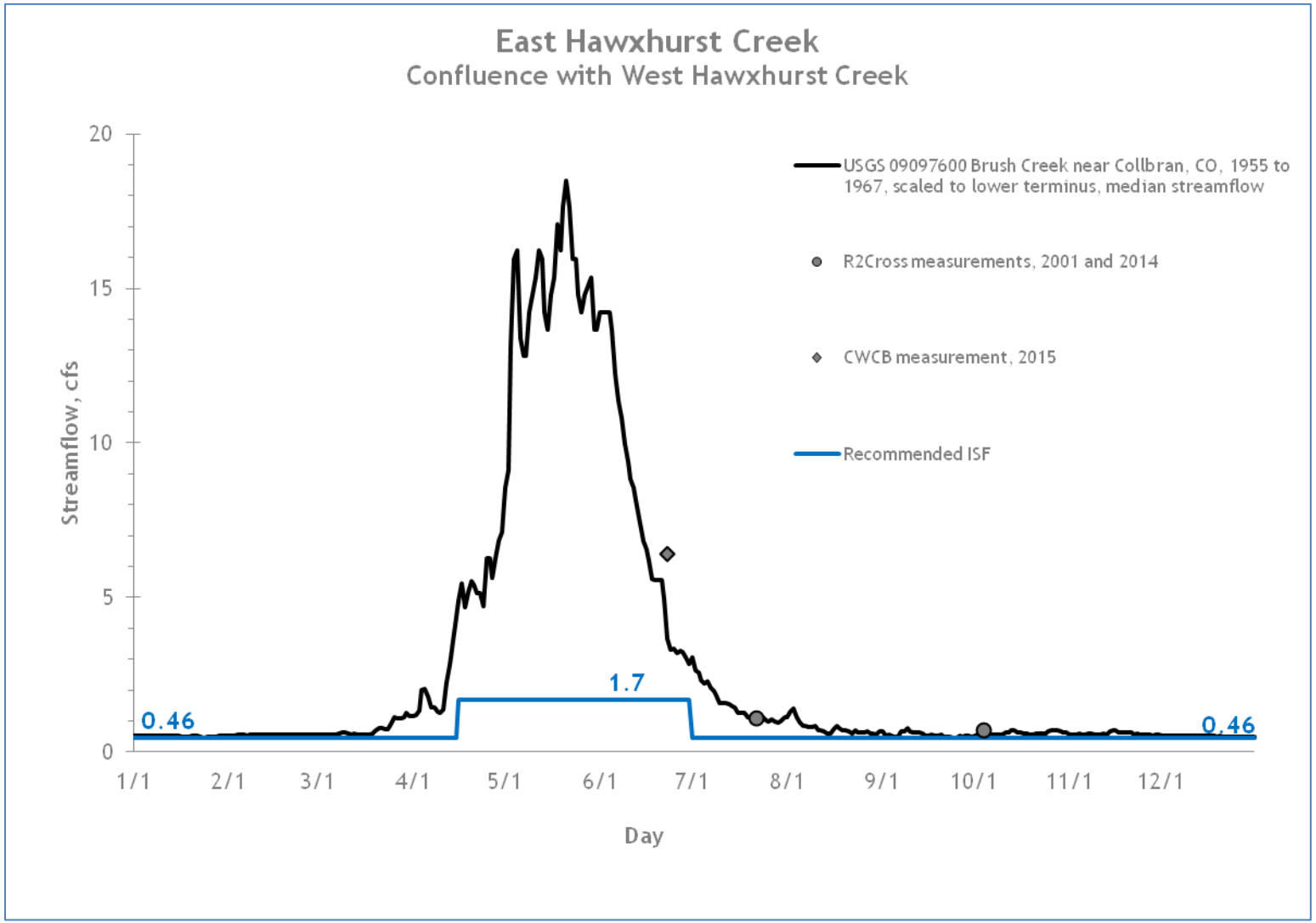
LAND OWNERSHIP MAP



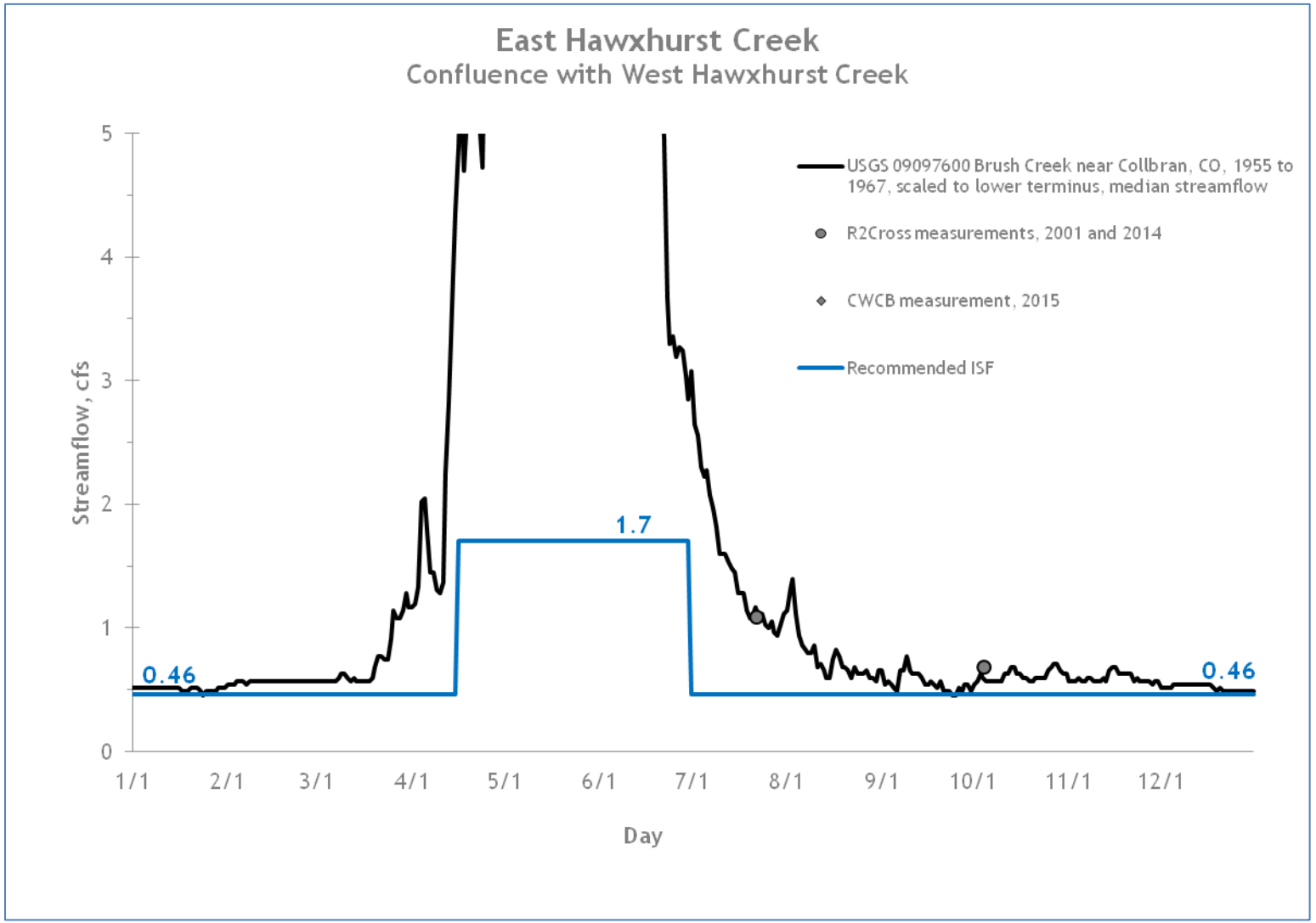
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Morgan Gulch
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4421517.50 UTM East: 409451.48
LOWER TERMINUS:	Confluence with Williams Fork River UTM North: 4419544.92 UTM East: 404582.18
WATER DIVISION:	5
WATER DISTRICT:	51
COUNTY:	Grand County
WATERSHED:	Colorado Headwaters (HUC#: 14010001)
CWCB ID:	16/5/A-004
RECOMMENDER:	Bureau of Land Management
LENGTH:	4.1 miles
FLOW RECOMMENDATION:	2.1 cfs (5/1 – 7/31) 0.8 cfs (8/1 – 9/30) 0.3 cfs (10/1 – 4/30)

Morgan Gulch

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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on Morgan Gulch. This stream is located within Grand County about 20 miles north of the town of Silverthorne (See Vicinity Map). Morgan Gulch originates on the Arapaho National Forest at an elevation of 9,800 ft approximately 6.7 miles southeast of Williams Fork Reservoir. The creek flows in a westerly direction as it drops to an elevation of 8,320 feet where it joins the Williams Fork River. The proposed reach extends from the headwaters downstream to the confluence with the Williams Fork River. Ninety-five percent of the land on the 4.1 mile proposed reach is publicly owned and managed by the BLM and the U.S. Forest Service (See Land Ownership Map). The BLM recommended this reach of Morgan Gulch 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.

Morgan Gulch is a cold-water, high gradient stream. It flows through a narrow valley floor slightly less than one-fourth mile in width. The stream cuts through alluvial deposits in the narrow valley and is confined by bedrock in many locations. The stream generally has small-sized substrate, consisting of gravels and small cobbles. The stream has a good mix of pools, small riffles, and runs.

Fisheries surveys have revealed a self-sustaining population of brook 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 Douglas fir, subalpine fir, willow species, and alder. The riparian community is in very good condition, and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in Morgan Gulch.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	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

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 (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). 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 four 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 2.12 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 1.16 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 Morgan Gulch.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	6/30/2014 - 1	0.93	0.37 – 2.33	0.84	2.05
BLM	6/30/2014 - 2	1.15	0.46 – 2.88	1.48	Out of range
BLM	6/05/2013 - 1	5.01	2.00 – 12.53	Out of range	2.29
BLM	6/05/2013 - 2	5.01	2.00 – 12.53	Out of range	2.01
			Mean	**1.16**	**2.12**

ISF Recommendation

The BLM recommends flows of 0.3 cfs (10/1 – 4/30), 2.1 cfs (5/1 – 7/31), and 0.80 cfs (8/1 – 9/30) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

2.1 cubic feet per second is recommended during the snowmelt runoff period from May 1 to July 31. This recommendation is driven by the average depth criteria. This creek is narrow and has limited physical habitat, so it is important to protect a flow rate that makes most of this habitat available to the fish population while they are completing critical life history functions during the warm weather months.

0.8 cubic feet per second is recommended during late summer, from August 1 to September 30. This recommendation is driven by limited water availability. This flow rate exceeds the wetted perimeter and average velocity criteria in most cross sections that were surveyed, and it meets the average depth criteria in some, but not all locations, that were surveyed.

0.3 cubic feet per second is recommended from October 1 to April 30. This recommendation is driven by limited water availability. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

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 Morgan Gulch is 3.61 square miles, with an average elevation of 9,170 ft and average annual precipitation of 19.06 inches. There are no known surface water diversions within the basin tributary to the proposed ISF, with the exception of two small spring rights. There are also no reservoirs or transbasin import or exports. Hydrology in this drainage basin represents natural flow conditions. See the Hydrologic Features Map.

Available Data
There are no current or historic streamflow gages in the vicinity of the proposed ISF reach. There are two historic gages on Skylark Creek (USGS 9037200 Skylark Creek near Parshall, CO, 1958 to 1965) located 3 miles to the west and Keyser Creek (USGS 9036500 Keyser Creek near Leal, 1942 to 1952) located 5 miles to the southeast. Prorating flow at these gages to the lower terminus of the proposed ISF produced differing results that could not be confirmed to be representative of the proposed ISF reach.

CWCB staff made two streamflow measurements on the proposed reach of Morgan Gulch in addition to visiting the site in 2013 when R2Cross data was collected. These measurements are included in the water availability analysis.

Data Analysis
StreamStats provides the best available estimate of streamflow on Morgan Gulch.

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 Morgan Gulch 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.

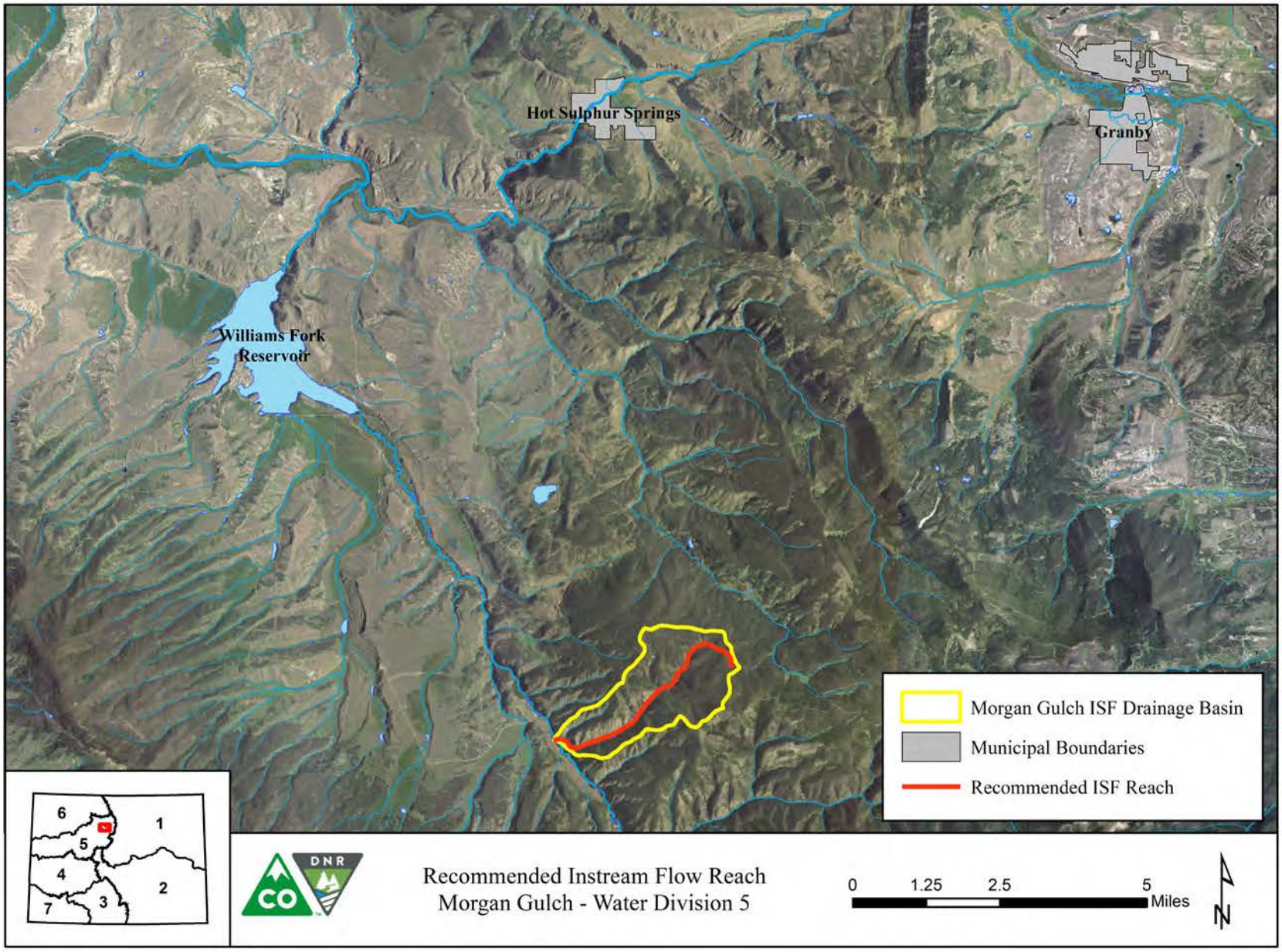
Nehring, B.R., 1979, Evaluation of Instream Flow Methods and Determination of Water Quantity Needs for Streams in the State of Colorado, Colorado Division of Wildlife.

Metadata Descriptions

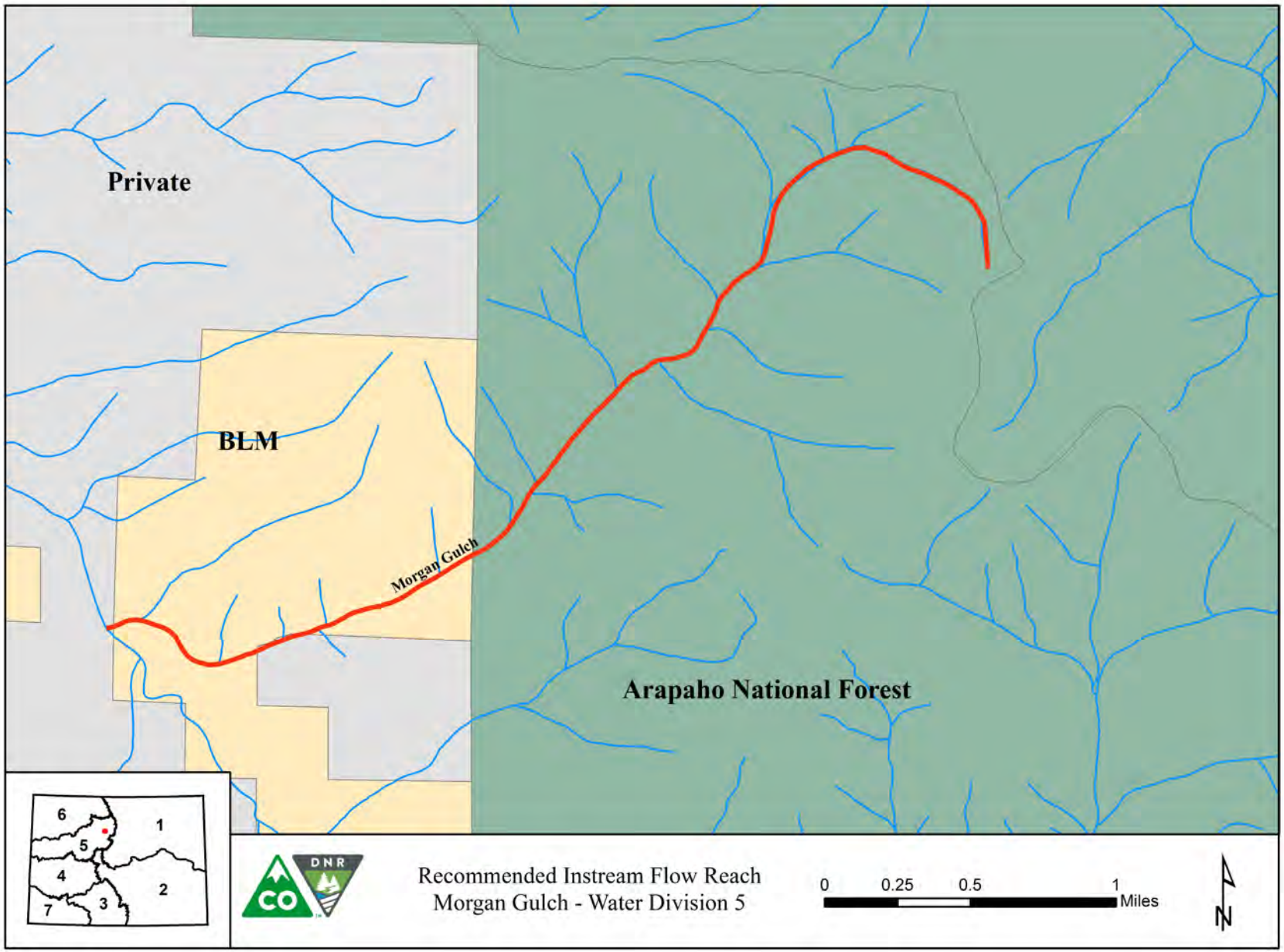
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

