COLORADO
Parks and Wildlife
Department of Natural Resources

Water Resources Section
6060 Broadway
Denver, CO 80216

November 1, 2024

Mr. Rob Viehl, Section Chief
Colorado Water Conservation Board
Stream and Lake Protection Section
1313 Sherman Street, 7th Floor
Denver, CO 80203

Subject: Instream Flow Recommendation for Middle Hubbard Creek in Water Division 4, Delta County to be presented at the January 2025 CWCB Meeting

Dear Mr. Viehl:

The information contained within and referred to in this letter forms the scientific and biological basis for an instream flow (ISF) recommendation on Middle Hubbard Creek in Water Division 4. Field investigations relating to this ISF recommendation were conducted by Colorado Parks and Wildlife (CPW) and Colorado Water Conservation Board (CWCB) staff in 2024. Middle Hubbard Creek is a first order stream that supports native Colorado River cutthroat trout. This ISF recommendation was first presented to interested parties at the ISF Workshop in January 2020. CPW and CWCB staff conducted outreach to the Delta County Commissioners in 2024, the North Fork Water Users in 2023 and to the Ragged Mountain Water Users Association in 2024. It is CPW staff's opinion that the information contained in this letter is sufficient for the CWCB's staff to recommend an ISF appropriation to the Board on Middle Hubbard Creek as it specifically addresses the findings required in Rule 5(i) of the Instream Flow Program Rules.

CPW participates in the ISF Program and develops ISF recommendations for the Board's consideration in an effort to address CPW's legislative directives "… that the wildlife and their environment are to be protected, preserved, enhanced, and managed for the use, benefit, and enjoyment of the people of this state and its visitors … and that, to carry out such program and policy, there shall be a continuous operation of planning, acquisition, and development of wildlife habitats and facilities for wildlife-related opportunities" [§33-1-101 (1) C.R.S.], and "… that the natural, scenic, scientific, and outdoor recreation areas … be protected, preserved, enhanced and managed for the use, benefit, and enjoyment of the people of this state and (its) visitors … and that, to carry out such program and policy, there shall be a continuous operation of acquisition, development, and management of … lands, waters, and facilities." [§33-10-101 (1) C.R.S.].

In addition to these broad statutory guidelines, CPW's strategic planning document (CPW Strategic Plan, 2015) explains the agency's current goals to, "[c]onserve wildlife and habitat to ensure healthy sustainable populations and ecosystems" in order to, "protect and enhance water resources for fish

and wildlife populations," by pursuing, "partnerships and agreements to enhance instream flows, protect reservoir levels, and influence water management activities," and to, "[a]dvocate for water quality and quantities to conserve aquatic resources." In addition to the CPW strategic plan, the agency's fish and wildlife conservation activities are also informed by the State Wildlife Action Plan (2002, Revised 2015). The aforementioned documents direct CPW to advocate for the preservation of the state's fish and wildlife resources and natural environment, and therefore link CPW's mission to the goals and priorities of CWCB's Instream Flow and Natural Lake Level Program.

Recommended Segments & Land Status

CPW is proposing an ISF recommendation on Middle Hubbard Creek from the headwaters (located at UTM 13S 270063.72 4324090.67) to Overland Canal diversion structure (located at UTM 13S 273218.73 4325516.75). The reach is approximately 2.4 miles in length. The proposed reach is entirely on public lands managed under the Grand Mesa National Forest.

Colorado Cutthroat Trout Conservation Goals

In 2001, CPW entered into a multi-state and multi-agency conservation agreement and strategy concerning Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*). Colorado's partners in this plan and agreement include the natural resource management agencies from Utah and Wyoming, a number of federal agencies including the USFS, USFWS, BLM and NPS, and the Ute Indian Tribe of the Uintah and Ouray Reservation. The purpose of the strategy is to provide a framework for the long-term conservation of the Colorado River cutthroat trout (CRCT) and to reduce or eliminate the threats that warrant its status as a sensitive species or species of concern by federal resource agencies. Essentially, the parties agreed that in order to prevent listing of the subspecies, and to reach desired recovery goals without hindering further development of our state resources, continued implementation of the conservation strategy was necessary.

The primary objectives of the strategy are to identify and characterize all CRCT core and conservation populations, secure and enhance conservation populations, restore populations, and secure and enhance watershed conditions they rely upon. CPW believes that flow protection via establishing an ISF water right is a conservation action aligned with the goal of "securing and enhancing watershed conditions" and will support the core conservation populations of CRCT which are resident to Middle Hubbard Creek. Information about the species and CPW's conservation strategy can be found here: CPW Cutthroat Trout Research. CPW believes that securing ISF water rights for core conservation populations of CRCT is a critical step in the overall preservation of these important native trout.

Natural Environment and Biological Summary

Middle Hubbard Creek is a tributary of Hubbard Creek which flows into the North Fork Gunnison River near the town of Somerset. Middle Hubbard Creek is a first order headwaters stream with hydrology that is snowmelt dominated with perennial baseflows throughout the year. The basin receives approximately 30 inches of mean annual precipitation. The drainage basin contributing to the ISF reach is approximately 1.4 square miles and is densely forested with stands of pine and aspen. Mean basin elevation is approximately 10,400 feet.

Middle Hubbard Creek has a confined, high-gradient channel with substrate that ranges from small boulder to large cobbles and gravels with predominantly large substrate. Fish habitat is complex and includes ample large woody debris in the channel, deep pools providing slower-velocity refuge, and side channels which create backwater habitats following high flow events.

Large pools are the dominant habitat features used by resident trout. These pools are mainly created from either large boulder step-pool drops or log jams. Deadfall in the basin is significant. There is ample canopy cover providing shading, cover, and thermal refuge for the resident cutthroat trout. The creek supports a healthy riparian community. Macroinvertebrates are diverse and abundant and include three species of caddisfly and mayflies which were observed in the field.

Middle Hubbard Creek supports a self-sustaining population of Colorado River cutthroat trout of the Gunnison Basin lineage. The population is considered a "core conservation population" meaning very high genetic purity because of limited hybridization with non-native trout species. Length-frequency data shows multiple age classes surveyed by CPW in 2007 (see attached). Multiple age classes indicate that the cutthroat trout population are self-sustaining with natural recruitment occurring.

