

COLORADO Parks and Wildlife Department of Natural Resources

Water Resources Section - Aquatic, Terrestrial, and Natural Resources Branch

January 6, 2021

Ms. Linda Bassi, Chief Stream and Lake Protection Section Colorado Water Conservation Board 1313 Sherman Street, Suite 721 Denver CO 80203

Subject:Instream Flow Recommendations for Redstone Creek in Water Division 1, Larimer
County to be presented at the January 2021 CWCB Meeting

Dear Ms. Bassi:

The information contained in and referred to in this letter forms the scientific and biological basis for an instream flow (ISF) recommendation on Redstone Creek in Water Division 1. The field investigations relating to this ISF recommendations were conducted by Colorado Parks and Wildlife (CPW) and Colorado Water Conservation Board (CWCB) personnel in 2019 and 2020 alongside representatives from Larimer County. Larimer County brought this stream candidate to CPW and is supportive of the proposed ISF reach. This stream reach was presented to interested parties at the ISF Workshop in January 2019 and 2020. It is the 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 Redstone Creek and to specifically address the findings required in Rule 5(i) of the Instream Flow Program Rules.

CPW participates in the ISF Program and develops instream flow recommendations for the Board's consideration in an effort to address CPW's legislative declarations "... 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" (See §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." (See §33-10-101 (1) C.R.S.).





In addition to these broad statutory guidelines, CPW's current strategic planning document (CPW Strategic Plan, 2015) explains current agency 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 directed by the State Wildlife Action Plan (2002, Revised 2015). The goals and priorities from these 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 ISF/NLL Program.

Recommended Segments

CPW is proposing an ISF recommendation on Redstone Creek from its headwaters (located at UTM 13T 472175 4496738) to the confluence with Buckhorn Creek (UTM 13T 482372 448078). The reach is approximately 15 miles in length. Approximately 7 percent of the proposed reach is on public lands managed by Larimer County as Horsetooth Mountain Open Space; the rest of the proposed reach is under private ownership. This recommendation is a continuation of efforts by CPW to work collaboratively with Larimer County to secure ISF protection on streams adjacent to properties protected as open space.

Natural Environment and Biological Summary

Redstone Creek is a tributary of Buckhorn Creek near Masonville. The stream's hydrology is dominated by snowmelt from lower elevation snow reserves from a maximum elevation of 8,300 feet. Redstone Creek's contributing basin receives approximately 20 inches of precipitation a year and is 31 square miles. Based on observations in 2019 and 2020, streamflow in this reach typically ceases to flow by mid to late-summer. Redstone Creek is a first to third order stream through the proposed reach. The lower portion of Redstone Creek on Larimer County Horsetooth Mountain Open Space is lower gradient with substrate that varies from medium-cobble to sand.

The reach investigated by CPW has a mixture of riffles, runs, glides, and pools, containing good fish habitat, including some large woody debris. Riparian communities include mature cottonwood galleries and juniper. Upland species supported by Redstone Creek include mountain mahogany and Bell's twin pod, considered to be imperiled at a global and state level by Colorado Natural Heritage Program. A 1993 CPW fish survey indicates populations of creek chub, longnose dace, and white sucker. Abundant riparian vegetation provides shading and cover for fish. Although no fish were observed during site visits, macroinvertebrates were noted in the field, including mayfly, caddisfly larvae, and diptera.

Initial Biological Flow Recommendation

Initial biological instream flow recommendations were developed using the R2Cross methodology (Espegren, 1996). R2Cross uses field data that has been collected in riffle habitat type. The field data collection includes a survey of stream channel geometry, a longitudinal slope of the water surface, and a streamflow measurement. This data is used by R2Cross to model

three hydraulic parameters; average depth, average velocity, and percent wetted perimeter. Maintaining these hydraulic parameters at adequate levels across riffle habitat types will also maintain aquatic habitat in pools and runs for most life stages of fish. Flow recommendations are developed based on the flows that meet two of the three hydraulic criteria and three of the three hydraulic criteria as described in Nehring (1979) and Espergren (1996).

In 2019 and 2020, CPW, CWCB, and Larimer County collected three cross-section data sets on Redstone Creek. The results of the R2CROSS analysis are summarized below.

	Bankfull Top Width	Date Measured	Q measured	Accuracy Range	Flow Meeting Two Criteria	Flow Meeting Three Criteria
1	24 ft	5/30/2019	11.6 cfs	4.6 – 29 cfs	Out of range	Out of range
2	25 ft	5/30/2019	11.4 cfs	4.6 – 29 cfs	Out of range	7.33 cfs
3	23 ft	4/29/2020	12.0 cfs	2.8 – 30 cfs	Out of range	4.96 cfs
A١	veraged Cros	s Section Resu	ults		None	6.15 cfs

The initial biological recommendation is 6.2 cfs during the high flow period. The lower portion of Redstone Creek has been observed to exhibit intermittent streamflow, but supports healthy riparian and macroinvertebrate communities. Therefore, CPW does not recommend a baseflow rate outside of the spring to early-summer period. The initial biological summer flow recommendation of 6.2 cfs maintains velocity of 1 foot per second (fps), depths of 0.2 feet, and at least 50 percent wetted perimeter of the stream channel on average over the cross-sections.

Water Availability

In order to make a preliminary determination whether water is available for the R2CROSS-based flow recommendations and to determine the appropriate seasonal transition dates, CPW examined basic hydrologic data and water rights information for Redstone Creek. Redstone Creek does not have any gage data other than the temporary gage CWCB installed in June 2019. The CWCB gage record is limited to less than two years of data, of which 2019 was relatively wet and 2020 exhibited a very pronounced early spring peak runoff and quick recession to a dry spring and summer. As such, CWCB and CPW also relied on records from the nearby USGS gage "Buckhorn Creek near Masonville" to determine the seasonality of the flow recommendation.