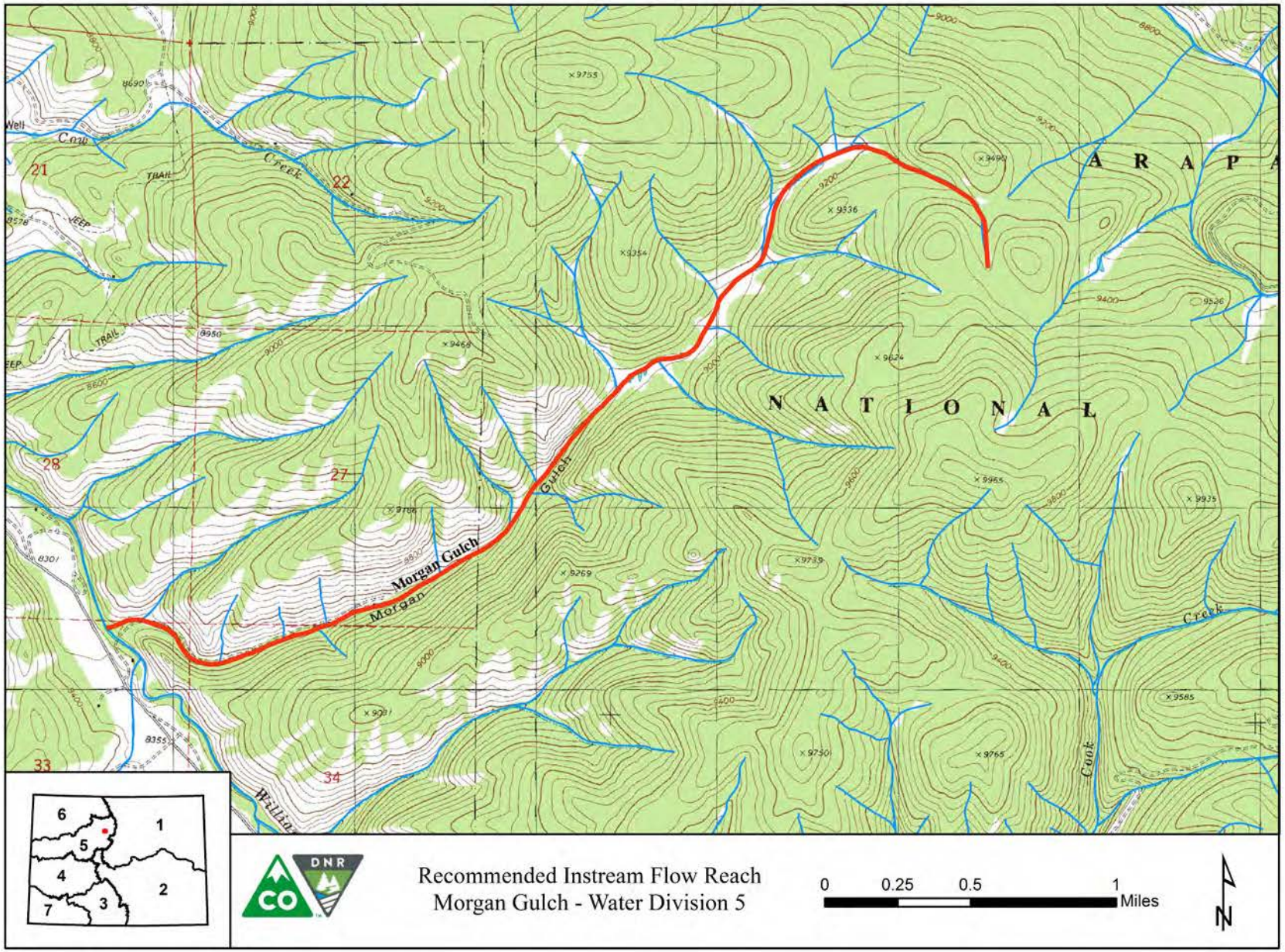
VICINITY MAP



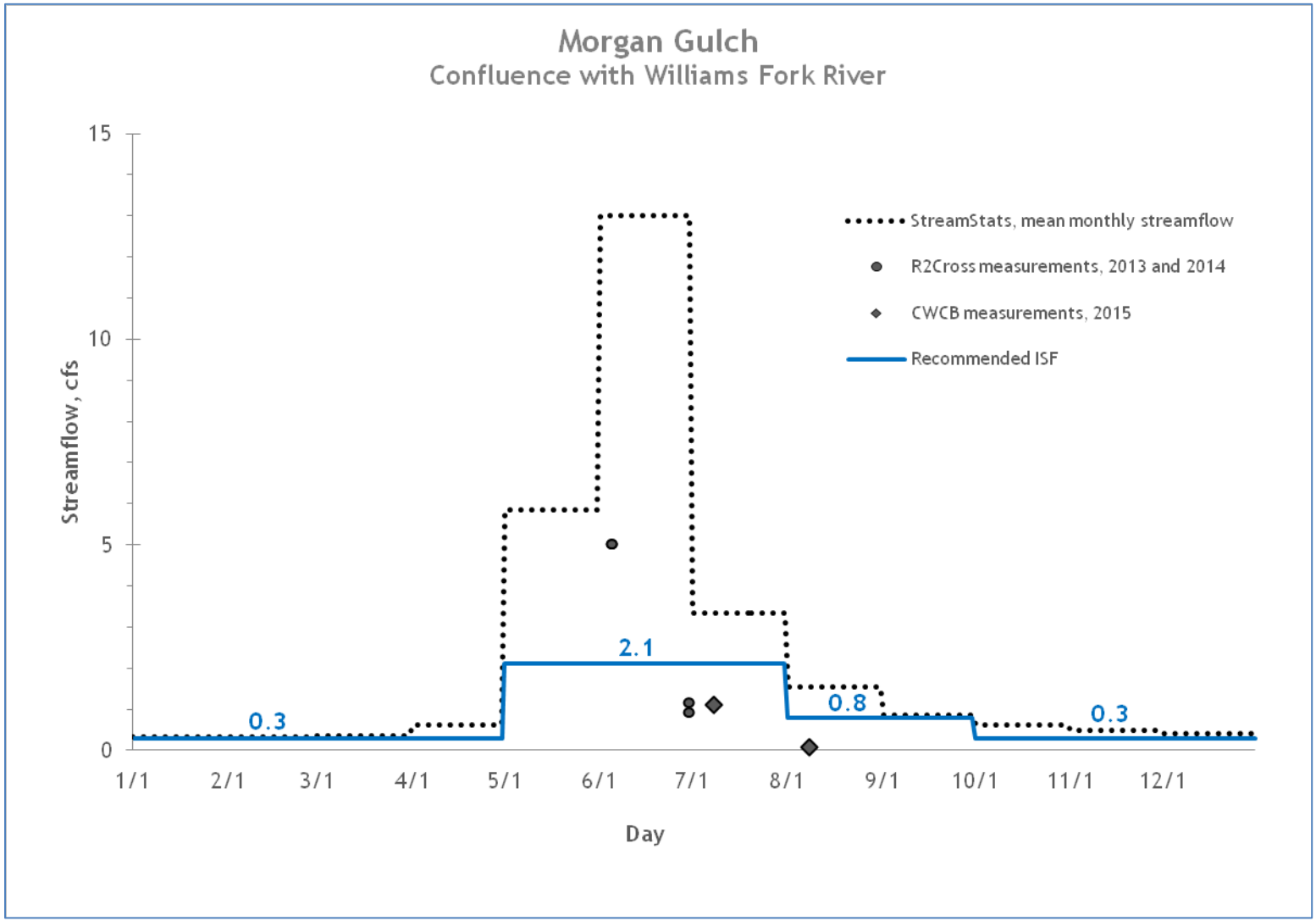
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

West Hawxhurst Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Headwaters in the vicinity of UTM North: 4361117.90 UTM East: 250123.61
LOWER TERMINUS:	Confluence with East Hawxhurst Creek UTM North: 4353102.99 UTM East: 248989.35
WATER DIVISION:	5
WATER DISTRICT:	72
COUNTY:	Mesa
WATERSHED:	Colorado Headwaters-Plateau (HUC#: 14010005)
CWCB ID:	16/5/A-003
RECOMMENDER:	Bureau of Land Management
LENGTH:	5.57 miles
FLOW RECOMMENDATION:	1.60 cfs (4/15 – 6/30) 0.56 cfs (7/1 – 4/14)

West Hawxhurst 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of West Hawxhurst Creek. This reach is located in Mesa County about 4 miles northeast of Collbran (See Vicinity Map). West Hawxhurst Creek originates on the south flank of Battlement Mesa at an elevation of 10,640 ft. The creek flows in a southerly direction as it drops to an elevation of 8,600 feet where it joins East Hawxhurst Creek to form Hawxhurst Creek, a tributary to Plateau Creek. The proposed reach extends from the headwaters downstream to the confluence with East Hawxhurst Creek. Ninety-nine percent of the land on the 5.57 mile proposed reach is publicly owned and managed by a combination of the BLM and the U.S. Forest Service (See Land Ownership Map). The BLM recommended this reach of West Hawxhurst 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.

West Hawxhurst Creek is a cold-water, high gradient stream. The stream is confined by bedrock in most locations. The stream generally has medium-sized substrate, consisting of gravels and small cobbles, and small boulders. The stream has a good mix of pools, small riffles, and runs. While deep pool habitat is absent, the existing pools are sufficient for overwintering fish.

Fisheries surveys have revealed a self-sustaining population of hybridized native cutthroat trout and rainbow 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 very diverse and is comprised of box elder, red osier dogwood, birch, willow species, and alder. The riparian community is in very good condition, and provides abundant shading and cover for fish habitat.

Table 1. List of fish species identified in West Hawxhurst Creek.

Species Name	Scientific Name	Status
native cutthroat trout	*Oncorhynchus clarkii*	None
rainbow trout	*Oncorhynchus mykiss*	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
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 (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). 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 three 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 1.63 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 1.23 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 West Hawxhurst Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	10/1/2011 - 1	1.15	0.46 – 2.88	1.51	2.01
BLM	7/22/2014 - 1	1.22	0.49 – 3.05	0.95	0.97
BLM	7/22/2014 - 2	1.10	0.44 – 2.75	1.24	1.91
			Mean	**1.23**	**1.63**

ISF Recommendation
The BLM recommends flows of 1.6 cfs (4/1 – 7/31), and 0.9 cfs (8/1 – 3/31) based on R2Cross modeling analyses and biological expertise. Staff recommends 1.6 cfs (4/15 – 6/30) and 0.56 cfs (7/1 – to 4/14) due to water availability.

1.60 cubic feet per second is recommended during the snowmelt runoff period and summer, from April 15 to June 30. This recommendation is driven by the wetted perimeter criteria. This creek is very steep and has limited usable habitat, so it is important to protect a flow rate that makes a high percentage of this habitat available to the fish population while they are completing critical life history functions during the warm weather months.

0.56 cubic feet per second is recommended during the cold weather period from July 1 to April 14. This recommendation is driven by limited water availability. This flow rate should prevent pools from freezing, allowing the fish population to successfully overwinter. Even though the base flow in this creek is small, it is extremely consistent, allowing the fishery to persist.

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 West Hawxhurst Creek is 6.57 square miles, with an average elevation of 9,300 ft and average annual precipitation of 30.71 inches. There is one surface water diversion within the basin tributary to the proposed ISF, the Hawxhurst Smalley Ditch (appropriation 1930 and 1950, 4.8 cfs). This diversion transports water out of the West Hawxhurst Creek drainage. There are no known transbasin imports. Hydrology in this drainage basin represents somewhat altered conditions due to the Hawxhurst Smalley Ditch. See the Hydrologic Features Map for more information.

Available Data

There is not a current or historic streamflow gage on West Hawxhurst Creek. The closest gage identified was the historic Brush Creek near Collbran, CO gage (USGS 09097600). The gage was located in a drainage basin approximately 4.3 miles northeast from the proposed lower terminus. The gage has a continuous short period of record from 1955 to 1967. The Brush Creek gage has a 9.29 square mile drainage basin. The average elevation of the basin is 9,590 ft and the average precipitation is 30.96 inches. Brush Creek drains the southern edge of Battlement Mesa and is oriented similar to West Hawxhurst Creek. The Brown No 1 Ditch (appropriation date 1928, 0.78 cfs) has absolute decreed water rights with diversion records in the drainage basin tributary to the historic gage. This structure irrigates land upstream from the Brush Creek gage and return flows may accrue to the stream above the gage.

The Hawxhurst Smalley ditch on West Hawxhurst Creek has daily diversion records starting in 1969 through present. Many intervening years do not have records and some years of records may be questionable based on previous water commission comments in the structure summary report. Based on discussions with Bruce Michaelson, the current water commissioner, water likely leaks through the diversion structure when it is in operation (personal communication, 1/5/2015). In addition, more senior water rights are located on the mainstem of Hawxhurst Creek downstream. These include the more senior rights for the following structures; McCurry Highline Ditch (appropriation dates 1888 to 1991, 5.29 cfs), McCurry Ditch (appropriation dates 1922 to 1991, 4.8 cfs), and Hawxhurst Ditch (appropriation dates 1988 to 1991, 13.99 cfs).

CWCB staff made one streamflow measurement on the proposed reach of West Hawxhurst Creek. This measurement is included in the water availability analysis.

Data Analysis

Due to the short period of record available for the Brush Creek gage, 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. However, none of the gages evaluated produced a reasonable regression coefficient and none were found suitable for regression extension.

Staff also examined climate stations and found that the Collbran climate station (Collbran, Station USC00051741, downloaded 1/10/2015) had a long, nearly continuous period of record and is located about 4.5 miles southwest from the lower terminus. The average annual precipitation at the Collbran station for the period of record (1893 to 1999, excluding years with incomplete records) was 14.89 inches. During the complete years the Brush Creek gage operated (1956 to 1966), the average precipitation was 13.41 inches, with five years above average precipitation at the Collbran station and six years below average. Therefore, the Brush Creek gage record likely represents average precipitation conditions.

The area-precipitation method was used to scale Brush Creek gage data to the West Hawxhurst Creek basin. The method estimates streamflow based on the ratio of the precipitation weighted drainage area. The scale factor for West Hawxhurst Creek basin at the lower terminus is 0.70, and for this analysis, the basin was subdivided into 0.55 for the contribution above the Hawxhurst Smalley Ditch and 0.15 for the contribution from the Ditch to the confluence with East Hawxhurst Creek. The location selected to represent the Hawxhurst Smalley ditch was slightly downstream from the location of the headgate in HydroBase to reflect tributaries also potentially captured by the ditch.

The Brush Creek gage was analyzed using the period of record available (1955 to 1967). Staff assumed the affects of the Brown No 1 diversion were included in the gage record. The Brush Creek gage data was scaled by 0.55 to the Hawxhurst Smalley ditch, as described above. The scaled data was adjusted for the Hawxhurst Smalley Ditch diversions by subtracting median Hawxhurst Smalley Ditch diversions. Additional flow accruing below the Hawxhurst Smalley Ditch was estimated by scaling the estimate of the Brush Creek gage by 0.15. The streamflow in both portions of the West Hawxhurst basin were then summed to estimate median streamflow at the proposed lower terminus. 95% confidence intervals were not calculated due to the short period of record at the Brush Creek gage.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show median streamflow for the Brush Creek gage adjusted for Hawxhurst Smalley Ditch diversions and scaled to the proposed lower terminus on West Hawxhurst Creek. The proposed ISF is below the median streamflow estimate at all times. Staff concludes that water is available for appropriation on West Hawxhurst Creek.

Material Injury
Because the proposed ISF on West Hawxhurst 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.

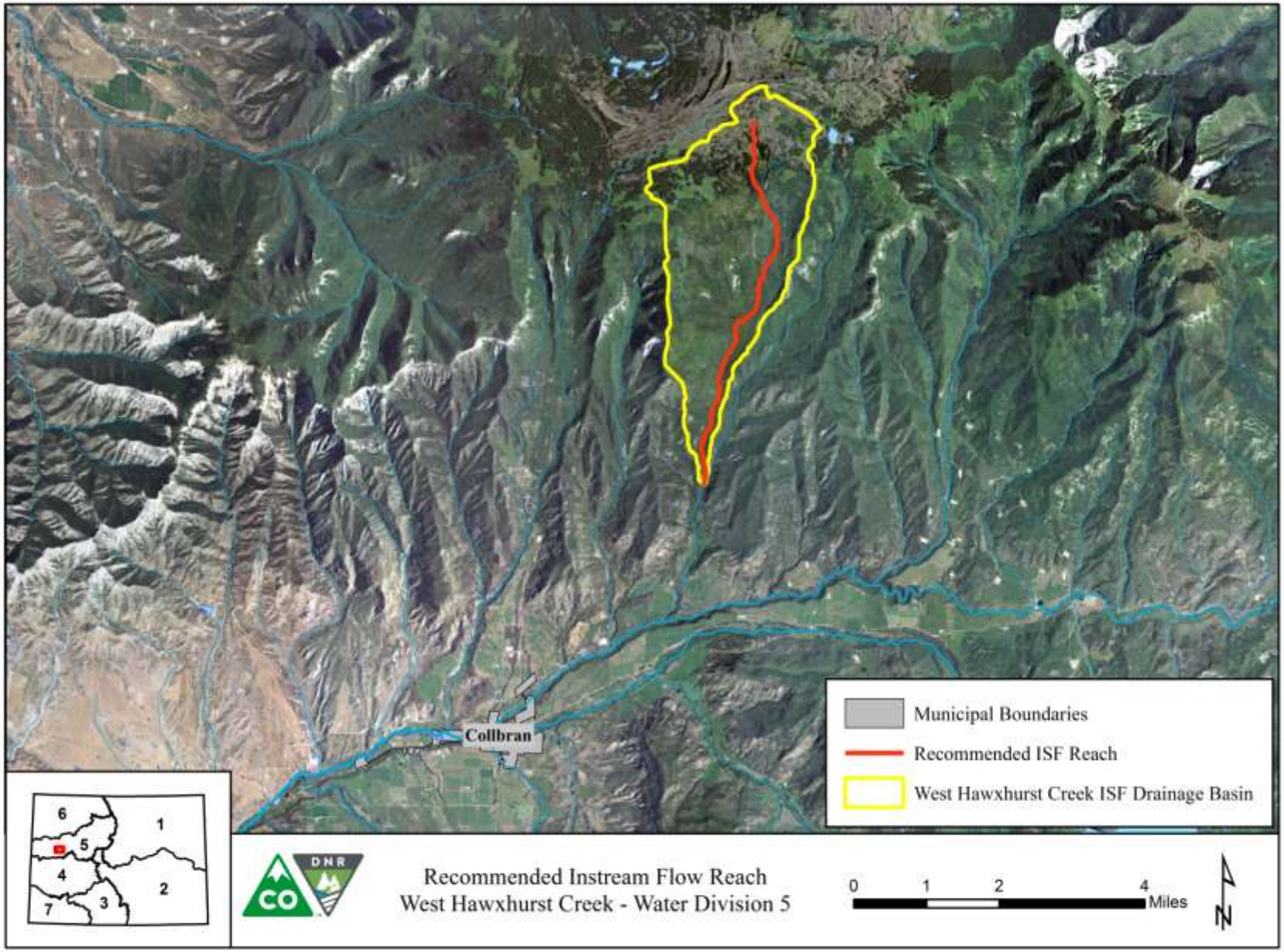
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

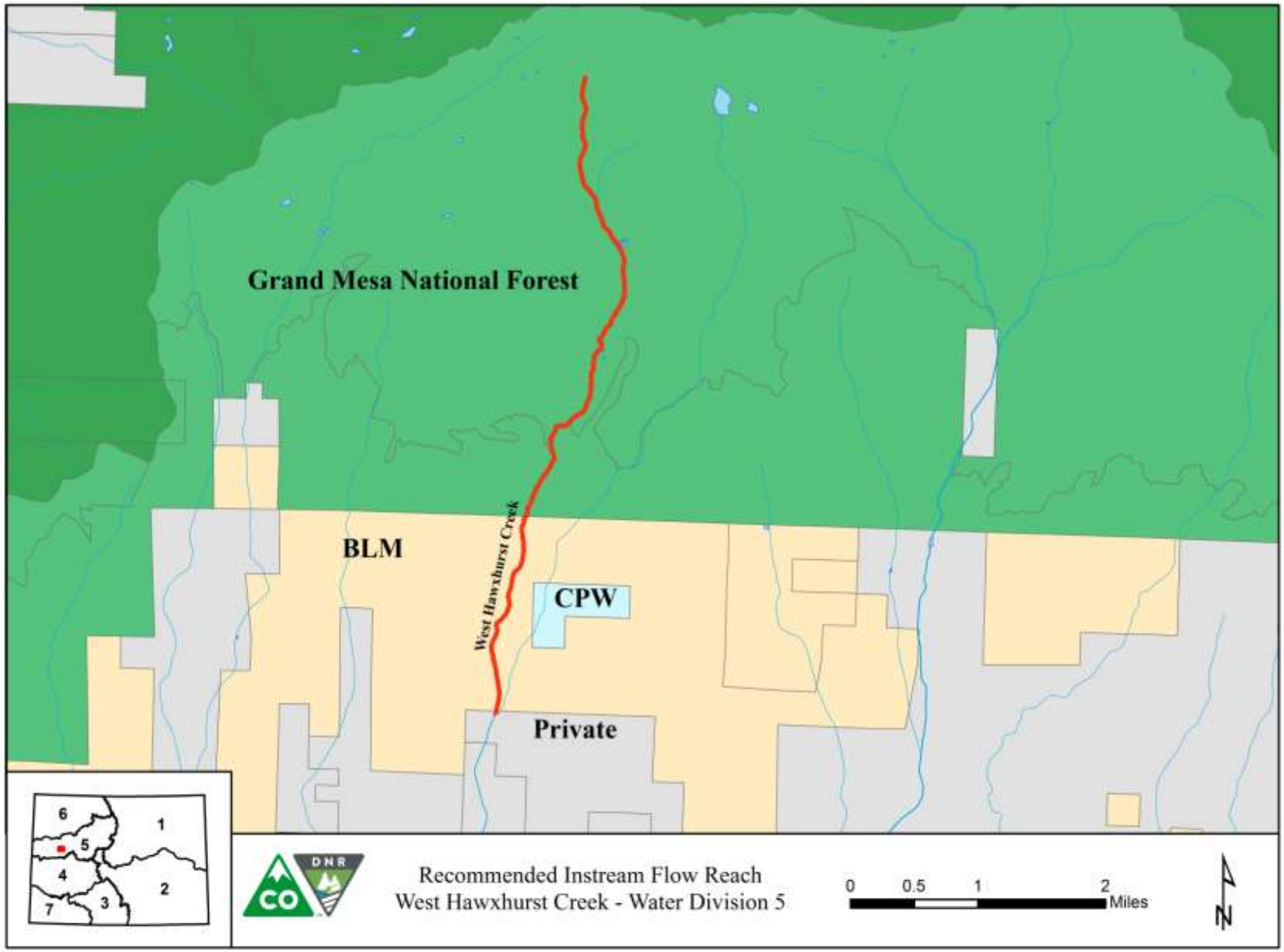
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