R2Cross Background

Initial biological instream flow recommendations were developed using the R2Cross methodology (Espegren, 1996[1]). R2Cross uses field data that has been collected in a riffle habitat type. Riffles are often the limiting habitat features in streams during low flow events, so maintaining specific hydraulic conditions across riffle habitat types will also maintain aquatic habitat in pools and glides for most life stages of fish and macroinvertebrates (Nehring, 1979[2]). The R2Cross model uses field data, including a survey of cross-sectional channel geometry, a longitudinal slope of the water surface, and a flow measurement, as input to a single transect hydraulic model. R2Cross uses Ferguson's Variable-Power Equation (Ferguson, 2007[3]) to model a stage-discharge relationship and compute corresponding hydraulic parameters of average depth, average velocity, and percent wetted perimeter over modeled stages. Maintaining these three hydraulic parameters at specified levels should ensure conditions that allow movement of fish longintudinally across riffles and adequate depths, velocities, and oxygenation for production of macroinvertebrates and development of trout eggs. Baseflow recommendations are typically developed based on the flows that meet two of three hydraulic criteria and summer flow recommendations are based on hydraulic criteria that meet three of three hydraulic criteria (as described in Nehring 1979 and Espergren 1996).

In 2021 and 2024, CPW and CWCB staff visited Middle Hubbard Creek to collect data upstream of the Overland Canal diversion structure. Streamflows were exceptionally low in 2021 due to the multi-year drought, so streamflow and cross-section results from 2021 will not be incorporated into flow recommendations. The in-range R2Cross results from 2024 are summarized below:

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

[2]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.

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

	Bankfull Top Width	Date Measured	Flow Measured	Flow Meeting Two Criteria	Flow Meeting Three Criteria
1	19.5 ft	8/14/2024	1.0 cfs	0.99 cfs	8.0 cfs
2	15.5 ft	8/14/2024	1.0 cfs	1.1 cfs	2.6 cfs
Recommended Flow Rates:				**1.0 cfs**	**5.3 cfs**

The biological flow recommendation during the baseflow period is 1.0 cfs. This flow rate will be protective by maintaining over 50 percent wetted perimeter in the active stream channel and average depth of 0.2 feet. The biological flow recommendation in the summer is 5.3 cfs. This flow rate will also maintain these two hydraulic parameters, as well as average velocity of 1 foot per second (fps).

Water Availability Refined Flow Recommendations

In order to make a preliminary determination where water is available for the R2Cross-based flow recommendations and to determine appropriate seasonal transition dates, CPW examined basic hydrological data and water rights information for Middle Hubbard Creek. There is a gage on Middle Hubbard Creek that was maintained by the USGS between 1960 and 1968 (USGS '9132800'). This dataset was analyzed by CWCB staff to help inform physical water availability to meet the biological flow recommendations. CPW's analysis indicates that the following flows are needed to protect the natural environment to a reasonable degree. There are water availability limitations during the transitional and baseflow periods. Therefore, CPW's flow recommendations have been refined to the following:

- Baseflow Recommendation (November 1 through March 31): **0.25 cfs**
    - This flow recommendation has been reduced due to water availability constraints but will maintain adequate habitat availability in holding habitats like pools and deep glides. This will support fish during overwintering period when metabolic activity is limited, and they are resting in discrete habitat features (not moving longitudinally throughout the stream).
- Rising Limb Flow Recommendation (April 1 through April 30): 0**.60 cfs**
    - This flow recommendation has been reduced due to water availability constraints but will maintain adequate wetted perimeter and sufficient depths in riffles to support fish as they transition into higher levels of metabolic activity and may begin to move longitudinally throughout the channel as ice cover decreases and flows start to rise during the beginning of snowmelt runoff.
- Summer Flow Recommendation (May 1 through June 30): **4.9 cfs**
    - This flow recommendation has been reduced slightly due to water availability constraints, but will maintain adequate depth and wetted perimeter, as well as sufficient velocities to support fish when they are active feeding and spawning. This flow rate supports beneficial spawning conditions during spring runoff high flow period. Cutthroat trout spawn in the early months of summer and this flow rate will support beneficial spawning conditions with increased habitat availability, as well as productivity of the macroinvertebrate community.

- July Flow Recommendation (July 1 through July 31): **2.9 cfs**
    - This flow recommendation will maintain adequate depth and wetted perimeter as well as higher velocities that support rearing and refuge habitats for fish. Longer days and warmer water temperature facilitate growth, so this is a critical time period for the resident cutthroat trout and their growth.
- August Flow Recommendation (August 1 through August 31): **1.0 cfs**
    - This flow recommendation will maintain adequate wetted perimeter and depth in riffles and will provide plenty of habitat availability in deeper habitat features like pools and glides. This will support rearing and refuge habitats for resident trout as they continue to grow in the later summer months.
- Fall Flow Recommendation (September 1 through October 31): **0.50 cfs**
    - This flow recommendation has been reduced due to water availability constraints but will provide sufficient wetted perimeter in riffles and adequate habitat availability in deeper features like pools and glides. This will support fish to move longitudinally through the channel to find overwintering habitats for the baseflow period.

The purpose of this letter is to formally transmit this ISF recommendation to CWCB for their Board's consideration. Based on CPW's opinion that there is a flow-dependent natural environment in Middle Hubbard Creek that can be preserved to a reasonable degree with an ISF water right in the recommended rates. Please refer to attachments which include; R2Cross field forms, R2Cross output, fish survey information, and photographs at each cross section location.

CPW personnel will be available at the January 2025 CWCB meeting to answer any questions that the Board might have regarding these flow recommendations. We appreciate your consideration.

Sincerely,

Katie Birch
CPW Instream Flow Program Coordinator
Attachments (as stated)

Length Frequency Data

Water **48620** **Hubbard Creek, Middle Fork** Date **8/7/2007**

Station **GU2337** **In 1st Meadow BLW Trib To N (nf Reach #2)**

Drainage **Gunnison River** UtmX **271975** UtmY **4325082** Elevation **3077 m**

Length **108 m** Width **2.03 m** Area **0.02 Ha**

Surveyors **JAMES, GARRISON, MUCH**

Gear **NOT LISTED** Effort **2.00** Metric **PASS** Protocol **TWO-PASS REMOVAL**

Total catch **21**

Species	Count	Length (mm)	Weight (gm)	Status	Mark	Tag ID	Habitat
CRN	1	198	103	1			A
CRN	1	226	165	1			A
CRN	1	190	87	1			A
CRN	1	192	78	1			A
CRN	1	200	82	1			A
CRN	1	232	163	1			A
CRN	1	195	86	1			A
CRN	1	163	64	1			A
CRN	1	208	102	1			A
CRN	1	191	71	1			A
CRN	1	226	135	1			A
CRN	1	224	140	1			A
CRN	1	60	2	1			A
CRN	1	71	5	1			A
CRN	1	185	72	1			A
CRN	1	105	12	1			A
CRN	1	145	31	1			A

Length Frequency Data

Water **48620** **Hubbard Creek, Middle Fork** Date **8/7/2007**

Station **GU2337** **In 1st Meadow BLW Trib To N (nf Reach #2)**

Species	Count	Length (mm)	Weight (gm)	Status	Mark	Tag ID	Habitat
CRN	1	169	52	1			A
CRN	1	159	47	1			A
CRN	1	152	41	2			A
CRN	1	202	100	2			A

