USDA United States Department of Agriculture
Forest Service
Grand Mesa, Uncompahgre and Gunnison National Forests
2250 Highway 50
Delta, CO 81416
970-874-6600
TDD: 970-874-6660
FAX: 970-874-6698

File Code: 2530; 2600
Date: January 8, 2015

Jeff Baessler
Deputy Section Chief
Colorado Water Conservation Board
Department of Natural Resources
1313 Sherman Street, Room 723
Denver, CO 80203

Dear Mr. Baessler:

Enclosed you will find a revised instream flow recommendation for Schaefer Creek on the Paonia Ranger District of the Grand Mesa, Uncompahgre, and Gunnison National Forests. These recommendations were prepared by our fisheries and hydrology specialists. The revised recommendation was the result of collaboration between your staff and the fisheries staff on the Forest. Schaefer Creek is an important aquatic resource on the Forest and an instream flow water right is one way we can insure the long-term presence of native Cutthroat Trout in the stream.

Please do not hesitate to contact the Forest Fisheries Biologist, Matthew Dare, at 970-874-6651 if you have questions about these recommendations.

Sincerely,

Scott Armentrout
Forest Supervisor

Enclosure

Schaefer Creek

Executive Summary
Water Division: 4
Water District: 40
CPW water code: 43000
CWCB ID:

Segment: Headwaters downstream to confluence with Grouse Spring Creek.
Upper terminus UTM: 13S 304657 E, 4303265 N
Lower terminus UTM: 13S 302327 E, 4310059 N

Watershed: Anthracite Creek
County(s): Gunnison
Length: 5.6 miles
USGS Quad(s): Paonia Reservoir, Marcellina Mountain, Anthracite Range
Flow recommendation:

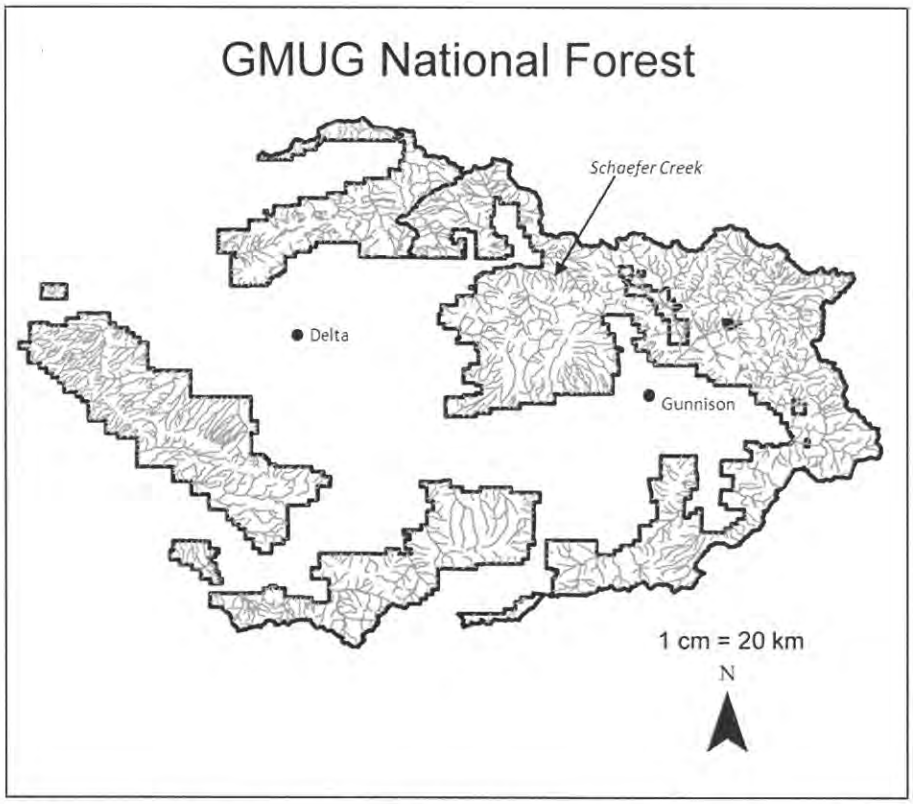

Figure 1: Schaefer Creek, located on the GMUG National Forest, east of Paonia, Colorado.

Staff Analysis and Recommendation

Summary

The information contained in this report and the associated instream flow file folder forms the basis for staff's instream flow recommendation to be considered by the Board. It is staff's opinion that the information contained in this report is sufficient to support the findings required in Rule 5.40.

Colorado's Instream Flow Program was created in 1973 when the Colorado State Legislature recognized "the need to correlate the activities of mankind with some reasonable preservation of the natural environment" (see 37-92-102 (3) C.R.S). The statute vests the CWCB 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 Instream Flow Program, the statute directs the CWCB to request instream flow recommendations from other state and federal agencies.

Schaefer Creek is located in the southern portion of the Anthracite Creek watershed, east of Paonia, Colorado. Schaefer Creek converges with Grouse Spring Creek to form Snowshoe Creek, upstream of Snowshoe Canyon. The area of the watershed is 5,097.5 acres. Approximately 6.5 percent of the watershed is private land (Figure 2); the remaining land is owned and managed by the USFS. Private lands are located in the downstream portion of the watershed. Schaefer Creek is a high-gradient stream (Figure 3), flowing through a mixed forest watershed that includes conifers and aspen.

The United States Forest Service (USFS) recommended this segment of Schaefer Creek to the CWCB for inclusion into the Instream Flow Program because it supports a healthy population of native Colorado River Cutthroat Trout (*Oncorhynchus clarki pleuriticus*; CRCT). CRCT in Schaefer Creek have been identified, through genetic analysis, as greenback, or GB-lineage CRCT. GB-lineage CRCT are protected as a threatened species under provisions of the U.S. Endangered Species Act. An instream flow in Schaefer Creek will contribute to the preservation, to a reasonable degree, of a natural environment and adequate habitat for CRCT.

Based on analysis of hydrological data and existing instream flow water rights in the Anthracite Creek watershed, and consideration of the conservation significance of the CRCT population in Schaefer Creek, the USFS recommended the following instream flow:

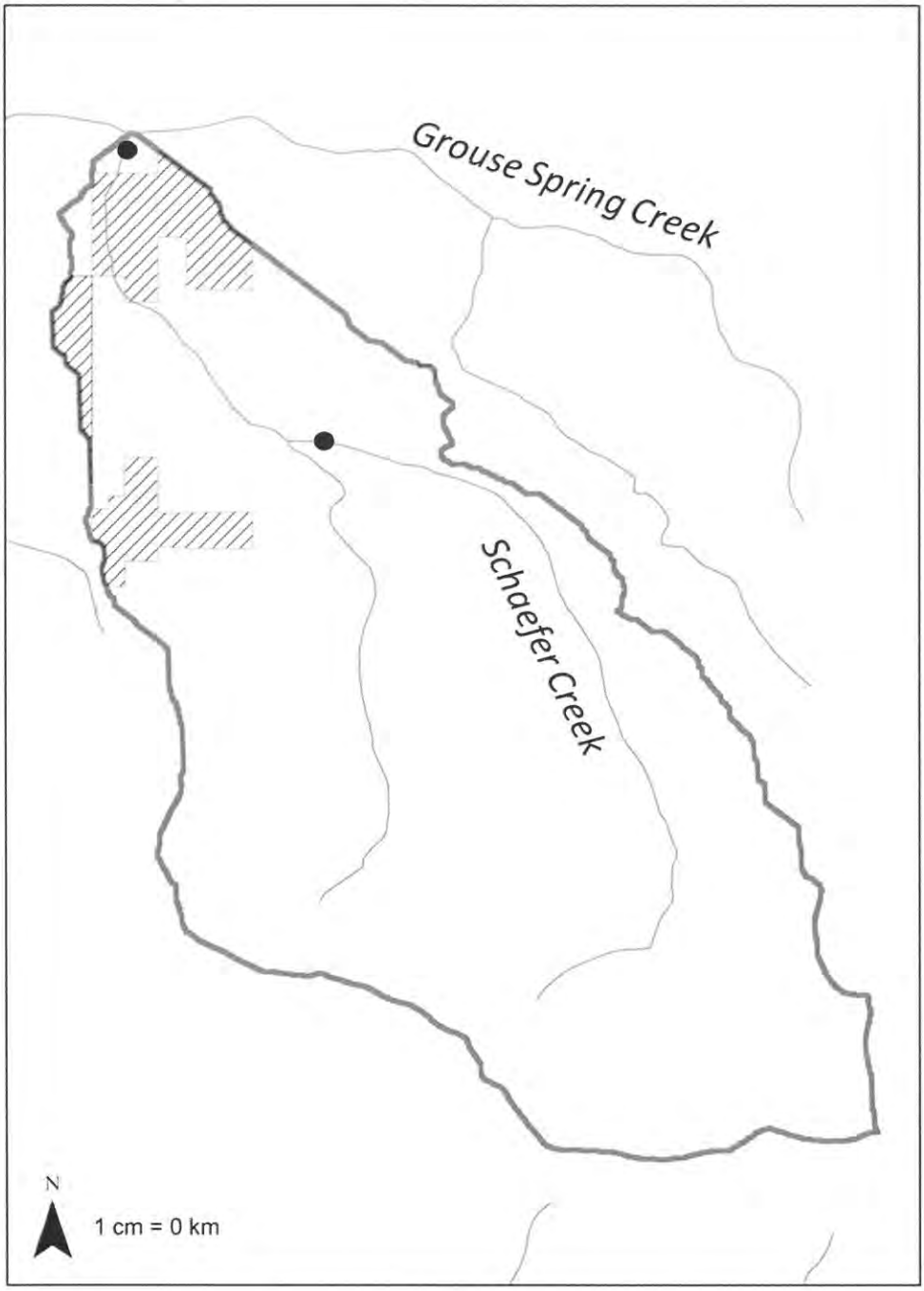

Figure 2: Detail of the Schaefer Creek watershed, near Paonia, Colorado. Private lands within the watershed are highlighted with cross-hatches. Closed circles denote locations of R2Cross cross-sections. The downstream sample was collected on August, 5, 2013; the upstream sample was collected on September 25, 2013.

