COLORADO
Parks and Wildlife
Department of Natural Resources

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

December 22, 2023

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 Recommendations for Square Top Creek in Water Division 1, Clear Creek County to be presented at the January 2024 CWCB Meeting

Dear Mr. Viehl:

The information contained in and referred to in this letter forms the scientific and biological basis for an instream flow (ISF) recommendation on Square Top Creek in Water Division 1. Field investigations relating to this ISF recommendation were conducted by Colorado Parks and Wildlife (CPW) and Colorado Water Conservation Board (CWCB) staff starting in 2019. Square Top Creek is a high-elevation montane stream that CPW reclaimed to support greenback cutthroat trout, along with two alpine lakes where the creek originates. During the summer of 2023, greenback cutthroat trout were stocked in both Upper and Lower Square Top Lakes and Square Top Creek for the first time. Given the recent stocking of the creek and lakes, CPW believes it is timely to bring this recommendation forward to the Board. This instream flow recommendation was first presented to interested parties at the ISF Workshop in January 2019. CPW and CWCB staff also conducted outreach to the Clear Creek County Commissioners in November 2020. 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 Square Top 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" [§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 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 Instream Flow and Natural Lake Level Program.

Recommended Segments

CPW is proposing an ISF recommendation on Square Top Creek from the outlet of Lower Square Top Lake (located at UTM 13S 436558.39 4382563.18) to Duck Lake (located at UTM 13S 437816.39 4381775.17). The reach is approximately 1.1 miles in length. The upper portions of the proposed reach is on public lands managed under the Pike National Forest. A short reach approximately 0.5 miles above the confluence with Duck Lake is under private ownership.

Greenback Cutthroat Trout Conservation Goals

The greenback cutthroat trout was designated Colorado's state fish in 1994. This subspecies of cutthroat trout has been listed as a threatened species by both the state and federal government. Following the listing of the greenback cutthroat trout under the authorities on the Endangered Species Act of 1973, state and federal fish and wildlife managers have engaged in efforts to establish new populations of this subspecies around the state of Colorado. The greenback cutthroat trout recovery plan's overall goal is as follows:

> "Recovery needs for the Greenback Cuthhroat Trout include the establishment of conservation populations through stocking efforts into streams and lakes with suitable habitat throughout the South Platte River drainage, and possibly within adjacent drainages east of the Continental Divide. Populations need to be sufficiently robust (i.e. resilient and redundant) to withstand stochastic, catastrophic, and anthropogenic influences such that they can persist into the future. Meeting these goals will require that threats be sufficiently understood and abated, and range-wide monitoring will be required." (Recovery Outline for the Greenback Cutthroat Trout, 2019)

Establishing new conservation populations of greenback cutthroat trout and protecting the habitat where these populations reside are both critical steps to the successful recovery of the species. CPW believes that instream flow protection on Square Top Creek is an imporant action in the overall conservation of greenback cutthroat trout.

Natural Environment and Biological Summary

Square Top Creek is a high-elevation headwaters creek located at the top of Guanella Pass. The creek flows into Duck Lake, an on-channel reservoir on Duck Creek, then into Geneva Creek and eventually the North Fork South Platte River. The creek's headwaters form downstream of two alpine lakes called Upper and Lower Square Top Lakes at the base of 13,783-foot Square Top Mountain. The stream's hydrology is driven by high-elevation snowmelt into the late summer with a mean basin elevation of 12,190 feet. This region receives approximately 27 inches of precipitation a year. The contributing

basin is approximately 0.9 square miles with alpine tundra ecosystem characteristics. The channel is extremely high-gradient and single thread with substrate that ranges from small gravels to medium-sized boulders. The channel is primarily large to medium-sized cobbles and small boulders that form a series of cascading step-pools. Suitable trout habitat includes slower-velocity pocket pools, large volume step-pools, and undercut banks.

In 2014, CPW biologists began a reclamation project with the goal of removing all non-native trout species in order to reestablish native greenback cutthroat trout. Following the 2014 reclamation effort, CPW biologists began monitoring the lake and stream system to ensure they were negative for whirling disease, a disease which cutthroat trout are highly suspectible to. CPW biologists wanted to ensure that whirling disease had been eradicted before stocking greenback cutthroat trout in the creek. Following a negative whiling disease result in late 2022, Square Top Creek was stocked for the first time with young-of-the-year greenback cutthroat in 2023. Square Top Lakes were also stocked with yearling greenback cutthroat trout. By stocking distinct age classes in the lakes and stream, CPW biologists will be able to better understand movement patterns of fish between Square Top Creek and the lakes.

Square Top Creek also supports a diverse macroinvertebrate community which includes multiple species of caddisflies and mayflies, diptera, odonata, and stonefly species. Colorado Natural Heritage Program notes observations of *Alloperla pilosa,* a stonefly with status as state imperiled and globally imperiled. Plants observed in the field include Short-Fruited Willow, watercress, and multiple types of wildflowers, including Rocky Mountain Columbine and Downy Indian-paintbrush.

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 runs 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

[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

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 2019 and 2023, CPW and CWCB staff collected three cross-section data sets on Square Top Creek. The results of the R2Cross analysis are summarized below.

	Bankfull Top Width	Date Measured	Flow Measured	Flow Meeting Two Criteria	Flow Meeting Three Criteria
1	8.20 ft	7/16/2019	5.52 cfs	0.84 cfs	1.46 cfs
2	4.31 ft	7/23/2019	4.43 cfs	0.58 cfs	0.82 cfs
3	6.98 ft	7/12/2023	2.72 cfs	0.76 cfs	1.56 cfs
Recommended Flow Rates:				**0.7 cfs**	**1.3 cfs**

The initial biological flow recommendation in the winter is 0.7 cfs. This rate is protective during the overwintering period by maintaining an average depth of 0.2 feet in the stream channel on average. The initial biological flow recommendation in the summer is 1.3 cfs, which will maintain hydraulic parameters of velocity of 1 foot per second (fps), 50 percent wetted perimeter, and adequate depth in critical riffle transects.

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 Square Top Creek. Square Top Creek does not have any gage data, and because it is high-elevation and undeveloped, CWCB staff relied upon regression equations for monthly flow estimates to determine the seasonality of the flow recommendations. CPW is not aware of any active water rights within the reach.

Water Availability-Refined Flow Recommendation

CPW's analysis indicates that the following flows are needed to protect the natural environment to a reasonable degree. Based on the hydrology from CSUFlow18 (Eurich et al., 2021[4]), there appears to be water availablity limitations during the late-summer and baseflow periods. Given these limitations, CPW's adjusted flow recommendations are the following:

- Early Spring Flow Recommendation (April 1 through April 30): **0.3 cfs**
    - This flow rate has been reduced due to water availability constraints but will maintain sufficient depth and wetted perimeter for movement of greenback cutthroat as they

[4] 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.

transition from overwintering conditions to more activity as snowmelt begins. Earlier spring runoff may be a reality in a changing climate.

- Spring Flow Recommendation (May 1 through May 31): **1.0 cfs**
    - Maintains adequate depth, velocity, and wetted perimeter at most riffle cross-sections. These hydraulic conditions will support trout as they transition to more metabolic activity as flows rise during the beginning of spring runoff. Earlier spring runoff may be a reality in a changing climate.
- June Flow Recommendation (June 1 through June 30): **1.3 cfs**
    - Maintains adequate depth, velocity, and wetted perimeter at all riffle cross-sections. This flow rate will support ideal conditions for feeding and spawning as the greenback cutthroat trout mature and grow.
- July Flow Recommendation (July 1 through July 31): **0.8 cfs**
    - Maintains adequate depth, velocity, and wetted perimeter at most riffle cross-sections. This flow rate will support beneficial conditions for feeding and spawning and will maintain suitable resting habitats.
- Late Summer Flow Recommendation (August 1 through August 31): **0.25 cfs**
    - This flow rate has been reduced due to water availability constrists but will maintain sufficient depth and wetted perimeter. Sufficient resting habitats will be maintained.
- Baseflow Recommendation (September 1 through March 31): **0.1 cfs**
    - This flow rate has been reduced due to water availability constraints but will provide sufficient wetted perimeter for yearling and age one cutthroat trout during the fall and into overwintering periods.

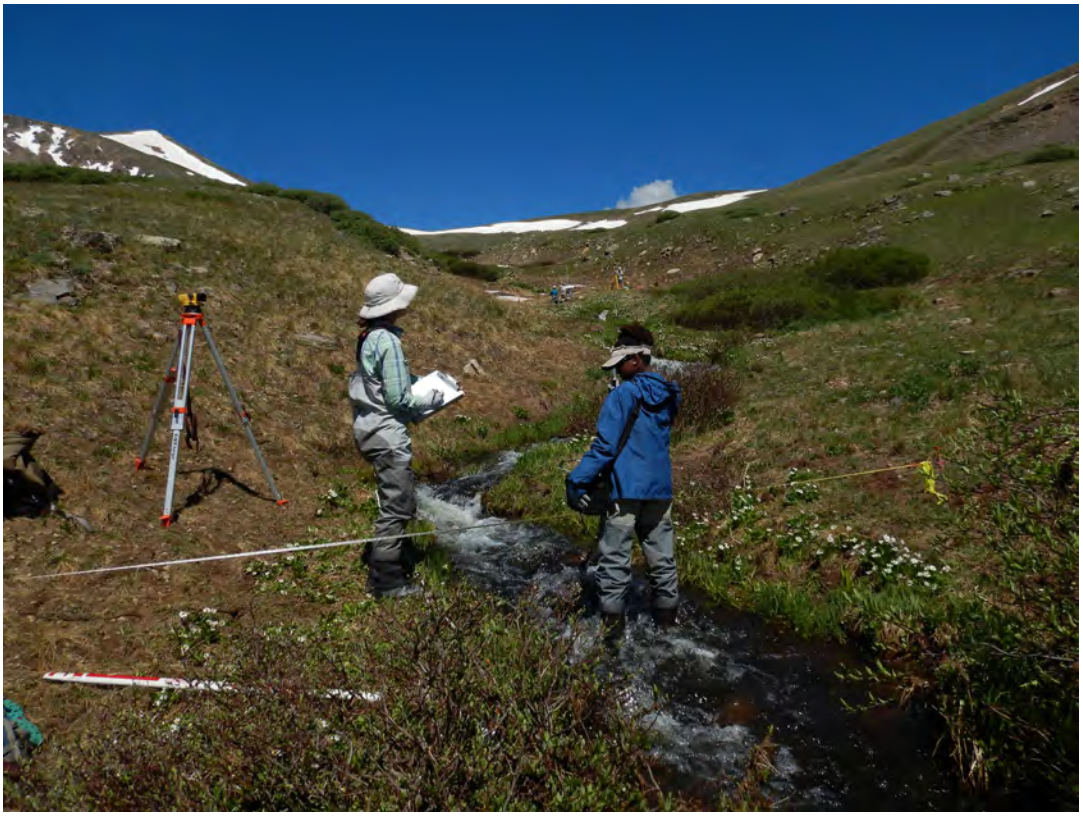
The purpose of this letter is to formally transmit this ISF recommendation to CWCB for the Board's consideration. CPW believes there is a flow-dependent natural environment in Square Top Creek that can be preserved to a reasonable degree with an ISF water right in the recommended rates. Please refer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

CPW personnel will be available at the January 2024 CWCB meeting to answer any questions that the Board might have regarding these flow recommendations. We appreciate your consideration.

