COLORADO
Parks and Wildlife
Department of Natural Resources

Water Resources Section
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10 December 2015

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

SUBJ: Instream Flow Recommendations for Streams in Park County, Water Division 1: Unnamed Tributary of Crooked Creek for CWCB Consideration at the January, 2016 CWCB Meeting

Dear Linda:

The information contained in and referred to in this letter and the associated instream flow file folders that are ready for posting to the CWCB website, form the basis for the instream flow recommendations for an unnamed tributary to Crooked Creek in Park County, Colorado. It is Colorado Parks and Wildlife's (CPW) intent that this stream be considered for appropriation by the Colorado Water Conservation Board (CWCB or Board) at their January, 2016 regular meeting. The investigations related to this instream flow recommendation were initiated in 2015 by CPW staff with some assistance from CWCB staff. This Instream Flow (ISF) recommendation is the first of several recommendations that CPW will be bringing to the Board in the coming years; quantification work on a number of Park County streams was initiated in 2015 at the request of the Park County Advisory Board on the Environment (ABE) and the Park County Board of County Commissioners. It is the CPW staff's opinion that the information contained in this letter is sufficient for the Board's staff to initiate instream flow appropriations on the above referenced stream and to specifically address the findings required in Rule 5(i) of the ISF Rules.

The State of Colorado's Instream Flow Program was created in 1973 when the Colorado General Assembly passed Senate Bill 97 which called for the recognition of "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3) C.R.S.). This statute vests the Board with the exclusive authority to appropriate and acquire instream flow and natural lake level water rights. In order to encourage other entities to participate in Colorado's ISF Program, the statute directs the Board to request and consider instream flow recommendations from other local, state and federal agencies. This stream segment should be considered for inclusion into the ISF Program because it has a natural environment that can be preserved to a reasonable degree with an instream flow water right.

The CPW is forwarding this ISF recommendation to the Board to meet CPW's legislative declaration "... 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 ... 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 statutory directives, the current CPW strategic planning documents (*DOW Strategic Plan*, 2010 and *A Path Forward*, 2014) state that "[h]ealthy aquatic environments are essential to maintain healthy and viable fisheries, and critical for self-sustaining populations...by protecting and enhancing the quality and quantity of aquatic habitats." and that "Ensuring the long term viability of native fish and wildlife ... and sport fish populations." - these statements encapsulate CPW's primary objectives and provide a guide to the agency's linkage to the goals and objectives of the CWCB ISF Program.

Natural Environment

The Crooked Creek drainage has been stocked by the former Colorado Division of Wildlife and CPW with hatchery strain (non-conservation lineage) greenback cutthroat trout first in 1973 and then again in 1989; stocking has occurred on nearly an annual schedule since 1989. This periodic stocking and some level of natural reproduction have sustained the population over time. It is our belief that existing land management protections provided by the US Forest Service, habitat protection and stewardship, and eventual ISF protection, it is likely that this fishery will persist for the foreseeable future.

Flow Quantification

On 6 August 2015, CPW and CWCB personnel collected stream cross section information on this unnamed tributary of Crooked Creek at two locations within the subject reach for R2CROSS analysis. CPW processed the data, ran the R2CROSS model, performed typical quality control checks, reviewed the output, and developed ISF recommendations utilizing the standard methodology and criteria. The following table summarizes the R2CROSS analysis:

Date	Measured Flow	40% - 250%	Flow meeting two criteria	Flow meeting three criteria
8/6/2015	0.66 cfs	0.3 - 1.6 cfs	0.3 cfs	0.62 cfs
8/6/2015	0.91 cfs	0.4 - 2.3 cfs	1.1 cfs	Flow outside range of accuracy
		AVERAGE	**0.7 cfs**	**0.62 cfs**

It is relatively rare for a multiple cross section data set to yield summer flow recommendations that are less than the winter flow recommendation. To protect this natural environment, CPW recommends an ISF appropriation of 0.62 cfs for the entire hydrologic year (subject to water availability considerations). This flow recommendation is intended for the

reach of stream from the headwaters to the confluence with Crooked Creek (also subject to water availability analyses and existing water right administration).

As stated above, the purpose of this letter is to formally transmit ISF recommendations from CPW to CWCB for the Board's consideration for the 2016 appropriation year. The field data sheets, R2CROSS outputs, and fishery information have been provided to your staff previously. Please contact me if you have additional questions or concerns. CPW personnel will be present at the January, 2016 CWCB meeting to answer any questions that the Board might have regarding this flow recommendation. We appreciate your consideration.

Sincerely,

Jay W. Skinner
CPW Instream Flow Program Coordinator

COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	Crooked Creek Trib
XS LOCATION:	50 ft ab road xing
XS NUMBER:	1
DATE:	6-Aug-15
OBSERVERS:	js bl kr rv pc
1/4 SEC:	0
SECTION:	0
TWP:	0
RANGE:	0
PM:	0
COUNTY:	Park
WATERSHED:	0
DIVISION:	0
DOW CODE:	0
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

TAPE WT:	0.0106
TENSION:	99999

*** NOTE ***
Leave TAPE WT and TENSION at defaults for data collected with a survey level and rod

CHANNEL PROFILE DATA

SLOPE:	0.036

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: ….....……..…….....DATE.....

STREAM NAME: Crooked Creek Trib
XS LOCATION: 50 ft ab road xing
XS NUMBER: 1

DATA POINTS= 18

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
1 gl s	0.00	6.33			0.00		0.00	0.00	0.0%
	1.00	6.31			0.00		0.00	0.00	0.0%
	1.70	5.98			0.00		0.00	0.00	0.0%
	2.20	6.18			0.00		0.00	0.00	0.0%
	2.70	6.35			0.00		0.00	0.00	0.0%
wl	3.00	6.56	0.00	0.00	0.00		0.00	0.00	0.0%
	3.30	6.72	0.20	0.49	0.34	0.20	0.06	0.03	4.5%
	3.60	6.78	0.25	1.29	0.31	0.25	0.08	0.10	14.7%
	3.90	6.82	0.30	1.43	0.30	0.30	0.09	0.13	19.5%
	4.20	6.85	0.30	1.69	0.30	0.30	0.09	0.15	23.1%
	4.50	6.83	0.25	1.44	0.30	0.25	0.08	0.11	16.4%
	4.80	6.82	0.20	1.70	0.30	0.20	0.06	0.10	15.5%
	5.10	6.82	0.15	0.92	0.30	0.15	0.05	0.04	6.3%
wl	5.40	6.61	0.00	0.00	0.37		0.00	0.00	0.0%
	5.50	6.28			0.00		0.00	0.00	0.0%
	6.00	6.33			0.00		0.00	0.00	0.0%
	6.80	6.28			0.00		0.00	0.00	0.0%
1 s gl	7.80	6.22			0.00		0.00	0.00	0.0%
TOTALS ----------					2.52	0.3 (Max.)	0.50	0.66	100.0%

Manning's n = 0.0717
Hydraulic Radius= 0.1966532

STREAM NAME: Crooked Creek Trib
XS LOCATION: 50 ft ab road xing
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	0.50	0.46	-6.2%
6.34	0.50	1.11	124.5%
6.36	0.50	1.06	113.2%
6.38	0.50	1.00	102.1%
6.40	0.50	0.95	91.1%
6.42	0.50	0.89	80.3%
6.44	0.50	0.84	69.6%
6.46	0.50	0.79	59.0%
6.48	0.50	0.74	48.6%
6.50	0.50	0.68	38.3%
6.52	0.50	0.63	28.1%
6.54	0.50	0.58	18.1%
6.55	0.50	0.56	13.2%
6.56	0.50	0.54	8.3%
6.57	0.50	0.51	3.4%
6.58	0.50	0.49	-1.4%
6.59	0.50	0.46	-6.2%
6.60	0.50	0.44	-11.0%
6.61	0.50	0.42	-15.7%
6.62	0.50	0.39	-20.3%
6.63	0.50	0.37	-24.9%
6.64	0.50	0.35	-29.5%
6.66	0.50	0.31	-38.3%
6.68	0.50	0.26	-46.9%
6.70	0.50	0.22	-55.2%
6.72	0.50	0.18	-63.3%
6.74	0.50	0.14	-71.0%
6.76	0.50	0.11	-78.2%
6.78	0.50	0.08	-84.8%
6.80	0.50	0.04	-91.0%
6.82	0.50	0.02	-96.3%
6.84	0.50	0.00	-99.4%

