DRAFT INSTREAM FLOW RECOMMENDATION – March 13, 2014 Version

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 instream flow water right on Timber Springs Gulch, located in Water Division 5.

Location and Land Status. Timber Springs Gulch originates from a large series of springs directly north of Wilmore Lake, which is located along Interstate 70 near Edwards, Colorado. This recommendation covers a reach that starts at a large complex of springs located at UTM readings 360417mE 4392857mN (NAD 1983 Zone 13)and extends downstream to the headgate of the Groff Ditch Cottonwood Enlargement. This stream reach covers a distance of approximately 0.5 miles. The BLM and U.S. Forest Service manage all of the lands along this stream reach.

Biological Summary. Timber Springs Gulch is a cold-water, high gradient stream. It flows through a canyon with a valley floor approximately one-fourth mile in width. The stream cuts through alluvial deposits in the narrow valley and is not confined by bedrock in most locations. The stream generally has small-sized substrate, consisting of gravels and small cobbles, and small boulders. While riffle habitat is abundant, parts of the stream lack extensive pool habitat.

Fisheries surveys have revealed a self-sustaining population of native cutthroat trout. Intensive macro-invertebrate surveys have not been conducted, but spot samples have revealed various species of mayfly, caddisfly, and stonefly.

The riparian community is generally comprised of blue spruce, willow species, and alder. The riparian community is in very good condition, and provides adequate shading and cover for fish habitat.

R2Cross Analysis. The BLM collected the following R2Cross data from Timber Springs Gulch:

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)
05/17/2013 #1	1.30 cfs	7.40 feet	1.34 cfs	1.88 cfs
05/17/2013 #2	1.34 cfs	7.60 feet	0.69 cfs	2.40 cfs
		Averages:	1.01 cfs	2.14 cfs

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.

> 1.3 cubic feet per second is recommended from January 1 to December 31..
> While 2.1 cubic feet per second would be required to meet all three instream flow criteria, it appears that the springs that feed this creek flow steadily year-round at 1.3 cfs. 1.3 cfs meets both the wetted perimeter and the average velocity criteria and provides an average depth 0.15 feet in riffles. The very stable flow rate of the creek allows the fishery to persist, even though depth conditions may not be optimal in all riffle locations.

Water Availability. The BLM does not recommend relying exclusively upon traditional water availability analysis for this stream. The BLM's observation is that streamflow is provided exclusively by a large spring complex located at the upper terminus of the proposed reach. Above these springs, there is no active runoff channel, indicating that snowmelt runoff and upstream groundwater discharge do not play a significant role in the flow regime. During 2014, the BLM intends to take multiple flow measurements to confirm spring flow over time. However, the BLM does recommend reviewing diversions for Groff Ditch and Groff Ditch Cottonwood Enlargement, both of which are located downstream from the proposed instream flow reach. Groff Ditch has diversion records since the 1950s and the diversion records since 2006 contain winter diversions.

The BLM is not aware of any decreed water rights within the proposed instream flow reach.

Relationship to Land Management Plans. BLM land use plans for this area call for actions to maintain and enhance riparian and fisheries habitat. In general, any proposed new land use, such as right-of-way corridors or mineral development, must be implemented with no surface occupancy to avoid impacts to the creek. Any proposed land uses along this creek are also carefully reviewed and mitigated to prevent impacts to native cutthroat trout, which appear on BLM's sensitive species list. Finally, BLM land use plans contain require stipulations on land uses to avoid impacts to important spring-fed habitats. Establishing an instream flow water right would assist in meeting these objectives. Appropriation of an instream flow water right would assist 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 2014. 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,

Leigh Espy
Deputy State Director
Resources and Fire

Cc: Pauline Adams, Colorado River Valley Field Office
Tom Fresques, Colorado River Valley Field Office
Steve Bennett, Colorado River Valley Field Office