Sincerely,

Katie Birch Digitally signed by Katie Birch Date: 2024.01.10 11:22:09 -07'00'

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



Square Top Creek Cross Section 1, looking upstream

Square Top Creek Cross Section 1, looking downstream

Square Top Creek Cross Section 1, downstream overview

Square Top Creek Cross Section 2, looking downstream

Square Top Creek Cross Section 2, Looking upstream

Square Top Creek Cross Section 2, looking across cross section

Square Top Creek, Overview looking downstream

Square Top Creek Cross Section 3, looking upstream

Square Top Creek Cross Section 3, looking downstream

Square Top Creek Cross Section 3, looking downstream from right bank

Square Top Creek, Multi-thread channel

Square Top Lake (Lower)

Square Top Creek, Overview & July 2023 snowmelt reserves

Square Top Creek, Fry greenback cutthroat trout in channel margin

Square Top Creek, August 2023 initial stocking of greenback cutthroat trout

PEBBLE COUNT

Site:

Party:

Reach: Square Tops Creek

Date: 7/16/19

Inches	PARTICLE	Millimeters		PARTICLE COUNT 1 2 3	TOT #	ITEM %	% CUM
	Silt / Clay	< .062	SILT				
	Very Fine	.062 - .125	SAND				
	Fine	.125 - .25					
	Medium	.25 - .50					
	Coarse	.50 - 1.0					
.04 - .08	Very Coarse	1.0 - 2			0		
.08 - .16	Very Fine	2 - 4	GRAVEL		0		
.16 - .22	Fine	4 - 5.7			0		
.22 - .31	Fine	5.7 - 8		||	2		
.31 - .44	Medium	8 - 11.3			0		
.44 - .63	Medium	11.3 - 16		𝍸	10		
.63 - .89	Coarse	16 - 22.6		𝍸 ||	11		
.89 - 1.26	Coarse	22.6 - 32		𝍸 𝍸 |||	13		
1.26 - 1.77	Very Coarse	32 - 45		𝍸 𝍸 𝍸	20		
1.77 - 2.5	Very Coarse	45 - 64		𝍸 𝍸 |	16		
2.5 - 3.5	Small	64 - 90	COBBLE	𝍸 𝍸 ||	18		
3.5 - 5.0	Small	90 - 128		𝍸 |	6		
5.0 - 7.1	Large	128 - 180		𝍸 |	6		
7.1 - 10.1	Large	180 - 256		|	1		
10.1 - 14.3	Small	256 - 362	BOULDER		0		
14.3 - 20	Small	362 - 512			0		
20 - 40	Medium	512 - 1024		|	1		
40 - 80	Large-Vry Large	1024 - 2048		|	1		
	Bedrock		BDRK				
				TOTALS →			

PEBBLE COUNT

Reach:

Date:

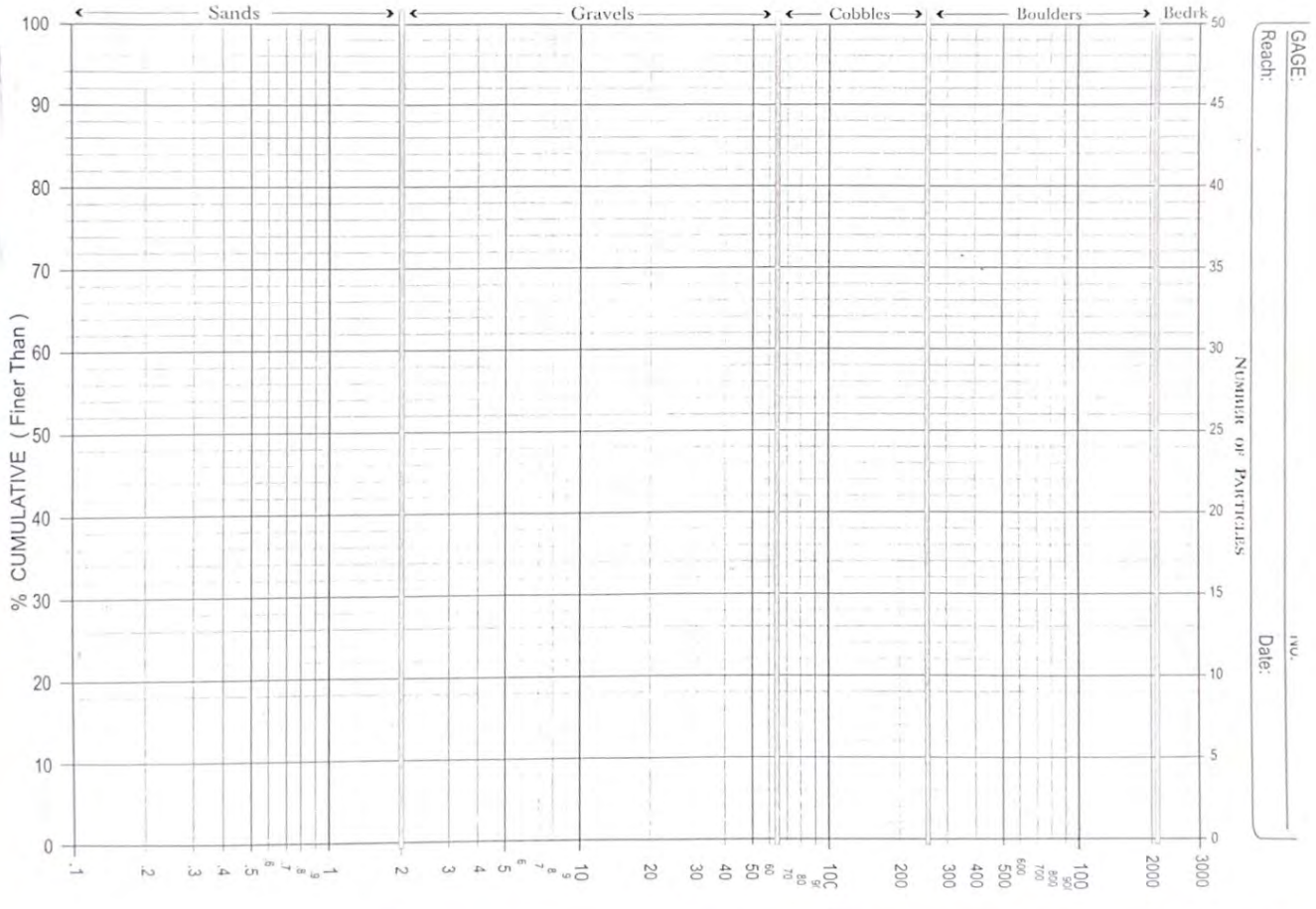
TOT #	ITEM %	% CUM

PEBBLE COUNT

Reach:

Date:

TOT #	ITEM %	% CUM



PEBBLE COUNT

Site:

Party:

Reach: Square Tops Creek

Date: 07/23/19

Inches	PARTICLE	Millimeters	PARTICLE COUNT 1	2	3	TOT #	ITEM %	% CUM
	Silt / Clay	< .062						
	Very Fine	.062 - .125						
	Fine	.125 - .25	I					
	Medium	.25 - .50						
	Coarse	.50 - 1.0						
.04 - .08	Very Coarse	1.0 - 2						
.08 - .16	Very Fine	2 - 4						
.16 - .22	Fine	4 - 5.7	III					
.22 - .31	Fine	5.7 - 8	IIII					
.31 - .44	Medium	8 - 11.3	IIII					
.44 - .63	Medium	11.3 - 16	IIII					
.63 - .89	Coarse	16 - 22.6	IIII III					
.89 - 1.26	Coarse	22.6 - 32	IIII IIII I					
1.26 - 1.77	Very Coarse	32 - 45	IIII III					
1.77 - 2.5	Very Coarse	45 - 64	IIII					
2.5 - 3.5	Small	64 - 90	IIII IIII I					
3.5 - 5.0	Small	90 - 128	IIII IIII II					
5.0 - 7.1	Large	128 - 180	IIII I					
7.1 - 10.1	Large	180 - 256	IIII					
10.1 - 14.3	Small	256 - 362	I					
14.3 - 20	Small	362 - 512						
20 - 40	Medium	512 - 1024	III					
40 - 80	Large-Vry Large	1024 - 2048						
	Bedrock							
					TOTALS →			

PEBBLE COUNT

Reach:

Date:

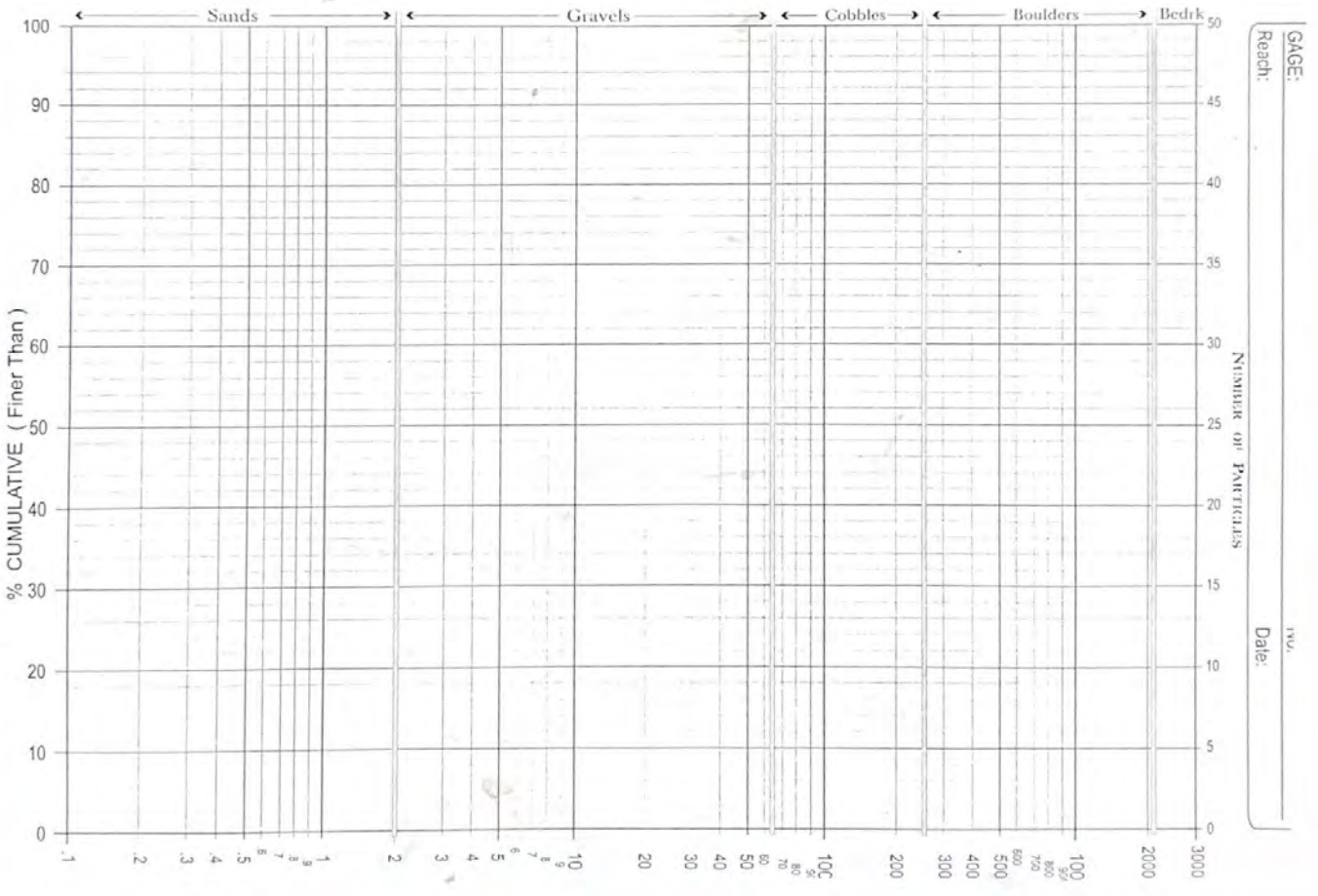
TOT #	ITEM %	% CUM

PEBBLE COUNT

Reach:

Date:

