United States Department of the Interior
BUREAU OF LAND MANAGEMENT
Colorado State Office
2850 Youngfield Street
Lakewood, Colorado 80215-7210
www.co.blm.gov

In Reply Refer To:
7250 (CO-932)

Ms. Linda Bassi
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Dear Ms. Bassi:

The Bureau of Land Management (BLM) is writing this letter to formally communicate its recommendation for an increase of two existing instream flow water rights on Willow Creek. Willow Creek is located in Water Division 6 near Steamboat Lake State Park. The Colorado Water Conservation Board (CWCB) appropriated instream flow water rights on Willow Creek in 1977 in the following amounts:

- Outlet of Steamboat Lake to confluence with Beaver Creek – 5 cfs, year round
- Confluence with Beaver Creek to confluence with Elk River – 7 cfs, year round

Location and Land Status. Willow Creek originates west of Hahns Peak and northwest of Steamboat Lake State Park. It flows into the Elk River approximately five miles southeast of Steamboat Lake State Park. This recommendation covers two stream reaches:

- Outlet of Steamboat Lake to confluence with Beaver Creek, a distance of approximately 4.8 miles. Of this mileage, BLM manages 1.9 miles, Colorado Parks and Wildlife manages 1.1 miles, and private owners manage 1.8 miles.

- Confluence with Beaver Creek to confluence with Lester Creek, a distance of approximately 1.5 miles. Note that this enlargement recommendation does not apply to the portion of Willow Creek between the confluence with Lester Creek and the confluence with the Elk River. Of this mileage, BLM manages 0.9 miles and private owners manage 0.6 miles.

Biological Summary. This portion of Willow Creek is a cold-water, low gradient stream that flows through wide stream valleys before entering the Routt National Forest. The stream has a good mix of riffle, run, and deep pool habitats. Substrate ranges from gravels to eight-inch cobbles. Presence of some filamentous algae indicates that the creek may have nutrient loading and/or excessively high water temperatures.

Fishery surveys revealed a self-sustaining native fishery which includes mountain suckers, mottled sculpin and speckled dace. White suckers, which are native to the Front Range, were also documented in the creek. Intensive macro-invertebrate surveys have not been conducted, but spot samples have revealed various species of mayfly and caddisfly,

The riparian community along Willow Creek is in good condition, and streambank stability appears to be improving. The riparian community is comprised mainly of willows and sedges, and it occupies the entire valley bottom.

Rationale for Instream Flow Increase. The BLM believes an instream flow increase for Willow Creek is warranted for two reasons:

Physical Habitat Characteristics – The R2Cross data summarized below clearly indicates that the current instream flow water right does not provide sufficient physical habitat during the warm weather portions of the year when the fish populations are feeding, growing and spawning. When the existing instream flow rights are applied to the cross sections that were collected, the stream averages 70 percent wetted perimeter immediately below Steamboat Lake and 55 percent below the confluence with Beaver Creek, so a significant portion of the potential habitat is not available. The available habitat is further reduced when the existing instream flow rates are applied to the cross section collected, because average depths are only 0.22 to 0.32 feet. These depths occur in a stream that averages 35 feet in width. While 0.22 feet is sufficient for fish passage, the fact that 0.22 feet is an *average* depth shows that, in many portions of the channel, depths are significantly *less* than 0.22 feet and may not be usable by the fish population. During the warm weather season, the fish population needs to have access to as much of the stream channel as possible for feeding, resting and spawning if it is to survive the pronounced cold winters in this location.

Stream Temperatures - After Willow Creek leaves Steamboat Lake, it exhibits a wide channel with almost no shading from shrubs and trees. In this type of creek environment, aquatic habitat can be at risk from excessively high temperatures during the summer months. For example, when the BLM surveyed the creek in August 2011, the stream temperature was 21 degrees Celsius, which is at the upper limit of what many cold water species, such as speckled dace and mottled sculpin, can tolerate without excessive stress on the fish population. This stream temperature was not taken on an excessively hot day or during excessively low flow conditions.

Protecting a higher flow rate will provide greater depths and faster velocities, which tend to reduce stream temperatures. In addition, the higher flow rate will allow the fishery greater access to locations with overhanging banks, where temperatures typically are cooler. An increased flow rate will provide more physical habitat during the spawning and growth seasons, which will help the fish population recover from any temperature extremes. In addition, the BLM believes that this creek has the potential to support trout species year-round if excessively high temperatures are prevented. The BLM notes that

speckled dace and mottled sculpin are present, and these species typically co-inhabit streams with trout species. BLM also notes that trout species are found in most of the perennial tributaries to Willow Creek.

R2Cross Analysis. BLM collected the following R2Cross data from Willow Creek:

Reach #1 – Outlet of Steamboat Lake to confluence with Beaver Creek:

Cross Section Date	Discharge Rate	Top Width	Winter Flow Recommendation (meets 2 of 3 hydraulic criteria)	Summer Flow Recommendation (meets 3 of 3 hydraulic criteria)
08/16/2011 #3	10.75 cfs	34.97 feet	7.22 cfs	11.94 cfs
08/16/2011 #4	10.27 cfs	34.81 feet	8.22 cfs	11.83 cfs
		Averages:	7.72 cfs	11.89 cfs

Reach #2 – Confluence with Beaver Creek to confluence with Lester Creek:

Cross Section Date	Discharge Rate	Top Width	Winter Flow Recommendation (meets 2 of 3 hydraulic criteria)	Summer Flow Recommendation (meets 3 of 3 hydraulic criteria)
09/26/2011 #1	13.78 cfs	36.79 feet	6.09 cfs	16.44 cfs
09/26/2011 #2	12.69 cfs	39.21 feet	Out of confidence interval	20.89 cfs
08/16/2011 #1	16.89 cfs	41.91 feet	Out of confidence interval	27.98 cfs
08/16/2011 #2	16.56 cfs	42.60 feet	8.56 cfs	15.97 cfs
		Averages:	7.33 cfs	20.32 cfs

The BLM's analysis of this data, coordinated with Colorado Parks and Wildlife, indicates that the following flows are needed to protect the fishery and natural environment to a reasonable degree:

Reach #1 – Outlet of Steamboat Lake to confluence with Beaver Creek

> An increase of 7.0 cfs to the existing 5.0 cfs instream flow water right is recommended during the snowmelt runoff period, from April 16 through June 30. This recommendation is driven by the average velocity criteria. This flow rate will assist in maintaining the native fish assemblage, by maintaining a sufficient amount of physical habitat during their spawning period. Appropriation of an additional 7.0 cfs would bring the total instream flow water right up to 12.0 cubic feet per second during April 16 to June 30 period.

Reach #2 – Confluence with Beaver Creek to confluence with Lester Creek

An increase of 13.0 cubic feet per second to the existing 7.0 cfs instream flow water right is recommended during the snowmelt runoff period, from April 16 through June 30. This recommendation is driven by the average depth criteria. This flow rate will assist in maintaining the native fish assemblage, by maintaining a sufficient amount of physical habitat during their spawning period. Appropriation of an additional 13.0 cfs would bring the total instream flow water right up to 20.0 cfs during the April 16 to June 30 period.

An increase of 3.0 cubic feet per second is recommended from July 1 to July 31, and is driven by water availability. While this flow rate doesn't meet the average depth criteria, it will provide an average velocity of 1.33 feet per second, average wetted perimeter of 63 percent, and average depth of 0.3 feet. Appropriation of an additional 3.0 cfs would bring the total instream flow water right up to 10.0 cfs during the July 1 to July 31 period. This amount of protection is superior to the existing flow rate of 7.0 during one of the warmest months of the year.

BLM recommends that the existing 7.0 cubic feet per second water right remain unchanged for the remainder of year, unless additional data collection demonstrates that this flow is not sufficient to meet instream flow criteria.

Water Availability. While there is no gage located on this creek, there is an abundance of gaging data in the larger Elk River watershed. Gage data that the CWCB could use for an analysis of comparable watersheds or for a basin apportionment analysis include the following United States Geological Survey (USGS) gages:

09241000 Elk River at Clark, CO
09244500 Elkhead Creek near Clark, CO
09240800 South Fork Elk River near Clark, CO

The BLM recommends using the StreamStats package developed jointly between USGS and the CWCB to develop a raw estimate of water availability. Historic diversions and storage volumes could be subtracted from streamflow estimates produced by the StreamStats package.

The BLM is not aware of any existing diversions in the proposed instream flow reaches. However, the BLM is aware of the following conditional water rights:

- Steamboat Lake Water District Well No. 1 is decreed for 13 cfs, 1976 priority, for municipal, domestic and other uses. While the well would not divert directly from the creek, it would be located very close to the alluvium associated with Willow Creek. As such, it could reduce flow in the creek.

- Grouse Mountain Reservoir is decreed for 79,262 acre feet for municipal, domestic, industrial, commercial and other uses to Tri-State Generation and Transmission Association. The water right was adjudicated in 1972. If constructed, the reservoir would

inundate the proposed instream flow reaches.

BLM is aware of other water rights owners in upsteam locations who may be interested in the proposed appropriation:

- Colorado Division of Parks and Wildlife holds an 18,064 acre foot storage decree for Steamboat Lake State Park. Tri-State Generation and Transmission Association also holds a right to store up to 5,000 acre feet of water in Steamboat Lake.

- There are two significant ditches upstream from Steamboat Lake. Folden Ditch holds a decree for 3.0 cfs for irrigation purposes. Willow Spring Ditch holds a water right for 0.5 cfs for irrigation purposes.

In addition to the water rights described above, there are also numerous small water rights upstream from Steamboat Lake on springs, wells and reservoirs with less than 10 acre feet capacity.

Relationship to Land Management Plans. Even though the BLM's ownership along the creek is limited, BLM has elected to retain that land in public ownership because of its high riparian and recreation values. Lands owned by the BLM are easily accessed by major roads and provide additional recreation opportunities adjacent to Steamboat Lake State Park. In addition, the creek provides important lower elevation habitat for native fish species in an area where most of the land is privately owned. The BLM intends to continue management for riparian and fishery values, with emphasis on improving livestock use patterns to maintain and improve riparian conditions. Appropriation of an instream flow water right would assist the BLM in long-term management of riparian values and important fishery values.

Data sheets, R2Cross output, fishery survey information and photographs of the cross section were included with BLM's draft recommendation in February 2012. We thank both Colorado Parks and Wildlife and the Colorado Water Conservation Board for their cooperation in this effort.

If you have any questions regarding our instream flow recommendation, please contact Roy Smith at 303-239-3940.

Sincerely,

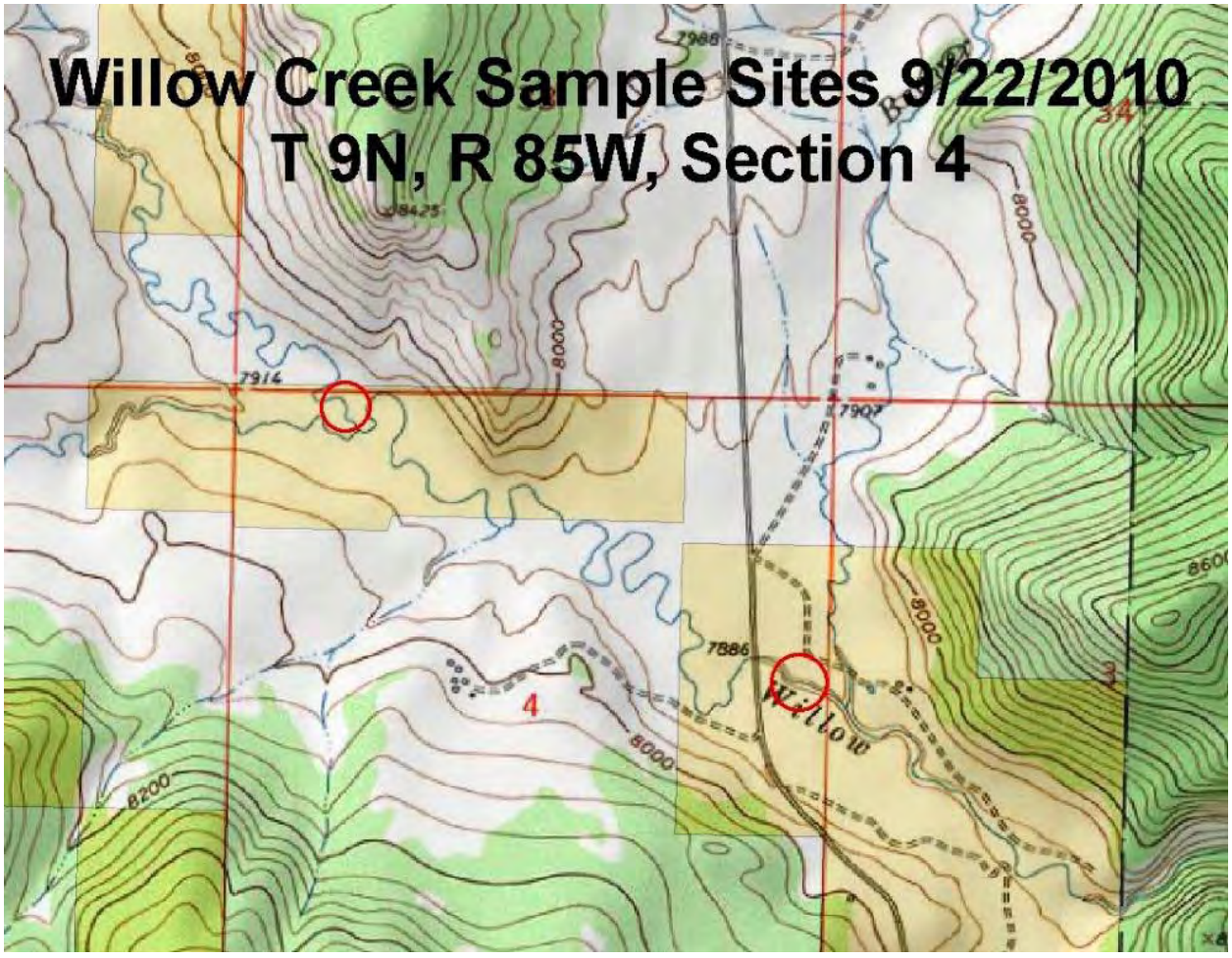
Brian St. George
Deputy State Director
Resources and Fire

Cc: Eric Scherff, Little Snake FO
Wendy Reynolds, Little Snake FO

Little Snake Field Office Stream Surveys
September 2010

Willow Creek - Water Code #22842

Willow Creek, located northwest and southeast of Steamboat Lake State Park on BLM lands managed by the Little Snake Field Office was sampled on September 22 and 23, 2010. Willow Creek is tributary to the Elk River and then the Yampa River. Sampling was done in support of the instream flow program. Presence/Absence sampling was completed to determine fishery status and composition. A two-pass removal population estimate was not completed due to the size of the stream and lack of personnel. Sampling was conducted at two sites, via one backpack electro-shocker. A 336 foot stream reach was sampled at the first site and a 300 foot stream reach was sampled at the second. Personnel present were Gregory Delevan and Clay Ramey, BLM.



Willow Creek

Mottled Scalping

STREAM SURVEY FISH SAMPLING FORM

Water Willow Creek **H_2O Code** 22842 **Date** 9/23/2010

Gear BPE **Effort** **Station #** 2 **Pass #** SPOT

Crew Dekleva, Ramey **Drainage** Yampa **Location** GPS

PASS	SPECIES	LENGTH	WEIGHT		PASS	SPECIES	LENGTH	WEIGHT
1	MOS	155			1	MOS	95	
1	MOS	141			1	MTS	80	
1	MTS	88						
1	MOS	93						
1	MOS	137						
1	MOS	100						
1	MOS	103						
1	MTS	72						
1	MOS	88						
1	MOS	97						
1	MOS	114						
1	MTS	75						
1	MTS	85						
1	MOS	111						
1	MTS	81						
1	MTS	94						
1	MTS	92						
1	M0S	103						
1	MOS	90						
1	MTS	80						
1	MTS	86						
1	MOS	94						
1	MTS	76						
1	MTS	91						
1	MTS	74						

GPS LOCATION: 13T 338189, 4514909

STREAM WIDTH: ~30 ft. SAMPLE REACH: 336 ft.

CONDUCTIVITY: ELECTROSHOCKER SETTINGS :

NOTES: Willows, Sedges, Embedded Cobbles, Wide Flat Bottom, Slow moving water

STREAM SURVEY FISH SAMPLING FORM

Water	Willow Creek	**H_2O Code**	22842	**Date**	9/22/2010		
Gear	BPE	**Effort**		**Station #**	2	**Pass #**	Spot
Crew	Dekleva, Ramey			**Drainage**	Yampa	**Location**	GPS

PASS	SPECIES	LENGTH	WEIGHT		PASS	SPECIES	LENGTH	WEIGHT
1	WHS	201						
1	WHS	168						
1	MTS	108						
1	MTS	109						
1	MTS	103						
1	WHS	91						
1	MOS	117						
1	MTS	42						
1	MTS	102						
1	FHM	44						
1	MOS	74						
1	MOS	71						
1	FHM	62						
1	MTS	47						
SPD COUNT		14						

GPS LOCATION:

STREAM WIDTH: ~30 ft. SAMPLE REACH: 300 ft.

CONDUCTIVITY: ELECTROSHOCKER SETTINGS :

NOTES: Big Stream, 1 BPE is insufficient, Riparian in good condition lots of Willows, Grasses, and Sedges, algae present and water is slightly stained. Caddis, Mayflies, and Damselflies present.

Discussion. Willow Creek is a source of water for Steamboat Lake and is the tailwater stream below the dam. Willow Creek contained a good mix of riffles, runs, and pools. At the sample sites the stream was wide with slow moving water and a cobble based bottom, the water was also slightly stained. The stream appeared to be a Rosgen C channel type. Riparian vegetation consisted of willows and sedges mainly, as well as a small grass component.

For the size of the stream less fish were captured at both sites versus the smaller tributaries, Red and Beaver Creeks. This may be due to the size of the stream and the ability of the fish to swim away from the electricity. A variety of fish were captured including Mountain suckers, Mottled sculpin, Speckled dace, Fathead minnow and White suckers. Macro-invertebrates present were caddis, mayflies, and damselflies.

Recommendations:

- This stream would benefit from an instream flow recommendation. Periodically monitor to ensure that stream habitats remain in good condition.

- Follow up with a two-pass removal population estimate with three backpack electro-fishers or possibly a bank shocking rig.

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Willow Creek | CROSS-SECTION NO.: 1

CROSS-SECTION LOCATION: 800 ft. downstream from confluence with Beaver Ck

DATE: 8-16-11 | OBSERVERS: R. Smith, E. Spencer

LEGAL DESCRIPTION | ¼ SECTION: SW | SECTION: 3 | TOWNSHIP: 9 (N)/S | RANGE: 85 E(W) | PM: 6th

COUNTY: Routt | WATERSHED: Yampa | WATER DIVISION: 6 | DOW WATER CODE: 02842

MAP(S): USGS: UTMs Zone 13 338449 4514639 | USFS:

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO | METER TYPE: M-M

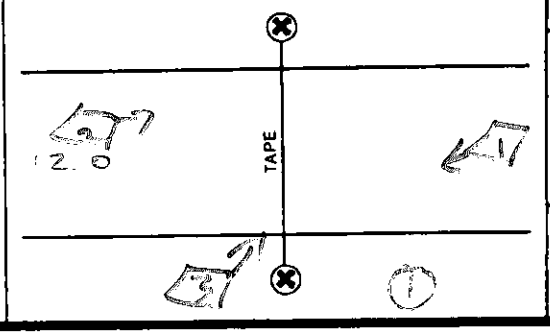
METER NUMBER: | DATE RATED: | CALIB/SPIN. ____ sec | TAPE WEIGHT surveyed ____ lbs/foot | TAPE TENSION: surveyed ____ lbs

CHANNEL BED MATERIAL SIZE RANGE: 4 cm & cobbles | PHOTOGRAPHS TAKEN: (YES/NO) | NUMBER OF PHOTOGRAPHS: 3

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0	7.22 / 7.23
② WS Upstream	17.6	7.18
③ WS Downstream	33.0	7.35
SLOPE	0.17 / 33.0 = .0034	

SKETCH



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

mayfly, caddisfly, stonefly

COMMENTS

Temp = 17.6° C
Cond = 54
Salinity = 0
Ph = 8.38

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek	CROSS-SECTION NO.: 1	DATE: 8-16-11	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 11:40

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)
RS	0.0		5.40								
G	6.0		5.92								
	8.0		6.83								
	10.0		7.15								
W	12.0		7.20								
	13.0		7.20	0				0			
	14.5		7.3	.1				.92			
	16		7.5	.3				.92			
	17.5		7.5	.3				1.56			
	19		7.65	.45				2.32			
	20.5		7.6	.40				2.34			
	22		7.7	.50				2.40			
	23.5		7.8	.60				2.06			
	25		7.7	.50				1.94			
	26.5		7.6	.40				2.08			
	28		7.5	.30				0.70			
	29.5		7.7	.50				2.08			
	31		7.55	.35				1.85			
	32.5		7.7	.50				1.97			
	34		7.6	.40				1.01			
	35.5		7.5	.30				1.58			
	37		7.4	.20				0.29			
	38.5		7.35	.15				0.92			
	40		7.3	.10				0.18			
	41.5		7.3	.10				0.48			
	43		7.6	.40				0.65			
W	43.6		7.20								
	43.7		6.43								
LS+G	48.0		5.96								
TOTALS:											

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

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

LOCATION INFORMATION

STREAM NAME:	Willow Creek
XS LOCATION:	800 ft downst fr conf w Beaver Creek
XS NUMBER:	1
DATE:	16-Aug-11
OBSERVERS:	R. Smith, E. Spencer
1/4 SEC:	SW
SECTION:	3
TWP:	9N
RANGE:	85W
PM:	6th
COUNTY:	Routt
WATERSHED:	Elk River
DIVISION:	6
DOW CODE:	22842
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:	0.0034

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

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

STREAM NAME: Willow Creek
XS LOCATION: 800 ft downst fr conf w Beaver Creek
XS NUMBER: 1

DATA POINTS= 29

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
RS	0.00	5.49			0.00		0.00	0.00	0.0%
1 G	6.00	5.92			0.00		0.00	0.00	0.0%
	8.00	6.83			0.00		0.00	0.00	0.0%
	10.00	7.15			0.00		0.00	0.00	0.0%
W	12.00	7.20	0.00	0.00	0.00		0.00	0.00	0.0%
	13.00	7.20	0.00	0.00	0.00		0.00	0.00	0.0%
	14.50	7.30	0.10	0.92	1.50	0.10	0.15	0.14	0.8%
	16.00	7.50	0.30	0.92	1.51	0.30	0.45	0.41	2.5%
	17.50	7.50	0.30	1.56	1.50	0.30	0.45	0.70	4.2%
	19.00	7.65	0.45	2.32	1.51	0.45	0.68	1.57	9.3%
	20.50	7.60	0.40	2.34	1.50	0.40	0.60	1.40	8.3%
	22.00	7.70	0.50	2.40	1.50	0.50	0.75	1.80	10.7%
	23.50	7.80	0.60	2.06	1.50	0.60	0.90	1.85	11.0%
	25.00	7.70	0.50	1.94	1.50	0.50	0.75	1.46	8.6%
	26.50	7.50	0.40	2.08	1.51	0.40	0.60	1.25	7.4%
	28.00	7.50	0.30	0.70	1.50	0.30	0.45	0.32	1.9%
	29.50	7.70	0.50	2.08	1.51	0.50	0.75	1.56	9.2%
	31.00	7.55	0.35	1.85	1.51	0.35	0.53	0.97	5.8%
	32.50	7.70	0.50	1.97	1.51	0.50	0.75	1.48	8.7%
	34.00	7.60	0.40	1.01	1.50	0.40	0.60	0.61	3.6%
	35.50	7.50	0.30	1.58	1.50	0.30	0.45	0.71	4.2%
	37.00	7.40	0.20	0.29	1.50	0.20	0.30	0.09	0.5%
	38.50	7.35	0.15	0.92	1.50	0.15	0.23	0.21	1.2%
	40.00	7.30	0.10	0.18	1.50	0.10	0.15	0.03	0.2%
	41.50	7.30	0.10	0.48	1.50	0.10	0.15	0.07	0.4%
	43.00	7.60	0.40	0.65	1.53	0.40	0.42	0.27	1.6%
W	43.60	7.20	0.00	0.00	0.72		0.00	0.00	0.0%
	43.70	6.43			0.00		0.00	0.00	0.0%
1 LS & G	48.00	5.96			0.00		0.00	0.00	0.0%
TOTALS ----------					30.84	0.6 (Max.)	10.10	16.89	100.0%

Manning's n = 0.0246
Hydraulic Radius= 0.3273464

STREAM NAME: Willow Creek
XS LOCATION: 800 ft downst fr conf w Beaver Creek
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.10	9.95	-1.5%
6.95	10.10	18.42	82.5%
6.97	10.10	17.73	75.6%
6.99	10.10	17.03	68.7%
7.01	10.10	16.34	61.9%
7.03	10.10	15.65	55.1%
7.05	10.10	14.97	48.3%
7.07	10.10	14.28	41.5%
7.09	10.10	13.60	34.8%
7.11	10.10	12.92	28.0%
7.13	10.10	12.25	21.3%
7.15	10.10	11.58	14.7%
7.16	10.10	11.24	11.4%
7.17	10.10	10.91	8.1%
7.18	10.10	10.59	4.9%
7.19	10.10	10.26	1.7%
7.20	10.10	9.95	-1.5%
7.21	10.10	9.64	-4.5%
7.22	10.10	9.34	-7.5%
7.23	10.10	9.03	-10.5%
7.24	10.10	8.73	-13.5%
7.25	10.10	8.44	-16.4%
7.27	10.10	7.84	-22.3%
7.29	10.10	7.26	-28.1%
7.31	10.10	6.70	-33.7%
7.33	10.10	6.16	-38.9%
7.35	10.10	5.65	-44.0%
7.37	10.10	5.15	-48.9%
7.39	10.10	4.68	-53.7%
7.41	10.10	4.21	-58.3%
7.43	10.10	3.76	-62.7%
7.45	10.10	3.33	-67.0%

WATERLINE AT ZERO
AREA ERROR = 7.195

STREAM NAME: Willow Creek
XS LOCATION: 800 ft downst fr conf w Beaver Creek
XS NUMBER: 1 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	5.96	41.91	1.33	1.84	55.55	43.07	100.0%	1.29	231.82	4.17
	6.20	39.24	1.17	1.60	46.00	40.33	93.7%	1.14	176.86	3.84
	6.25	38.67	1.14	1.55	44.05	39.75	92.3%	1.11	166.15	3.77
	6.30	38.11	1.11	1.50	42.13	39.17	91.0%	1.08	155.78	3.70
	6.35	37.54	1.07	1.45	40.24	38.59	89.6%	1.04	145.75	3.62
	6.40	36.97	1.04	1.40	38.38	38.01	88.3%	1.01	136.04	3.54
	6.45	36.54	1.00	1.35	36.54	37.55	87.2%	0.97	126.39	3.46
	6.50	36.43	0.95	1.30	34.72	37.38	86.8%	0.93	116.40	3.35
	6.55	36.31	0.91	1.25	32.90	37.21	86.4%	0.88	106.74	3.24
	6.60	36.19	0.86	1.20	31.09	37.04	86.0%	0.84	97.42	3.13
	6.65	36.08	0.81	1.15	29.28	36.87	85.6%	0.79	88.44	3.02
	6.70	35.96	0.76	1.10	27.48	36.70	85.2%	0.75	79.81	2.90
	6.75	35.85	0.72	1.05	25.68	36.53	84.8%	0.70	71.53	2.79
	6.80	35.73	0.67	1.00	23.89	36.36	84.4%	0.66	63.62	2.66
	6.85	35.55	0.62	0.95	22.11	36.13	83.9%	0.61	56.14	2.54
	6.90	35.23	0.58	0.90	20.34	35.76	83.0%	0.57	49.19	2.42
	6.95	34.91	0.53	0.85	18.59	35.39	82.2%	0.53	42.62	2.29
	7.00	34.59	0.49	0.80	16.85	35.03	81.3%	0.48	36.44	2.16
	7.05	34.27	0.44	0.75	15.13	34.66	80.5%	0.44	30.66	2.03
	7.10	33.96	0.40	0.70	13.42	34.29	79.6%	0.39	25.30	1.88
	7.15	33.64	0.35	0.65	11.73	33.92	78.8%	0.35	20.36	1.74
WL	7.20	31.79	0.32	0.60	10.09	32.03	74.4%	0.32	16.46	1.63
	7.25	29.85	0.29	0.55	8.58	30.08	69.8%	0.29	13.09	1.53
	7.30	29.03	0.24	0.50	7.10	29.23	67.9%	0.24	9.74	1.37
	7.35	25.46	0.23	0.45	5.77	25.64	59.5%	0.23	7.52	1.30
	7.40	23.26	0.20	0.40	4.55	23.42	54.4%	0.19	5.38	1.18
	7.45	21.74	0.16	0.35	3.43	21.87	50.8%	0.16	3.51	1.02
	7.50	20.29	0.12	0.30	2.38	20.40	47.4%	0.12	2.00	0.84
	7.55	15.04	0.10	0.25	1.55	15.12	35.1%	0.10	1.20	0.77
	7.60	11.81	0.07	0.20	0.88	11.86	27.5%	0.07	0.55	0.62
	7.65	6.75	0.06	0.15	0.41	6.77	15.7%	0.06	0.22	0.54
	7.70	3.31	0.05	0.10	0.16	3.31	7.7%	0.05	0.08	0.48
	7.75	1.64	0.03	0.05	0.04	1.65	3.8%	0.03	0.01	0.32
	7.80	0.14	0.00	0.00	0.00	0.14	0.3%	0.00	0.00	0.06