DITCH	WDID
SODERBERG BROS DITCH 1	400882
BUCKHORN METHODIST AUG IMPACT REACH	402229
BUCKSKIN RESERVOIR	403335
MCKEON UPPER POND	403607
BLEASDALE STOCK POND	403614
GATES LOWER RESERVOIR	403635
GATES MIDDLE RESERVOIR	403636
GATES UPPER RESERVOIR	403637
MOORE RESERVOIR	403672

CPW is aware of the following water rights within the reach:

SODERBERG RANCH RESERVIOR	403686
BUCKHORN METHODIST POND	403710
ESH POND	403712

Biological Flow Recommendation

CPW's analysis of the hydrological data indicates that the following flow rate is needed to protect the natural environment to a reasonable degree. Since no flow has been observed in the lower portion of Redstone Creek after late June and the stream supports healthy riparian and macroinvertebrate communities, no baseflow rate is recommended outside of the runoff period.

- Summer Seasonal Flow Recommendation: 6.2 cfs (May 1 through June 15)
 - This flow rate will provide adequate average depth and percent wetted perimeter across the surveyed riffles although velocity of 1 fps is not quite met in the widest riffle (cross-section 2).

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 Redstone Creek that can be preserved to a reasonable degree with an ISF water right in the recommended rate. Please refer to attachments which include; R2Cross field forms, R2CROSS output, CPW fish survey data, and photographs at each cross section location.

CPW personnel will be available at the January 2021 CWCB meeting to answer any questions that the Board might have regarding these flow recommendations. We appreciate your consideration.

Sincerely,

Katip Birch

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

Redstone Creek

1993 Fishery Survey



Water: Redstone Creek Station: SP0705 Station Description: Above Glade Road #1 Sampling Date: 8/18/1993 Method: Presence/Absence Drainage: South Platte Water Code: 12889



Total catch for selected waters by year





FIELD DATA FOR **INSTREAM FLOW DETERMINATIONS**



CONSERVATION BOARD

COLORADO WATER LOCATION INFORMATION STREAM NAME: Red Stone CROSS-SECTION NO .: Creek CROSS-SECTION LOCATION: @ Larimer count Driperty DATE: 5 30 19 OBSERVERS: Birch, Scheel Gilboy A (Lavimer (not LEGAL & SECTION: GPS Taken SECTION TOWNSHIP RANGE: PM: N/S E/W COUNTY: WATERSHED: WATER DIVISION: DOW WATER CODE: USGS: 482367 13T MAP(S): USFS: 4486274 SUPPLEMENTAL DATA SAG TAPE SECTION SAME AS METER TYPE: YES / NO Marsh MCB DISCHARGE SECTION: METER NUMBER: DATE RATED: CALIB/SPIN: TAPE WEIGHT: Ibs/foot TAPE TENSION: sec Ibs CHANNEL BED MATERIAL SIZE RANGE: NUMBER OF PHOTOGRAPHS: PHOTOGRAPHS TAKEN: YES/NO **CHANNEL PROFILE DATA** DISTANCE FROM TAPE (ft) STATION LEGEND: ROD READING (ft) * Tape @ Stake LB (\mathbf{X}) 0.0 N Stake 🗙 X Tape @ Stake RB 0.0 n s Station (1) ET TAPE (1)WS @ Tape LB/RB 0.0 С Photo 1 5.11 (2)WS Upstream 51.5 (3) 5.90 WS Downstream Direction of Flow $(\Gamma$ S SLOPE 0.79 51 = 0,015 AQUATIC SAMPLING SUMMARY STREAM ELECTROFISHED: YES/NO DISTANCE ELECTROFISHED: ft FISH CAUGHT: YES/NO WATER CHEMISTRY SAMPLED: YES/NO LENGTH - FREQUENCY DISTRIBUTION BY ONE-INCH SIZE GROUPS (1.0-1.9, 2.0-2.9, ETC.) SPECIES (FILL IN) 2 3 4 5 1 6 7 8 9 10 11 12 13 14 15 >15 TOTAL AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME: COMMENTS

Mosa cothnwood CNHP Bell's Twin Pod Diaua SCINIL 3 Mtn Diminan Mahogener rilgge la v CAddis 1044

FORM #ISF FD 1-85

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FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



COLORADO WATER CONSERVATION BOARD

LOCATION INFORMATION

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FORM #ISF FD 1-85

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DISCHARGE/CROSS SECTION NOTES



FIELD DATA FOR INSTREAM FLOW DETERMINATIONS



COLORADO WATER CONSERVATION BOARD

LOCATION INFORMATION

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CROSS-SECT	TION LOC	ATION: 1)TM	12	T AS	1850						
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SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS YES NO	METER TYPE: AW	Tracke	(2 by Fi	elds-Somme	rs C Staf	f gaze
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CHANNEL BED MATERIAL SIZE RANGE:			PHOTOGRAPHS TA	KEN: YES/NO	NUMBER OF PI	HOTOGRAPHS:

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (H)	ROD READING (tt)		(*)	LEGEND:
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2 WS Upstream	4.6	48.1	н		
3 WS Downstream	5.47	/	- -		Direction of Flow
SLOPE	0.87/48.1	= 0.018		(3)	