Land Status Review

The Schaefer Creek watershed includes the lands that drain into Schaefer Creek from its confluence with Grouse Spring Creek upstream to the headwaters. The area of this watershed is 5,097.5 acres. There are 332 acres of private land within the Schaefer Creek watershed. The

private land is distributed among three parcels (Figure 2). All of the public land in the Schaefer Creek watershed is owned and managed by the USFS.

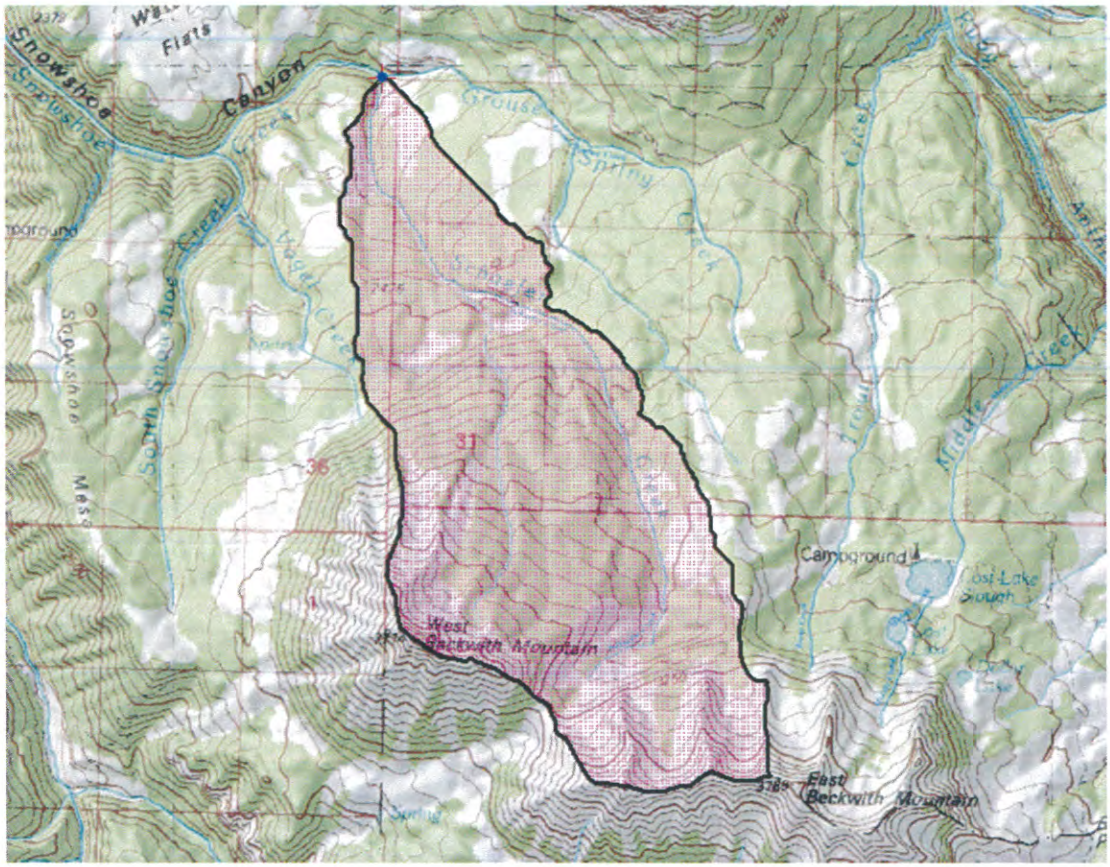

Figure 3: StreamStats map of the Schaefer Creek watershed. The instream flow recommendation contained in this report includes the entire perennial length of Schaefer Creek, from its confluence with Grouse Spring Creek to the headwaters at the base of West Beckwith Peak.

Existing Water Right Information

There are four diversion structures on Schaefer Creek: EKB Ditch 1, Beckwith Ditch, Shaffer Ditch, and Norris Ditch. According to the Colorado Water Rights database, Shaffer Ditch is a historical structure that no longer exists. EKB Ditch 1 is described as a "non-existent structure." Active water rights on Beckwith Ditch and Norris Ditch total 22.66 cfs.

In addition to consumptive water rights there are instream flow rights assigned to Grouse Spring Creek and Snowshoe Creek. Grouse Spring Creek and Schaefer Creek form Snowshoe Creek at their confluence. Both Grouse Spring and Snowshoe has a 3 cfs minimum flow water right.

Biological Data

Fish Population Survey Data

USFS personnel sampled the fish community in Schaefer Creek on November 8, 2012, in response to a request from the unit hydrologist. Sampling revealed populations of both cutthroat trout and non-native brown trout (*Salmo trutta*). Several age classes of cutthroat trout were collected during sampling suggesting the population is self-sustaining. All but one brown trout were less than 100 mm total length. USFS personnel concluded cutthroat trout are year-round occupants of Schaefer Creek while brown trout probably come upstream from Snowshoe Creek and Coal Creek in order to spawn and return to downstream habitats for most of the year. The brown trout in the sample were likely young-of-year that will eventually move downstream.

The presence of brown trout could impact CRCT in Schaefer Creek. Brown trout cannot hybridize with CRCT and they do not typically exhibit the invasive tendencies that western North American populations of brook trout (*Salvelinus fontinalis*) do. Regardless, it would be preferable to remove brown trout from the system. There is a bridge located at the place Forest Road 913 crosses Schaefer Creek. In 2012 GMUG personnel worked to stabilize the bridge as the foundation became unstable after spring run-off. The bridge is likely to have to be replaced in the next five years. A new bridge will integrate a fish passage barrier in order to prevent adult brown trout from spawning in the most upstream sections of Schaefer Creek. GMUG fisheries personnel believe, because the size structure of brown trout sampled in 2012 suggested the habitat was used primarily for spawning, brown trout will extirpate themselves from upper Schaefer Creek. Installing a barrier and securing an instream flow are the two actions most likely to provide long-term benefits to the CRCT in Schaefer Creek.

Genetic Data

GMUG personnel collected tissue samples from 32 CRCT for genetic analysis. Testing revealed 96 percent of the genetic composition of the population was that of greenback, or GB-lineage Colorado River Cutthroat Trout. Populations having greater than 90 percent native CRCT genes are classified as conservation populations by the USFS and Colorado Parks and Wildlife. These populations are of the greatest conservation significance on the GMUG NF and are managed to maximize the probability of long-term persistence.

Field Survey Data

USFS personnel used the R2Cross method to quantify the amount of water required to preserve the natural environment to a reasonable degree. The R2Cross method requires that stream discharge and channel profile data be collected in a riffle stream habitat type. Riffles are most easily visualized as the stream habitat types that would dry up first should streamflow cease. This type of hydraulic data collection consists of setting up a transect, surveying the stream channel geometry, and measuring the stream discharge.

Hydrologic Data and Analysis

Biological Flow Recommendation

The CWCB staff relied upon the biological expertise of the cooperating agencies to interpret output from the R2Cross model to develop the initial, biological instream flow recommendation.

This initial recommendation is designed to address the unique biological requirements of each stream without regard to water availability. Three instream flow hydraulic parameters, average depth, percent wetted perimeter, and average velocity are used to develop biological instream flow recommendations. CPW has determined that maintaining these three hydraulic parameters at adequate levels across riffle habitat types will also maintain aquatic habitat in pools and runs for most life stages of fish and aquatic invertebrates (Nehring 1979; Espegren 1996).

For this stream, two data sets were collected with the results shown in Table 1.

Table 1. Stream flow and R2Cross output from two cross sections located on Schaefer Creek.

Party	Date	Q	40% - 250%	Summer (3/3)	Winter (2/3)
U.S. Forest Service	August 5, 2013	5.80	2.3-14.5	15.21	2.45
U.S. Forest Service	September 25, 2013	7.73	3.1-19.3	4.54	2.44

In addition to R2Cross, USFS personnel used the USGS program, StreamStats, to estimate an annual hydrograph for Schaefer Creek. Schaefer Creek is an ungauged stream; therefore, the estimated hydrograph was based on watershed size and stream gauge data from nearby watersheds. The annual average discharge is an estimated 12.3 cfs, with a prediction error of 11 percent (Table 2). Predictions for monthly average discharge were most precise during baseflow periods and the least precise predictions were for July and August (Table 2).

Table 2. Annual and monthly average streamflow estimates derived using the USGS StreamStats program. Estimates were derived using the "area-averaged" approach. Discharge is reported in CFS; prediction error is reported as percentage of each estimate.

Period	Discharge (prediction error)
January	1.83 (24)
February	1.68 (26)
March	1.78 (24)
April	3.79 (19)
May	27.8 (21)
June	58.6 (21)
July	22.9 (56)
August	8.9 (61)
September	5.08 (32)
October	4.02 (19)
November	2.87 (21)
December	2.09 (21)
Annual mean	12.3 (11)

USFS Instream Flow Recommendation

The analysis of water availablility that is a predicate to an instream flow filing is likely to reveal Schaefer Creek has very little water available to allocate to an instream flow. However, USFS personnel measured instream flows during the irrigation season (August and September) and measured 5.8 cfs at the mouth of Schaefer Creek.

USFS Proposal: Summer instream flow of 2.9 cfs and a winter instream flow of 4.6 cfs.