TOT #	ITEM %	% CUM



COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Square Tops Creek (AKA CPW Duck Creek) Unamed trib to Duck Creek					CROSS-SECTION NO.: 1
CROSS-SECTION LOCATION: Between Upper & Lower Square Tops					
DATE: 7/16/19	OBSERVERS: Birch, M. Painter, Ayanna Brune (USFS)				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY:	WATERSHED:	WATER DIVISION:	DOW WATER CODE:		
MAP(S): USGS: See Lat/Long	USFS:				

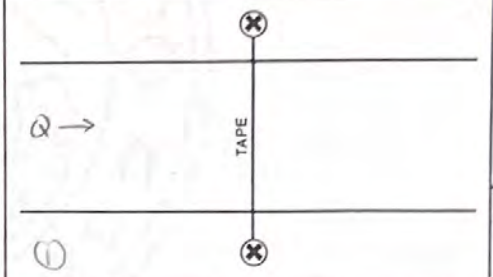
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE: Marsh McB			
METER NUMBER:	DATE RATED:	CALIB/SPIN: _____ sec	TAPE WEIGHT: _____ lbs/foot	TAPE TENSION: _____ lbs
CHANNEL BED MATERIAL SIZE RANGE:	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	X
⊗ Tape @ Stake RB	0.0	X
① WS @ Tape LB/RB	0.0	6.35 / 6.36
② WS Upstream	14.2	5.75
③ WS Downstream		6.40
SLOPE		

SKETCH



LEGEND:
Stake ⊗
Station ①
Photo ①→
Direction of Flow ← →

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)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	>15	TOTAL

AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:

COMMENTS

FORM #ISF FD 1-85

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Sq	CROSS-SECTION NO:	DATE:	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME:

Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec)		Area (ft^2)	Discharge (cfs)
								At Point	Mean in Vertical		
S	0	X	5.0	–							
	2.5	X	5.45	–							
BF	3.5	X	5.93	–							
	4.8	X	6.20	–							
W	5.1	X	6.35	0	–	–	–	–	–		
	5.4	X	6.45	0.10	–	–	–	–	0.07		
	5.7	X		0.45	–	–	–	–	0.44		
	6.0	X		0.50	–	–	–	–	1.89		
	6.3	X		0.50	–	–	–	–	0.78		
	6.6	X		0.55	–	–	–	–	2.91		
	6.9	X		0.60	–	–	–	–	2.93		
	7.2	X		0.50	–	–	–	–	4.21		
	7.5	X		0.45	–	–	–	–	4.45		
	7.8	X		0.40	–	–	–	–	4.30		
	8.1	X		0.50	–	–	–	–	4.43		
R	8.4	X		0.55	–	–	–	–	5.07		
R	8.7	X		0.55	–	–	–	–	2.64		
	9.0	X		0.45	–	–	–	–	1.73		
	9.3	X		0.35	–	–	–	–	0.99		
	9.6	X		0.25	–	–	–	–	0.29		
	9.9	X		0.10	–	–	–	–	0.09		
W	10.0	X	6.36	0	–	–	–	–	–		
BF↓	10.2		6.13								
BF*	11.8		5.95								
	14.6		5.90								
	16.4		5.75								
S	18.1		5.45								
TOTALS:											

End of Measurement	Time:	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Square Tops Creek (aka Unnamed trib to Duck Ck)					CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: Below Lwer Square Tops Lake					
DATE: 7/23/19	OBSERVERS: Birch, Viehl, Landers, Scheel, Lis, Swarr				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY:	WATERSHED:	WATER DIVISION:	DOW WATER CODE:		
MAP(S): USGS: 13S 0436641 4382466					
USFS:					

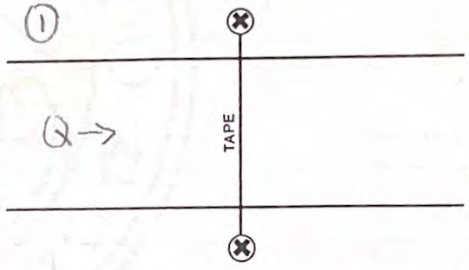
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) / NO	METER TYPE: Marsh McB			
METER NUMBER:	DATE RATED:	CALIB/SPIN: _____ sec	TAPE WEIGHT: _____ lbs/foot	TAPE TENSION: _____ lbs
CHANNEL BED MATERIAL SIZE RANGE:	PHOTOGRAPHS TAKEN: YES/NO	NUMBER OF PHOTOGRAPHS:		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	~
⊗ Tape @ Stake RB	0.0	~
① WS @ Tape LB/RB	0.0	6.01/6.04
② WS Upstream	>14	5.76
③ WS Downstream		6.03
SLOPE		

SKETCH



LEGEND:
Stake ⊗
Station ①
Photo ◇→
Direction of Flow ←→

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STREAM ELECTROFISHED: YES/NO	DISTANCE ELECTROFISHED: _____ft	FISH CAUGHT: YES/NO	WATER CHEMISTRY SAMPLED: YES/NO

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AQUATIC INSECTS IN STREAM SECTION BY COMMON OR SCIENTIFIC ORDER NAME:

COMMENTS

DISCHARGE/CROSS SECTION NOTES

STREAM NAME:	CROSS-SECTION NO:	DATE:	SHEET ___ OF ___

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Features: Stake (S) Grassline (G) Waterline (W) Rock (R)	Distance From Initial Point (ft)	Width (ft)	Total Vertical Depth From Tape/Inst (ft)	Water Depth (ft)	Depth of Observation (ft)	Revolutions	Time (sec)	Velocity (ft/sec): At Point	Velocity (ft/sec): Mean in Vertical	Area (ft^2)	Discharge (cfs)
S	0		5.3								
	1.5		5.6								
	3.0		5.8								
G	4.0		5.9								
W	4.2		6.04	0							
	4.5		6.2	0.2					1.21		
	4.8		6.4	0.35					2.0		
	5.2		6.5	0.55					2.94		
	5.5		6.4	0.55					3.62		
	5.8		6.5	0.5					3.30		
	6.1		6.6	0.7					3.71		
	6.4		6.6	0.7	* 0.6 on	wading rod			3.46		
	6.7		6.6	0.65					1.98		
	7.0		6.6	0.6					1.54		
	7.3		6.5	0.6					0.78		
	7.6		6.3	0.3					1.23		
	7.9		6.4	0.3					0.37		
Undercut Bank	8.2		6.2	0.25					0		
W	8.2		6.01	0							
G	8.5		5.7								
	14.5		5.9								
S	17.9		6.0								
TOTALS:											

End of Measurement	Time:	Gage Reading: _____ ft	CALCULATIONS PERFORMED BY:	CALCULATIONS CHECKED BY:

3

Square Tops Ck XS # 4. 23
7/12/25
KB LFS
UTM 436812 4382380

WB - 6.92 R bank
WS - 6.93 L bank
Left edge - 5.18
1ft - 5.49
1.5ft BF - 6.38
LWS 2.1ft @ 6.93
2.4ft - 7.37, 0.42 d.
2.7ft - 7.38, 0.44 d
3.0ft - 7.42, 0.47 d
3.3ft - 7.40, 0.46 d
3.6 - 7.38, 0.48 d * turbulent
3.9 - 7.27, 0.35 d
4.2 - 7.32, 0.35 d ↓

Squaretops cont. July 21

4.5ft 7.31, 0.42d
4.8ft 7.33, 0.40d
5.1ft, 7.25, 0.35d
5.4ft, 7.24, 0.35d
5.7ft, 7.24, 0.35d
6.0ft, 7.26, 0.38d
6.3ft, 7.27, 0.4d
6.7ft, 7.10, 0.2d
7.0ft, 7.16, 0.25d
7.3ft, 7.38, 0.36d
7.6ft, 7.20, 0.24d
7.9ft, 6.98, 0.08d
WSR - 8.1ft, 6.92
~~8.6ft, 6.44~~
BFR - 8.5ft, 6.35
9.6ft, 5.93

□ tops
Stake, 13.6ft, 4.50ft

Afternoon storms rolling in
Reach Slope
70°F's

Slope Upstream 6.91 elev.
10.4ft length
Down Slope 6.81

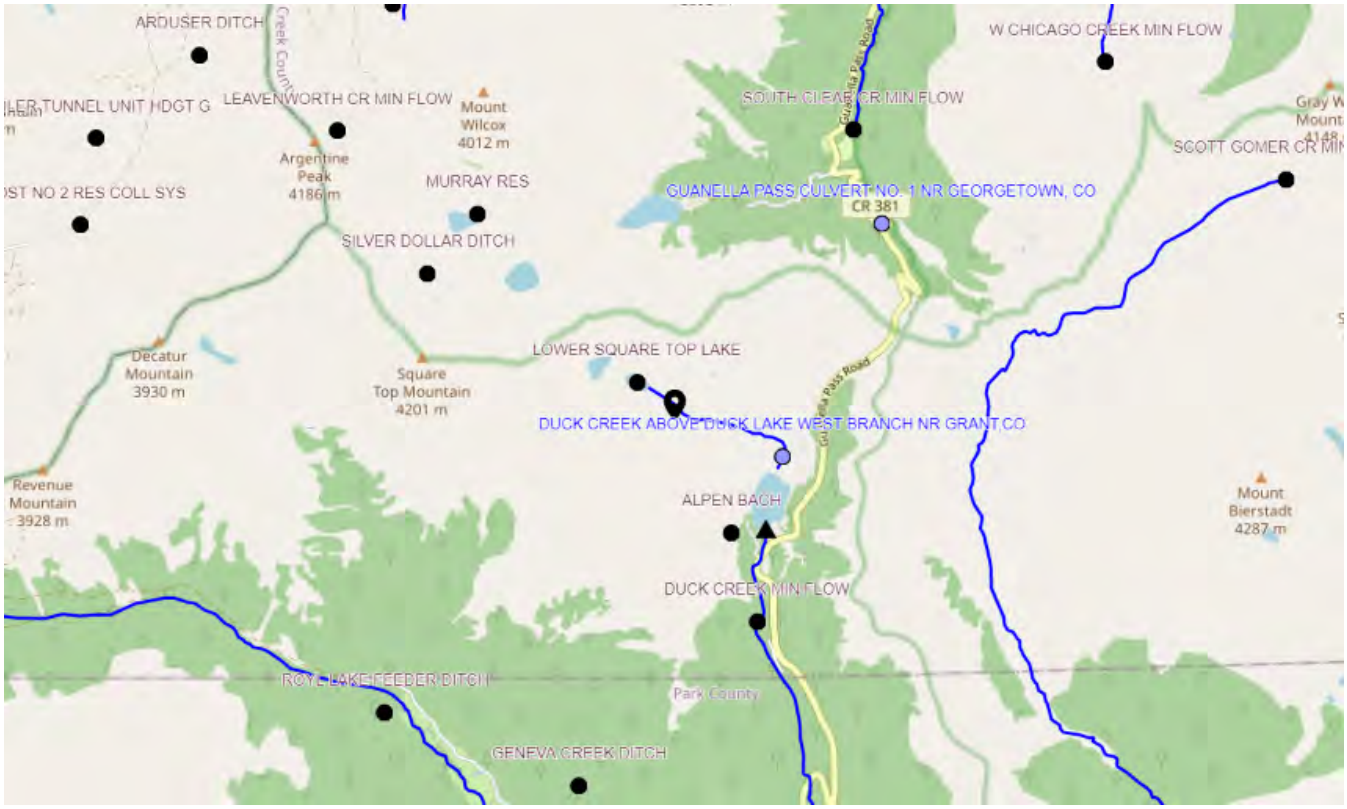
Q meas, taken 5ft downstm

high elevation alpine willow
high elevation meadows - diverse
Wetland seeps w/ flowers
Cascades, variety cobbles,
Similar to Herman's dry
moss, sand - fill fine side