WATERLINE AT ZERO
AREA ERROR = 6.572

STREAM NAME: Crooked Creek Trib
XS LOCATION: 50 ft ab road xing
XS NUMBER: 1

Constant Manning's n

STAGING TABLE

GL = lowest Grassline elevation corrected for sag
WL = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	6.33	2.84	0.40	0.52	1.13	3.24	100.0%	0.35	2.19	1.94
	6.37	2.74	0.37	0.48	1.01	3.09	95.5%	0.33	1.88	1.86
	6.42	2.65	0.33	0.43	0.87	2.95	91.2%	0.30	1.53	1.75
	6.47	2.57	0.29	0.38	0.74	2.81	86.9%	0.26	1.20	1.62
	6.52	2.48	0.25	0.33	0.62	2.68	82.6%	0.23	0.91	1.48
WL	6.57	2.39	0.21	0.28	0.49	2.53	78.2%	0.20	0.66	1.33
	6.62	2.27	0.17	0.23	0.38	2.36	73.0%	0.16	0.44	1.16
	6.67	2.10	0.13	0.18	0.27	2.17	67.0%	0.12	0.26	0.98
	6.72	1.93	0.09	0.13	0.17	1.97	60.9%	0.09	0.13	0.76
	6.77	1.61	0.05	0.08	0.08	1.63	50.3%	0.05	0.04	0.53
	6.82	0.82	0.01	0.03	0.01	0.82	25.4%	0.01	0.00	0.21

STREAM NAME: Crooked Creek Trib
XS LOCATION: 50 ft ab road xing
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	0.66	cfs
CALCULATED FLOW (Qc)=	0.66	cfs
(Qm-Qc)/Qm * 100 =	0.4	%
MEASURED WATERLINE (WLm)=	6.59	ft
CALCULATED WATERLINE (WLc)=	6.57	ft
(WLm-WLc)/WLm * 100 =	0.2	%
MAX MEASURED DEPTH (Dm)=	0.30	ft
MAX CALCULATED DEPTH (Dc)=	0.28	ft
(Dm-Dc)/Dm * 100	7.3	%
MEAN VELOCITY=	1.33	ft/sec
MANNING'S N=	0.072	
SLOPE=	0.036	ft/ft
.4 * Qm =	0.3	cfs
2.5 * Qm=	1.6	cfs

RECOMMENDED INSTREAM FLOW:
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FLOW (CFS)	PERIOD
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____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

RATIONALE FOR RECOMMENDATION:
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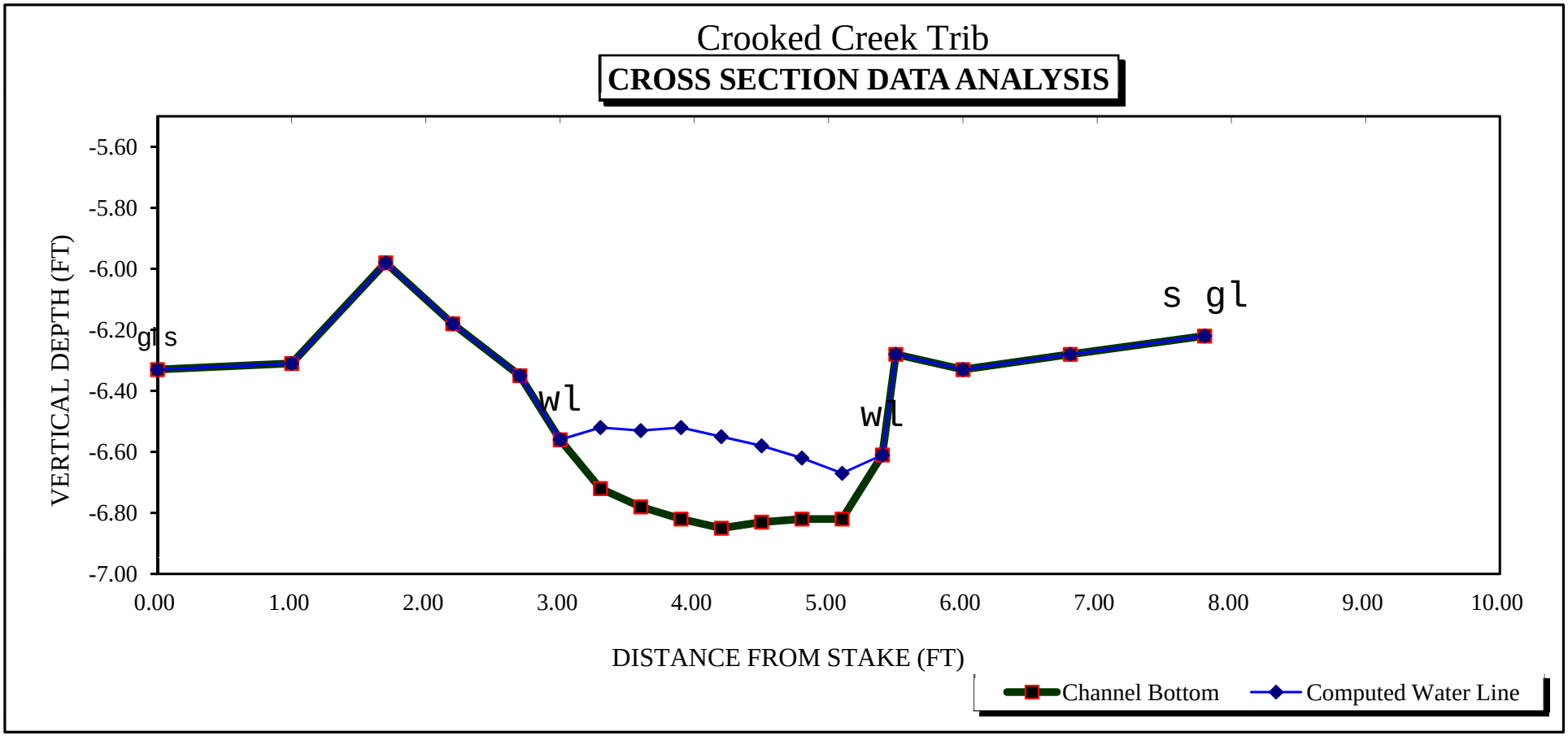
RECOMMENDATION BY: ……………………………………………………… AGENCY……………………………………………… DATE:……………………………