CWCB Instream Flow Recommendation

TBD

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

LOCATION INFORMATION

STREAM NAME:	Schaefer Creek
XS LOCATION:	About 50 m upstream from bridge crossing
XS NUMBER:	2
DATE:	25-Sep-13
OBSERVERS:	Dare, Stratton (USFS)
1/4 SEC:	0
SECTION:	0
TWP:	0
RANGE:	0
PM:	0
COUNTY:	0
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
with a survey level and rod

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE:	0.0687

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

ASSIGNED TO: ….....…….....DATE.....

STREAM NAME: Schaefer Creek
XS LOCATION: About 50 m upstream from bridge crossing
XS NUMBER: 2

DATA POINTS= 34

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	0.50	3.16	0.00	0.00	0.00		0.00	0.00	0.0%
	1.00	3.38	0.00	0.00	0.00		0.00	0.00	0.0%
	1.50	3.44	0.00	0.00	0.00		0.00	0.00	0.0%
	2.00	3.68	0.00	0.00	0.00		0.00	0.00	0.0%
	2.50	3.86	0.00	0.00	0.00		0.00	0.00	0.0%
WL	3.00	4.18	0.00	0.00	0.00		0.00	0.00	0.0%
	3.50	4.44	0.10	0.00	0.56	0.10	0.05	0.00	0.0%
	4.00	4.48	0.10	0.00	0.50	0.10	0.05	0.00	0.0%
R	4.50	4.28	0.10	0.00	0.54	0.10	0.05	0.00	0.0%
	5.00	4.82	0.50	0.00	0.74	0.50	0.25	0.00	0.0%
	5.50	5.08	0.70	0.06	0.56	0.70	0.35	0.02	0.3%
	6.00	5.22	1.00	0.21	0.52	1.00	0.50	0.11	1.4%
	6.50	5.30	0.90	1.43	0.51	0.90	0.45	0.64	8.3%
	7.00	5.24	0.90	2.00	0.50	0.90	0.45	0.90	11.6%
	7.50	5.18	0.80	2.24	0.50	0.80	0.40	0.90	11.6%
	8.00	5.14	0.50	2.10	0.50	0.50	0.25	0.53	6.8%
	8.50	5.02	0.70	2.32	0.51	0.70	0.35	0.81	10.5%
	9.00	5.04	0.80	1.27	0.50	0.80	0.40	0.51	6.6%
	9.50	4.86	0.60	1.19	0.53	0.60	0.30	0.36	4.6%
	10.00	5.10	0.90	1.52	0.55	0.90	0.45	0.68	8.9%
	10.50	4.98	0.80	1.54	0.51	0.80	0.40	0.62	8.0%
	11.00	4.96	0.60	2.33	0.50	0.60	0.30	0.70	9.0%
	11.50	4.86	0.40	1.70	0.51	0.40	0.20	0.34	4.4%
	12.00	4.76	0.50	0.11	0.51	0.50	0.25	0.03	0.4%
	12.50	4.54	0.30	1.51	0.55	0.30	0.15	0.23	2.9%
	13.00	4.56	0.20	2.78	0.50	0.20	0.10	0.28	3.6%
	13.50	4.50	0.30	0.45	0.50	0.30	0.15	0.07	0.9%
	14.00	4.46	0.20	0.21	0.50	0.20	0.10	0.02	0.3%
	14.50	4.28	0.10	0.00	0.53	0.10	0.05	0.00	0.0%
WL	15.00	4.12	0.00	0.00	0.52		0.00	0.00	0.0%
	15.50	3.96	0.00	0.00	0.00		0.00	0.00	0.0%
	16.00	4.10	0.00	0.00	0.00		0.00	0.00	0.0%
	16.50	3.40	0.00	0.00	0.00		0.00	0.00	0.0%
1 GL	17.00	3.38	0.00	0.00	0.00		0.00	0.00	0.0%
TOTALS ----------					12.68	1 (Max.)	6.00	7.73	100.0%

Manning's n = 0.1836
Hydraulic Radius= 0.47315646

STREAM NAME: Schaefer Creek
XS LOCATION: About 50 m upstream from bridge crossing
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	6.00	7.83	30.5%
3.90	6.00	11.04	83.9%
3.92	6.00	10.76	79.4%
3.94	6.00	10.49	74.9%
3.96	6.00	10.22	70.4%
3.98	6.00	9.96	66.0%
4.00	6.00	9.69	61.6%
4.02	6.00	9.43	57.2%
4.04	6.00	9.18	53.0%
4.06	6.00	8.93	48.8%
4.08	6.00	8.68	44.6%
4.10	6.00	8.43	40.5%
4.11	6.00	8.31	38.5%
4.12	6.00	8.19	36.5%
4.13	6.00	8.07	34.5%
4.14	6.00	7.95	32.4%
4.15	6.00	7.83	30.5%
4.16	6.00	7.71	28.5%
4.17	6.00	7.59	26.5%
4.18	6.00	7.47	24.5%
4.19	6.00	7.35	22.5%
4.20	6.00	7.24	20.6%
4.22	6.00	7.00	16.7%
4.24	6.00	6.77	12.8%
4.26	6.00	6.54	9.0%
4.28	6.00	6.31	5.2%
4.30	6.00	6.09	1.5%
4.32	6.00	5.87	-2.2%
4.34	6.00	5.65	-5.8%
4.36	6.00	5.44	-9.4%
4.38	6.00	5.22	-12.9%
4.40	6.00	5.02	-16.4%

WATERLINE AT ZERO
AREA ERROR = 4.308

STREAM NAME: Schaefer Creek
XS LOCATION: About 50 m upstream from bridge crossing
XS NUMBER: 2 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	3.38	16.00	1.16	1.92	18.53	17.27	100.0%	1.07	41.19	2.22
	3.41	15.26	1.19	1.89	18.09	16.52	95.7%	1.10	40.77	2.25
	3.46	14.92	1.16	1.84	17.34	16.15	93.5%	1.07	38.56	2.22
	3.51	14.78	1.12	1.79	16.60	15.97	92.5%	1.04	36.11	2.18
	3.56	14.64	1.08	1.74	15.86	15.80	91.5%	1.00	33.73	2.13
	3.61	14.50	1.04	1.69	15.13	15.62	90.5%	0.97	31.42	2.08
	3.66	14.36	1.00	1.64	14.41	15.44	89.4%	0.93	29.19	2.03
	3.71	14.20	0.96	1.59	13.70	15.25	88.3%	0.90	27.04	1.97
	3.76	14.03	0.93	1.54	12.99	15.04	87.1%	0.86	24.99	1.92
	3.81	13.85	0.89	1.49	12.29	14.83	85.9%	0.83	23.01	1.87
	3.86	13.68	0.85	1.44	11.61	14.62	84.7%	0.79	21.10	1.82
	3.91	13.56	0.81	1.39	10.93	14.47	83.8%	0.76	19.22	1.76
	3.96	13.45	0.76	1.34	10.25	14.31	82.9%	0.72	17.40	1.70
	4.01	13.01	0.74	1.29	9.59	13.82	80.0%	0.69	15.94	1.66
	4.06	12.56	0.71	1.24	8.95	13.32	77.1%	0.67	14.56	1.63
	4.11	12.15	0.69	1.19	8.33	12.85	74.4%	0.65	13.24	1.59
	4.16	11.91	0.65	1.14	7.73	12.60	72.9%	0.61	11.84	1.53
	4.21	11.67	0.61	1.09	7.14	12.33	71.4%	0.58	10.52	1.47
	4.26	11.42	0.57	1.04	6.56	12.06	69.8%	0.54	9.28	1.41
WL	4.31	11.08	0.54	0.99	6.00	11.68	67.6%	0.51	8.16	1.36
	4.36	10.67	0.51	0.94	5.46	11.22	65.0%	0.49	7.15	1.31
	4.41	10.27	0.48	0.89	4.93	10.76	62.3%	0.46	6.22	1.26
	4.46	9.67	0.46	0.84	4.43	10.12	58.6%	0.44	5.42	1.22
	4.51	8.72	0.46	0.79	3.98	9.14	52.9%	0.44	4.84	1.22
	4.56	7.76	0.46	0.74	3.56	8.15	47.2%	0.44	4.34	1.22
	4.61	7.54	0.42	0.69	3.17	7.90	45.7%	0.40	3.67	1.16
	4.66	7.38	0.38	0.64	2.80	7.71	44.6%	0.36	3.03	1.08
	4.71	7.22	0.34	0.59	2.44	7.51	43.5%	0.32	2.44	1.00
	4.76	7.06	0.29	0.54	2.08	7.32	42.4%	0.28	1.91	0.92
	4.81	6.77	0.26	0.49	1.73	7.00	40.6%	0.25	1.45	0.84
	4.86	6.44	0.22	0.44	1.40	6.65	38.5%	0.21	1.06	0.75
	4.91	5.86	0.19	0.39	1.10	6.03	34.9%	0.18	0.75	0.68
	4.96	5.27	0.16	0.34	0.82	5.41	31.3%	0.15	0.49	0.60
	5.01	4.30	0.14	0.29	0.58	4.40	25.5%	0.13	0.32	0.55
	5.06	3.14	0.13	0.24	0.40	3.21	18.6%	0.12	0.21	0.53
	5.11	2.53	0.10	0.19	0.26	2.57	14.9%	0.10	0.12	0.46
	5.16	1.99	0.07	0.14	0.14	2.02	11.7%	0.07	0.05	0.36
	5.21	1.31	0.05	0.09	0.06	1.32	7.7%	0.05	0.02	0.27
	5.26	0.61	0.02	0.04	0.01	0.62	3.6%	0.02	0.00	0.16