AQUATIC SAMPLING SUMMARY

STREAM ELECTROFISHED: YES/NO	DISTANCE	ELEC	TROFIS	HED:	ft		F	ISH CA	UGHT:	YES/NO	C	-	WATE	RCHEN	AISTRY	SAMPL	ED: YES	S/NO
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worms	3						1			-					-			
									-									
AQUATIC INSECTS IN STREAM SECTION	BY COMMON	OR SC	ENTIFI	C ORDE	R NAM	E:											10	and the second second
5 m			-															100

COMMENTS

-	Tuniper 2 cottonwood in riparian area Mountain mahagony.
	Good habitat but no fish observed. Long runs w/ underout banks.
	wood James creating good-sized Dools.
	Q=12.44 cfs 1 Q=11.56 cfs Q=12 cfs (average)

FORM #ISF FD 1-85

EAM NAME:	Redstr	ne (ireen		President.	Chose		2	4/29/2	SHEE	
INNING OF ME	ASUREMENT	EDGE OF	NATER LOOKING DO	WNSTREAM:	LEFT / RIGHT	Gage Rea	ading:	ft	TIME: 21.15	pm	1
Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth Ri of Obser- vation (ft)	evolutions	Time (sec)	Velocit At Point	y (ft/sec) Mean in Vertical	Area (ft ²)	Discharge (cfs)
	0		4.67		1					-	
RE	107		4.85		Sec. a. K.	11.23		1		-	
01	17	-	4.9.25	_							
-	ZZ		4.95		11/10/2	1200					-
A	5.0	188631	4.75		1. 1. 1.				-		
- Reality	6.5	10.2 M	4.81					-	1		
	7.4		4.95								
	81		515		Succession Succession		- and the	and the second	and the second second	-	
11.5	G		5 34	Ø	23.3	a second		- lai			-
M	0.6		5 13	011		S. B. Star	1.1			-	
	20		2.43	DIS						-	
	10		5.51	0.13					111	-	
	11		5.6	D. L							
And and and	12		5.45	0.42		1.1.1					
	13		5.9	0.5							
	14	-	5.9	0.50							
	15		5.0	0.0		1					
	16	-	5.05	0.4	++				1.2	_	
	17		5.95	615		15			12 -		
	18		5.95	0.59	and the second	and the same is the	and the second	1.2.00		1	
	19	-	5.0	0.51	12.10 - 15- 1	1. E. F. 1	2 2	Mr. Sal			
1. A.S.	20	-	6.0	0.6	and and	Press .		ad annual	Carlo Carlos		
	21		6.0	0.65	-		-				
	22		6.05	0.65	1 21.27			1			
-	23		5.825	0.55			1				
Trans. Stores	24		5.85	0.65		a character	1.000 2.0	1. 1. 1. 11	1000		
a second second	25		5,82	0.55	-	NAME OF T	-				
	26		5.5	0.28			-	6			
WS	26,3		5.33	P					-		
BF	26.6		4.85				_				1
	26.7	-	4.45						1 1		1.
	26.0	1	4.23		-		1				1112
S	28.0	0	5.23								
	_	_									
	_										and the second
	_										
and the									100		
	-				-	P. C.		-			
							861 - 1		Cherry Chan	a de pagla	
								-			
						1					
					-		1			1	
TOTALS:						a. anna ann ann ann ann ann ann ann ann	and		CALCULA	TIONS CHECK	ED BY:

DISCHARGE/CROSS SECTION NOTES



COLORADO Colorado Water

Conservation Board

Department of Natural Resources 1313 Sherman Street, Room 718 Denver, CO 80203

Redstone Creek CWCB Temporary Streamgage

Location: 13N 482374 4486238

Installation Date: 6/6/2019

Equipment: Onset Hobo MX2001 water level logger, staff gage

Description: The streamgage consists of a data logger and pressure transducer protected in a 2 inch PVC pipe, secured to the bank with a t-pot fence post. The pressure transducer measured water level and temperature on 15 minute intervals in a pool formed by a riffle. A co-located staff gage was used as a secondary water level measurement device.





Discharge Measurment Field Visit Data Report (Filters: Name begins with Redstone Creek; Division = 1;)

Div	Name	CWCB Case Number	Segment ID	Meas. Date	UTM	Location	Flow Amount (cfs)	Meas #	Rating	Station ID
1	Redstone Creek		20/1/A-001	05/13/2020	UTMx: 482374 UTMy: 4486238	15ft downstream of gage	4.82	5	G	REDSTND1
1	Redstone Creek		20/1/A-001	06/05/2019	UTMx: 482374 UTMy: 4486238	At Redstone Creek Gage	5.66	1	G	REDSTND1
1	Redstone Creek		20/1/A-001	07/15/2019	UTMx: 482374 UTMy: 4486238	At Redstone Creek Gage	1.02	2	F	REDSTND1
1	Redstone Creek		20/1/A-001	04/29/2020	UTMx: 482374 UTMy: 4486238	At Redstone Creek Gage	12.44	3	G	REDSTND1
1	Redstone Creek		20/1/A-001	04/29/2020	UTMx: 482374 UTMy: 4486238	At Redstone Creek Gage	11.56	4	G	REDSTND1