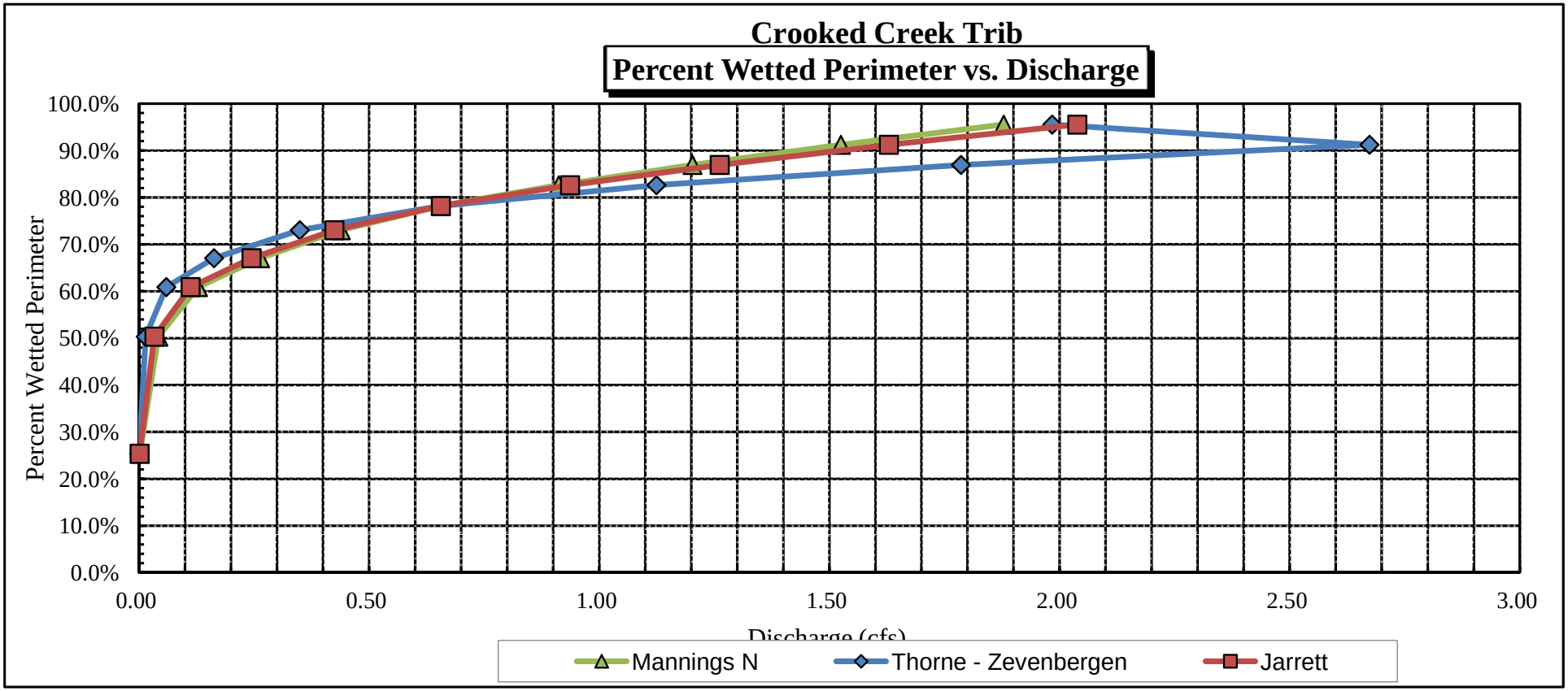
CWCB REVIEW BY: …… DATE:……………………………

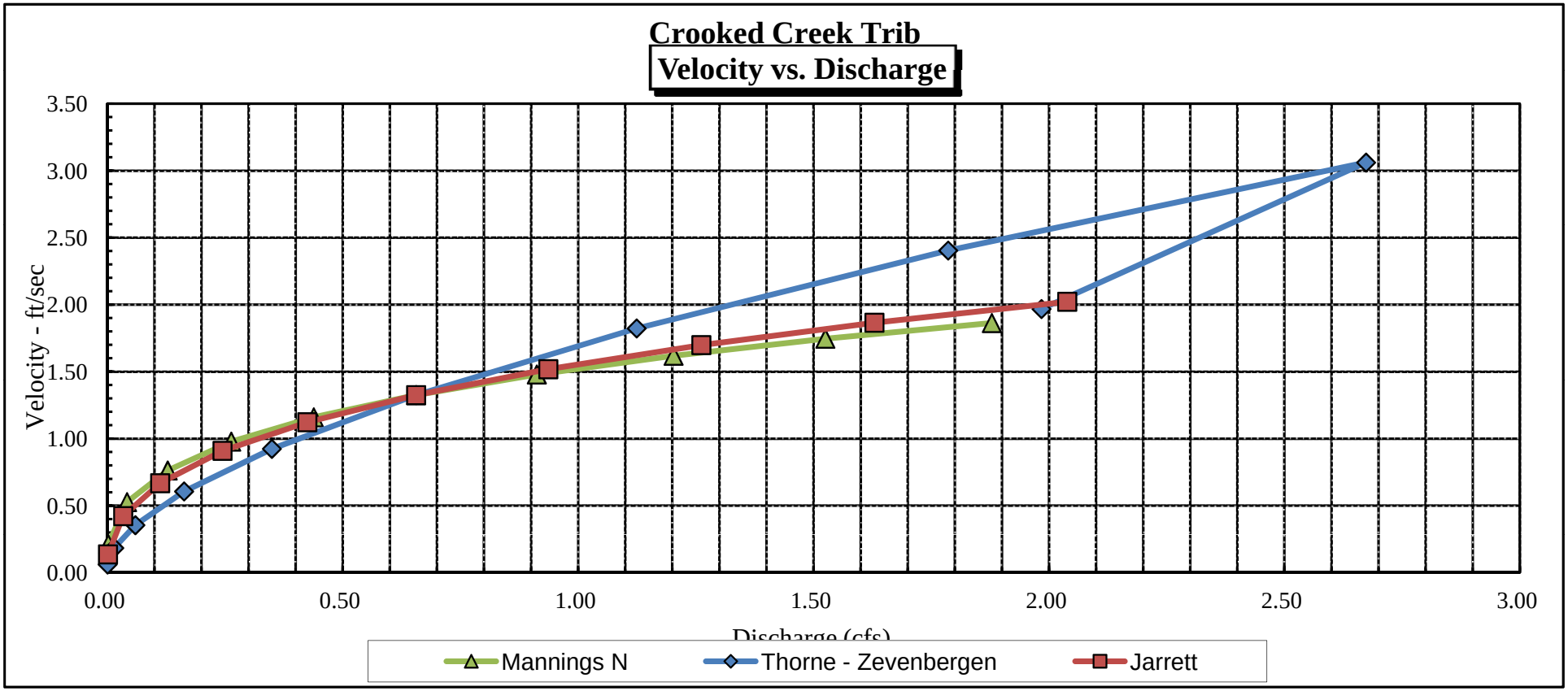
STREAM NAME: Crooked Creek Trib
XS LOCATION: 50 ft ab road xing
XS NUMBER: 1 Jarrett Variable Manning's n Correction Applied

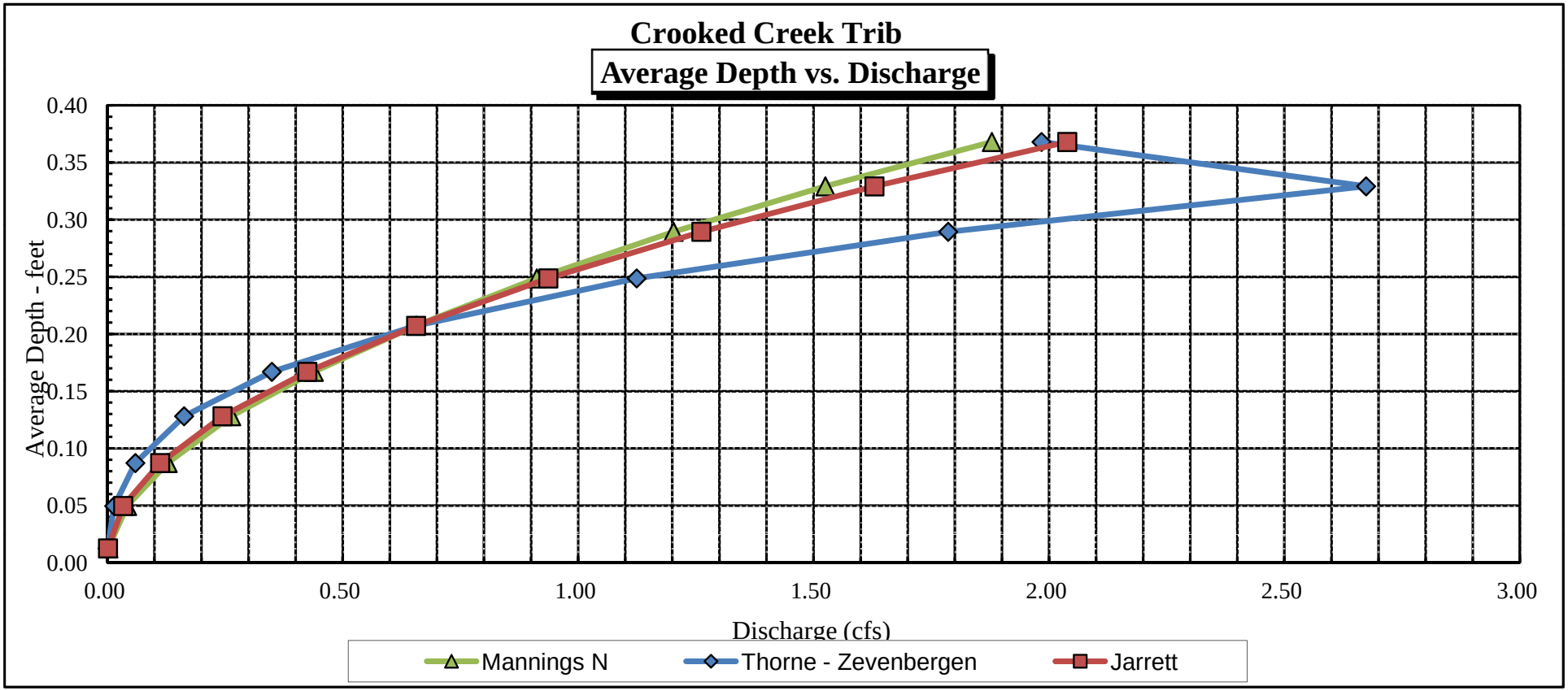
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