Notes: N 39.04507 W 107.63443 No temps or effort. Unfertilized eggs visible along reach

Middle Hubbard 8-14-23 XS 1

XB LC RBUS 6.66 LB 6.65WS

~~DD~~: 93°2.9406" W 107°37.550"

Photos taken by LC

H	V	Depth	Feature
0.6	5.22		
3.0	5.46		*Bank Full High WS
3.8	6.65		
4.6	6.75	0.1	
5.4	6.68	0.05	
6.2	6.71	0.05	
7.0	6.71	0.08	
7.8	6.73	0.09	
8.8	6.73	0.08	
9.6	6.73	0.08	
10.4	6.60	dry	Rock
11.2	6.78	0.11	
11.1	6.48	dry	other end of Rock
12.0	6.75	0.10	
12.8	6.73	0.09	
13.6	6.83	0.18	
14.4	7.35	0.70	
15.2	7.32	0.68	
16.0	7.33	0.73	
16.8	6.94	0.3	
17.6	6.74	0.1	
18.4	6.79	0.25	

H	V	Depth	Feature
19.2	6.83	0.18	
20.0	6.88	0.22	
20.5	6.65		WS
22.1	6.22		
22.4	5.50		BankFull low
22.8	5.19		~~Bankfo~~ LFSC Bank Full High
26.3	4.96		Stake

Slope

Distance 10.1ft

upstream Elevation 6.40ft

Downstream Elevation 6.71ft

Lots of canopy cover - pine, shade - lots of deadfall

LWD in channel, lg pools w/ backwater

Cool, clear water

Dark, lg cobble, lg drop pools from boulders (LWD)

3sp Caddis, many mayflies

Middle Hubbard XS 2 8-14-24

KB LC

Narrower riffle Very limited selection Higher gradient
more LWD & more side channel than other Hubbard
tribs. confined

DD: Left bank WS 8.33ft
Right bank WS 8.33ft

Feature	H	V	D
Stake	0.6	6.15	
Bank Full	2.0	6.69	
	3.0	7.25	
	3.4	8.00	
WS	3.5	8.33	
	4.0	8.39	0.10
	4.5	8.54	0.27
	5.0	8.53	0.26
	5.5	8.56	0.28
	6.0	8.61	0.34
	6.5	8.74	0.50
Rock edge	6.8	8.20	dry
Rock	7.3	7.95	dry
Rock edge	8.0	8.35	0
	8.5	8.74	0.48
	9.0	8.57	0.26
	9.5	8.54	0.18
	10.0	8.56	0.26

Feature	H	V	Depth	
Rock edge	10.5	8.31	0	
Rock edge	11.0	8.32	0	
	11.5	8.51	0.19	
	12.0	8.38	0.05	
	12.5	8.36	0.05	
WS	12.9	8.33		
	13.7	8.07		
	14.3	7.34		
	16.3	6.91		
	17.1	6.76		← bankfull
	17.9	6.63		
	19.3	6.28		

Slope

distance 6.7ft

downstream elevation 8.36ft

upstream elevation 8.29ft

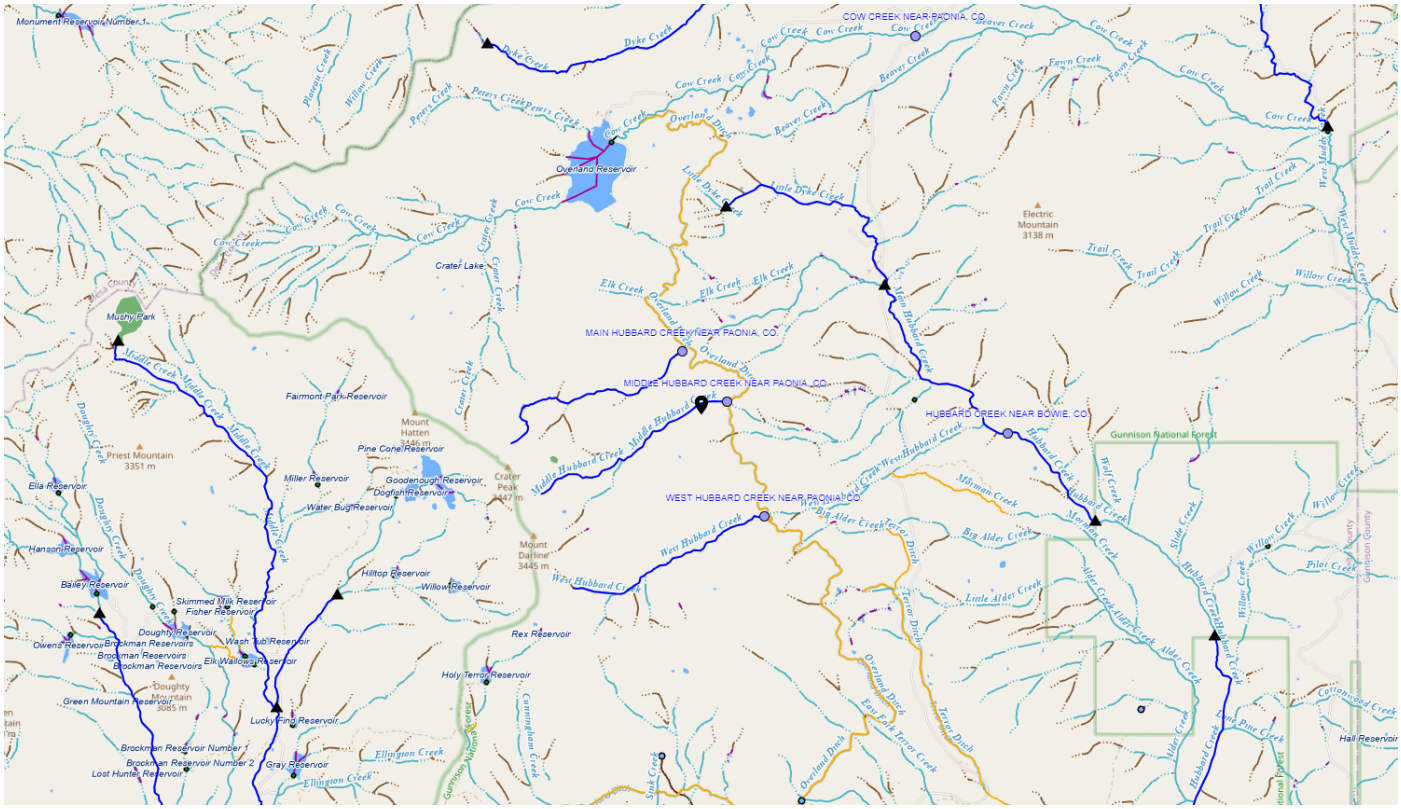
N 39° 2.9667'