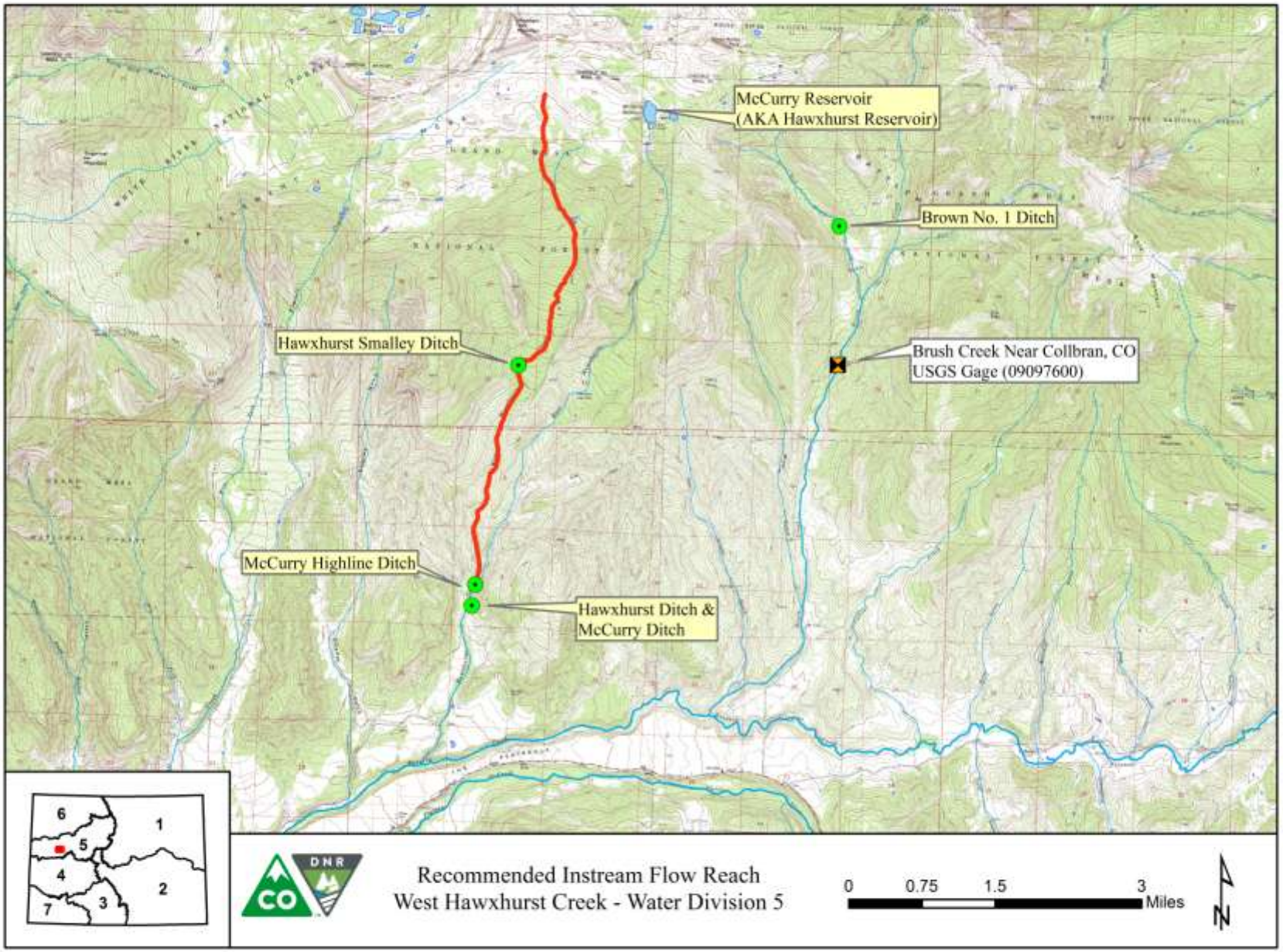
VICINITY MAP



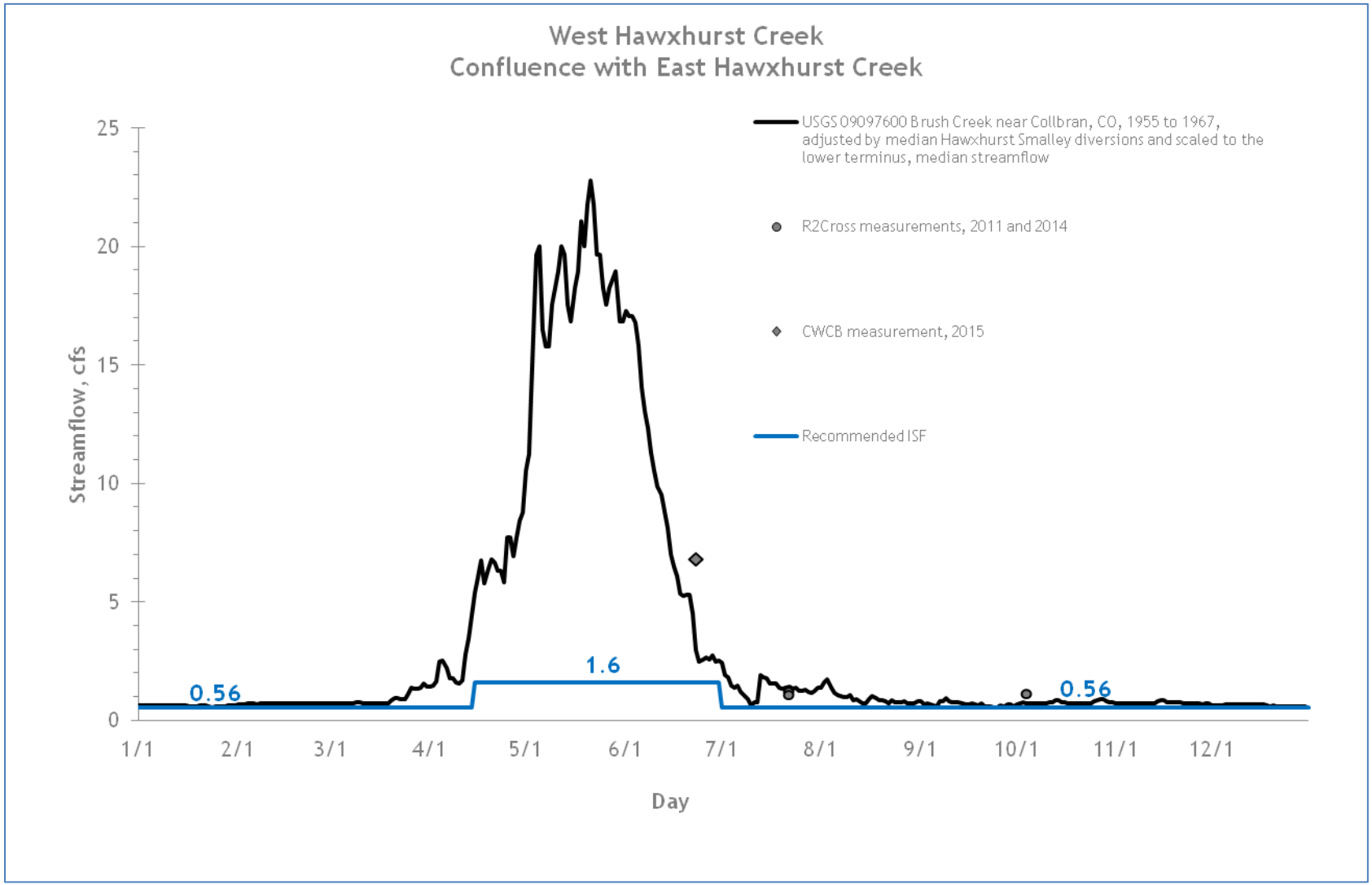
LAND OWNERSHIP MAP



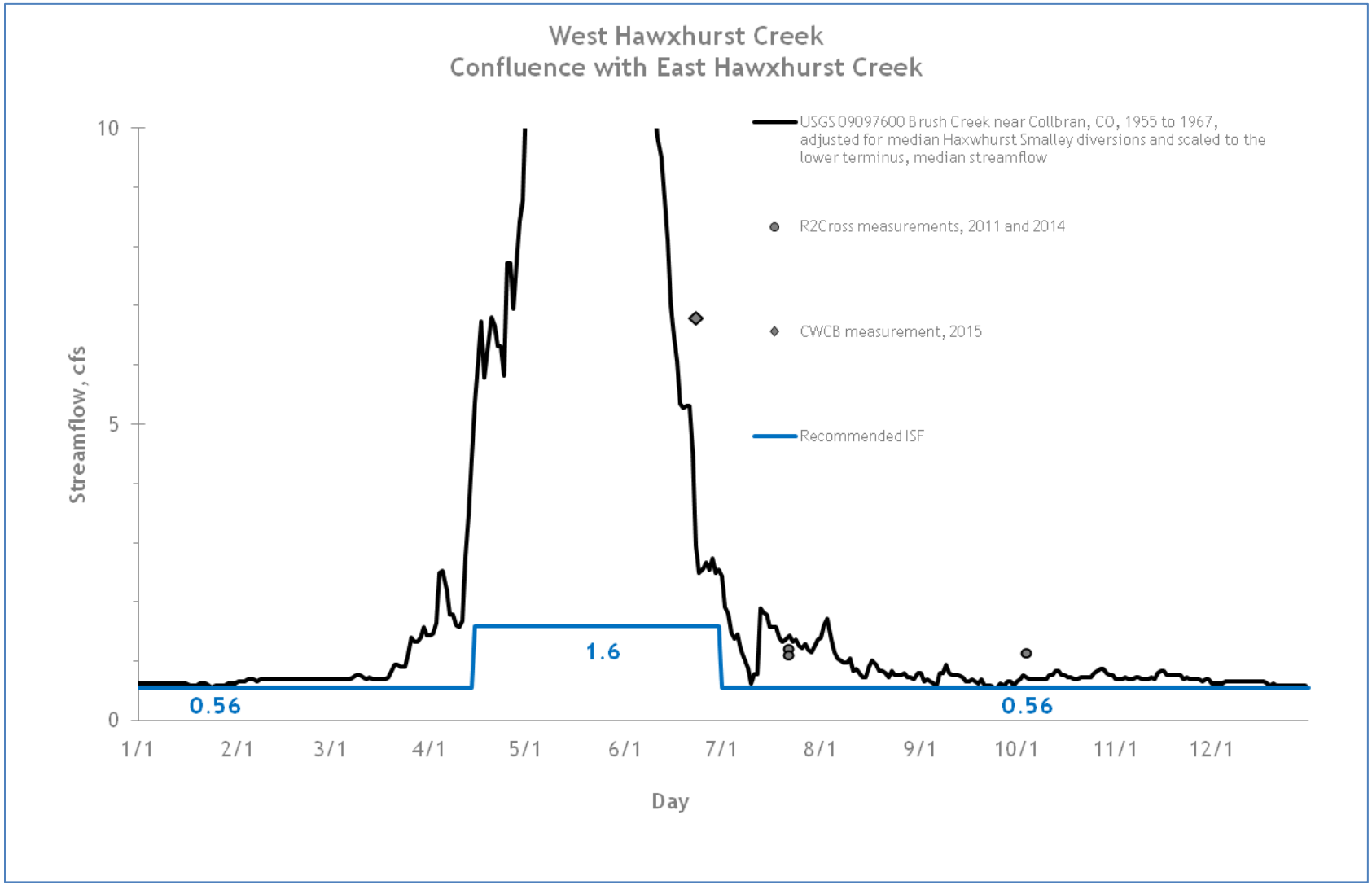
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Piceance Creek
EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence with the Dry Fork Piceance Creek UTM North: 4433646.00 UTM East: 222937.34
LOWER TERMINUS:	Confluence White River UTM North: 4442727.72 UTM East: 223357.83
WATER DIVISION:	6
WATER DISTRICT:	43
COUNTY:	Rio Blanco
WATERSHED:	Piceance – Yellow (HUC#: 14050006)
CWCB ID:	08/6/A-004
RECOMMENDER:	Bureau of Land Management
LENGTH:	9.96 miles
FLOW RECOMMENDATION:	4.0 cfs (1/1-12/31)

Piceance 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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Piceance Creek. This reach is located within Rio Blanco County about 17 miles west of the town of Meeker (See Vicinity Map). Piceance Creek originates on the west flank of Big Mountain in the White River National Forest at an elevation of 9,200 ft. The creek flows in a northwesterly direction as it drops to an elevation of 5,900 feet where it joins the White River. The proposed reach extends from the confluence with Dry Fork Piceance Creek downstream to the confluence with the White River. Fifty-eight percent of the land on the 9.96 mile proposed reach is publicly owned and managed by the BLM and Colorado Parks and Wildlife (See Land Ownership Map). The BLM recommended this reach of Piceance 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.

Piceance Creek is a moderate gradient stream in a canyon with variable widths. In some locations, there is sufficient width in the canyon bottom for the stream to meander over time. In other locations, stream movement is confined by bedrock. As such, the stream has a stable channel but has a highly variable substrate size. The stream has a good mix of riffle, run, and pool habitat to support native fish populations. Water quality, water temperatures, and food sources are also suitable for native species.

Fishery surveys indicate that the creek supports self-sustaining populations of flannelmouth suckers, speckled dace, and mountain sucker. Fish surveys have confirmed the presence of flannelmouth suckers during the fall, confirming that this species uses the creek year-round and not just during the spring spawning season. Very few significant tributaries enter the White River at the low elevations that are required for flannelmouth sucker habitat. Accordingly, this tributary provides a very important extension of the flannelmouth sucker habitat in the White River. The creek is also known to provide habitat for leopard frogs, which appear on BLM's sensitive species list.

The creek supports a riparian community comprised of willows, sedges, and rushes. The riparian community has been impacted by historic grazing practices but is now on an upward trend.

Table 1. List of fish species identified in Piceance Creek.

Species Name	Scientific Name	Status
flannelmouth sucker	*Catostomus latipinnis*	None
speckled dace	*Rhinichthys osculus*	None
mountain sucker	*Catostomas platyrhynchus*	State Species of Special Concern BLM Sensitive Species
northern leopard frog	*Acris crepitans*	State Species of Special Concern BLM Sensitive Species

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 (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). 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 6 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 4.10 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 3.93 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 Piceance Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	9/18/2000 -1	4.63	1.9 - 11.6	3.76	Out of range
BLM	9/18/2000 -2	3.82	2.1 – 13.4	5.48	Out of range
CPW	6/21/2005	11.07	4.4 – 27.7	Out of Range	4.89
BLM	7/5/2006	2.32	0.9 – 5.8	5.00	5.00
BLM	9/12/2012 -2	5.36	2.1 – 13.4	2.12	2.74
BLM	9/12/2012 -3	5.78	2.3 – 14.4	3.29	3.79
			Mean	**3.93**	**4.10**

Note: The first cross-section taken on 9/12//2012 produced results outside of the accuracy range for both the winter and summer. Since no data was within range, this data was not used in formulating the recommendation.

ISF Recommendation
The BLM recommends flows of 4.0 cfs (1/1 – 12/31) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

4.0 cubic feet per second is recommended from January 1 to December 31. In most of the cross sections collected, the recommended flow rates are driven by the average depth and average velocity criteria. Protecting average velocity for spawning habitat is important, because many portions of this reach that are suitable for spawning are low gradient. Some portions of this reach have a high width-to-depth ratio, so it is also important to maintain sufficient depth for fish passage and overwintering of fish. BLM believes that maintaining 4.0 cfs will maintain acceptable physical habitat characteristics over a wide variety of riffle widths, and will also serve to keep pools sufficiently free of ice to allow overwintering of fish.

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 Piceance Creek is 653 square miles, with an average elevation of 7,300 ft and average annual precipitation of 18.36 inches. The relatively low elevation drainage basin results in the potential for relatively early snowmelt runoff. The Piceance Creek basin supports agriculture and oil and gas extraction, among other uses. Hydrology is altered by water use within the basin.

Available Data

Piceance Creek has a USGS gage located approximately 1.25 miles upstream from the lower terminus (USGS 09306222 Piceance Creek near White River, CO). The drainage basin of the Piceance Creek gage is 652 square miles, with an average elevation of 7,300 ft and average annual precipitation of 18.36 inches. The proximity of the gage to the lower terminus and an extensive period of record (1964 to present) make this gage ideally suited for water availability analysis. No intervening diversions between the gage and the lower terminus were identified at the time of analysis. Therefore, the gage provides the best estimate of stream flow conditions at the confluence with the White River.

Data Analysis

The USGS Piceance Creek gage was analyzed from 10/1/1964 to 10/6/2015 based on USGS approved data available through HydroBase on 1/5/2016. No gage data was available from 10/1/1964 to 10/1/1970. The gage data was not scaled to the lower terminus due to negligible differences in contributing drainage basin area. Median streamflow and 95% confidence intervals for median streamflow were calculated for the Piceance Creek gage record.

Water Availability Summary

The hydrograph (Figure 1) shows the median streamflow and 95% confidence intervals for the median streamflow based on the Piceance Creek gage record. The proposed ISF rate is below the median streamflow at all times. The proposed ISF rate is below the 95% confidence interval of the median at all times. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Piceance 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.

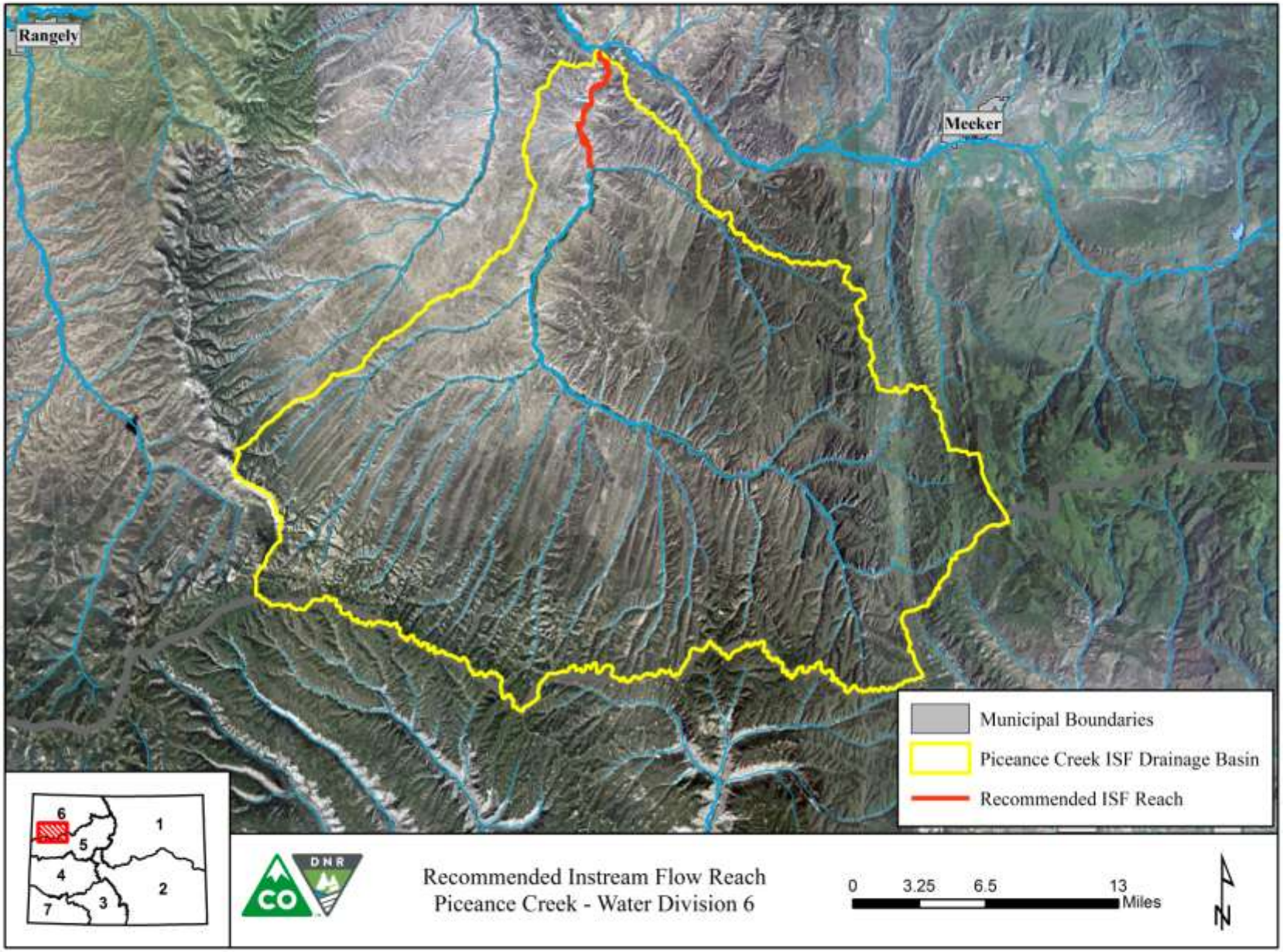
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