R2Cross RESULTS

Stream Name: Square Tops Creek
Stream Locations: Below Square Tops Lake
Fieldwork Date: 07/16/2019
Cross-section: 1
Observers: Birch Painter Broyone (USFS)
Coordinate System: UTM Zone 13
X (easting): 436759
Y (northing): 4382411
Date Processed: 09/20/2023
Slope: 0.0458
Discharge: R2Cross data file: 5.52 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: R2Cross_Square Tops-1-2019-07-16.xlsx
R2Cross version: 2.0.2

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 8.2

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	0.84
Percent Wetted Perimeter (%)	50.0	1.46
Mean Velocity (ft/s)	1.0	0.77

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	5.95	8.2	0.54	1.0	4.44	8.73	100.0	0.51	0.05	3.82	16.99
	5.95	8.2	0.54	1.0	4.44	8.73	99.98	0.51	0.05	3.82	16.98
	6.0	7.52	0.54	0.95	4.05	8.04	92.05	0.5	0.05	3.78	15.3
	6.05	6.83	0.54	0.9	3.69	7.35	84.11	0.5	0.05	3.77	13.9
	6.1	6.15	0.55	0.85	3.36	6.65	76.17	0.51	0.05	3.8	12.78
	6.15	5.62	0.55	0.8	3.07	6.11	69.99	0.5	0.05	3.77	11.59
	6.2	5.34	0.52	0.75	2.8	5.8	66.42	0.48	0.05	3.59	10.04
	6.25	5.2	0.49	0.7	2.54	5.62	64.38	0.45	0.06	3.3	8.37
	6.3	5.05	0.45	0.65	2.28	5.44	62.34	0.42	0.06	3.01	6.86
Waterline	6.35	4.91	0.41	0.6	2.03	5.27	60.3	0.39	0.06	2.71	5.5
	6.4	4.71	0.38	0.55	1.79	5.03	57.65	0.36	0.07	2.44	4.36
	6.45	4.5	0.35	0.5	1.56	4.8	54.99	0.32	0.07	2.16	3.38
	6.5	4.36	0.31	0.45	1.34	4.62	52.95	0.29	0.08	1.85	2.48
	6.55	4.21	0.27	0.4	1.12	4.45	50.92	0.25	0.08	1.54	1.73
	6.6	4.07	0.23	0.35	0.92	4.27	48.88	0.21	0.09	1.23	1.13
	6.65	3.88	0.19	0.3	0.72	4.04	46.32	0.18	0.11	0.94	0.67
	6.7	3.69	0.14	0.25	0.53	3.82	43.75	0.14	0.13	0.66	0.35
	6.75	3.49	0.1	0.2	0.35	3.6	41.18	0.1	0.17	0.39	0.14
	6.8	2.85	0.07	0.15	0.19	2.91	33.32	0.07	0.24	0.22	0.04
	6.85	1.65	0.04	0.1	0.07	1.68	19.29	0.04	0.34	0.11	0.01
	6.9	0.45	0.02	0.05	0.01	0.46	5.28	0.02	0.54	0.05	0.0
	6.93	0.13	0.01	0.01	0.0	0.14	1.59	0.01	1.46	0.01	0.0

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

MODEL SUMMARY

Measured Flow (Qm) =	5.52	(cfs)
Calculated Flow (Qc) =	5.51	(cfs)
(Qm-Qc)/Qm * 100 =	0.16%	
Measured Waterline (WLm) =	6.36	(ft)
Calculated Waterline (WLc) =	6.35	(ft)
(WLm-WLc)/WLm * 100 =	0.08%	
Max Measured Depth (Dm) =	0.6	(ft)
Max Calculated Depth (Dc) =	0.6	(ft)
(Dm-Dc)/Dm * 100 =	0.02%	
Mean Velocity =	2.71	(ft/s)
Manning's n =	0.062	
0.4 * Qm =	2.21	(cfs)
2.5 * Qm =	13.79	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	5		
	2.5	5.45		
Bankfull	3.5	5.93		
	4.8	6.2		
Waterline	5.1	6.35	0	0
	5.4	6.45	0.1	0.07
	5.7	6.8	0.45	0.44
	6	6.85	0.5	1.89
	6.3	6.85	0.5	0.78
	6.6	6.9	0.55	2.91
	6.9	6.95	0.6	2.93
	7.2	6.85	0.5	4.21
	7.5	6.8	0.45	4.45
	7.8	6.75	0.4	4.3
	8.1	6.85	0.5	4.43
	8.4	6.9	0.55	5.07
	8.7	6.9	0.55	2.64
	9	6.8	0.45	1.73
	9.3	6.7	0.35	0.99
	9.6	6.6	0.25	0.29
	9.9	6.45	0.1	0.09
Waterline	10	6.36	0	0
	10.2	6.13		
Bankfull	11.8	5.95		
	14.6	5.9		
	16.4	5.75		
	18.1	5.45		

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
0.32	0.1	0.03	0	0.04
0.46	0.45	0.14	0.06	1.08
0.3	0.5	0.15	0.28	5.14
0.3	0.5	0.15	0.12	2.12
0.3	0.55	0.17	0.48	8.71
0.3	0.6	0.18	0.53	9.56
0.32	0.5	0.15	0.63	11.45
0.3	0.45	0.14	0.6	10.89
0.3	0.4	0.12	0.52	9.36
0.32	0.5	0.15	0.66	12.05
0.3	0.55	0.17	0.84	15.17
0.3	0.55	0.17	0.44	7.9
0.32	0.45	0.14	0.23	4.23
0.32	0.35	0.1	0.1	1.89
0.32	0.25	0.07	0.02	0.39
0.34	0.1	0.02	0	0.03
0.13	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

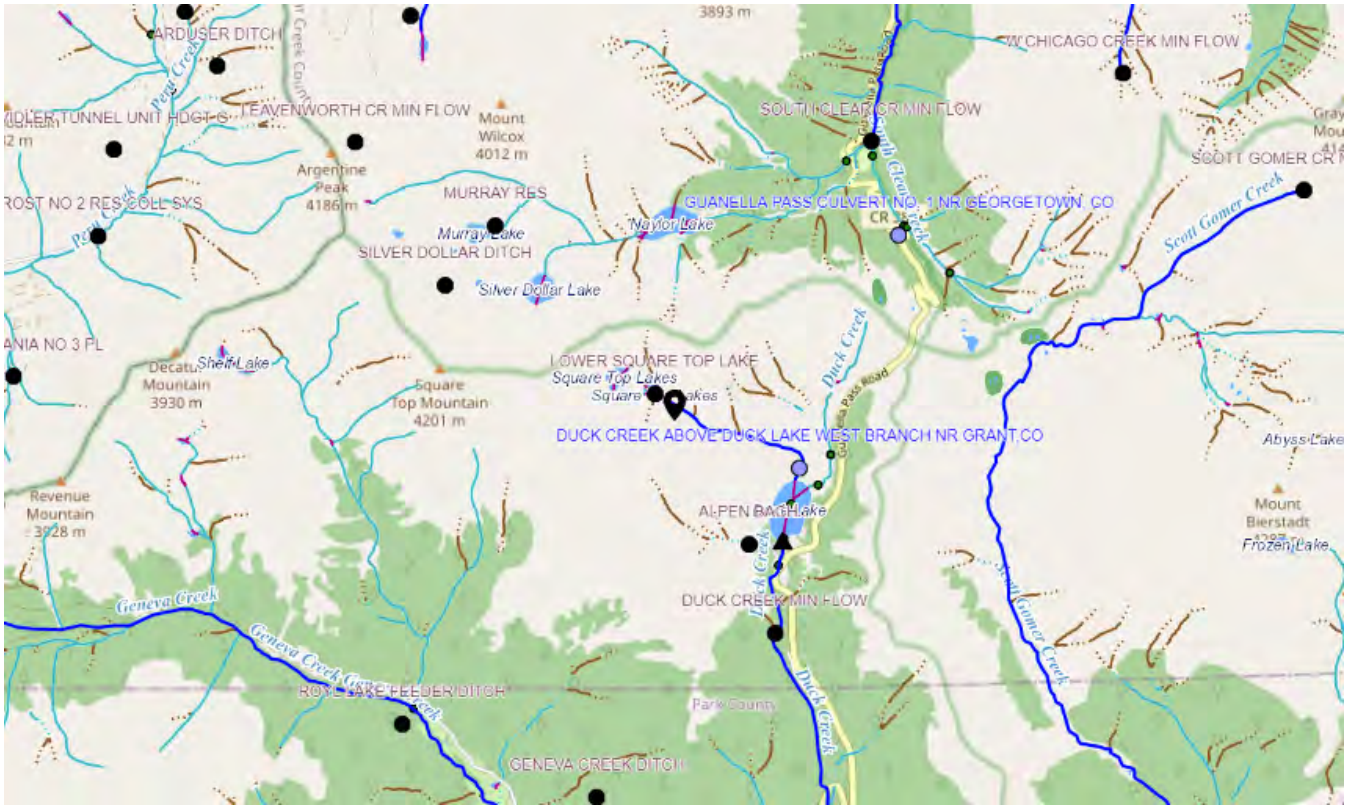
DISCLAIMER

"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: ET to Duck Creek (AKA Square Tops Creek)
Stream Locations: Below Square Tops Lake
Fieldwork Date: 07/23/2019
Cross-section: 2
Observers: Birch Ris Viehl Lander
Coordinate System: UTM Zone 13
X (easting): 436642
Y (northing): 4382480
Date Processed: 09/20/2023
Slope: 0.0193
Discharge: R2Cross data file: 4.43 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: R2Cross_Square Tops-2-2019-07-23.xlsx
R2Cross version: 2.0.2

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 4.31

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	0.58
Percent Wetted Perimeter (%)	50.0	0.1
Mean Velocity (ft/s)	1.0	0.82

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	5.9	4.31	0.51	0.7	2.18	4.9	100.0	0.44	0.05	2.53	5.52
	5.92	4.26	0.49	0.68	2.11	4.85	98.88	0.43	0.05	2.46	5.19
	5.93	4.22	0.48	0.66	2.03	4.79	97.76	0.42	0.05	2.39	4.86
	5.95	4.18	0.47	0.65	1.96	4.74	96.64	0.41	0.05	2.32	4.55
	5.97	4.14	0.46	0.63	1.89	4.68	95.52	0.4	0.05	2.25	4.24
Waterline	5.97	4.13	0.45	0.63	1.87	4.67	95.3	0.4	0.05	2.24	4.18
	5.99	4.1	0.44	0.61	1.81	4.63	94.4	0.39	0.05	2.18	3.95
	6.0	4.05	0.43	0.59	1.74	4.57	93.28	0.38	0.05	2.11	3.67
	6.02	4.03	0.42	0.58	1.67	4.52	92.27	0.37	0.05	2.03	3.39
	6.04	4.0	0.4	0.56	1.6	4.48	91.29	0.36	0.05	1.95	3.12
	6.06	3.97	0.39	0.54	1.53	4.42	90.17	0.35	0.05	1.87	2.87
	6.08	3.93	0.37	0.52	1.46	4.37	89.05	0.33	0.06	1.8	2.63
	6.09	3.9	0.36	0.51	1.39	4.31	87.94	0.32	0.06	1.72	2.4
	6.11	3.87	0.34	0.49	1.33	4.26	86.82	0.31	0.06	1.64	2.17
	6.13	3.84	0.33	0.47	1.26	4.2	85.71	0.3	0.06	1.56	1.96
	6.14	3.8	0.31	0.45	1.19	4.15	84.59	0.29	0.06	1.48	1.76
	6.16	3.77	0.3	0.44	1.13	4.09	83.48	0.27	0.06	1.4	1.57
	6.18	3.74	0.28	0.42	1.06	4.04	82.36	0.26	0.06	1.31	1.39
	6.2	3.7	0.27	0.4	0.99	3.98	81.25	0.25	0.07	1.23	1.22
	6.21	3.65	0.25	0.39	0.93	3.92	79.98	0.24	0.07	1.15	1.07
	6.23	3.6	0.24	0.37	0.87	3.86	78.7	0.22	0.07	1.07	0.92
	6.25	3.55	0.23	0.35	0.8	3.79	77.41	0.21	0.07	0.99	0.79
	6.27	3.5	0.21	0.33	0.74	3.73	76.12	0.2	0.08	0.9	0.67
	6.29	3.44	0.2	0.32	0.68	3.67	74.83	0.19	0.08	0.82	0.56
	6.3	3.38	0.18	0.3	0.62	3.59	73.29	0.17	0.09	0.75	0.46

	6.32	3.25	0.17	0.28	0.56	3.44	70.24	0.16	0.09	0.69	0.39
	6.34	3.12	0.16	0.26	0.51	3.29	67.18	0.15	0.09	0.63	0.32
	6.36	2.99	0.15	0.24	0.45	3.14	64.12	0.14	0.1	0.58	0.26
	6.37	2.86	0.14	0.23	0.4	2.99	61.06	0.13	0.1	0.52	0.21
	6.39	2.73	0.13	0.21	0.35	2.84	58.0	0.12	0.11	0.47	0.17
	6.41	2.56	0.12	0.19	0.31	2.67	54.37	0.12	0.12	0.42	0.13
	6.42	2.36	0.11	0.17	0.26	2.45	50.0	0.11	0.12	0.38	0.1
	6.44	2.16	0.1	0.16	0.23	2.24	45.63	0.1	0.13	0.34	0.08
	6.46	1.96	0.1	0.14	0.19	2.02	41.26	0.09	0.14	0.31	0.06
	6.48	1.76	0.09	0.12	0.16	1.81	36.88	0.09	0.15	0.28	0.04
	6.5	1.56	0.08	0.1	0.13	1.59	32.51	0.08	0.16	0.25	0.03
	6.51	1.43	0.07	0.09	0.1	1.45	29.65	0.07	0.17	0.2	0.02
	6.53	1.32	0.06	0.07	0.08	1.34	27.39	0.06	0.2	0.15	0.01
	6.55	1.22	0.05	0.05	0.06	1.23	25.13	0.05	0.25	0.11	0.01
	6.57	1.11	0.03	0.04	0.04	1.12	22.87	0.03	0.34	0.06	0.0
	6.58	1.0	0.02	0.02	0.02	1.01	20.62	0.02	0.57	0.02	0.0

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

MODEL SUMMARY

Measured Flow (Qm) =	4.43	(cfs)
Calculated Flow (Qc) =	4.28	(cfs)
(Qm-Qc)/Qm * 100 =	3.42%	
Measured Waterline (WLm) =	6.03	(ft)
Calculated Waterline (WLc) =	5.97	(ft)
(WLm-WLc)/WLm * 100 =	0.85%	
Max Measured Depth (Dm) =	0.7	(ft)
Max Calculated Depth (Dc) =	0.63	(ft)
(Dm-Dc)/Dm * 100 =	10.51%	
Mean Velocity =	2.29	(ft/s)
Manning's n =	0.049	
0.4 * Qm =	1.77	(cfs)
2.5 * Qm =	11.07	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	5.3		
	1.5	5.6		
	3	5.8		
Bankfull	4	5.9		
Waterline	4.2	6.04	0	0
	4.5	6.2	0.2	1.21
	4.8	6.4	0.35	2
	5.2	6.5	0.55	2.94
	5.5	6.4	0.55	3.62
	5.8	6.5	0.5	3.3
	6.1	6.6	0.7	3.71
	6.4	6.6	0.7	3.46
	6.7	6.6	0.65	1.98
	7	6.6	0.6	1.54
	7.3	6.5	0.6	0.78
	7.6	6.3	0.3	1.23
	7.9	6.4	0.3	0.37
	8.2	6.2	0.25	0
Waterline	8.2	6.01	0	0
Bankfull	8.5	5.7		
	14.5	5.9		
	17.9	6		

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
0.34	0.2	0.06	0.07	1.64
0.36	0.35	0.12	0.24	5.53
0.41	0.55	0.19	0.57	12.78
0.32	0.55	0.17	0.6	13.49
0.32	0.5	0.15	0.49	11.18
0.32	0.7	0.21	0.78	17.59
0.3	0.7	0.21	0.73	16.4
0.3	0.65	0.2	0.39	8.72
0.3	0.6	0.18	0.28	6.26
0.32	0.6	0.18	0.14	3.17
0.36	0.3	0.09	0.11	2.5
0.32	0.3	0.09	0.03	0.75
0.36	0.25	0.04	0	0
0.19	0	0	0	0
0	0	0	0	0
0	0	0	0	0
0	0	0	0	0

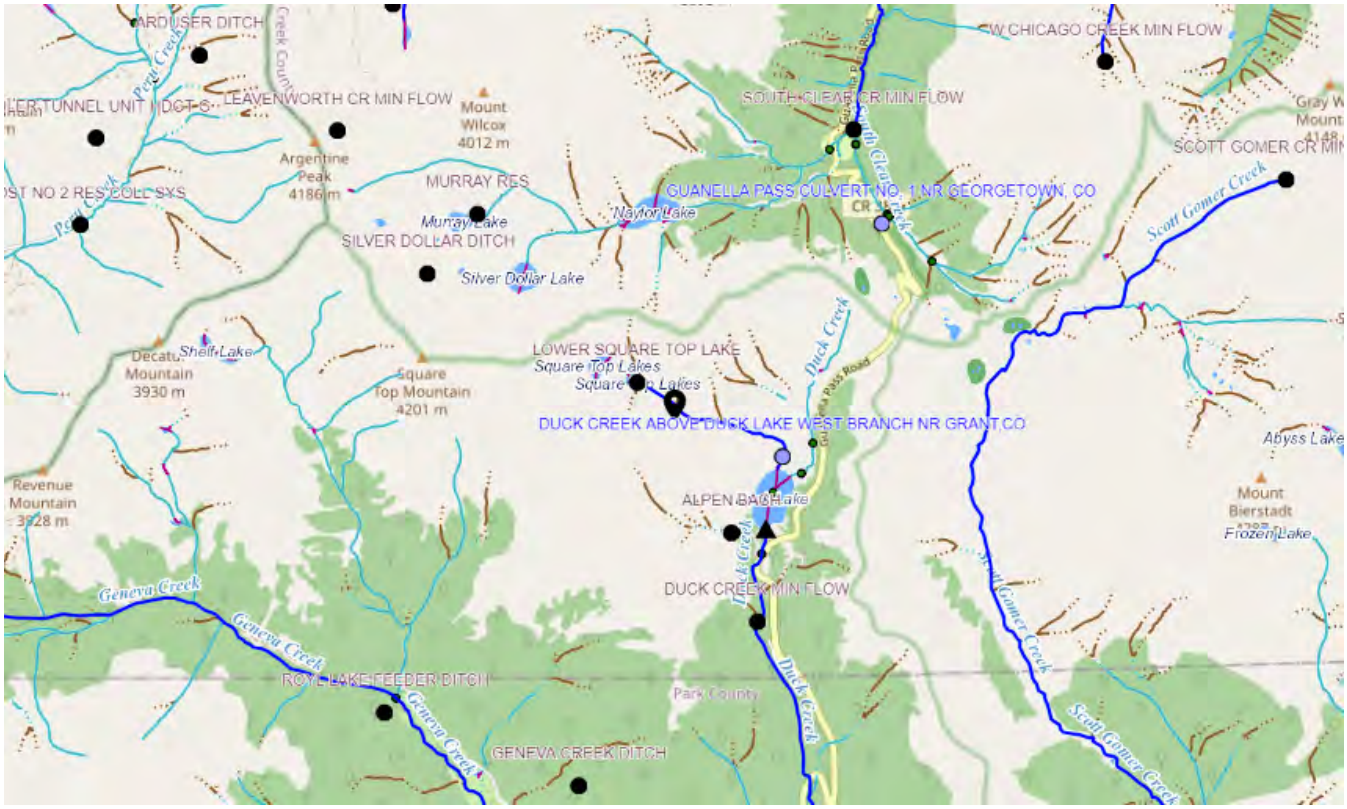
DISCLAIMER

"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: Square Tops Creek
Stream Locations: Below Square Tops Lake
Fieldwork Date: 07/12/2023
Cross-section: 3
Observers: KB LFS
Coordinate System: UTM Zone 13
X (easting): 436812
Y (northing): 4382380
Date Processed: 09/20/2023
Slope: 0.0096
Discharge: Entered Value: 2.72 (cfs)
Computation method: Ferguson VPE
R2Cross data filename: R2Cross_Square Tops-3-2023-07-12.xlsx
R2Cross version: 2.0.2

LOCATION



ANALYSIS RESULTS

Habitat Criteria Results

Bankfull top width (ft) = 6.98

	Habitat Criteria	Discharge (cfs) Meeting Criteria
Mean Depth (ft)	0.2	0.76
Percent Wetted Perimeter (%)	50.0	0.07
Mean Velocity (ft/s)	1.0	1.56

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	6.38	6.98	0.8	1.04	5.57	7.99	100.0	0.7	0.04	3.15	17.53
	6.42	6.9	0.76	1.0	5.28	7.88	98.6	0.67	0.04	3.03	16.02
	6.47	6.82	0.72	0.95	4.94	7.74	96.91	0.64	0.04	2.89	14.27
	6.52	6.73	0.68	0.9	4.6	7.61	95.22	0.6	0.04	2.74	12.6
	6.57	6.64	0.64	0.85	4.26	7.47	93.53	0.57	0.04	2.59	11.03
	6.62	6.55	0.6	0.8	3.93	7.34	91.84	0.54	0.04	2.43	9.54
	6.67	6.46	0.56	0.75	3.61	7.2	90.15	0.5	0.04	2.26	8.15
	6.72	6.37	0.52	0.7	3.29	7.07	88.46	0.47	0.04	2.09	6.86
	6.77	6.28	0.47	0.65	2.97	6.93	86.77	0.43	0.04	1.91	5.66
	6.82	6.19	0.43	0.6	2.66	6.8	85.08	0.39	0.05	1.72	4.57
	6.87	6.1	0.39	0.55	2.35	6.66	83.39	0.35	0.05	1.52	3.59
Waterline	6.92	6.0	0.34	0.5	2.05	6.52	81.66	0.31	0.05	1.33	2.72
	6.97	5.8	0.3	0.45	1.76	6.29	78.69	0.28	0.05	1.14	2.01
	7.02	5.68	0.26	0.4	1.47	6.13	76.68	0.24	0.06	0.94	1.38
	7.07	5.58	0.21	0.35	1.19	5.98	74.87	0.2	0.07	0.73	0.87
	7.12	5.32	0.17	0.3	0.91	5.67	71.01	0.16	0.08	0.55	0.5
	7.17	4.89	0.13	0.25	0.66	5.18	64.88	0.13	0.09	0.4	0.26
	7.22	4.6	0.09	0.2	0.42	4.82	60.34	0.09	0.12	0.23	0.1
	7.27	3.0	0.08	0.15	0.23	3.16	39.53	0.07	0.15	0.17	0.04
	7.32	1.73	0.06	0.1	0.1	1.81	22.66	0.05	0.18	0.12	0.01
	7.37	1.21	0.02	0.05	0.03	1.22	15.28	0.02	0.38	0.03	0.0
	7.41	0.34	0.01	0.01	0.0	0.34	4.24	0.01	0.94	0.01	0.0

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

MODEL SUMMARY

Measured Flow (Qm) =	2.72	(cfs)
Calculated Flow (Qc) =	2.72	(cfs)
(Qm-Qc)/Qm * 100 =	0.08%	
Measured Waterline (WLm) =	6.92	(ft)
Calculated Waterline (WLc) =	6.92	(ft)
(WLm-WLc)/WLm * 100 =	0.05%	
Max Measured Depth (Dm) =	0.48	(ft)
Max Calculated Depth (Dc) =	0.5	(ft)
(Dm-Dc)/Dm * 100 =	-3.89%	
Mean Velocity =	1.33	(ft/s)
Manning's n =	0.051	
0.4 * Qm =	1.09	(cfs)
2.5 * Qm =	6.8	(cfs)

FIELD DATA

Feature	Station (ft)	Rod Height (ft)	Water depth (ft)	Velocity (ft/s)
	0	5.18		
	1	5.69		
Bankfull	1.5	6.38		
Waterline	2.1	6.93	0	
	2.4	7.37	0.42	
	2.7	7.38	0.44	
	3	7.42	0.47	
	3.3	7.4	0.46	
	3.6	7.38	0.48	
	3.9	7.27	0.35	
	4.2	7.32	0.35	
	4.5	7.31	0.42	
	4.8	7.33	0.4	
	5.1	7.25	0.35	
	5.4	7.24	0.35	
	5.7	7.24	0.35	
	6	7.26	0.38	
	6.3	7.27	0.4	
	6.7	7.1	0.2	
	7	7.16	0.25	
	7.3	7.38	0.36	
	7.6	7.2	0.24	
	7.9	6.98	0.08	
Waterline	8.1	6.92	0	
Bankfull	8.5	6.35		
	9.6	5.93		
	13.6	4.5		

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
0.53	0.42	0.13	0.17	6.14
0.3	0.44	0.13	0.18	6.44
0.3	0.47	0.14	0.19	6.88
0.3	0.46	0.14	0.18	6.73
0.3	0.48	0.14	0.19	7.02
0.32	0.35	0.1	0.14	5.12
0.3	0.35	0.1	0.14	5.12
0.3	0.42	0.13	0.17	6.14
0.3	0.4	0.12	0.16	5.85
0.31	0.35	0.1	0.14	5.12
0.3	0.35	0.1	0.14	5.12
0.3	0.35	0.1	0.14	5.12
0.3	0.38	0.11	0.15	5.56
0.3	0.4	0.14	0.19	6.83
0.43	0.2	0.07	0.09	3.41
0.31	0.25	0.07	0.1	3.66
0.37	0.36	0.11	0.14	5.27
0.35	0.24	0.07	0.1	3.51
0.37	0.08	0.02	0.03	0.98
0.21	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.

General Site Field Visit Data Report *(Filters: Name begins with Square Top Creek;)*

Type		Div	Name	CWCB Case Number	Segment ID	Visit Date	Location Description	Watershed Name
Stream		1	Square Top Creek		16/1/A-003	7/11/2016	Duck Creek (?) and Square Top Lakes	Upper South Platte

Remarks

Date	Remark
11/07/16 10:20	Arrive at site. Drove up above Duck Lake to take overview pictures.
11/07/16 11:43	Julie Holmes 303-569-2681, angels11@wildblue.net, PO Box 819, Georgetown, CO, 80444. Cabin owner. Owns land on downstream portion of Duck Lake. Alpenboch, creek that comes into west side of Duck Lake. Flows all year. February low month. Bill Holmes memorial power plant powers the cabin. Has diversion for domestic. Famers Reservoir Irrigation Company / Burlington Ditch Reservoir and Land Company owns land above Duck Lake.
11/07/16 12:38	Duck Creek may not be the proper name for the proposed creek. Julie Holmes informed me that the creek that has been proposed as Duck Creek is actually named Glacier Creek. It enters northwest side and Evens Creek enters northeast side of Duck Lake. The notes will refer to the proposed creek as Duck Creek (?) or DC?. Julie Holmes, Square Top Lakes have hydro permit through FERC. Might be interested in 102(3)b.
11/07/16 14:07	Trail to STLs passes two unnamed unmapped lakes. Lakes are referred to in notes as 1 which is the southern and 2 the northern lake. A GPS point DC002 was take. South of the southern lake, referred to as 1. Photographs of the lakes we're taken and tracks were made around the lakes.
11/07/16 16:24	Spot discharge measurement taken, below proposed UT. DCNRLSTL.001

Stream	GPS Log	GPS Date	Device	GPSPoint Name	Latitude	Longitude	UTM Zone	UTM Easting	UTMNorthing	Horizontal Accuracy
		11/07/16 13:15	Phone (BJE)	DC001	39.597126	-105.713109				5.000000
		11/07/16 13:43	Phone (BJE)	DC002	39.591485	-105.731599				5.000000
		11/07/16 14:24	Phone (BJE)	DC003	39.591106	-105.735434				5.000000
		11/07/16 14:49	Phone (BJE)	DC005	39.590039	-105.738112				5.000000
		11/07/16 14:57	Phone (BJE)	DC006	39.590508	-105.738651				5.000000
		11/07/16 15:11	Phone (BJE)	DC007	39.591770	-105.740171				5.000000
		11/07/16 15:13	Phone (BJE)	DC008	39.591743	-105.740559				5.000000
		11/07/16 15:19	Phone (BJE)	DC009	39.590908	-105.741571				5.000000
		11/07/16 15:48	Phone (BJE)	DC010	39.589892	-105.738043				5.000000

GPSDescription	
Trail head to Square Top Lakes. Parked at Guanella Pass and hiked from here "South Park 600 Trail"	
Unnamed unmapped natural lake.	
Draw that feed Duck Creek (name ?) at trail crossing.	
Pictures of DC? Taken from this location, just below proposed UT.	
Actual location of proposed UT. Outflow point of Lower Square Top Lake, spilling into Duck Creek (?).	
Spring inflow to Lower Square Top Lake.	
Spring inflow to Lower Square Top Lake.	
Main inflow to Lower Square Top Lake.	
Duck Creek (?) near upper terminus spot discharge measurement location.	

Stream	Photo Log	Photo Date	Camera	Media Type	Photo Video ID	Caption	Photo Comment
		11/07/16 10:55		Photograph	660	Overview picture of Duck Creek	Photo taken from Guanella Pass Road looking at pr flow reach on Duck Creek, from Duck Lake to Lowe Lakes.
		Link:					
		11/07/16 10:55		Photograph	661	Lower portion of proposed isf reach	Duck Lake is on the middle left of the photo. The se reach pictured is lower gradient. Duck Creek enters photo middle right.
		Link:					
		11/07/16 10:55		Photograph	662	Close up of steep canyon middle of proposed reach	Duck Creek enters the steep tight canyon on the mi and exits on the lower left of the photo.
		Link:					
		11/07/16 10:56		Photograph	663	Upper portion of Duck Creek	Square Top Mountain towering over the headwaters photo upper right.
		Link:					
		11/07/16 10:56		Photograph	664	Headwaters of Duck Creek	Square Top Mountain towering over the headwaters photo upper right.
		Link:					
		11/07/16 12:15		Photograph		Duck Lake Bathimetry	Duck Lake bathimetry
		Link: https://620638672b84d7ed4da9-bca54e529e5752f1e6d63fb4a534334b.ssl.cf2.rackcdn.com/iformbuilder.com/461577/_data461577_cwcb_general_subform_photos/field_145016004579134ba7fbff.jpg					
		11/07/16 13:46		Photograph	665	Unnamed unmapped lake 1 (south)	The trail from Guanella Pass to Square Top Lakes p natural lake. Photo taken looking southeast.
		Link:					
		11/07/16 14:03		Photograph	666	Unnamed unmapped lake 2 (north)	The trail from Guanella Pass to Square Top Lakes p natural lake. Photo looking northeast.
		Link:					
		11/07/16 14:25		Photograph		Draw that feed Duck Creek	Standing at GPS point DC003, in creek on trail, look headwaters.
		Link: https://620638672b84d7ed4da9-bca54e529e5752f1e6d63fb4a534334b.ssl.cf2.rackcdn.com/iformbuilder.com/461577/_data461577_cwcb_general_subform_photos/field_1355395963579134be5ed05.jpg					
		11/07/16 14:33		Photograph		Draw that feeds Duck Creek (?)	Another unnamed feeder to Duck Creek (?), further previous and flowing less.
		Link: https://620638672b84d7ed4da9-bca54e529e5752f1e6d63fb4a534334b.ssl.cf2.rackcdn.com/iformbuilder.com/461577/_data461577_cwcb_general_subform_photos/field_1831619661579134bfc42cd.jpg					
		11/07/16 14:40		Photograph	667	Duck Creek (?) below lower Square Top Lake near UT	Pictures 667-669 taken from same location, DC005, DC?. Looking downstream. Creek is stable and well high gradient, plunge pool, through alpine meadow, through willows, rushes, sedges and wildflowers, an boulder/cobble bed.
		Link:					
		11/07/16 14:59		Photograph		Proposed upper terminus.	Photo of GPS DC006
		Link: https://620638672b84d7ed4da9-bca54e529e5752f1e6d63fb4a534334b.ssl.cf2.rackcdn.com/iformbuilder.com/461577/_data461577_cwcb_general_subform_photos/field_1641815423579134c21f638.jpg					

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Stream		1	Square Top Creek		16/1/A-003	7/20/2016	Duck Creek (?) and Square Top Lakes

Remarks

Date	Remark
20/07/16 13:12	Track 1 on Trimble GPS Hunt is the circumnavigation of Upper Square Top Lake. The lake has three surface inflows and three springs inflowing at edge of lake. Abundant wildflowers ringing lake.

GPS Log

GPS Date	Device	GPSPoint Name	Latitude	Longitude	UTM Zone	UTM Easting	UTMNorthing	Horizontal Accuracy
20/07/16 11:48	Phone (BJE)	STL001			13N	438777	4383292	
20/07/16 12:27	Phone (BJE)	STL002	39.590877	-105.737819				5.000000
20/07/16 12:53	Phone (BJE)	STL003	39.591139	-105.744836				5.000000

Photo Log

Photo Date	Camera	Media Type	Photo Video ID	Caption	Photo Comment
20/07/16 12:28		Photograph	705	Lower Square Top Lake	Taken from GPS STL002. LSTL with Square Top M background.
Link:					
20/07/16 13:31		Photograph	706	Upper Square Top Lake	Photo taken from the south west side of the lake.
Link:					
20/07/16 13:33		Photograph	707	Upper Square Top Lake	Photo taken from the south west side of the lake. W foreground.
Link:					
20/07/16 13:36		Photograph	709	Upper Square Top Lake	Photo taken from the south west side of the lake. Mt the Sawtooth in the background. Left portion of a pa completed by 710.
Link:					
20/07/16 13:36		Photograph	708	Upper Square Top Lake	Photo taken from the south west side of the lake. Mt the Sawtooth in the background.
Link:					
20/07/16 13:37		Photograph	710	Upper Square Top Lake	Photo taken from the south west side of the lake. Mt the Sawtooth in the background. Right portion of a p completed by 709.
Link:					
20/07/16 13:50		Photograph	711	Upper and Lower Square Top Lakes	Photo taken from the south side of the USTL. The le photo is the south side of Upper Square Top Lake w water spills into a channel that leads to Lower Squa center right. Mt. Bierstadt and the Sawtooth in the b
Link:					
20/07/16 13:51		Photograph	712	Lower Square Top Lake	Photo taken from the south east side of Upper Squa Lower Square Top is in the bottom center of the pho Bierstadt and the Sawtooth in the background.
Link:					

	Upper South Platte
GPSDescription	
Parking lot, location of truck. On iPhone map Trimble (GPS Hunt).	
Location from which picture 705, Lower Square Top Lake taken.	
Upper Square Top Lake outflow.	