STREAM NAME: Schaefer Creek
XS LOCATION: About 50 m upstream from bridge crossing
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	7.73	cfs
CALCULATED FLOW (Qc)=	8.16	cfs
(Qm-Qc)/Qm * 100 =	-5.6	%
MEASURED WATERLINE (WLm)=	4.15	ft
CALCULATED WATERLINE (WLc)=	4.31	ft
(WLm-WLc)/WLm * 100 =	-3.8	%
MAX MEASURED DEPTH (Dm)=	1.00	ft
MAX CALCULATED DEPTH (Dc)=	0.99	ft
(Dm-Dc)/Dm * 100	0.8	%
MEAN VELOCITY=	1.36	ft/sec
MANNING'S N=	0.184	
SLOPE=	0.0687	ft/ft
.4 * Qm =	3.1	cfs
2.5 * Qm=	19.3	cfs

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

FLOW (CFS)	PERIOD
==========	========
_____	_____
_____	_____
_____	_____
_____	_____

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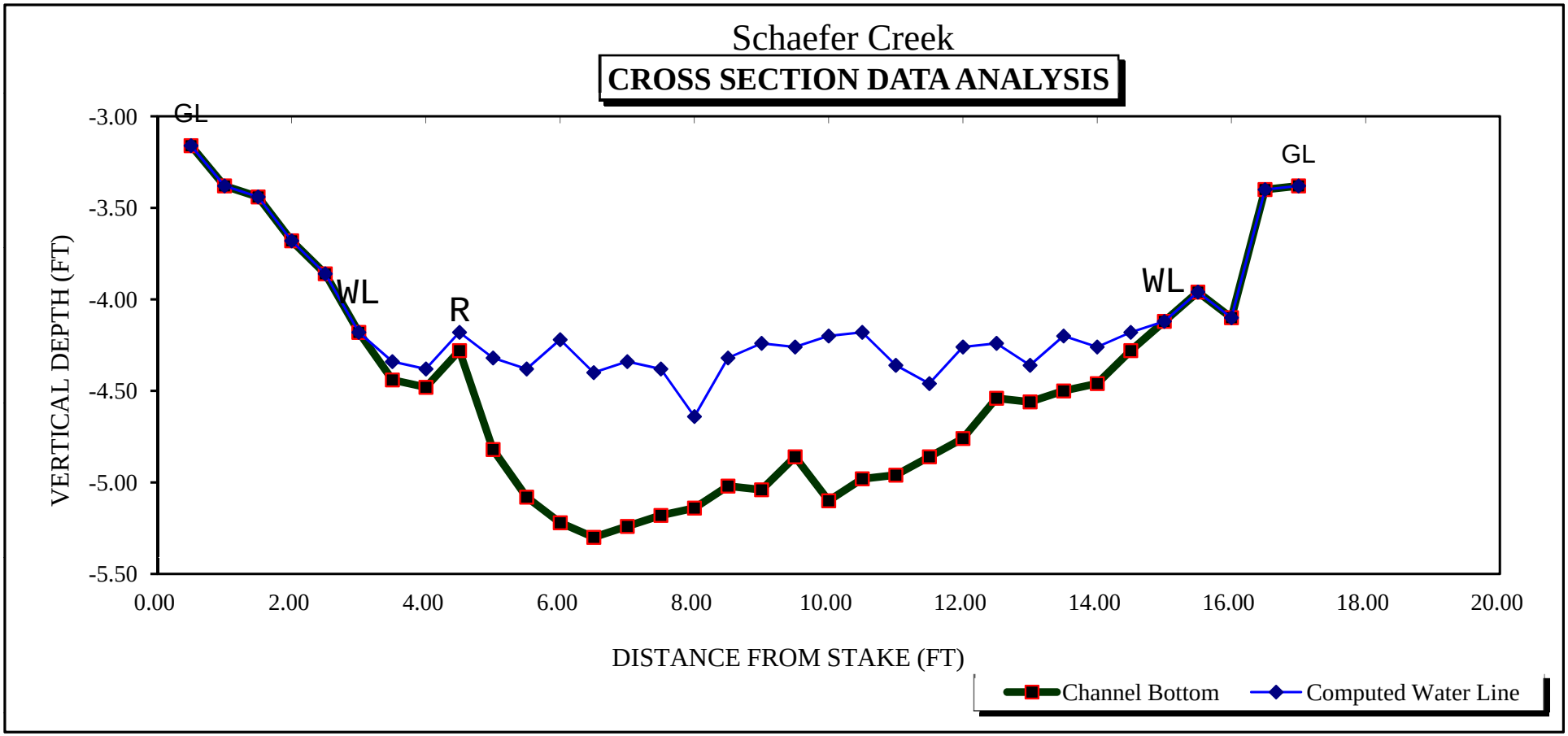
RECOMMENDATION BY: …….…….……..... AGENCY..……..……..……..…….... DATE:.....…….....……

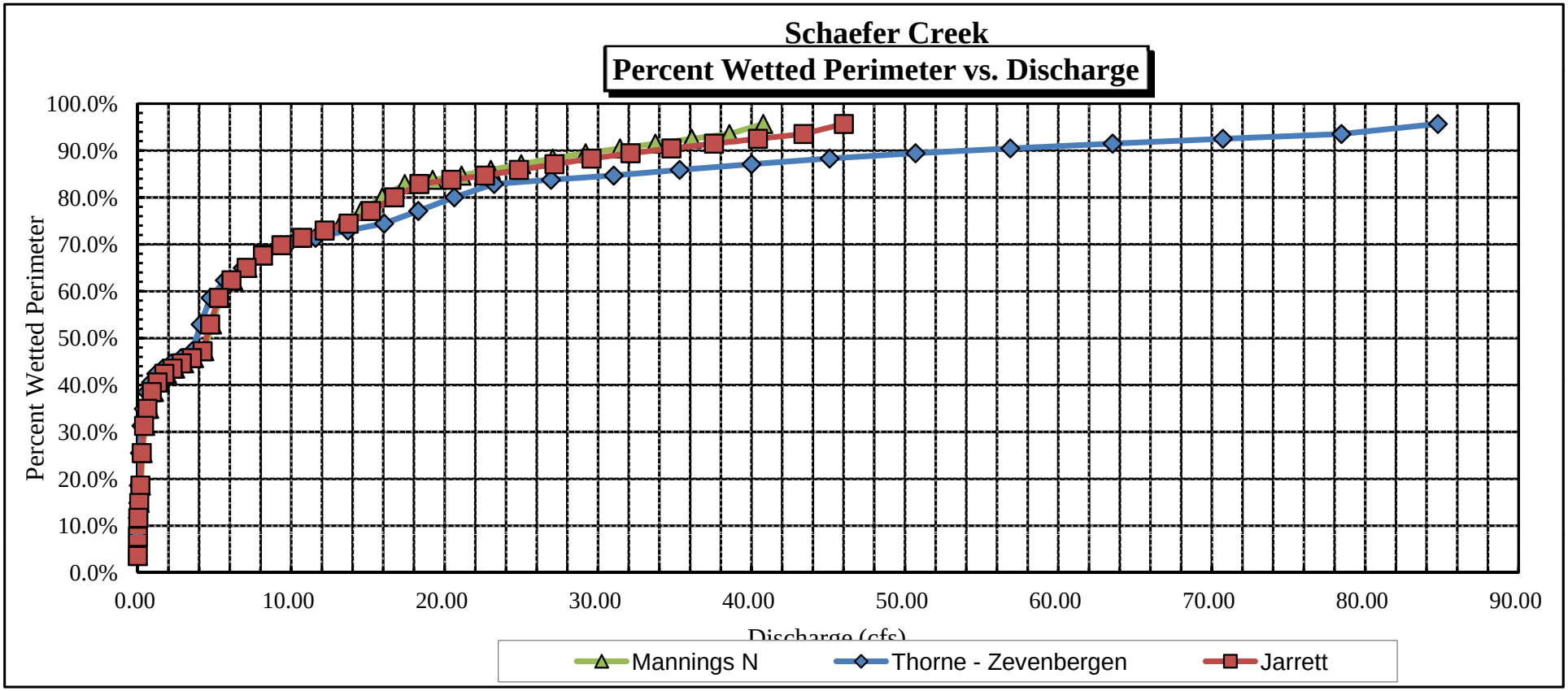
CWCB REVIEW BY: ..……...…….....…….....…..... DATE:.....……..…