							_	
Site name	Redstone (Cr						
Site number	001							
Operator(s)	161							
Filo namo	Podstopo (~r 20100	1605-13344) f+				
Commont		20190	000-100442	2.10				
Comment	Temp gage	2						
Start time		6/5/2019	1:13 PM	Sensor ty	ре	Top Setting		
End time		6/5/2019	1:32 PM	Handheld	serial number	FT2H1747037		
Start location la	atitude	40.5	527	Probe ser	ial number	FT2P1747048		
Start location l	ongitude	-105.	.208	Probe firm	nware	1.23		
Calculations en	gine	FlowTra	acker2	Handheld	software	1.4		
# Sta	tions	1	Avg interva	l (s)	Total disch	arge (ft³/s)		
1	9		40		5.	662		
Total w	idth (ft)		Total area ((m²)	Wetted Pe	rimeter (ft)		
15.	700		0.557			15.931		
Mean S	NR (dB)	I	Mean depth	i (ft)	Mean velocity (m/s)			
34.	483		0.382		0.288			
Mean te	mp (°C)		Max depth	(ft)	Max velo	Max velocity (m/s)		
16.	073		0.510		0.455			
	070		0.010				_	
Disc	harge Uncerta	intv	Discharg	e equation	Mid	Section		
Category	V ISO	TVE	Discharg	e uncertair	ntv	IVE		
Accuracy	1.0%	1.0%	Discharg	e reference	e R	ated		
Denth	0.4%	6.9%						
Velocity	0.6%	5 3%		Data Col	lection Settings			
Width	0.070	0.1%	Salinity	Data Col		1 PSS-78		
Method	2.0%	0.170	Tempera	ture	0.000	-		
# Statio	ns 2.0%		Sound su	heed		_		
0verall	3.5%	8.8%	Mountin	a correction	n 0.(000 %		
overall		0.0 /0			. 0.0			
			Summary eve	rviow		1		
	No changes we	ere made t	this file					



Site number001Operator(s)JELFile nameRedstone Cr_20190605-133442.ftCommontTomp gage	Site name	Redstone Cr
Operator(s)JELFile nameRedstone Cr_20190605-133442.ftCommontTomp appa	Site number	001
File nameRedstone Cr_20190605-133442.ftCommontTomp gage	Operator(s)	JEL
Commont Tomp gago	File name	Redstone Cr_20190605-133442.ft
Comment remp gage	Comment	Temp gage

	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%	









Site name	Redstone Cr
Site number	001
Operator(s)	JEL
File name	Redstone Cr_20190605-133442.ft
Comment	Temp gage

Measu	Measurement results														
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (m/s)	Correcti on	Mean Velocity (m/s)	Area (m²)	Flow (ft³/s)	%Q		
0	1:13 PM	4.600	None	0.000	0.000	0.000	0	0.000	1.000	0.000	0.000	0.000	0.000	1	
1	1:14 PM	5.000	0.6	0.150	0.600	0.090	80	0.000	1.000	0.000	0.010	0.000	-0.001	1	
2	1:15 PM	6.000	0.6	0.380	0.600	0.228	80	0.070	1.000	0.070	0.035	0.087	1.539	1	
3	1:16 PM	7.000	0.6	0.400	0.600	0.240	80	0.198	1.000	0.198	0.037	0.259	4.582	1	
4	1:18 PM	8.000	0.6	0.500	0.600	0.300	80	0.250	1.000	0.250	0.046	0.409	7.230	1	
5	1:19 PM	9.000	0.6	0.450	0.600	0.270	80	0.271	1.000	0.271	0.042	0.400	7.060	1	
6	1:20 PM	10.000	0.6	0.510	0.600	0.306	80	0.285	1.000	0.285	0.047	0.477	8.432	1	
7	1:21 PM	11.000	0.6	0.500	0.600	0.300	80	0.154	1.000	0.154	0.046	0.253	4.461	1	
8	1:22 PM	12.000	0.6	0.480	0.600	0.288	80	0.386	1.000	0.386	0.033	0.456	8.060	1	
9	1:32 PM	12.500	0.6	0.400	0.600	0.240	80	0.345	1.000	0.345	0.019	0.226	3.996	1	
10	1:23 PM	13.000	0.6	0.300	0.600	0.180	80	0.428	1.000	0.428	0.021	0.316	5.580	1	
11	1:24 PM	14.000	0.6	0.250	0.600	0.150	80	0.414	1.000	0.414	0.023	0.339	5.994	1	
12	1:25 PM	15.000	0.6	0.250	0.600	0.150	80	0.455	1.000	0.455	0.023	0.373	6.596	1	
13	1:26 PM	16.000	0.6	0.420	0.600	0.252	80	0.338	1.000	0.338	0.039	0.465	8.214	1	
14	1:28 PM	17.000	0.6	0.400	0.600	0.240	80	0.379	1.000	0.379	0.037	0.498	8.790	1	
15	1:29 PM	18.000	0.6	0.400	0.600	0.240	80	0.394	1.000	0.394	0.037	0.517	9.127	1	
16	1:30 PM	19.000	0.6	0.450	0.600	0.270	80	0.311	1.000	0.311	0.042	0.459	8.108	1	
17	1:31 PM	20.000	0.6	0.300	0.600	0.180	80	0.197	1.000	0.197	0.018	0.126	2.229	1	
18	1:32 PM	20.300	None	0.000	0.000	0.000	0	0.000	1.000	0.197	0.000	0.000	0.000	1	



Site name	Redstone Cr
Site number	001
Operator(s)	JEL
File name	Redstone Cr_20190605-133442.ft
Comment	Temp gage

Quality Control S	Settings
Maximum depth change	50.000%
Maximum spacing change	100.000%
SNR threshold	10.000 dB
Standard error threshold	0.010 m/s
Spike threshold	10.000%
Maximum velocity angle	20.000 deg
Maximum tilt angle	5.000 deg

luality control warnings									
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings		
1	1:14 PM	5.000	0.6	0.150	0.600	0.090	Beam SNRs Not Similar, SNR Threshold Variation		
2	1:15 PM	6.000	0.6	0.380	0.600	0.228	Boundary Interference, Standard Error > QC		