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20/07/16 13:52		Photograph	713	Marmot	Marmot that make the Square Top Lakes area hom
Link:					
20/07/16 13:52		Photograph	714	Marmot	Marmot family that make the Square Top Lakes are
Link:					
20/07/16 13:53		Photograph	715	Marmot	Marmot family that make the Square Top Lakes are
Link:					
20/07/16 13:54		Photograph	716	Lower Square Top Lake	Photo taken from the south east side of Upper Squa Marshy area creates from Upper Square Top Lake t Lower Square Top is in the center of the photograph and the Sawtooth in the background.
Link:					
20/07/16 13:58		Photograph	717	Lower Square Top Lake	Photo taken from the south east side of Upper Squa Lower Square Top is in the center of the photograph the background.
Link:					
20/07/16 14:03		Video	718	Duck Creek (?)	Duck Creek (?) taken from near the trail crossing be Square Top Lake.
Link:					

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Discharge Measurment Field Visit Data Report *(Filters: Name begins with Square Top Creek;)*

Div	Name	CWCB Case Number	Segment ID	Meas. Date	UTM	Location	Flow Amount (cfs)	Meas #	Rating	Station ID
1	Square Top Creek		16/1/A-003	07/11/2016	UTMx: 436623.9768 UTMy: 4382499.5562	Duck (?) Creek Near Lower Square Top Lake	2.04	1	p	DCNRLSTL
1	Square Top Creek		16/1/A-003	07/23/2019	UTMx: 436658 UTMy: 4382486	Unnamed trib to Duck Creek - 500ft ds of lower Square Top Lake - R2Cross	4.43	2	P	
1	Square Top Creek		16/1/A-003	07/23/2019	UTMx: 436714 UTMy: 4382457	Unnamed trib to Duck Creek 1000ft DS lower lake	3.84	3	F	

Discharge Measurement Summary

Date Generated: Tue Nov 14 2023

File Information

File Name	DCNRLSTL.001.WAD
Start Date and Time	2016/07/11 14:06:12

Site Details

Site Name	DUCK CR N L SQ TOP L
Operator(s)	BJE

System Information

Sensor Type	FlowTracker
Serial #	P2355
CPU Firmware Version	3.9
Software Ver	2.30
Mounting Correction	0.0%

Units (Metric Units)

Distance	m
Velocity	m/s
Area	m^2
Discharge	m^3/s

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.6%	4.2%
Velocity	1.3%	10.6%
Width	0.2%	0.2%
Method	3.1%	-
# Stations	5.1%	-
Overall	**6.2%**	**11.4%**

Summary

Averaging Int.	40	# Stations	10
Start Edge	REW	Total Width	0.884
Mean SNR	49.6 dB	Total Area	0.104
Mean Temp	15.12 °C	Mean Depth	0.118
Disch. Equation	Mid-Section	Mean Velocity	0.5542
		Total Discharge	**0.0577**

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	14:06	0.43	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	14:06	0.58	0.6	0.122	0.6	0.049	0.2204	1.00	0.2204	0.015	0.0033	5.7
2	14:07	0.67	0.6	0.155	0.6	0.062	0.2494	1.00	0.2494	0.014	0.0035	6.1
3	14:08	0.76	0.6	0.159	0.6	0.063	0.3320	1.00	0.3320	0.015	0.0048	8.3
4	14:09	0.85	0.6	0.165	0.6	0.066	0.6980	1.00	0.6980	0.015	0.0105	18.2
5	14:11	0.95	0.6	0.149	0.6	0.060	0.8676	1.00	0.8676	0.014	0.0119	20.6
6	14:12	1.04	0.6	0.152	0.6	0.061	1.0578	1.00	1.0578	0.014	0.0148	25.6
7	14:15	1.13	0.6	0.098	0.6	0.039	0.5081	1.00	0.5081	0.009	0.0045	7.9
8	14:16	1.22	0.6	0.098	0.6	0.039	0.4936	1.00	0.4936	0.009	0.0044	7.6
9	14:16	1.31	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

Discharge Measurement Summary

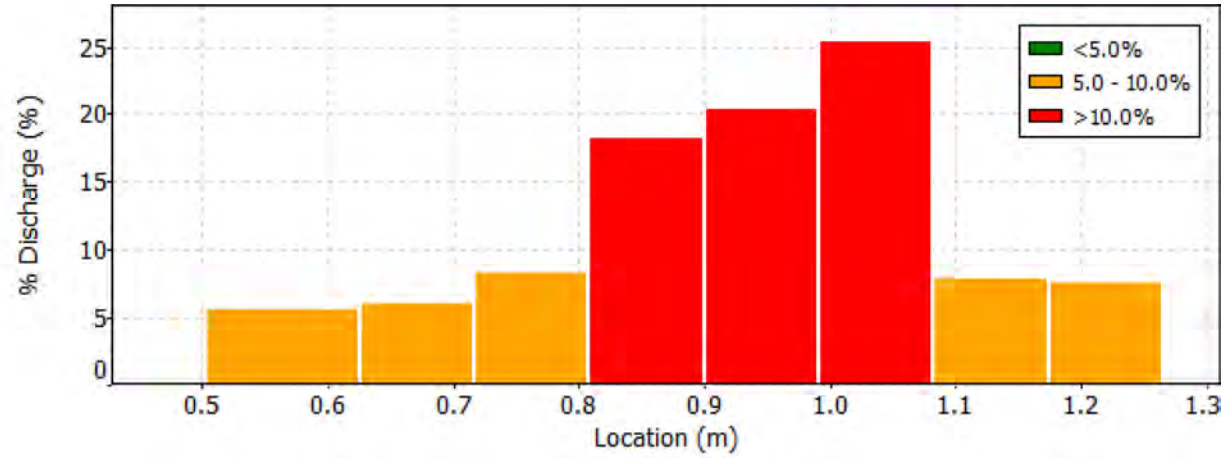
Date Generated: Tue Nov 14 2023

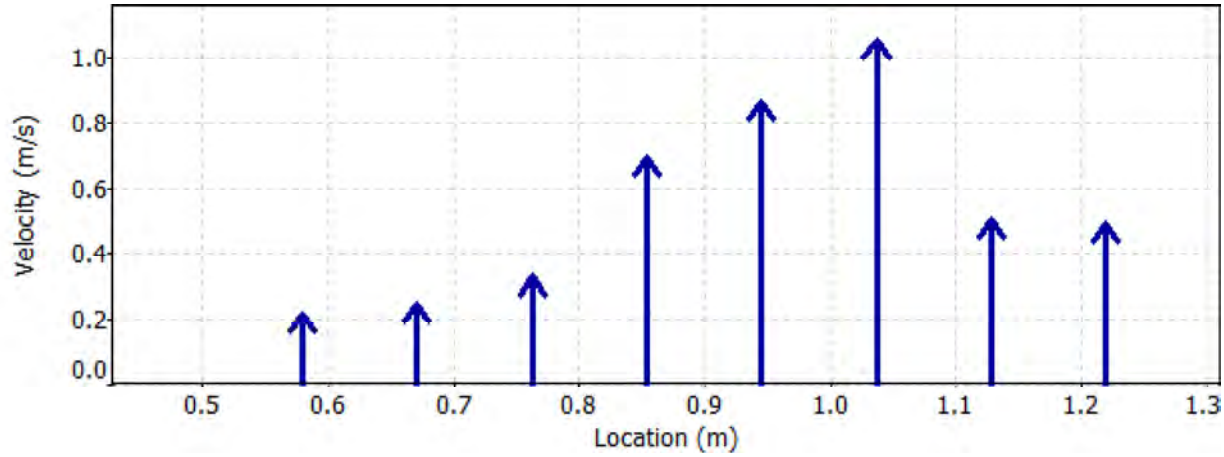
File Information

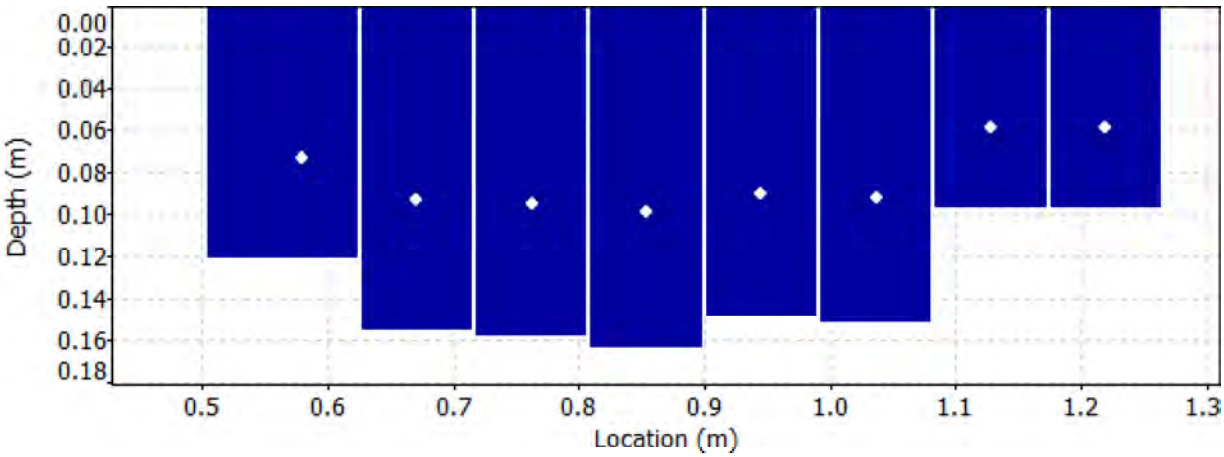
File Name	DCNRLSTL.001.WAD
Start Date and Time	2016/07/11 14:06:12

Site Details

Site Name	DUCK CR N L SQ TOP L
Operator(s)	BJE







Discharge Measurement Summary

Date Generated: Tue Nov 14 2023

File Information		Site Details	
File Name	DCNRLSTL.001.WAD	Site Name	DUCK CR N L SQ TOP L
Start Date and Time	2016/07/11 14:06:12	Operator(s)	BJE

Quality Control

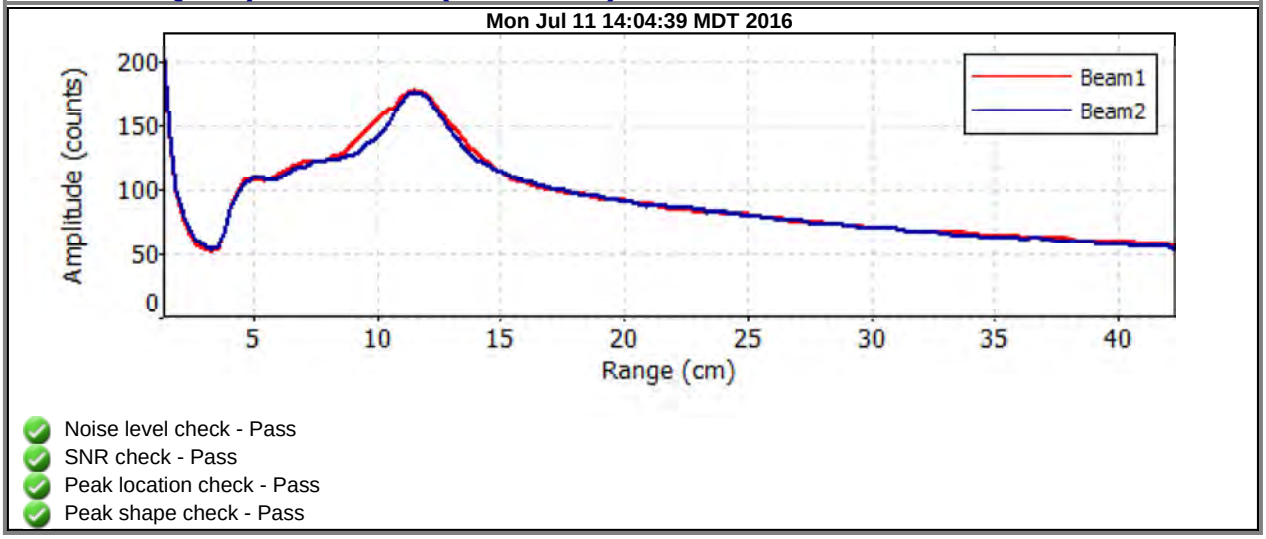
No Quality Control warnings

Discharge Measurement Summary

Date Generated: Tue Nov 14 2023

File Information		Site Details	
File Name	DCNRLSTL.001.WAD	Site Name	DUCK CR N L SQ TOP L
Start Date and Time	2016/07/11 14:06:12	Operator(s)	BJE