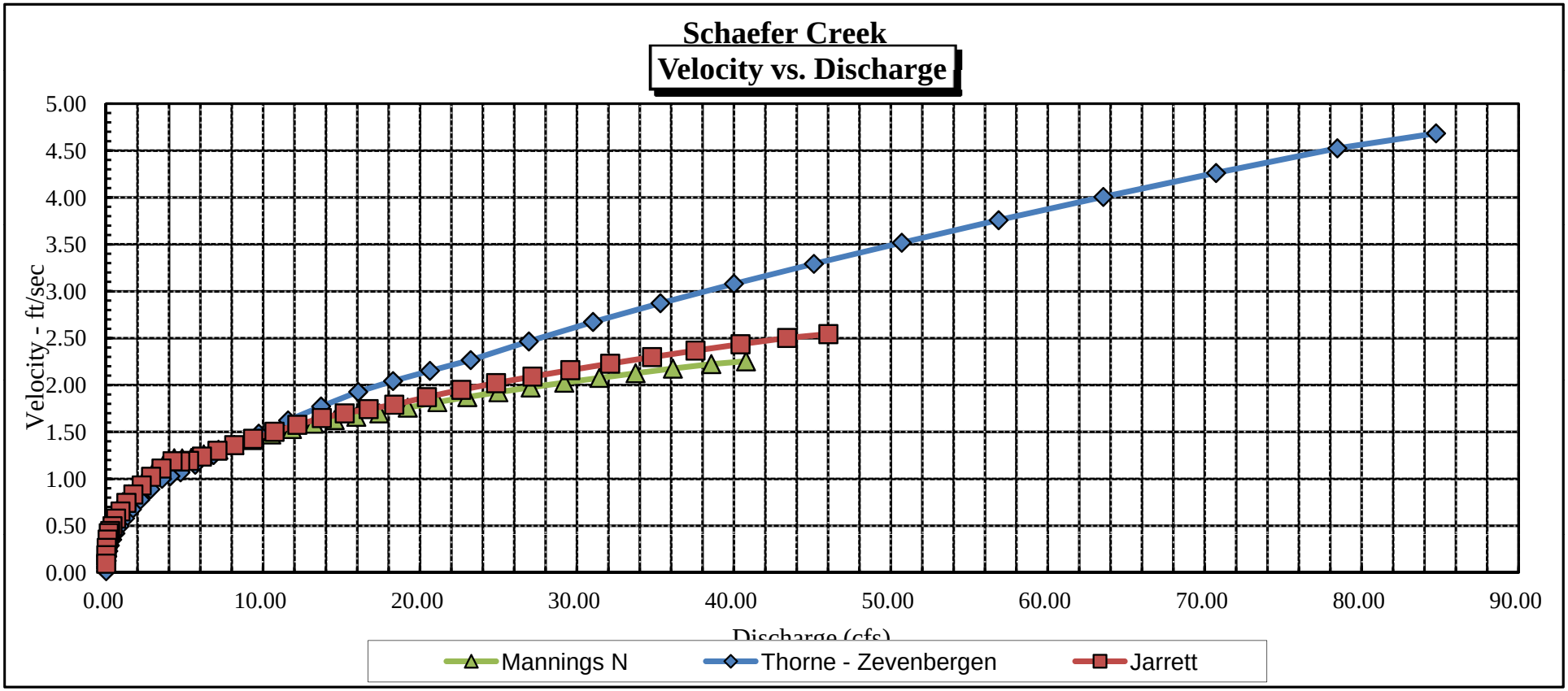
STREAM NAME: Schaefer Creek
XS LOCATION: About 50 m upstream from bridge crossing
XS NUMBER: 2 Jarrett Variable Manning's n Correction Applied

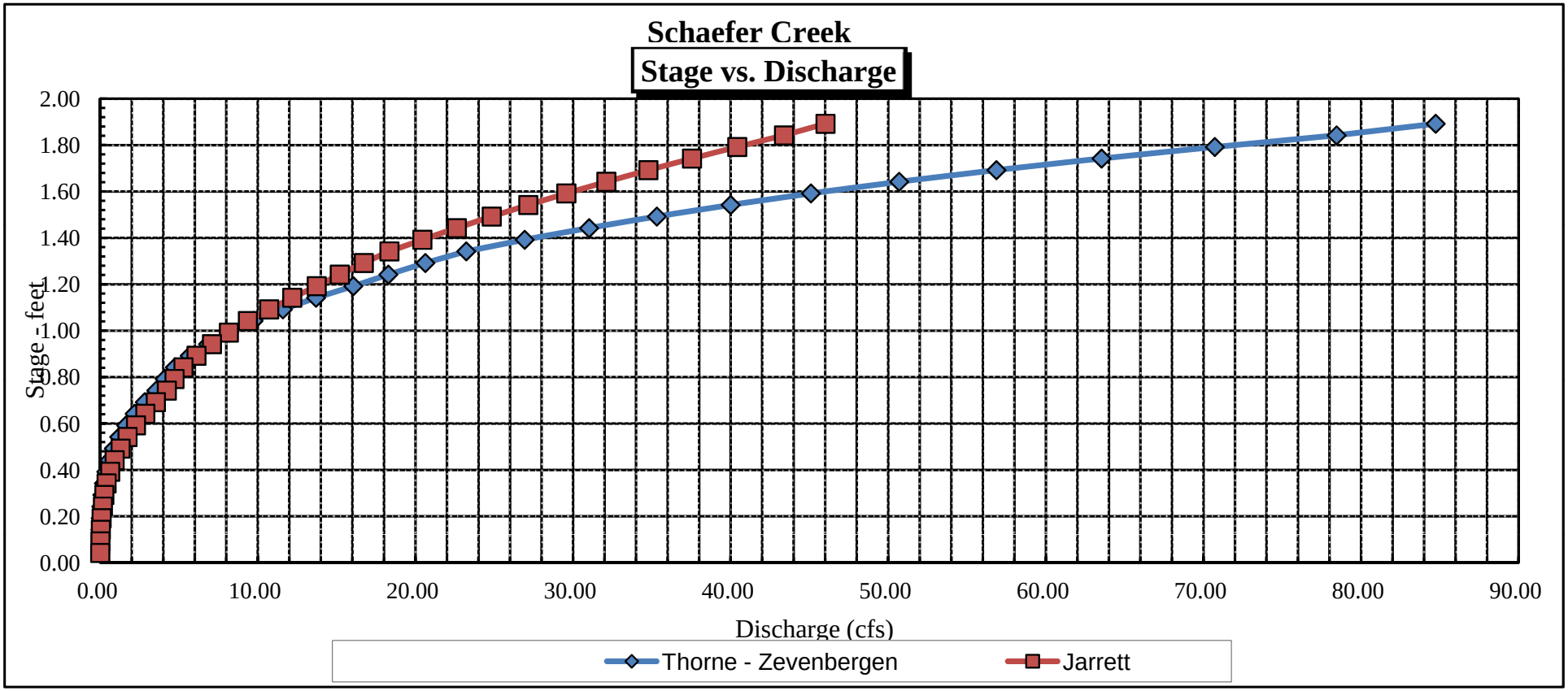
STAGING TABLE *GL* = lowest Grassline elevation corrected for sag
WL = Waterline corrected for variations in field measured water surface elevations and sag

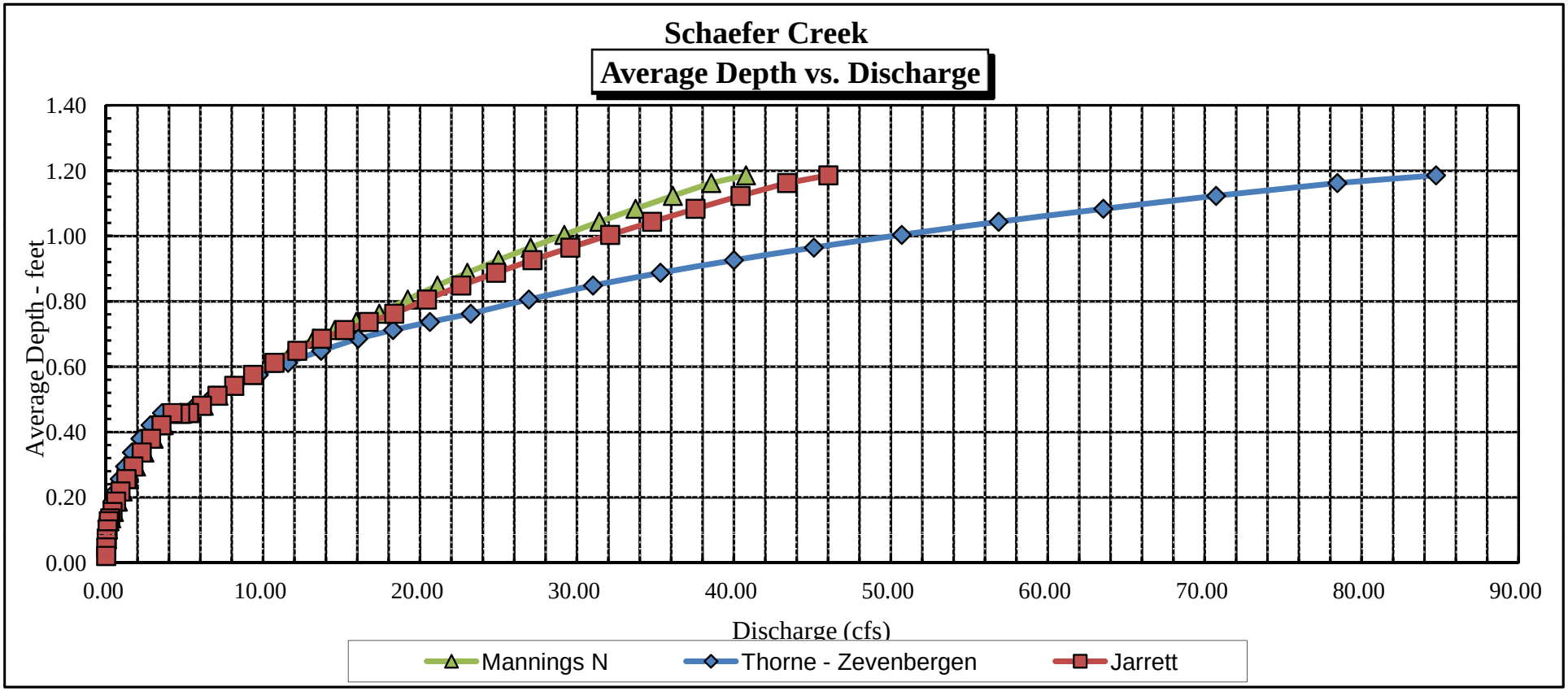
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	3.38	16.00	1.16	1.92	18.53	17.27	100.0%	1.07	46.35	2.50
	3.41	15.26	1.19	1.89	18.09	16.52	95.7%	1.10	46.02	2.54
	3.46	14.92	1.16	1.84	17.34	16.15	93.5%	1.07	43.39	2.50
	3.51	14.78	1.12	1.79	16.60	15.97	92.5%	1.04	40.42	2.44
	3.56	14.64	1.08	1.74	15.86	15.80	91.5%	1.00	37.55	2.37
	3.61	14.50	1.04	1.69	15.13	15.62	90.5%	0.97	34.78	2.30
	3.66	14.36	1.00	1.64	14.41	15.44	89.4%	0.93	32.11	2.23
	3.71	14.20	0.96	1.59	13.70	15.25	88.3%	0.90	29.58	2.16
	3.76	14.03	0.93	1.54	12.99	15.04	87.1%	0.86	27.16	2.09
	3.81	13.85	0.89	1.49	12.29	14.83	85.9%	0.83	24.84	2.02
	3.86	13.68	0.85	1.44	11.61	14.62	84.7%	0.79	22.63	1.95
	3.91	13.56	0.81	1.39	10.93	14.47	83.8%	0.76	20.44	1.87
	3.96	13.45	0.76	1.34	10.25	14.31	82.9%	0.72	18.35	1.79
	4.01	13.01	0.74	1.29	9.59	13.82	80.0%	0.69	16.72	1.74
	4.06	12.56	0.71	1.24	8.95	13.32	77.1%	0.67	15.20	1.70
	4.11	12.15	0.69	1.19	8.33	12.85	74.4%	0.65	13.74	1.65
	4.16	11.91	0.65	1.14	7.73	12.60	72.9%	0.61	12.18	1.58
	4.21	11.67	0.61	1.09	7.14	12.33	71.4%	0.58	10.72	1.50
	4.26	11.42	0.57	1.04	6.56	12.06	69.8%	0.54	9.37	1.43
WL	4.31	11.08	0.54	0.99	6.00	11.68	67.6%	0.51	8.16	1.36
	4.36	10.67	0.51	0.94	5.46	11.22	65.0%	0.49	7.09	1.30
	4.41	10.27	0.48	0.89	4.93	10.76	62.3%	0.46	6.11	1.24
	4.46	9.67	0.46	0.84	4.43	10.12	58.6%	0.44	5.28	1.19
	4.51	8.72	0.46	0.79	3.98	9.14	52.9%	0.44	4.71	1.19
	4.56	7.76	0.46	0.74	3.56	8.15	47.2%	0.44	4.23	1.19
	4.61	7.54	0.42	0.69	3.17	7.90	45.7%	0.40	3.53	1.11
	4.66	7.38	0.38	0.64	2.80	7.71	44.6%	0.36	2.86	1.02
	4.71	7.22	0.34	0.59	2.44	7.51	43.5%	0.32	2.27	0.93
	4.76	7.06	0.29	0.54	2.08	7.32	42.4%	0.28	1.73	0.83
	4.81	6.77	0.26	0.49	1.73	7.00	40.6%	0.25	1.29	0.74
	4.86	6.44	0.22	0.44	1.40	6.65	38.5%	0.21	0.92	0.65
	4.91	5.86	0.19	0.39	1.10	6.03	34.9%	0.18	0.63	0.58
	4.96	5.27	0.16	0.34	0.82	5.41	31.3%	0.15	0.41	0.50
	5.01	4.30	0.14	0.29	0.58	4.40	25.5%	0.13	0.26	0.44
	5.06	3.14	0.13	0.24	0.40	3.21	18.6%	0.12	0.17	0.42
	5.11	2.53	0.10	0.19	0.26	2.57	14.9%	0.10	0.09	0.35
	5.16	1.99	0.07	0.14	0.14	2.02	11.7%	0.07	0.04	0.26
	5.21	1.31	0.05	0.09	0.06	1.32	7.7%	0.05	0.01	0.19
	5.26	0.61	0.02	0.04	0.01	0.62	3.6%	0.02	0.00	0.10