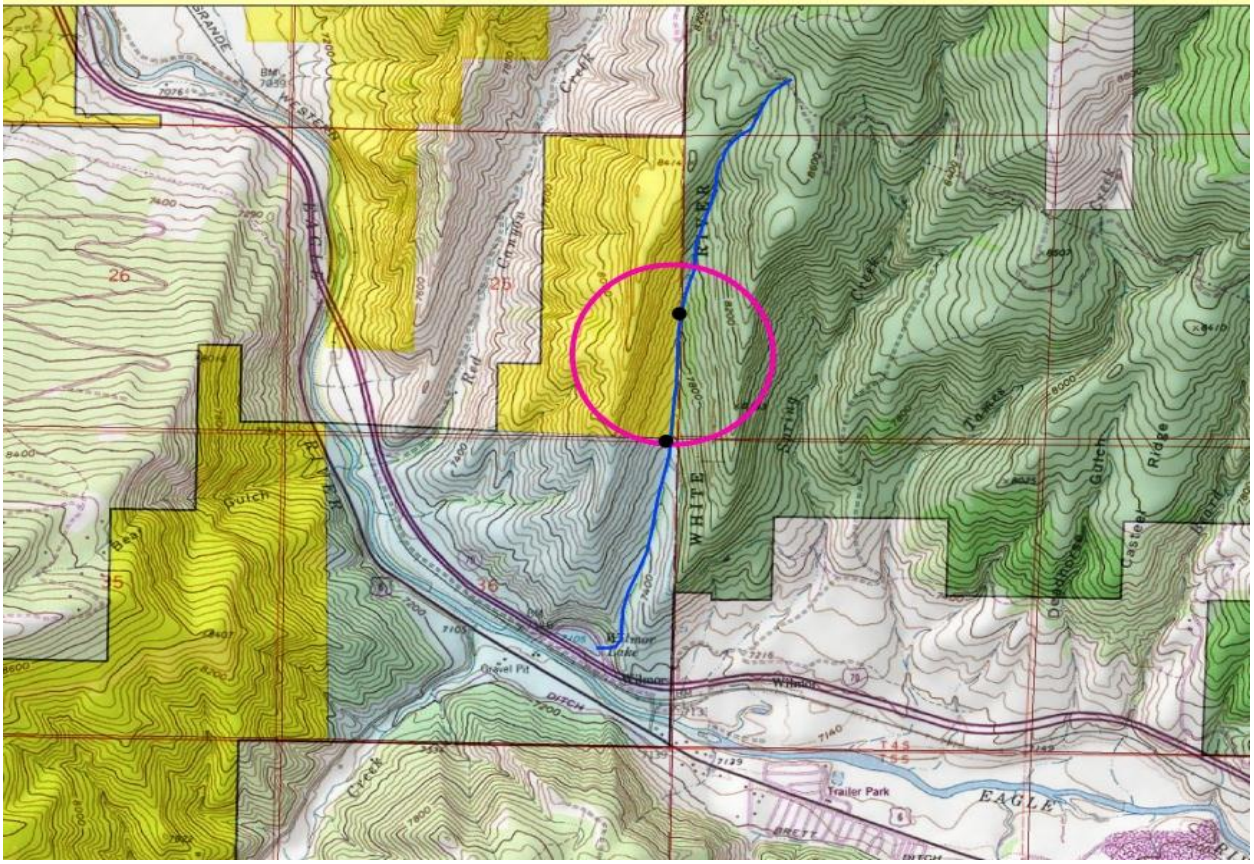
Colorado River Valley Field Office Stream Surveys
June 2012

Unnamed Tributary to Eagle River near Edwards, CO. - Water Code #(unknown)

An unnamed tributary to Wilmor Lake/Eagle River, located west of Edwards, CO and referred to locally as "Timber Springs Gulch" was sampled on June 21, 2012. This stream is located on BLM lands managed by the Colorado River Valley Field Office and USFS lands managed by the White River National Forest. Access to the stream was obtained through private property via permission from land owners in the Timber Springs subdivision. The unnamed tributary was historically a tributary to the Eagle River via Wilmore Lake, but is now mostly diverted to the east prior to reaching the lake/river. A 325-foot long reach was sampled and a two-pass removal population estimate was completed. In addition, 30 fin clips were collected from cutthroat trout within, above, and below the sample reach. Sampling was conducted via backpack electro-shocker. Personnel present were Tom Fresques, Pauline Adams, Gregor Dekleva, Andrea Sponseller and Kyle Bond.

A total of 52 fish were collected during the population estimate and 16 additional adult fish were collected for genetic analyses up and downstream of the 325-foot population estimate reach. All fish collected were Colorado River cutthroat trout.