Site name	Redstone Cr
Site number	001
Operator(s)	JEL
File name	Redstone Cr_20190605-133442.ft
Comment	Temp gage

Supplemental data summary

Gauge height time	Gauge height (ft)	Rated discharge (ft³/s)	Temperature (°C)	Salinity (PSS-78)	Gauge height comments
6/5/2019 1:33 PM	2.610				

~



Site name	Redstone Cr
Site number	001
Operator(s)	JEL
File name	Redstone Cr_20190605-133442.ft
Comment	Temp gage



Automated beam check Start time 6/5/2019 1:13:20 PM



No quality control warnings



0.376

2

3

4 5

6

No quality control warnings

1

Site name	Redstone Cr
Site number	001
Operator(s)	JEL
File name	Redstone Cr 20190605-133442.ft
Comment	Temp gage



Automated beam check Start time 6/5/2019 1:13:20 PM



9

8

7

10 11

Automated beam check Quality control warnings

12

13

14

15

16 17

18

19

20 21



Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Start time	4/29/2020 2:25 PM	Sensor type	Top Setting
End time	4/29/2020 2:49 PM	Handheld serial number	FT2H1747037
Start location latitude	40.527	Probe serial number	FT2P1747048
Start location longitude	-105.208	Probe firmware	1.23
Calculations engine	FlowTracker2	Handheld software	1.4

# Stations	Avg interval (s)	Total discharge (ft ³ /s)
19	40	11.564

Total width (ft)	Total area (m ²)	Wetted Perimeter (ft)
18.400	1.123	18.635

Mean SNR (dB)	Mean depth (ft)	Mean velocity (m/s)
41.259	0.657	0.291

Mean temp (°C)	Max depth (ft)	Max velocity (m/s)
13.208	1.060	0.419

Discharge Uncertainty			Discharge equation	Mid Section		
Category	ISO	ÍVE	Discharge uncertainty IVE			
Accuracy	1.0%	1.0%	Discharge reference	Rated		
Depth	0.3%	3.4%				
Velocity	0.4%	1.7%	Data Collection	Settings		
Width	0.1%	0.1%	Salinity	0.000 PSS-78		
Method	1.9%		Temperature	-		
# Stations	2.6%		Sound speed	-		
Overall	3.5%	4.0%	Mounting correction	0.000 %		

Summary overview

No changes were made to this file Quality control warnings



Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check











Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Measu	irement	results												~
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (m/s)	Correcti on	Mean Velocity (m/s)	Area (m²)	Flow (ft³/s)	%Q	
18	2:49 PM	0.600	None	0.010	0.000	0.000	0	0.000	0.000	0.000	0.001	0.000	0.000	1
17	2:47 PM	3.000	0.6	0.660	0.600	0.396	80	0.165	1.000	0.165	0.120	0.697	6.028	1
16	2:46 PM	4.500	0.6	0.860	0.600	0.516	80	0.286	1.000	0.286	0.100	1.010	8.738	1
15	2:44 PM	5.500	0.6	1.000	0.600	0.600	80	0.327	1.000	0.327	0.070	0.804	6.951	1
14	2:43 PM	6.000	0.6	1.050	0.600	0.630	80	0.339	1.000	0.339	0.049	0.585	5.056	1
13	2:42 PM	6.500	0.6	1.030	0.600	0.618	80	0.344	1.000	0.344	0.048	0.582	5.029	1
12	2:41 PM	7.000	0.6	1.060	0.600	0.636	80	0.373	1.000	0.373	0.049	0.649	5.615	1
11	2:40 PM	7.500	0.6	1.020	0.600	0.612	80	0.375	1.000	0.375	0.047	0.627	5.423	1
10	2:38 PM	8.000	0.6	0.970	0.600	0.582	80	0.382	1.000	0.382	0.045	0.607	5.251	1
9	2:37 PM	8.500	0.6	0.900	0.600	0.540	80	0.409	1.000	0.409	0.042	0.603	5.216	1
8	2:35 PM	9.000	0.6	0.880	0.600	0.528	80	0.411	1.000	0.411	0.041	0.593	5.125	1
7	2:34 PM	9.500	0.6	0.790	0.600	0.474	80	0.413	1.000	0.413	0.037	0.536	4.632	1
6	2:33 PM	10.000	0.6	0.630	0.600	0.378	80	0.419	1.000	0.419	0.044	0.650	5.623	1
5	2:32 PM	11.000	0.6	0.630	0.600	0.378	80	0.411	1.000	0.411	0.059	0.850	7.353	1
4	2:30 PM	12.000	0.6	0.580	0.600	0.348	80	0.345	1.000	0.345	0.081	0.984	8.508	1
3	2:29 PM	14.000	0.6	0.670	0.600	0.402	80	0.270	1.000	0.270	0.124	1.187	10.269	1
2	2:27 PM	16.000	0.6	0.660	0.600	0.396	80	0.113	1.000	0.113	0.123	0.488	4.223	1
1	2:25 PM	18.000	0.6	0.320	0.600	0.192	80	0.071	1.000	0.071	0.045	0.111	0.961	1
0	2:25 PM	19.000	None	0.010	0.000	0.000	0	0.000	0.000	0.000	0.000	0.000	0.000	1



Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Quality Control	Settings
Maximum depth change	50.000%
Maximum spacing change	100.000%
SNR threshold	10.000 dB
Standard error threshold	0.010 m/s
Spike threshold	10.000%
Maximum velocity angle	20.000 deg
Maximum tilt angle	5.000 deg