W 107° 37.3463'

R2Cross RESULTS

Stream Name: Middle Hubbard Creek
Stream Locations: Above Overland Canal
Fieldwork Date: 08/14/2024
Cross-section: 1
Observers: KB LC
Coordinate System: Lat/Long
X (easting): -107.625833
Y (northing): 39.04901
Date Processed: 09/12/2024
Slope: 0.0307
Discharge: Entered Value: 1 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: MiddleHubbard_R2Cross_XS-1_08-14-24_Q=1.00.xlsx
R2Cross version: 2.0.3

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 19.45

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	0.99
Percent Wetted Perimeter (%)	50.0	0.62
Mean Velocity (ft/s)	1.0	8.02

STAGING TABLE

Feature	Distance to Water (ft)	Top Width (ft)	Mean Depth (ft)	Maximum Depth (ft)	Area (sq ft)	Wetted Perimeter (ft)	Percent Wetted Perimeter	Hydraulic Radius (ft)	Manning's n	Mean Velocity (ft/s)	Discharge (cfs)
Bankfull	5.46	19.45	1.29	1.89	25.03	21.21	100.0	1.18	0.07	4.05	101.31
	5.49	19.39	1.26	1.86	24.39	21.12	99.56	1.15	0.07	3.94	96.09
	5.54	19.33	1.21	1.81	23.42	21.0	99.0	1.12	0.07	3.77	88.25
	5.59	19.27	1.17	1.76	22.46	20.89	98.46	1.08	0.08	3.59	80.71
	5.64	19.22	1.12	1.71	21.5	20.77	97.93	1.03	0.08	3.42	73.5
	5.69	19.16	1.07	1.66	20.54	20.66	97.39	0.99	0.08	3.24	66.62
	5.74	19.11	1.02	1.61	19.58	20.54	96.85	0.95	0.08	3.07	60.08
	5.79	19.05	0.98	1.56	18.63	20.43	96.31	0.91	0.08	2.89	53.88
	5.84	19.0	0.93	1.51	17.68	20.32	95.77	0.87	0.09	2.72	48.02
	5.89	18.95	0.88	1.46	16.73	20.2	95.23	0.83	0.09	2.54	42.5
	5.94	18.89	0.84	1.41	15.78	20.09	94.69	0.79	0.09	2.37	37.34
	5.99	18.84	0.79	1.36	14.84	19.97	94.15	0.74	0.1	2.19	32.52
	6.04	18.78	0.74	1.31	13.9	19.86	93.61	0.7	0.1	2.02	28.04
	6.09	18.73	0.69	1.26	12.96	19.74	93.07	0.66	0.11	1.85	23.92
	6.14	18.67	0.64	1.21	12.02	19.63	92.53	0.61	0.11	1.68	20.15
	6.19	18.62	0.6	1.16	11.09	19.52	91.99	0.57	0.12	1.51	16.72
	6.24	18.49	0.55	1.11	10.16	19.34	91.16	0.53	0.13	1.35	13.71
	6.29	18.27	0.51	1.06	9.24	19.08	89.96	0.48	0.13	1.2	11.1
	6.34	18.05	0.46	1.01	8.34	18.83	88.77	0.44	0.14	1.05	8.79
	6.39	17.83	0.42	0.96	7.44	18.58	87.58	0.4	0.16	0.91	6.79
	6.44	17.61	0.37	0.91	6.55	18.33	86.39	0.36	0.17	0.77	5.07
	6.49	17.31	0.33	0.86	5.68	17.98	84.78	0.32	0.19	0.65	3.66
	6.54	16.78	0.29	0.81	4.83	17.38	81.94	0.28	0.21	0.53	2.58
	6.59	16.26	0.25	0.76	4.0	16.78	79.1	0.24	0.23	0.43	1.71
Waterline	6.64	15.71	0.2	0.71	3.2	16.17	76.21	0.2	0.27	0.32	1.04

	6.69	14.44	0.17	0.66	2.44	14.83	69.91	0.16	0.32	0.25	0.6
	6.74	8.58	0.21	0.61	1.84	8.92	42.05	0.21	0.26	0.34	0.63
	6.79	5.82	0.26	0.56	1.49	6.11	28.79	0.24	0.23	0.44	0.66
	6.84	4.25	0.29	0.51	1.24	4.51	21.25	0.28	0.21	0.53	0.66
	6.89	3.29	0.32	0.46	1.06	3.52	16.61	0.3	0.19	0.6	0.63
	6.94	3.02	0.3	0.41	0.9	3.23	15.23	0.28	0.21	0.54	0.48
	6.99	2.84	0.27	0.36	0.75	3.03	14.26	0.25	0.23	0.46	0.34
	7.04	2.66	0.23	0.31	0.62	2.82	13.29	0.22	0.25	0.38	0.23
	7.09	2.48	0.2	0.26	0.49	2.61	12.32	0.19	0.29	0.3	0.14
	7.14	2.3	0.16	0.21	0.37	2.41	11.35	0.15	0.34	0.22	0.08
	7.19	2.12	0.12	0.16	0.26	2.2	10.38	0.12	0.42	0.15	0.04
	7.24	1.94	0.08	0.11	0.16	2.0	9.41	0.08	0.59	0.08	0.01
	7.29	1.76	0.04	0.06	0.06	1.79	8.44	0.04	1.13	0.02	0.0
	7.33	0.42	0.01	0.01	0.0	0.43	2.02	0.01	4.18	0.0	0.0

This Manning's roughness coefficient was calculated based on velocity estimates from the Ferguson VPE method

MODEL SUMMARY

Measured Flow (Qm) =	1	(cfs)
Calculated Flow (Qc) =	1.02	(cfs)
(Qm-Qc)/Qm * 100 =	-1.65%	
Measured Waterline (WLm) =	6.65	(ft)
Calculated Waterline (WLc) =	6.64	(ft)
(WLm-WLc)/WLm * 100 =	0.11%	
Max Measured Depth (Dm) =	0.73	(ft)
Max Calculated Depth (Dc) =	0.71	(ft)
(Dm-Dc)/Dm * 100 =	3.12%	
Mean Velocity =	0.32	(ft/s)
Manning's n =	0.279	
0.4 * Qm =	0.4	(cfs)
2.5 * Qm =	2.5	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0.6	5.22		
Bankfull	3	5.46		
Waterline	3.8	6.65	0	
	4.6	6.75	0.1	
	5.4	6.68	0.05	
	6.2	6.71	0.05	
	7	6.71	0.08	
	7.8	6.73	0.09	
	8.8	6.73	0.08	
	9.6	6.73	0.08	
	10.4	6.6	0	
	11.1	6.48	0	
	11.2	6.78	0.11	
	12	6.75	0.1	
	12.8	6.73	0.09	
	13.6	6.83	0.18	
	14.4	7.35	0.7	
	15.2	7.32	0.68	
	16	7.33	0.73	
	16.8	6.94	0.3	
	17.6	6.74	0.1	
	18.4	6.79	0.15	
	19.2	6.83	0.18	
	20	6.88	0.22	
Waterline	20.5	6.65	0	
	22.1	6.22		
	22.4	5.5		
Bankfull	22.8	5.19		
	26.3	4.96		