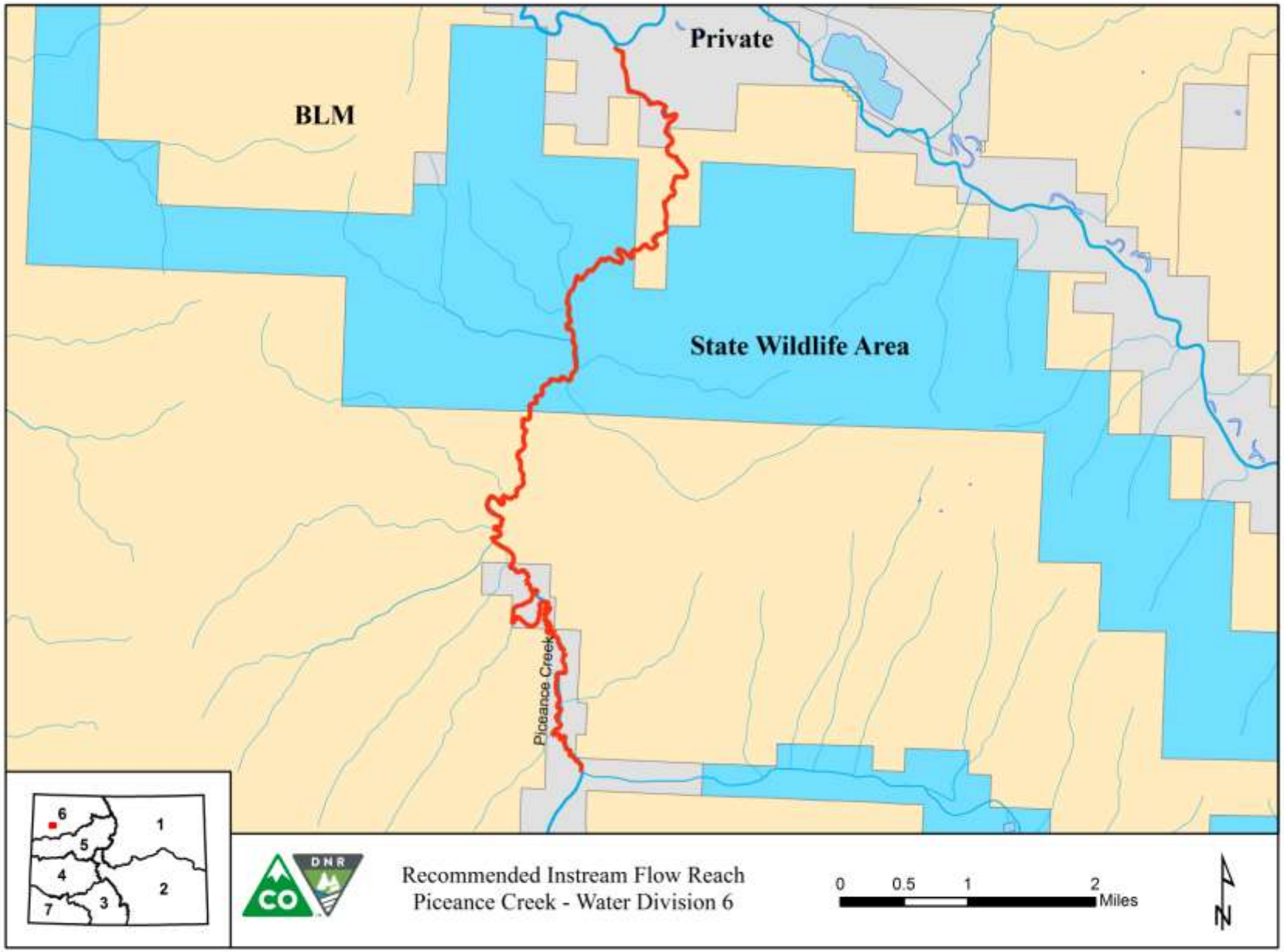
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

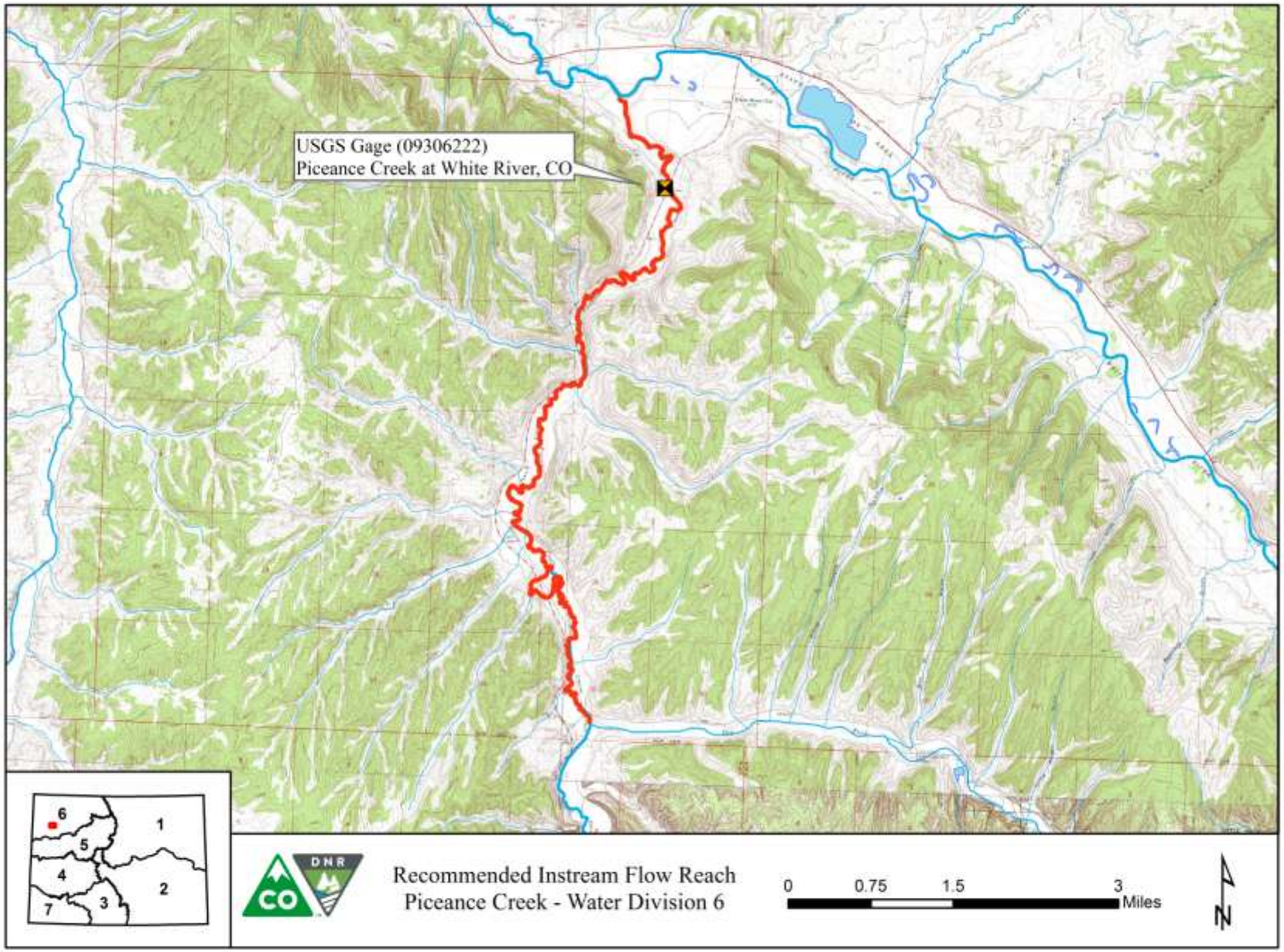
VICINITY MAP



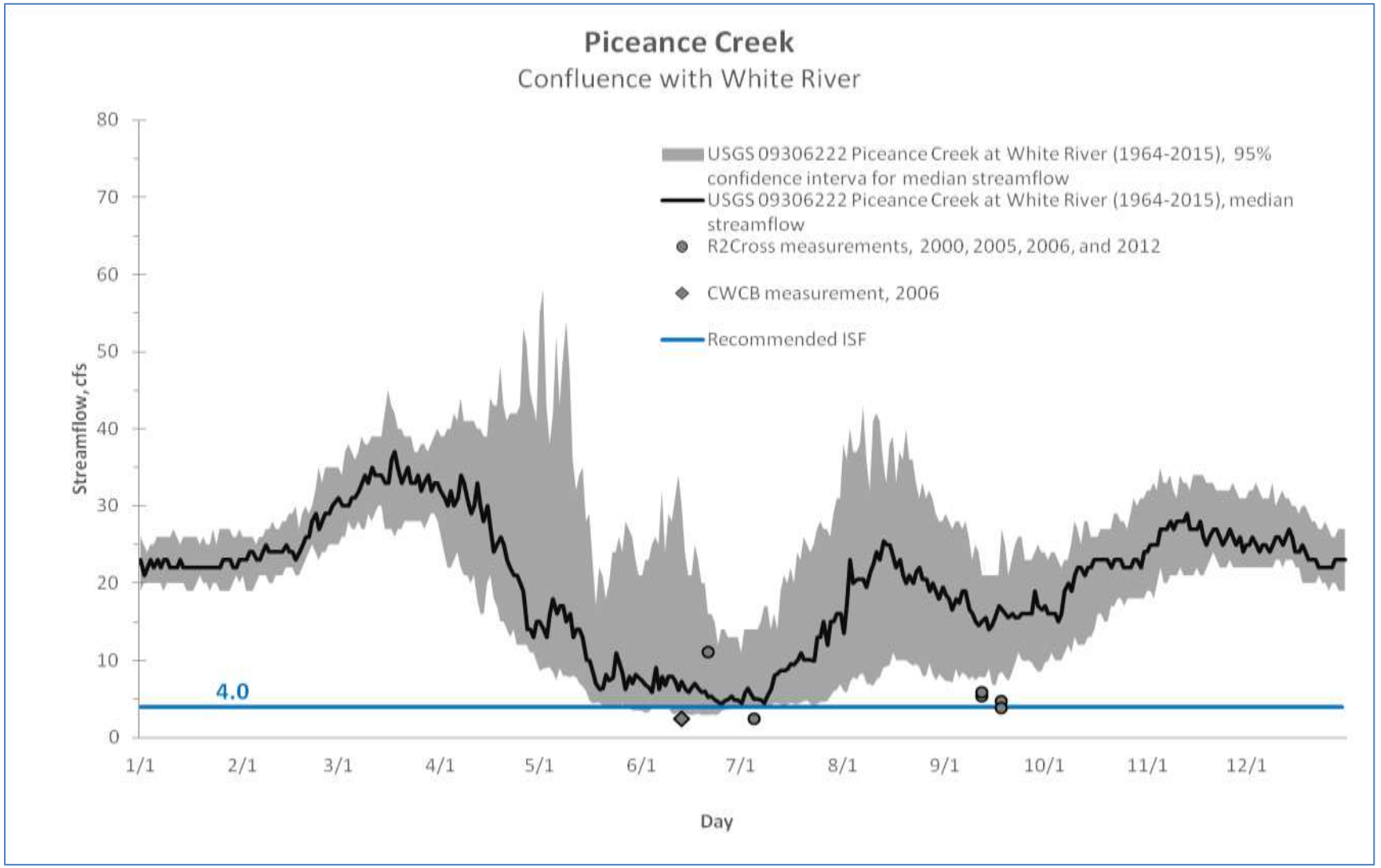
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

Willow Creek (Upper)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Outlet of Steamboat Lake	
	UTM North: 4517363.92	UTM East: 335797.39
LOWER TERMINUS:	Confluence with Beaver Creek	
	UTM North: 4514833.43	UTM East: 338266.18
WATER DIVISION:	6	
WATER DISTRICT:	58	
COUNTY:	Routt County	
WATERSHED:	Upper Yampa (HUC#: 14050001)	
CWCB ID:	13/6/A-003	
RECOMMENDER:	Bureau of Land Management	
LENGTH:	4.94 miles	
FLOW RECOMMENDATION:	7.0 cfs (4/16-6/30)	
EXISTING ISF:	6-77W1270; 5.0 cfs (1/1-12/31)	

Willow Creek (Upper)

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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an increase to the existing ISF water right on Willow Creek. The CWCB currently holds an instream flow water right on Willow Creek for 5.0 cfs (1/1-12/31) in Case No. 6-77W1270. The BLM does not consider the current instream flow water right to be sufficiently protective of the natural environment in Willow Creek, in light of CWCB's current application of R2Cross. 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.

This reach is located within Routt County and is about 16 miles northwest of the Town of Steamboat Springs (See Vicinity Map). Willow Creek originates west of Hahns Peak at an elevation of about 8,360 feet. The creek flows in a southeasterly direction as it drops to an elevation of 7,600 feet where it joins the Elk River. The proposed reach extends from the outlet of Steamboat Lake downstream to confluence with Beaver Creek. Fifty-four percent of the land on the 4.94 mile proposed reach is publicly owned and managed by the BLM and Colorado Parks and Wildlife (See Land Ownership Map).

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.

This portion of Willow Creek is a cold-water, low gradient stream that flows through wide stream valleys before entering the Routt National Forest. The stream has a good mix of riffle, run, and deep pool habitats. Substrate ranges from gravels to eight-inch cobbles. Presence of some filamentous algae indicates that the creek may have nutrient loading and/or excessively high water temperatures.

Fishery surveys revealed a self-sustaining native fishery which included mountain suckers, mottled sculpin, and speckled dace. White suckers, which are native to the Front Range, were also documented in the creek. Intensive macro-invertebrate surveys have not been conducted but spot samples have revealed various species of mayfly and caddisfly.

Table 1. List of fish species identified in Willow Creek.

Species Name	Scientific Name	Status
mottled sculpin	*Cottus bairdii*	None
mountain sucker	*Catostomas platyrhynchus*	State Species of Special Concern BLM Sensitive Species
speckled dace	*Rhinichthys osculus*	None
white suckers	*Catostomus commersonii*	None

Justification for Increase

The R2Cross data summarized below clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing and spawning. When the existing instream flow rights are applied to the cross sections that were collected, the stream averages 70 percent wetted perimeter immediately below Steamboat Lake, so a significant portion of the potential habitat is not available. The available habitat is further reduced when the existing instream flow rates are applied to the cross sections collected, because average depths are only 0.22 to 0.32 feet. These depths occur in a stream that averages 35 feet in width. While 0.22 feet is sufficient for fish passage, the fact that 0.22 feet is an *average* depth shows that, in many portions of the channel, depths are significantly *less* than 0.22 feet and may not be usable by the fish population. During the warm weather season, the fish population needs to have access to as much of the stream channel as possible for feeding, resting and spawning if it is to survive the pronounced cold winters in this location.

After Willow Creek leaves Steamboat Lake, it exhibits a wide channel with almost no shading from shrubs and trees. In this type of creek environment, aquatic habitat can be at risk from excessively high temperatures during the summer months. For example, when the BLM surveyed the creek in August 2011, the stream temperature was 21 degrees Celsius, which is at the upper limit of what many cold water species, such as speckled dace and mottled sculpin, can tolerate without excessive stress on the fish population. This stream temperature was not taken on an excessively hot day or during excessively low flow conditions. CWCB staff installed a temperature sensor in this reach of stream from July 1, to November 4, 2013 and confirmed that the reach regularly experiences excessively high temperatures during the summer months.

Protecting a higher flow rate will provide greater depths and faster velocities, which tend to reduce stream temperatures. In addition, the higher flow rate will allow the fishery greater access to locations with overhanging banks, where temperatures typically are cooler. An increased flow rate will provide more physical habitat during the spawning and growth seasons, which will help the fish population recover from any temperature extremes. In addition, the BLM believes that this creek has the potential to support trout species year-round if excessively high temperatures are prevented. The BLM notes that speckled dace and mottled sculpin are present, and these species typically co-inhabit streams with trout species. BLM also notes that trout species are found in most of the perennial tributaries to Willow Creek.

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 (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). 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 increased 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 12.0 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	8/16/2011 - 1	10.75	4.3 – 26.9	7.22	11.94
BLM	8/16/2011 - 2	10.27	4.1 – 25.7	8.22	11.83
			Mean	**7.72**	**11.89**

ISF Recommendation
The BLM recommends increased flows of 7.0 cfs (4/16-6/30) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

An increase of 7.0 cfs to the existing 5.0 cfs instream flow water right is recommended during the snowmelt runoff period, from April 16 through June 30. This recommendation is driven by the average velocity criteria. This flow rate will assist in maintaining the native fish assemblage, by maintaining a sufficient amount of physical habitat during their spawning period. Appropriation of an additional 7.0 cfs would bring the total instream flow water right up to 12.0 cubic feet per second during April 16 to June 30 period.

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 upper Willow Creek is 50.9 square miles, with an average elevation of 8,630 ft and average annual precipitation of 30.56 inches. The drainage basin tributary to the lower terminus has a number of surface water diversions. There is a total of 30.85 cfs in decreed active diversion structures with records. However, Steamboat Reservoir operations have the most impact on the proposed reach of Willow Creek. There are no known absolute surface water diversions in the proposed reach. Ways Gulch contributes addition flow below the reservoir as does Red Creek. Due to surface water diversions and the reservoir, hydrology in this drainage basin does not represent natural flow conditions.

Available Data
There is one gage located at the upstream terminus of the proposed reach at the outlet of Steamboat Lake. The Willow Creek below Steamboat Lake gage (WILBSLCO) is operated by the Division of Water Resources. The available period of record as of 11/17/2015 was 10/1/1978 to 12/31/2014. The gage appears to operate primarily during the irrigation season and there are many years without records. The total number of records available on any given day varies between 8 and 16 years, depending on the day. The Willow Creek gage has a 35.3 square mile drainage basin, and therefore has less contributing area than at the lower terminus of the reach.

Data Analysis
Because streamflow in the proposed reach of Willow Creek is largely controlled by Steamboat Lake releases, it is not reasonable to extend the period of record at the Willow Creek gage through regression analysis with other gages. However, because of the short period of record, staff examined climate stations to compare conditions during the gaged period of record to a longer term record. The Steamboat Springs climate station (Station ID USC00057936, downloaded 12/1/2015) is located about 20 miles south of the lower terminus. This climate station has a relatively long period of record with fairly consistent records starting in 1909 and some records as early as the 1890s. Only years with complete records, meaning that all 12 months had data were included in the analysis. The average annual precipitation at the Steamboat Springs Station for the period of record for years with complete records was 23.89 inches. During the years the Willow Creek gage operated with complete climate data, the average annual precipitation was 24.31 inches. Therefore, the Willow Creek gage represents approximately average precipitation conditions.

Median streamflow was calculated using the available Willow Creek gage record. 95% confidence intervals were not calculated due to the short period of record and variable number of days of record.

Water Availability Summary
The hydrograph shows the median streamflow based on the Willow Creek gage record. The proposed ISF is less than the median streamflow. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Willow 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.