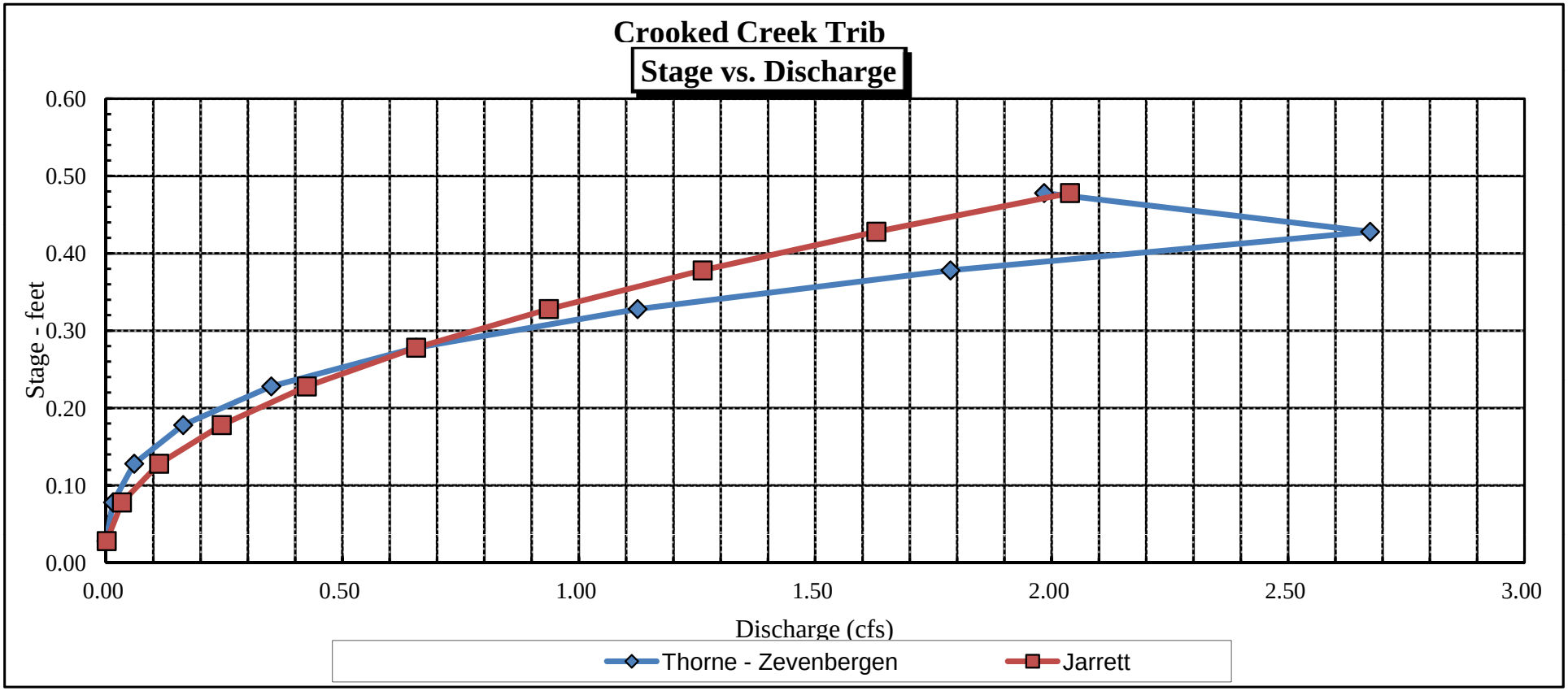
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	6.33	2.84	0.40	0.52	1.13	3.24	100.0%	0.35	2.40	2.13
	6.37	2.74	0.37	0.48	1.01	3.09	95.5%	0.33	2.04	2.02
	6.42	2.65	0.33	0.43	0.87	2.95	91.2%	0.30	1.63	1.87
	6.47	2.57	0.29	0.38	0.74	2.81	86.9%	0.26	1.26	1.70
	6.52	2.48	0.25	0.33	0.62	2.68	82.6%	0.23	0.94	1.52
WL	6.57	2.39	0.21	0.28	0.49	2.53	78.2%	0.20	0.66	1.33
	6.62	2.27	0.17	0.23	0.38	2.36	73.0%	0.16	0.42	1.12
	6.67	2.10	0.13	0.18	0.27	2.17	67.0%	0.12	0.24	0.91
	6.72	1.93	0.09	0.13	0.17	1.97	60.9%	0.09	0.11	0.67
	6.77	1.61	0.05	0.08	0.08	1.63	50.3%	0.05	0.03	0.42
	6.82	0.82	0.01	0.03	0.01	0.82	25.4%	0.01	0.00	0.14


Crooked Creek Trib
CROSS SECTION DATA ANALYSIS
VERTICAL DEPTH (FT)
-5.60
-5.80
-6.00
-6.20
-6.40
-6.60
-6.80
-7.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
DISTANCE FROM STAKE (FT)
gl s
wl
wl
s gl
Channel Bottom
Computed Water Line


Crooked Creek Trib
Percent Wetted Perimeter vs. Discharge
Percent Wetted Perimeter
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Crooked Creek Trib
Velocity vs. Discharge
Velocity - ft/sec
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Crooked Creek Trib
Average Depth vs. Discharge
Average Depth - feet
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Crooked Creek Trib
Stage vs. Discharge
Stage - feet
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD
INSTREAM FLOW / NATURAL LAKE LEVEL PROGRAM
STREAM CROSS-SECTION AND FLOW ANALYSIS

LOCATION INFORMATION

STREAM NAME:	Crooked Creek trib
XS LOCATION:	n39 17 52.45 w105 58 25.15
XS NUMBER:	2
DATE:	6-Aug-15
OBSERVERS:	js kr pc bl rv
1/4 SEC:	0
SECTION:	0
TWP:	0
RANGE:	0
PM:	0
COUNTY:	Park
WATERSHED:	0
DIVISION:	0
DOW CODE:	0
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

		*** NOTE ***
		Leave TAPE WT and TENSION
		at defaults for data collected
TAPE WT:	0.0106	with a survey level and rod
TENSION:	99999	

CHANNEL PROFILE DATA

SLOPE:	0.038

INPUT DATA CHECKED BY: .....DATE.....

ASSIGNED TO: ….....……..…….....DATE.....

STREAM NAME: Crooked Creek trib
XS LOCATION: n39 17 52.45 w105 58 25.15
XS NUMBER: 2

DATA POINTS= 21

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
1 s gl	0.00	5.64			0.00		0.00	0.00	0.0%
	0.80	6.04			0.00		0.00	0.00	0.0%
	1.40	6.62			0.00		0.00	0.00	0.0%
wl	2.00	7.11	0.00	0.00	0.00		0.00	0.00	0.0%
	2.60	7.44	0.15	0.06	0.68	0.15	0.07	0.00	0.4%
	2.90	7.55	0.15	0.37	0.32	0.15	0.05	0.02	1.8%
	3.20	7.61	0.20	0.77	0.31	0.20	0.06	0.05	5.1%
	3.50	7.60	0.20	1.46	0.30	0.20	0.06	0.09	9.7%
	3.80	7.65	0.20	1.60	0.30	0.20	0.06	0.10	10.6%
	4.10	7.70	0.15	1.81	0.30	0.15	0.05	0.08	9.0%
	4.40	7.71	0.15	2.02	0.30	0.15	0.05	0.09	10.0%
	4.70	7.70	0.30	2.41	0.30	0.30	0.09	0.22	23.9%
	5.00	7.71	0.25	2.17	0.30	0.25	0.08	0.16	18.0%
	5.30	7.63	0.15	1.97	0.31	0.15	0.05	0.10	11.4%
wl	5.70	7.45	0.00	0.00	0.44		0.00	0.00	0.0%
	6.00	7.31			0.00		0.00	0.00	0.0%
	6.60	7.21			0.00		0.00	0.00	0.0%
	7.40	7.10			0.00		0.00	0.00	0.0%
	7.70	6.90			0.00		0.00	0.00	0.0%
	8.30	6.48			0.00		0.00	0.00	0.0%
1 s gl	8.90	6.04			0.00		0.00	0.00	0.0%
TOTALS ----------					3.87	0.3 (Max.)	0.60	0.91	100.0%

Manning's n = 0.0554
Hydraulic Radius= 0.15510708

STREAM NAME: Crooked Creek trib
XS LOCATION: n39 17 52.45 w105 58 25.15
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	0.60	1.13	88.9%
7.03	0.60	2.35	291.7%
7.05	0.60	2.24	273.1%
7.07	0.60	2.13	254.7%
7.09	0.60	2.02	236.5%
7.11	0.60	1.91	218.5%
7.13	0.60	1.81	201.0%
7.15	0.60	1.71	184.2%
7.17	0.60	1.61	167.9%
7.19	0.60	1.51	152.3%
7.21	0.60	1.42	137.3%
7.23	0.60	1.34	122.8%
7.24	0.60	1.29	115.8%
7.25	0.60	1.25	108.9%
7.26	0.60	1.21	102.1%
7.27	0.60	1.17	95.4%
7.28	0.60	1.13	88.9%
7.29	0.60	1.10	82.5%
7.30	0.60	1.06	76.3%
7.31	0.60	1.02	70.1%
7.32	0.60	0.98	64.1%
7.33	0.60	0.95	58.2%
7.35	0.60	0.88	46.4%
7.37	0.60	0.81	35.0%
7.39	0.60	0.74	23.8%
7.41	0.60	0.68	12.8%
7.43	0.60	0.61	2.2%
7.45	0.60	0.55	-8.2%
7.47	0.60	0.49	-18.3%
7.49	0.60	0.43	-28.1%
7.51	0.60	0.38	-37.5%
7.53	0.60	0.32	-46.6%