COMPUTED FROM MEASURED FIELD DATA

Wetted Perimeter (ft)	Water Depth (ft)	Area (ft^2)	Discharge (cfs)	Percent Discharge
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.81	0.1	0.08	0.02	2.5
0.8	0.05	0.04	0.01	1.25
0.8	0.05	0.04	0.01	1.25
0.8	0.08	0.06	0.02	2
0.8	0.09	0.08	0.03	2.53
1	0.08	0.07	0.02	2.25
0.8	0.08	0.06	0.02	2
0.81	0	0	0	0
0	0	0	0	0
0.32	0.11	0.05	0.02	1.55
0.8	0.1	0.08	0.02	2.5
0.8	0.09	0.07	0.02	2.25
0.81	0.18	0.14	0.04	4.5
0.95	0.7	0.56	0.17	17.49
0.8	0.68	0.54	0.17	16.99
0.8	0.73	0.58	0.18	18.24
0.89	0.3	0.24	0.07	7.5
0.82	0.1	0.08	0.02	2.5
0.8	0.15	0.12	0.04	3.75
0.8	0.18	0.14	0.04	4.5
0.8	0.22	0.14	0.04	4.47
0.55	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

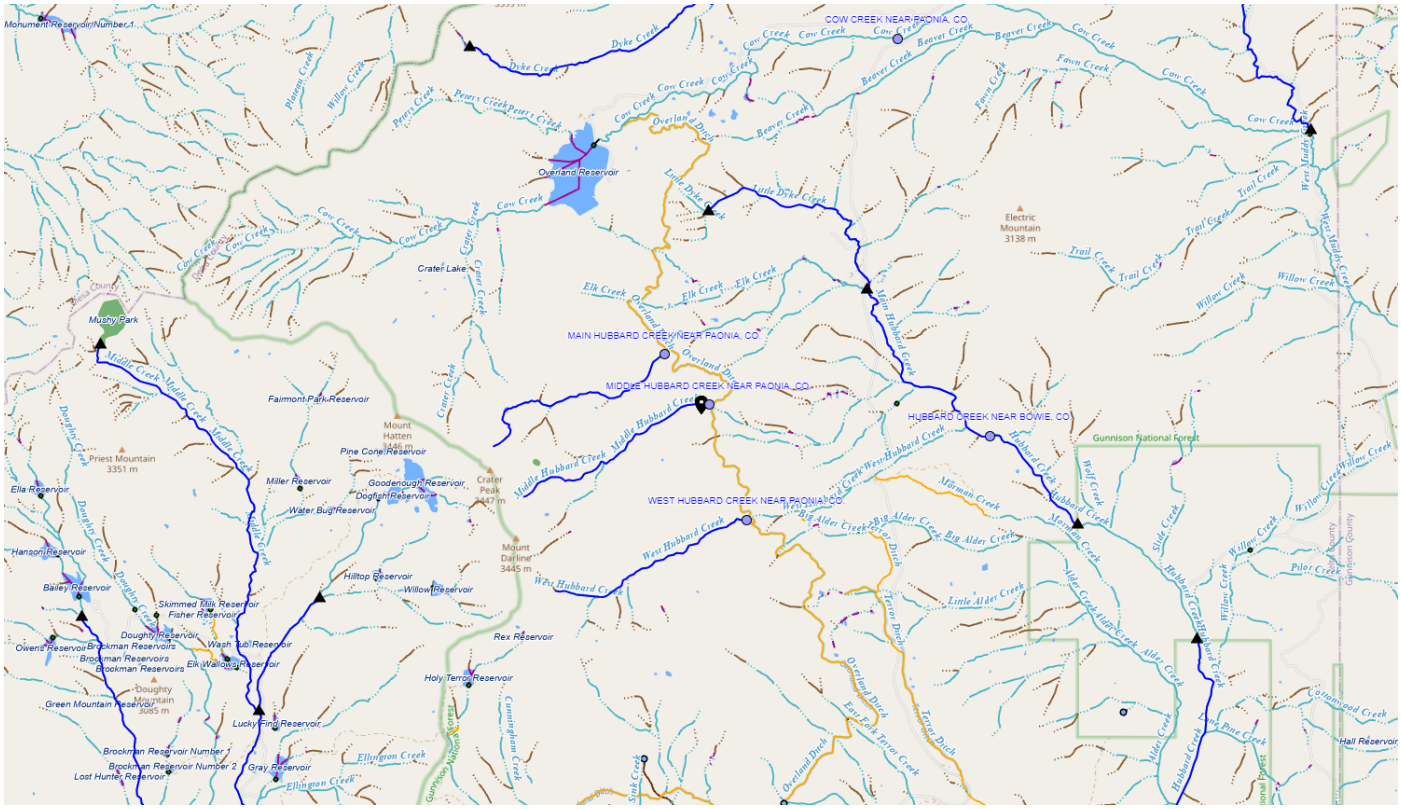
DISCLAIMER

"The Colorado Water Conservation Board makes no representations about the use of the software contained in the R2Cross platform for any purpose besides that for which it was designed. To the maximum extent permitted by applicable law, all information, modeling results, and software are provided “as is” without warranty or condition of any kind, including all implied warranties or conditions of merchantability, or fitness for a particular purpose. The user assumes all responsibility for the accuracy and suitability of this program for a specific application. In no event shall the Colorado Water Conservation Board or any state agency, official or employee be liable for any direct, indirect, punitive, incidental, special, consequential damages or any damages whatsoever including, without limitation, damages for loss of use, data, profits, or savings arising from the implementation, reliance on, or use of or inability to use the R2Cross platform.