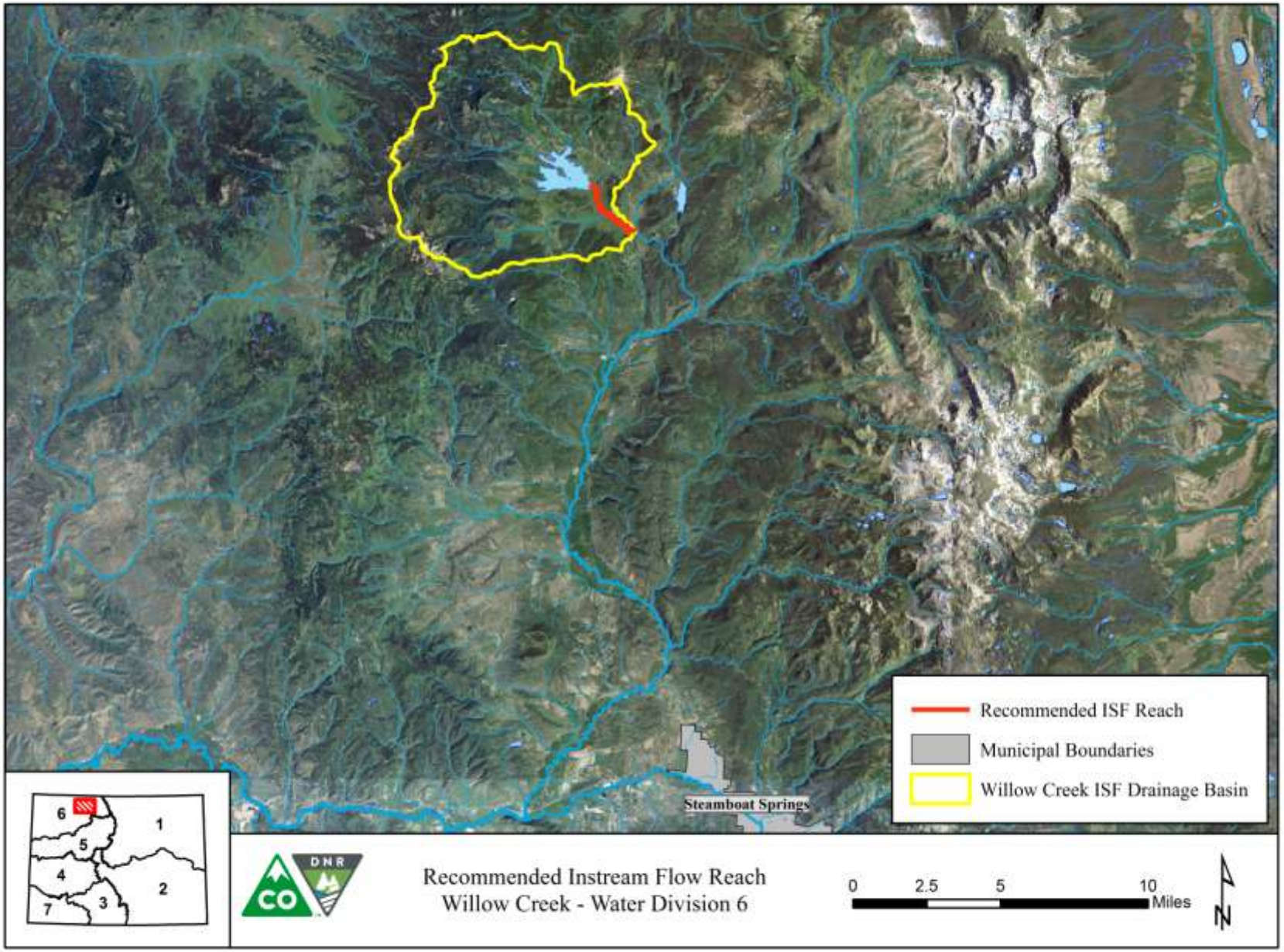
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

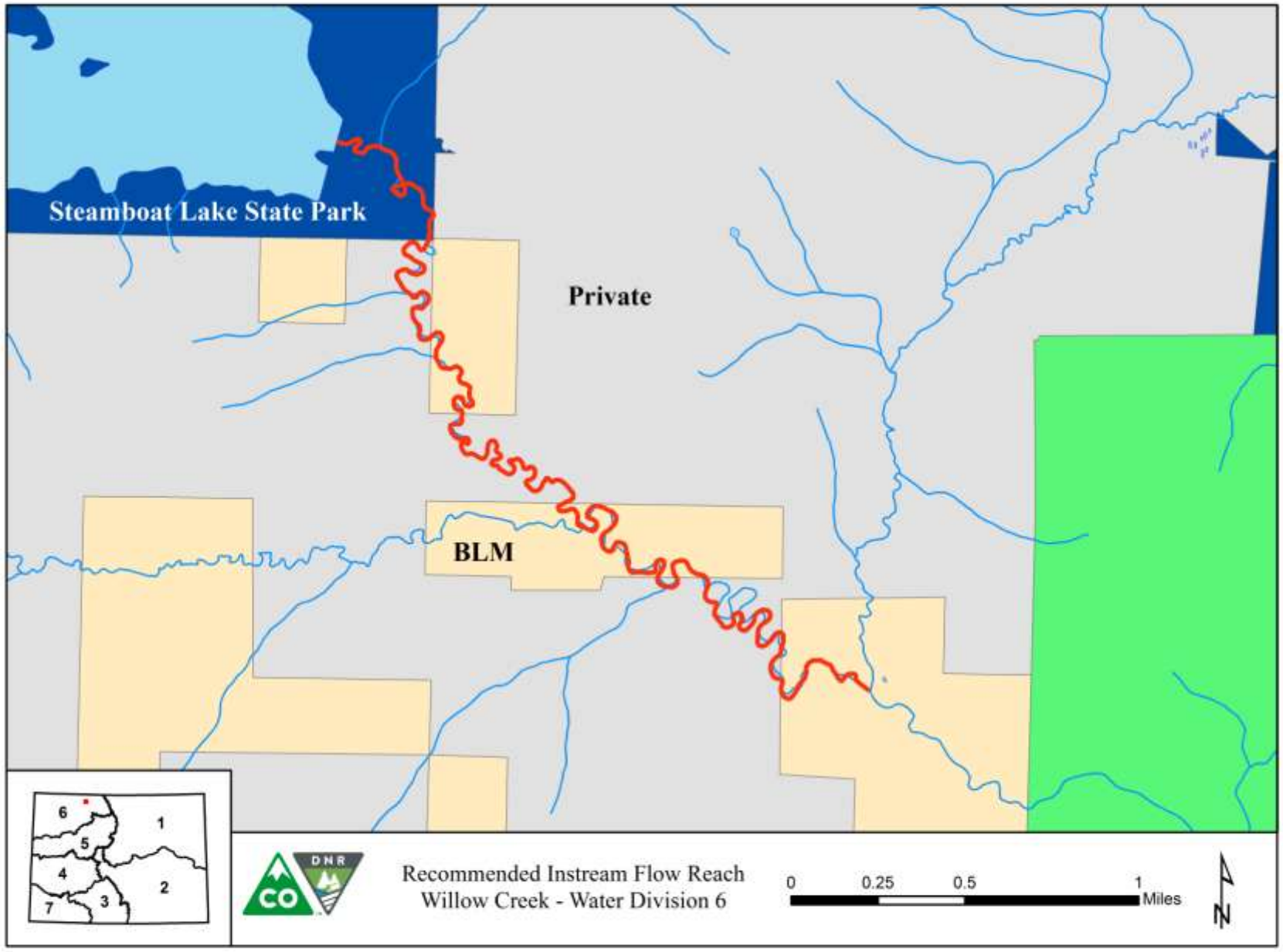
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

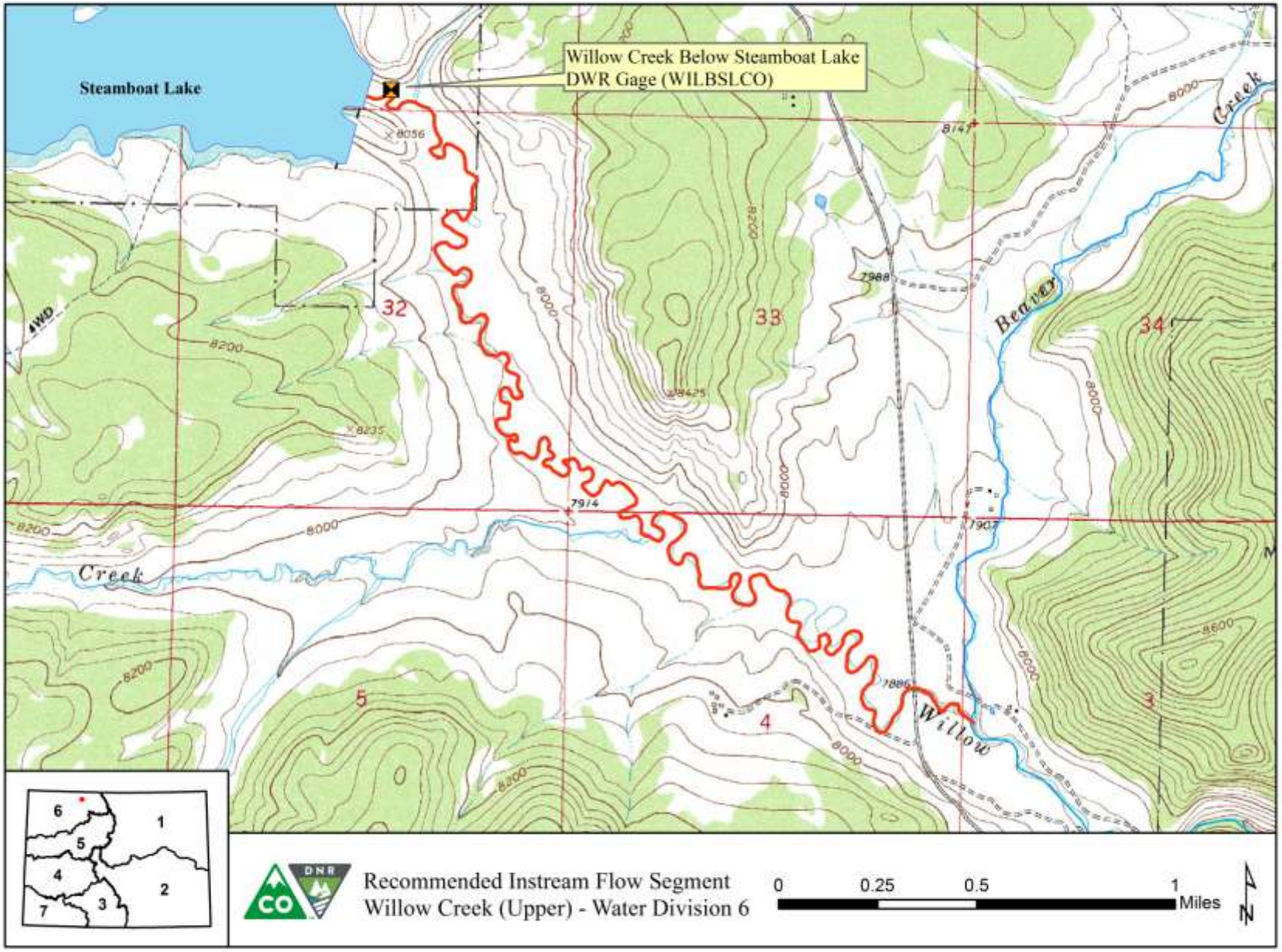
VICINITY MAP



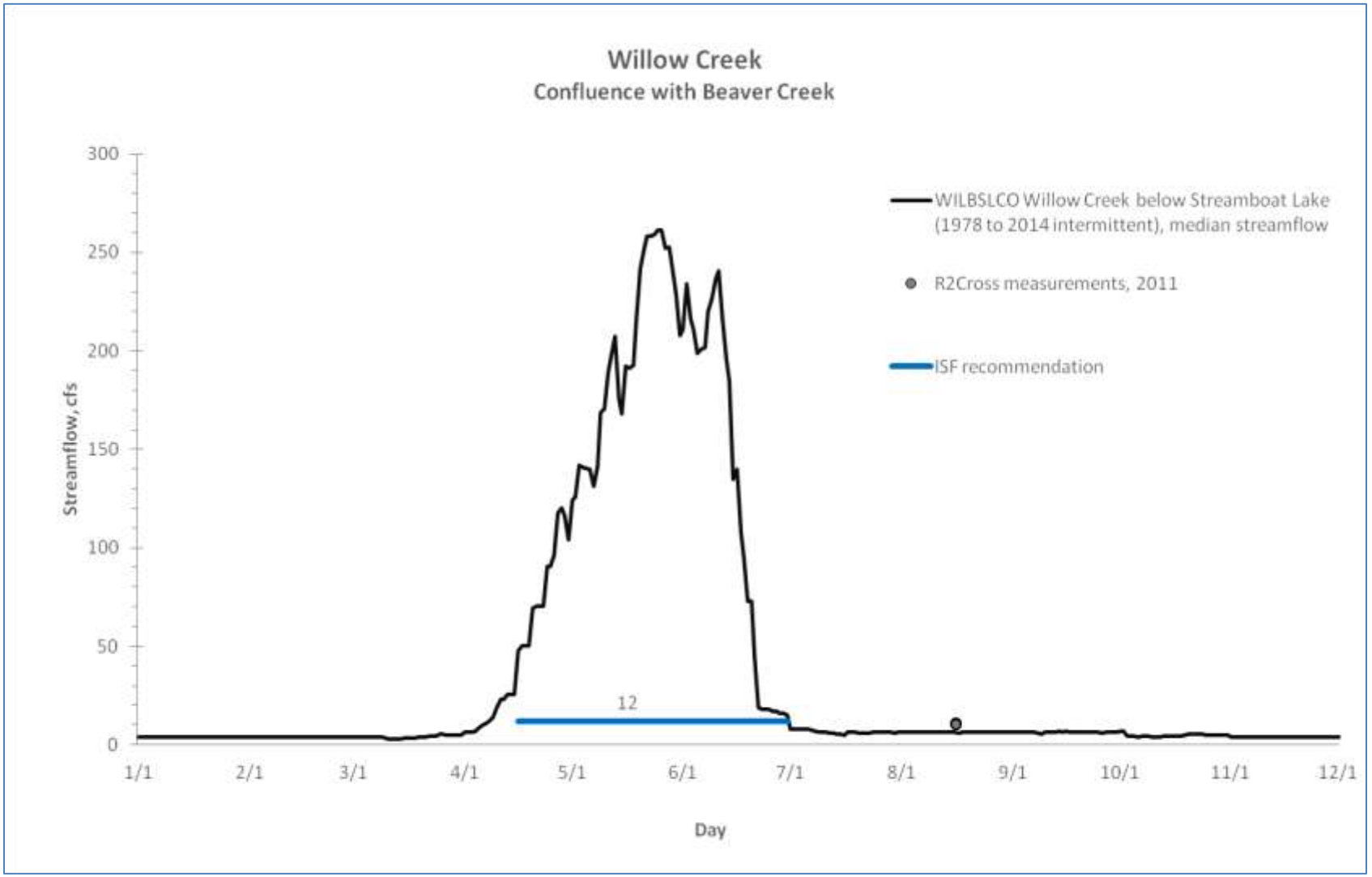
LAND OWNERSHIP MAP



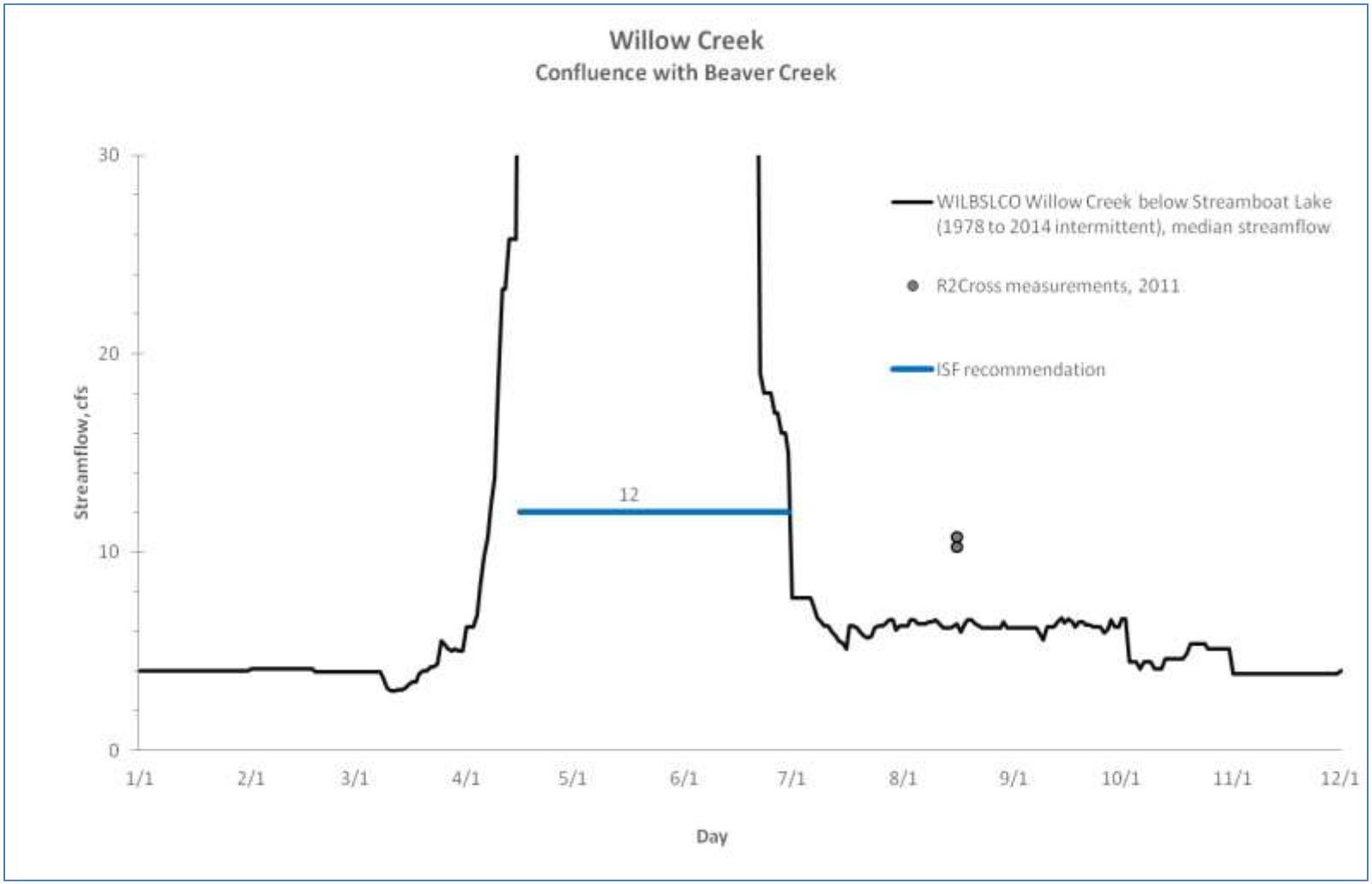
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Willow Creek (Lower)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence with Beaver Creek UTM North: 4514833.43	UTM North: 338266.19
LOWER TERMINUS:	Confluence with Lester Creek UTM North: 4514098.44	UTM East: 339789.19
WATER DIVISION:	6	
WATER DISTRICT:	58	
COUNTY:	Routt County	
WATERSHED:	Upper Yampa (HUC#: 14050001)	
CWCB ID:	13/6/A-004	
RECOMMENDER:	Bureau of Land Management	
LENGTH:	1.47 miles	
FLOW RECOMMENDATION:	13.0 cfs (4/16-6/30) 3.0 cfs (7/1-7/31)	
EXISTING ISF:	6-77W1273; 7.0 cfs (1/1-12/31)	

Willow Creek (Lower)

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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an increase to the existing ISF water right on Willow Creek. The CWCB currently holds an instream flow water right on Willow Creek for 7.0 cfs (1/1-12/31), decreed in Case No. 6-77W1273. The BLM does not consider the current instream flow water right to be sufficiently protective of the natural environment in Willow Creek, in light of CWCB's current application of R2Cross. 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.

This reach is located within Routt County and is about 16 miles northwest of the Town of Steamboat Springs (See Vicinity Map). Willow Creek originates west of Hahns Peak at an elevation of about 8,360 feet. The creek flows in a southeasterly direction as it drops to an elevation of 7,600 feet where it joins the Elk River. The proposed reach extends from the confluence with Beaver Creek downstream to confluence with Lester Creek. One-Hundred percent of the land on the 1.47 mile proposed reach is publicly owned and managed by the BLM and U.S. Forest Service (See Land Ownership Map).

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.

This portion of Willow Creek is a cold-water, low gradient stream that flows through wide stream valleys before entering the Routt National Forest. The stream has a good mix of riffle, run, and deep pool habitats. Substrate ranges from gravels to eight-inch cobbles. Presence of some filamentous algae indicates that the creek may have nutrient loading and/or excessively high water temperatures.

Fishery surveys revealed a self-sustaining native fishery which includes mountain suckers, mottled sculpin, and speckled dace. White suckers, which are native to the Front Range, were also

documented in the creek. Intensive macro-invertebrate surveys have not been conducted, but spot samples have revealed various species of mayfly and caddisfly.

The riparian community along Willow Creek is in good condition, and streambank stability appears to be improving. The riparian community is comprised mainly of willows and sedges, and it occupies the entire valley bottom.

Table 1. List of fish species identified in Willow Creek.

Species Name	Scientific Name	Status
mottled sculpin	*Cottus bairdii*	None
mountain sucker	*Catostomas platyrhynchus*	State Species of Special Concern BLM Sensitive Species
speckled dace	*Rhinichthys osculus*	None
white suckers	*Catostomus commersonii*	None

Justification for Increase

The R2Cross data summarized below clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing and spawning. When the existing instream flow rights are applied to the cross sections that were collected, the stream averages 55 percent wetted perimeter, so a significant portion of the potential habitat is not available. The available habitat is further reduced when the existing instream flow rates are applied to the cross section collected, because average depths are only 0.22 to 0.32 feet. These depths occur in a stream that averages 35 feet in width. While 0.22 feet is sufficient for fish passage, the fact that 0.22 feet is an *average* depth shows that, in many portions of the channel, depths are significantly *less* than 0.22 feet and may not be usable by the fish population. During the warm weather season, the fish population needs to have access to as much of the stream channel as possible for feeding, resting and spawning if it is to survive the pronounced cold winters in this location.

After Willow Creek leaves Steamboat Lake, it exhibits a wide channel with almost no shading from shrubs and trees. In this type of creek environment, aquatic habitat can be at risk from excessively high temperatures during the summer months. For example, when the BLM surveyed the creek in August 2011, the stream temperature was 21 degrees Celsius, which is at the upper limit of what many cold water species, such as speckled dace and mottled sculpin, can tolerate without excessive stress on the fish population. This stream temperature was not taken on an excessively hot day or during excessively low flow conditions. CWCB staff installed a temperature sensor in this reach of stream from July 1, to November 4, 2013 and confirmed that the reach regularly experiences excessively high temperatures during the summer months.