Unnamed Tributary to Eagle River Sample Site
June 21, 2012 T 4 S, R 83 W, Sec 25



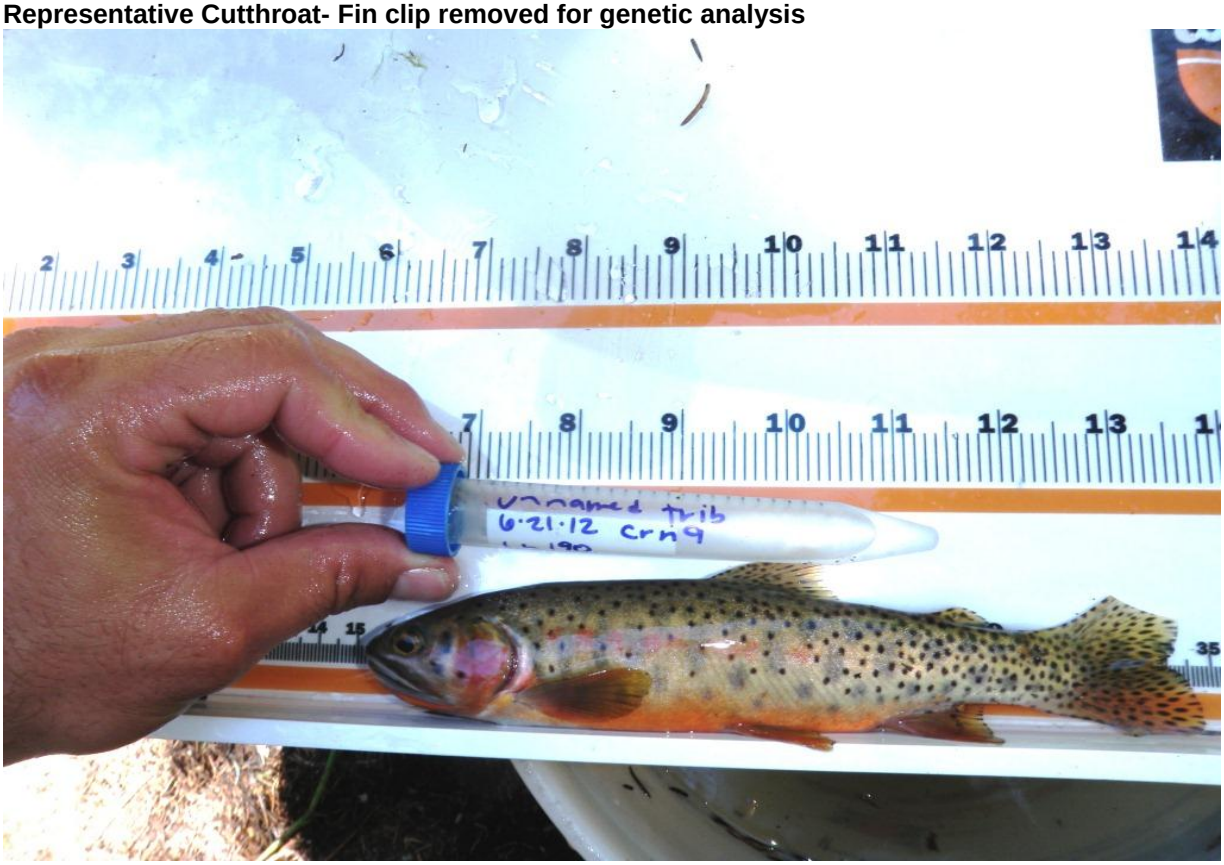
Stream reach

Stream habitat

Travertine cascade

2 pass removal- population estimate

Representative Cutthroat- Fin clip removed for genetic analysis



Fin-clipped cutthroat

Irrigation Ditch

Headgate

Population Estimate Data

STREAM SURVEY FISH SAMPLING FORM 2012

WATER Unnamed Tributary- Eagle River (Timber Spring) DATE 6/21/2012 GEAR BPE - 1

EFFORT 325ft. STATION # 1 CREW Fresques,Dekleva,Sponseller,Adams,Bond LOCATION BLM

#	Pass	species	length	weight	#	species	length	weight	Pass
1	1	CRN	118	14.4	26	CRN	103	10.3	1
2	1	CRN	189	68.7	27	CRN	82	5.6	1
3	1	CRN	149	54.3	28	CRN	136	25.8	1
4	1	CRN	156	53.7	29	CRN	168	41.8	1
5	1	CRN	192	61.1	30	CRN	176	53.8	1
6	1	CRN	113	12.6	31	CRN	131	21.4	1
7	1	CRN	137	20.6	32	CRN	197	58.3	1
8	1	CRN	192	53.7	33	CRN	141	22.9	1
9	1	CRN	164	35.2	34	CRN	126	19.3	1
10	1	CRN	168	40.9	35	CRN	79	4.6	1
11	1	CRN	225	122.7	36	CRN	132	18.3	1
12	1	CRN	157	38	37	CRN	118	15.1	1
13	1	CRN	164	42.6	38	CRN	136	22.5	1
14	1	CRN	167	43.8	39	CRN	189	68.7	1
15	1	CRN	104	8.8	40	CRN	117	13.4	1
16	1	CRN	91	7.7	41	CRN	128	12	1
17	1	CRN	133	20.8	42	CRN	112	13.1	1
18	1	CRN	86	7.6					
19	1	CRN	148	26.9					
20	1	CRN	190	64.4					
21	1	CRN	143	24.4					
22	1	CRN	121	15					
23	1	CRN	182	47.4					
24	1	CRN	207	79.8					
25	1	CRN	117	14.1					