WATERLINE AT ZERO
AREA ERROR = 7.434

STREAM NAME: Crooked Creek trib
XS LOCATION: n39 17 52.45 w105 58 25.15
XS NUMBER: 2

Constant Manning's n

GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	6.04	8.10	1.13	1.67	9.17	9.06	100.0%	1.01	48.32	5.27
	6.43	7.15	0.86	1.28	6.16	7.83	86.4%	0.79	27.47	4.46
	6.48	7.03	0.83	1.23	5.81	7.67	84.7%	0.76	25.22	4.34
	6.53	6.91	0.79	1.18	5.46	7.51	82.9%	0.73	23.07	4.23
	6.58	6.79	0.75	1.13	5.12	7.35	81.1%	0.70	21.01	4.11
	6.63	6.66	0.72	1.08	4.78	7.19	79.4%	0.66	19.03	3.98
	6.68	6.53	0.68	1.03	4.45	7.03	77.5%	0.63	17.16	3.86
	6.73	6.40	0.64	0.98	4.13	6.86	75.7%	0.60	15.38	3.73
	6.78	6.26	0.61	0.93	3.81	6.69	73.9%	0.57	13.68	3.59
	6.83	6.13	0.57	0.88	3.50	6.53	72.0%	0.54	12.08	3.45
	6.88	6.00	0.53	0.83	3.20	6.36	70.2%	0.50	10.57	3.31
	6.93	5.86	0.49	0.78	2.90	6.19	68.3%	0.47	9.15	3.15
	6.98	5.73	0.46	0.73	2.61	6.02	66.5%	0.43	7.82	2.99
	7.03	5.59	0.42	0.68	2.33	5.85	64.6%	0.40	6.58	2.83
	7.08	5.46	0.38	0.63	2.05	5.68	62.7%	0.36	5.43	2.65
	7.13	5.11	0.35	0.58	1.78	5.31	58.6%	0.34	4.51	2.53
	7.18	4.65	0.33	0.53	1.54	4.84	53.5%	0.32	3.76	2.44
	7.23	4.23	0.31	0.48	1.32	4.40	48.6%	0.30	3.09	2.34
	7.28	3.84	0.29	0.43	1.12	4.00	44.1%	0.28	2.50	2.24
	7.33	3.54	0.26	0.38	0.93	3.68	40.6%	0.25	1.96	2.10
	7.38	3.34	0.23	0.33	0.76	3.46	38.1%	0.22	1.45	1.91
WL	7.43	3.14	0.19	0.28	0.60	3.23	35.7%	0.19	1.02	1.70
	7.48	2.90	0.15	0.23	0.45	2.97	32.8%	0.15	0.66	1.48
	7.53	2.66	0.12	0.18	0.31	2.70	29.9%	0.11	0.38	1.23
	7.58	2.33	0.08	0.13	0.18	2.36	26.1%	0.08	0.18	0.95
	7.63	1.58	0.06	0.08	0.09	1.60	17.6%	0.05	0.07	0.76
	7.68	1.09	0.02	0.03	0.02	1.10	12.1%	0.02	0.01	0.37

STREAM NAME: Crooked Creek trib
XS LOCATION: n39 17 52.45 w105 58 25.15
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	0.91	cfs
CALCULATED FLOW (Qc)=	1.02	cfs
(Qm-Qc)/Qm * 100 =	-12.7	%
MEASURED WATERLINE (WLm)=	7.28	ft
CALCULATED WATERLINE (WLc)=	7.43	ft
(WLm-WLc)/WLm * 100 =	-2.1	%
MAX MEASURED DEPTH (Dm)=	0.30	ft
MAX CALCULATED DEPTH (Dc)=	0.28	ft
(Dm-Dc)/Dm * 100	8.1	%
MEAN VELOCITY=	1.70	ft/sec
MANNING'S N=	0.055	
SLOPE=	0.038	ft/ft
.4 * Qm =	0.4	cfs
2.5 * Qm=	2.3	cfs

RECOMMENDED INSTREAM FLOW:
=============================

FLOW (CFS)	PERIOD
===========	========
____________________	___________________
____________________	___________________
____________________	___________________
____________________	___________________

RATIONALE FOR RECOMMENDATION:
=============================

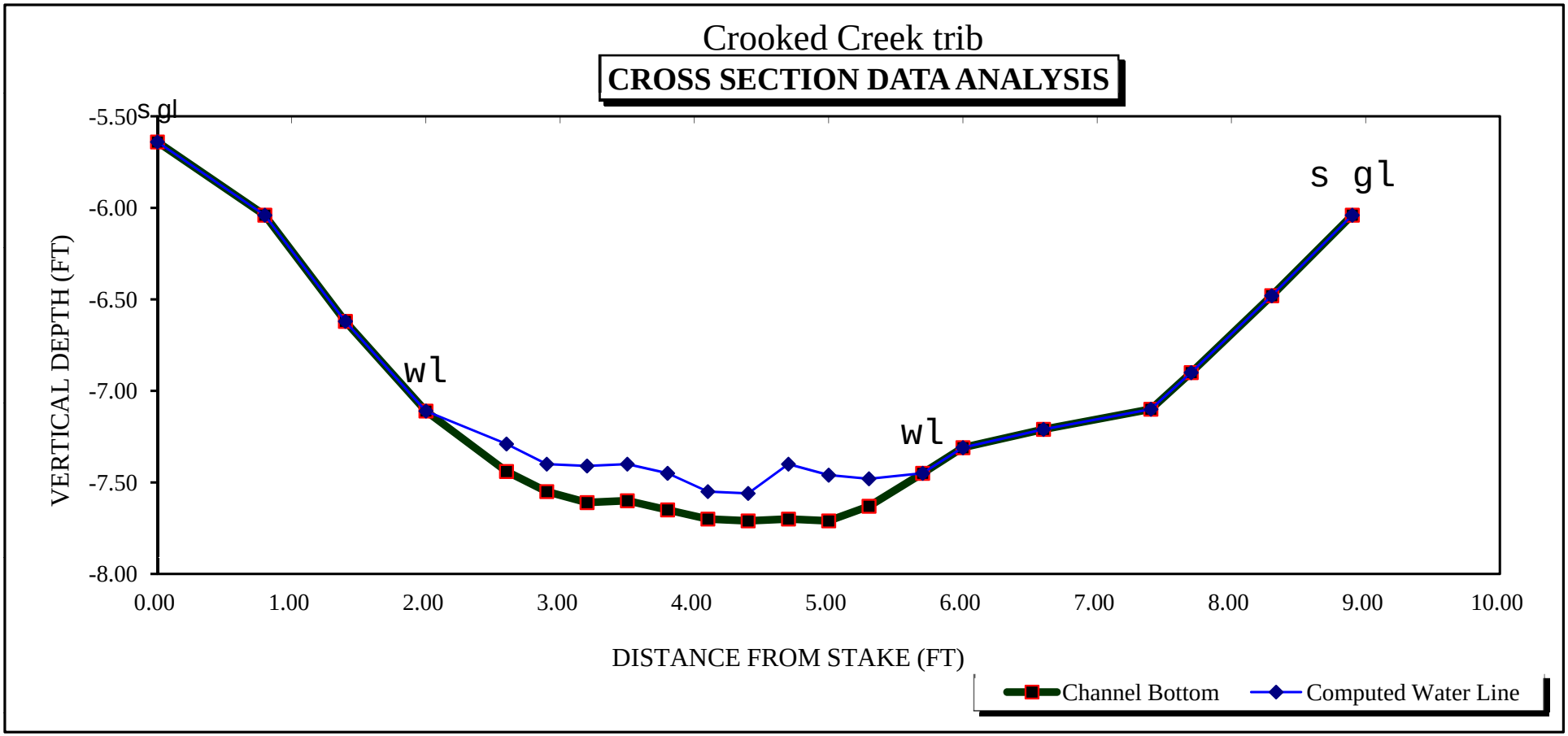
RECOMMENDATION BY: ………………...………..……............................... AGENCY...……………………......…....…...…….…..... DATE:.......….....…......……………

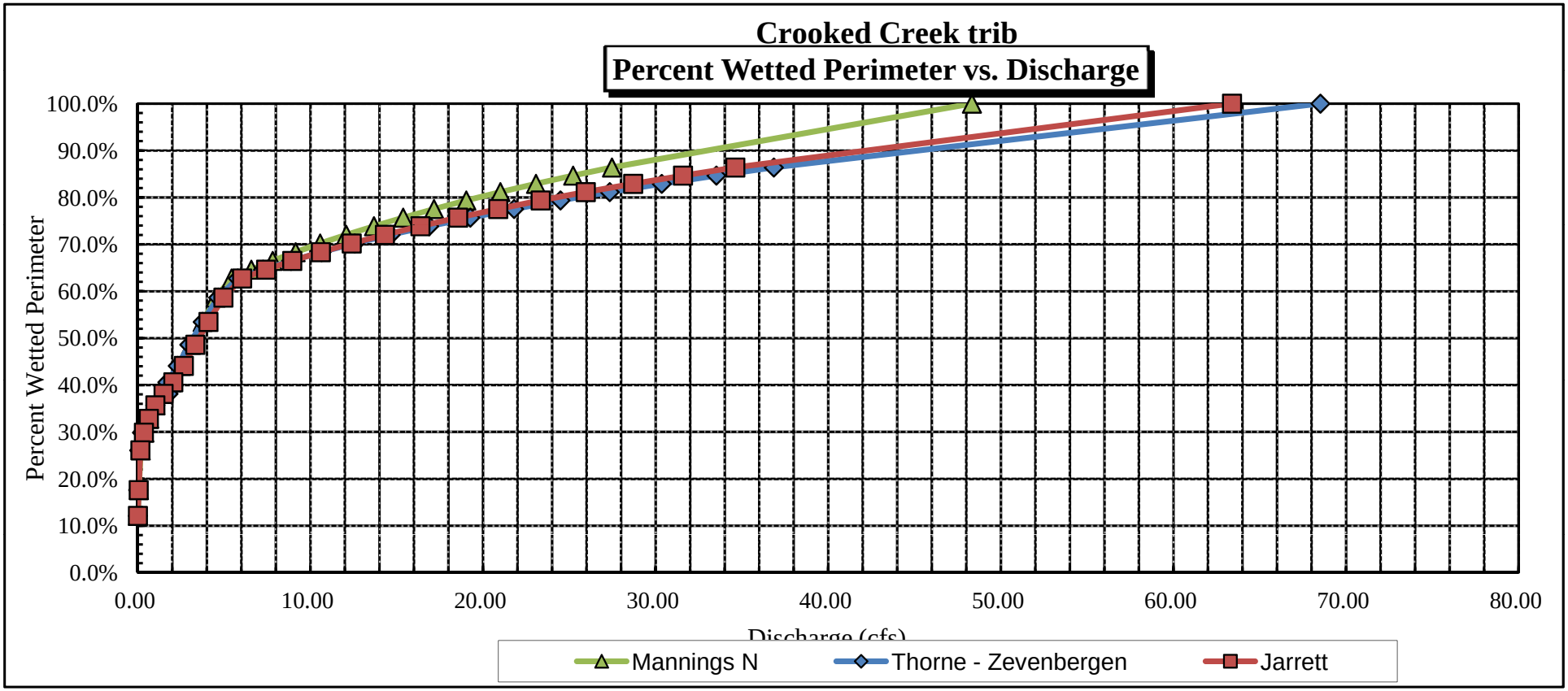
CWCB REVIEW BY: ..…………………………....………………………………………………...…............. DATE:..................…………….....

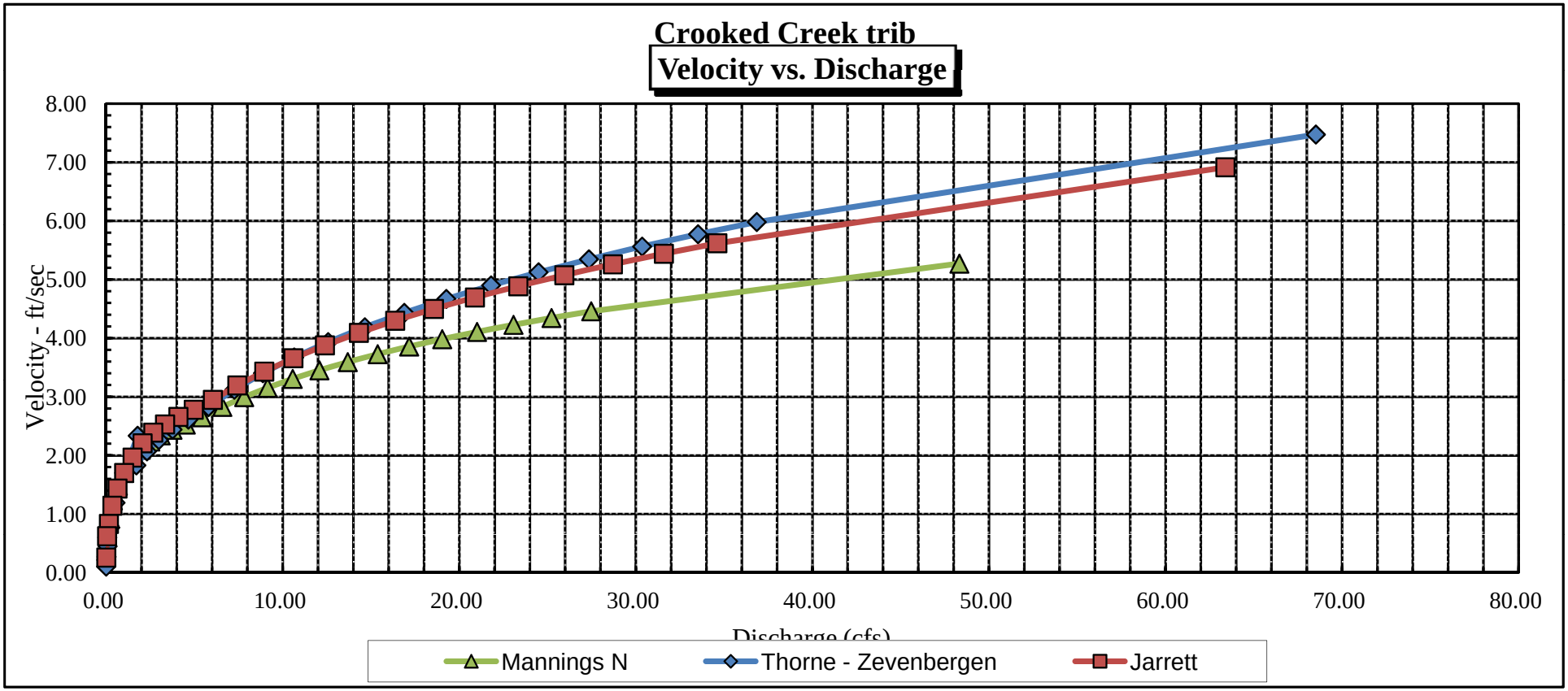
STREAM NAME: Crooked Creek trib
XS LOCATION: n39 17 52.45 w105 58 25.15
XS NUMBER: 2 Jarrett Variable Manning's n Correction Applied

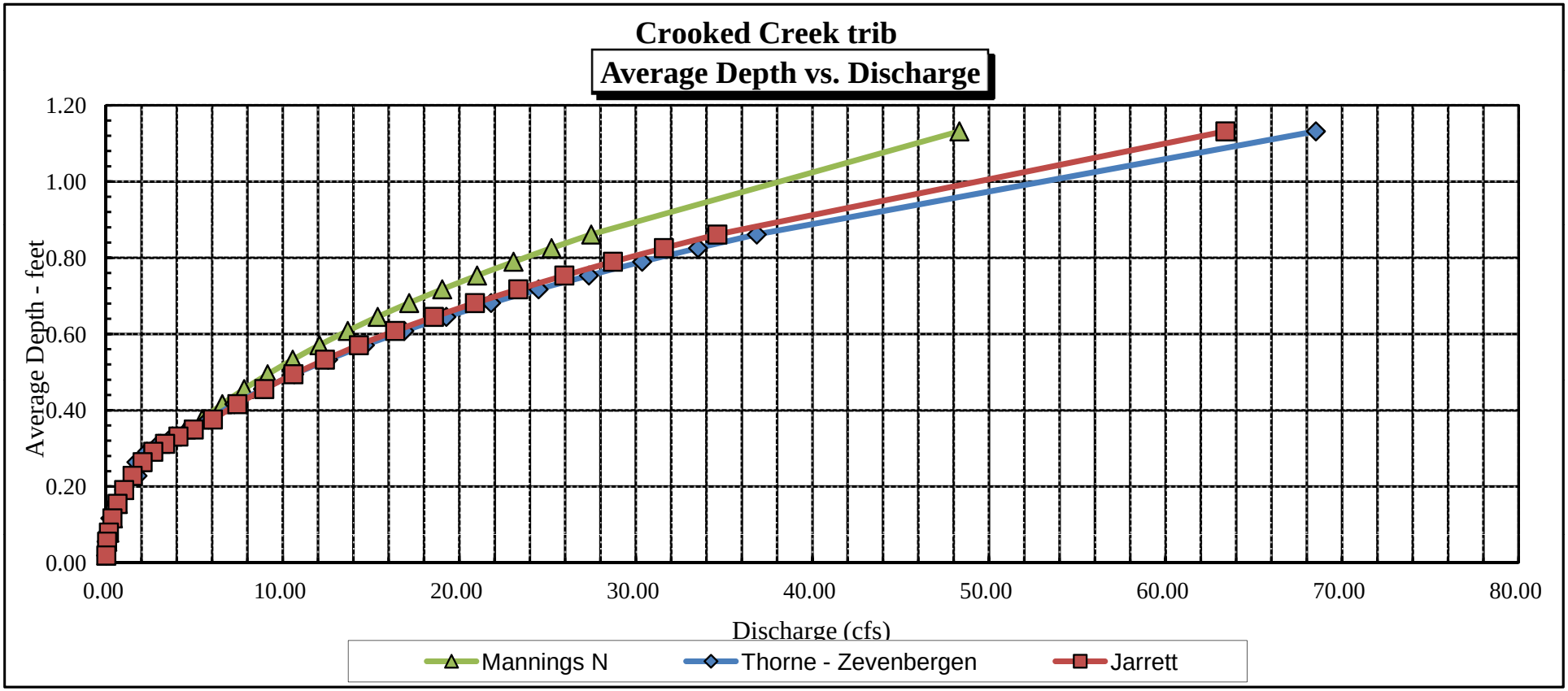
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