Protecting a higher flow rate will provide greater depths and faster velocities, which tend to reduce stream temperatures. In addition, the higher flow rate will allow the fishery greater access to locations with overhanging banks, where temperatures typically are cooler. An increased flow rate will provide more physical habitat during the spawning and growth seasons, which will help the fish population recover from any temperature extremes. In addition, the BLM believes that this creek has the potential to support trout species year-round if excessively high temperatures are prevented.

The BLM notes that speckled dace and mottled sculpin are present, and these species typically co-inhabit streams with trout species. BLM also notes that trout species are found in most of the perennial tributaries to Willow Creek.

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 (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). 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 four transects for this proposed increased 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 20 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model.

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

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	8/16/2011 - 1	16.89	6.8 – 42.2	Out of Range	27.89
BLM	8/16/2011 - 2	16.56	6.6 – 41.4	8.56	15.97
BLM	9/26/2011 – 1	13.78	5.5 – 34.4	6.09	16.44
BLM	9/26/2011 – 2	12.69	5.1 – 31.7	Out of Range	20.89
			Mean	**7.33**	**20.32**

ISF Recommendation

The BLM recommends increased flows of 13.0 cfs (4/16-6/30), and 3.0 cfs (7/1-7/31) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

An increase of 13.0 cubic feet per second to the existing 7.0 cfs instream flow water right is recommended during the snowmelt runoff period, from April 16 through June 30. This recommendation is driven by the average depth criteria. This flow rate will assist in maintaining the native fish assemblage, by maintaining a sufficient amount of physical habitat during their spawning period. Appropriation of an additional 13.0 cfs would bring the total instream flow water right up to 20.0 cfs during the April 16 to June 30 period.

An increase of 3.0 cubic feet per second is recommended from July 1 to July 31, and is driven by water availability. While this flow rate doesn't meet the average depth criteria, it will provide an average velocity of 1.33 feet per second, average wetted perimeter of 63 percent, and average depth of 0.3 feet. Appropriation of an additional 3.0 cfs would bring the total instream flow water right up to 10.0 cfs during the July 1 to July 31 period. This additional amount of protection is critical to addressing high temperatures during one of the warmest months of the year.

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 lower Willow Creek is 65.2 square miles, with an average elevation of 8,670 ft and average annual precipitation of 30.88 inches. The drainage basin tributary to the lower terminus has a number of surface water diversions. There is a total of 41.42 cfs in decreed active diversion structures with records. Steamboat Reservoir operations have a substantial impact on the proposed reach of Willow Creek. There are no known absolute surface water diversions in the proposed reach. In addition to Ways Gulch and Red Creek, which are tributary to the upper Willow Creek reach, the lower Willow Creek reach benefits from flow contributed by Beaver Creek. Due to surface water diversions and the reservoir, hydrology in this drainage basin does not represent natural flow conditions. See the Hydrologic Features Map.

Available Data

There is one gage located approximately 4.8 miles upstream from the proposed reach at the outlet of Steamboat Lake. The Willow Creek below Steamboat Lake gage (WILBSLCO) is operated by the Division of Water Resources. The available period of record as of 11/17/2015 was 10/1/1978 to 12/31/2014. The gage appears to operate primarily during the irrigation season and there are many years without records. The total number of records available on any given day varies between 8 and 14 years depending on the day. The Willow Creek gage has a 35.3 square mile drainage basin, and therefore has less contributing area than at the lower terminus of the reach.

The upper terminus of the proposed reach is the confluence with Beaver Creek. Beaver Creek has a 13.5 square mile drainage basin and contributes additional flow to Willow Creek. There is no known gage or streamflow data available for Beaver Creek. There are 15 surface water diversions (ditches, pumps, or pipelines) with a total of 10.82 cfs in decreed diversions in the Beaver Creek drainage. StreamStats results are used in the hydrologic analysis to provide some indication of streamflow in the Beaver Creek basin. However, StreamStats does not account for water diversions.

Data Analysis

Because streamflow in the proposed reach of Willow Creek is largely controlled by Steamboat Lake releases, it is not reasonable to extend the period of record at the Willow Creek gage through regression analysis with other gages. However, because of the short period of record, staff examined climate stations to compare conditions during the gaged period of record to a longer term record. The Steamboat Springs climate station (Station ID USC00057936, downloaded 12/1/2015) is located about 20 miles south from the lower terminus. This climate station has a relatively long period of record with fairly consistent records starting in 1909 and some records as early as the 1890s. Only

years with complete records, meaning that all 12 months had data, were included in the analysis. The average annual precipitation at the Steamboat Springs Station for the period of record for years with complete records was 23.86 inches. During the years the Willow Creek gage operated with complete climate data, the average annual precipitation was 24.31 inches. Therefore, the Willow Creek gage represents approximately average precipitation conditions.

Median streamflow was calculated using the available Willow Creek gage record. 95% confidence intervals were not calculated due to the short period of record and variable number of days of record.

Water Availability Summary
The hydrographs (See Complete and Detailed Hydrographs) show the median streamflow based on the Willow Creek gage record. StreamStats for the Beaver Creek basin is provided for comparison. Releases from Steamboat Lake indicate that water is available for the proposed increase in April, May, and June. In July, the median releases are as low as 5 cfs. The StreamStats results for Beaver Creek indicate that mean monthly streamflow in July is 32.4 cfs. The water commissioner estimated that typical Beaver Creek streamflow in July is 5 or 6 cfs (Brian Romig, personal communication 11/14/2014). Adding the median streamflow at the Willow Creek gage (5 cfs) to the water commissioner's more conservative estimate of Beaver Creek flow (5 cfs) results in an estimate of 10 cfs available in July. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Willow 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.

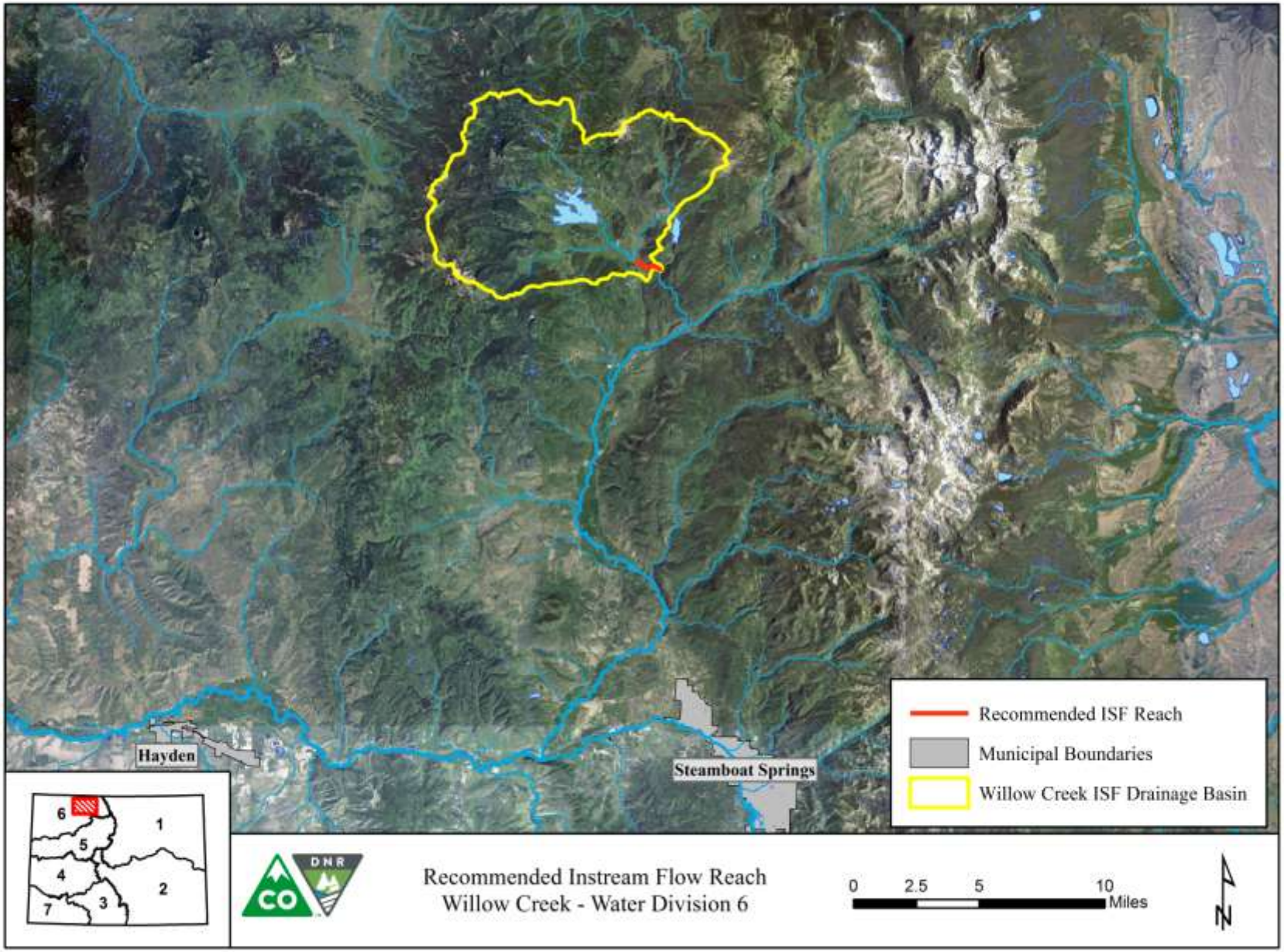
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

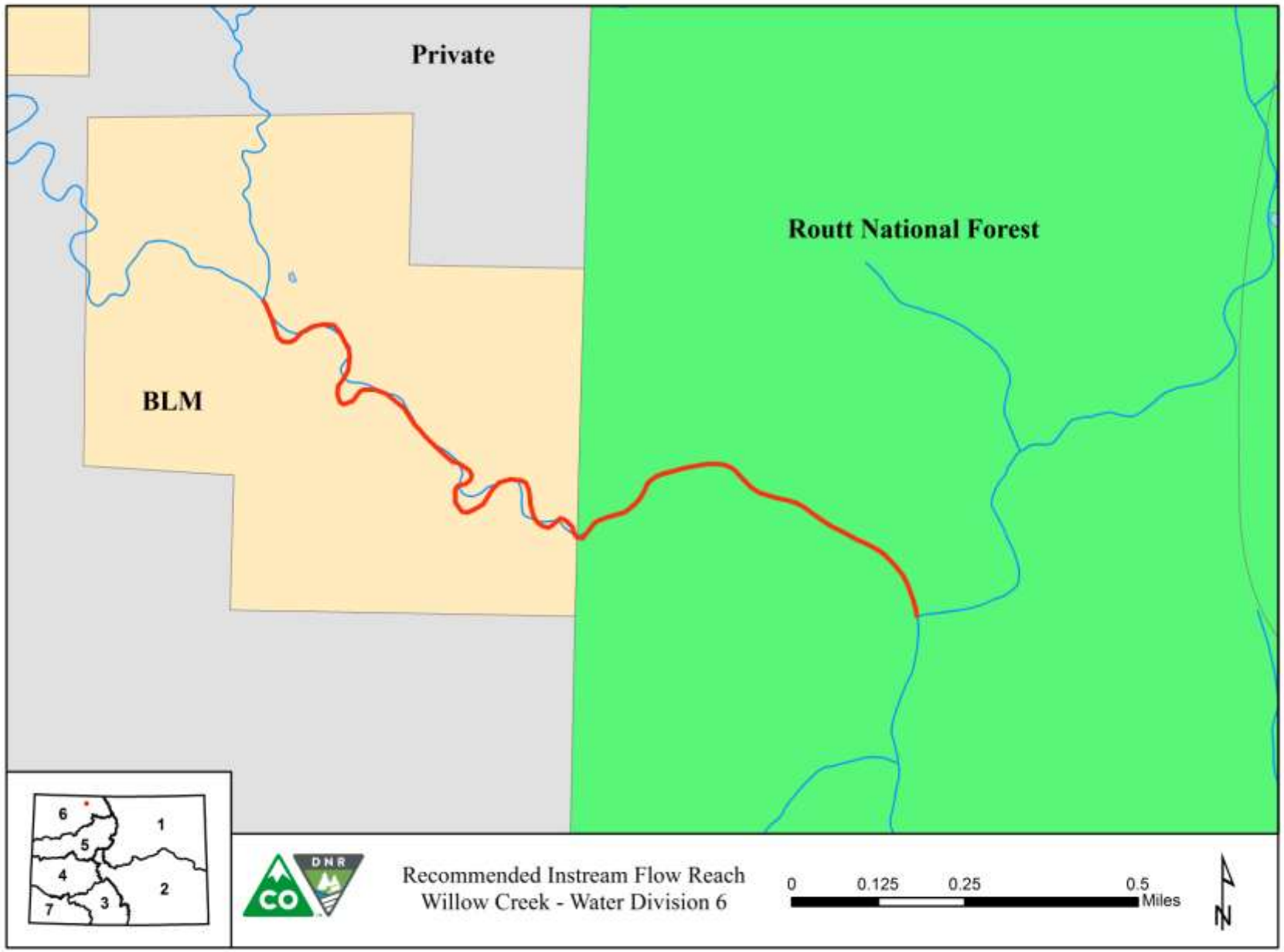
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