#	Pass	species	length	weight		species	length	weight	Pass
43	2	CRN	150	33					
44	2	CRN	221	98.2					
45	2	CRN	180	54.2					
46	2	CRN	177	50.4					
47	2	CRN	134	22.6					
48	2	CRN	173	43					
49	2	CRN	97	6.6					
50	2	CRN	96	7.8					
51	2	CRN	100	9.5					
52	2	CRN	93	5.8					

CRN = Cutthroat Trout

GPS Coordinates: Population estimate GPS location- bottom of reach:
13S X:0360349 Y:4392151- top of reach- 13S X:0360360 Y:4392240

Notes: Stream Width Ave = 5.9 ft. Sample Reach 325 ft

Stream/Riparian Area Characteristics:
Slightly incised and braided channel with step-pool, travertine, silt/sandy bottom, mix riffles/pools with dense riparian: Alder, Hawthorne, Willows, Sedges, Carex, Thistle (Canada), Spruce Fir forest, Geranium, Rose. Visual estimate of flow: 1-2 cfs. Insects: Tricoptera, Ephemeroptera, Tipulidae

Water Quality:
Water Temperature = 11.6° C/ 52.8° F
Air Temperature = 78° F
pH = 9.16
Conductivity = 671 us
Total Dissolved Solids (TDS) = 476 ppm
Salinity = 371 ppm

Fin Clip Data

#	Fin Clip #	species	length			#	Fin Clip #	species	length
1	1	CRN	150	33		26	26	CRN	174
2	2	CRN	221	98.2		27	27	CRN	180
3	3	CRN	180	54.2		28	28	CRN	154

4	4	CRN	177	50.4		29	29	CRN	151
5	5	CRN	173	43		30	30	CRN	150
6	6	CRN	192	61.1					
7	7	CRN	197	58.3					
8	8	CRN	192	53.7					
9	9	CRN	190	64.4					
10	10	CRN	225	122.7					
11	11	CRN	207	79.8					
12	12	CRN	189	68.7					
13	13	CRN	176	53.8					
14	14	CRN	189	68.7					
15	15	CRN	193						
16	16	CRN	165						
17	17	CRN	190						
18	18	CRN	216						
19	19	CRN	173						
20	20	CRN	161						
21	21	CRN	216						
22	22	CRN	198						
23	23	CRN	185						
24	24	CRN	217						
25	25	CRN	185						

Notes: Fish 1-14 were collected in the population estimation reach. Fish 15-20 were collected below the reach. Fish 21-30 were collected from above the reach.

Discussion:

The unnamed tributary to Wilmor Lake is a high gradient step-pool channel confined by its V-shaped valley and fed primarily from contact springs along the east valley slope. This channel could more specifically be described as a Rosgen A4 type channel based on its low sinuosity, entrenchment, and steep channel gradient. Channel substrate consists of locally derived sandstone, shale, and limestone rocks. This channel is braided in the lower reaches of the drainage as a result of relic beaver activity and local geology including bedrock configurations and groundwater influence.

The contact springs at the headwaters of the perennial section (which is erroneously mapped as ephemeral on USGS maps) and at the beginning of the riparian corridor are responsible for maintenance of base flows and the establishment of riparian vegetation. Groundwater recharge is occurring higher up in the watershed through snowmelt and precipitation events. At the point of emergence, tufa formations were observed as a result of chemical dissolution and the associated

precipitation processes. More specifically, acidic groundwater (carbonic acid: H_2CO_3) has dissolved surrounding limestone rocks and the calcareous material is deposited where the spring emerges. In addition, the majority of the channel substrate is composed of limestone cobbles, gravel, and bedrock. Limestone's susceptibility to chemical weathering is the primary cause of the unique drainage pattern observed in the lower reaches (e.g. dissolution along pockets, fractures, etc.). Evidence of such processes was the presence of several dissolution holes in the channel bottom.