Schaefer Creek
CROSS SECTION DATA ANALYSIS
GL
WL
R
WL
GL
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
VERTICAL DEPTH (FT)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


Schaefer Creek
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
90.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Schaefer Creek
Velocity vs. Discharge
Velocity - ft/sec
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Schaefer Creek
Stage vs. Discharge
Stage - feet
2.00
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
90.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett


Schaefer Creek
Average Depth vs. Discharge
Average Depth - feet
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
90.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett

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

LOCATION INFORMATION

STREAM NAME:	Schaefer Creek
XS LOCATION:	25 m upstream from Grouse confluence
XS NUMBER:	1
DATE:	2-Aug-13
OBSERVERS:	Carrillo, Dare, Stratton
1/4 SEC:	0
SECTION:	0
TWP:	0
RANGE:	0
PM:	0
COUNTY:	0
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
with a survey level and rod

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE:	0.09982

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

ASSIGNED TO: ….....…….....DATE.....

STREAM NAME: Schaefer Creek
XS LOCATION: 25 m upstream from Grouse confluence
XS NUMBER: 1

DATA POINTS= 44

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	0.00	4.50			0.00		0.00	0.00	0.0%
	WL	1.50	5.63			0.00		0.00	0.00	0.0%
		2.00	6.11	0.10	0.00	0.69	0.10	0.05	0.00	0.0%
		2.50	6.06	0.40	0.03	0.50	0.40	0.20	0.01	0.1%
		3.00	6.08	0.20	0.01	0.50	0.20	0.10	0.00	0.0%
		3.50	6.15	0.40	0.64	0.50	0.40	0.20	0.13	2.2%
		4.00	6.10	0.30	0.75	0.50	0.30	0.15	0.11	1.9%
		4.50	6.05	0.30	0.94	0.50	0.30	0.15	0.14	2.4%
		5.00	6.04	0.30	1.39	0.50	0.30	0.15	0.21	3.6%
		5.50	6.07	0.20	1.01	0.50	0.20	0.10	0.10	1.7%
		6.00	6.04	0.15	0.27	0.50	0.15	0.08	0.02	0.3%
		6.50	6.01	0.10	0.49	0.50	0.10	0.05	0.02	0.4%
		7.00	6.22	0.10	0.49	0.54	0.10	0.05	0.02	0.4%
	R	7.50	4.93			1.38		0.00	0.00	0.0%
	R	8.00	4.82			0.00		0.00	0.00	0.0%
	R	8.50	4.84			0.00		0.00	0.00	0.0%
	R	9.00	5.23			0.00		0.00	0.00	0.0%
	R	9.50	6.01			0.00		0.00	0.00	0.0%
		10.00	6.03	0.40	4.01	0.50	0.40	0.20	0.80	13.8%
		10.50	6.05	0.30	1.18	0.50	0.30	0.15	0.18	3.1%
		11.00	6.03	0.50	0.64	0.50	0.50	0.25	0.16	2.8%
		11.50	6.20	0.60	2.18	0.53	0.60	0.30	0.65	11.3%
		12.00	6.33	0.90	2.74	0.52	0.90	0.45	1.23	21.3%
		12.50	5.96	0.60	2.74	0.62	0.60	0.30	0.82	14.2%
		13.00	5.19	0.85	1.39	0.92	0.85	0.43	0.59	10.2%
		13.50	5.93	0.55	1.19	0.89	0.55	0.28	0.33	5.6%
		14.00	5.94	0.35	0.35	0.50	0.35	0.18	0.06	1.1%
		14.50	5.55	0.35	0.69	0.63	0.35	0.18	0.12	2.1%
		15.00	5.56	0.20	0.85	0.50	0.20	0.10	0.09	1.5%
	R	15.50	5.29			0.57		0.00	0.00	0.0%
	R	16.00	5.00			0.00		0.00	0.00	0.0%
	R	16.50	4.99			0.00		0.00	0.00	0.0%
	R	17.00	5.13			0.00		0.00	0.00	0.0%
	WL	17.50	5.25			0.00		0.00	0.00	0.0%
		18.50	5.32			0.00		0.00	0.00	0.0%
		19.50	5.39			0.00		0.00	0.00	0.0%
		20.50	5.05			0.00		0.00	0.00	0.0%
		21.50	5.29			0.00		0.00	0.00	0.0%
		22.50	4.52			0.00		0.00	0.00	0.0%
		23.50	5.09			0.00		0.00	0.00	0.0%
		24.50	4.25			0.00		0.00	0.00	0.0%
		25.50	4.81			0.00		0.00	0.00	0.0%
1	GL	26.50	4.52			0.00		0.00	0.00	0.0%
		27.00	4.22			0.00		0.00	0.00	0.0%
	TOTALS ----------					14.32	0.9 (Max.)	4.08	5.80	100.0%

Manning's n = 0.1427
Hydraulic Radius= 0.28464324

STREAM NAME: Schaefer Creek
XS LOCATION: 25 m upstream from Grouse confluence
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	4.08	3.96	-2.7%
5.40	4.08	6.75	65.7%
5.42	4.08	6.51	59.8%
5.44	4.08	6.28	54.0%
5.46	4.08	6.04	48.2%
5.48	4.08	5.81	42.5%
5.50	4.08	5.58	36.9%
5.52	4.08	5.35	31.3%
5.54	4.08	5.12	25.7%
5.56	4.08	4.90	20.3%
5.58	4.08	4.69	15.1%
5.60	4.08	4.48	9.9%
5.61	4.08	4.38	7.4%
5.62	4.08	4.27	4.8%
5.63	4.08	4.17	2.3%
5.64	4.08	4.07	-0.2%
5.65	4.08	3.96	-2.7%
5.66	4.08	3.86	-5.2%
5.67	4.08	3.76	-7.7%
5.68	4.08	3.66	-10.2%
5.69	4.08	3.56	-12.6%
5.70	4.08	3.46	-15.1%
5.72	4.08	3.26	-20.0%
5.74	4.08	3.07	-24.8%
5.76	4.08	2.87	-29.5%
5.78	4.08	2.68	-34.3%
5.80	4.08	2.49	-39.0%
5.82	4.08	2.30	-43.6%
5.84	4.08	2.11	-48.2%
5.86	4.08	1.93	-52.7%
5.88	4.08	1.74	-57.2%
5.90	4.08	1.56	-61.7%

WATERLINE AT ZERO
AREA ERROR = 5.639

STREAM NAME: Schaefer Creek
XS LOCATION: 25 m upstream from Grouse confluence
XS NUMBER: 1 Jarrett Variable Manning's n Correction Applied