Automatic Quality Control Test (BeamCheck)



- Noise level check - Pass
- SNR check - Pass
- Peak location check - Pass
- Peak shape check - Pass

Discharge Measurement Summary

Site name	Squaretops
Site number	07123
Operator(s)	Kb
File name	Squaretops_20230712-182209.ft
Comment	

Start time	7/12/2023 5:56 PM
End time	7/12/2023 6:21 PM
Start location latitude	39.589
Start location longitude	-105.736
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)
19	40	2.722

Total width (ft)	Total area (ft²)	Wetted Perimeter (ft)
5.000	2.710	6.122

Mean SNR (dB)	Mean depth (ft)	Mean velocity (ft/s)
58.577	0.542	1.004

Mean temp (°F)	Max depth (ft)	Max velocity (ft/s)
56.846	0.800	2.304

Discharge Uncertainty		
Category	**ISO**	**IVE**
Accuracy	1.0%	1.0%
Depth	0.5%	6.1%
Velocity	1.4%	9.2%
Width	0.2%	0.2%
Method	2.6%	
# Stations	2.6%	
Overall	**4.1%**	**11.1%**

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 %

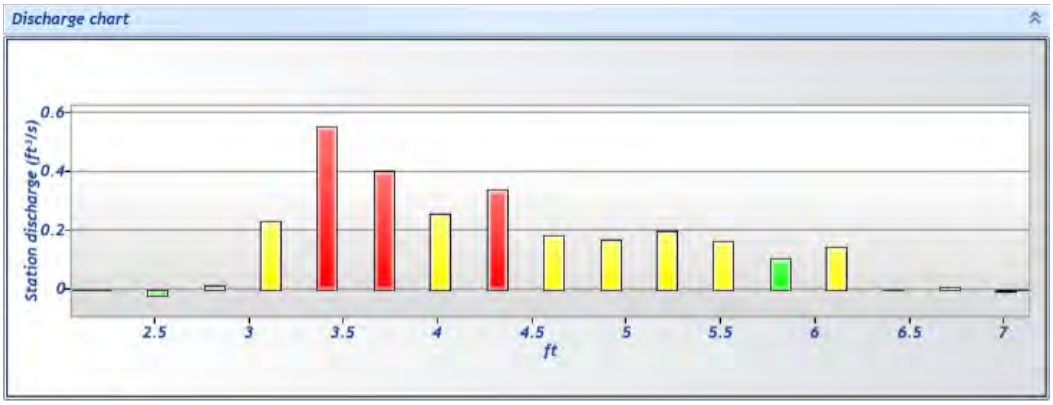
Summary overview

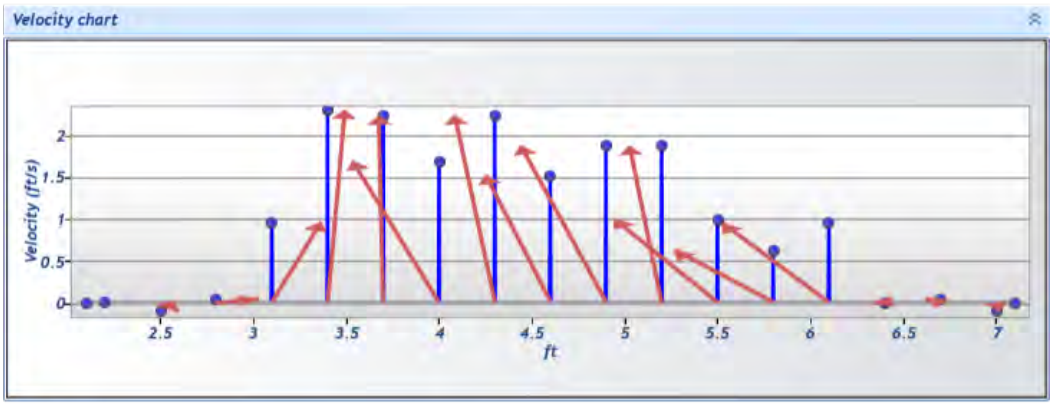
No changes were made to this file
Quality control warnings

Discharge Measurement Summary

Site name	Squaretops
Site number	07123
Operator(s)	Kb
File name	Squaretops_20230712-182209.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	Squaretops
Site number	07123
Operator(s)	Kb
File name	Squaretops_20230712-182209.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	5:56 PM	2.100	None	0.000	0.000	0.000	0	0.000		0.001	0.000	0.000	0.000	✓
1	5:56 PM	2.200	0.6	0.700	0.600	0.420	61	0.001	1.000	0.001	0.140	0.000	0.005	✓
2	6:00 PM	2.500	0.6	0.700	0.600	0.420	80	-0.097	1.000	-0.097	0.210	-0.020	-0.746	✓
3	6:03 PM	2.800	0.6	0.750	0.600	0.450	80	0.051	1.000	0.051	0.225	0.012	0.425	✓
4	6:04 PM	3.100	0.6	0.800	0.600	0.480	80	0.961	1.000	0.961	0.240	0.231	8.471	✓
5	6:05 PM	3.400	0.6	0.800	0.600	0.480	63	2.304	1.000	2.304	0.240	0.553	20.320	✓
6	6:06 PM	3.700	0.6	0.600	0.600	0.360	76	2.235	1.000	2.235	0.180	0.402	14.779	✓
7	6:08 PM	4.000	0.6	0.500	0.600	0.300	63	1.693	1.000	1.693	0.150	0.254	9.328	✓
8	6:09 PM	4.300	0.6	0.500	0.600	0.300	64	2.238	1.000	2.238	0.150	0.336	12.336	✓
9	6:10 PM	4.600	0.6	0.400	0.600	0.240	80	1.514	1.000	1.514	0.120	0.182	6.677	✓
10	6:11 PM	4.900	0.6	0.300	0.600	0.180	62	1.872	1.000	1.872	0.090	0.169	6.191	✓
11	6:12 PM	5.200	0.6	0.350	0.600	0.210	64	1.874	1.000	1.874	0.105	0.197	7.228	✓
12	6:13 PM	5.500	0.6	0.550	0.600	0.330	80	0.996	1.000	0.996	0.165	0.164	6.036	✓
13	6:15 PM	5.800	0.6	0.550	0.600	0.330	64	0.627	1.000	0.627	0.165	0.103	3.802	✓
14	6:16 PM	6.100	0.6	0.500	0.600	0.300	65	0.950	1.000	0.950	0.150	0.142	5.233	✓
15	6:17 PM	6.400	0.6	0.500	0.600	0.300	80	-0.006	1.000	-0.006	0.150	-0.001	-0.033	✓
16	6:19 PM	6.700	0.6	0.500	0.600	0.300	58	0.043	1.000	0.043	0.150	0.006	0.235	✓
17	6:20 PM	7.000	0.6	0.400	0.600	0.240	80	-0.097	1.000	-0.097	0.080	-0.008	-0.287	✓
18	6:21 PM	7.100	None	0.000	0.000	0.000	0	0.000		-0.097	0.000	0.000	0.000	✓

Discharge Measurement Summary

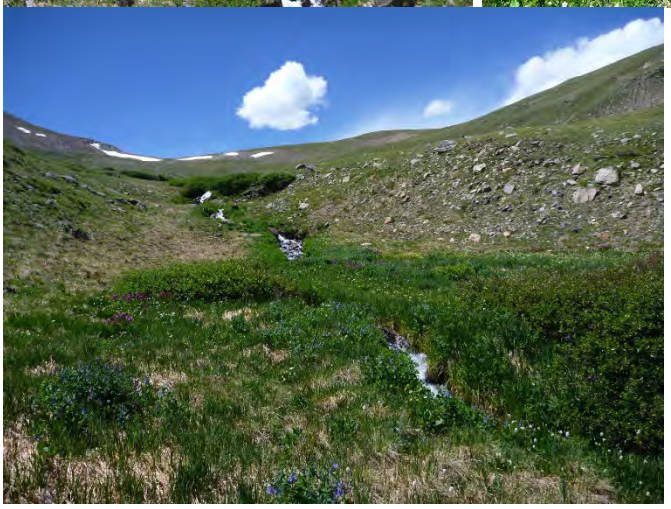
Site name	Squaretops
Site number	07123
Operator(s)	Kb
File name	Squaretops_20230712-182209.ft
Comment	

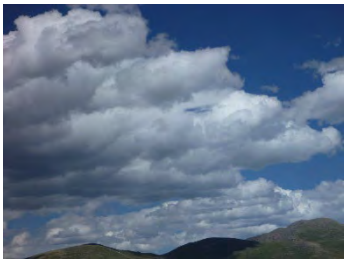
Quality Control Settings	
Maximum depth change	50.000%
Maximum spacing change	100.000%
SNR threshold	10.000 dB
Standard error threshold	0.033 ft/s
Spike threshold	10.000%
Maximum velocity angle	20.000 deg
Maximum tilt angle	5.000 deg

Quality control warnings

St#	Time	Location (ft)	Method	Depth (ft)	%Depth	Measured Depth (ft)	Warnings
1	5:56 PM	2.200	0.6	0.700	0.600	0.420	SNR Threshold Variation,Rod Angle > QC
2	6:00 PM	2.500	0.6	0.700	0.600	0.420	Velocity Angle > QC
4	6:04 PM	3.100	0.6	0.800	0.600	0.480	Standard Error > QC
5	6:05 PM	3.400	0.6	0.800	0.600	0.480	Standard Error > QC,High Stn % Discharge
6	6:06 PM	3.700	0.6	0.600	0.600	0.360	Standard Error > QC,High Stn % Discharge
7	6:08 PM	4.000	0.6	0.500	0.600	0.300	Standard Error > QC
8	6:09 PM	4.300	0.6	0.500	0.600	0.300	Standard Error > QC,High Stn % Discharge
9	6:10 PM	4.600	0.6	0.400	0.600	0.240	Standard Error > QC
10	6:11 PM	4.900	0.6	0.300	0.600	0.180	Standard Error > QC
11	6:12 PM	5.200	0.6	0.350	0.600	0.210	Standard Error > QC
12	6:13 PM	5.500	0.6	0.550	0.600	0.330	Standard Error > QC,Velocity Angle > QC
13	6:15 PM	5.800	0.6	0.550	0.600	0.330	Standard Error > QC,Velocity Angle > QC
14	6:16 PM	6.100	0.6	0.500	0.600	0.300	Standard Error > QC,Velocity Angle > QC
15	6:17 PM	6.400	0.6	0.500	0.600	0.300	Rod Angle > QC
16	6:19 PM	6.700	0.6	0.500	0.600	0.300	Standard Error > QC,Rod Angle > QC
17	6:20 PM	7.000	0.6	0.400	0.600	0.240	Velocity Angle > QC



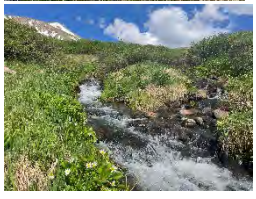















TRAIL CLOSED