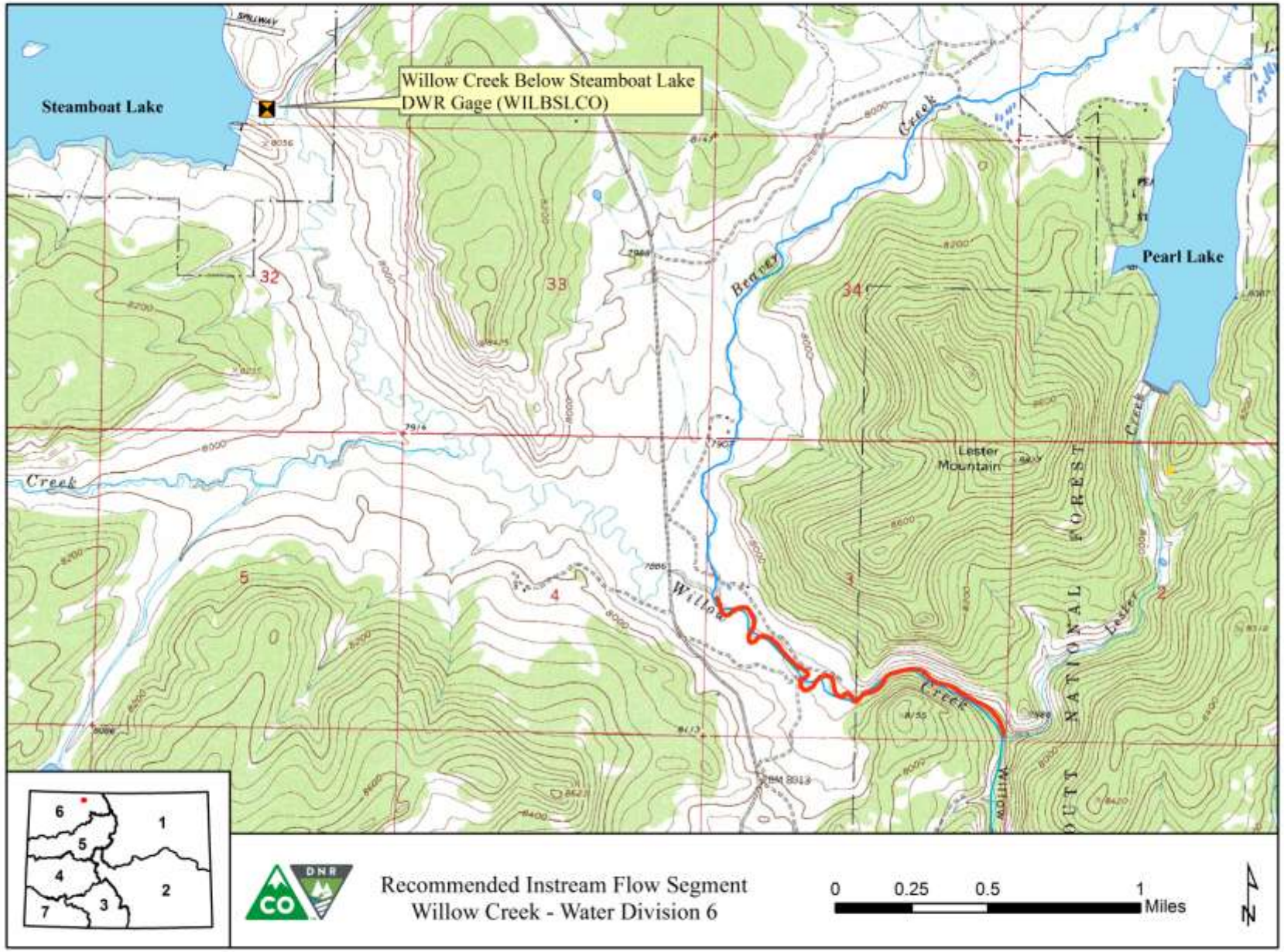
VICINITY MAP



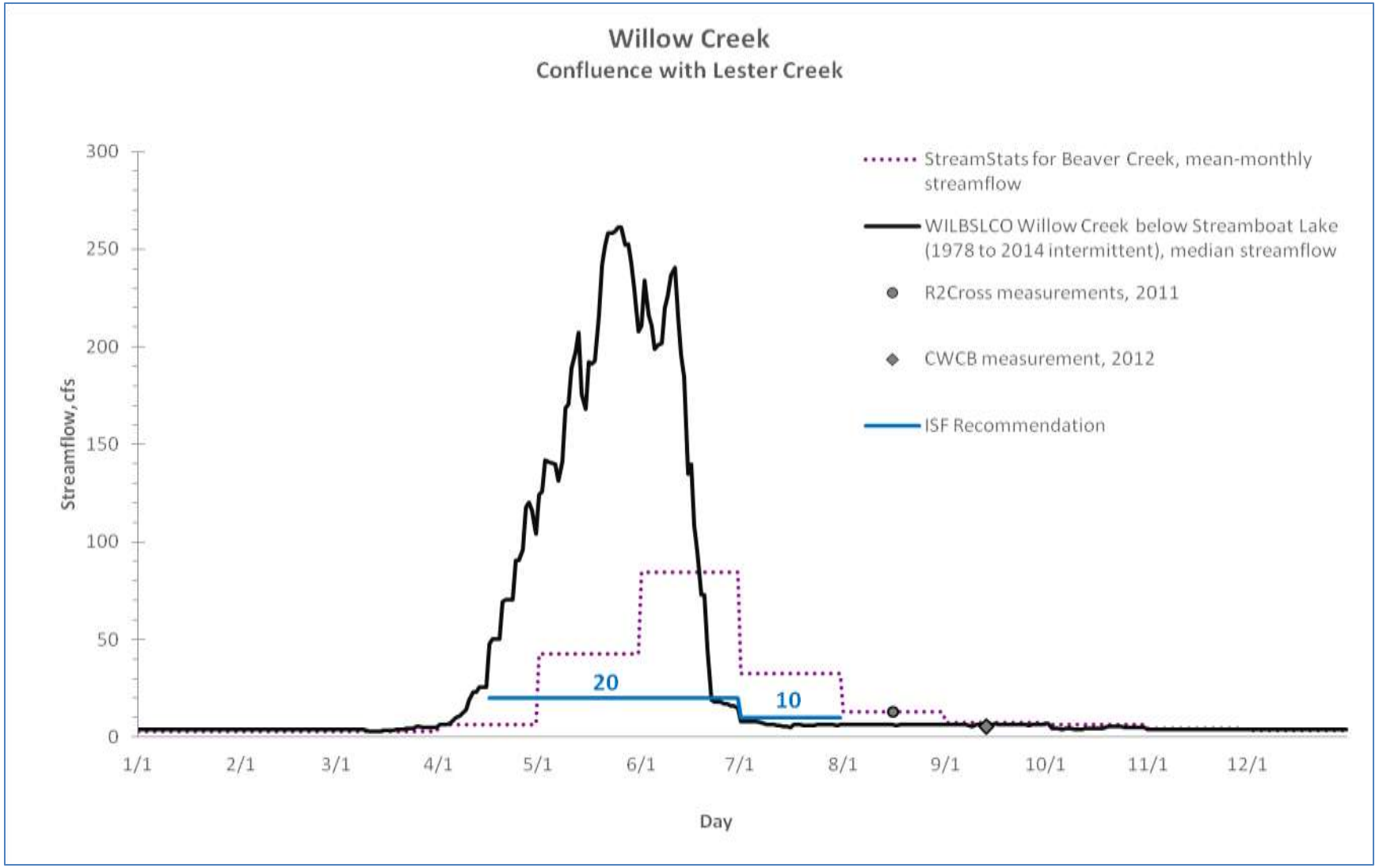
LAND OWNERSHIP MAP



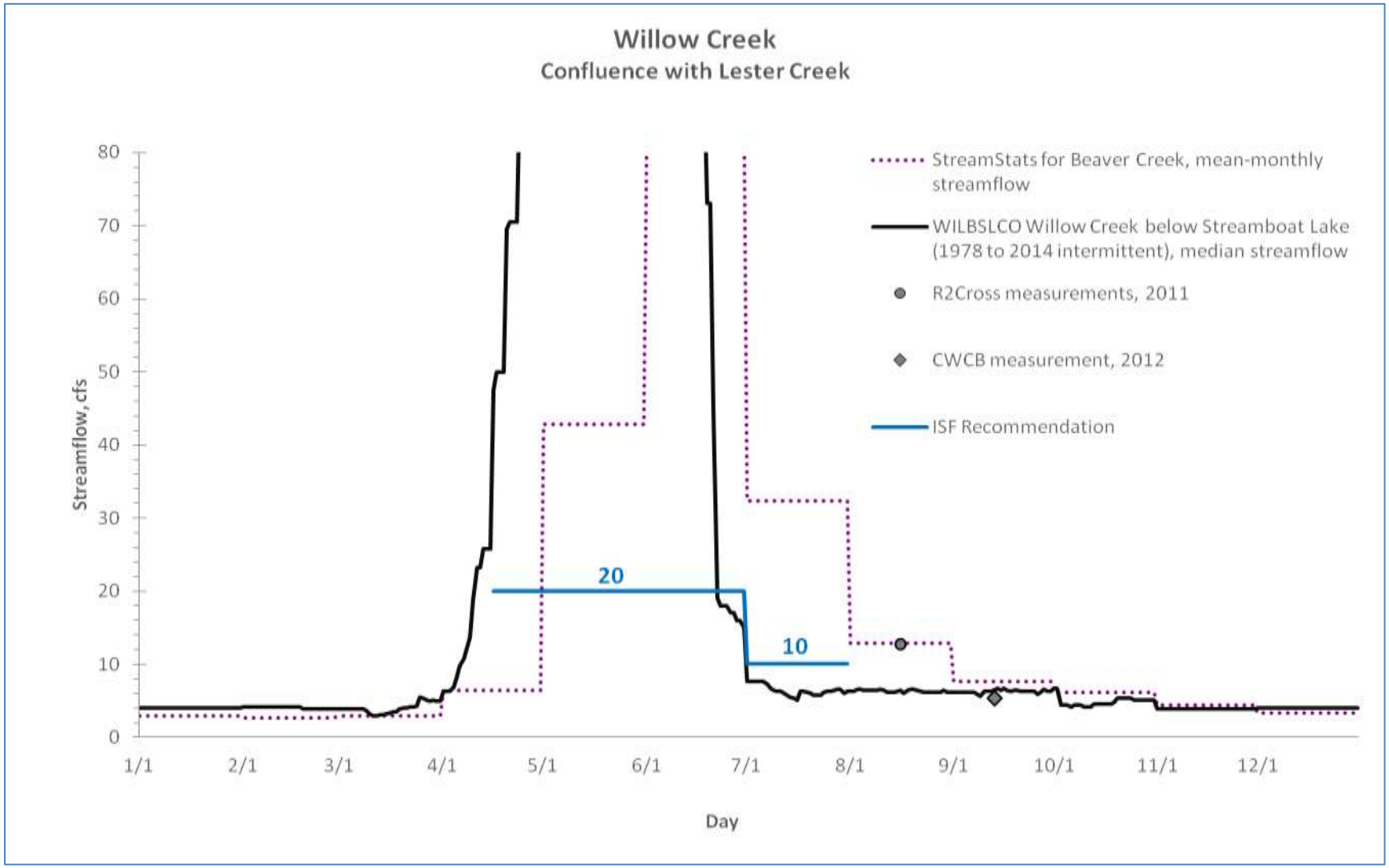
HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH



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

Yellow Creek (Upper)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence Barcus Creek UTM North: 4446251.97	UTM East: 213556.69
LOWER TERMINUS:	Confluence Lambert Springs UTM North: 4449129.57	UTM East: 211572.39
WATER DIVISION:	6	
WATER DISTRICT:	43	
COUNTY:	Rio Blanco	
WATERSHED:	Piceance – Yellow (HUC#: 14050006)	
CWCB ID:	13/6/A-005	
RECOMMENDER:	Bureau of Land Management	
LENGTH:	3.66 miles	
FLOW RECOMMENDATION:	0.82 cfs (3/1-6/15) 0.40 cfs (6/16-2/29)	

Yellow Creek (Upper)

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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Yellow Creek. This reach is located within Rio Blanco County about 19 miles east of the town of Rangely (See Vicinity Map). The Yellow Creek headwaters originate in the Cathedral Bluffs at an elevation of 8,200 feet. The creek flows in a northerly direction as it drops to an elevation of 5,700 feet where it joins the White River. The proposed reach extends from the confluence with Barcus Creek downstream to the confluence with Lambert Springs. One-hundred percent of the land on the 3.66 mile proposed reach is publicly owned and managed by the BLM and Colorado Parks and Wildlife (See Land Ownership Map). The BLM recommended this reach of Yellow 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 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.

Yellow Creek is a small, moderate gradient stream with a variable substrate size and a stable channel. Water quality, food sources and physical habitat characteristics are suitable for native species. Because of the small stream size, protection of flows is extremely important for continued existence of the fishery and riparian community.

Fishery surveys indicate that the creek supports self-sustaining populations of speckled dace and native mountain suckers, with density of mountain suckers slightly exceeding densities of speckled dace. The creek also provides habitat for northern leopard frogs. It is important to note that both mountain suckers and northern leopard frogs appear on BLM's sensitive species list.

The riparian community is in stable condition and comprised primarily of willows and grasses. Riparian community health has been impaired by historic grazing practices and invasion of tamarisk. The BLM is taking actions to modify management and place the riparian community on an upward trend.

Table 1. List of species identified in Yellow Creek.

Species Name	Scientific Name	Status
speckled dace	*Rhinichthys osculus*	None
mountain sucker	*Catostomas platyrhynchus*	State Species of Special Concern BLM Sensitive Species
northern leopard frog	*Acris crepitans*	State Species of Special Concern BLM Sensitive Species

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 (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). 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 five 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 0.82 cfs, which meets 3 of 3 criteria and is within the accuracy range of the R2Cross model; and a winter flow of 0.40 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 Yellow Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	9/9/2004 – 1	0.49	0.2 – 1.2	0.32	Out of range
BLM	9/9/2004 - 2	0.57	0.2 – 1.4	0.44	Out of range
BLM	9/27/2011	0.39	0.2 – 1.0	Out of range	out of range
BLM	4/23/2015 – 1	0.83	0.3 – 2.1	0.36	0.77
BLM	4/23/2015 – 2	0.94	0.4 – 2.4	0.47	0.86
			Mean	**0.40**	**0.82**

ISF Recommendation
The BLM recommends flows of 0.40 cfs (6/16-2/29), and 0.82 cfs (3/1-6/15) based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

0.82 cubic feet per second is recommended for the snowmelt runoff period from March 1 through June 15. This recommendation is driven by the average depth criteria.

0.40 cubic feet per second is recommended from June 16 through February 29. This recommendation is driven by either the average depth criteria or the average velocity criteria, depending upon the cross section geometry. Many portions of this reach have a high width-to-depth ratio, so it is important to maintain sufficient depth for fish passage and overwintering of fish. Since this creek is very small and has limited physical habitat, meeting the wetted perimeter and depth criteria will ensure that the limited usable habitat is available to the native fish population.

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 upper Yellow Creek is 229 square miles, with an average elevation of 6,890 ft and average annual precipitation of 16.79 inches. The relatively low elevation drainage basin results in the potential for relatively early snowmelt runoff. The river system may have dry sections at different times in the year upstream from the BLM recommended reaches. Springs located in the vicinity of the proposed ISF reaches (upper and lower) have been observed to contribute a significant amount of the flow to the stream. Notable springs include an unnamed spring located above Barcus Creek, Stinking Springs, and Lambert Springs. The Yellow Creek basin supports agriculture and oil and gas extraction, among other uses. Hydrology is altered by water use within the basin.

Available Data

Yellow Creek has a USGS gage located approximately 3.15 miles downstream from the lower terminus (USGS 09306255 Yellow Creek near White River, CO). The drainage basin of the Yellow Creek gage is 263 square miles, with an average elevation of 6,880 ft and average annual precipitation of 16.72 inches. The proximity of the gage to the lower terminus and an extensive period of record (1972 to present) make this gage well suited for water availability analysis.

CWCB staff made one streamflow measurement on the proposed reach of Yellow Creek in 2006 and a set of measurements in 2014. These measurements are included in the water availability analysis.

Data Analysis

The USGS Yellow Creek gage was analyzed from 10/1/1972 to 7/22/2015 based on USGS approved data available through HydroBase on 12/21/2015. No gage data was available from 1983 to 1987. Because the gage is not located at the lower terminus, a method of accounting for differences between flow at the confluence with Lambert Springs and the Yellow Creek gage was necessary. The Yellow Creek gage record was scaled by 0.87 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 is the best available method, particularly during runoff when Yellow Creek is hydraulically connected to the upper portions of the basin. During base flows, it is likely that much of the flow in the proposed ISF reaches originates from springs. Median streamflow and 95% confidence intervals for median streamflow was calculated for the scaled Yellow Creek gage record.

Water Availability Summary

The hydrograph (Figure 1) shows the median streamflow and 95% confidence intervals for the median streamflow based on the Yellow Creek gage record. The proposed ISF rate is below the median streamflow at all times. The proposed ISF rate is below the 95% confidence interval of the median at all times. Staff has concluded that water is available for appropriation.

Material Injury
Because the proposed ISF on Yellow 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.

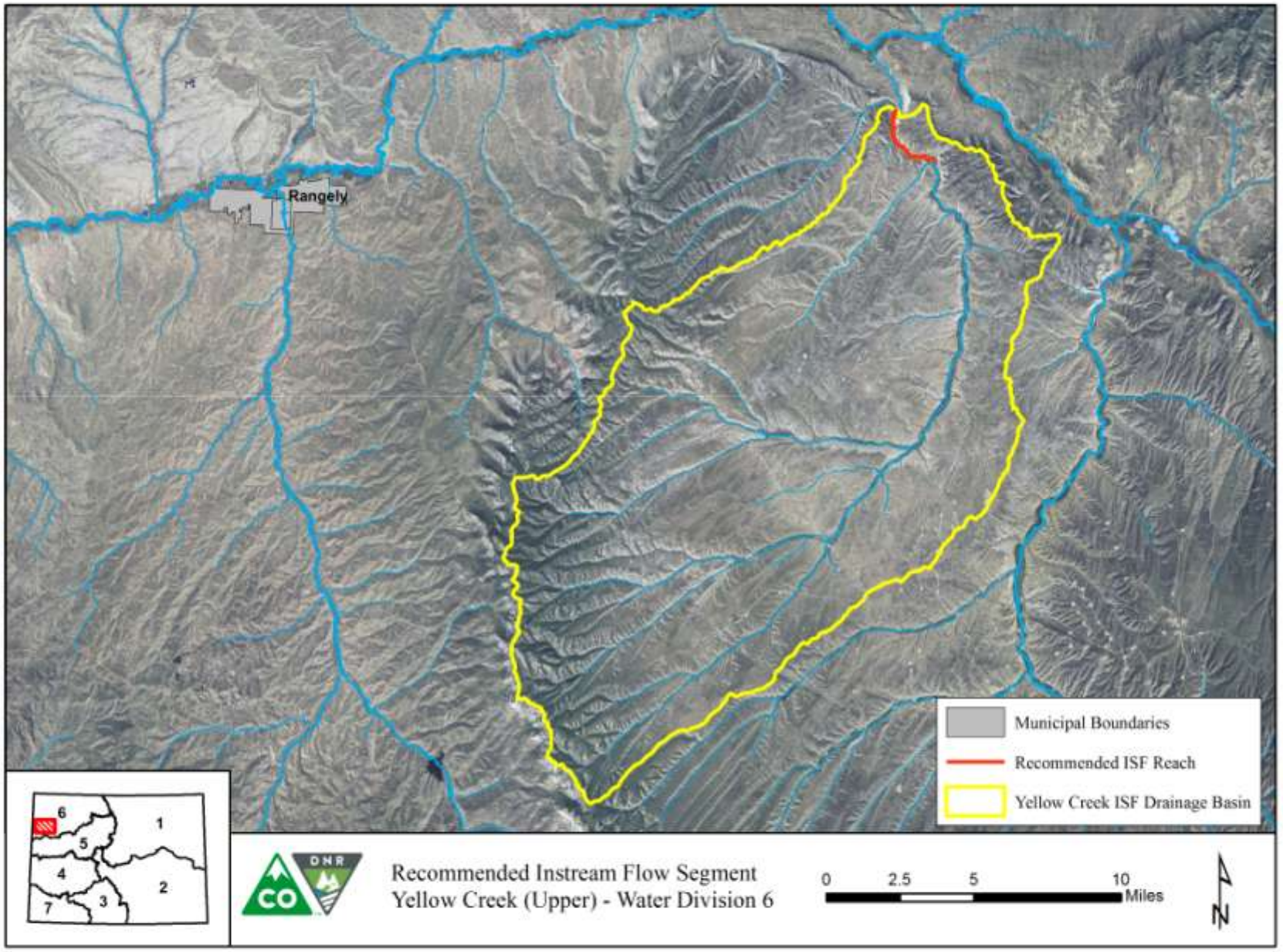
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

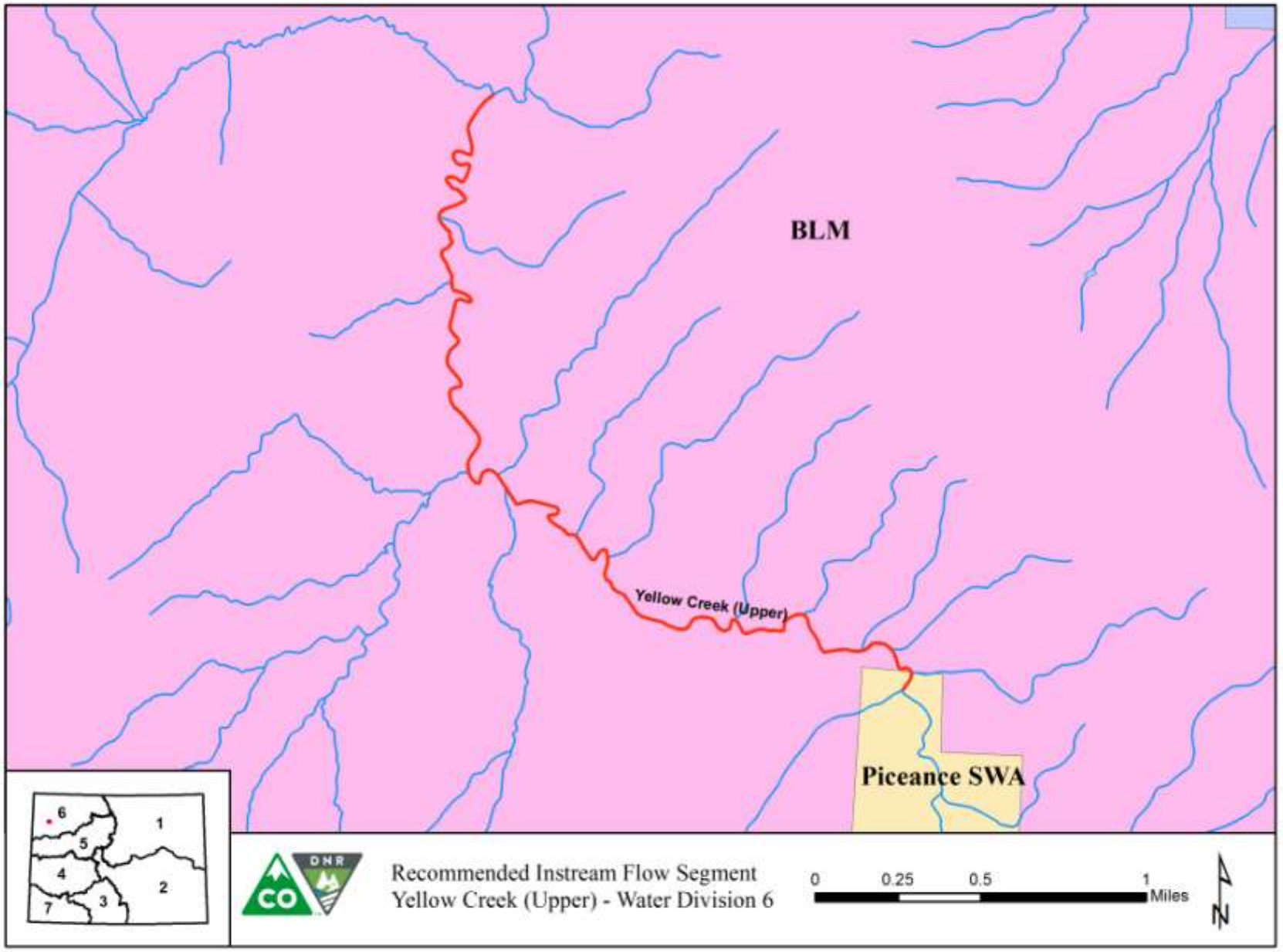
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