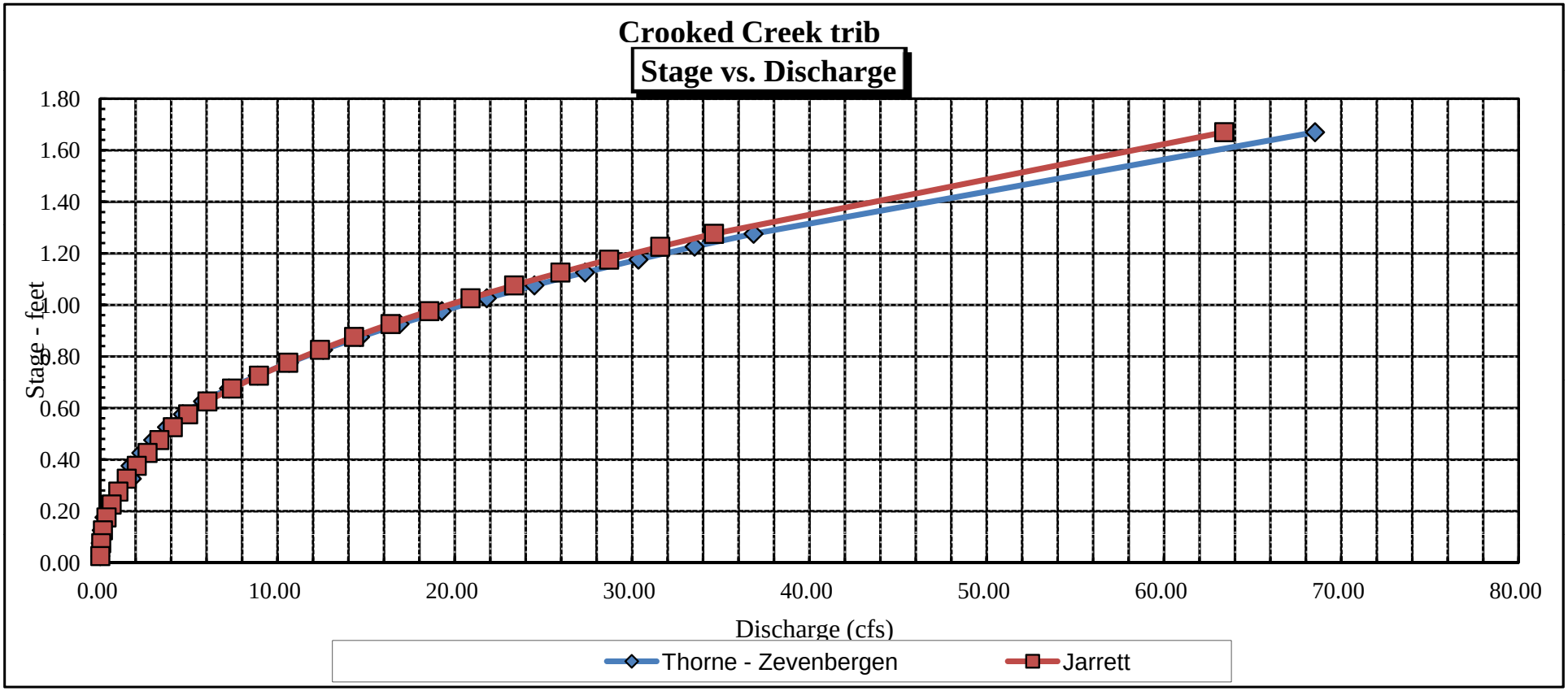
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	6.04	8.10	1.13	1.67	9.17	9.06	100.0%	1.01	63.39	6.91
	6.43	7.15	0.86	1.28	6.16	7.83	86.4%	0.79	34.62	5.62
	6.48	7.03	0.83	1.23	5.81	7.67	84.7%	0.76	31.59	5.44
	6.53	6.91	0.79	1.18	5.46	7.51	82.9%	0.73	28.70	5.26
	6.58	6.79	0.75	1.13	5.12	7.35	81.1%	0.70	25.95	5.07
	6.63	6.66	0.72	1.08	4.78	7.19	79.4%	0.66	23.34	4.88
	6.68	6.53	0.68	1.03	4.45	7.03	77.5%	0.63	20.89	4.69
	6.73	6.40	0.64	0.98	4.13	6.86	75.7%	0.60	18.56	4.50
	6.78	6.26	0.61	0.93	3.81	6.69	73.9%	0.57	16.37	4.30
	6.83	6.13	0.57	0.88	3.50	6.53	72.0%	0.54	14.32	4.09
	6.88	6.00	0.53	0.83	3.20	6.36	70.2%	0.50	12.39	3.88
	6.93	5.86	0.49	0.78	2.90	6.19	68.3%	0.47	10.61	3.66
	6.98	5.73	0.46	0.73	2.61	6.02	66.5%	0.43	8.95	3.43
	7.03	5.59	0.42	0.68	2.33	5.85	64.6%	0.40	7.43	3.19
	7.08	5.46	0.38	0.63	2.05	5.68	62.7%	0.36	6.04	2.95
	7.13	5.11	0.35	0.58	1.78	5.31	58.6%	0.34	4.96	2.78
	7.18	4.65	0.33	0.53	1.54	4.84	53.5%	0.32	4.09	2.66
	7.23	4.23	0.31	0.48	1.32	4.40	48.6%	0.30	3.34	2.53
	7.28	3.84	0.29	0.43	1.12	4.00	44.1%	0.28	2.67	2.39
	7.33	3.54	0.26	0.38	0.93	3.68	40.6%	0.25	2.06	2.21
	7.38	3.34	0.23	0.33	0.76	3.46	38.1%	0.22	1.50	1.96
WL	7.43	3.14	0.19	0.28	0.60	3.23	35.7%	0.19	1.02	1.70
	7.48	2.90	0.15	0.23	0.45	2.97	32.8%	0.15	0.64	1.43
	7.53	2.66	0.12	0.18	0.31	2.70	29.9%	0.11	0.35	1.14
	7.58	2.33	0.08	0.13	0.18	2.36	26.1%	0.08	0.15	0.83
	7.63	1.58	0.06	0.08	0.09	1.60	17.6%	0.05	0.05	0.62
	7.68	1.09	0.02	0.03	0.02	1.10	12.1%	0.02	0.01	0.26


Crooked Creek trib
CROSS SECTION DATA ANALYSIS
s gl
s gl
wl
wl
-5.50
-6.00
-6.50
-7.00
-7.50
-8.00
VERTICAL DEPTH (FT)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


Crooked Creek trib
Percent Wetted Perimeter vs. Discharge
Percent Wetted Perimeter
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Crooked Creek trib
Velocity vs. Discharge
Velocity - ft/sec
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Crooked Creek trib
Average Depth vs. Discharge
Average Depth - feet
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Crooked Creek trib
Stage vs. Discharge
Stage - feet
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO WATER CONSERVATION BOARD

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Tributary to Crooked Creek					CROSS-SECTION NO.: #1
CROSS-SECTION LOCATION: 50' U/S of Road					
N: 39 17 47.50 : 105 58 79.57					
DATE: 8/6/15	OBSERVERS: Jay Skinner, Brandy Logan, Kate Ryon, Rob Vicht, Pete Conovitz				
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:
COUNTY: Park	WATERSHED:		WATER DIVISION: 1	DOW WATER CODE:	
MAP(S):	USGS:				
	USFS:				