Qua	Quality control warnings							
Sta	t Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings	
17	2:47 PM	3.000	0.6	0.660	0.600	0.396	Velocity Angle > QC	
16	2:46 PM	4.500	0.6	0.860	0.600	0.516	Velocity Angle > QC	
3	2:29 PM	14.000	0.6	0.670	0.600	0.402	High Stn % Discharge	
2	2:27 PM	16.000	0.6	0.660	0.600	0.396	Velocity Angle > QC	



Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Beam 1	
Beam 2	

Automated beam check Start time 4/29/2020 2:24:18 PM



Peak Location > QC



Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Beam 1	
Beam 2	
B	

Automated beam check Start time 4/29/2020 2:24:18 PM





Automated beam check Quality control warnings Peak Location > QC



Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Beam 1	
Beam 2	

Automated beam check Start time 4/29/2020 2:24:55 PM





Site name	Redstone Creek near Horsetooth Mountain on Larimer
Site number	042920202
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain on Larimer_20200429-
	145032.ft
Comment	Check

Beam 1	
Beam 2	

Automated beam check Start time 4/29/2020 2:24:55 PM





Automated beam check Quality control warnings No quality control warnings



Site name	Redstone Creek near Horsetooth Mountain
Site number	4292020
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain_20200429-141654.ft
Comment	

Start time End time Start location latitude Start location longitude Calculations engine		4/29/2020 1:34 PM 4/29/2020 2:06 PM 40.527 -105.208 FlowTracker2		Sensor typeTop SeHandheld serial numberFT2H17Probe serial numberFT2P17Probe firmware1.2Handheld software1.4		Top Setting FT2H1747037 FT2P1747048 1.23 1.4
# Sta	tions		Avg interval (s)		Total discharge (ft ³ /s)	
2	6		40		12.443	
lotal w	ath (ft)		lotal area ((m²)	wetted Pe	rimeter (ft)
18.4	400		1.159		18	.599
Moon SNR (dR)			Maan danth (ft)		Mean velocity (m/s)	
41.0	41.004		0.678		0.304	
Mean te	Mean temp (°C)		Max depth (ft)		Max velo	city (m/s)
12.9	915		1.050		0.414	
Discharge UncertainCategoryISOAccuracy1.0%Denth0.3%		tainty IVE 1.0% 2.8%	Discharge equation Discharge uncertainty Discharge reference		Mid Section IVE Rated	
Velocity 0.3% Width 0.1% Method 1.6% # Stations 2.0% Overall 2.8%		0.8% 0.1% 3.1%	0.8%Data Collect0.1%SalinityTemperatureSound speed3.1%Mounting correction		tion Settings 0.000) PSS-78 - - 000 %
Summary overview No changes were made to this file Quality control warnings						



Site nameRedstone Creek near Horsetooth MountainSite number4292020Operator(s)Jack LandersFile nameRedstone Creek near Horsetooth Mountain_20200429-141654.ftCommentImage: Comment State S











Site name	Redstone Creek near Horsetooth Mountain
Site number	4292020
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain_20200429-141654.ft
Comment	

Measu	irement	results												~
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (m/s)	Correcti on	Mean Velocity (m/s)	Area (m²)	Flow (ft³/s)	%Q	
0	1:34 PM	0.600	None	0.100	0.000	0.000	0	0.000	0.000	0.000	0.007	0.000	0.000	1
1	1:34 PM	2.000	0.6	0.550	0.600	0.330	80	0.193	1.000	0.193	0.061	0.419	3.364	1
2	1:36 PM	3.000	0.6	0.610	0.600	0.366	80	0.261	1.000	0.261	0.043	0.393	3.154	1
3	1:37 PM	3.500	0.6	0.720	0.600	0.432	80	0.286	1.000	0.286	0.033	0.338	2.717	1
4	1:39 PM	4.000	0.6	0.800	0.600	0.480	80	0.301	1.000	0.301	0.037	0.395	3.178	1
5	1:40 PM	4.500	0.6	0.850	0.600	0.510	80	0.322	1.000	0.322	0.039	0.449	3.609	1
6	1:41 PM	5.000	0.6	0.900	0.600	0.540	80	0.332	1.000	0.332	0.042	0.491	3.942	1
7	1:43 PM	5.500	0.6	1.000	0.600	0.600	80	0.334	1.000	0.334	0.046	0.548	4.404	1
8	1:44 PM	6.000	0.6	1.040	0.600	0.624	80	0.341	1.000	0.341	0.048	0.582	4.679	1
9	1:46 PM	6.500	0.6	1.020	0.600	0.612	80	0.359	1.000	0.359	0.047	0.601	4.833	1
10	1:47 PM	7.000	0.6	1.050	0.600	0.630	80	0.389	1.000	0.389	0.049	0.670	5.387	1
11	1:48 PM	7.500	0.6	1.010	0.600	0.606	80	0.405	1.000	0.405	0.047	0.671	5.390	1
12	1:49 PM	8.000	0.6	0.960	0.600	0.576	80	0.393	1.000	0.393	0.045	0.619	4.978	1
13	1:51 PM	8.500	0.6	0.900	0.600	0.540	80	0.402	1.000	0.402	0.042	0.594	4.776	1
14	1:52 PM	9.000	0.6	0.870	0.600	0.522	80	0.410	1.000	0.410	0.040	0.585	4.700	1
15	1:53 PM	9.500	0.6	0.830	0.600	0.498	80	0.414	1.000	0.414	0.039	0.564	4.533	1
16	1:55 PM	10.000	0.6	0.750	0.600	0.450	80	0.399	1.000	0.399	0.052	0.737	5.921	1
17	1:56 PM	11.000	0.6	0.620	0.600	0.372	80	0.403	1.000	0.403	0.058	0.820	6.593	1
18	1:57 PM	12.000	0.6	0.590	0.600	0.354	80	0.374	1.000	0.374	0.055	0.725	5.825	1
19	1:59 PM	13.000	0.6	0.620	0.600	0.372	80	0.307	1.000	0.307	0.058	0.625	5.019	1
20	2:00 PM	14.000	0.6	0.680	0.600	0.408	80	0.275	1.000	0.275	0.063	0.615	4.939	1
21	2:01 PM	15.000	0.6	0.630	0.600	0.378	80	0.217	1.000	0.217	0.059	0.448	3.601	1
22	2:02 PM	16.000	0.6	0.650	0.600	0.390	80	0.134	1.000	0.134	0.060	0.285	2.293	1
23	2:03 PM	17.000	0.6	0.590	0.600	0.354	80	0.118	1.000	0.118	0.055	0.229	1.840	1
24	2:05 PM	18.000	0.6	0.320	0.600	0.192	80	0.038	1.000	0.038	0.030	0.040	0.324	1
25	2:06 PM	19.000	None	0.100	0.000	0.000	0	0.000	0.000	0.000	0.005	0.000	0.000	1