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	4.52	25.67	0.94	1.81	24.22	29.87	100.0%	0.81	79.31	3.27
	4.64	24.38	0.87	1.69	21.24	28.38	95.0%	0.75	65.09	3.06
	4.69	23.84	0.84	1.64	20.03	27.75	92.9%	0.72	59.59	2.97
	4.74	23.30	0.81	1.59	18.86	27.13	90.8%	0.70	54.36	2.88
	4.79	22.76	0.78	1.54	17.70	26.50	88.7%	0.67	49.39	2.79
	4.84	21.79	0.76	1.49	16.58	25.45	85.2%	0.65	45.31	2.73
	4.89	21.22	0.73	1.44	15.51	24.79	83.0%	0.63	40.97	2.64
	4.94	20.69	0.70	1.39	14.46	24.17	80.9%	0.60	36.83	2.55
	4.99	20.37	0.66	1.34	13.44	23.74	79.5%	0.57	32.68	2.43
	5.04	19.22	0.65	1.29	12.46	22.45	75.2%	0.55	29.80	2.39
	5.09	18.31	0.63	1.24	11.52	21.40	71.6%	0.54	26.87	2.33
	5.14	17.47	0.61	1.19	10.62	20.44	68.4%	0.52	24.08	2.27
	5.19	16.61	0.59	1.14	9.77	19.45	65.1%	0.50	21.53	2.20
	5.24	15.68	0.57	1.09	8.96	18.36	61.5%	0.49	19.29	2.15
	5.29	14.38	0.57	1.04	8.21	16.88	56.5%	0.49	17.61	2.15
	5.34	13.25	0.57	0.99	7.52	15.58	52.2%	0.48	16.02	2.13
	5.39	12.09	0.57	0.94	6.88	14.28	47.8%	0.48	14.67	2.13
	5.44	11.82	0.53	0.89	6.29	13.85	46.4%	0.45	12.74	2.03
	5.49	11.54	0.49	0.84	5.70	13.43	45.0%	0.42	10.93	1.92
	5.54	11.26	0.46	0.79	5.13	13.01	43.6%	0.39	9.26	1.80
	5.59	10.49	0.44	0.74	4.59	12.09	40.5%	0.38	8.04	1.75
WL	5.64	10.24	0.40	0.69	4.07	11.69	39.1%	0.35	6.64	1.63
	5.69	10.01	0.36	0.64	3.57	11.31	37.9%	0.32	5.36	1.50
	5.74	9.78	0.31	0.59	3.07	10.92	36.6%	0.28	4.20	1.37
	5.79	9.54	0.27	0.54	2.59	10.53	35.3%	0.25	3.16	1.22
	5.84	9.31	0.23	0.49	2.12	10.15	34.0%	0.21	2.26	1.07
	5.89	9.07	0.18	0.44	1.66	9.76	32.7%	0.17	1.49	0.90
	5.94	8.35	0.15	0.39	1.21	8.88	29.7%	0.14	0.91	0.75
	5.99	8.19	0.10	0.34	0.80	8.62	28.9%	0.09	0.44	0.55
	6.04	6.56	0.06	0.29	0.42	6.90	23.1%	0.06	0.16	0.38
	6.09	2.79	0.07	0.24	0.20	3.04	10.2%	0.07	0.08	0.42
	6.14	1.35	0.08	0.19	0.10	1.51	5.1%	0.07	0.04	0.42
	6.19	0.81	0.07	0.14	0.05	0.90	3.0%	0.06	0.02	0.37
	6.24	0.47	0.05	0.09	0.02	0.51	1.7%	0.04	0.01	0.28
	6.29	0.21	0.02	0.04	0.00	0.23	0.8%	0.02	0.00	0.15

STREAM NAME: Schaefer Creek
XS LOCATION: 25 m upstream from Grouse confluence
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	5.80	cfs
CALCULATED FLOW (Qc)=	6.64	cfs
(Qm-Qc)/Qm * 100 =	-14.5	%
MEASURED WATERLINE (WLm)=	5.65	ft
CALCULATED WATERLINE (WLc)=	5.64	ft
(WLm-WLc)/WLm * 100 =	0.2	%
MAX MEASURED DEPTH (Dm)=	0.90	ft
MAX CALCULATED DEPTH (Dc)=	0.69	ft
(Dm-Dc)/Dm * 100	23.2	%
MEAN VELOCITY=	1.63	ft/sec
MANNING'S N=	0.143	
SLOPE=	0.09982	ft/ft
.4 * Qm =	2.3	cfs
2.5 * Qm=	14.5	cfs

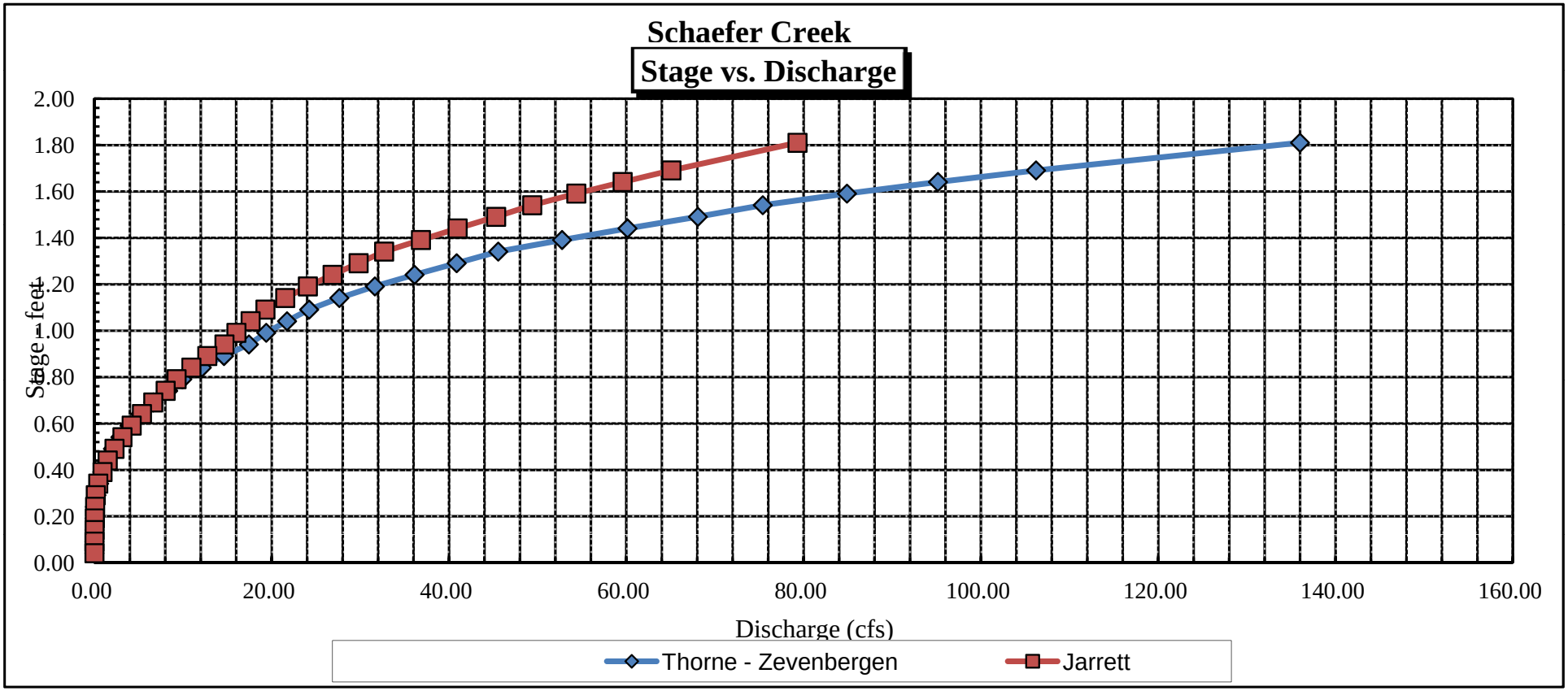
RECOMMENDED INSTREAM FLOW:
==========

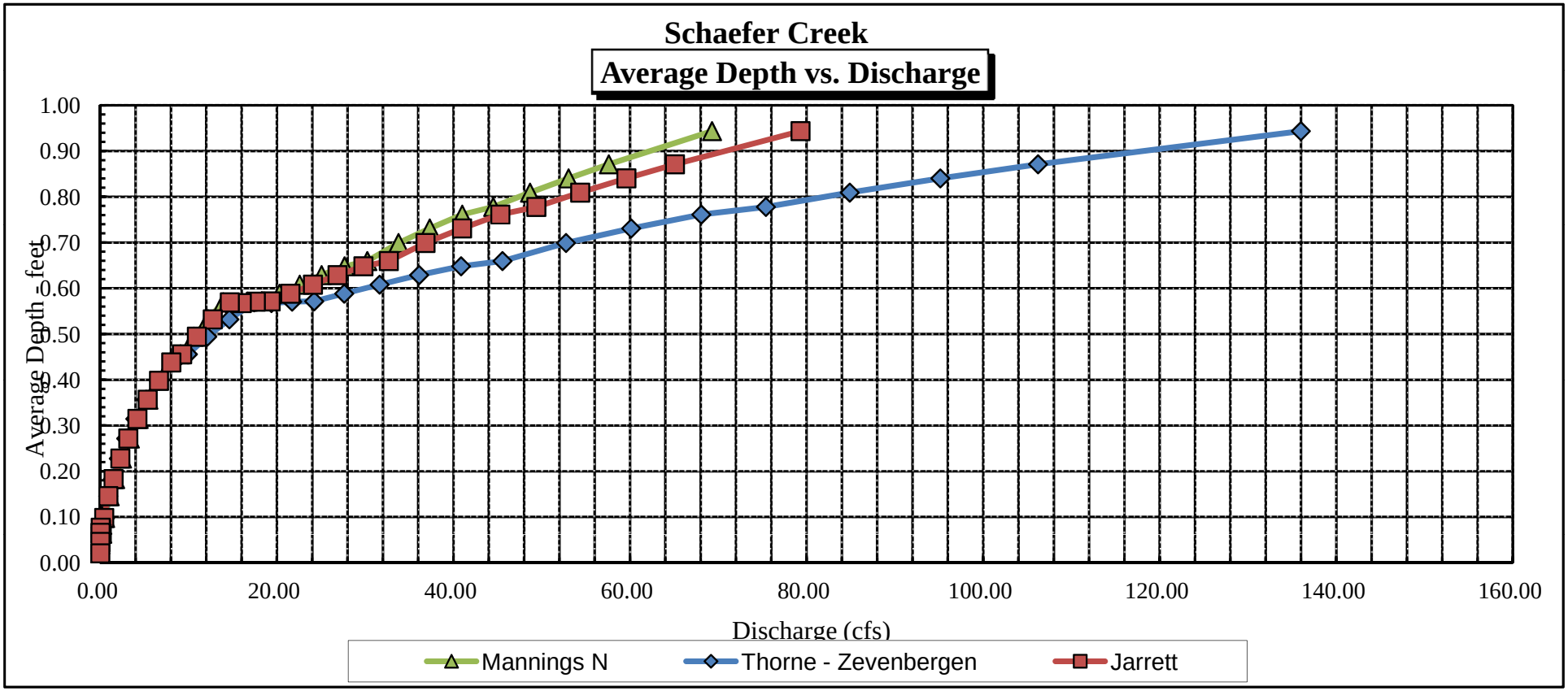
FLOW (CFS)	PERIOD
==========	========
_____	_____
_____	_____
_____	_____
_____	_____

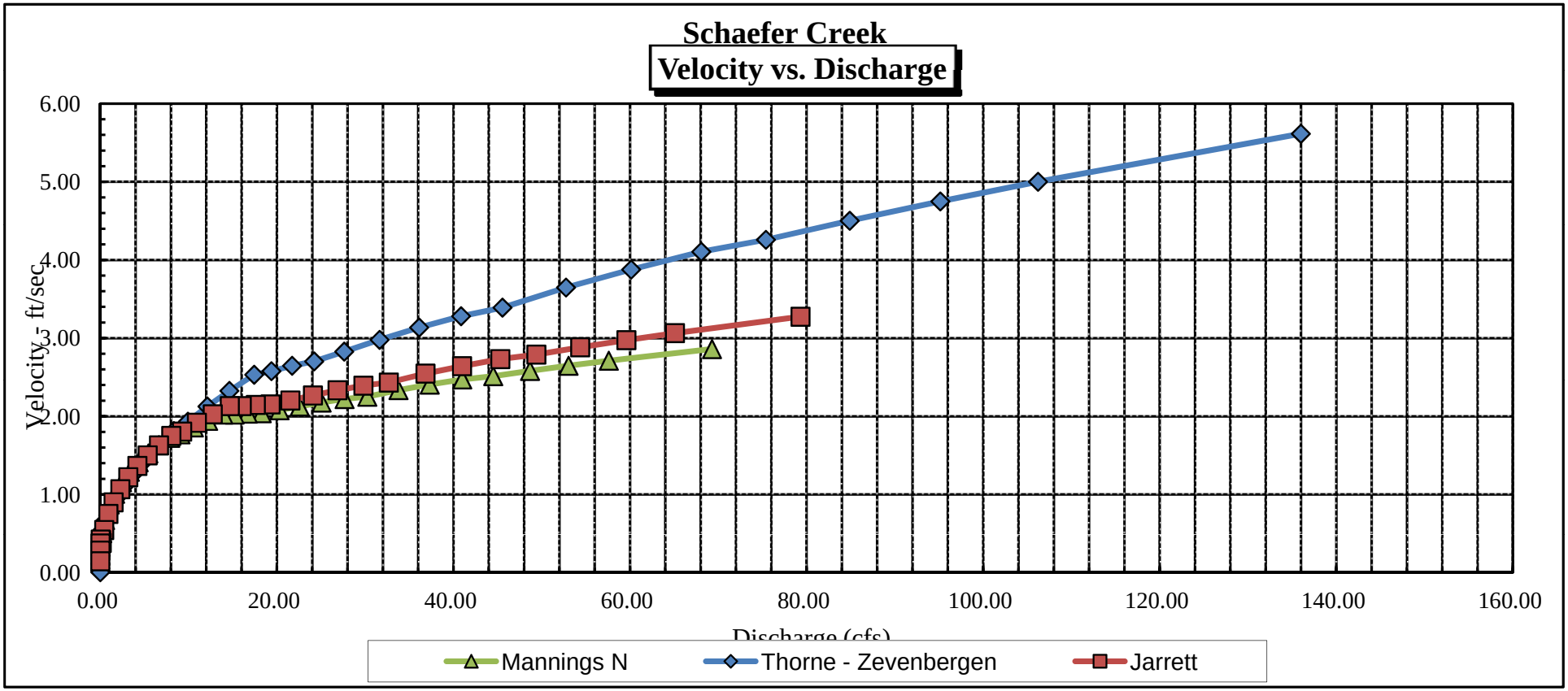
RATIONALE FOR RECOMMENDATION:
==========

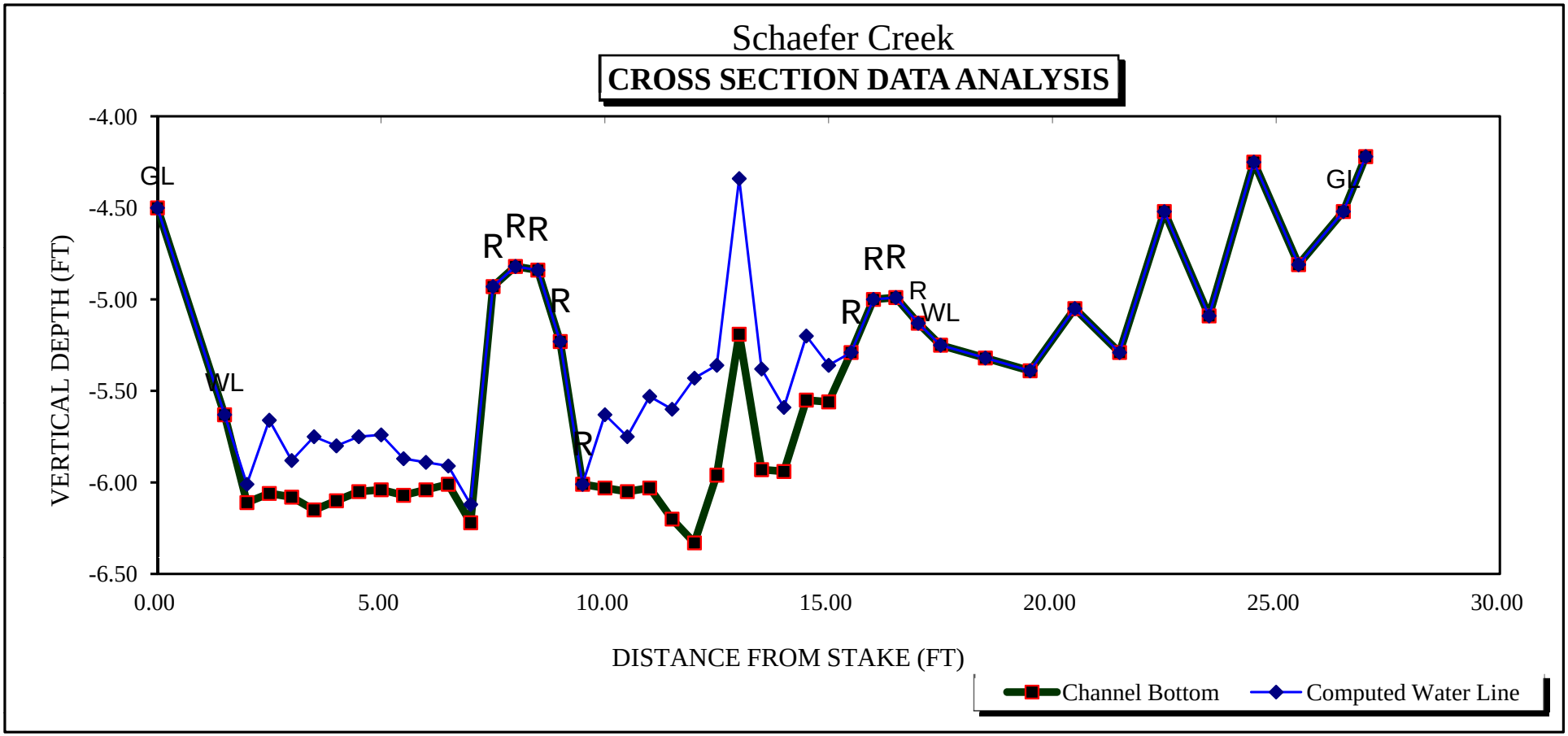
RECOMMENDATION BY: …….…….……..... AGENCY..……...……..……..…..... DATE:.....…..…...……

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


Schaefer Creek
Stage vs. Discharge
Stage - feet
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett


Schaefer Creek
Average Depth vs. Discharge
Average Depth - feet
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Schaefer Creek
Velocity vs. Discharge
Velocity - ft/sec
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
160.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Schaefer Creek
CROSS SECTION DATA ANALYSIS
-4.00
-4.50
-5.00
-5.50
-6.00
-6.50
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
DISTANCE FROM STAKE (FT)
GL
WL
R
RR
R
R
RR
R
R
WL
GL
Channel Bottom
Computed Water Line