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE:			
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	(LSP) 6.56 / 6.61
(2) WS Upstream	4.5	6.53
(3) WS Downstream	4	6.84
SLOPE	.31 / 8.5 = 0.036	

SKETCH: TAPE

LEGEND: Stake ⊗ Station (1) Photo ◇→ 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

2 PM 69° overcast

DISCHARGE/CROSS SECTION NOTES

STREAM NAME:	CROSS-SECTION NO.: 1	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) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
(RB) GS	0		6.33								
	1.0		6.31								
	1.7		5.98								
	2.2		6.18								
W	2.7		6.35								
WL	3.0		6.56								
	3.3		6.72	.2				0.49			
	3.6		6.78	.25				1.29			
	3.9		6.82	.30				1.43			
	4.2		6.85	.30				1.69			
	4.5		6.83	.25				1.44			
	4.8		6.82	.20				1.70			
	5.1		6.82	.15				0.92			
WL	5.4		6.61								
	5.5		6.28								
	6.0		6.33								
	6.8		6.28								
(LB) St GL	7.8		6.22								
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: Trib to Crooked Creek						CROSS-SECTION NO.: #2
CROSS-SECTION LOCATION: N39 17 52.45 W 105 58 25.15						
DATE: 8/6/15	OBSERVERS: J. Skinner, Kate Ryan, Pete Convitz, B. Logan, R Viehl					
LEGAL DESCRIPTION	¼ SECTION:	SECTION:	TOWNSHIP: N/S	RANGE: E/W	PM:	
COUNTY: Park	WATERSHED:	WATER DIVISION:	DOW WATER CODE:			
MAP(S): USGS:						
USFS:						

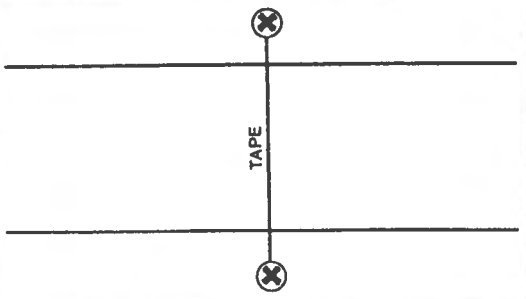
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: YES / NO	METER TYPE:			
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	7.45 / 7.44
② WS Upstream	2	7.35
③ WS Downstream	9	7.77
SLOPE	0.42 / 11 = 0.038	

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

DISCHARGE/CROSS SECTION NOTES

STREAM NAME:	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) At Point	Velocity (ft/sec) Mean in Vertical	Area (ft^2)	Discharge (cfs)
SG	0		5.64								
	0.8		6.04								
	1.4		6.62								
WL	2.0		7.11								
	2.6		7.44	.15				.06			
	2.9		7.55	.15				0.37			
	3.2		7.61	.20				.77			
	3.5		7.60	.20				1.46			
	3.8		7.65	.20				1.6			
	4.1		7.70	.15				1.81			
	4.4		7.71	.15				2.02			
	4.7		7.70	.30				2.41			
	5.0		7.71	.25				2.17			
	5.3		7.63	.15				1.97			
WL	5.7		7.45	—	—						
	6.0		7.31								
	6.6		7.21								
	7.4		7.10								
	7.7		6.90								
	8.3		6.48								
SGL	8.9		6.04								
TOTALS:											

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

Fish plant tally

Tally on	*Year*					Number	Pounds	Inches	Mean length	Mean #/lb
Date	Control	Unit	Water	Species	Length	Number	Pounds	Inches		
1973										
08/01/1973		MSO	29543 CROOKED CREEK	NAT	0.86"	450	0.10	386.77		
Sum for 1973						**450**	**0.10**	**386.77**	**0.86**	**4,500.00**
1989										
09/20/1989		MSO	29543 CROOKED CREEK	NAT	1.86"	534	1.20	992.50		
Sum for 1989						**534**	**1.20**	**992.50**	**1.86**	**445.00**
1990										
09/17/1990		MSO	29543 CROOKED CREEK	NAT	1.64"	500	0.77	819.32		
Sum for 1990						**500**	**0.77**	**819.32**	**1.64**	**649.35**
1991										
06/07/1991		MSO	29543 CROOKED CREEK	BRK	2.83"	522	4.75	1,478.61		
09/17/1991		MOH	29543 CROOKED CREEK	NAT	1.90"	499	1.20	948.52		
Sum for 1991						**1,021**	**5.95**	**2,427.13**	**2.38**	**171.60**
1992										
06/30/1992		GSU	29543 CROOKED CREEK	BRK	2.81"	500	4.44	1,404.89		
10/19/1992		MOH	29543 CROOKED CREEK	NAT	2.35"	499	2.26	1,171.15		
Sum for 1992						**999**	**6.70**	**2,576.04**	**2.58**	**149.10**
1993										
09/11/1993		MOH	29543 CROOKED CREEK	NAT	1.63"	499	0.76	814.91		
Sum for 1993						**499**	**0.76**	**814.91**	**1.63**	**656.58**
1994										
09/26/1994		MOH	29543 CROOKED CREEK	NAT	1.74"	498	0.91	864.07		
Sum for 1994						**498**	**0.91**	**864.07**	**1.74**	**547.25**
1996										
09/30/1996		MOH	29543 CROOKED CREEK	NAT	1.61"	500	0.74	807.42		
Sum for 1996						**500**	**0.74**	**807.42**	**1.61**	**675.68**

Fish plant tally

Tally on	*Year*					Number	Pounds	Inches	Mean length	Mean #/lb
Date	Control	Unit	Water	Species	Length	Number	Pounds	Inches		
1998										
09/15/1998		MOH	29543 CROOKED CREEK	NAT	1.51"	499	0.60	752.84		
Sum for 1998						**499**	**0.60**	**752.84**	**1.51**	**831.67**
2004										
09/24/2004	2305	SIU	29543 CROOKED CREEK	GBN	1.44"	1,056	1.10	1,518.98		
Sum for 2004						**1,056**	**1.10**	**1,518.98**	**1.44**	**960.00**
2005										
10/27/2005	5240	SIU	29543 CROOKED CREEK	GBN	1.42"	800	0.81	1,139.00		
Sum for 2005						**800**	**0.81**	**1,139.00**	**1.42**	**990.10**
2006										
09/22/2006	0283	SIU	29543 CROOKED CREEK	GBN	1.74"	1,000	1.84	1,737.18		
Sum for 2006						**1,000**	**1.84**	**1,737.18**	**1.74**	**544.96**
2007										
09/25/2007	2865	SIU	29543 CROOKED CREEK	GBN	2.16"	1,000	3.51	2,156.23		
Sum for 2007						**1,000**	**3.51**	**2,156.23**	**2.16**	**284.98**
2008										
09/28/2008	4687	SIU	29543 CROOKED CREEK	GBN	1.18"	1,000	0.58	1,183.17		
Sum for 2008						**1,000**	**0.58**	**1,183.17**	**1.18**	**1,724.14**
2009										
10/08/2009	2237	SIU	29543 CROOKED CREEK	GBN	1.74"	1,000	1.84	1,737.18		
Sum for 2009						**1,000**	**1.84**	**1,737.18**	**1.74**	**544.96**
2011										
09/28/2011	5304	SIU	29543 CROOKED CREEK	GBN	1.86"	1,000	2.25	1,859.40		
Sum for 2011						**1,000**	**2.25**	**1,859.40**	**1.86**	**444.44**
2012										
09/27/2012	6397	SIU	29543 CROOKED CREEK	GBN	2.02"	1,000	2.88	2,019.50		
Sum for 2012						**1,000**	**2.88**	**2,019.50**	**2.02**	**346.86**

Fish plant tally

Tally on	*Year*					Number	Pounds	Inches	Mean length	Mean #/lb
Date	Control	Unit	Water	Species	Length	Number	Pounds	Inches		
2013										
09/26/2013	2215	SIU	29543 CROOKED CREEK	GBN	1.52"	1,000	1.23	1,521.80		
Sum for 2013						**1,000**	**1.23**	**1,521.80**	**1.52**	**810.37**
2014										
09/25/2014	5535	SIU	29543 CROOKED CREEK	GBN	1.44"	1,009	1.06	1,454.17		
Sum for 2014						**1,009**	**1.06**	**1,454.17**	**1.44**	**954.59**
2015										
10/30/2015	2591	SIU	29543 CROOKED CREEK	GBN	2.21"	795	2.99	1,754.72		
Sum for 2015						**795**	**2.99**	**1,754.72**	**2.21**	**265.71**
				Totals, Means:		**16,160**	**37.81**	**28,522.33**	**1.76**	**427.37**