R2Cross RESULTS

Stream Name: Middle Hubbard Creek
Stream Locations: Above Overland Canal
Fieldwork Date: 08/14/2024
Cross-section: 2
Observers: KB LC
Coordinate System: Lat/Long
X (easting): -107.622438
Y (northing): 39.049445
Date Processed: 09/12/2024
Slope: 0.0104
Discharge: Entered Value: 1 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: MiddleHubbard_R2Cross_XS-2_08-14-24_Q=1.00.xlsx
R2Cross version: 2.0.3

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 15.53

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	1.09
Percent Wetted Perimeter (%)	50.0	0.87
Mean Velocity (ft/s)	1.0	2.57

STAGING TABLE

Feature	Distance to Water (ft)	Top Width (ft)	Mean Depth (ft)	Maximum Depth (ft)	Area (sq ft)	Wetted Perimeter (ft)	Percent Wetted Perimeter	Hydraulic Radius (ft)	Manning's n	Mean Velocity (ft/s)	Discharge (cfs)
Bankfull	6.69	15.53	1.29	2.05	20.09	17.63	100.0	1.14	0.03	4.9	98.34
	6.7	15.45	1.29	2.04	19.93	17.54	99.52	1.14	0.03	4.88	97.31
	6.75	15.05	1.27	1.99	19.17	17.13	97.17	1.12	0.03	4.82	92.39
	6.8	14.69	1.25	1.94	18.42	16.75	95.01	1.1	0.03	4.75	87.52
	6.85	14.33	1.23	1.89	17.7	16.37	92.89	1.08	0.03	4.68	82.81
	6.9	13.98	1.22	1.84	16.99	16.0	90.77	1.06	0.03	4.61	78.3
	6.95	13.65	1.19	1.79	16.3	15.65	88.8	1.04	0.03	4.53	73.85
	7.0	13.33	1.17	1.74	15.63	15.31	86.87	1.02	0.03	4.45	69.55
	7.05	13.0	1.15	1.69	14.97	14.97	84.94	1.0	0.03	4.37	65.43
	7.1	12.68	1.13	1.64	14.33	14.63	83.01	0.98	0.03	4.29	61.48
	7.15	12.36	1.11	1.59	13.7	14.29	81.08	0.96	0.04	4.21	57.7
	7.2	12.04	1.09	1.54	13.09	13.95	79.15	0.94	0.04	4.13	54.08
	7.25	11.72	1.07	1.49	12.5	13.61	77.22	0.92	0.04	4.05	50.62
	7.3	11.46	1.04	1.44	11.92	13.32	75.55	0.89	0.04	3.96	47.17
	7.35	11.24	1.01	1.39	11.35	13.06	74.08	0.87	0.04	3.85	43.74
	7.4	11.17	0.97	1.34	10.79	12.94	73.39	0.83	0.04	3.71	40.03
	7.45	11.1	0.92	1.29	10.23	12.82	72.7	0.8	0.04	3.56	36.44
	7.5	11.03	0.88	1.24	9.68	12.7	72.02	0.76	0.04	3.41	32.99
	7.55	10.97	0.83	1.19	9.13	12.57	71.33	0.73	0.04	3.25	29.68
	7.6	10.9	0.79	1.14	8.58	12.45	70.64	0.69	0.04	3.09	26.51
	7.65	10.83	0.74	1.09	8.04	12.33	69.95	0.65	0.04	2.92	23.48
	7.7	10.76	0.7	1.04	7.5	12.21	69.26	0.61	0.04	2.75	20.61
	7.75	10.7	0.65	0.99	6.96	12.09	68.57	0.58	0.04	2.57	17.9
	7.8	10.63	0.6	0.94	6.43	11.97	67.89	0.54	0.04	2.39	15.35
	7.85	10.56	0.56	0.89	5.9	11.85	67.2	0.5	0.04	2.2	12.97

	7.9	10.49	0.51	0.84	5.37	11.72	66.51	0.46	0.05	2.0	10.76
	7.95	10.42	0.47	0.79	4.85	11.6	65.81	0.42	0.05	1.8	8.74
	8.0	10.17	0.43	0.74	4.34	11.27	63.92	0.38	0.05	1.63	7.09
	8.05	9.93	0.39	0.69	3.83	10.94	62.05	0.35	0.05	1.46	5.6
	8.1	9.61	0.35	0.64	3.34	10.55	59.85	0.32	0.05	1.29	4.31
	8.15	9.26	0.31	0.59	2.87	10.12	57.43	0.28	0.06	1.12	3.22
	8.2	8.9	0.27	0.54	2.42	9.7	55.01	0.25	0.06	0.95	2.29
	8.25	8.62	0.23	0.49	1.98	9.33	52.9	0.21	0.07	0.77	1.52
Waterline	8.3	8.33	0.19	0.44	1.56	8.95	50.79	0.17	0.08	0.58	0.91
	8.35	7.13	0.16	0.39	1.17	7.66	43.45	0.15	0.09	0.49	0.57
	8.4	5.62	0.15	0.34	0.85	6.08	34.48	0.14	0.1	0.43	0.37
	8.45	4.94	0.12	0.29	0.59	5.32	30.15	0.11	0.11	0.31	0.18
	8.5	4.26	0.08	0.24	0.36	4.55	25.82	0.08	0.15	0.19	0.07
	8.55	2.6	0.07	0.19	0.17	2.83	16.06	0.06	0.19	0.13	0.02
	8.6	1.27	0.07	0.14	0.08	1.44	8.14	0.06	0.19	0.12	0.01
	8.65	0.77	0.04	0.09	0.03	0.88	5.01	0.04	0.26	0.07	0.0
	8.7	0.34	0.02	0.04	0.01	0.39	2.22	0.02	0.52	0.02	0.0
	8.72	0.13	0.01	0.02	0.0	0.15	0.84	0.01	1.16	0.0	0.0

This Manning's roughness coefficient was calculated based on velocity estimates from the Ferguson VPE method

MODEL SUMMARY

Measured Flow (Qm) =	1	(cfs)
Calculated Flow (Qc) =	0.95	(cfs)
(Qm-Qc)/Qm * 100 =	4.63%	
Measured Waterline (WLm) =	8.33	(ft)
Calculated Waterline (WLc) =	8.3	(ft)
(WLm-WLc)/WLm * 100 =	0.36%	
Max Measured Depth (Dm) =	0.5	(ft)
Max Calculated Depth (Dc) =	0.44	(ft)
(Dm-Dc)/Dm * 100 =	12.05%	
Mean Velocity =	0.61	(ft/s)
Manning's n =	0.077	
0.4 * Qm =	0.4	(cfs)
2.5 * Qm =	2.5	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0.6	6.15		
Bankfull	2	6.69		
	3	7.25		
	3.4	8		
Waterline	3.5	8.33	0	
	4	8.39	0.1	
	4.5	8.54	0.27	
	5	8.53	0.26	
	5.5	8.56	0.28	
	6	8.61	0.34	
	6.5	8.74	0.5	
	6.8	8.2	0	
	7.3	7.95	0	
	8	8.35	0	
	8.5	8.74	0.48	
	9	8.57	0.26	
	9.5	8.54	0.18	
	10	8.56	0.26	
	10.5	8.31	0	
	11	8.32	0	
	11.5	8.51	0.19	
	12	8.38	0.05	
	12.5	8.38	0.05	
Waterline	12.9	8.33	0	
	13.7	8.07		
	14.3	7.34		
	16.3	6.91		
	17.1	6.76		
Bankfull	17.9	6.63		
	19.3	6.28		