Site name	Redstone Creek near Horsetooth Mountain
Site number	4292020
Operator(s)	Jack Landers
File name	Redstone Creek near Horsetooth Mountain_20200429-141654.ft
Comment	

Quality Control Settings

Maximum depth change Maximum spacing change SNR threshold Standard error threshold Spike threshold Maximum velocity angle Maximum tilt angle

50.000% 100.000 dB 0.010 m/s 10.000% 20.000 deg 5.000 deg

	Quality control warnings										
ſ	St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings			
	12	1:49 PM	8.000	0.6	0.960	0.600	0.576	Velocity Angle > QC			
ľ	16	1:55 PM	10.000	0.6	0.750	0.600	0.450	Velocity Angle > QC			
	17	1:56 PM	11.000	0.6	0.620	0.600	0.372	Velocity Angle > QC			
	19	1:59 PM	13.000	0.6	0.620	0.600	0.372	Velocity Angle > QC	_		



Site name Site number Operator(s) File name Comment Ma	LFS RED5132 easured wit	0.FlowTra 1 Flowtrac	cker2.ft ker1 and rec	alculated wit	h Flowtracker	2 algorithms	
Start time End time Start location I Start location I Calculations en	atitude ongitude gine	5/13/2020 5/13/2020 - - FlowTra	9:08 AM 10:12 AM acker2	Sensor type Handheld se Probe serial Probe firmw Handheld so	rial number number are ftware	Unknown n/a P2355 3.90 n/a	
# Sta 3	tions 2		Avg interva 40	l (s)	Total discha 4.82	o rge (ft³/s) 213	
Total w 19.	idth (ft) 100		Total area (9.8053	(ft²)	Wetted Perimeter (ft) 19.420		
Mean S	NR (dB) 2		Mean depth 0.513	(ft)	Mean velocity (ft/s) 0.4917		
Mean temp (°F) 47.865			Max depth 0.940	(ft)	Max velocity (ft/s) 0.7423		
Discharge UncerCategoryISOAccuracy1.0%Depth0.3%Velocity0.5%Width0.1%Mathed1.5%		tainty IVE 1.0% 2.1% 1.6% 0.1%	Discharge equation Discharge uncertain Discharge reference Data Colle Salinity		Mid Section ISO Measured ection Settings 0.000 PSS-78		
# Stations 1.6% Overall 2.5%		2.8%	Sound sp Mounting	peed correction	0.00	-)0 %	
	No changes Quality contr	s were made t ol warnings	Summary over to this file	rview			



Site name Site number Operator(s) File name Comment

LFS RED51320.FlowTracker2.ft

Station Warning Settings							
Station discharge OK	Station discharge < 5.00%						
Station discharge caution	5.00% >= Station discharge < 10.00%						
Station discharge warning	Station discharge >= 10.00%						