STREAM NAME: Willow Creek
XS LOCATION: 800 ft downst fr conf w Beaver Creek
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	16.89	cfs
CALCULATED FLOW (Qc)=	16.46	cfs
(Qm-Qc)/Qm * 100 =	2.5	%
MEASURED WATERLINE (WLm)=	7.20	ft
CALCULATED WATERLINE (WLc)=	7.20	ft
(WLm-WLc)/WLm * 100 =	0.1	%
MAX MEASURED DEPTH (Dm)=	0.60	ft
MAX CALCULATED DEPTH (Dc)=	0.60	ft
(Dm-Dc)/Dm * 100	-0.8	%
MEAN VELOCITY=	1.63	ft/sec
MANNING'S N=	0.025	
SLOPE=	0.0034	ft/ft
.4 * Qm =	6.8	cfs
2.5 * Qm=	42.2	cfs

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

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

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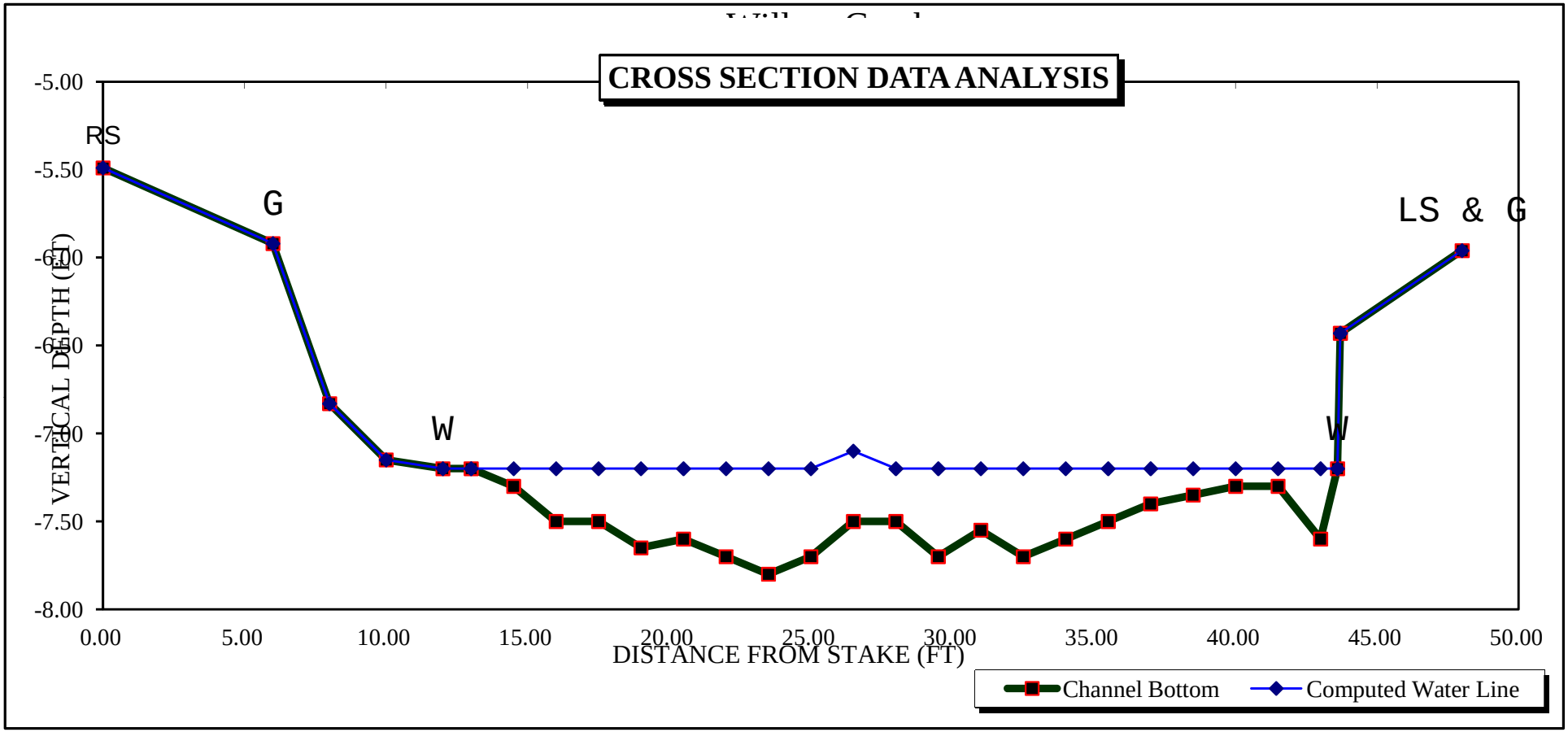
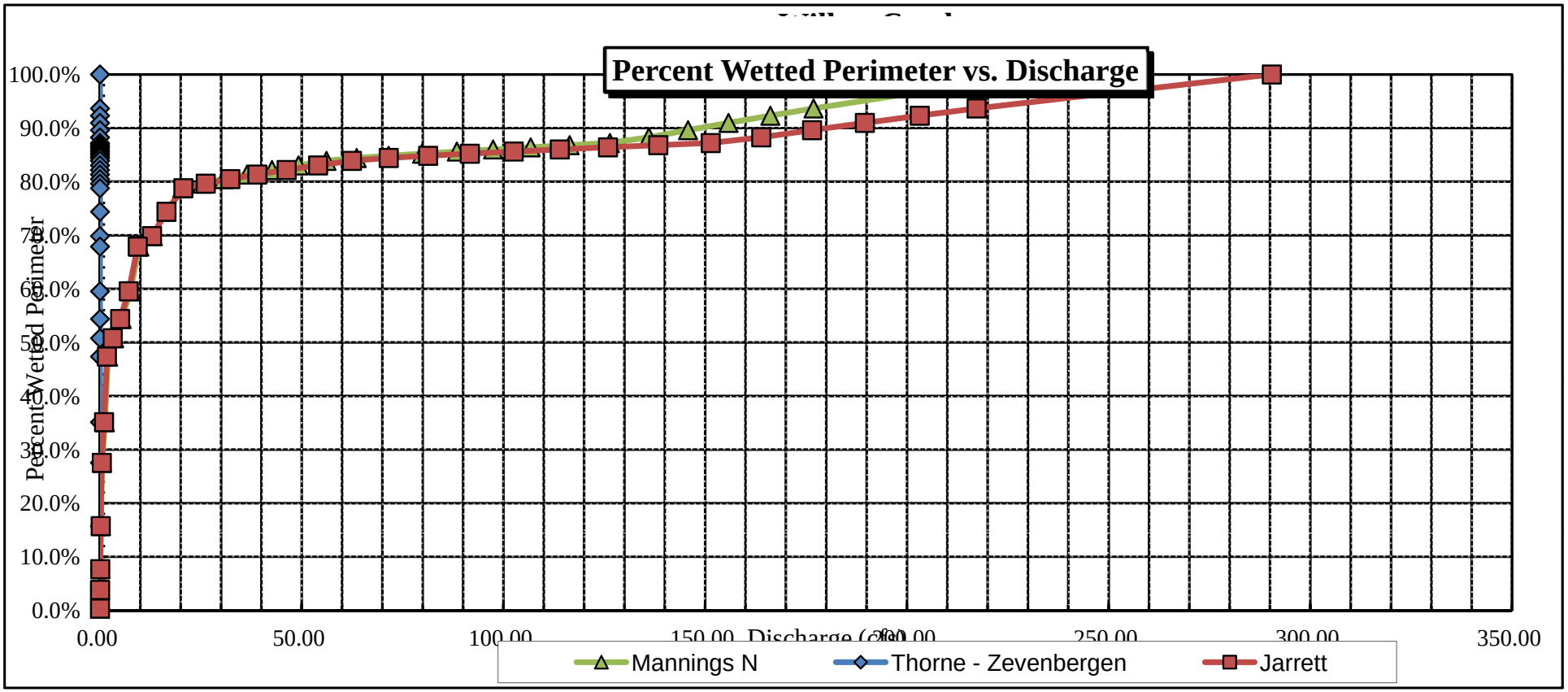
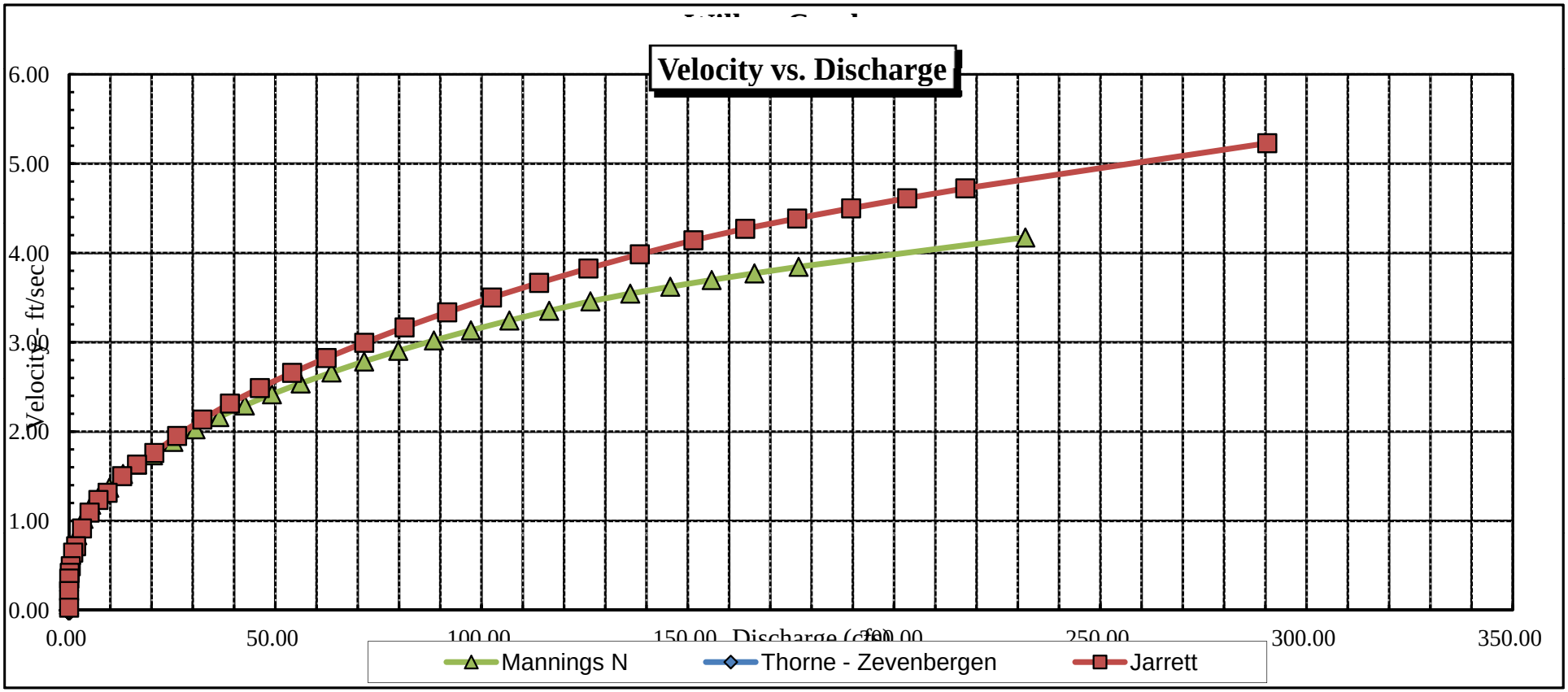
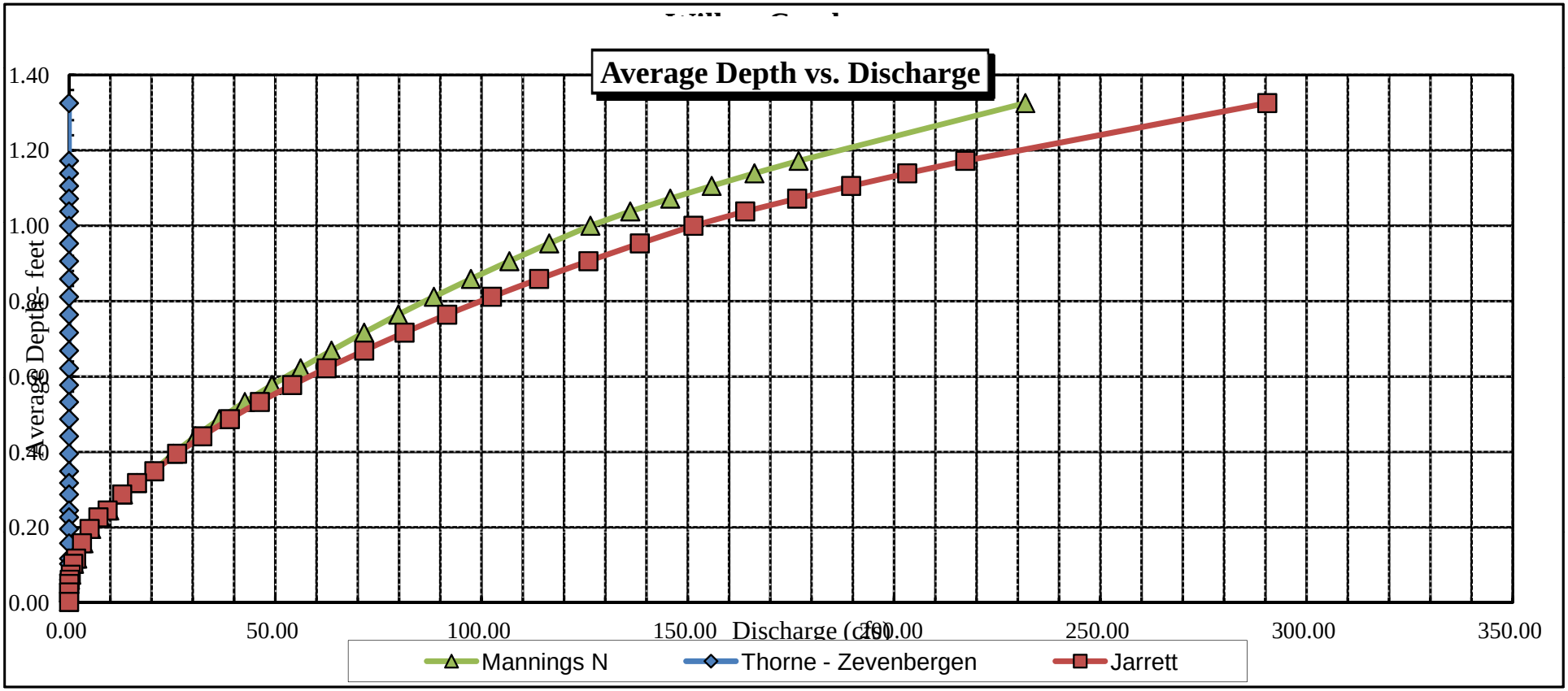
RECOMMENDATION BY: ………………...………..……............................... AGENCY..……………………......……....…....…....... DATE:......…...….......……………

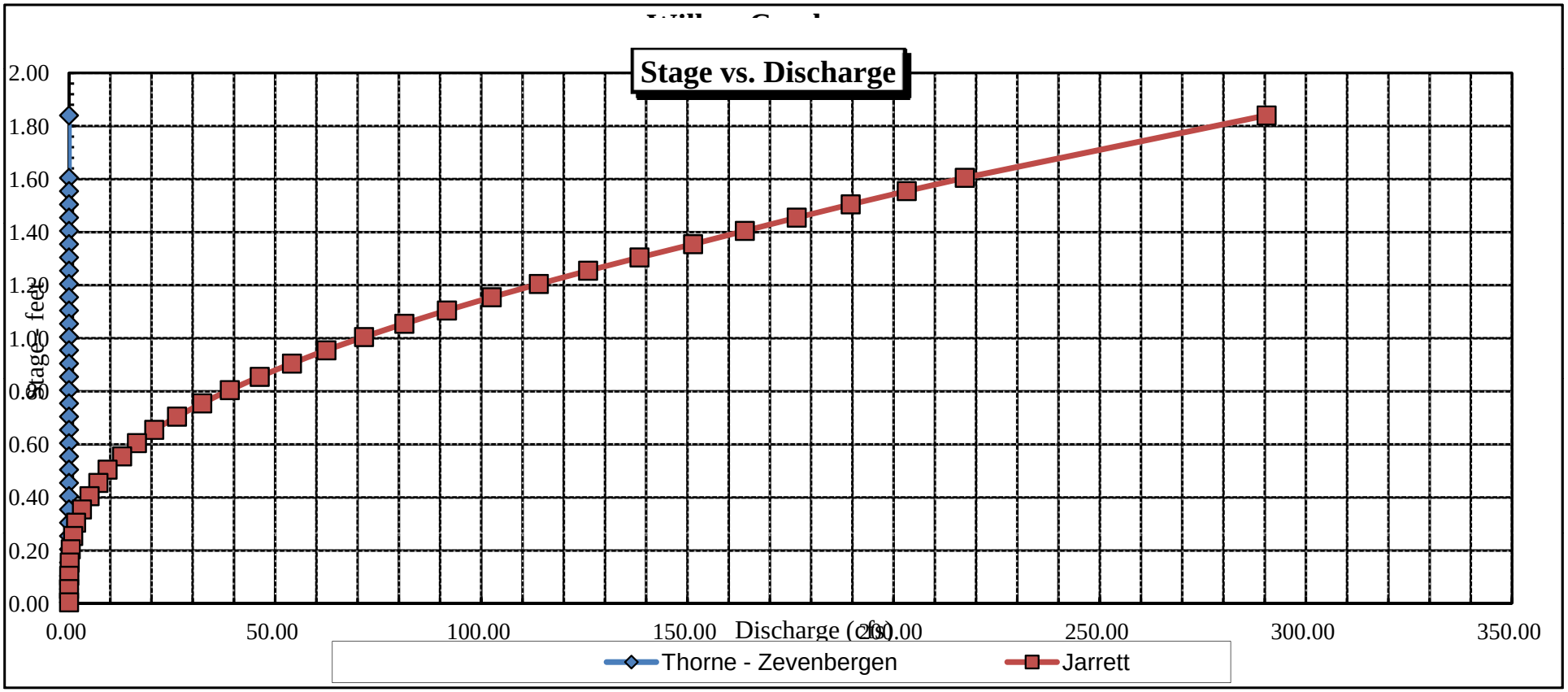
CWCB REVIEW BY: ..……………………………....………………………………………………...…............. DATE:.................…………….....


CROSS SECTION DATA ANALYSIS
RS
G
W
W
LS & G
-5.00
-5.50
-6.00
-6.50
-7.00
-7.50
-8.00
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


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
50.00
100.00
150.00
250.00
300.00
350.00
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Velocity - ft/sec
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Average Depth vs. Discharge
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Average Depth - feet
0.00
50.00
100.00
150.00
200.00
250.00
300.00
350.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


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
50.00
100.00
150.00
200.00
250.00
300.00
350.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Willow Creek						CROSS-SECTION NO.: 2
CROSS-SECTION LOCATION: 400 ft. downstream from conf. w/ Beaver Creek						
DATE: 8-16-11	OBSERVERS: R. Smith, E. Spencer					
LEGAL DESCRIPTION	¼ SECTION: SW	SECTION: 3	TOWNSHIP: 9 (N)/S	RANGE: 95 E/W	PM: 6th	
COUNTY: Routt	WATERSHED: Yampa	WATER DIVISION: 6	DOW WATER CODE: 22842			
MAP(S): USGS:			GPS Zone 13 338423			
USFS:			4514773			

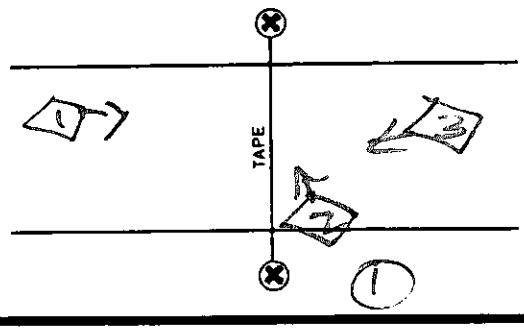
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES)/NO	METER TYPE: M-M			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed lbs/foot	TAPE TENSION: surveyed lbs
CHANNEL BED MATERIAL SIZE RANGE: 2 to 8" cobbles	PHOTOGRAPHS TAKEN (YES)/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0	5.15 / 5.10
② WS Upstream	27.5'	5.03
③ WS Downstream	35.0'	5.26
SLOPE	0.23 / 62.5 = .0036	

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

mayfly, caddisfly, stonefly

COMMENTS

Ph: 8.38
Cond: 54
Temp: 17.60° C
Salinity: 0

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek	CROSS-SECTION NO.: 2	DATE: 8-16-11	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 12:45 pm

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)
LS	0.0		2.16								
G	1.4		2.56								
	3.1		4.48								
	7.0		4.70								
W	11.2		5.15								
	12.0		5.40	.25				.31			
	13.5		5.65	.50				1.73			
	15.0		5.65	.50				.58			
	16.5		5.75	.60				1.62			
	18.0		5.90	.75				1.70			
	19.5		5.95	.80				2.06			
~~20.25~~ >	21.0	6.95 >	5.85	.70	< .80			2.25	< 1.84		
	22.5		6.75	.165				1.77			
	24.0		5.75	.605				1.55			
	25.5		5.8	.70				1.56			
	27.0		5.5	.40				1.48			
	28.5		6.3	.20				1.28			
	30.0		5.35	.25				0.30			
	31.5		5.3	.20				0.42			
	33.0		5.35	.25				0.40			
	34.5		6.3	.20				0.28			
	36.0		5.2	.10				0.22			
	37.5		5.1	ϕ				ϕ			
W	38.4		5.10								
	40.0		4.66								
	44.0		3.56								
	57.0		2.68								
TOTALS:											

End of Measurement	Time	Gage Reading ___ ft	CALCULATIONS PERFORMED BY	CALCULATIONS CHECKED BY

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

LOCATION INFORMATION

STREAM NAME:	Willow Creek
XS LOCATION:	400 ft ds fr conf w Beaver Creek
XS NUMBER:	2
DATE:	16-Aug-11
OBSERVERS:	R. Smith, E. Spencer
1/4 SEC:	SW
SECTION:	3
TWP:	9N
RANGE:	85W
PM:	6th
COUNTY:	Routt
WATERSHED:	Elk River
DIVISION:	6
DOW CODE:	22842
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:	0.0036

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

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

STREAM NAME: Willow Creek
XS LOCATION: 400 ft ds fr conf w Beaver Creek
XS NUMBER: 2

DATA POINTS= 28

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
	LS	0.00	2.16			0.00		0.00	0.00	0.0%
1	G	1.40	3.56			0.00		0.00	0.00	0.0%
		3.10	4.48			0.00		0.00	0.00	0.0%
		9.00	4.70			0.00		0.00	0.00	0.0%
	W	11.20	5.15	0.00	0.00	0.00		0.00	0.00	0.0%
		12.00	5.40	0.25	0.31	0.84	0.25	0.29	0.09	0.5%
		13.50	5.65	0.50	1.73	1.52	0.50	0.75	1.30	7.8%
		15.00	5.65	0.50	0.58	1.50	0.50	0.75	0.44	2.6%
		16.50	5.75	0.60	1.62	1.50	0.60	0.90	1.46	8.8%
		18.00	5.90	0.75	1.70	1.51	0.75	1.13	1.91	11.5%
		19.50	5.95	0.80	2.06	1.50	0.80	0.90	1.85	11.2%
		20.25	5.95	0.80	1.84	0.75	0.80	0.60	1.10	6.7%
		21.00	5.85	0.70	2.23	0.76	0.70	0.79	1.76	10.6%
		22.50	5.75	0.65	1.77	1.50	0.65	0.98	1.73	10.4%
		24.00	5.75	0.65	1.55	1.50	0.65	0.98	1.51	9.1%
		25.50	5.80	0.70	1.56	1.50	0.70	1.05	1.64	9.9%
		27.00	5.50	0.40	1.48	1.53	0.40	0.60	0.89	5.4%
		28.50	5.30	0.20	1.28	1.51	0.20	0.30	0.38	2.3%
		30.00	5.35	0.25	0.30	1.50	0.25	0.38	0.11	0.7%
		31.50	5.30	0.20	0.42	1.50	0.20	0.30	0.13	0.8%
		33.00	5.35	0.25	0.40	1.50	0.25	0.38	0.15	0.9%
		34.50	5.30	0.20	0.28	1.50	0.20	0.30	0.08	0.5%
		36.00	5.20	0.10	0.22	1.50	0.10	0.15	0.03	0.2%
		37.50	5.10	0.00	0.00	1.50		0.00	0.00	0.0%
	W	38.40	5.10	0.00	0.00	0.00		0.00	0.00	0.0%
		40.00	4.66			0.00		0.00	0.00	0.0%
1	G	44.00	3.56			0.00		0.00	0.00	0.0%
	RS	57.00	2.68			0.00		0.00	0.00	0.0%
	TOTALS ----------					26.43	0.8 (Max.)	11.50	16.56	100.0%

Manning's n = 0.0356
Hydraulic Radius= 0.4350415

STREAM NAME: Willow Creek
XS LOCATION: 400 ft ds fr conf w Beaver Creek
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	11.50	11.38	-1.1%
4.88	11.50	18.42	60.2%
4.90	11.50	17.84	55.1%
4.92	11.50	17.26	50.1%
4.94	11.50	16.68	45.0%
4.96	11.50	16.10	40.0%
4.98	11.50	15.53	35.1%
5.00	11.50	14.96	30.1%
5.02	11.50	14.40	25.2%
5.04	11.50	13.84	20.3%
5.06	11.50	13.28	15.5%
5.08	11.50	12.72	10.6%
5.09	11.50	12.45	8.2%
5.10	11.50	12.17	5.8%
5.11	11.50	11.90	3.5%
5.12	11.50	11.64	1.2%
5.13	11.50	11.38	-1.1%
5.14	11.50	11.12	-3.3%
5.15	11.50	10.86	-5.6%
5.16	11.50	10.60	-7.8%
5.17	11.50	10.35	-10.0%
5.18	11.50	10.10	-12.2%
5.20	11.50	9.60	-16.5%
5.22	11.50	9.11	-20.8%
5.24	11.50	8.63	-25.0%
5.26	11.50	8.15	-29.1%
5.28	11.50	7.68	-33.2%
5.30	11.50	7.22	-37.2%
5.32	11.50	6.78	-41.1%
5.34	11.50	6.38	-44.5%
5.36	11.50	6.04	-47.4%
5.38	11.50	5.72	-50.2%

WATERLINE AT ZERO
AREA ERROR = 5.120

STREAM NAME: Willow Creek
XS LOCATION: 400 ft ds fr conf w Beaver Creek
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	3.56	42.60	1.60	2.39	68.09	43.22	100.0%	1.58	231.19	3.40
	4.12	39.53	1.14	1.83	45.08	39.93	92.4%	1.13	122.59	2.72
	4.17	39.25	1.10	1.78	43.11	39.64	91.7%	1.09	114.35	2.65
	4.22	38.98	1.06	1.73	41.16	39.35	91.0%	1.05	106.36	2.58
	4.27	38.70	1.01	1.68	39.22	39.05	90.4%	1.00	98.62	2.51
	4.32	38.43	0.97	1.63	37.29	38.76	89.7%	0.96	91.13	2.44
	4.37	38.16	0.93	1.58	35.37	38.47	89.0%	0.92	83.89	2.37
	4.42	37.88	0.88	1.53	33.47	38.17	88.3%	0.88	76.90	2.30
	4.47	37.61	0.84	1.48	31.58	37.88	87.6%	0.83	70.17	2.22
	4.52	36.33	0.82	1.43	29.73	36.59	84.6%	0.81	64.93	2.18
	4.57	34.80	0.80	1.38	27.95	35.06	81.1%	0.80	60.28	2.16
	4.62	33.28	0.79	1.33	26.25	33.53	77.6%	0.78	55.92	2.13
	4.67	31.76	0.78	1.28	24.62	32.00	74.0%	0.77	51.86	2.11
	4.72	30.68	0.75	1.23	23.07	30.91	71.5%	0.75	47.60	2.06
	4.77	30.26	0.71	1.18	21.55	30.47	70.5%	0.71	42.89	1.99
	4.82	29.83	0.67	1.13	20.04	30.03	69.5%	0.67	38.39	1.92
	4.87	29.40	0.63	1.08	18.56	29.60	68.5%	0.63	34.11	1.84
	4.92	28.98	0.59	1.03	17.10	29.16	67.5%	0.59	30.06	1.76
	4.97	28.55	0.55	0.98	15.67	28.72	66.4%	0.55	26.23	1.67
	5.02	28.12	0.51	0.93	14.25	28.28	65.4%	0.50	22.63	1.59
	5.07	27.70	0.46	0.88	12.85	27.84	64.4%	0.46	19.25	1.50
WL	5.12	26.14	0.44	0.83	11.50	26.28	60.8%	0.44	16.62	1.45
	5.17	25.18	0.41	0.78	10.22	25.31	58.6%	0.40	14.00	1.37
	5.22	24.27	0.37	0.73	8.98	24.39	56.4%	0.37	11.57	1.29
	5.27	23.36	0.33	0.68	7.79	23.47	54.3%	0.33	9.37	1.20
	5.32	20.17	0.33	0.63	6.67	20.27	46.9%	0.33	7.97	1.20
	5.37	16.07	0.36	0.58	5.80	16.15	37.4%	0.36	7.34	1.27
	5.42	15.48	0.32	0.53	5.01	15.55	36.0%	0.32	5.90	1.18
	5.47	14.80	0.29	0.48	4.25	14.87	34.4%	0.29	4.63	1.09
	5.52	14.18	0.25	0.43	3.53	14.24	32.9%	0.25	3.49	0.99
	5.57	13.63	0.21	0.38	2.83	13.68	31.6%	0.21	2.49	0.88
	5.62	13.08	0.17	0.33	2.17	13.12	30.4%	0.17	1.63	0.75
	5.67	10.84	0.14	0.28	1.56	10.88	25.2%	0.14	1.07	0.69
	5.72	9.84	0.11	0.23	1.04	9.87	22.8%	0.11	0.58	0.56
	5.77	6.53	0.09	0.18	0.61	6.55	15.2%	0.09	0.32	0.52
	5.82	4.24	0.08	0.13	0.35	4.26	9.8%	0.08	0.17	0.48
	5.87	3.15	0.05	0.08	0.17	3.15	7.3%	0.05	0.06	0.36
	5.92	1.87	0.02	0.03	0.04	1.87	4.3%	0.02	0.01	0.19