COMPUTED FROM MEASURED FIELD DATA

Wetted Perimeter (ft)	Water Depth (ft)	Area (ft^2)	Discharge (cfs)	Percent Discharge
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.5	0.1	0.05	0.03	3.21
0.52	0.27	0.14	0.09	8.67
0.5	0.26	0.13	0.08	8.35
0.5	0.28	0.14	0.09	8.99
0.5	0.34	0.17	0.11	10.91
0.52	0.5	0.2	0.13	12.84
0.62	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0.63	0.48	0.24	0.15	15.41
0.53	0.26	0.13	0.08	8.35
0.5	0.18	0.09	0.06	5.78
0.5	0.26	0.13	0.08	8.35
0.56	0	0	0	0
0	0	0	0	0
0.53	0.19	0.1	0.06	6.1
0.52	0.05	0.03	0.02	1.6
0.5	0.05	0.02	0.01	1.45
0.4	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

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General Site Field Visit Data Report *(Filters: Name begins with Middle Hubbard Creek; Division = 4;)*

Type		Div	Name	CWCB Case Number	Segment ID	Visit Date	Location Description	Watershed Name
Stream		4	Middle Hubbard Creek		21/4/A-007	8/14/2024	Middle Hubbard Creek above Overland Ditch	North Fork Gunnison

Remarks	Date	Remark	
	14/08/24 09:13	Assisted CPW in collecting R2Cross measurements and assesed the natural environment.	
GPS Log	No GPS Log records for this visit.		
Photo Log	No Photo Log records for this visit.		

Discharge Measurement Summary

Site name	Middle Hubbard
Site number	081424
Operator(s)	Kb
File name	Kb_20240814-191806.ft
Comment	

Start time	8/14/2024 6:51 PM
End time	8/14/2024 7:16 PM
Start location latitude	-
Start location longitude	-
Calculations engine	FlowTracker2

Sensor type	Top Setting
Handheld serial number	FT2H2113010
Probe serial number	FT2P2114008
Probe firmware	1.30
Handheld software	1.6.4

# Stations	Avg interval (s)	Total discharge (ft³/s)
24	40	1.001

Total width (ft)	Total area (ft²)	Wetted Perimeter (ft)
5.200	2.694	5.586

Mean SNR (dB)	Mean depth (ft)	Mean velocity (ft/s)
53.219	0.518	0.372

Mean temp (°F)	Max depth (ft)	Max velocity (ft/s)
47.763	0.750	0.813

Discharge Uncertainty		
Category	**ISO**	**IVE**
Accuracy	1.0%	1.0%
Depth	0.4%	4.1%
Velocity	1.4%	8.4%
Width	0.1%	0.1%
Method	2.0%	
# Stations	2.1%	
Overall	**3.4%**	**9.4%**

Discharge equation	Mid Section
Discharge uncertainty	IVE
Discharge reference	Rated

Data Collection Settings	
Salinity	0.000 PSS-78
Temperature	-
Sound speed	-
Mounting correction	0.000 %

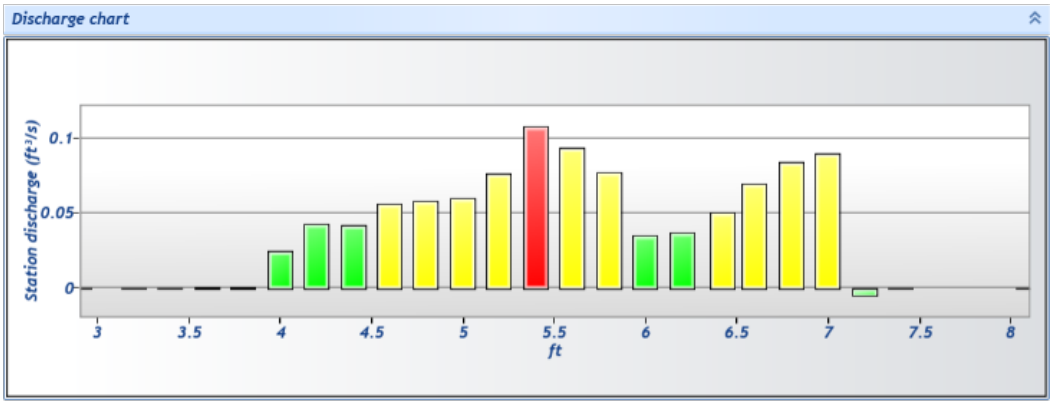
Summary overview

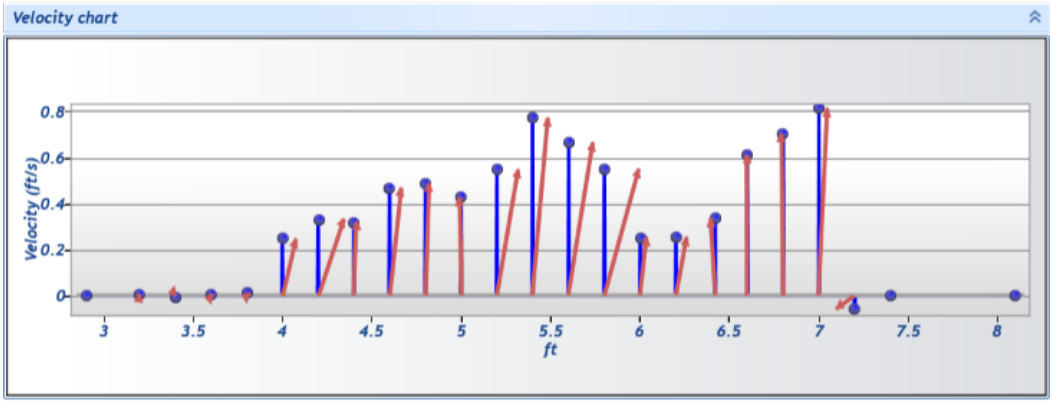
No changes were made to this file
Quality control warnings