Site name Site number Operator(s) LFS File name RED Comment

RED51320.FlowTracker2.ft

Measu	irement r	esults												~
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Samples	Velocity (ft/s)	Correcti on	Mean Velocity (ft/s)	Area (ft²)	Flow (ft³/s)	%Q	
0	9:08 AM	1.300	None	0.100	0.0000	0.000	0	0.0000	1.0000	0.3460	0.0600	0.0208	0.43	1
1	9:14 AM	2.500	0.6	0.410	0.6000	0.246	40	0.3460	1.0000	0.3460	0.4922	0.1703	3.53	1
2	9:16 AM	3.700	0.6	0.690	0.6000	0.414	40	0.4389	1.0000	0.4389	0.4829	0.2120	4.40	1
3	9:18 AM	3.900	0.6	0.780	0.6000	0.468	40	0.4562	1.0000	0.4562	0.1169	0.0533	1.11	1
4	9:21 AM	4.000	0.6	0.770	0.6000	0.462	40	0.5716	1.0000	0.5716	0.2310	0.1321	2.74	1
5	9:22 AM	4.500	0.6	0.880	0.6000	0.528	40	0.5866	1.0000	0.5866	0.4400	0.2581	5.35	1
6	9:24 AM	5.000	0.6	0.890	0.6000	0.534	40	0.6276	1.0000	0.6276	0.4450	0.2793	5.79	1
7	9:26 AM	5.500	0.6	0.930	0.6000	0.558	40	0.6534	1.0000	0.6534	0.5117	0.3344	6.94	1
8	9:19 AM	6.100	0.6	0.770	0.6000	0.462	40	0.5509	1.0000	0.5509	0.3850	0.2121	4.40	1
9	9:32 AM	6.500	0.6	0.920	0.6000	0.552	40	0.6653	1.0000	0.6653	0.2988	0.1988	4.12	1
10	9:35 AM	6.750	0.6	0.940	0.6000	0.564	40	0.6814	1.0000	0.6814	0.2350	0.1601	3.32	1
11	9:37 AM	7.000	0.6	0.940	0.6000	0.564	40	0.6689	1.0000	0.6689	0.3525	0.2358	4.89	1
12	9:38 AM	7.500	0.6	0.940	0.6000	0.564	40	0.7081	1.0000	0.7081	0.3759	0.2662	5.52	1
13	9:40 AM	7.800	0.6	0.900	0.6000	0.540	40	0.7116	1.0000	0.7116	0.2250	0.1601	3.32	1
14	9:42 AM	8.000	0.6	0.870	0.6000	0.522	40	0.7394	1.0000	0.7394	0.1741	0.1288	2.67	1
15	9:43 AM	8.200	0.6	0.870	0.6000	0.522	40	0.7413	1.0000	0.7413	0.2175	0.1613	3.34	1
16	9:45 AM	8.500	0.6	0.810	0.6000	0.486	40	0.7300	1.0000	0.7300	0.2025	0.1478	3.07	1
17	9:46 AM	8.700	0.6	0.810	0.6000	0.486	40	0.7423	1.0000	0.7423	0.2025	0.1503	3.12	1
18	9:47 AM	9.000	0.6	0.680	0.6000	0.408	40	0.7254	1.0000	0.7254	0.2039	0.1479	3.07	1
19	9:49 AM	9.300	0.6	0.630	0.6000	0.378	40	0.7336	1.0000	0.7336	0.1889	0.1386	2.87	1
20	9:51 AM	9.600	0.6	0.600	0.6000	0.360	40	0.6431	1.0000	0.6431	0.3000	0.1929	4.00	1
21	9:53 AM	10.300	0.6	0.550	0.6000	0.330	40	0.6817	1.0000	0.6817	0.3300	0.2249	4.67	1
22	9:56 AM	10.800	0.6	0.520	0.6000	0.312	40	0.6864	1.0000	0.6864	0.2600	0.1785	3.70	1
23	9:57 AM	11.300	0.6	0.320	0.6000	0.192	40	0.7337	1.0000	0.7337	0.1920	0.1408	2.92	1
24	10:00 AM	12.000	0.6	0.490	0.6000	0.294	40	0.6093	1.0000	0.6093	0.4167	0.2539	5.27	1
25	10:02 AM	13.000	0.6	0.320	0.6000	0.192	40	0.5023	1.0000	0.5023	0.3199	0.1607	3.33	1
26	10:03 AM	14.000	0.6	0.380	0.6000	0.228	40	0.2594	1.0000	0.2594	0.3799	0.0986	2.04	1
27	10:05 AM	15.000	0.6	0.350	0.6000	0.210	40	0.0058	1.0000	0.0058	0.3501	0.0020	0.04	1
28	10:07 AM	16.000	0.6	0.400	0.6000	0.240	40	0.0047	1.0000	0.0047	0.3999	0.0019	0.04	1
29	10:09 AM	17.000	0.6	0.500	0.6000	0.300	40	-0.0006	1.0000	-0.0006	0.6750	-0.0004	-0.01	1
30	10:12 AM	18.700	0.6	0.200	0.6000	0.120	40	-0.0012	1.0000	-0.0012	0.3402	-0.0004	-0.01	1
31	10:12 AM	20.400	None	0.000	0.0000	0.000	0	0.0000	1.0000	-0.0012	0.0000	0.0000	0.00	1



Site name Site number Operator(s) File name Comment

LFS RED51320.FlowTracker2.ft

Quality Control Settings							
Maximum depth change	50.00%						
Maximum spacing change	100.00%						
SNR threshold	4 dB						
Standard error threshold	0.0328 ft/s						
Spike threshold	10.00%						
Maximum velocity angle	20.0 deg						
Maximum tilt angle	5.0 deg						

Qualit	uality control warnings											
St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings					
3	9:18 AM	3.900	0.6	0.780	0.6000	0.468	Stn Spacing > QC					
4	9:21 AM	4.000	0.6	0.770	0.6000	0.462	Stn Spacing > QC					
23	9:57 AM	11.300	0.6	0.320	0.6000	0.192	Boundary Interference					
24	10:00 AM	12.000	0.6	0.490	0.6000	0.294	SNR Threshold Variation					
25	10:02 AM	13.000	0.6	0.320	0.6000	0.192	SNR Threshold Variation					
26	10:03 AM	14.000	0.6	0.380	0.6000	0.228	Boundary Interference, Standard Error > QC					
27	10:05 AM	15.000	0.6	0.350	0.6000	0.210	SNR Threshold Variation					
28	10:07 AM	16.000	0.6	0.400	0.6000	0.240	Large SNR Variation, SNR Threshold Variation					
29	10:09 AM	17.000	0.6	0.500	0.6000	0.300	Boundary Interference, SNR Threshold Variation					
30	10:12 AM	18.700	0.6	0.200	0.6000	0.120	Boundary Interference, High % Spikes					



























