STREAM NAME: Willow Creek
XS LOCATION: 400 ft ds fr conf w Beaver Creek
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	16.56	cfs
CALCULATED FLOW (Qc)=	16.62	cfs
(Qm-Qc)/Qm * 100 =	-0.4	%
MEASURED WATERLINE (WLm)=	5.13	ft
CALCULATED WATERLINE (WLc)=	5.12	ft
(WLm-WLc)/WLm * 100 =	0.1	%
MAX MEASURED DEPTH (Dm)=	0.80	ft
MAX CALCULATED DEPTH (Dc)=	0.83	ft
(Dm-Dc)/Dm * 100	-3.7	%
MEAN VELOCITY=	1.45	ft/sec
MANNING'S N=	0.036	
SLOPE=	0.0036	ft/ft
.4 * Qm =	6.6	cfs
2.5 * Qm=	41.4	cfs

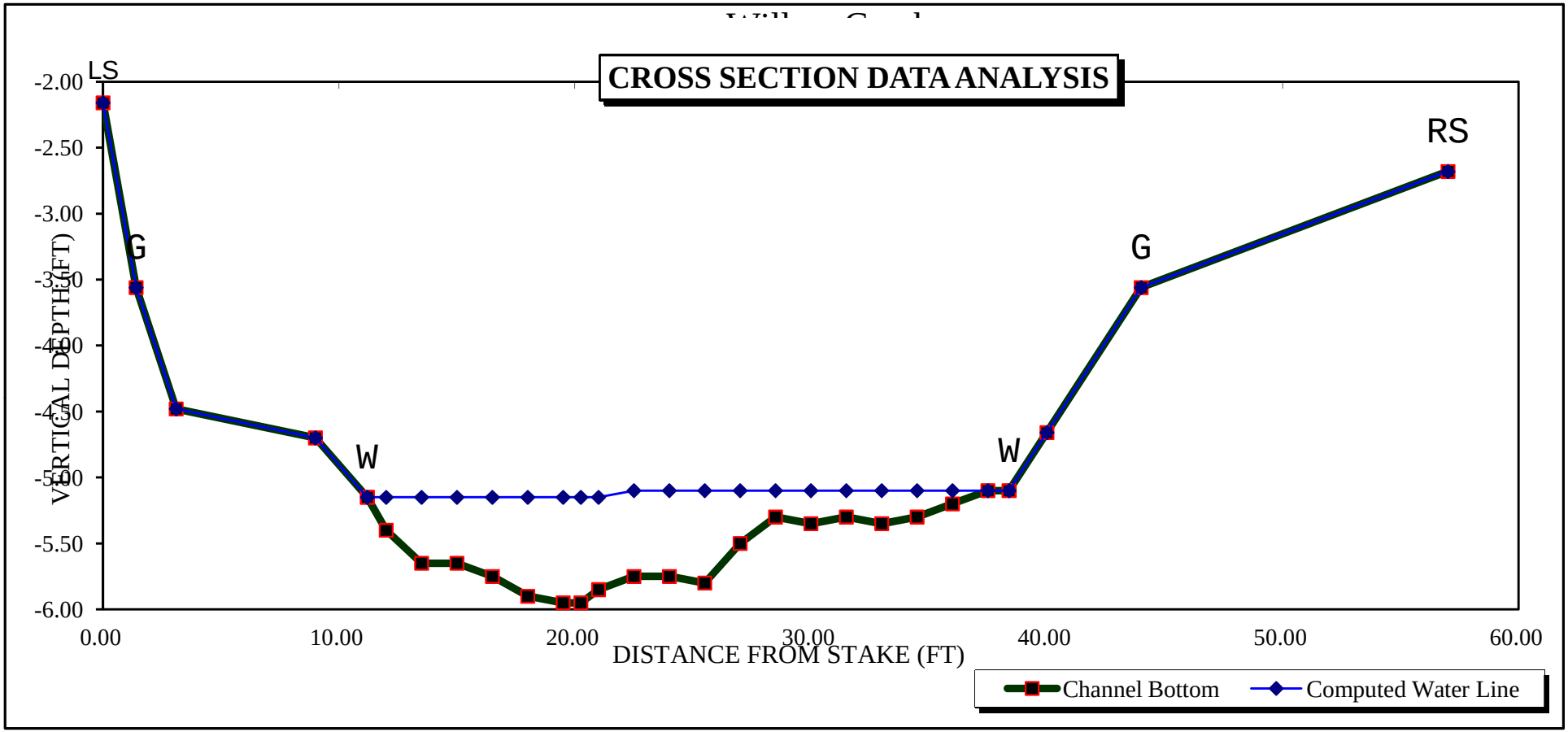
RECOMMENDED INSTREAM FLOW:
=============================

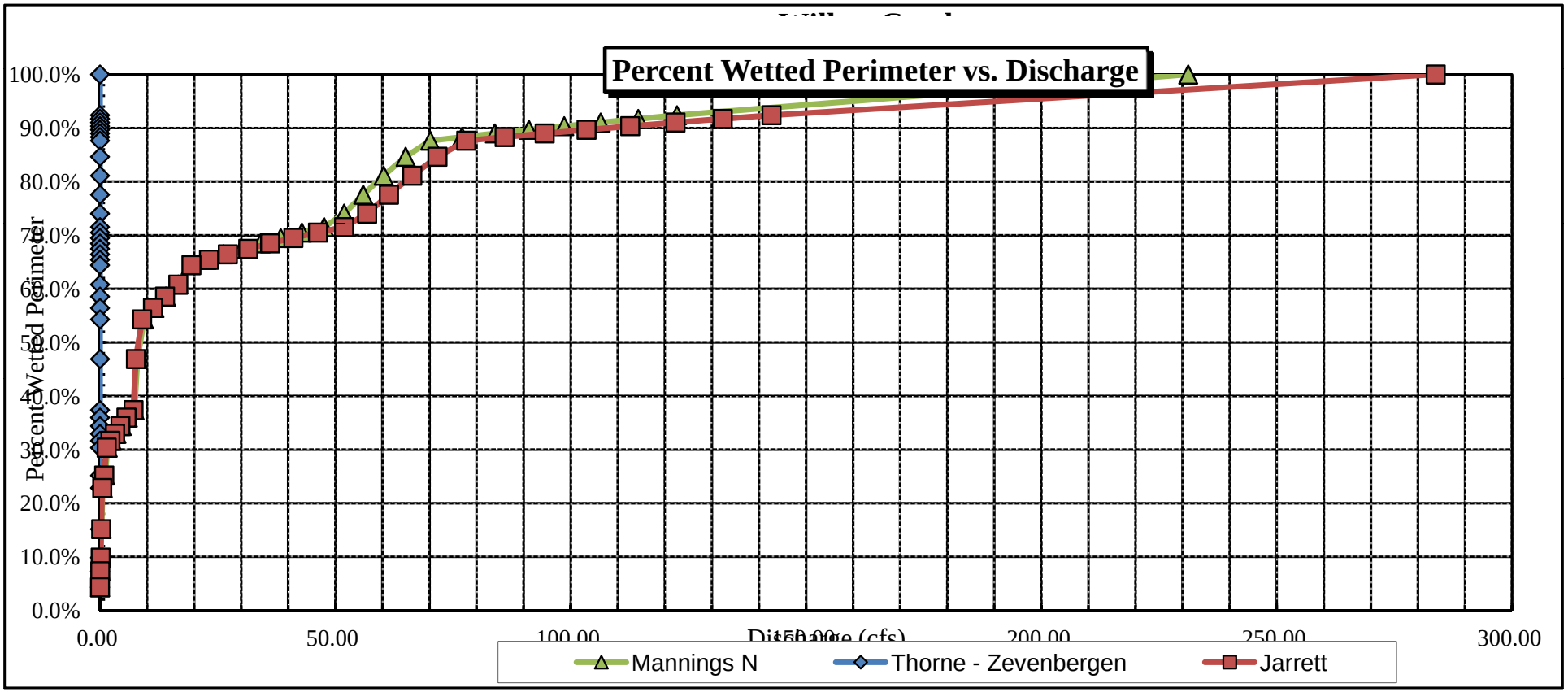
FLOW (CFS)	PERIOD
===========	========
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

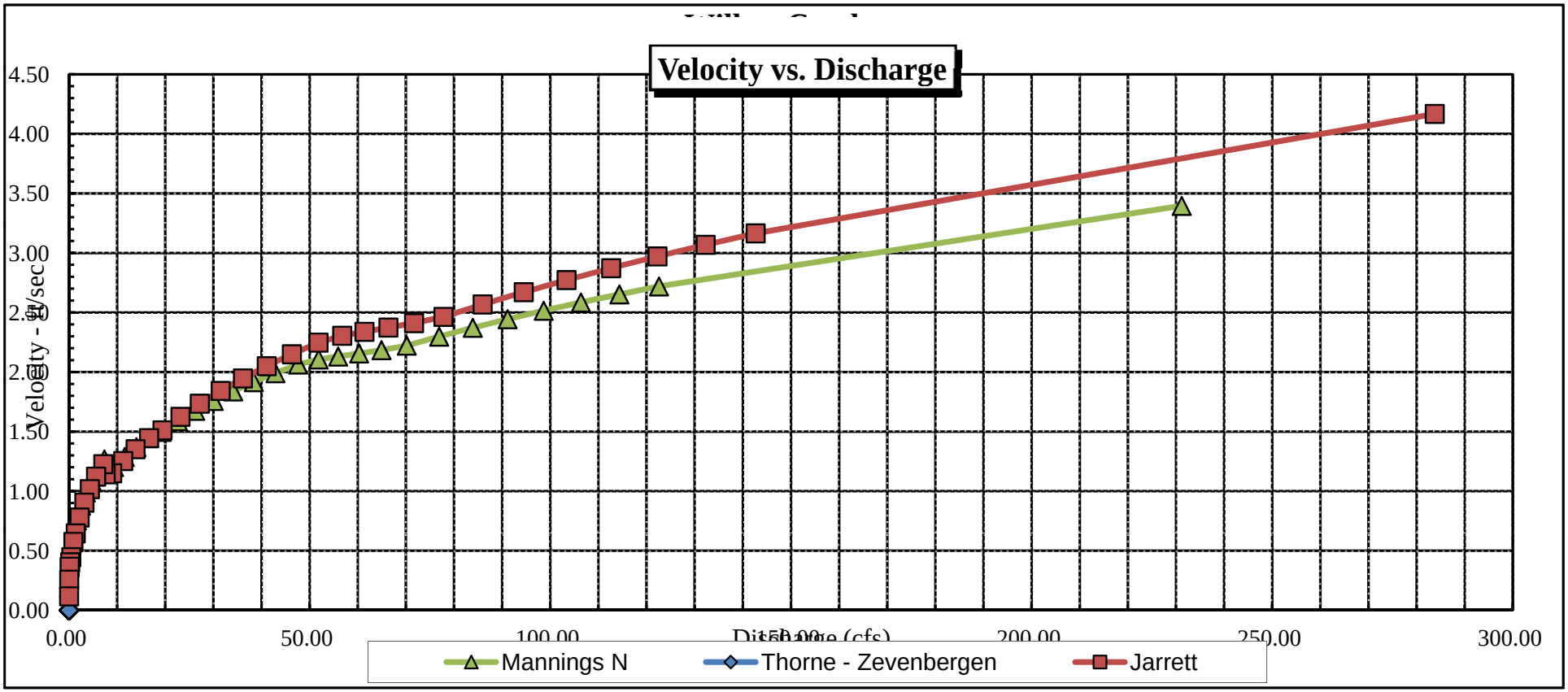
RATIONALE FOR RECOMMENDATION:
=============================

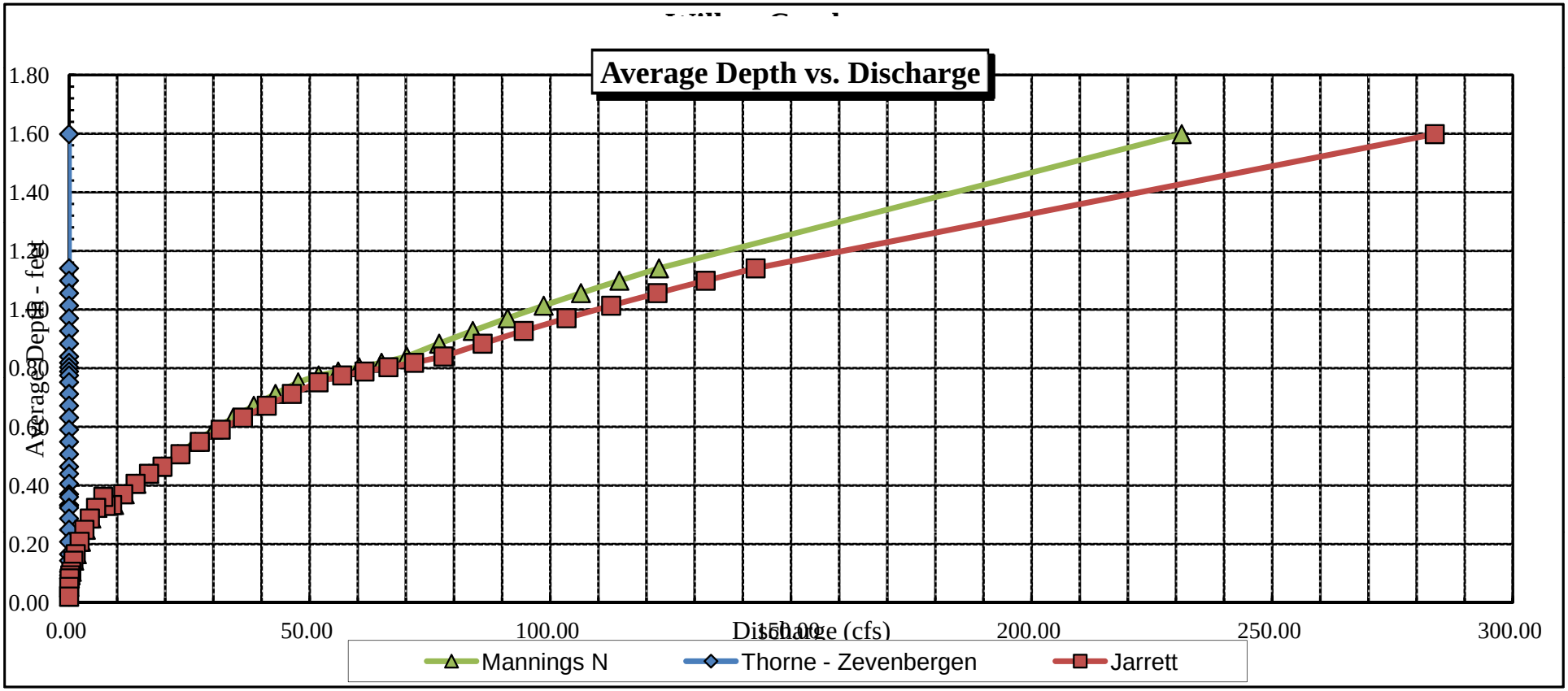
RECOMMENDATION BY: …………………....………..……............................... AGENCY...……………………….....……....…...…….…...... DATE:......…...….......……………

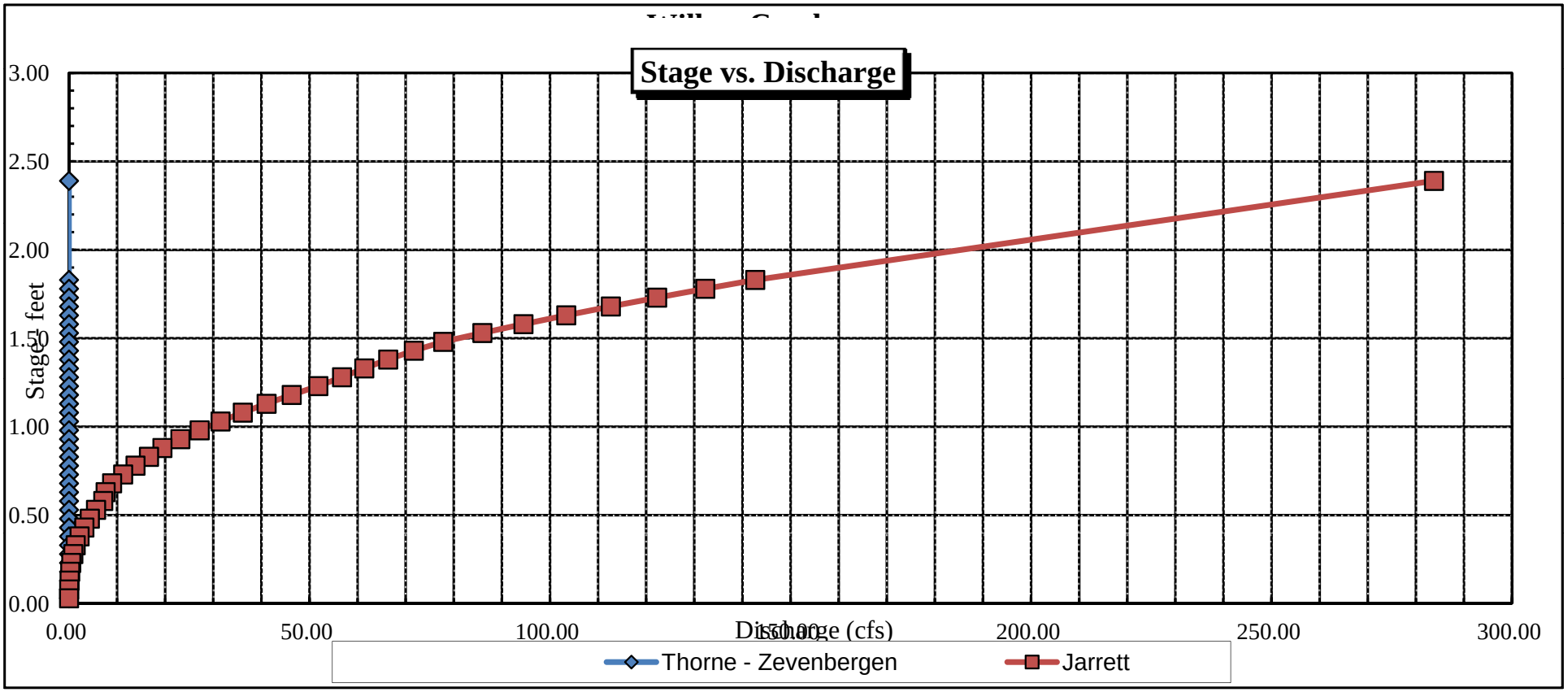
CWCB REVIEW BY: ..…………………………......………………………………………………...……............. DATE:.................….……………...…


CROSS SECTION DATA ANALYSIS
LS
G
W
W
G
RS
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
VERTICAL DEPTH (FT)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


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
50.00
100.00
150.00
200.00
250.00
300.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Mannings N
Thorne - Zevenbergen
Jarrett


Average Depth vs. Discharge
Average Depth - feet
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Stage vs. Discharge
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Stage, feet
0.00
50.00
100.00
150.00
200.00
250.00
300.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Willow Creek						CROSS-SECTION NO.: 3
CROSS-SECTION LOCATION: 200 ft. upstream from confluence w/ Beaver Creek						
DATE: 8-16-11	OBSERVERS: R. Smith, E. Spencer					
LEGAL DESCRIPTION	¼ SECTION: NE	SECTION: 4	TOWNSHIP: 9 (N)/S	RANGE: 85 E(W)	PM: 6th	
COUNTY: Routt	WATERSHED: Yampa	WATER DIVISION: 6	DOW WATER CODE: 22842			
MAP(S): USGS:			GPS 338258 Zone 13			
USFS:			4514834			

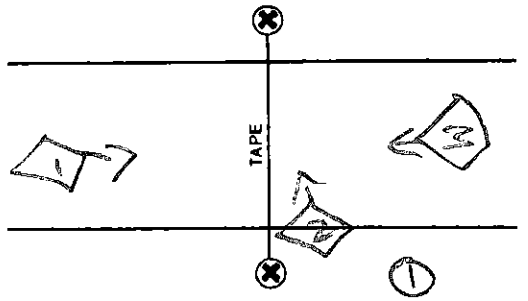
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO	METER TYPE: M-M			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed ____ lbs/foot	TAPE TENSION: surveyed ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: 2" to 8" cobbles	PHOTOGRAPHS TAKEN: (YES) NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0	4.97 / 4.98
② WS Upstream	33.5	4.80
③ WS Downstream	44.0	5.40
SLOPE	0.6 / 73.5 = .008	

SKETCH



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:

mayfly, caddisfly

COMMENTS

Ph = 8.72
Temp = 21.0° C
Cond = 86
Salinity = 0.0

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek	CROSS-SECTION NO: 3	DATE: 8-16-11	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 2:05 pm

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)
G + LS	0.0		3.75								
	0.8		4.49								
W	1.3		5.0								
	3.0		5.2	.2				1.04			
	4.5		5.4	.4				1.52			
	6.0		5.55	.5				1.11			
	7.5		5.55	.55				0.63			
	9.0		5.7	.70				0.49			
	10		5.7	.70				1.24			
	11		5.7	.70				0.85			
	12		5.5	.50				1.26			
	13		5.55	.55				1.49			
	14		5.5	.50				1.39			
	15		5.5	.50				1.50			
	16		5.15	.45				0.79			
	17		5.1	.30				1.19			
	18		5.30	.35				.07			
	19		5.1	.30				.61			
	20		5.30	.35				.72			
	21		5.15	.25				1.41			
	22		5.5	.50				.89			
	23		5.5	.50				.94			
	24		5.4	.40				.74			
	25		5.5	.50				1.14			
	26		5.40	.40				.12			
W	27.4		5.0								
	30.0		4.40								
G	35.0		3.78								
RS	36.8		3.10								
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: Willow Creek					CROSS-SECTION NO.: 4	
CROSS-SECTION LOCATION: 800 ft. upstream from confluence w/ Beaver Ck.						
DATE: 8-16-11	OBSERVERS: R. Smith, E Spencer					
LEGAL DESCRIPTION	¼ SECTION: NE	SECTION: 4	TOWNSHIP: 9 (N)/S	RANGE: 85 E/(W)	PM: 6th	
COUNTY: Routt	WATERSHED: Yampa	WATER DIVISION: 6	DOW WATER CODE: 22842			
MAP(S): USGS:						
USFS:						

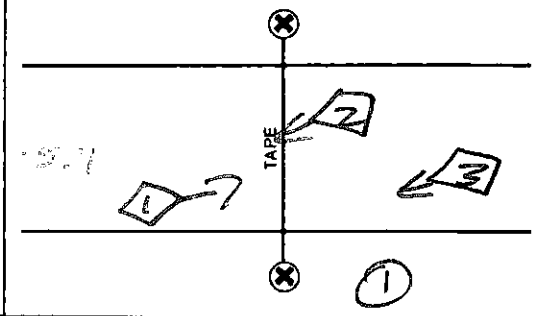
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES)/NO	METER TYPE: M-M			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed ____ lbs/foot	TAPE TENSION: surveyed ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: 2 to 8" cobbles	PHOTOGRAPHS TAKEN (YES)/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0	6.75 / 6.80
② WS Upstream	24.0	6.67
③ WS Downstream	17.7	6.86
SLOPE	0.19/41.7 = .004	

SKETCH



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:

mayfly, caddisfly

COMMENTS

Ph = 8.72
Cond = 86
Temp = 21°C
Salinity = 0.0

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek	CROSS-SECTION NO.: 4	DATE: 8-16-11	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: _____ ft	TIME: 3 pm

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)
RS	0.0		3.60								
G	2.6		5.77								
W	5.7		6.80								
	7.0		6.90	Ø					Ø		
	9.0		7.10	Ø					Ø		
	10.0		7.30	.5					.33		
	11		7.40	.6					1.46		
	12		7.50	.7					1.02		
	13		7.45	.65					.86		
	14		7.40	.60					.73		
	15		7.35	.55					1.04		
	16		7.25	.45					1.72		
	17		7.30	.50					1.29		
	18		7.10	.30					1.66		
	19.5		7.15	.40					.72		
	21.0		6.95	.20					.94		
	22.5		7.05	.30					Ø		
	24.0		6.90	.15					Ø		
	25.5		6.95	.20					.99		
	27		7.25	.50					.90		
	28		7.25	.50					1.31		
	29		7.15	.40					1.61		
	30		7.15	.40					1.14		
	31		7.25	.50					1.22		
	32		7.25	.50					1.07		
	33		7.25	.50					1.07		
W	33.6		6.75								
G	37.9		5.80								
LS	41.9		4.82								
TOTALS:											

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

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

LOCATION INFORMATION

STREAM NAME:	Willow Creek
XS LOCATION:	800 ft upst fr conf w Beaver Creek
XS NUMBER:	4
DATE:	16-Aug-11
OBSERVERS:	R. Smith, E. Spencer
1/4 SEC:	NE
SECTION:	4
TWP:	9N
RANGE:	85W
PM:	6th
COUNTY:	Routt
WATERSHED:	Elk River
DIVISION:	6
DOW CODE:	22842
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:	0.004

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

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

STREAM NAME: Willow Creek
XS LOCATION: 800 ft upst fr conf w Beaver Creek
XS NUMBER: 4

DATA POINTS= 29

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
	RS	0.00	3.60			0.00		0.00	0.00	0.0%
1	G	2.60	5.77			0.00		0.00	0.00	0.0%
	W	5.70	6.80	0.00	0.00	0.00		0.00	0.00	0.0%
		7.00	6.80	0.00	0.00	0.00		0.00	0.00	0.0%
		9.00	7.10	0.30	0.00	2.02	0.30	0.45	0.00	0.0%
		10.00	7.30	0.50	0.33	1.02	0.50	0.50	0.17	1.6%
		11.00	7.40	0.60	1.46	1.00	0.60	0.60	0.88	8.5%
		12.00	7.50	0.70	1.02	1.00	0.70	0.70	0.71	7.0%
		13.00	7.45	0.65	0.86	1.00	0.65	0.65	0.56	5.4%
		14.00	7.40	0.60	0.73	1.00	0.60	0.60	0.44	4.3%
		15.00	7.35	0.55	1.04	1.00	0.55	0.55	0.57	5.6%
		16.00	7.25	0.45	1.72	1.00	0.45	0.45	0.77	7.5%
		17.00	7.30	0.50	1.29	1.00	0.50	0.50	0.65	6.3%
		18.00	7.10	0.30	1.66	1.02	0.30	0.38	0.62	6.1%
		19.50	7.15	0.40	0.72	1.50	0.40	0.60	0.43	4.2%
		21.00	6.95	0.20	0.94	1.51	0.20	0.30	0.28	2.7%
		22.50	7.05	0.30	0.00	1.50	0.30	0.45	0.00	0.0%
		24.00	6.90	0.15	0.00	1.51	0.15	0.23	0.00	0.0%
		25.50	6.95	0.20	0.99	1.50	0.20	0.30	0.30	2.9%
		27.00	7.25	0.50	0.90	1.53	0.50	0.63	0.56	5.5%
		28.00	7.25	0.50	1.31	1.00	0.50	0.50	0.66	6.4%
		29.00	7.15	0.40	1.61	1.00	0.40	0.40	0.64	6.3%
		30.00	7.15	0.40	1.14	1.00	0.40	0.40	0.46	4.4%
		31.00	7.25	0.50	1.22	1.00	0.50	0.50	0.61	5.9%
		32.00	7.25	0.50	1.07	1.00	0.50	0.50	0.54	5.2%
		33.00	7.25	0.50	1.07	1.00	0.50	0.40	0.43	4.2%
	W	33.60	6.75	0.00	0.00	0.78		0.00	0.00	0.0%
1	G	37.50	5.80			0.00		0.00	0.00	0.0%
	LS	41.90	4.82			0.00		0.00	0.00	0.0%
	TOTALS ----------					26.93	0.7 (Max.)	10.58	10.27	100.0%

Manning's n = 0.0519
Hydraulic Radius= 0.39270807

STREAM NAME: Willow Creek
XS LOCATION: 800 ft upst fr conf w Beaver Creek
XS NUMBER: 4

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.58	10.53	-0.4%
6.53	10.58	17.72	67.6%
6.55	10.58	17.13	62.0%
6.57	10.58	16.54	56.4%
6.59	10.58	15.96	50.9%
6.61	10.58	15.37	45.4%
6.63	10.58	14.79	39.9%
6.65	10.58	14.22	34.4%
6.67	10.58	13.64	29.0%
6.69	10.58	13.07	23.6%
6.71	10.58	12.50	18.2%
6.73	10.58	11.93	12.9%
6.74	10.58	11.65	10.2%
6.75	10.58	11.37	7.5%
6.76	10.58	11.09	4.9%
6.77	10.58	10.81	2.2%
6.78	10.58	10.53	-0.4%
6.79	10.58	10.25	-3.1%
6.80	10.58	9.97	-5.7%
6.81	10.58	9.70	-8.3%
6.82	10.58	9.44	-10.8%
6.83	10.58	9.17	-13.3%
6.85	10.58	8.65	-18.2%
6.87	10.58	8.13	-23.2%
6.89	10.58	7.61	-28.1%
6.91	10.58	7.09	-32.9%
6.93	10.58	6.59	-37.7%
6.95	10.58	6.11	-42.2%
6.97	10.58	5.65	-46.6%
6.99	10.58	5.20	-50.8%
7.01	10.58	4.78	-54.8%
7.03	10.58	4.37	-58.7%

WATERLINE AT ZERO
AREA ERROR = 6.773

STREAM NAME: Willow Creek
XS LOCATION: 800 ft upst fr conf w Beaver Creek
XS NUMBER: 4 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	5.80	34.81	1.18	1.70	41.09	35.41	100.0%	1.16	82.14	2.00
	5.82	34.64	1.16	1.68	40.28	35.24	99.5%	1.14	79.71	1.98
	5.87	34.29	1.12	1.63	38.55	34.87	98.5%	1.11	74.63	1.94
	5.92	33.93	1.09	1.58	36.85	34.50	97.4%	1.07	69.70	1.89
	5.97	33.58	1.05	1.53	35.16	34.13	96.4%	1.03	64.93	1.85
	6.02	33.22	1.01	1.48	33.49	33.76	95.3%	0.99	60.31	1.80
	6.07	32.86	0.97	1.43	31.84	33.39	94.3%	0.95	55.84	1.75
	6.12	32.51	0.93	1.38	30.20	33.02	93.2%	0.91	51.53	1.71
	6.17	32.15	0.89	1.33	28.59	32.65	92.2%	0.88	47.37	1.66
	6.22	31.80	0.85	1.28	26.99	32.28	91.2%	0.84	43.36	1.61
	6.27	31.44	0.81	1.23	25.41	31.91	90.1%	0.80	39.51	1.56
	6.32	31.09	0.77	1.18	23.84	31.54	89.1%	0.76	35.82	1.50
	6.37	30.73	0.73	1.13	22.30	31.17	88.0%	0.72	32.29	1.45
	6.42	30.37	0.68	1.08	20.77	30.80	87.0%	0.67	28.92	1.39
	6.47	30.02	0.64	1.03	19.26	30.43	85.9%	0.63	25.71	1.33
	6.52	29.66	0.60	0.98	17.77	30.06	84.9%	0.59	22.66	1.28
	6.57	29.31	0.56	0.93	16.29	29.69	83.8%	0.55	19.77	1.21
	6.62	28.95	0.51	0.88	14.84	29.32	82.8%	0.51	17.06	1.15
	6.67	28.60	0.47	0.83	13.40	28.95	81.8%	0.46	14.51	1.08
	6.72	28.24	0.42	0.78	11.98	28.58	80.7%	0.42	12.15	1.01
WL	6.77	27.95	0.38	0.73	10.57	28.28	79.8%	0.37	9.94	0.94
	6.82	26.36	0.35	0.68	9.21	26.66	75.3%	0.35	8.22	0.89
	6.87	25.96	0.30	0.63	7.91	26.24	74.1%	0.30	6.43	0.81
	6.92	24.63	0.27	0.58	6.63	24.89	70.3%	0.27	4.97	0.75
	6.97	22.30	0.24	0.53	5.46	22.52	63.6%	0.24	3.84	0.70
	7.02	20.03	0.22	0.48	4.40	20.22	57.1%	0.22	2.88	0.65
	7.07	18.35	0.19	0.43	3.45	18.50	52.3%	0.19	2.04	0.59
	7.12	16.55	0.15	0.38	2.56	16.67	47.1%	0.15	1.33	0.52
	7.17	13.27	0.14	0.33	1.82	13.36	37.7%	0.14	0.87	0.48
	7.22	11.46	0.11	0.28	1.20	11.51	32.5%	0.10	0.48	0.40
	7.27	6.56	0.11	0.23	0.75	6.59	18.6%	0.11	0.32	0.42
	7.32	5.03	0.09	0.18	0.46	5.05	14.2%	0.09	0.17	0.37
	7.37	3.80	0.06	0.13	0.24	3.81	10.7%	0.06	0.07	0.29
	7.42	2.30	0.04	0.08	0.09	2.30	6.5%	0.04	0.02	0.21
	7.47	0.80	0.01	0.03	0.01	0.80	2.3%	0.01	0.00	0.10

STREAM NAME: Willow Creek
XS LOCATION: 800 ft upst fr conf w Beaver Creek
XS NUMBER: 4

SUMMARY SHEET

MEASURED FLOW (Qm)=	10.27	cfs
CALCULATED FLOW (Qc)=	9.94	cfs
(Qm-Qc)/Qm * 100 =	3.2	%
MEASURED WATERLINE (WLm)=	6.78	ft
CALCULATED WATERLINE (WLc)=	6.77	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.70	ft
MAX CALCULATED DEPTH (Dc)=	0.73	ft
(Dm-Dc)/Dm * 100	-3.8	%
MEAN VELOCITY=	0.94	ft/sec
MANNING'S N=	0.052	
SLOPE=	0.004	ft/ft
.4 * Qm =	4.1	cfs
2.5 * Qm=	25.7	cfs

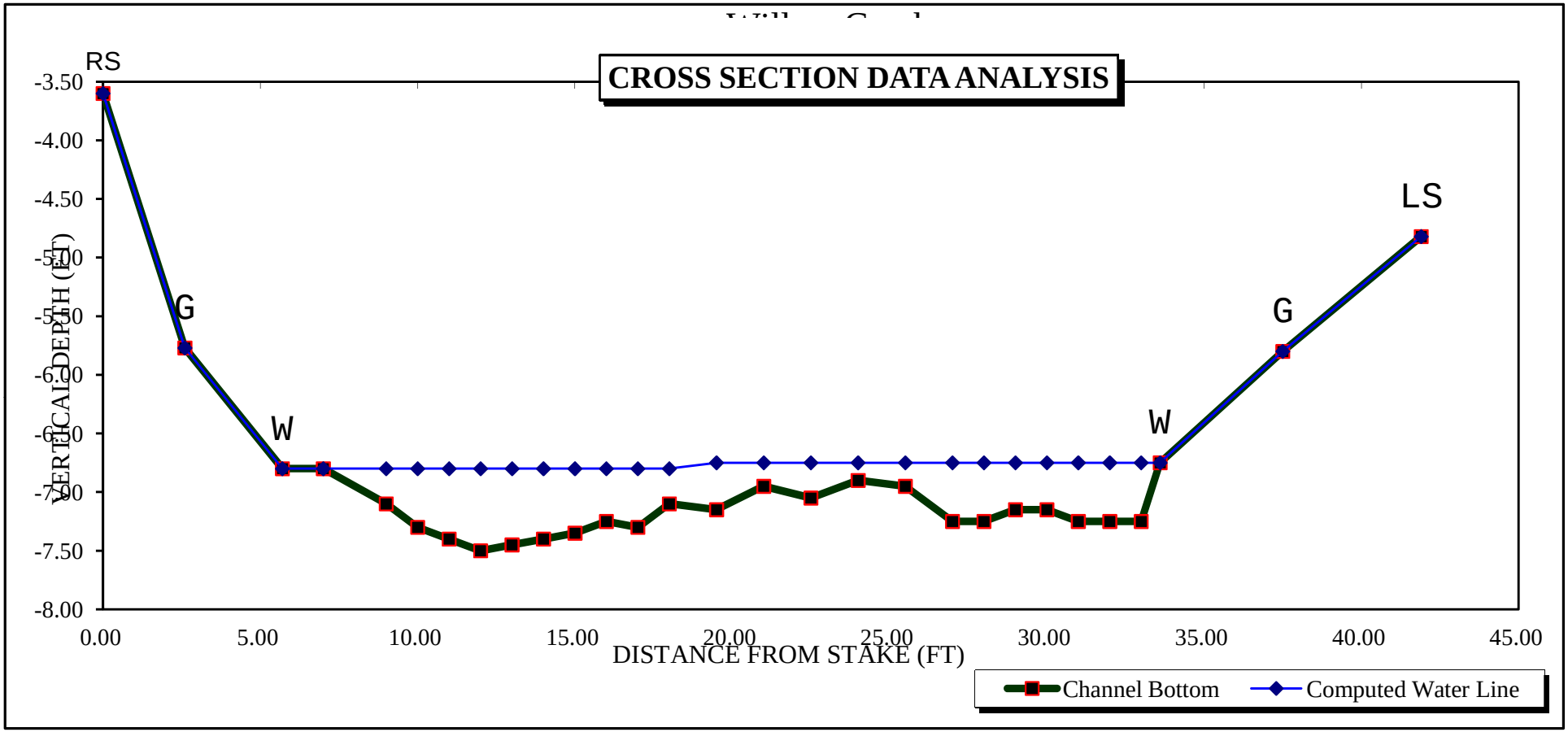
RECOMMENDED INSTREAM FLOW:
=============================

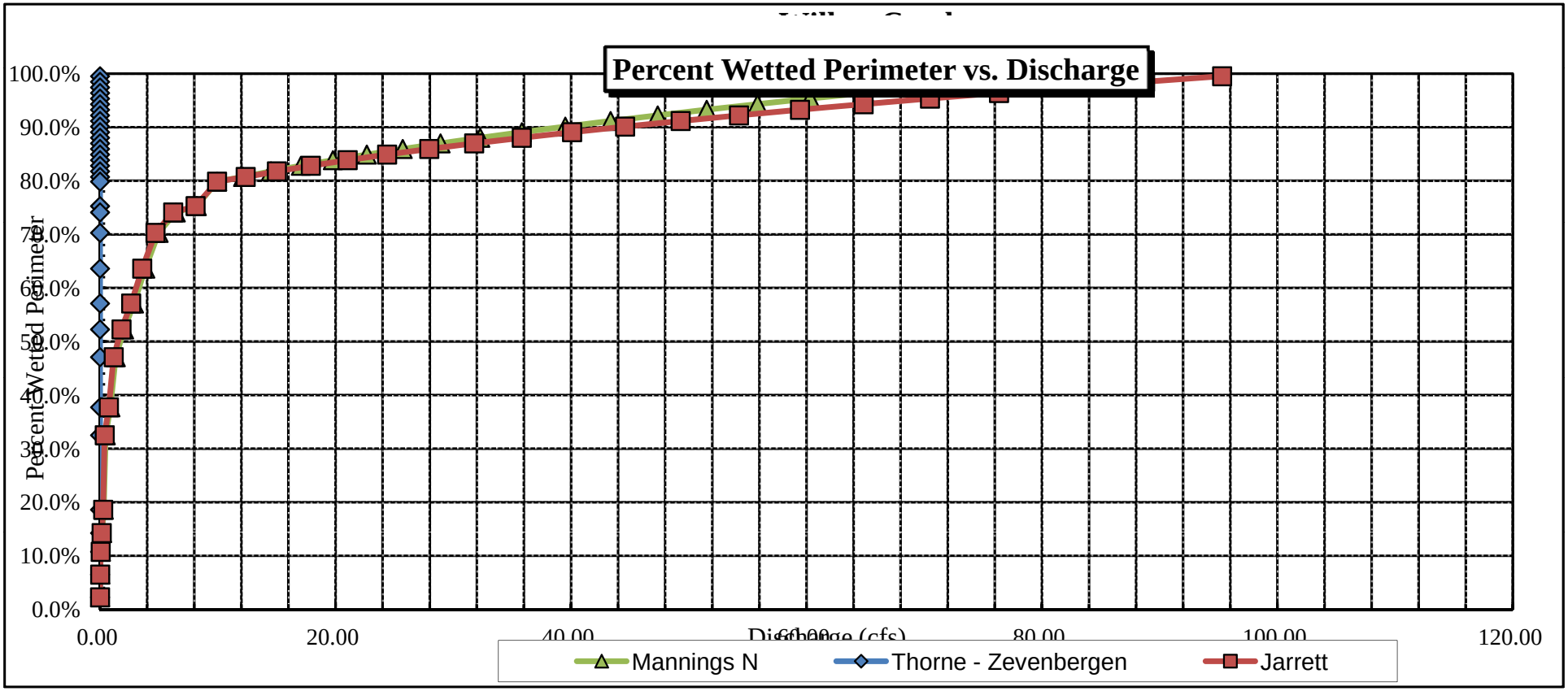
FLOW (CFS)	PERIOD
===========	========
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

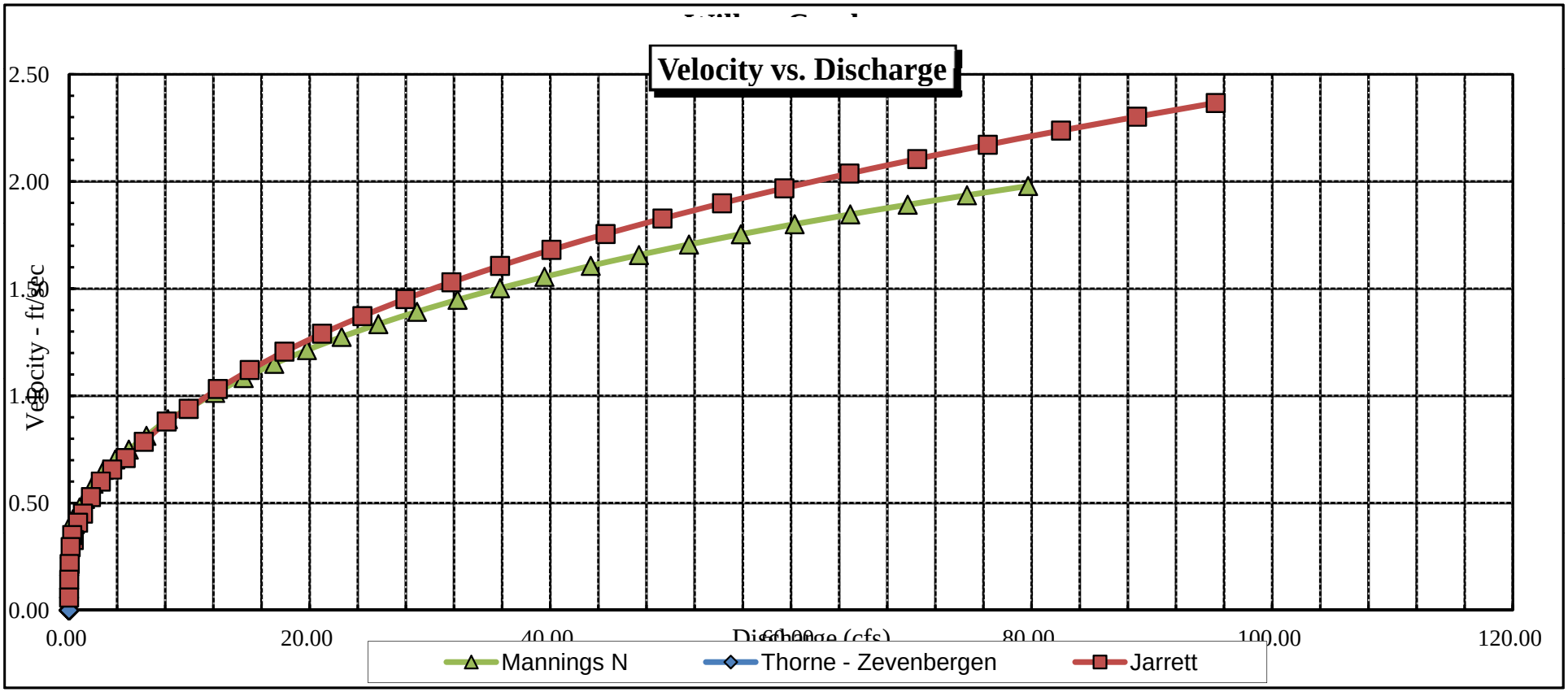
RATIONALE FOR RECOMMENDATION:
=============================

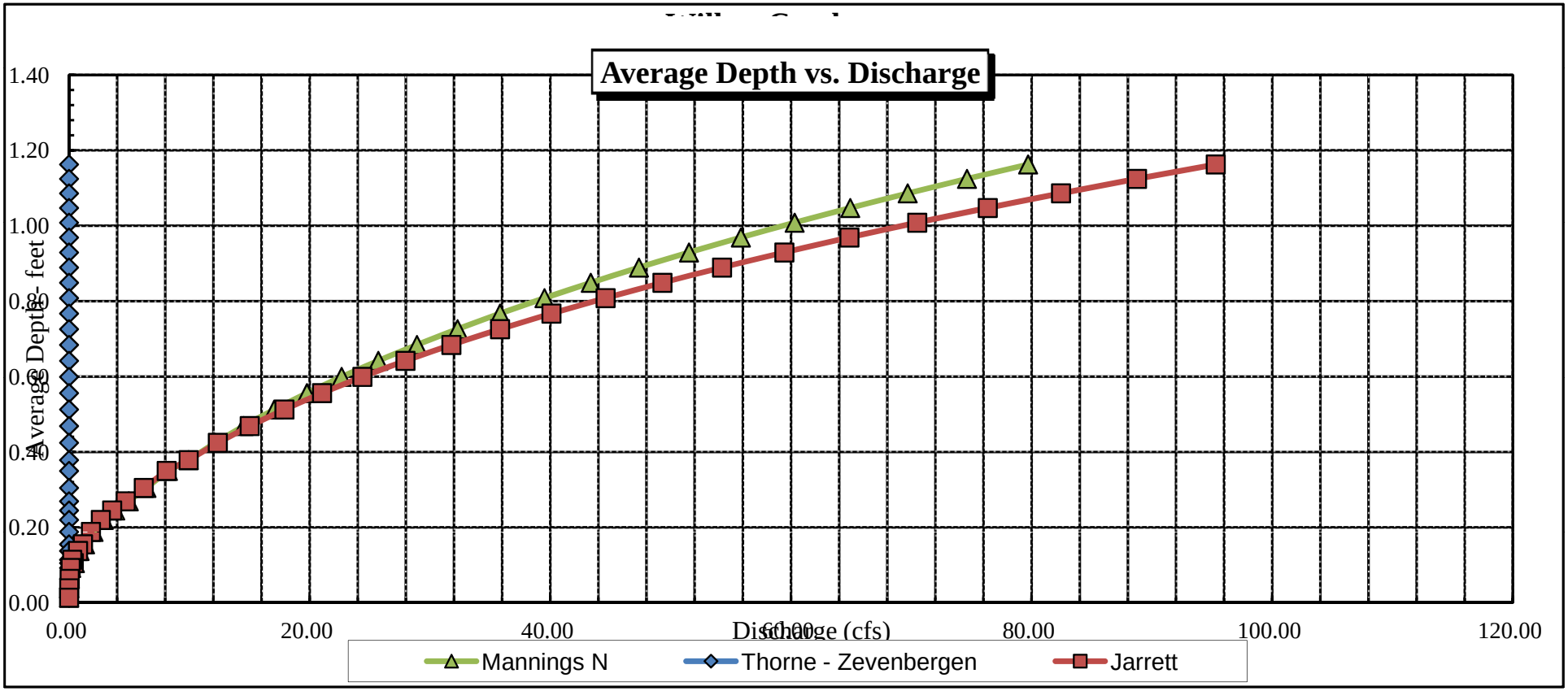
RECOMMENDATION BY: …………………...………..……............................... AGENCY...……………………......……....…....……...... DATE:.......….....…......……………

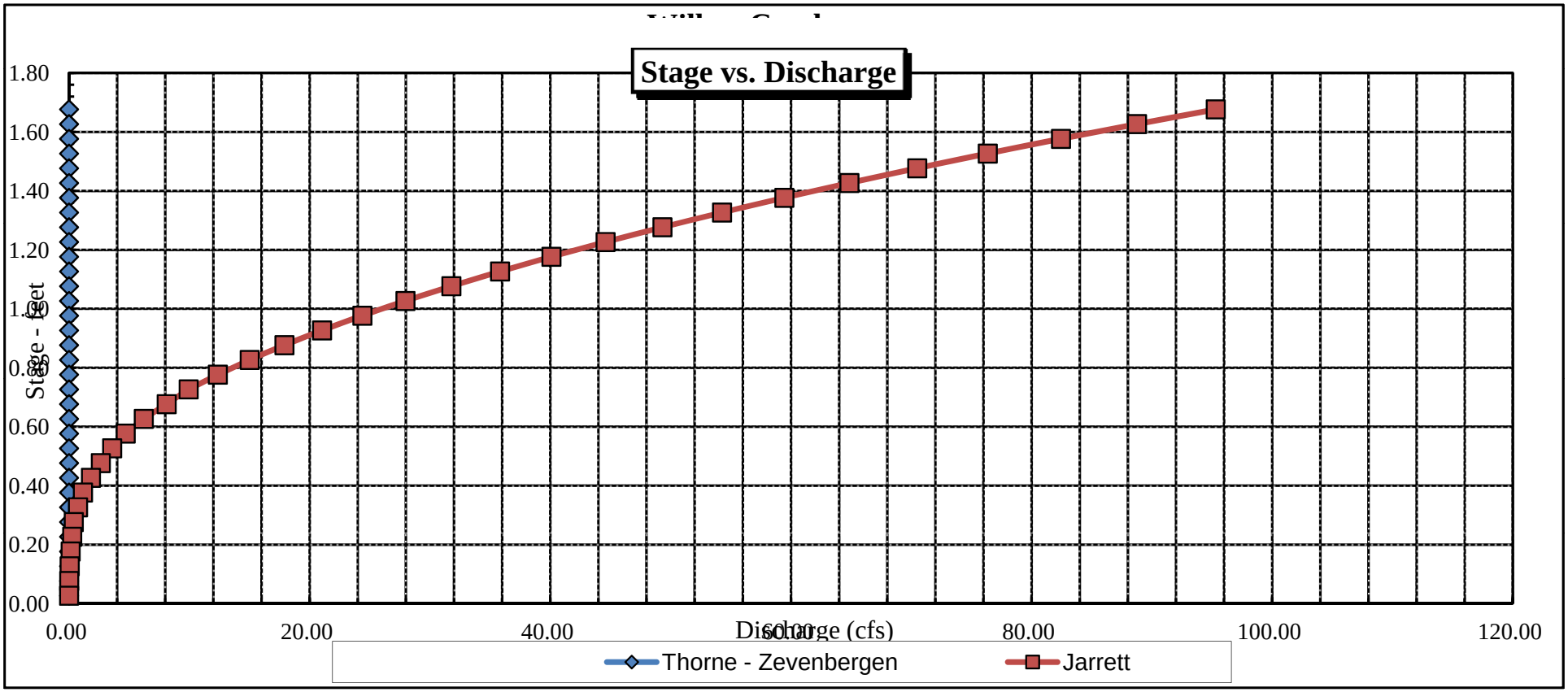
CWCB REVIEW BY: ...……………………….....…………………………………………………...…............. DATE:.................…………….....


CROSS SECTION DATA ANALYSIS
RS
G
W
W
G
LS
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
-6.50
-7.00
-7.50
-8.00
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


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
20.00
40.00
80.00
100.00
120.00
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
Velocity - ft/sec
2.50
2.00
1.50
1.00
0.50
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


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
20.00
40.00
80.00
100.00
120.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


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

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Willow Creek | CROSS-SECTION NO.: 1

CROSS-SECTION LOCATION: at mouth of canyon

DATE: 9-26-11 | OBSERVERS: R Smith, Jo Neely

LEGAL DESCRIPTION | ¼ SECTION: SW | SECTION: 3 | TOWNSHIP: 9 (N)/S | RANGE: 95 E/(W) | PM: 6th

COUNTY: Routt | WATERSHED: Elk River | WATER DIVISION: | DOW WATER CODE: 22842

MAP(S): USGS: GPS 339034 | USFS: 4514300

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO | METER TYPE: M-M

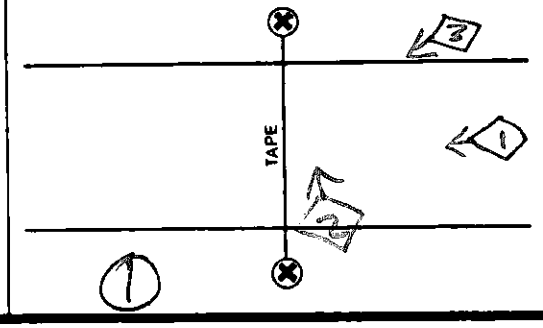
METER NUMBER: | DATE RATED: | CALIB/SPIN: _____ sec | TAPE WEIGHT: surveyed _____ lbs/foot | TAPE TENSION: surveyed _____ lbs

CHANNEL BED MATERIAL SIZE RANGE: 4" cobbles to 2' boulders | PHOTOGRAPHS TAKEN (YES)/NO | NUMBER OF PHOTOGRAPHS: 3

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0	4.28 / 4.28
② WS Upstream	38.5	3.86
③ WS Downstream	27.8	4.30
SLOPE	0.94 / 66.3 =	

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:

mayfly, caddisfly, stonefly

COMMENTS

pH = 8.84
Cond = 80.9
Salinity = 0
Temp = 15.1° C

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek	CROSS-SECTION NO: 1	DATE: 9-26-11	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: ____ ft	TIME: 2:00 pm

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)
LS	0.0		2.82								
G	3.0		3.40								
	5.0		3.40								
	7.0		3.72								
W	9.5		4.28								
	10		4.4	.1				0			
	11		4.4	.1				.10			
	12		4.4	.1				.72			
	13		4.4	.1				.44			
	14		4.4	.1				.88			
	15		4.4	.10				.11			
	16		11.35	.05				0			
	17		4.5	.20				0.65			
	18		4.8	.50				2.17			
	19		4.7	.40				1.83			
	20		5.0	.70				2.13			
	21		5.05	.75				1.58			
	22		5.0	.70				1.28			
	23		4.9	.60				1.35			
	24		4.8	.50				1.44			
	25		4.8	.50				1.57			
	26		4.9	.60				1.78			
	27		4.6	.30				1.92			
	28		4.5	.20				1.60			
	30		4.35	.25				.78			
	32		4.95	.65				1.53			
	34		4.90	.60				.96			
	36		4.50	.20				.16			
	38		4.45	.15				0			
W	40.5		4.28								
G	42.0		3.26								
	43.7		2.62								
RS	49.5		2.30								
TOTALS											

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

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

LOCATION INFORMATION

STREAM NAME:	Willow Creek
XS LOCATION:	At mouth of canyon
XS NUMBER:	1
DATE:	26-Sep-11
OBSERVERS:	R. Smith, J. Neely
1/4 SEC:	SW
SECTION:	3
TWP:	9N
RANGE:	95W
PM:	Sixth
COUNTY:	Routt
WATERSHED:	Elk River
DIVISION:	6
DOW CODE:	22842
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:	0.014

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

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

STREAM NAME: Willow Creek
XS LOCATION: At mouth of canyon
XS NUMBER: 1

DATA POINTS= 33

VALUES COMPUTED FROM RAW FIELD DATA

FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
LS	0.00	2.82			0.00		0.00	0.00	0.0%
1 G	3.00	3.40			0.00		0.00	0.00	0.0%
	5.00	3.40			0.00		0.00	0.00	0.0%
	7.00	3.72			0.00		0.00	0.00	0.0%
W	9.50	4.28	0.00	0.00	0.00		0.00	0.00	0.0%
	10.00	4.40	0.10	0.00	0.51	0.10	0.08	0.00	0.0%
	11.00	4.40	0.10	0.10	1.00	0.10	0.10	0.01	0.1%
	12.00	4.40	0.10	0.72	1.00	0.10	0.10	0.07	0.5%
	13.00	4.40	0.10	0.44	1.00	0.10	0.10	0.04	0.3%
	14.00	4.40	0.10	0.88	1.00	0.10	0.10	0.09	0.6%
	15.00	4.40	0.10	0.11	1.00	0.10	0.10	0.01	0.1%
	16.00	4.35	0.05	0.00	1.00	0.05	0.05	0.00	0.0%
	17.00	4.50	0.20	0.65	1.01	0.20	0.20	0.13	0.9%
	18.00	4.80	0.50	2.17	1.04	0.50	0.50	1.09	7.9%
	19.00	4.70	0.40	1.83	1.00	0.40	0.40	0.73	5.3%
	20.00	5.00	0.70	2.13	1.04	0.70	0.70	1.49	10.8%
	21.00	5.05	0.75	1.58	1.00	0.75	0.75	1.19	8.6%
	22.00	5.00	0.70	1.28	1.00	0.70	0.70	0.90	6.5%
	23.00	4.90	0.60	1.35	1.00	0.60	0.60	0.81	5.9%
	24.00	4.80	0.50	1.44	1.00	0.50	0.50	0.72	5.2%
	25.00	4.80	0.50	1.57	1.00	0.50	0.50	0.79	5.7%
	26.00	4.90	0.60	1.78	1.00	0.60	0.60	1.07	7.8%
	27.00	4.60	0.30	1.92	1.04	0.30	0.30	0.58	4.2%
	28.00	4.50	0.20	1.60	1.00	0.20	0.30	0.48	3.5%
	30.00	4.55	0.25	0.78	2.00	0.25	0.50	0.39	2.8%
	32.00	4.95	0.65	1.53	2.04	0.65	1.30	1.99	14.4%
	34.00	4.90	0.60	0.96	2.00	0.60	1.20	1.15	8.4%
	36.00	4.50	0.20	0.16	2.04	0.20	0.40	0.06	0.5%
	38.00	4.45	0.15	0.00	2.00	0.15	0.34	0.00	0.0%
W	40.50	4.28	0.00	0.00	2.51		0.00	0.00	0.0%
1 G	42.00	3.26			0.00		0.00	0.00	0.0%
	43.70	2.62			0.00		0.00	0.00	0.0%
RS	49.50	2.30			0.00		0.00	0.00	0.0%
TOTALS ----------					31.27	0.75 (Max.)	10.41	13.78	100.0%

Manning's n = 0.0638
Hydraulic Radius= 0.33295466

STREAM NAME: Willow Creek
XS LOCATION: At mouth of canyon
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	10.41	11.00	5.7%
4.03	10.41	18.94	81.9%
4.05	10.41	18.29	75.7%
4.07	10.41	17.64	69.4%
4.09	10.41	17.00	63.3%
4.11	10.41	16.36	57.1%
4.13	10.41	15.72	51.0%
4.15	10.41	15.08	44.9%
4.17	10.41	14.45	38.8%
4.19	10.41	13.82	32.7%
4.21	10.41	13.19	26.6%
4.23	10.41	12.56	20.6%
4.24	10.41	12.25	17.6%
4.25	10.41	11.94	14.6%
4.26	10.41	11.62	11.6%
4.27	10.41	11.31	8.6%
4.28	10.41	11.00	5.7%
4.29	10.41	10.69	2.7%
4.30	10.41	10.39	-0.2%
4.31	10.41	10.08	-3.2%
4.32	10.41	9.78	-6.1%
4.33	10.41	9.48	-9.0%
4.35	10.41	8.88	-14.7%
4.37	10.41	8.29	-20.3%
4.39	10.41	7.73	-25.8%
4.41	10.41	7.23	-30.6%
4.43	10.41	6.79	-34.8%
4.45	10.41	6.36	-38.9%
4.47	10.41	5.94	-42.9%
4.49	10.41	5.54	-46.8%
4.51	10.41	5.16	-50.4%
4.53	10.41	4.81	-53.8%

WATERLINE AT ZERO
AREA ERROR = 4.299

STREAM NAME: Willow Creek
XS LOCATION: At mouth of canyon
XS NUMBER: 1

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	3.40	36.79	1.11	1.65	40.67	37.43	100.0%	1.09	118.43	2.91
	3.45	36.41	1.07	1.60	38.87	37.03	98.9%	1.05	110.61	2.85
	3.50	36.03	1.03	1.55	37.06	36.62	97.9%	1.01	102.91	2.78
	3.55	35.64	0.99	1.50	35.27	36.22	96.8%	0.97	95.46	2.71
	3.60	35.26	0.95	1.45	33.50	35.81	95.7%	0.94	88.25	2.63
	3.65	34.87	0.91	1.40	31.74	35.41	94.6%	0.90	81.31	2.56
	3.70	34.48	0.87	1.35	30.01	35.00	93.5%	0.86	74.61	2.49
	3.75	34.15	0.83	1.30	28.30	34.65	92.6%	0.82	68.10	2.41
	3.80	33.85	0.79	1.25	26.60	34.33	91.7%	0.77	61.80	2.32
	3.85	33.56	0.74	1.20	24.91	34.01	90.9%	0.73	55.75	2.24
	3.90	33.26	0.70	1.15	23.24	33.69	90.0%	0.69	49.97	2.15
	3.95	32.96	0.65	1.10	21.58	33.37	89.2%	0.65	44.46	2.06
	4.00	32.67	0.61	1.05	19.94	33.06	88.3%	0.60	39.22	1.97
	4.05	32.37	0.57	1.00	18.32	32.74	87.5%	0.56	34.26	1.87
	4.10	32.07	0.52	0.95	16.71	32.42	86.6%	0.52	29.58	1.77
	4.15	31.78	0.48	0.90	15.11	32.10	85.8%	0.47	25.18	1.67
	4.20	31.48	0.43	0.85	13.53	31.79	84.9%	0.43	21.08	1.56
	4.25	31.18	0.38	0.80	11.96	31.47	84.1%	0.38	17.29	1.45
WL	4.30	30.64	0.34	0.75	10.41	30.91	82.6%	0.34	13.89	1.33
	4.35	29.72	0.30	0.70	8.90	29.98	80.1%	0.30	10.92	1.23
	4.40	22.42	0.33	0.65	7.48	22.67	60.6%	0.33	9.83	1.31
	4.45	21.37	0.30	0.60	6.38	21.62	57.8%	0.29	7.78	1.22
	4.50	19.05	0.28	0.55	5.37	19.29	51.5%	0.28	6.30	1.17
	4.55	16.10	0.28	0.50	4.49	16.33	43.6%	0.27	5.22	1.16
	4.60	14.93	0.25	0.45	3.71	15.14	40.4%	0.25	4.00	1.08
	4.65	14.10	0.21	0.40	2.98	14.28	38.2%	0.21	2.90	0.97
	4.70	13.28	0.17	0.35	2.30	13.43	35.9%	0.17	1.95	0.85
	4.75	11.78	0.14	0.30	1.67	11.90	31.8%	0.14	1.25	0.75
	4.80	9.28	0.12	0.25	1.12	9.37	25.0%	0.12	0.75	0.67
	4.85	7.45	0.09	0.20	0.70	7.51	20.1%	0.09	0.40	0.57
	4.90	5.63	0.07	0.15	0.38	5.66	15.1%	0.07	0.17	0.45
	4.95	2.68	0.06	0.10	0.17	2.69	7.2%	0.06	0.07	0.44
	5.00	2.03	0.03	0.05	0.05	2.04	5.4%	0.03	0.01	0.24
	5.05	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!

STREAM NAME:	Willow Creek
XS LOCATION:	At mouth of canyon
XS NUMBER:	1

SUMMARY SHEET

MEASURED FLOW (Qm)=	13.78	cfs
CALCULATED FLOW (Qc)=	13.89	cfs
(Qm-Qc)/Qm * 100 =	-0.8	%
MEASURED WATERLINE (WLm)=	4.28	ft
CALCULATED WATERLINE (WLc)=	4.30	ft
(WLm-WLc)/WLm * 100 =	-0.4	%
MAX MEASURED DEPTH (Dm)=	0.75	ft
MAX CALCULATED DEPTH (Dc)=	0.75	ft
(Dm-Dc)/Dm * 100	-0.1	%
MEAN VELOCITY=	1.33	ft/sec
MANNING'S N=	0.064	
SLOPE=	0.014	ft/ft
.4 * Qm =	5.5	cfs
2.5 * Qm=	34.4	cfs

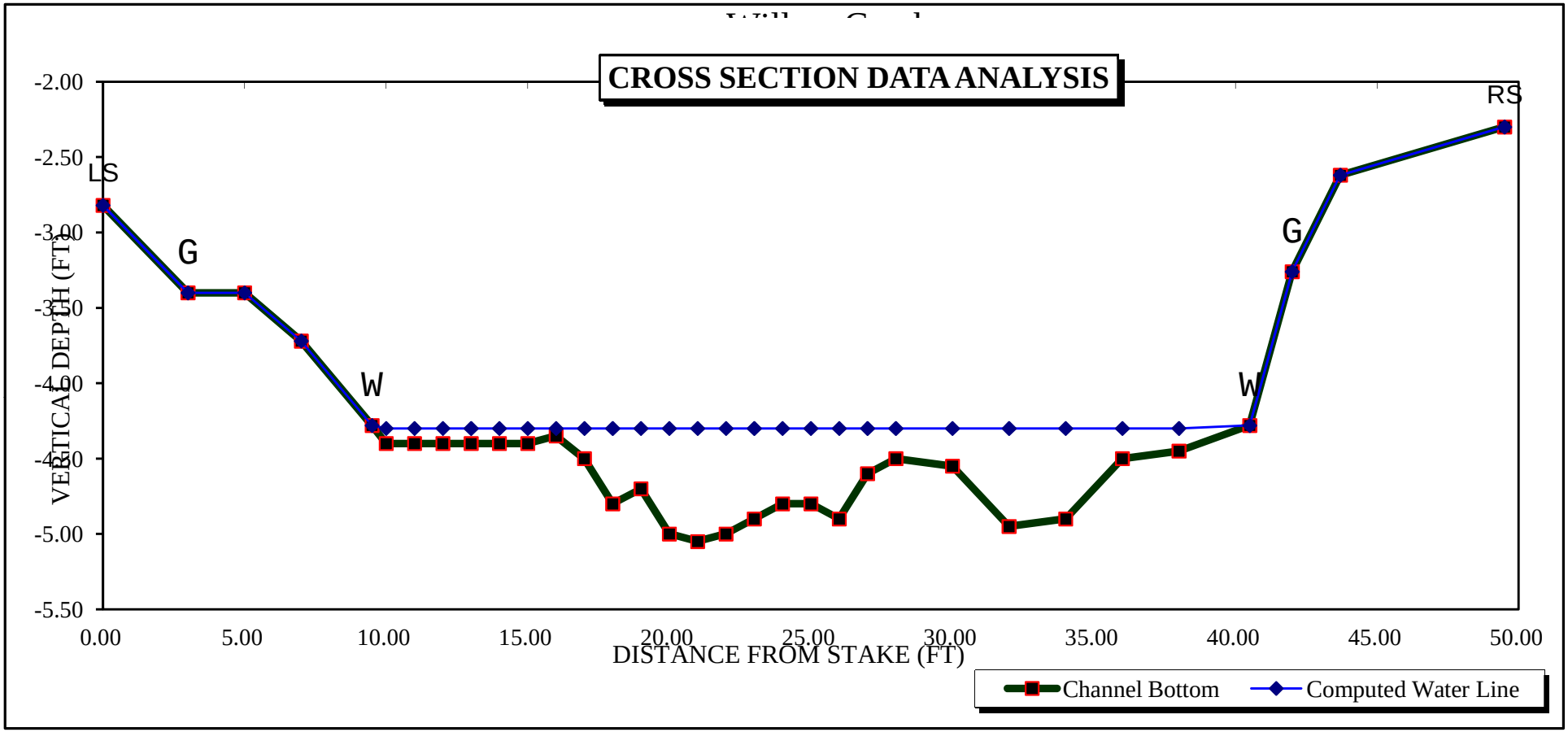
RECOMMENDED INSTREAM FLOW:
=============================

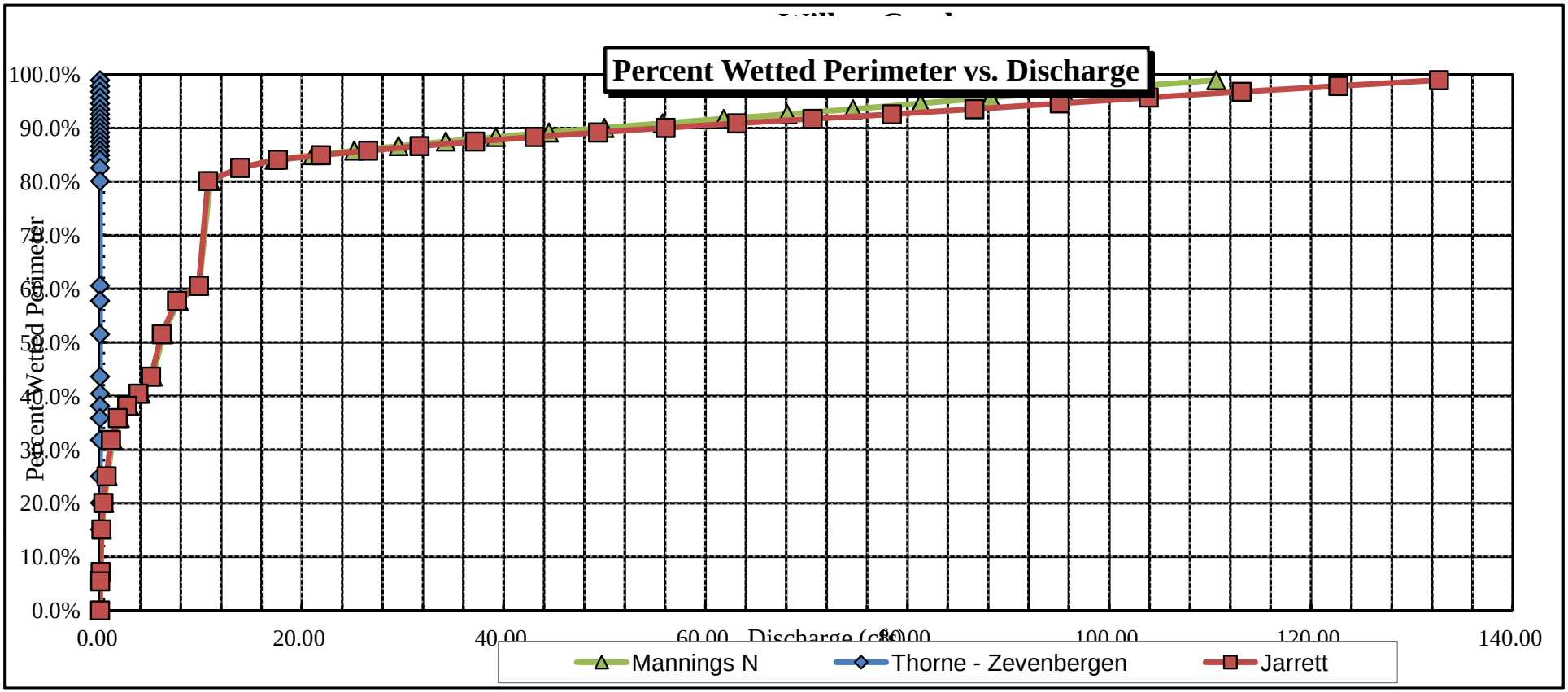
FLOW (CFS)	PERIOD
___________________	___________________
___________________	___________________
___________________	___________________
___________________	___________________

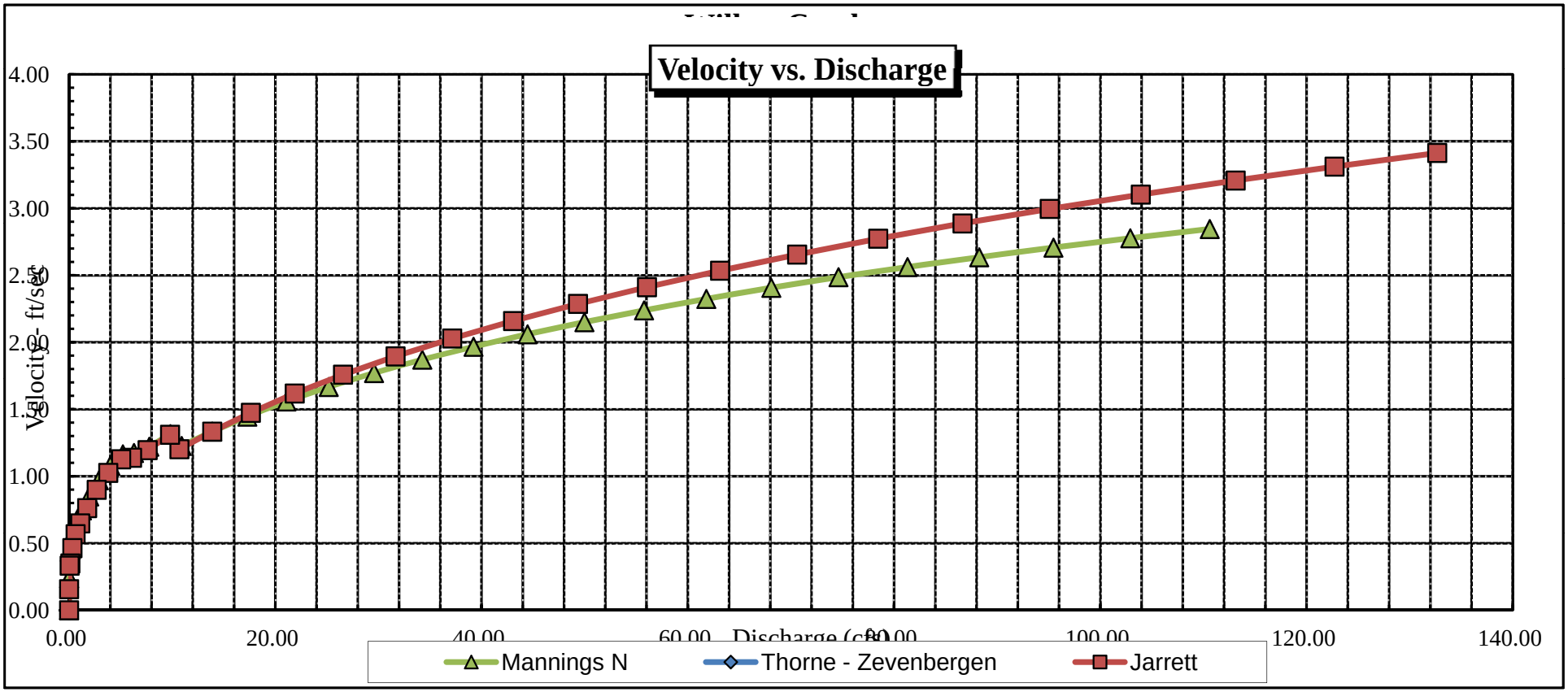
RATIONALE FOR RECOMMENDATION:
=============================

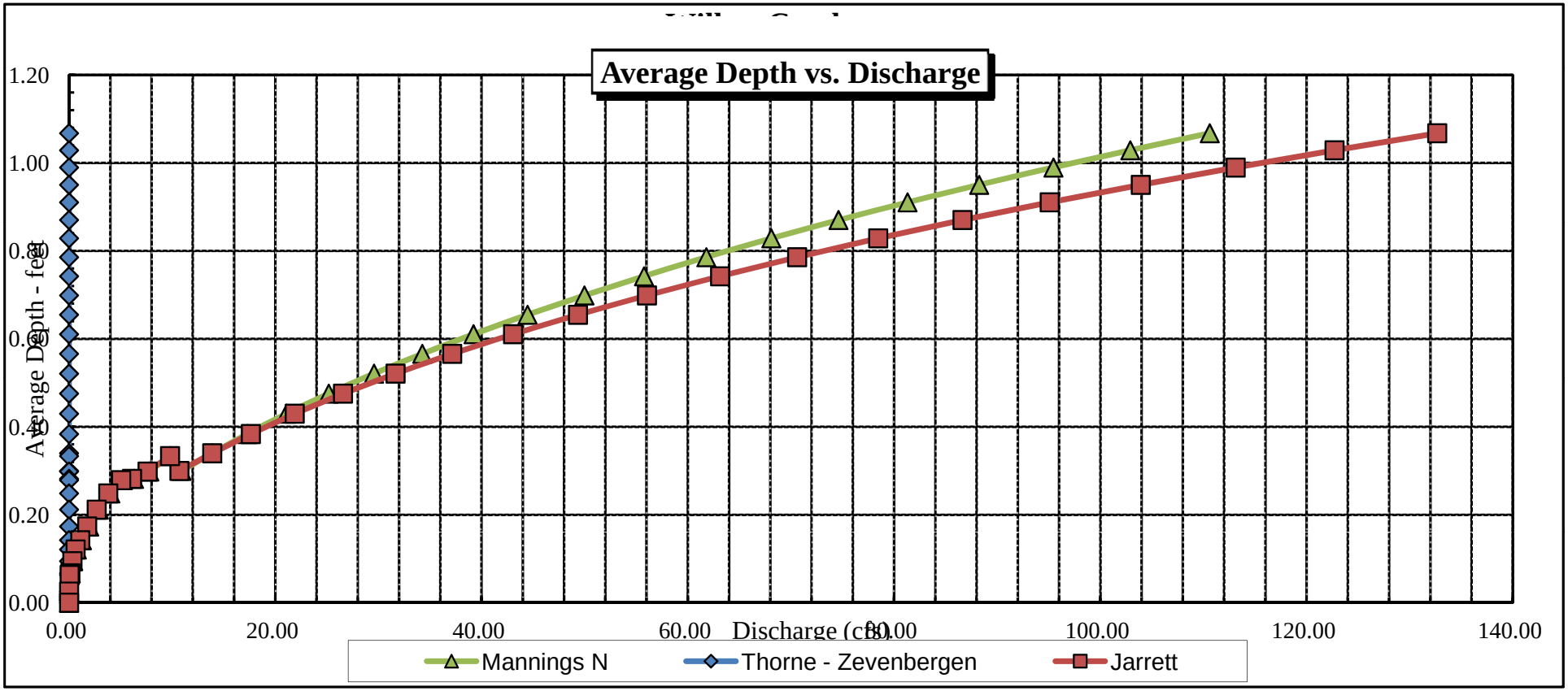
RECOMMENDATION BY: ……………………..……….……............................... AGENCY..…………………………......…….....…....……....... DATE:.......…....….......……………

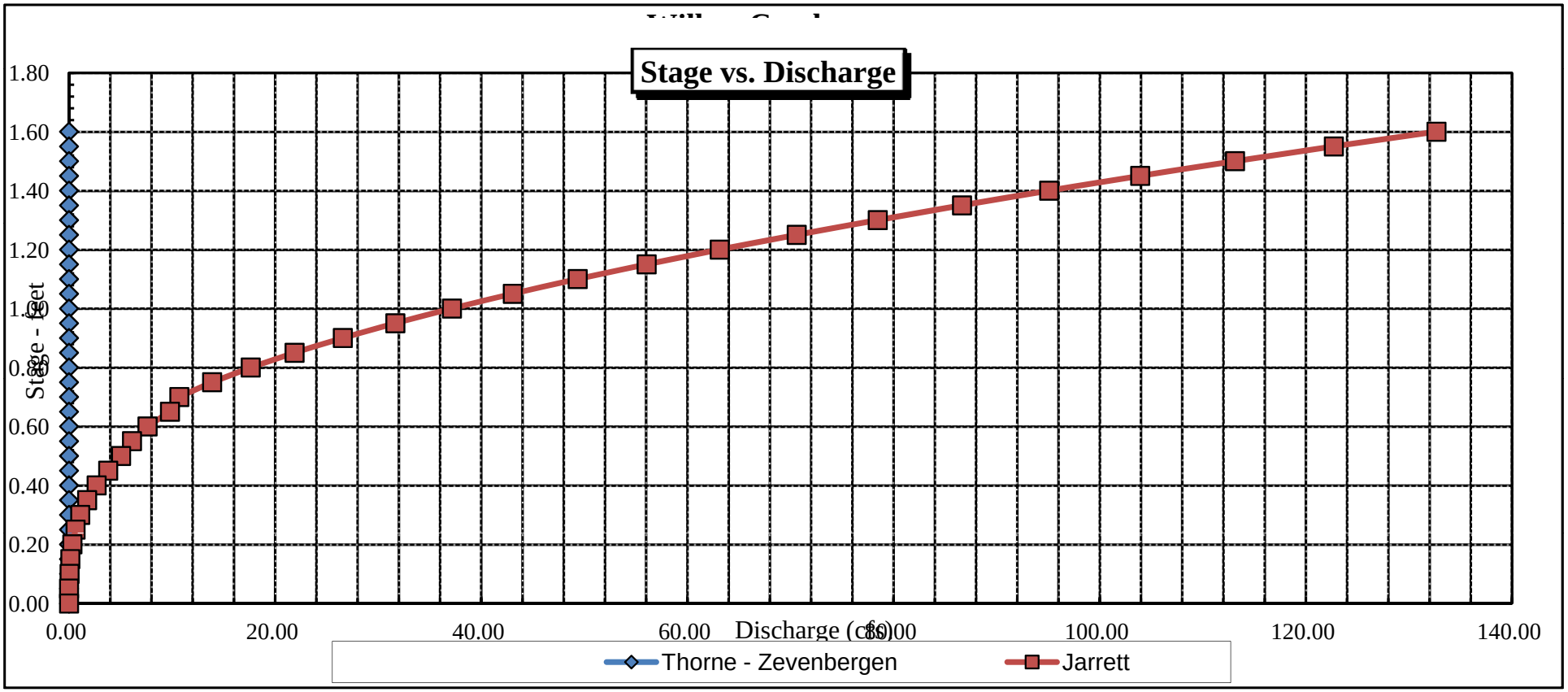
CWCB REVIEW BY: ..…………………………….....……………………………………………………...…............. DATE:.................…………….....


CROSS SECTION DATA ANALYSIS
LS
G
W
G
W
RS
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


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
20.00
40.00
60.00
Discharge (cfs)
100.00
120.00
140.00
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
Velocity - ft/sec
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
Mannings N
Thorne - Zevenbergen
Jarrett


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


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

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Willow Creek						CROSS-SECTION NO.: 2	
CROSS-SECTION LOCATION: 800 ft. downstream from confluence with Beaver Creek							
DATE: 9-26-11	OBSERVERS: R. Smith, J. Neely						
LEGAL DESCRIPTION	¼ SECTION: SW	SECTION: 3	TOWNSHIP: 9 (N) S	RANGE: 85 E (W)	PM: 6th		
COUNTY: Routt	WATERSHED: Elk River	WATER DIVISION: 6	DOW WATER CODE: 22842				
MAP(S): USGS:	GPS = 338444						
USFS:	4514648						

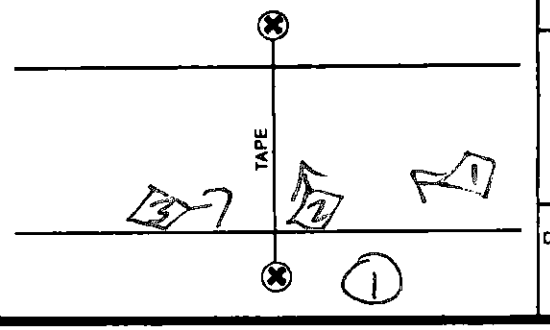
SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) / NO	METER TYPE: M-M			
METER NUMBER:	DATE RATED:	CALIB/SPIN: ____ sec	TAPE WEIGHT: surveyed ____ lbs/1000	TAPE TENSION: surveyed ____ lbs
CHANNEL BED MATERIAL SIZE RANGE: gravel to 8" cobbles	PHOTOGRAPHS TAKEN: (YES)/NO	NUMBER OF PHOTOGRAPHS: 3		

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
⊗ Tape @ Stake LB	0.0	surveyed
⊗ Tape @ Stake RB	0.0	surveyed
① WS @ Tape LB/RB	0.0	4.97 / 5.01
② WS Upstream	18.0	4.84
③ WS Downstream	35.5	5.05
SLOPE	0.21 / 53.5	

SKETCH



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:

mayfly, caddisfly, stonefly

COMMENTS

Ph = 8.84
Cond = 80.9
Salinity = 0
Temp = 15.1 °C

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Willow Creek	CROSS-SECTION NO.: 2	DATE: 9-26-11	SHEET ___ OF ___
BEGINNING OF MEASUREMENT	EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT	Gage Reading: ____ ft	TIME: 3.15 pm

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)
RS	0.0	3.0	2.98	< 3.08							
G	4.0		3.21								
	7.0		4.66								
W	12.6		5.01								
	13		5.1	.1				1.03			
	14		5.1	.1				∅			
	15		5.25	.25				1.26			
	16		5.4	.40				1.73			
	17		5.25	.25				1.11			
	18		5.2	.20				1.97			
	19		5.3	.30				2.04			
	20		5.3	.30				2.17			
	21		5.4	.40				2.11			
	22		5.55	.55				1.40			
	23		5.5	.50				1.89			
	24		5.4	.40				1.88			
	25		5.3	.30				1.93			
	26		5.25	.25				1.77			
	27		5.35	.35				1.61			
	28		5.50	.50				1.46			
	29		5.55	.55				1.64			
	30		5.60	.60				1.35			
	31		5.50	.50				1.57			
	32		5.40	.40				1.35			
	33		5.45	.45				1.16			
	34		5.45	.40				0.91			
	35		5.10	.10				0.42			
	36		5.00	∅				∅			
	37		5.10	.10				0.56			
	38		5.10	.10				0.28			
	39		5.0	∅				∅			
	40		5.30	.30				0.35			
	41		5.20	.20				0.32			
W	41.5		4.97								
G	42.9		3.17								
LS	44.5		3.10								
TOTALS:											

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

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

LOCATION INFORMATION

STREAM NAME:	Willow Creek
XS LOCATION:	800 ft. downst fr conf w/ Beaver Creek
XS NUMBER:	2
DATE:	26-Sep-11
OBSERVERS:	R. Smith, J. Neely
1/4 SEC:	SW
SECTION:	3
TWP:	9N
RANGE:	85W
PM:	Sixth
COUNTY:	Routt
WATERSHED:	Elk River
DIVISION:	6
DOW CODE:	22842
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

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

CHANNEL PROFILE DATA

SLOPE:	0.004

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

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

STREAM NAME: Willow Creek
XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
XS NUMBER: 2

DATA POINTS= 37

VALUES COMPUTED FROM RAW FIELD DATA

	FEATURE	DIST	VERT DEPTH	WATER DEPTH	VEL	WETTED PERIM.	WATER DEPTH	AREA (Am)	Q (Qm)	% Q CELL
	RS	0.00	2.98			0.00		0.00	0.00	0.0%
1	G	3.00	3.08			0.00		0.00	0.00	0.0%
		4.00	3.21			0.00		0.00	0.00	0.0%
		7.00	4.66			0.00		0.00	0.00	0.0%
	W	12.60	5.01	0.00	0.00	0.00		0.00	0.00	0.0%
		13.00	5.10	0.10	1.03	0.41	0.10	0.07	0.07	0.6%
		14.00	5.10	0.10	0.00	1.00	0.10	0.10	0.00	0.0%
		15.00	5.25	0.25	1.26	1.01	0.25	0.25	0.32	2.5%
		16.00	5.40	0.40	1.73	1.01	0.40	0.40	0.69	5.5%
		17.00	5.25	0.25	1.11	1.01	0.25	0.25	0.28	2.2%
		18.00	5.20	0.20	1.97	1.00	0.20	0.20	0.39	3.1%
		19.00	5.30	0.30	2.04	1.00	0.30	0.30	0.61	4.8%
		20.00	5.30	0.30	2.17	1.00	0.30	0.30	0.65	5.1%
		21.00	5.40	0.40	2.11	1.00	0.40	0.40	0.84	6.6%
		22.00	5.55	0.55	1.40	1.01	0.55	0.55	0.77	6.1%
		23.00	5.50	0.50	1.89	1.00	0.50	0.50	0.95	7.4%
		24.00	5.40	0.40	1.88	1.00	0.40	0.40	0.75	5.9%
		25.00	5.30	0.30	1.93	1.00	0.30	0.30	0.58	4.6%
		26.00	5.25	0.25	1.77	1.00	0.25	0.25	0.44	3.5%
		27.00	5.35	0.35	1.61	1.00	0.35	0.35	0.56	4.4%
		28.00	5.50	0.50	1.46	1.01	0.50	0.50	0.73	5.8%
		29.00	5.55	0.55	1.64	1.00	0.55	0.55	0.90	7.1%
		30.00	5.60	0.60	1.35	1.00	0.60	0.60	0.81	6.4%
		31.00	5.50	0.50	1.57	1.00	0.50	0.50	0.79	6.2%
		32.00	5.40	0.40	1.35	1.00	0.40	0.40	0.54	4.3%
		33.00	5.45	0.45	1.16	1.00	0.45	0.45	0.52	4.1%
		34.00	5.45	0.40	0.54	1.00	0.40	0.40	0.22	1.7%
		35.00	5.10	0.10	0.42	1.06	0.10	0.10	0.04	0.3%
		36.00	5.00	0.00	0.00	1.00		0.00	0.00	0.0%
		37.00	5.10	0.10	0.56	1.00	0.10	0.10	0.06	0.4%
		38.00	5.10	0.10	0.28	1.00	0.10	0.10	0.03	0.2%
		39.00	5.00	0.00	0.00	1.00		0.00	0.00	0.0%
		40.00	5.30	0.30	0.35	1.04	0.30	0.30	0.11	0.8%
		41.00	5.20	0.20	0.32	1.00	0.20	0.15	0.05	0.4%
	W	41.50	4.97	0.00	0.00	0.55		0.00	0.00	0.0%
1	G	42.90	3.17			0.00		0.00	0.00	0.0%
	LS	44.50	3.10			0.00		0.00	0.00	0.0%
	TOTALS ----------					29.18	0.6 (Max.)	8.77	12.69	100.0%

Manning's n = 0.0291
Hydraulic Radius= 0.30052596

STREAM NAME: Willow Creek
XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	8.77	8.67	-1.1%
4.76	8.77	16.43	87.4%
4.78	8.77	15.77	79.9%
4.80	8.77	15.12	72.4%
4.82	8.77	14.47	65.0%
4.84	8.77	13.84	57.8%
4.86	8.77	13.20	50.5%
4.88	8.77	12.58	43.4%
4.90	8.77	11.96	36.3%
4.92	8.77	11.34	29.4%
4.94	8.77	10.74	22.4%
4.96	8.77	10.14	15.6%
4.97	8.77	9.84	12.2%
4.98	8.77	9.55	8.9%
4.99	8.77	9.25	5.5%
5.00	8.77	8.96	2.2%
5.01	8.77	8.67	-1.1%
5.02	8.77	8.39	-4.4%
5.03	8.77	8.11	-7.6%
5.04	8.77	7.83	-10.7%
5.05	8.77	7.56	-13.8%
5.06	8.77	7.29	-16.9%
5.08	8.77	6.76	-22.9%
5.10	8.77	6.25	-28.7%
5.12	8.77	5.79	-34.0%
5.14	8.77	5.34	-39.2%
5.16	8.77	4.89	-44.2%
5.18	8.77	4.45	-49.2%
5.20	8.77	4.02	-54.1%
5.22	8.77	3.60	-59.0%
5.24	8.77	3.20	-63.5%
5.26	8.77	2.82	-67.9%

WATERLINE AT ZERO
AREA ERROR = 5.002

STREAM NAME: Willow Creek
XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
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	3.17	39.21	1.90	2.43	74.59	40.72	100.0%	1.83	360.27	4.83
	4.00	36.62	1.18	1.60	43.15	37.53	92.2%	1.15	152.76	3.54
	4.05	36.47	1.13	1.55	41.32	37.35	91.7%	1.11	142.58	3.45
	4.10	36.33	1.09	1.50	39.50	37.18	91.3%	1.06	132.69	3.36
	4.15	36.19	1.04	1.45	37.69	37.00	90.9%	1.02	123.09	3.27
	4.20	36.05	1.00	1.40	35.88	36.82	90.4%	0.97	113.78	3.17
	4.25	35.90	0.95	1.35	34.08	36.64	90.0%	0.93	104.78	3.07
	4.30	35.76	0.90	1.30	32.29	36.46	89.6%	0.89	96.07	2.98
	4.35	35.62	0.86	1.25	30.51	36.29	89.1%	0.84	87.67	2.87
	4.40	35.48	0.81	1.20	28.73	36.11	88.7%	0.80	79.59	2.77
	4.45	35.33	0.76	1.15	26.96	35.93	88.2%	0.75	71.82	2.66
	4.50	35.19	0.72	1.10	25.20	35.75	87.8%	0.70	64.37	2.55
	4.55	35.05	0.67	1.05	23.44	35.57	87.4%	0.66	57.26	2.44
	4.60	34.91	0.62	1.00	21.69	35.39	86.9%	0.61	50.49	2.33
	4.65	34.76	0.57	0.95	19.95	35.22	86.5%	0.57	44.06	2.21
	4.70	34.04	0.54	0.90	18.23	34.47	84.6%	0.53	38.45	2.11
	4.75	33.20	0.50	0.85	16.55	33.60	82.5%	0.49	33.28	2.01
	4.80	32.37	0.46	0.80	14.91	32.74	80.4%	0.46	28.46	1.91
	4.85	31.53	0.42	0.75	13.31	31.87	78.3%	0.42	23.99	1.80
	4.90	30.69	0.38	0.70	11.75	31.01	76.2%	0.38	19.86	1.69
	4.95	29.85	0.34	0.65	10.24	30.14	74.0%	0.34	16.08	1.57
WL	5.00	28.91	0.30	0.60	8.77	29.19	71.7%	0.30	12.69	1.45
	5.05	26.82	0.28	0.55	7.38	27.06	66.5%	0.27	10.01	1.36
	5.10	22.86	0.27	0.50	6.09	23.07	56.7%	0.26	8.09	1.33
	5.15	22.11	0.22	0.45	4.97	22.29	54.7%	0.22	5.89	1.19
	5.20	21.30	0.18	0.40	3.88	21.45	52.7%	0.18	4.00	1.03
	5.25	18.63	0.15	0.35	2.88	18.75	46.1%	0.15	2.67	0.93
	5.30	14.19	0.14	0.30	2.04	14.28	35.1%	0.14	1.80	0.88
	5.35	11.88	0.12	0.25	1.39	11.95	29.4%	0.12	1.06	0.77
	5.40	9.72	0.09	0.20	0.85	9.77	24.0%	0.09	0.53	0.63
	5.45	5.95	0.07	0.15	0.43	5.97	14.7%	0.07	0.24	0.56
	5.50	4.24	0.04	0.10	0.18	4.25	10.4%	0.04	0.07	0.39
	5.55	1.45	0.02	0.05	0.04	1.46	3.6%	0.02	0.01	0.27

STREAM NAME: Willow Creek
XS LOCATION: 800 ft. downst fr conf w/ Beaver Creek
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	12.69	cfs
CALCULATED FLOW (Qc)=	12.69	cfs
(Qm-Qc)/Qm * 100 =	0.0	%
MEASURED WATERLINE (WLm)=	5.01	ft
CALCULATED WATERLINE (WLc)=	5.00	ft
(WLm-WLc)/WLm * 100 =	0.1	%
MAX MEASURED DEPTH (Dm)=	0.60	ft
MAX CALCULATED DEPTH (Dc)=	0.60	ft
(Dm-Dc)/Dm * 100	0.3	%
MEAN VELOCITY=	1.45	ft/sec
MANNING'S N=	0.029	
SLOPE=	0.004	ft/ft
.4 * Qm =	5.1	cfs
2.5 * Qm=	31.7	cfs

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

FLOW (CFS)	PERIOD
___________	___________
___________	___________
___________	___________
___________	___________

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

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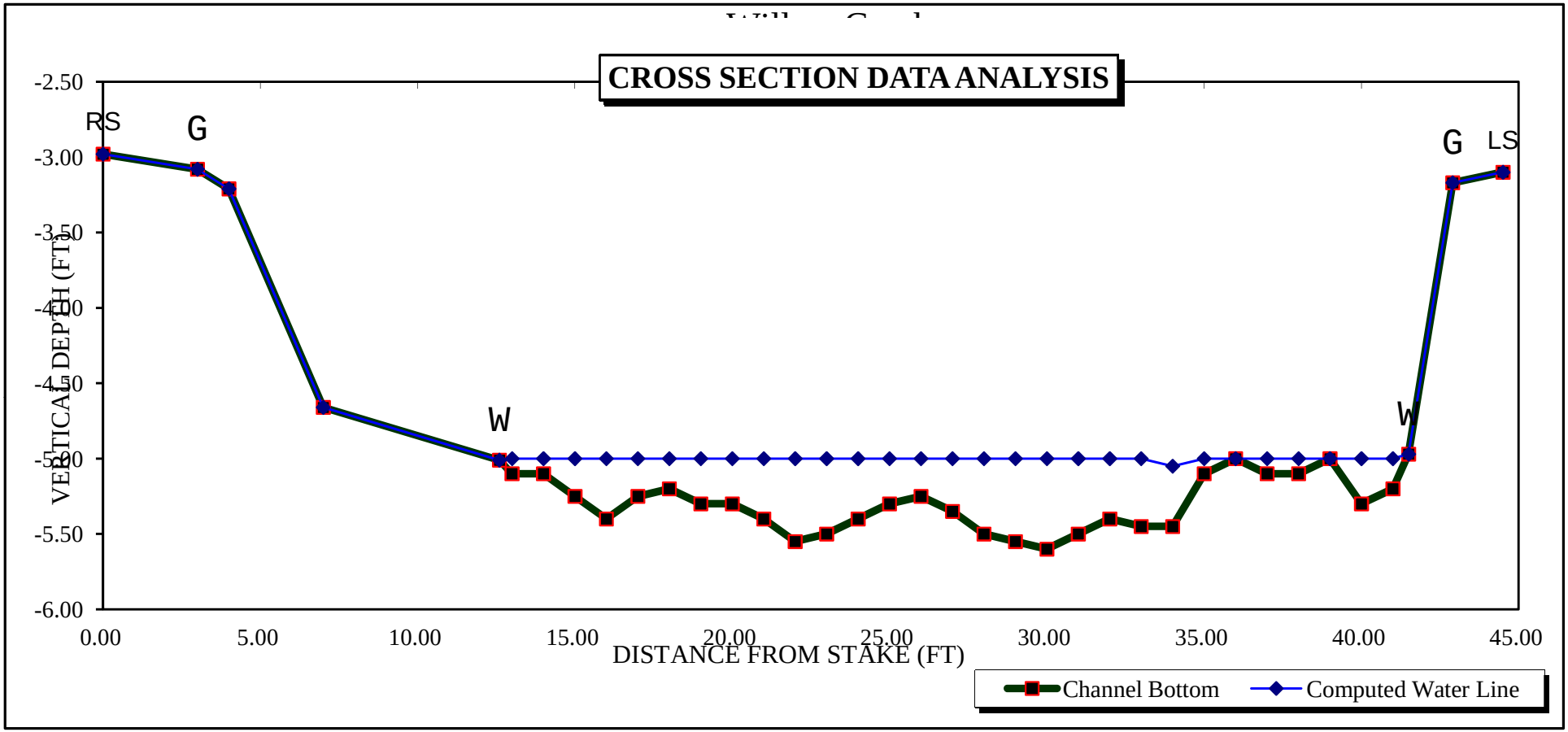
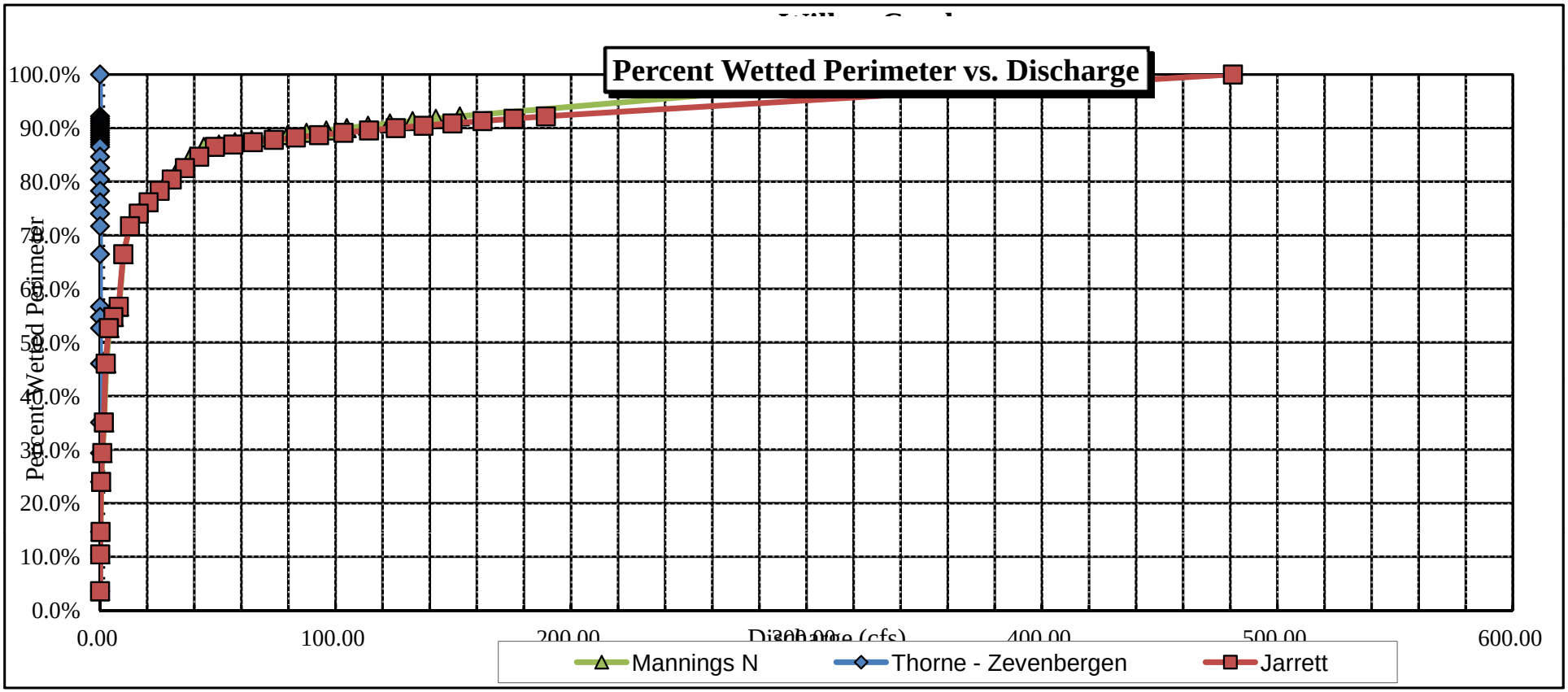
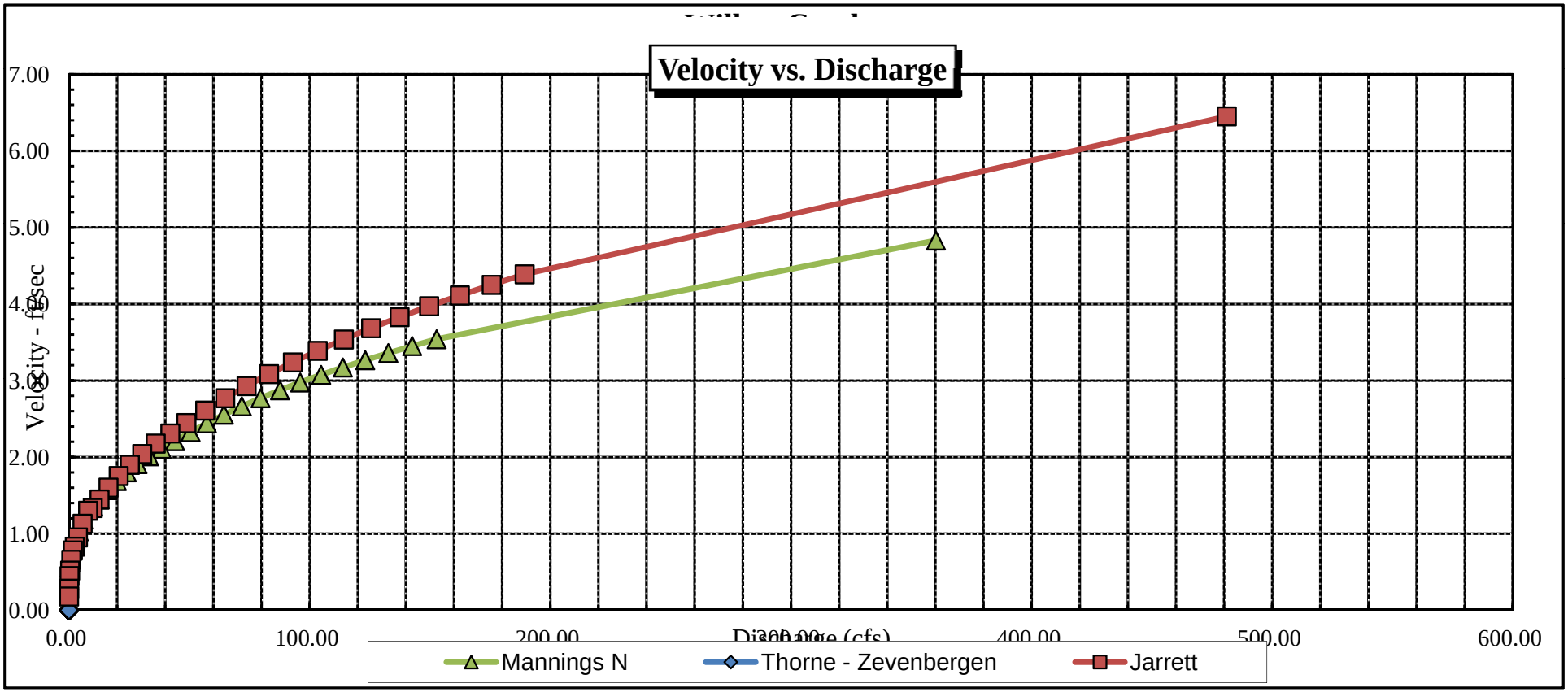
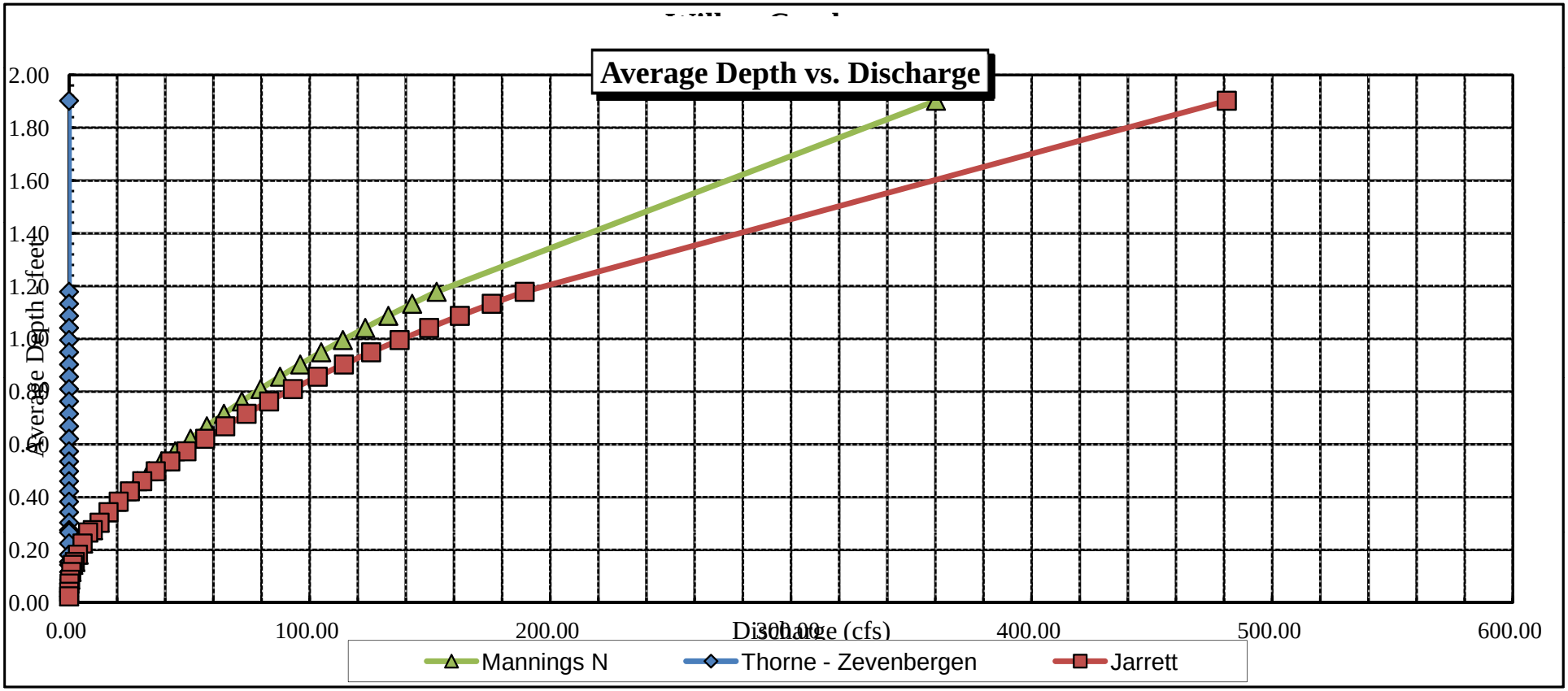
RECOMMENDATION BY: .... AGENCY.. DATE:..................................

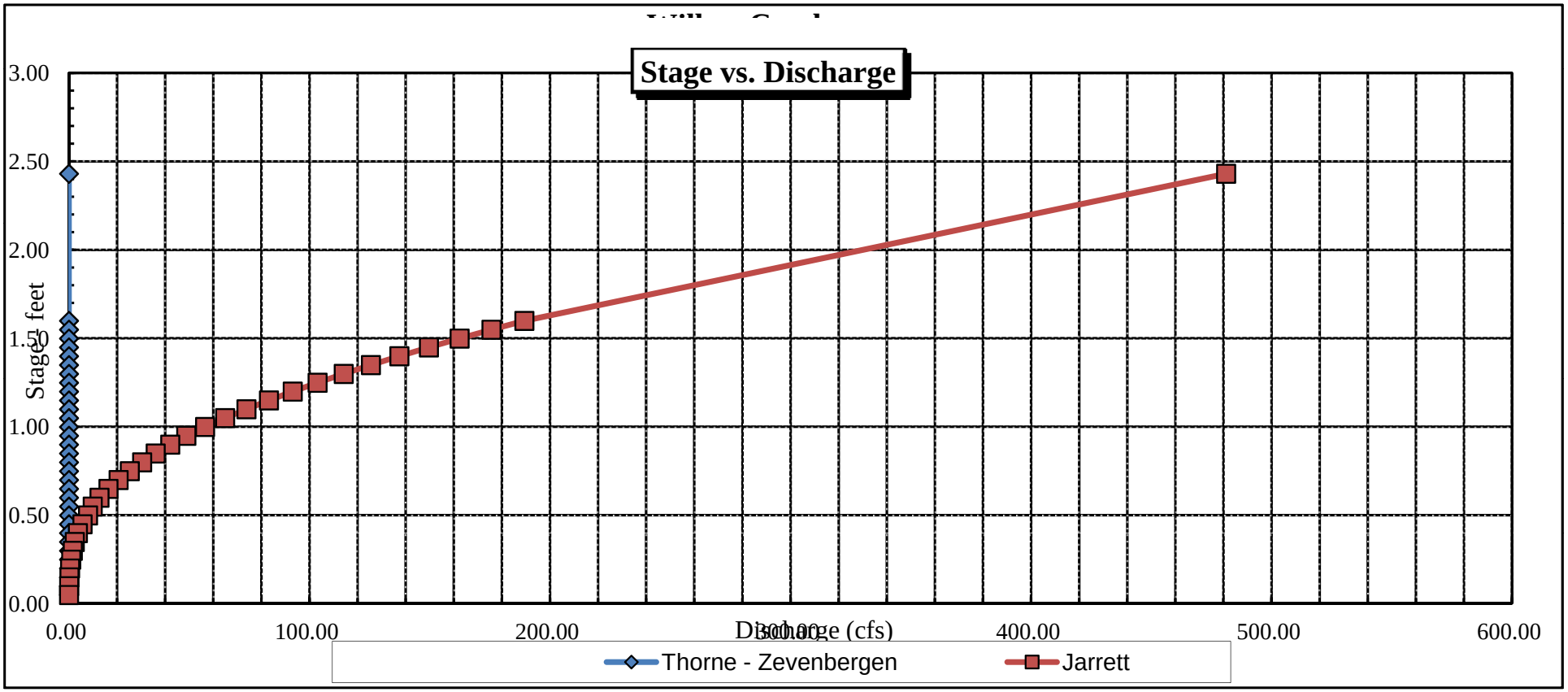
CWCB REVIEW BY: .... DATE:..................................


CROSS SECTION DATA ANALYSIS
RS
G
W
G
LS
W
-2.50
-3.00
-3.50
-4.00
-4.50
-5.00
-5.50
-6.00
VERTICAL DEPTH (FT)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


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
100.00
200.00
400.00
500.00
600.00
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.00
100.00
200.00
400.00
500.00
600.00
Mannings N
Thorne - Zevenbergen
Jarrett


Average Depth vs. Discharge
Average Depth (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
100.00
200.00
300.00
400.00
500.00
600.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Stage vs. Discharge
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Stage - feet
0.00
100.00
200.00
300.00
400.00
500.00
600.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

Discharge Measurement Summary

Date Generated: Tue Dec 17 2013

File Information

File Name	WILWCRQ2.001.WAD
Start Date and Time	2013/07/03 15:10:45

Site Details

Site Name	WILLOW CR BLW LESTER
Operator(s)	BRIAN EPSTEIN

System Information

Sensor Type	FlowTracker
Serial #	P2354
CPU Firmware Version	3.9
Software Ver	2.30
Mounting Correction	0.0%

Units (English Units)

Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.3%	5.8%
Velocity	0.6%	4.7%
Width	0.1%	0.1%
Method	1.6%	-
# Stations	1.8%	-
Overall	**2.7%**	**7.5%**

Summary

Averaging Int.	40	# Stations	29
Start Edge	REW	Total Width	42.000
Mean SNR	26.2 dB	Total Area	31.503
Mean Temp	69.52 °F	Mean Depth	0.750
Disch. Equation	Mid-Section	Mean Velocity	0.2499
		Total Discharge	**7.8714**

Measurement Results

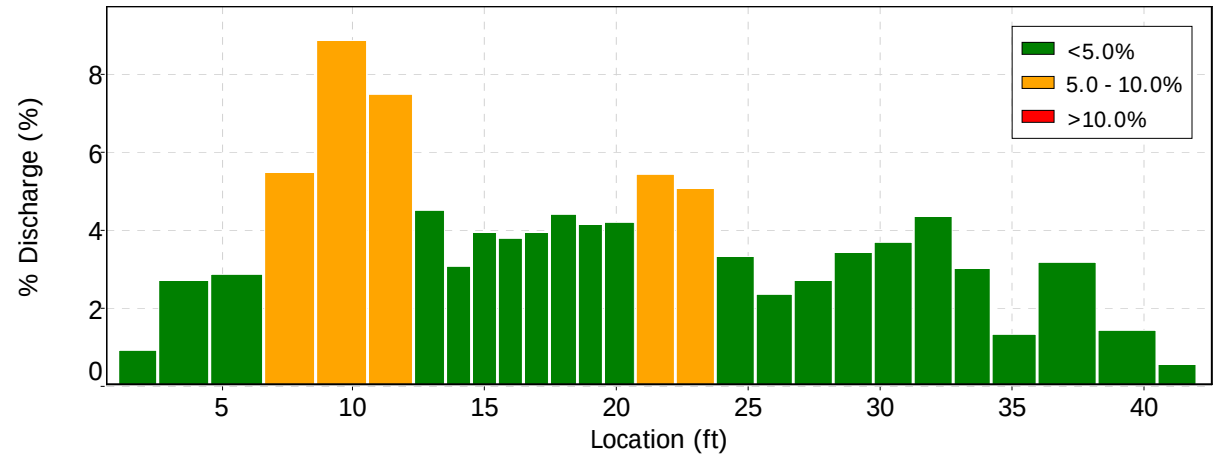
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	15:10	0.60	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	15:10	1.60	0.6	0.220	0.6	0.088	0.2113	1.00	0.2113	0.330	0.0698	0.9
2	15:13	3.60	0.6	0.320	0.6	0.128	0.3340	1.00	0.3340	0.640	0.2137	2.7
3	15:14	5.60	0.6	0.650	0.6	0.260	0.1726	1.00	0.1726	1.300	0.2243	2.8
4	15:15	7.60	0.6	0.680	0.6	0.272	0.3173	1.00	0.3173	1.360	0.4315	5.5
5	15:17	9.60	0.6	0.830	0.6	0.332	0.4213	1.00	0.4213	1.660	0.6993	8.9
6	15:19	11.60	0.6	0.910	0.6	0.364	0.3816	1.00	0.3816	1.547	0.5903	7.5
7	15:21	13.00	0.6	0.870	0.6	0.348	0.3386	1.00	0.3386	1.044	0.3535	4.5
8	15:24	14.00	0.6	0.600	0.6	0.240	0.4012	1.00	0.4012	0.600	0.2408	3.1
9	15:25	15.00	0.6	0.840	0.6	0.336	0.3668	1.00	0.3668	0.840	0.3081	3.9
10	15:26	16.00	0.6	1.180	0.6	0.472	0.2516	1.00	0.2516	1.180	0.2970	3.8
11	15:27	17.00	0.6	0.920	0.6	0.368	0.3376	1.00	0.3376	0.920	0.3106	3.9
12	15:28	18.00	0.6	1.100	0.6	0.440	0.3143	1.00	0.3143	1.100	0.3458	4.4
13	15:30	19.00	0.6	1.190	0.6	0.476	0.2749	1.00	0.2749	1.190	0.3272	4.2
14	15:31	20.00	0.6	0.820	0.6	0.328	0.3219	1.00	0.3219	1.025	0.3298	4.2
15	15:33	21.50	0.6	1.240	0.6	0.496	0.2293	1.00	0.2293	1.860	0.4266	5.4
16	15:34	23.00	0.6	1.170	0.6	0.468	0.2267	1.00	0.2267	1.755	0.3979	5.1
17	15:36	24.50	0.6	0.610	0.6	0.244	0.2871	1.00	0.2871	0.915	0.2626	3.3
18	15:37	26.00	0.6	0.900	0.6	0.360	0.1365	1.00	0.1365	1.350	0.1842	2.3
19	15:38	27.50	0.6	0.600	0.6	0.240	0.2349	1.00	0.2349	0.900	0.2114	2.7
20	15:39	29.00	0.6	1.000	0.6	0.400	0.1788	1.00	0.1788	1.500	0.2682	3.4
21	15:41	30.50	0.6	0.820	0.6	0.328	0.2365	1.00	0.2365	1.230	0.2909	3.7
22	15:42	32.00	0.6	1.030	0.6	0.412	0.2221	1.00	0.2221	1.545	0.3431	4.4
23	15:43	33.50	0.6	0.940	0.6	0.376	0.1683	1.00	0.1683	1.410	0.2373	3.0
24	15:45	35.00	0.6	0.250	0.6	0.100	0.2359	1.00	0.2359	0.438	0.1032	1.3
25	15:46	37.00	0.6	0.780	0.6	0.312	0.1430	1.00	0.1430	1.755	0.2510	3.2
26	15:49	39.50	0.6	0.600	0.6	0.240	0.0827	1.00	0.0827	1.350	0.1116	1.4
27	15:50	41.50	0.6	0.490	0.6	0.196	0.0548	1.00	0.0548	0.760	0.0416	0.5
28	15:50	42.60	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

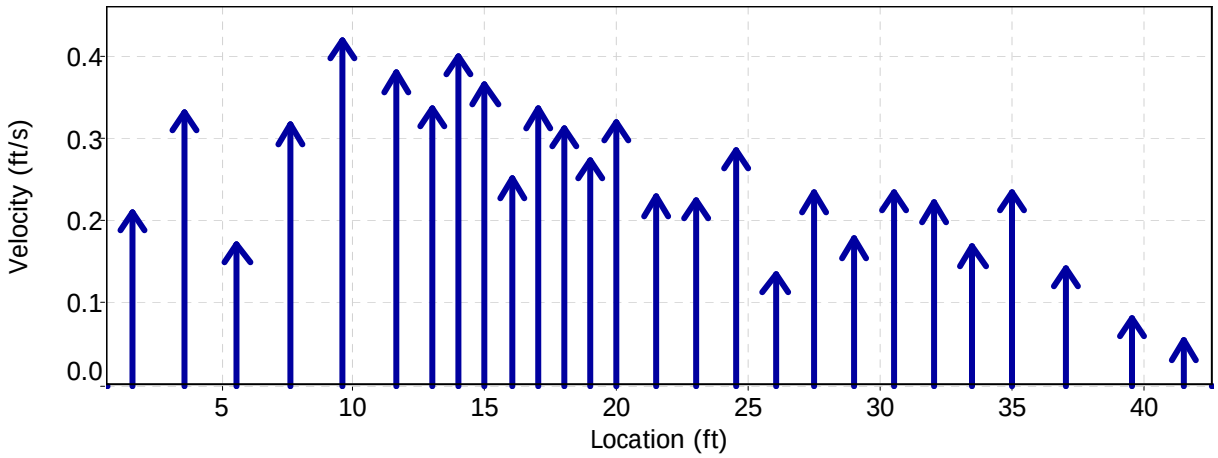
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

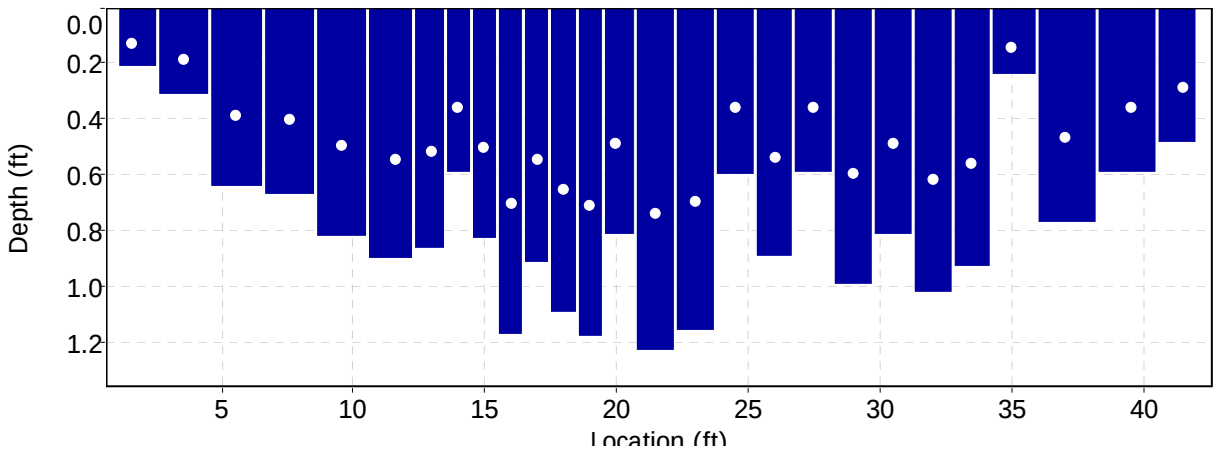
Discharge Measurement Summary

Date Generated: Tue Dec 17 2013

File Information		Site Details	
File Name	WILWCRQ2.001.WAD	Site Name	WILLOW CR BLW LESTER
Start Date and Time	2013/07/03 15:10:45	Operator(s)	BRIAN EPSTEIN







Discharge Measurement Summary

Date Generated: Tue Dec 17 2013

File Information		Site Details	
File Name	WILWCRQ2.001.WAD	Site Name	WILLOW CR BLW LESTER
Start Date and Time	2013/07/03 15:10:45	Operator(s)	BRIAN EPSTEIN

Quality Control

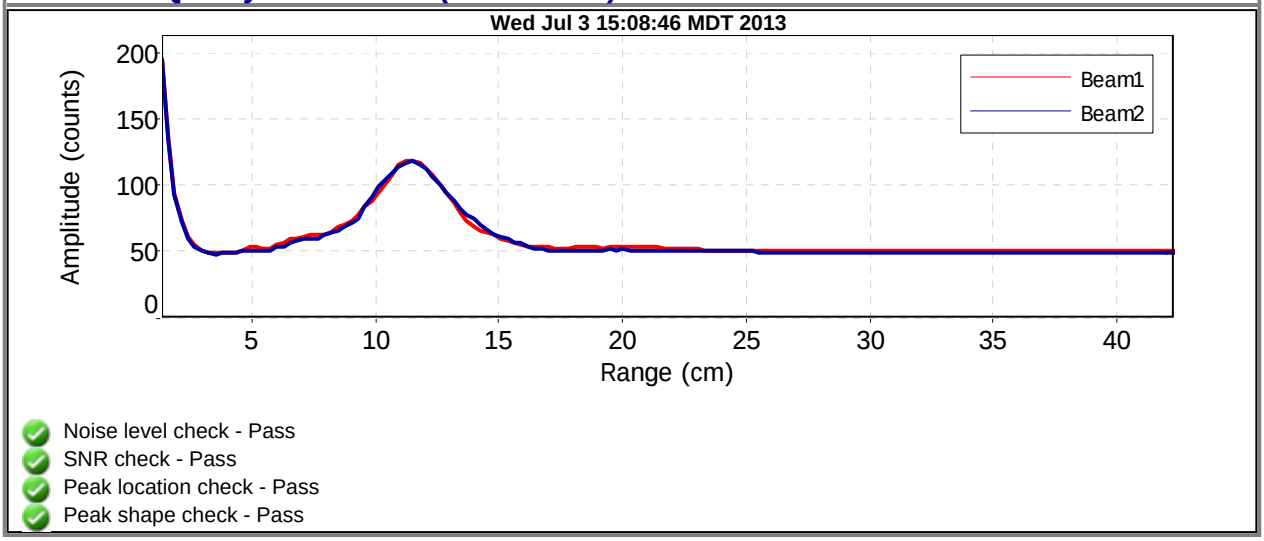
No Quality Control warnings

Discharge Measurement Summary

Date Generated: Tue Dec 17 2013

File Information		Site Details	
File Name	WILWCRQ2.001.WAD	Site Name	WILLOW CR BLW LESTER
Start Date and Time	2013/07/03 15:10:45	Operator(s)	BRIAN EPSTEIN

Automatic Quality Control Test (BeamCheck)



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

Discharge Measurement Summary

Date Generated: Fri Sep 21 2012

File Information

File Name	WLWCRBBC.001.WAD
Start Date and Time	2012/09/13 15:09:18

Site Details

Site Name	WILLOW CR BLW BEAVER
Operator(s)	BRIAN EPSTEIN

System Information

Sensor Type	FlowTracker
Serial #	P2354
CPU Firmware Version	3.9
Software Ver	2.30
Mounting Correction	0.0%

Units (English Units)

Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.4%	3.7%
Velocity	0.8%	2.5%
Width	0.1%	0.1%
Method	2.0%	-
# Stations	2.4%	-
Overall	**3.4%**	**4.6%**

Summary

Averaging Int.	40	# Stations	21
Start Edge	REW	Total Width	29.700
Mean SNR	23.8 dB	Total Area	16.308
Mean Temp	58.91 °F	Mean Depth	0.549
Disch. Equation	Mid-Section	Mean Velocity	0.3298
		Total Discharge	**5.3788**

Measurement Results

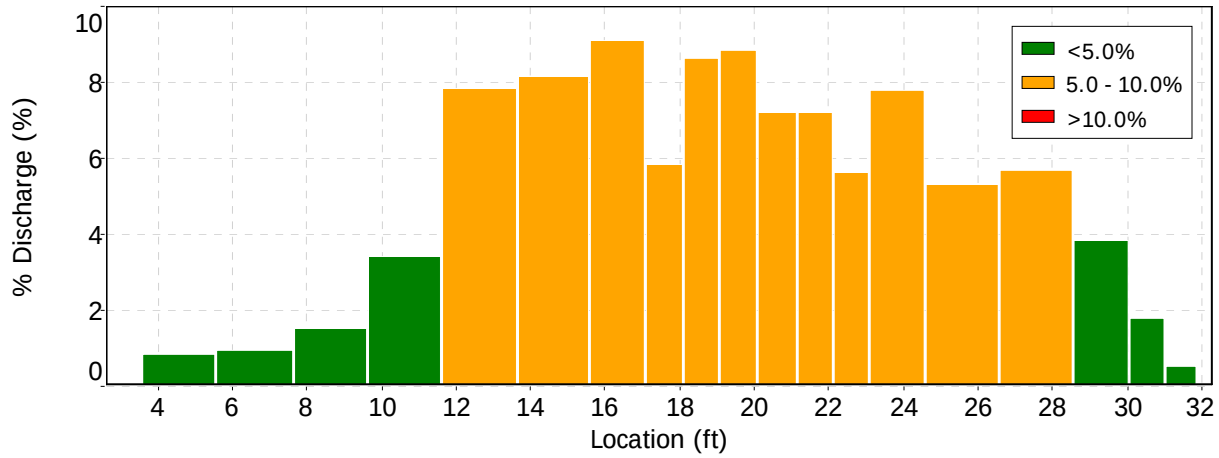
St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	15:09	2.60	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	15:09	4.60	0.6	0.230	0.6	0.092	0.0938	1.00	0.0938	0.460	0.0432	0.8
2	15:11	6.60	0.6	0.370	0.6	0.148	0.0669	1.00	0.0669	0.759	0.0508	0.9
3	15:12	8.70	0.6	0.390	0.6	0.156	0.1043	1.00	0.1043	0.780	0.0814	1.5
4	15:14	10.60	0.6	0.530	0.6	0.212	0.1736	1.00	0.1736	1.060	0.1839	3.4
5	15:16	12.70	0.6	0.720	0.6	0.288	0.2936	1.00	0.2936	1.440	0.4229	7.9
6	15:17	14.60	0.6	0.580	0.6	0.232	0.3885	1.00	0.3885	1.131	0.4394	8.2
7	15:20	16.60	0.6	0.700	0.6	0.280	0.4669	1.00	0.4669	1.050	0.4903	9.1
8	15:21	17.60	0.6	0.780	0.6	0.312	0.4009	1.00	0.4009	0.780	0.3127	5.8
9	15:22	18.60	0.6	0.900	0.6	0.360	0.5144	1.00	0.5144	0.900	0.4630	8.6
10	15:24	19.60	0.6	0.910	0.6	0.364	0.5220	1.00	0.5220	0.910	0.4751	8.8
11	15:26	20.60	0.6	0.700	0.6	0.280	0.5259	1.00	0.5259	0.735	0.3866	7.2
12	15:28	21.70	0.6	0.940	0.6	0.376	0.4111	1.00	0.4111	0.940	0.3864	7.2
13	15:29	22.60	0.6	0.720	0.6	0.288	0.4416	1.00	0.4416	0.684	0.3021	5.6
14	15:31	23.60	0.6	0.720	0.6	0.288	0.3885	1.00	0.3885	1.080	0.4196	7.8
15	15:33	25.60	0.6	0.430	0.6	0.172	0.3330	1.00	0.3330	0.860	0.2865	5.3
16	15:35	27.60	0.6	0.500	0.6	0.200	0.3133	1.00	0.3133	0.975	0.3055	5.7
17	15:37	29.50	0.6	0.520	0.6	0.208	0.2638	1.00	0.2638	0.780	0.2058	3.8
18	15:40	30.60	0.6	0.490	0.6	0.196	0.1949	1.00	0.1949	0.490	0.0955	1.8
19	15:44	31.50	0.6	0.580	0.6	0.232	0.0574	1.00	0.0574	0.493	0.0283	0.5
20	15:44	32.30	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

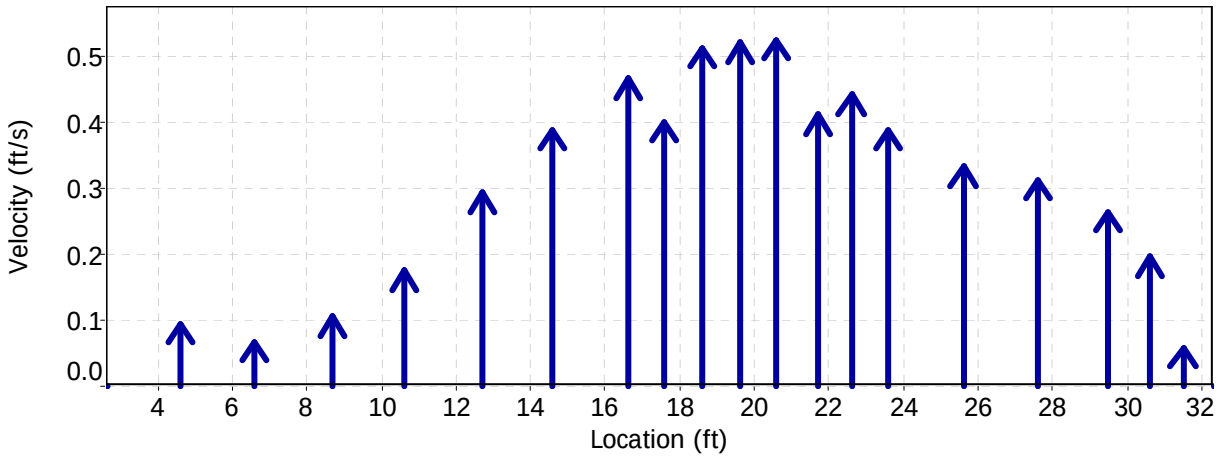
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

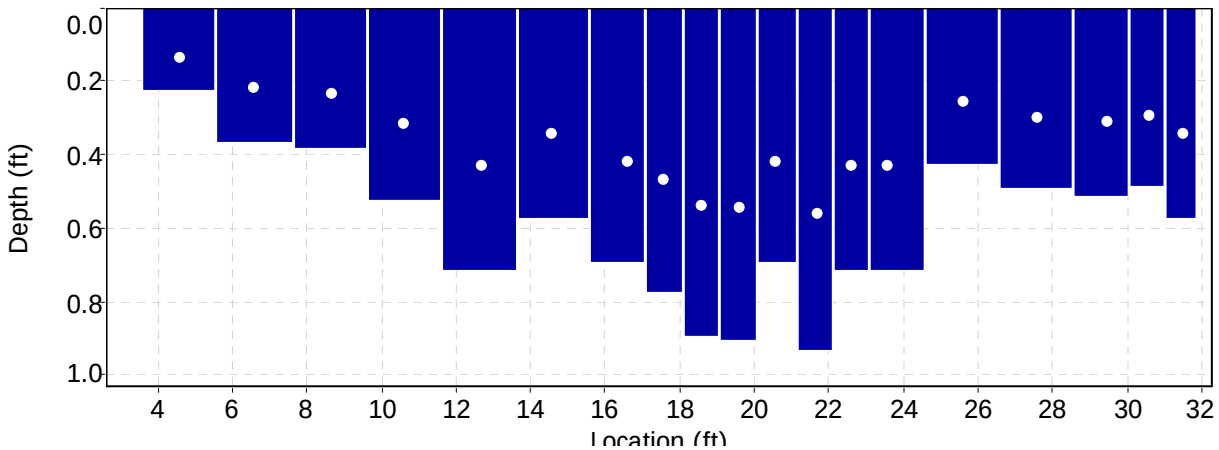
Discharge Measurement Summary

Date Generated: Fri Sep 21 2012

File Information		Site Details	
File Name	WLWCRBBC.001.WAD	Site Name	WILLOW CR BLW BEAVER
Start Date and Time	2012/09/13 15:09:18	Operator(s)	BRIAN EPSTEIN







Discharge Measurement Summary

Date Generated: Fri Sep 21 2012

File Information		Site Details	
File Name	WLWCRBBC.001.WAD	Site Name	WILLOW CR BLW BEAVER
Start Date and Time	2012/09/13 15:09:18	Operator(s)	BRIAN EPSTEIN

Quality Control

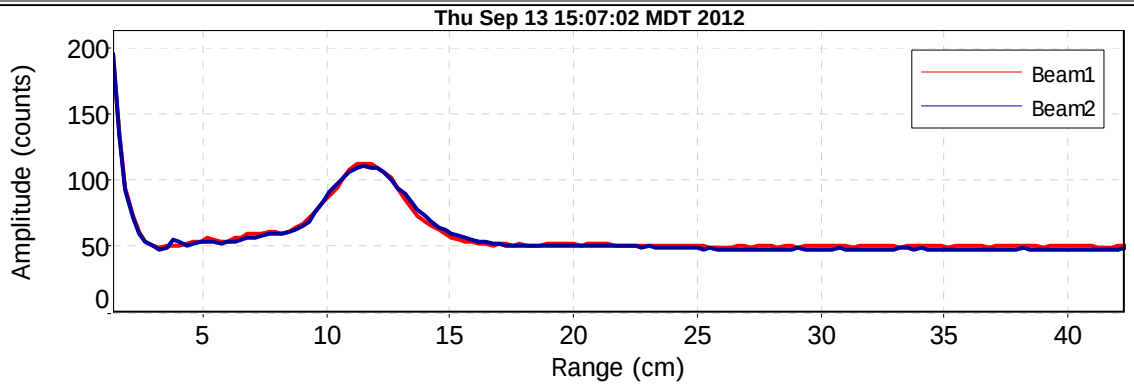
No Quality Control warnings

Discharge Measurement Summary

Date Generated: Fri Sep 21 2012

File Information		Site Details	
File Name	WLWCRBBC.001.WAD	Site Name	WILLOW CR BLW BEAVER
Start Date and Time	2012/09/13 15:09:18	Operator(s)	BRIAN EPSTEIN

Automatic Quality Control Test (BeamCheck)



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

State of Colorado
Colorado Water Conservation Board
Field Notes

Brian Epstein
Brandy Logan

Willow Creek
downstream of Steamboat Lake

Time	Pic	Comment
10:54	160	From left bank, Brandy looking for temp sensor, upstream of sensor
10:59	161	Retrieval of Temp sensor
10:59	162	Gloria's retrieval of temp sensor
10:59	163	Close up " " " "
11:00	164-166	Sensor close up after retrieval
11:01	167	Willow Creek, from left bank, looking downstream
11:01	168	Willow Creek, from left bank, looking upstream

10:59 Temp sensor / logger removed from water
→ in same location as deployed
→ flows visually similar to deployment date

Notes By: BJE

YYYY-MM-DD:
2013-11-04

Page 1 of 2	State of Colorado	Meas. No.: 001
YYYY: 2013	**Colorado Water Conservation Board**	Division: 6
MM-DD: 07-03	ADV Discharge Measurement Notes	District: 58

Station Name: N/A

Willow River, (Creek), Canal, Ditch

At, Near, Above, (Below) 45' Lester Creek

Latitude: N 40° ~~38~~ 34.22" Longitude: W 106° 53' 55.04" NAD 83

Party: Brian Epstein

Conditions

Weather: Mostly cloudy, periodic light sprinkle, ~75°F

Wind Spd / Dir: variable, light Water Temp:

X-Sec Desc: middle of 200' straight section, bed cobbles

Flow Conds: Laminar, Steady

Control Desc.: N/A

Measurement Rated: (Excelent (2%)) / Good (5%) / Fair (8%) / Poor (>8%) [based on the above conditions]

Water Level Reading

Time	Staff Gage	Pressure Trans.	Time	Staff Gage	Pressure Trans.
N/A					

Pressure Transducer Download		Weighted MGH	
File Name:	N/A	GH Corr.	
Time:		Correct MGH	

Discharge Measurement

Manufacturer:	SonTek	Model:	FlowTracker	S/N:	(P2354) / P2355
Firmware:	3.7	Software:	2.20		
Diag Test File:	(Yes) or No	Raw Data File:	WILWCRQ2.001		
Meas Type:	(Wading) / Boat / Bridge / Cableway			Method:	0.6
	N/A		ft. or mi / upstream or downstream of gage		
Start Edge:	REW 0.6	End Edge:	42.6	Total Width:	42.0
Start Time:	15:09	End Time:	15:52		
Discharge:	7.87	Unsertainty:	2.7	# Stations:	29
Mean v:	0.250	Width	41.999	Mean d:	0.75
Max v:	0.421	Area:	31.503	Max d:	1.24
Mean SNR:	26.2	σv:	0.007	Mean Temp:	69.5°F

Meas. By:	BJE	Notes By:	BJE
Processed By:	AJE	Reviewed By:	

Remarks:

14:41 WillowCrQ2 is the waypoint name
14:51 Pic 828 Willow Creek Q2 cross-section from REW
14:53 Pic 829 Willow Creek Q2 cross-section from downstream center
14:54 Mov 830 "
15:05 FlowTracker = GPS = Camera Time

State of Colorado

Colorado Water Conservation Board

Field Notes

Willow Creek July 3, 2013
Brian Epstein

12:40 Arrive at site parking
- 11:40 in Ace Hardware parking lot built pendant temperature logger weight housing
  - 3" pvc cap
  - black metal plate
  - 1/2" wide nylon rope
  - drilled holes in pvc
  - tied together
  - 12:48 Pic 825 weight housing
  - 12:49 Pic 826 weight housing

10:47 Camera time = GPS time
12:55 FlowTracker time = GPS time
12:55 replaced FlowTracker batteries
13:13 Located Hobo Pendant Temp Logger SW
- bellow rifle in thalwag
- Waypoint name: WillowCrTempLgr
  N 40° 46' 09.44" NAD83
  W 106° 55' 02.63"
- downstream of County Road 129 bridge over Willow Creek
- upstream of confluence with Beaver Creek
- 13:21 Pic 827 white cap center picture show location of temperature logger taken from downstream center of creek

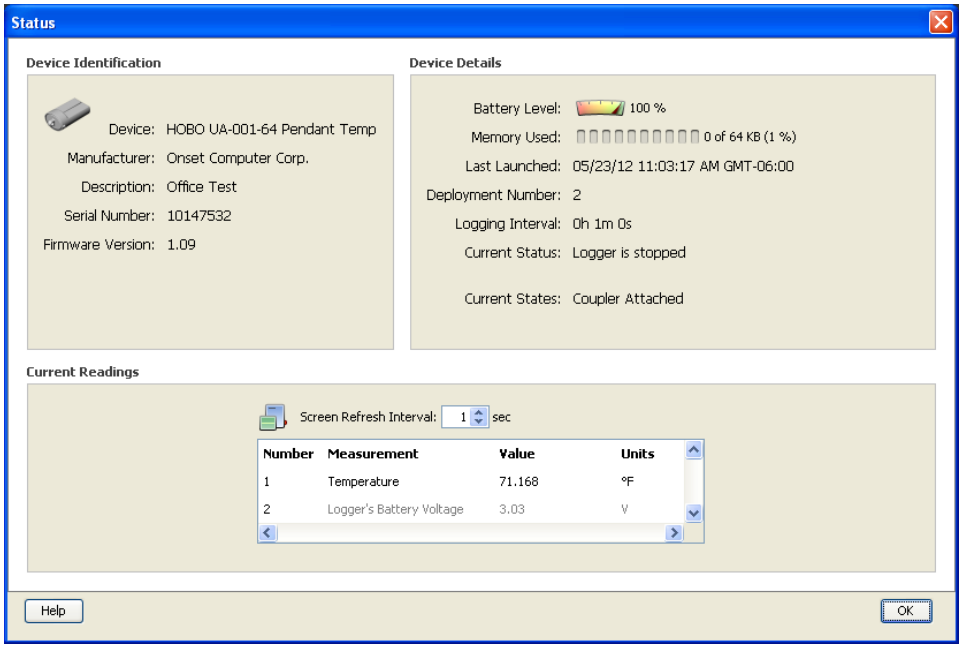
15:12 831 video of Bank
16:29 832 Willow Creek from ridge to the south looking toward Steamboat Lake

Notes By: Brian Epstein YYYY-MM-DD: 2013-07-03 Page 1 of 2

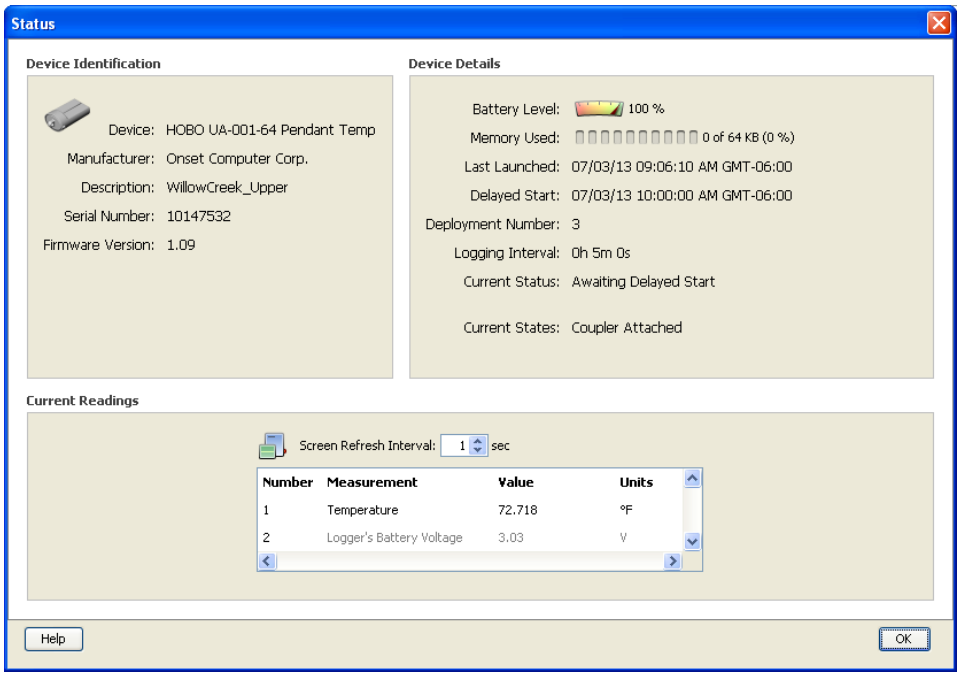
Willow Creek Preparation Notes July 3, 2013

08:59 Preparing temperature sensor pendant SN 10147532 for Willow Creek below Steamboat Lake deployment

- Information and status of the pendant being prepped for deployment



- Downloaded pendant C:\CWCB\ISF-Rights\FieldWork\Download\HoboLoggers\20130703_SN10147532_DowloadContent.hobo
- Pendant prepared for launch



Page 1 of 2	State of Colorado	Meas. No.: 001
YYYY: 2012	**Colorado Water Conservation Board**	Division: 6
MM-DD: 09-13	ADV Discharge Measurement Notes	District: 58

Station Name: Willow

River, (Creek), Canal, Ditch

At, Near, Above, Below: Beaver Creek

Latitude: N 40° 46' 5.54" Longitude: W 106° 54' 57.87" NAD 83

Party: Brian Epstein

Conditions

Weather: Sunny ~72°

Wind Spd / Dir: 3-5mph / SE at 150° Water Temp:

X-Sec Desc: GPS: WillowCrQ

Flow Conds: laminar

Control Desc.: N/A

Measurement Rated: Excelent (2%) / (Good (5%)) / Fair (8%) / Poor (>8%) [based on the above conditions]

Water Level Reading

Time	Staff Gage	Pressure Trans.	Time	Staff Gage	Pressure Trans.
N/A: spot measurement					

Pressure Transducer Download		Weighted MGH		
File Name:	N/A	GH Corr.		
Time:		Correct MGH		

Discharge Measurement

Manufacturer:	SonTek	Model:	FlowTracker	S/N:	(P2354) / P2355
Firmware:	3.7	Software:	2.20		
Diag Test File:	Yes or No	Raw Data File:	WLWCRABC.001		
Meas Type:	(Wading) / Boat / Bridge / Cableway			Method:	0.6
	N/A		ft. or mi / upstream or downstream of gage		
Start Edge:	REW	Total Width:	29.7	# Stations:	
Start Time:	13:07		End Time:	13:47	
Discharge:	5.379	Uncertainty:	3.4%		
Mean v:	0.330	Width	29.699	Mean d:	0.55
Max v:	0.526	Area:	16.307	Max d:	0.94
Mean SNR:	23.8	ov:	0.010	Mean Temp:	58.9

REW 0.2 0.6 33.3 REW 29.7

Meas. By:	BJE	Notes By:	BJE
Processed By:		Reviewed By:	

Remarks: Willow Cr below confl w/ Beaver Cr

→ aquatic vegetative growth is plentiful

Time	Pic/Vid	Comment
15:04	0081	Willow Creek X-sec, from LEW
15:42	0082	fish fry ~1.5 to 2", video
15:50	0083	aquatic vegetation
15:50	0084	Willow Creek X-sec ~~from~~ looking upstream ~~looking~~ from downstream
15:51	0085	"
15:51	0086	" video
15:52	0087	X-section, from REW
15:52	0088	Willow Creek @ x-sec video from REW
15:53	0089	aquatic vegetation
15:53	0090	Measurement station taken from upstream looking downstream

State of Colorado

Colorado Water Conservation Board

Field Notes

July 26, 2012 Brian Epstein
Willow Creek

Waypoint	Comment
Willow Crk CR129	Pic/Vid 799-~~800~~ upstream of Road 800-801 downstream of road

July 27, 2012 9:40 Brian Epstein
Willow Creek w/ Brian Romig, WC
Willow Creek at CR129
→ visual estimate below bridge, 7-10 cfs

July 27, 2012 Brian Epstein
Willow Creek at CR129
14:24 Pic 806 Willow Creek downstream of CR129 showing beaver dam in culvert
14:24 Pic 807 " close up
14:25 Video 808 "

→ started to hike down to confluence w/ Beaver Creek, turned around because of lightening

14:33 Pic 809-10 Willow Creek lower leg before tight canyon
14:35 Pic 811-813 Willow Creek (lower center) with Beaver Creek flowing into Willow at lower center of picture

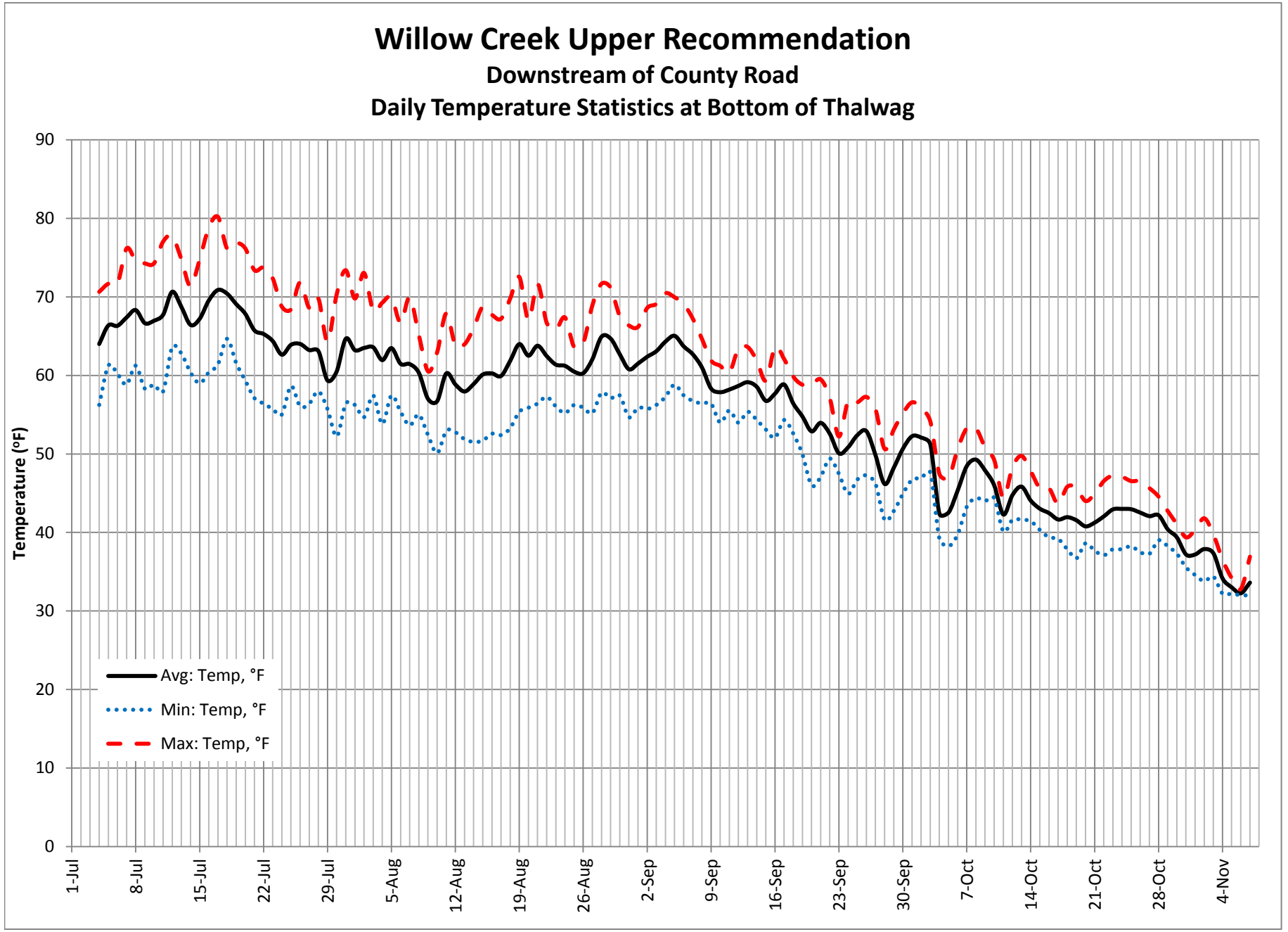
State of Colorado

Colorado Water Conservation Board

Field Notes

July 26, 2012
Steamboat Lake State Park
Reservoir Inflow Tributaries at culvert locs:

Waypoint	Comment
C1	dry
C2	dry
C3	Wet & Flowing Pic/Vid 778-779 est flow 0.5 cfs
C4	dry
C5	dry
C6	Standing water, not flowing
C7	Wet unmeasurable small flow
C8	Wet & Flowing Pic/Vid 780-781 est flow 0.25 cfs
C9	Standing water
C10	flowing water two d=3' cmp culvert water height at deepest is 0.2' water width is 1.4'
C11	cannot see down to culvert
C12	water, cannot determine flow (too far down)
C13	Standing water upstream 786 no flow at outflow end 787
C14	flowing 788-789 upstream end 790-791 downstream end est flow 0.25 cfs
C15	minsicule flow through culvert likely subsurface flow 792-793 upstream 794 downstream
C16	no flow through culvert likely subsurface flow 795-798 Hoover Dam of Beaver Dams


Willow Creek Upper Recommendation
Downstream of County Road
Daily Temperature Statistics at Bottom of Thalwag
Temperature (ºF)
90
80
70
60
50
40
30
20
10
0
1-Jul
8-Jul
15-Jul
22-Jul
29-Jul
5-Aug
12-Aug
19-Aug
26-Aug
2-Sep
9-Sep
16-Sep
23-Sep
30-Sep
7-Oct
14-Oct
21-Oct
28-Oct
4-Nov
Avg: Temp, °F
Min: Temp, °F
Max: Temp, °F

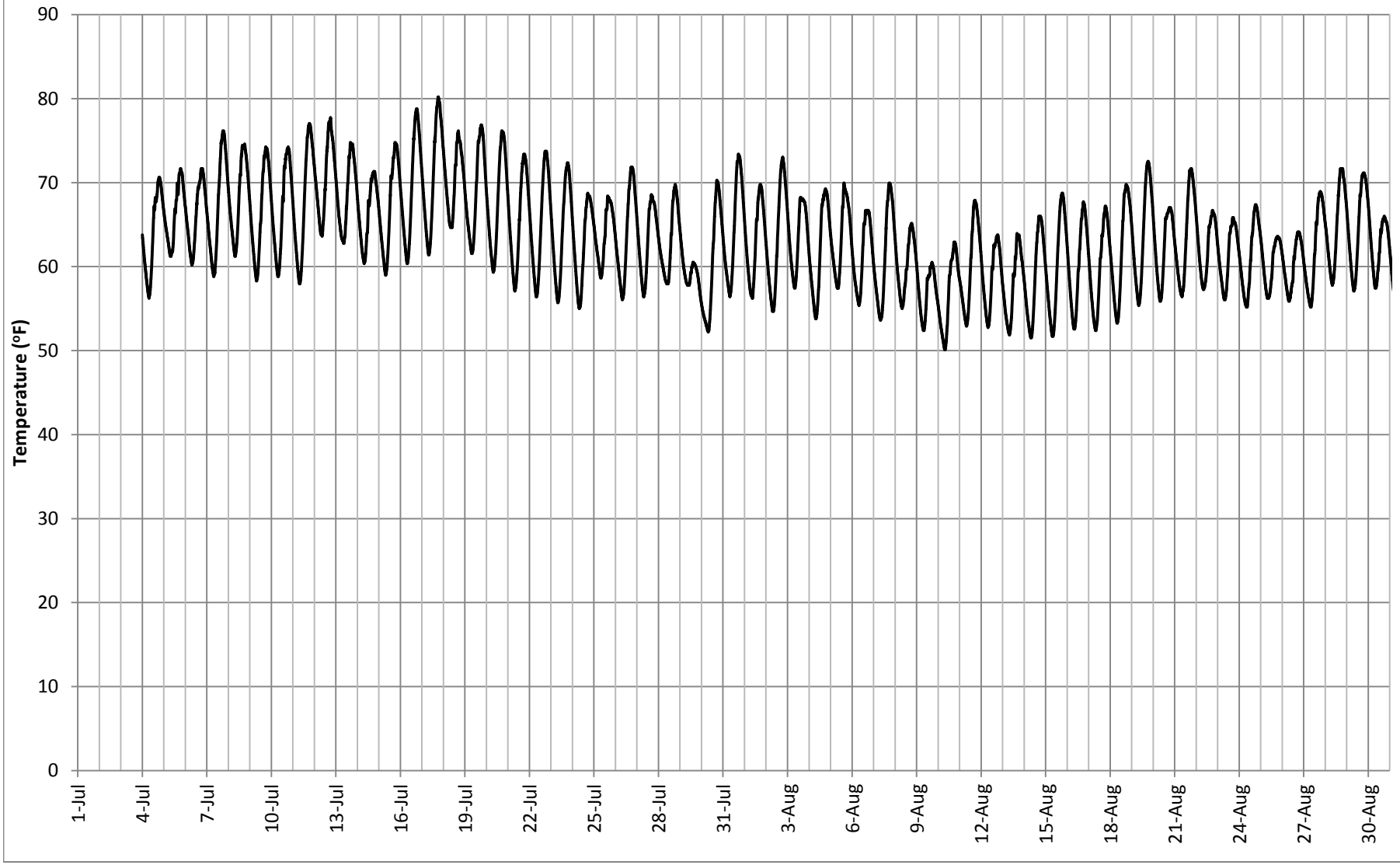
Willow Creek Upper Recommendation

Downstream of County Road

5 Minute Readings

Temperature at Bottom of Thalwag

Graph 1 of 2
July 4 to August 31



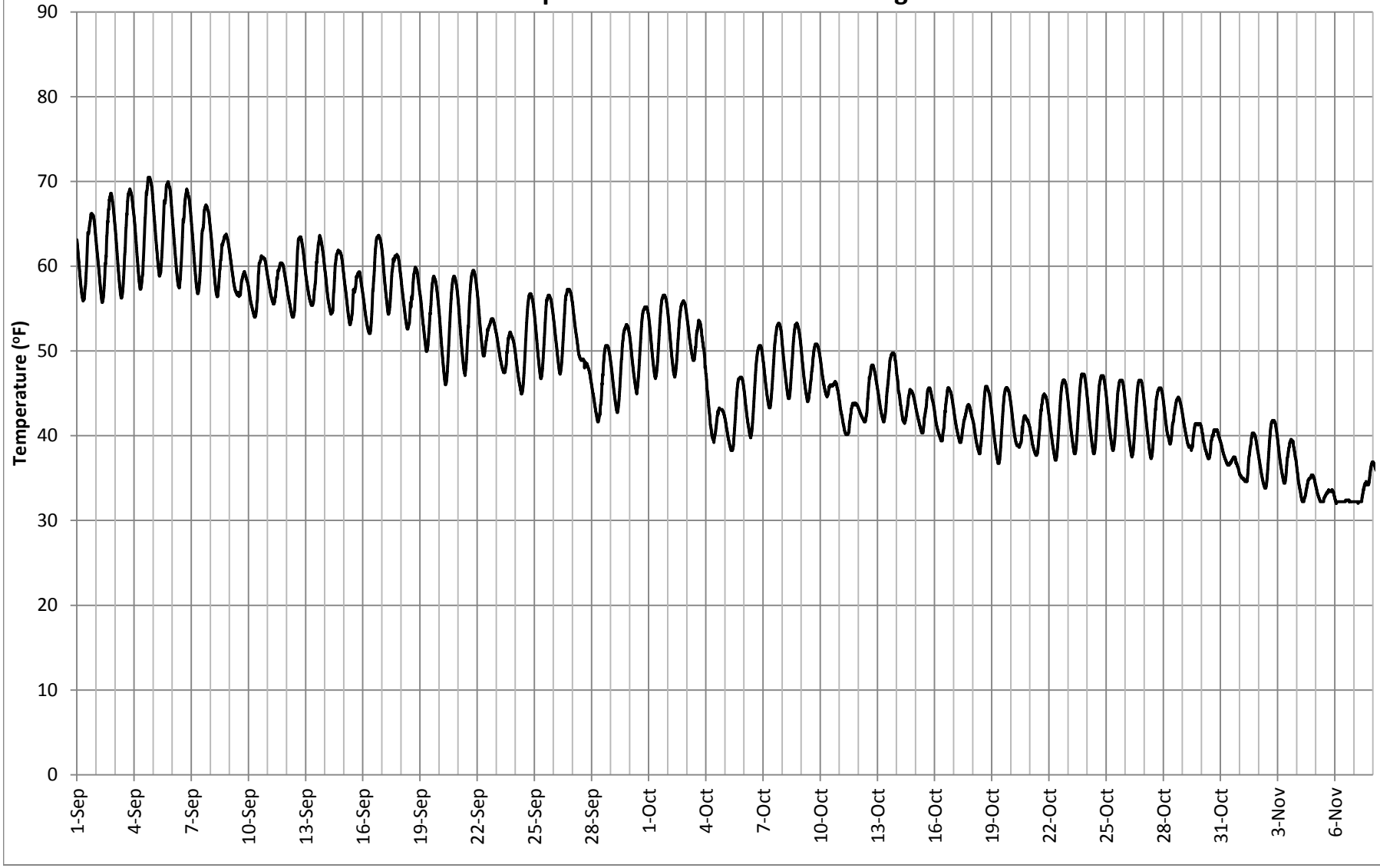
Willow Creek Upper Recommendation

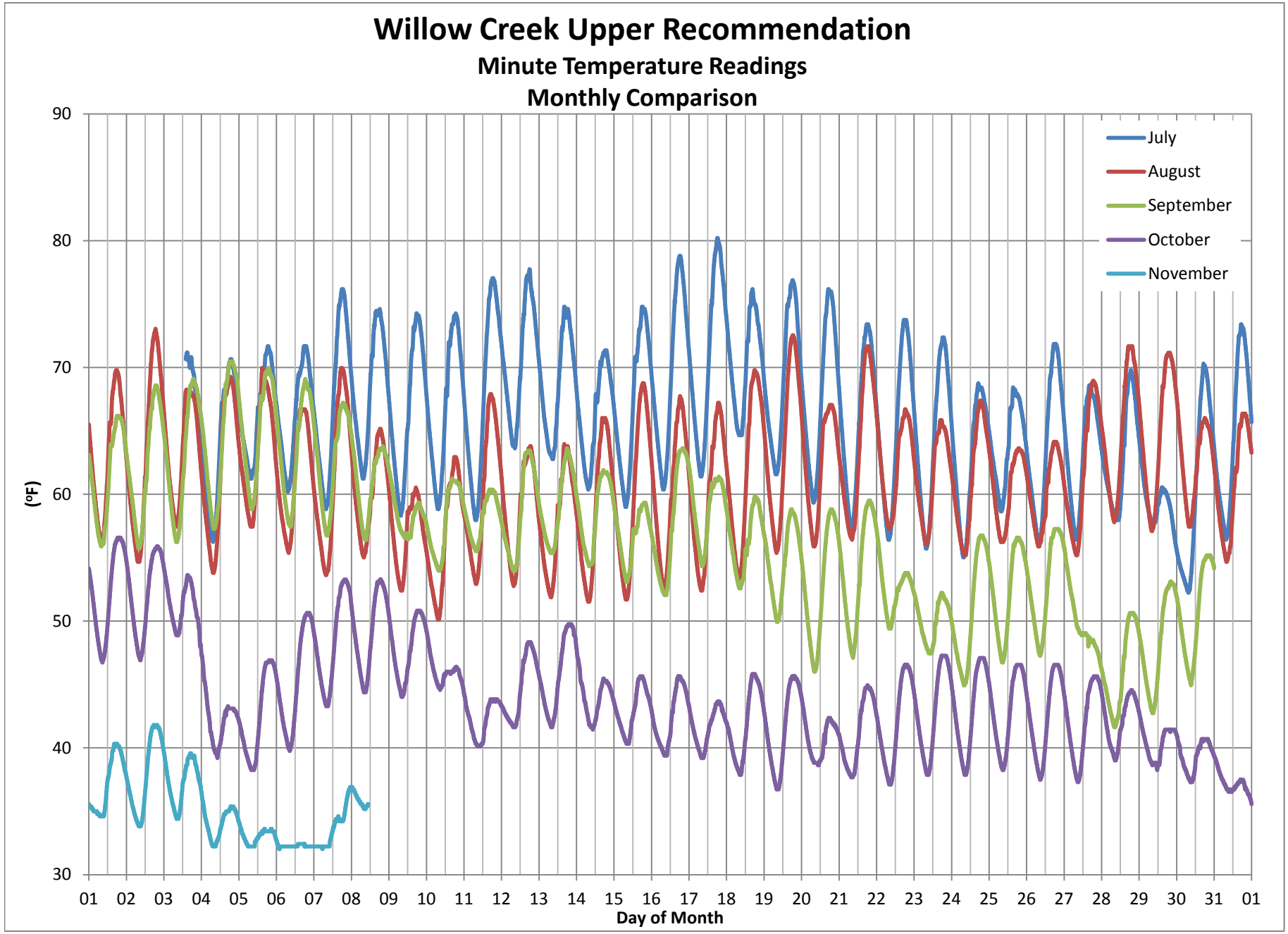
Downstream of County Road

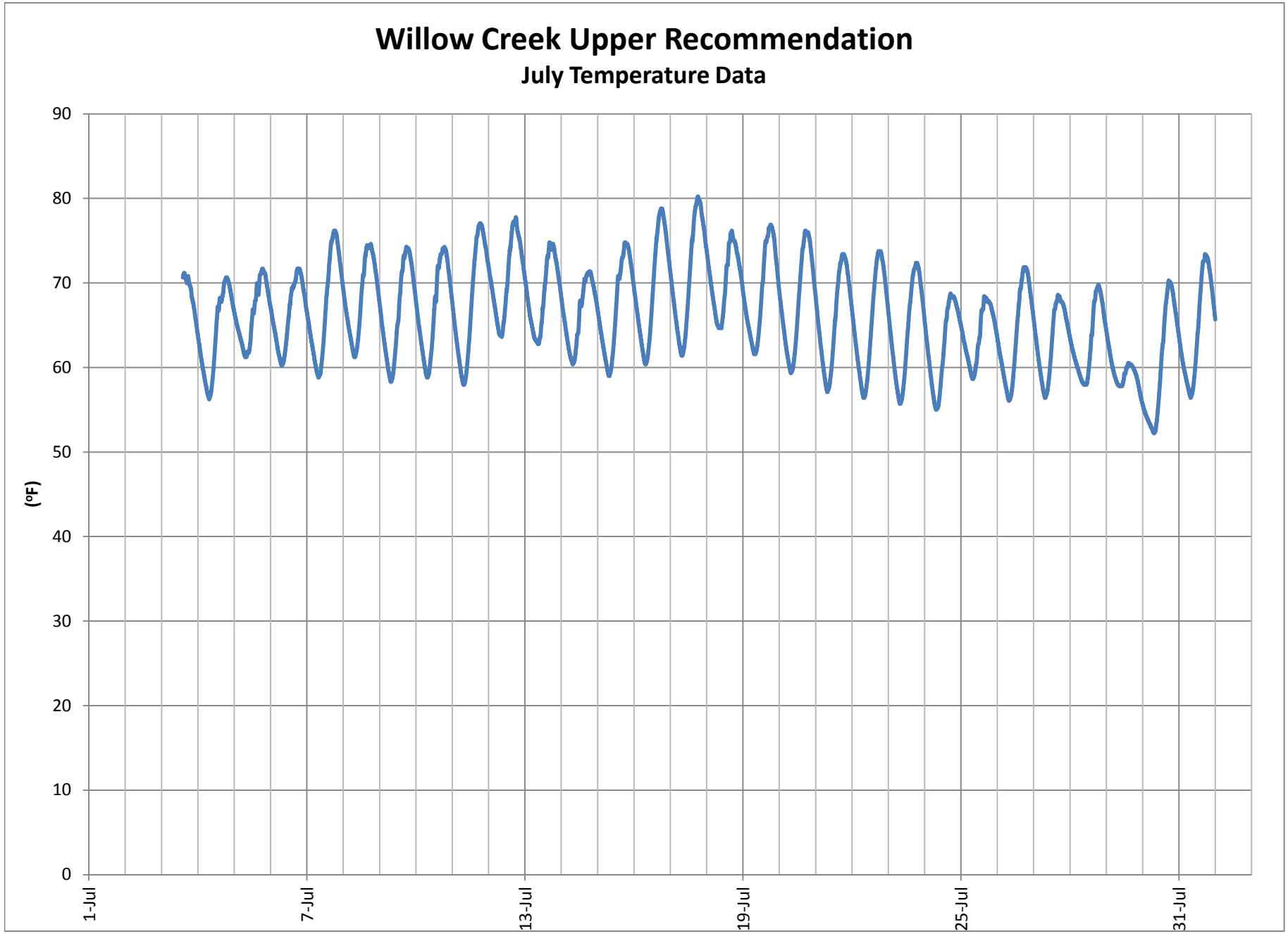
5 Minute Readings

Temperature at Bottom of Thalwag

Graph 2of 2
September 1 to November 8

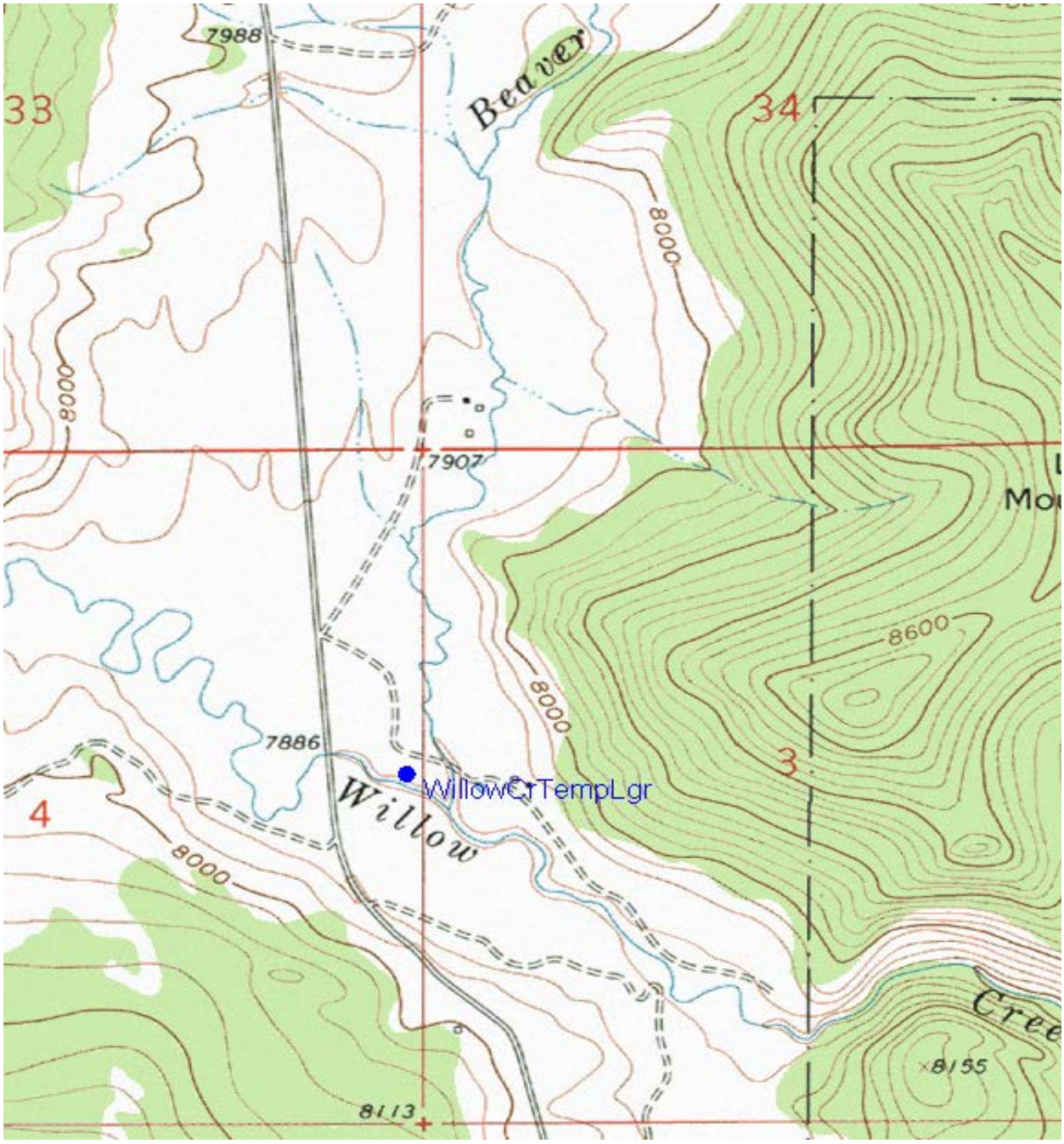



Willow Creek Upper Recommendation
Minute Temperature Readings
Monthly Comparison
July
August
September
October
November
(ºF)
90
80
70
60
50
40
30
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 01
Day of Month


Willow Creek Upper Recommendation
July Temperature Data
(ºF)
90
80
70
60
50
40
30
20
10
0
1-Jul
7-Jul
13-Jul
19-Jul
25-Jul
31-Jul

Location Information

GPS Waypoint Name:	WillowCrTempLgr
Latitude:	40.769289
Longitude:	-106.917400
Horizontal Datum:	North American Datum 1983
Notes:	Temperature logger deployed July 3, 2013 13:13 and retrieved November 8, 2013 10:59. Hobo temperature pendant deployed below riffle in thalweg, tied to three inch pvc pipe cap with holes drilled in it and anchored to steel plate.

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