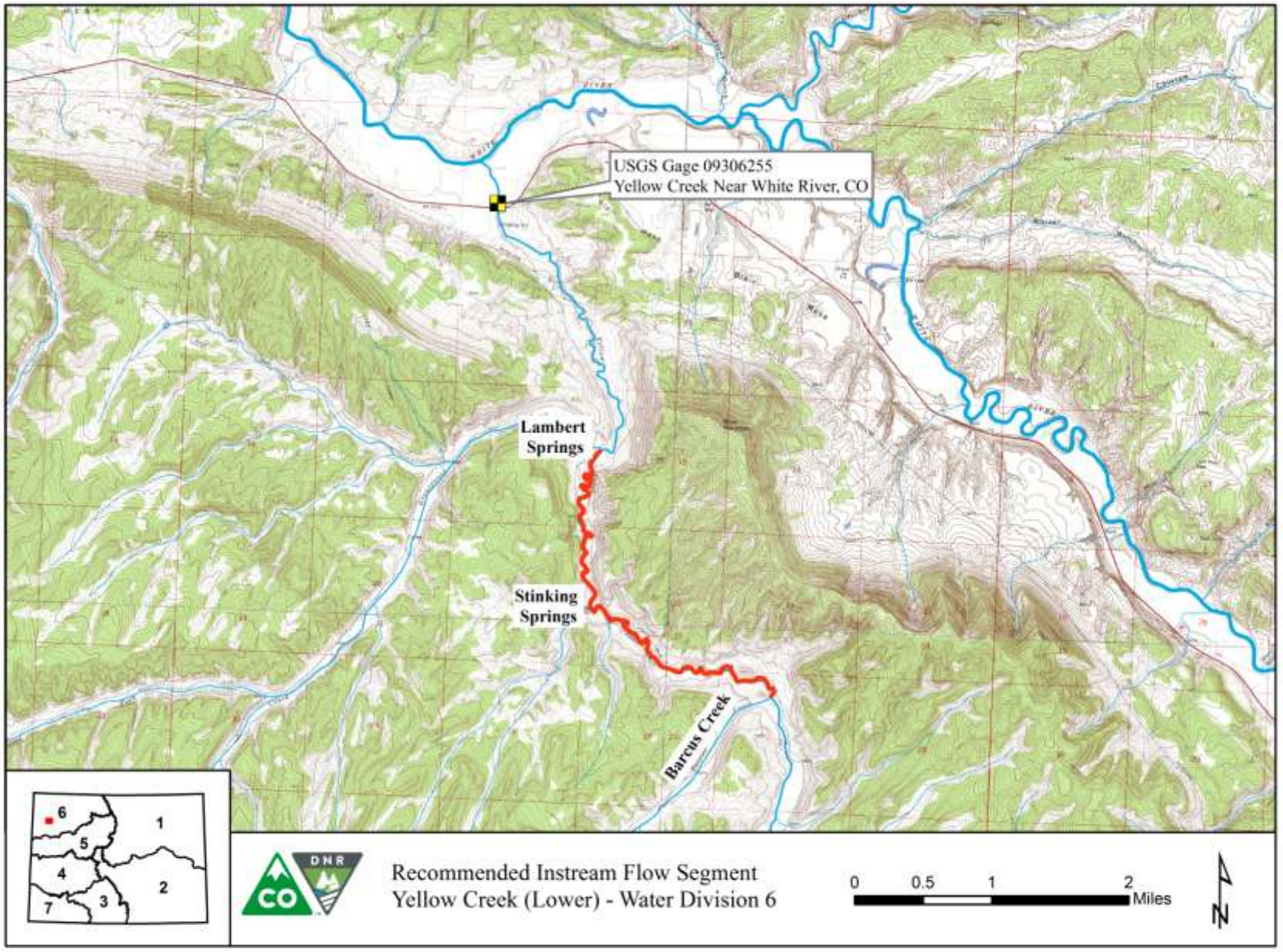
VICINITY MAP



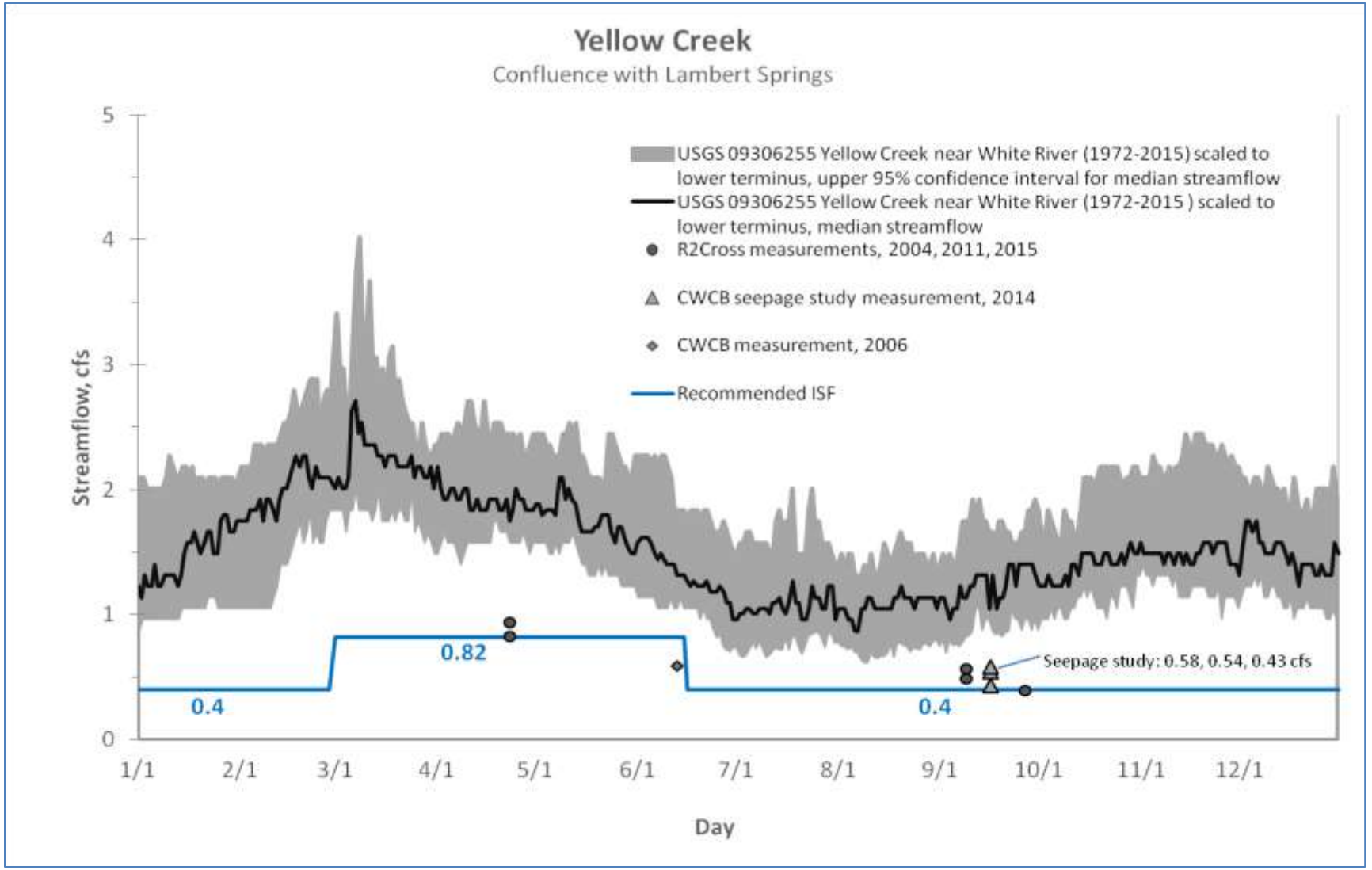
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



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

Yellow Creek (Lower)

EXECUTIVE SUMMARY

CWCB STAFF INSTREAM FLOW RECOMMENDATION

UPPER TERMINUS:	Confluence Lambert Springs	
	UTM North: 4449129.57	UTM East: 211572.39
LOWER TERMINUS:	Confluence White River	
	UTM North: 4452477.49	UTM East: 210214.46
WATER DIVISION:	6	
WATER DISTRICT:	43	
COUNTY:	Rio Blanco	
WATERSHED:	Piceance – Yellow (HUC#: 14050006)	
CWCB ID:	13/6/A-006	
RECOMMENDER:	Bureau of Land Management	
LENGTH:	3.45 miles	
FLOW RECOMMENDATION:	1.80 cfs (3/1-6/15) 1.20 cfs (6/16-2/29)	

Yellow Creek (Lower)

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.

The Bureau of Land Management (BLM) recommended that the CWCB appropriate an ISF water right on a reach of Yellow Creek. This reach is located within Rio Blanco County about 19 miles east of the town of Rangely (See Vicinity Map). The Yellow Creek headwaters originate in the Cathedral Bluffs at an elevation of 8,200 feet. The creek flows in a northerly direction as it drops to an elevation of 5,700 feet where it joins the White River. The proposed reach extends from the confluence with Lambert Springs downstream to the confluence with the White River. Seventy-three percent of the land on the 3.45 mile proposed reach is publicly owned and managed by the BLM (See Land Ownership Map). The BLM recommended this reach of Yellow 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 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.

Yellow Creek is a small, moderate gradient stream with a variable substrate size and a stable channel. Water quality, food sources and physical habitat characteristics are suitable for native species. Because of the small stream size, protection of flows is extremely important for continued existence of the fishery and riparian community.

Fishery surveys indicate that the creek supports self-sustaining populations of speckled dace and native mountain suckers, with density of mountain suckers slightly exceeding densities of speckled dace. The creek also provides habitat for northern leopard frogs. It is important to note that both mountain suckers and northern leopard frog appear on BLM's sensitive species list.

The riparian community is in stable condition and comprised primarily of willows and grasses. Riparian community health has been impaired by historic grazing practices and invasion of tamarisk. The BLM is taking actions to modify management and place the riparian community on an upward trend.

Table 1. List of species identified in Yellow Creek.

Species Name	Scientific Name	Status
speckled dace	*Rhinichthys osculus*	None
mountain sucker	*Catostomas platyrhynchus*	State Species of Special Concern BLM Sensitive Species
northern leopard frog	*Acris crepitans*	State Species of Special Concern BLM Sensitive Species

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 (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). 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 four 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 1.80 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 rate of 1.20 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 Yellow Creek.

Entity	Date	Streamflow (cfs)	Accuracy Range (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
BLM	9/27/2011 – 1	1.19	0.5 – 3.0	1.18	Out of range
BLM	9/27/2011 – 2	1.04	0.4 – 2.6	0.91	1.65
BLM	7/7/2015 – 1	1.31	0.5 – 3.3	1.58	2.15
BLM	7/7/2015 – 2	1.22	0.5 – 3.0	1.20	1.70
			Mean	**1.22**	**1.83**

ISF Recommendation
The BLM recommends flows of 1.20 cfs (6/16-2/29) and 1.80 cfs (3/1 – 6/15), based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

1.80 cubic feet per second is recommended for the snowmelt runoff period from March 1 through June 15. Each surveyed reach had distinctly different hydraulic characteristics, so this recommendation is driven by both the average velocity and wetted perimeter criteria. Since this creek is very small and has limited physical habitat, it is important to meet all three instream flow criteria during the spawning season to insure the survival of the native fish population.

1.20 cubic feet per second is recommended for the remainder of year, from June 16 through February 29. This recommendation is driven by a variety of the instream flow criteria, since each surveyed reach had distinctly different hydraulic characteristics. Many portions of this reach have a high width-to-depth ratio, so it is important to maintain sufficient depth for fish passage and overwintering of fish. This flow rate also protects the inflow to the creek from Lambert Spring, which is critical in maintaining water quality and quantity that is capable of supporting a native fishery.

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 lower Yellow Creek is 263 square miles, with an average elevation of 6,880 ft and average annual precipitation of 16.72 inches. The relatively low elevation drainage basin results in the potential for relatively early snowmelt runoff. The river system may have dry sections at different points in the year upstream from the BLM recommended reaches. Springs located in the vicinity of the proposed ISF reaches (upper and lower) have been observed to contribute a significant amount of flow to the stream. Notable springs include an unnamed spring located above Barcus Creek, Stinking Springs, and Lambert Springs. The Yellow Creek basin supports agriculture and oil and gas extraction among other uses. Hydrology is altered by water use within the basin.

Available Data

Yellow Creek has a USGS gage located approximately 1,600 ft upstream from the lower terminus (USGS gage 09306255 Yellow Creek near White River, CO). The drainage basin of the Yellow Creek gage is 263 square miles, with an average elevation of 6,880 ft and average annual precipitation of 16.72 inches. The proximity of the gage to the lower terminus and an extensive period of record (1972 to present) make this gage well suited for water availability analysis. No intervening diversions between the gage and the lower terminus were identified at the time of analysis. Therefore, the gage provides the best available estimate of stream flow conditions at the confluence with the White River.

Data Analysis

The USGS Yellow Creek gage was analyzed from 10/1/1972 to 7/22/2015 based on USGS approved data available through HydroBase on 12/21/2015. No gage data was available from 1983 to 1987. The gage data was not scaled to the lower terminus due to negligible differences in contributing drainage basin area. Median streamflow and 95% confidence intervals for median streamflow were calculated for the Yellow Creek gage record.

Water Availability Summary

The hydrograph (Figure 1) shows the median streamflow and 95% confidence intervals for the median streamflow based on the Yellow Creek gage record. The proposed ISF rate is below the median for the majority of the year. The proposed ISF rate is below the upper 95% confidence interval of the median at all times. Staff has concluded that water is available for appropriation.

CWCB staff made one streamflow measurement on the proposed reach of Yellow Creek in 2006 and one measurements in 2014. These measurements are included in the water availability analysis.

Material Injury
Because the proposed ISF on Yellow 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.

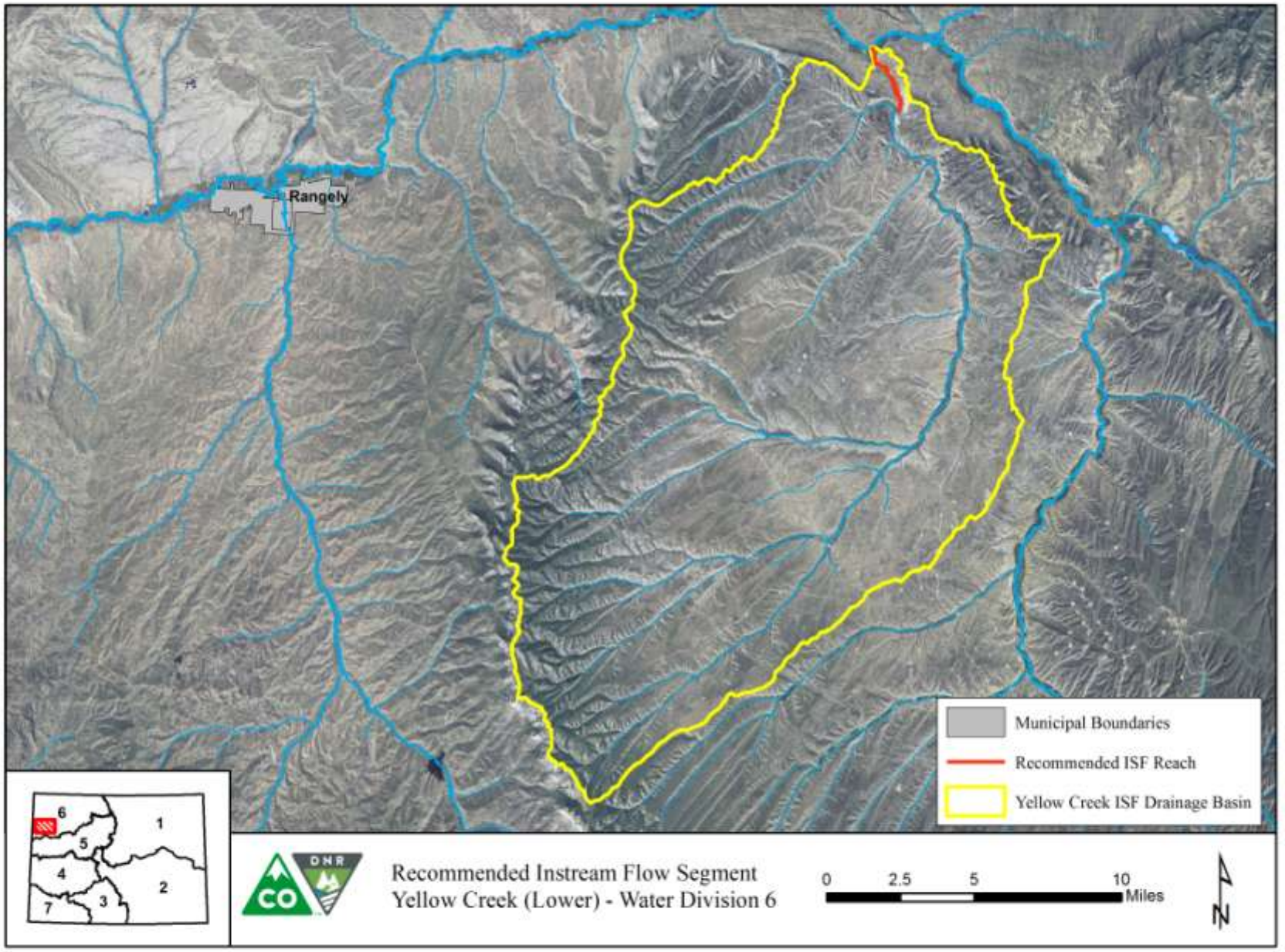
Espegren, G.D., 1996, Development of Instream Flow Recommendations in Colorado Using R2CROSS, Colorado Water Conservation Board.

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.

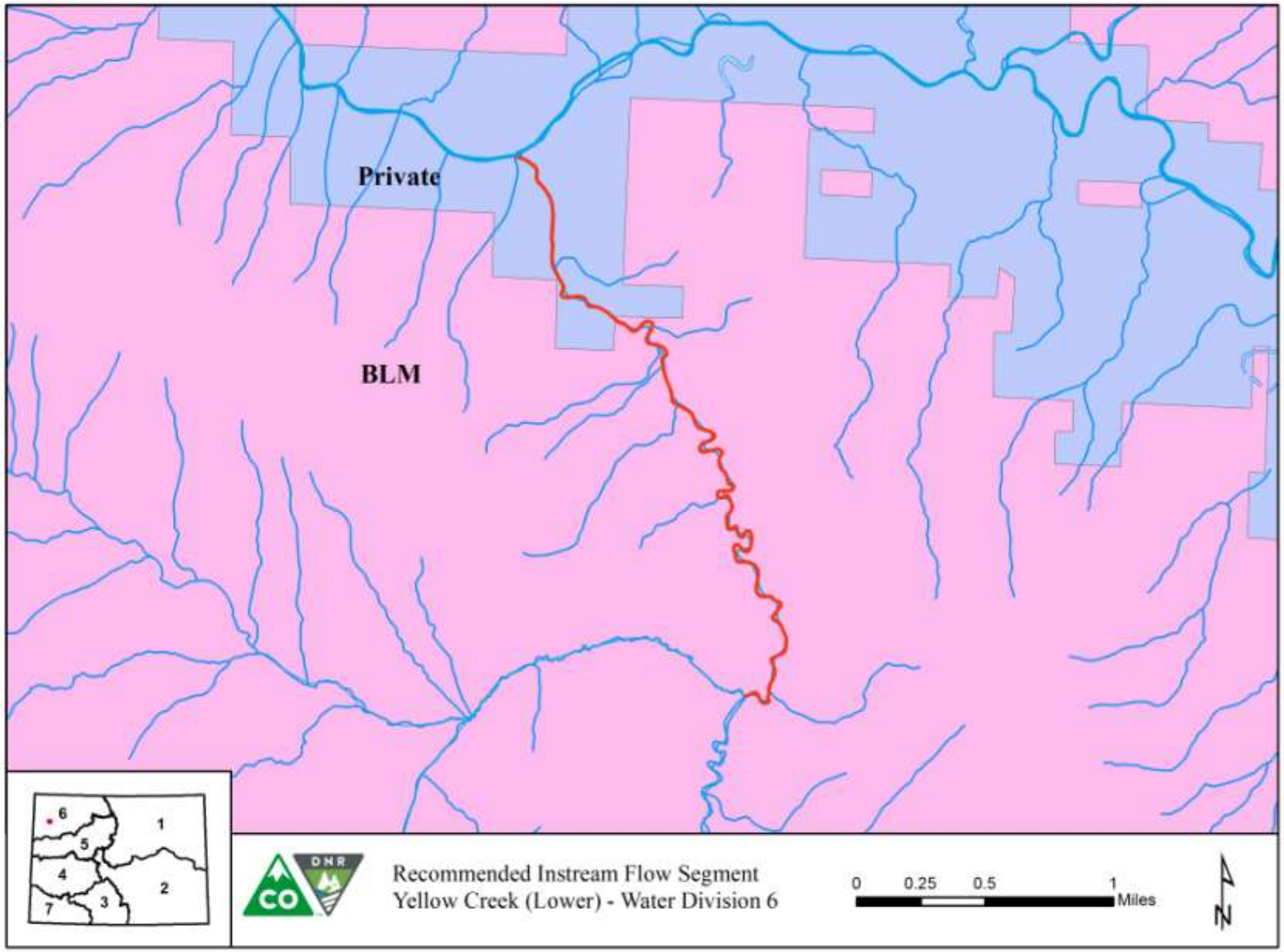
Metadata Descriptions
The UTM locations for the upstream and downstream termini were derived from CWCB GIS using the National Hydrography Dataset (NHD).

Projected Coordinate System: NAD 1983 UTM Zone 13N.

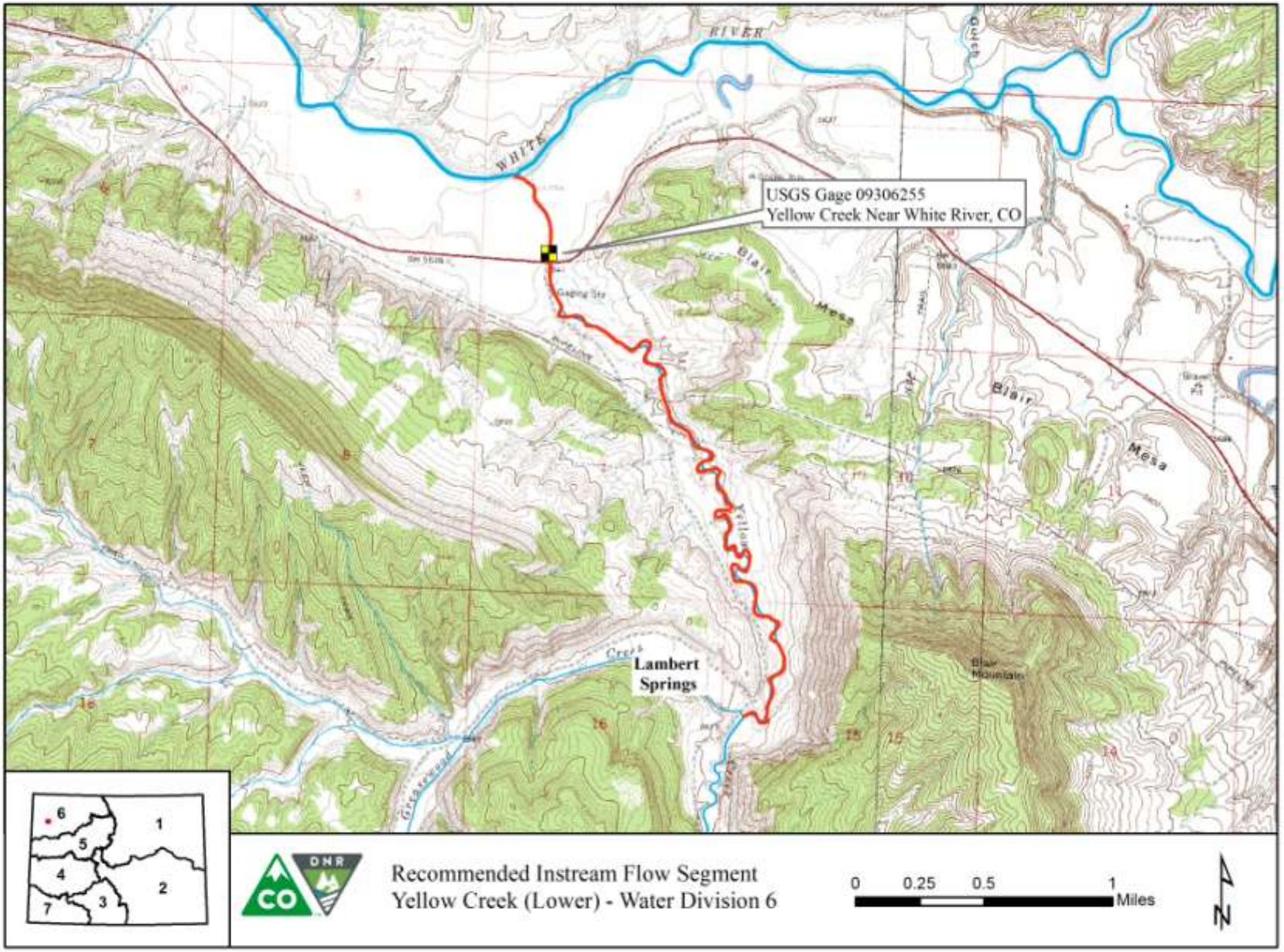
VICINITY MAP



LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH