East Muddy Creek Executive Summary

CWCB STAFF INSTREAM FLOW RECOMMENDATION

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UPPER TERMINUS:	confluence Lee Creek at UTM North: 4327742.52 UTM East: 295050.07
LOWER TERMINUS:	confluence Muddy Creek at UTM North: 4319399.06 UTM East: 295770.58
WATER DIVISION/DISTRICT:	4/40
COUNTY:	Gunnison
WATERSHED:	North Fork Gunnison
CWCB ID:	21/4/A-005
RECOMMENDER:	Bureau of Land Management (BLM)
LENGTH:	6.32 miles
FLOW RECOMMENDATION:	11.2 cfs (11/01 - 03/15) 23.25 cfs (03/16 - 07/15) 14 cfs (07/16 - 10/31)

COLORADO
Colorado Water Conservation Board
Department of Natural Resources

BACKGROUND

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 information contained in this Executive Summary and the associated supporting data and analyses form the basis for staff's ISF recommendation to be considered by the Board. This Executive Summary provides sufficient information to support the CWCB findings required by ISF Rule 5i on natural environment, water availability, and material injury. Additional supporting information is located at: https://cwcb.colorado.gov/2024-isf-recommendations.

RECOMMENDED ISF REACH

The BLM recommended that the CWCB appropriate an ISF water right on a reach of East Muddy Creek at the January 2020 ISF workshop. East Muddy Creek is located within Gunnison County (See Vicinity Map), and is approximately 14.5 miles northeast of Paonia, CO. The stream originates at the confluence of Little Muddy Creek and Clear Fork and flows south until it reaches the confluence with Paonia Reservoir.

The proposed ISF reach extends from the confluence Lee Creek downstream to the confluence with West Muddy Creek for a total of 6.32 miles. Approximately 19% of the proposed reach is managed by the BLM, while 81% is managed under private ownership (See Land Ownership Map). BLM is interested in protecting this stream to preserve the natural environment in and around Gunnison County. BLM's management goals include maintaining and enhancing habitat that supports fish species and functional riparian and wetland systems. Establishing an ISF water right will assist in meeting these BLM objectives.

OUTREACH

Stakeholder input is a valued part of the CWCB staff's analysis of ISF recommendations. Currently, more than 1,100 people subscribe to the ISF mailing list. Notice of the potential appropriation of an ISF water right on East Muddy Creek was sent to the mailing list in November 2023, March 2023, March 2022, March 2021, and March 2020. Staff sent letters to identified landowners adjacent to East Muddy Creek based on information from the county assessor's website. A public notice about this recommendation was also published in the Crested Butte News on January 5, 2024.

Staff presented information about the ISF program and this recommendation to the Gunnison County Board of County Commissioners on November 10, 2020, September 13, 2022, and October 24, 2023. Staff met with Luke Reschke, District 40 Lead Water Commissioner, and Doug Christner, District 40 Water Commissioner, on September 26, 2023 to better understand the administration on West Muddy Creek and its tributaries. In addition, CWCB staff and BLM staff met with a number of stakeholders from the area on November 28, 2023. This included a

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presentation on the West Muddy and East Muddy Creek ISF recommendations and discussions and questions about the purpose of ISF protection, stock uses, water availablity, and other concerns.

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 provides the Board with a basis for determining that a natural environment exists.

East Muddy Creek is a cool-water, low to moderate gradient stream. It flows through a mountain valley approximately 0.5 miles in width. The stream cuts through alluvial deposits in some locations and is constrained by bedrock in locations where the stream comes close to valley walls. The stream generally has medium-sized substrate, consisting of gravels, cobbles, and small boulders. The stream has a good mix of pool and riffle habitat for supporting introduced trout species as well as native fish species.

Fisheries surveys have revealed self-sustaining populations of speckled dace, mottled sculpin, bluehead sucker, rainbow trout, fathead minnow and white sucker (Table 1). Speckled dace, mottled sculpin, flannelmouth suckers, and bluehead suckers are native species, and the bluehead sucker appears on BLM's sensitive species list. Since Paonia Reservoir prevents migration of fishes between East Muddy Creek and the Gunnison River, it is likely that East Muddy Creek provides year-round habitat for bluehead sucker.

Table 1. List of species identified in East Muddy Creek.

Species Name	Scientific Name	Status
brook trout	*Salvelinus fontinalis*	None
white-blue sucker hybrid	*Catostomus commersoni x discobolus*	None
white-flannelmouth hybrid	*Catostomus commersoni x latipinnis*	None
bluehead sucker	*Catostomus discobolus*	State - Species of Greatest Conservation Need
flannelmouth sucker	*Catostomus latipinnis*	State - Species of Greatest Conservation Need
fathead minnow	*Pimephales promelas*	None
mottled sculpin	*Cottus bairdii*	None
speckled dace	*Rhinichthys osculus*	None
white sucker	*Catostomus commersonii*	None

The riparian community in this part of East Muddy Creek is generally comprised of willow species, alder, spruce, and narrowleaf cottonwood. Overall, the riparian community is in good condition, provides some shading and cover for fish habitat, and provides stream stability during flood events.

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ISF QUANTIFICATION

CWCB staff relies on 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.

Quantification Methodology

BLM staff used the R2Cross method 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; CWCB, 2022). Riffles are the stream habitat type that are most vulnerable to dry if streamflow ceases. The data collected consists of a streamflow measurement, a survey of channel geometry and features at a cross-section, and a survey of the longitudinal slope of the water surface.

The R2Cross model uses Ferguson's Variable-Power Equation (VPE) to estimate roughness and hydraulic conditions at different water stages at the measured cross-section (Ferguson, 2007; Ferguson, 2021). This approach is based on calibrating the model as described in Ferguson (2021). The model is used to evaluate three hydraulic criteria: 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 macroinvertebrates (Nehring, 1979). BLM staff use the model results to develop an initial recommendation for summer and winter flows. The summer flow recommendation is based on the flow that meets all three hydraulic criteria. The winter flow recommendation is based on the flow that meets two of the three hydraulic criteria.

The R2Cross method estimates the biological amount of water needed for summer and winter periods. 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 Collection and Analysis

BLM collected R2Cross data 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 stream reach. The R2Cross model results in a winter flow of 11.22 cfs and a summer flow of 23.28 cfs. R2Cross field data and model results can be found in the appendix to this report.

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

Date, XS #	Top Width (feet)	Streamflow (cfs)	Winter Rate (cfs)	Summer Rate (cfs)
06/01/2018, 1	49.90	45.34	15.16	32.41
06/01/2018, 2	42.37	43.24	6.80	15.59
09/24/2019, 1	50.54	11.58	13.42	17.19
09/24/2019, 2	44.45	12.17	9.48	27.91
			11.22	23.28

ISF Recommendation

The BLM recommends the following flows based on R2Cross modeling analyses, biological expertise, and staff's water availability analysis.

11.2 cfs is recommended from November 1 to March 15. This recommended flow rate meets two of three hydraulic criteria during the winter. This flow rate either meets or comes close to meeting the average depth and average velocity criteria in cross-sections analyzed and should prevent icing in pools.

23.25 cfs is recommended from March 16 to July 15. This flow rate meets three of three hydraulic criteria during the snowmelt runoff period. The recommended flow rate is driven by the wetted perimeter criteria in a majority of the cross-section data collected. Wetting 50% to 60% of the channel, as recommended by the R2Cross manual for streams 40 to 60 feet in width, will provide important physical habitat during a time of year when the fish population is completing key life cycle functions.

14.0 cfs is recommended from July 16 to October 31; this flow rate is reduced due to limited water availability. This flow rate will generally meet the average velocity and average depth criteria in the cross-sections analyzed, while providing approximately 50% wetted perimeter in the wider cross-sections.

WATER AVAILABILITY

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

Water Availability 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.). This approach focuses on streamflow 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) are used to evaluate

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streamflow. Other streamflow information such as short-term gages, temporary gages, spot streamflow measurements, diversion records, and regression-based models are used when long-term gage data is not available. CSUFlow18 is a multiple regression model developed by Colorado State University researchers using streamflow gage data collected between 2001 and 2018 (Eurich et al., 2021). This model estimates mean-monthly streamflow based on drainage basin area, basin terrain variables, and average basin precipitation and snow persistence. Diversion records are 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 from gage records; 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 Muddy Creek is 135.4 square miles, with an average elevation of 8,673 feet and average annual precipitation of 27.3 inches (See the Hydrologic Features Map). East Muddy Creek is a cold-water, moderate gradient snowmelt driven hydrologic system with influence from mid-season monsoonal periods. Peak flows initiate in early April and generally reach peak flow conditions by early to mid-May. Baseflow conditions are generally lowest in August and September when heavy irrigation practices combine with late summer climate conditions. Baseflow increases slightly when upstream irrigation ends each season.

Water Rights Assessment

There are 94 active water rights on East Muddy Creek and its tributaries. These include up to 290 cfs of direct flow ditch diversions, with seasonal limitations, 376 acre-feet of reservoir storage, and four minimum flow ISF water rights: Clear Fork of East Muddy Creek (case number 09CW0077), Spring Creek (case number 05CW0245A) and two reaches of Little Spring Creek (case numbers 09CW0072 and 09CW0073). There is one transbasin diversion high up in the Clear Fork contributing basin, a tributary to East Muddy Creek, that exports water to West Divide Creek in Division 5. Diversion records are consistently reported from 2004 to present and show high variability in exported water volumes for the Clear Fork Feeder Ditch (station ID CLFOFDCO) from nothing in 2005 to just under 1,624 acre feet in 2023.

The North Fork Gunnison River is often under administration with calls extending up both West and East Muddy Creek. The priority calling dates are typically in the late 1800s to early 1900's, but the exact priority can shift through the season. Typically, the call is on by late-July, but some calls have occurred as early as June. North Fork Water Conservancy District was decreed multiple points of exchange upstream of Paonia Reservoir in case number 05CW0236, with up to a volumetric limit of 2,000 acre feet. According to Water Commissioner Luke Reschke, in

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most years this exchange starts towards the end of July and the seasonal limit is reached by early to mid-September (personal communication, 9/26/2023 and 1/03/2024).

Data Collection and Analysis

Representative Gage

No current or long-term gages exist within the reach extent for the ISF recommendation on East Muddy Creek. There is one historic gage, East Muddy Creek Near Bardine, CO (BARDINE, USGS ID 9130500) that monitored streamflow conditions from 1934-1953 at a point approximately 1 mile above the confluence of West and East Muddy Creek. For a more current dataset, CWCB staff opted to install a temporary gage at the lower terminus of the current recommended ISF reach on West Muddy Creek (CWCB ID: 21/4/A-011); no suitable gage locations were identified for a temporary gage on East Muddy Creek. Staff used this data in conjunction with current streamflow conditions gaged downstream to estimate daily median streamflow on East Muddy Creek.

West Muddy Temporary Gage Analysis

CWCB installed the West Muddy gage at the lower terminus of the reach, 500 feet above the confluence where West Muddy Creek and East Muddy Creek combine to create Muddy Creek. This gage included a Hobo MX2001 pressure transducer recorded at a 15-minute interval that was installed on May 19, 2021 and maintained through present. Gaged West Muddy streamflow data is analyzed through August 15, 2023. The gage was ice affected at times each winter and the pressure transducer failed for two weeks during the rising limb of runoff in 2022. The 2022/2023 winter received less precipitation than the 2023/2024 winter and this is reflected in the hydrographs for each year. In 2022, streamflow peaked in early May at less than 200 cfs and gradually reached baseflow conditions by mid-July. In 2023 streamflow peaked at over 400 cfs, 10 days earlier than 2022 and maintained high flows longer than the previous year. The two years monitored two different hydrologic regimes during the period of record (POR), representing variability in patterns of streamflow generation and timing.

Staff analyzed total streamflow from the Division of Water Resources Muddy Creek above Paonia Reservoir, CO gage (MUDAPRCO) during its POR from 1985 to present to contextualize gaged data on West Muddy gage. MUDAPRCO is located approximately 2,300 ft downstream from the confluence of East and West Muddy Creek. Annual yield at MUDAPRCO shows 2021, 2022 and 2023 were below the 25th percentile yield.

The West Muddy gage was used in conjunction with the MUDAPRCO gage to estimate streamflow for a longer period of record on East Muddy Creek. Staff developed a linear model (LM) by comparing streamflow data from the two gages from 5/19/2021 – 8/15/2023. The two gages have over 450 days of data in common, only these daily data were used in the development of the LM. The resulting model shows the gages are highly correlated with an r^2 value of over 0.95. The estimated West Muddy gage record was developed by applying the LM to the entire MUDAPRCO POR (10/1/1985 – 8/15/2023).

East Muddy Creek daily streamflow is estimated by reducing MUDAPRCO complete POR of daily streamflow by West Muddy gage estimated daily streamflow. The estimated East Muddy Creek daily streamflow represents a nearly 40-year POR. This long-term record was then used to calculate daily median streamflow (See Complete and Detailed Hydrographs). Staff additionally considered hydrologic input from Dugout Creek, a tributary below the East Muddy Creek and

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above MUDAPRCO. Staff determined contributions to be negligible; no further adjustments were made to the streamflow record. Given that the impacts of diversions and reservoir releases are reflected in gage records no further adjustments were made.

CWCB staff made one streamflow measurement on the proposed reach of East Muddy Creek as summarized in Table 3.

Table 3. Summary of streamflow measurements for East Muddy Creek.

Visit Date	Flow (cfs)	Collector
11/06/2023	16.9	CWCB

Water Availability Summary
The hydrograph shows estimated median streamflow on East Muddy Creek, as described in the West Muddy Temporary Gage Analysis section above, along with the proposed ISF rate (See Complete Hydrograph). The proposed ISF flow rate is below the median streamflow. Staff has concluded that water is available for appropriation on East Muddy Creek.

MATERIAL INJURY
Because the proposed ISF on East Muddy 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., the CWCB will recognize any uses or exchanges of water in existence on the date this ISF water right is appropriated.

ADDITIONAL INFORMATION

Citations
Colorado Water Conservation Board, 2022, R2Cross model- user's manual and technical guide. Retrieve from URL: https://r2cross.erams.com/

Eurich, A., Kampf, S.K., Hammond, J.C., Ross, M., Willi, K., Vorster, A.G. and Pulver, B., 2021, Predicting mean annual and mean monthly streamflow in Colorado ungauged basins, River Research and Applications, 37(4), 569-578.

Espegren, G.D., 1996, Development of instream flow recommendations in Colorado using R2CROSS, Colorado Water Conservation Board.

Ferguson, R.I., 2007. Flow resistance equations for gravel- and boulder-bed streams. Water Resources Research 43. https://doi.org/10.1029/2006WR005422

Ferguson, R.I., 2021. Roughness calibration to improve flow predictions in coarse-bed streams. Water Res 57. https://doi.org/10.1029/2021WR029979

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.

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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.

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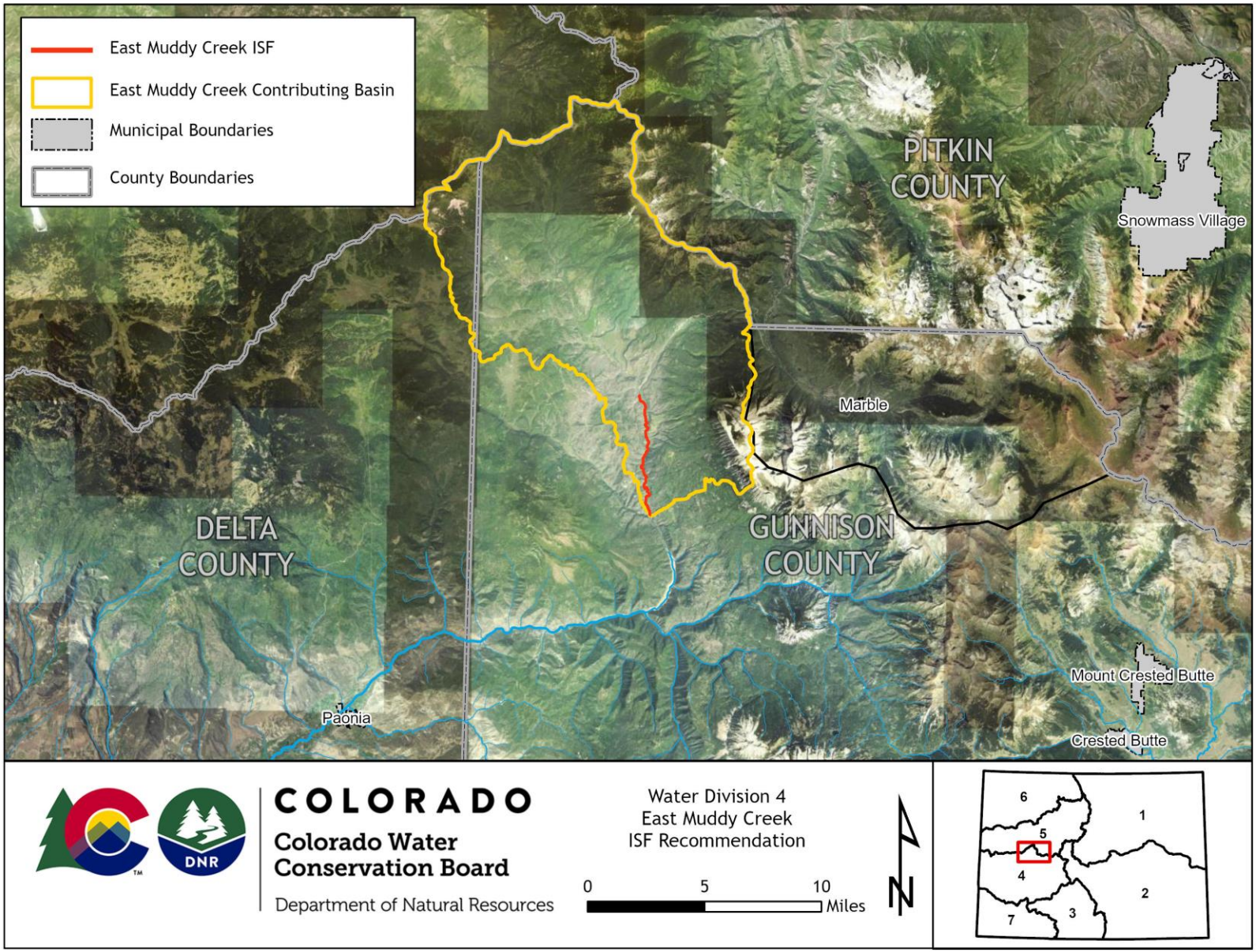
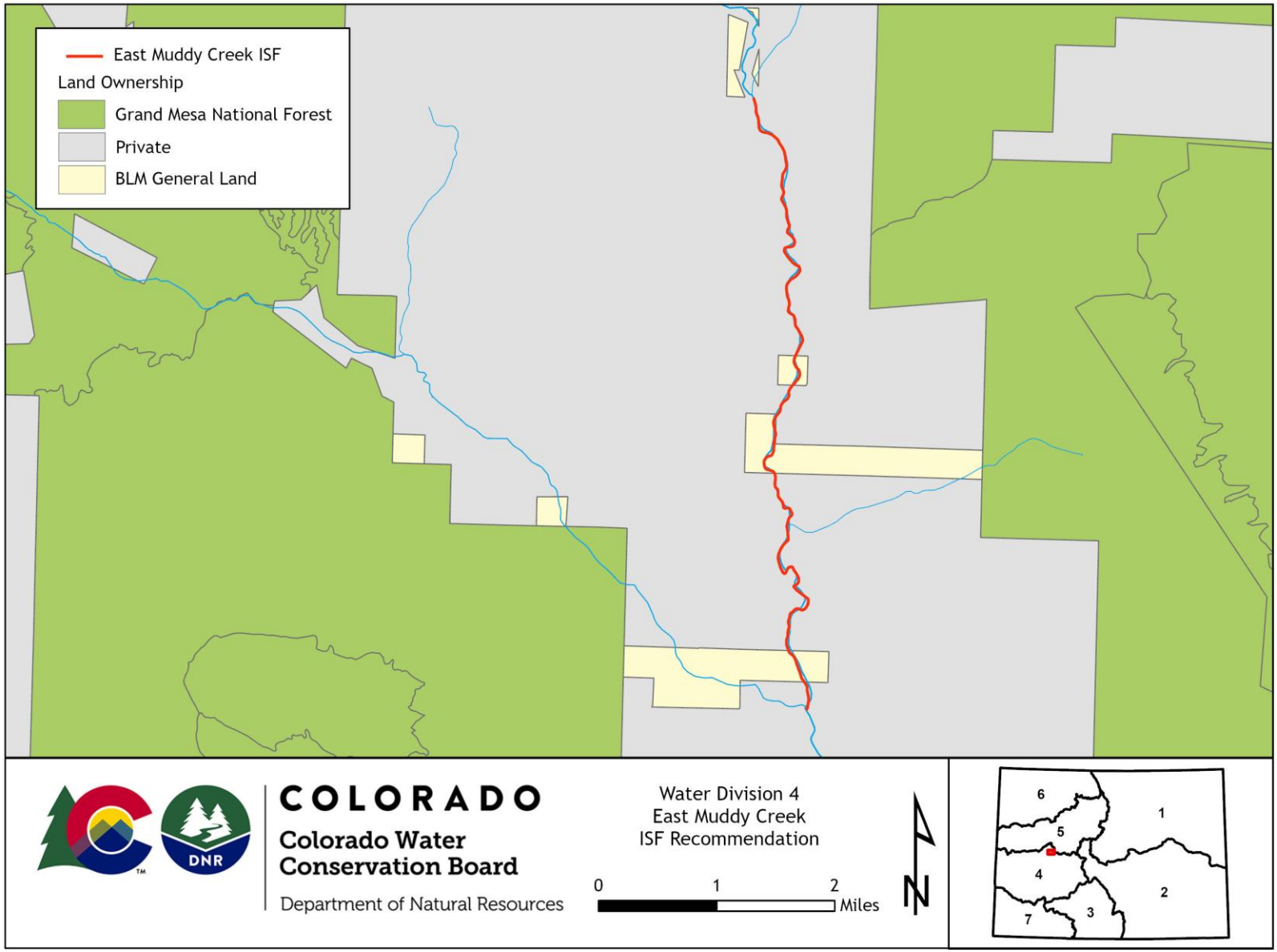
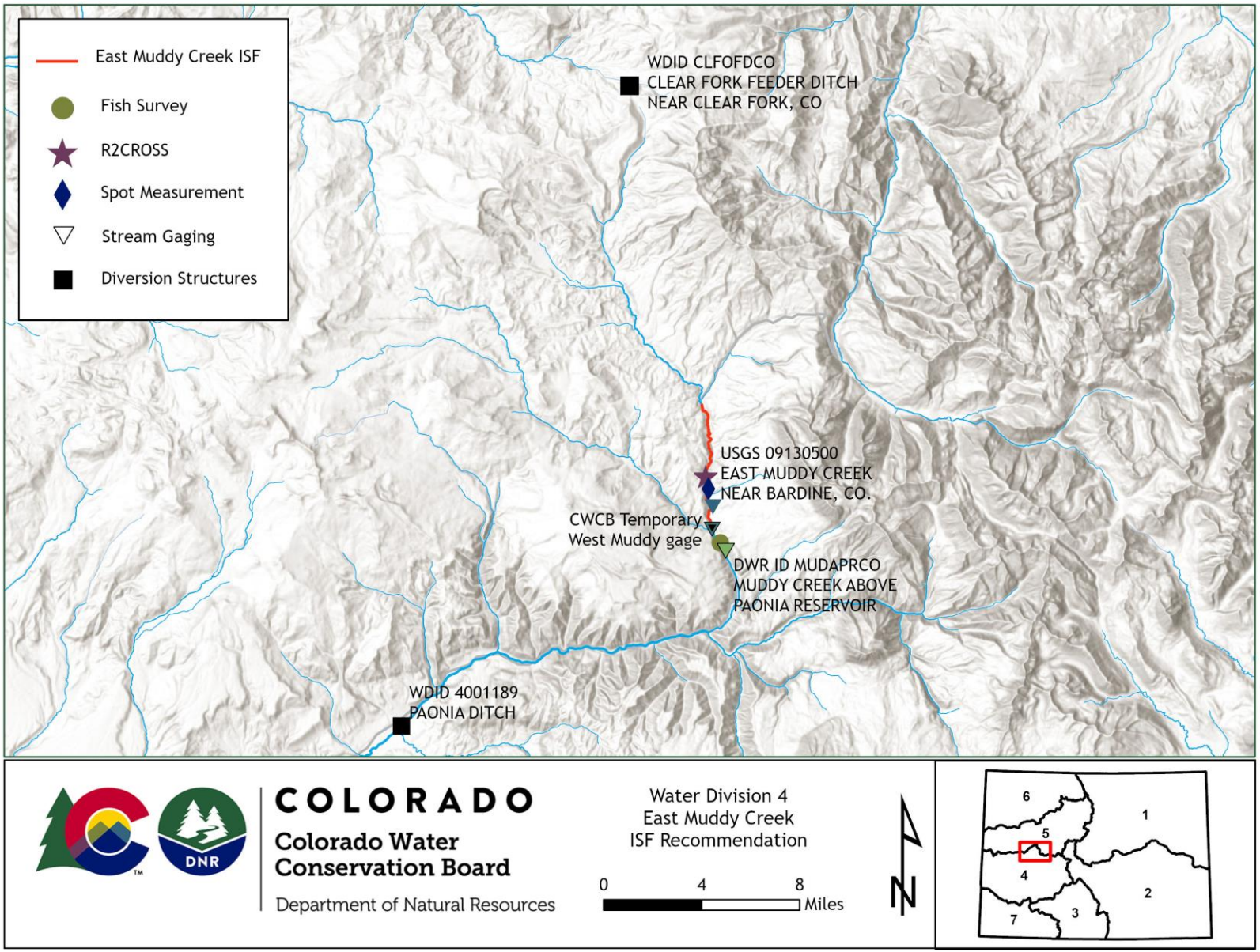
VICINITY MAP



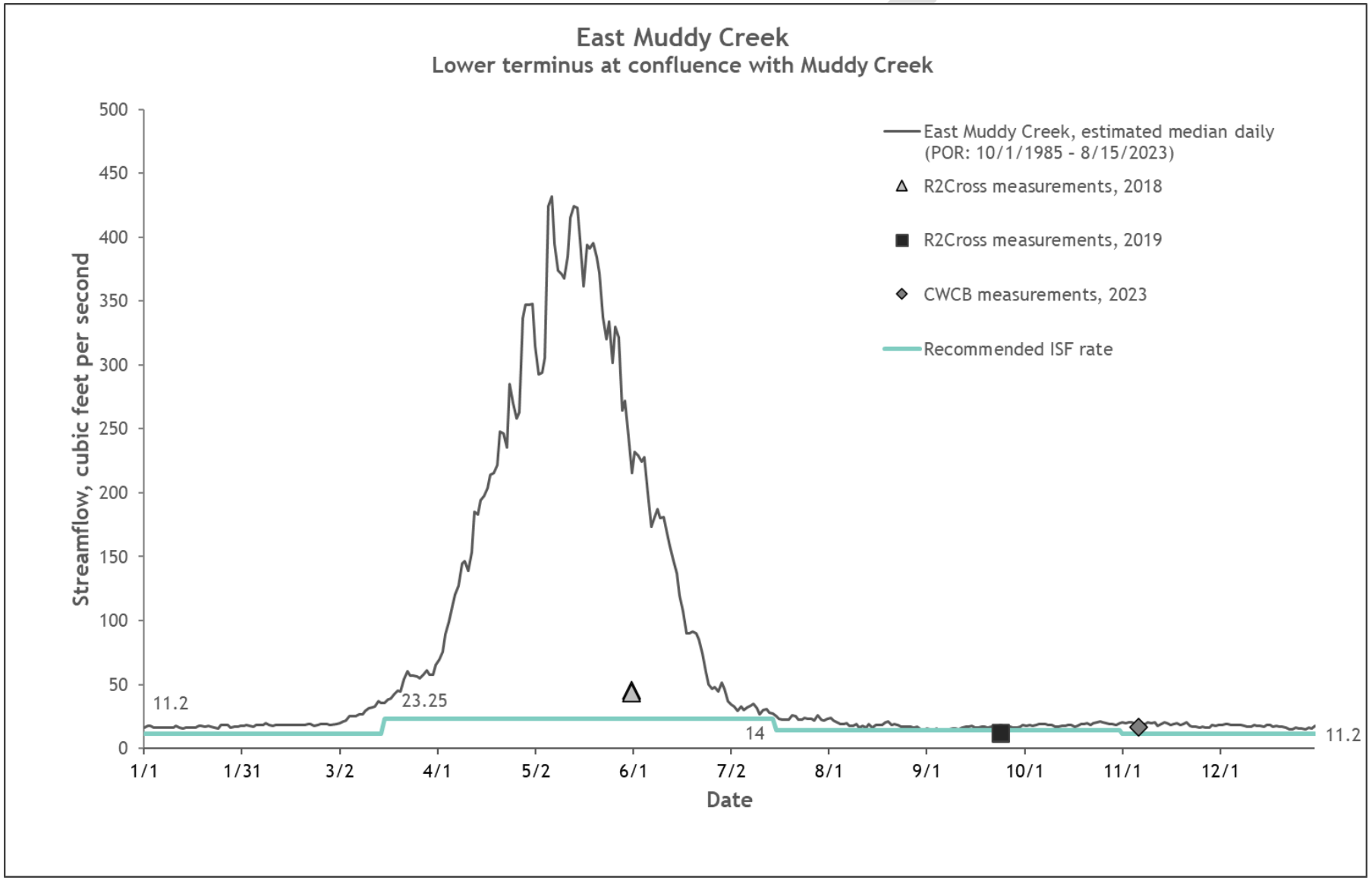
LAND OWNERSHIP MAP



HYDROLOGIC FEATURES MAP



COMPLETE HYDROGRAPH



DETAILED HYDROGRAPH