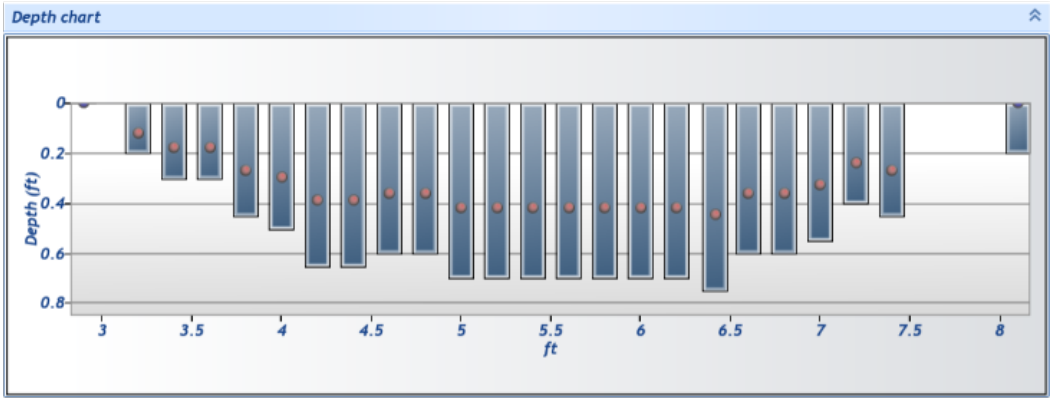
Discharge Measurement Summary

Site name	Middle Hubbard
Site number	081424
Operator(s)	Kb
File name	Kb_20240814-191806.ft
Comment	

Station Warning Settings	
Station discharge OK	Station discharge < 5.000%
Station discharge caution	5.000% >= Station discharge < 10.000%
Station discharge warning	Station discharge >= 10.000%







Discharge Measurement Summary

Site name	Middle Hubbard
Site number	081424
Operator(s)	Kb
File name	Kb_20240814-191806.ft
Comment	

Measurement results

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (ft/s)	Correction	Mean Velocity (ft/s)	Area (ft²)	Flow (ft³/s)	%Q	
0	6:51 PM	2.900	None	0.000	0.000	0.000	0	0.000		0.006	0.000	0.000	0.000	✓
1	6:52 PM	3.200	0.6	0.200	0.600	0.120	62	0.006	1.000	0.006	0.050	0.000	0.029	✓
2	6:53 PM	3.400	0.6	0.300	0.600	0.180	80	-0.004	1.000	-0.004	0.060	0.000	-0.026	✓
3	6:54 PM	3.600	0.6	0.300	0.600	0.180	62	0.008	1.000	0.008	0.060	0.000	0.047	✓
4	6:56 PM	3.800	0.6	0.450	0.600	0.270	62	0.012	1.000	0.012	0.090	0.001	0.109	✓
5	6:57 PM	4.000	0.6	0.500	0.600	0.300	61	0.247	1.000	0.247	0.100	0.025	2.470	✓
6	6:58 PM	4.200	0.6	0.650	0.600	0.390	62	0.332	1.000	0.332	0.130	0.043	4.318	✓
7	6:59 PM	4.400	0.6	0.650	0.600	0.390	69	0.320	1.000	0.320	0.130	0.042	4.160	✓
8	7:00 PM	4.600	0.6	0.600	0.600	0.360	63	0.467	1.000	0.467	0.120	0.056	5.594	✓
9	7:01 PM	4.800	0.6	0.600	0.600	0.360	61	0.486	1.000	0.486	0.120	0.058	5.830	✓
10	7:02 PM	5.000	0.6	0.700	0.600	0.420	60	0.427	1.000	0.427	0.140	0.060	5.968	✓
11	7:03 PM	5.200	0.6	0.700	0.600	0.420	61	0.546	1.000	0.546	0.140	0.076	7.643	✓
12	7:04 PM	5.400	0.6	0.700	0.600	0.420	62	0.771	1.000	0.771	0.140	0.108	10.784	✓
13	7:05 PM	5.600	0.6	0.700	0.600	0.420	62	0.665	1.000	0.665	0.140	0.093	9.302	✓
14	7:06 PM	5.800	0.6	0.700	0.600	0.420	62	0.549	1.000	0.549	0.140	0.077	7.680	✓
15	7:07 PM	6.000	0.6	0.700	0.600	0.420	63	0.252	1.000	0.252	0.140	0.035	3.522	✓
16	7:08 PM	6.200	0.6	0.700	0.600	0.420	65	0.253	1.000	0.253	0.147	0.037	3.710	✓
17	7:09 PM	6.420	0.6	0.750	0.600	0.450	75	0.335	1.000	0.335	0.150	0.050	5.023	✓
18	7:10 PM	6.600	0.6	0.600	0.600	0.360	61	0.610	1.000	0.610	0.114	0.069	6.944	✓
19	7:11 PM	6.800	0.6	0.600	0.600	0.360	63	0.701	1.000	0.701	0.120	0.084	8.405	✓
20	7:12 PM	7.000	0.6	0.550	0.600	0.330	62	0.813	1.000	0.813	0.110	0.089	8.939	✓
21	7:14 PM	7.200	0.6	0.400	0.600	0.240	79	-0.057	1.000	-0.057	0.080	-0.005	-0.454	✓
22	7:15 PM	7.400	0.6	0.450	0.600	0.270	60	0.000	1.000	0.000	0.203	0.000	0.002	✓
23	7:16 PM	8.100	None	0.200	0.000	0.000	0	0.000	1.000	0.000	0.070	0.000	0.001	✓

Discharge Measurement Summary

Site name	Middle Hubbard
Site number	081424
Operator(s)	Kb
File name	Kb_20240814-191806.ft
Comment	

Quality Control Settings	
Maximum depth change	50.000%
Maximum spacing change	100.000%
SNR threshold	10.000 dB
Standard error threshold	0.033 ft/s
Spike threshold	10.000%
Maximum velocity angle	20.000 deg
Maximum tilt angle	5.000 deg

Quality control warnings

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings
1	6:52 PM	3.200	0.6	0.200	0.600	0.120	Beam SNRs Not Similar
2	6:53 PM	3.400	0.6	0.300	0.600	0.180	Large SNR Variation,SNR Threshold Variation
3	6:54 PM	3.600	0.6	0.300	0.600	0.180	Boundary Interference
6	6:58 PM	4.200	0.6	0.650	0.600	0.390	Velocity Angle > QC
12	7:04 PM	5.400	0.6	0.700	0.600	0.420	High Stn % Discharge
18	7:10 PM	6.600	0.6	0.600	0.600	0.360	Standard Error > QC
19	7:11 PM	6.800	0.6	0.600	0.600	0.360	Standard Error > QC
22	7:15 PM	7.400	0.6	0.450	0.600	0.270	Beam SNRs Not Similar
23	7:16 PM	8.100	None	0.200	0.000	0.000	Stn Spacing > QC

Middle Hubbard Creek, Cross Section 1, looking downstream from right bank.

Middle Hubbard Creek, Cross Section 1, looking upstream from right bank.

Middle Hubbard Creek, Cross Section `, looking across from right bank.

Middle Hubbard Creek, Cross Section 2, looking downstream

Middle Hubbard Creek, Cross Section 2, looking upstream

Middle Hubbard Creek, Cross Section 2, looking across from left bank

Middle Hubbard Creek, Flow measurement location