The riparian corridor is in very good condition. It is dominated by alder, hawthorne, willows, spruce, fir, geranium, rose, sedges, and thistle. Geology of the valley slopes are dominated by shale and sandstone colluvium with the occasional sandstone outcrop, while the drainage appears to be dominated by limestone as mentioned above. Pools were small but abundant in areas. Fish were found throughout the creek in each channel sampled. Sampling was difficult given the abundant woody cover, downed trees, and multiple channels.

The trout in this tributary were analyzed for genetic purity and lineage delineation and results suggest that they are pure Colorado River cutthroat trout – Blue Lineage fish. Blue Lineage fish are native to the White-Yampa river basins so it is apparent that these fish were stocked. The native lineage to the upper Colorado River would be Green Lineage. Fish collected were healthy and numerous with good age-class diversity. The stream flow appeared to be excellent, given the drought conditions persistent at the time of sampling. Insects observed included Tricoptera, Ephemeroptera, and Tipulidae, as well as snails and beetles.

Recommendations:

- Determine if fish entrainment into area ditches is occurring and if so to what degree
- Periodically sample the stream to assess fishery condition and trend
- Pursue Instream Flow recommendation

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

LOCATION INFORMATION

STREAM NAME:	Timber Springs Gulch
XS LOCATION:	0.5 mile u/s from Timber Spring Subdiv.
XS NUMBER:	1
DATE:	17-May-13
OBSERVERS:	R. Smith, P. Adams
1/4 SEC:	SE SE
SECTION:	25
TWP:	4S
RANGE:	83W
PM:	Sixth
COUNTY:	Eagle
WATERSHED:	Eagle River
DIVISION:	5
DOW CODE:	not numbered
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

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

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE:	0.088

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

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

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.5 mile u/s from Timber Spring Subdiv.
XS NUMBER: 1

DATA POINTS= 25

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	6.35			0.00		0.00	0.00	0.0%
1	G	0.90	7.40			0.00		0.00	0.00	0.0%
	W	1.00	7.95	0.00	0.00	0.00		0.00	0.00	0.0%
		1.40	8.10	0.15	0.23	0.43	0.15	0.06	0.01	1.1%
		1.80	8.10	0.15	0.48	0.40	0.15	0.06	0.03	2.2%
		2.20	8.05	0.10	1.32	0.40	0.10	0.04	0.05	4.1%
		2.60	8.05	0.10	0.20	0.40	0.10	0.04	0.01	0.6%
		3.00	8.15	0.20	1.78	0.41	0.20	0.08	0.14	10.9%
		3.40	8.10	0.15	0.00	0.40	0.15	0.06	0.00	0.0%
		3.80	8.10	0.15	1.01	0.40	0.15	0.06	0.06	4.7%
		4.20	8.10	0.15	1.89	0.40	0.15	0.06	0.11	8.7%
		4.60	8.15	0.20	1.48	0.40	0.20	0.08	0.12	9.1%
		5.00	8.15	0.20	1.31	0.40	0.20	0.08	0.10	8.0%
		5.40	8.10	0.15	1.14	0.40	0.15	0.06	0.07	5.3%
	R	5.80	7.95	0.00	0.00	0.43		0.00	0.00	0.0%
		6.20	8.15	0.20	0.04	0.45	0.20	0.08	0.00	0.2%
		6.60	8.15	0.20	0.43	0.40	0.20	0.08	0.03	2.6%
		7.00	8.25	0.30	1.19	0.41	0.30	0.12	0.14	11.0%
		7.40	8.25	0.30	1.66	0.40	0.30	0.12	0.20	15.3%
		7.80	8.25	0.30	0.86	0.40	0.30	0.12	0.10	7.9%
		8.20	8.10	0.15	1.23	0.43	0.15	0.06	0.07	5.7%
		8.60	8.05	0.10	0.69	0.40	0.10	0.05	0.03	2.6%
	W	9.20	7.95	0.00	0.00	0.61		0.00	0.00	0.0%
1	G	10.50	7.40			0.00		0.00	0.00	0.0%
	RS	12.60	6.48			0.00		0.00	0.00	0.0%
	TOTALS ----------					8.38	0.3 (Max.)	1.31	1.30	100.0%

Manning's n = 0.1287
Hydraulic Radius= 0.15637541

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.5 mile u/s from Timber Spring Subdiv.
XS NUMBER: 1

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	1.31	1.31	0.0%
7.70	1.31	3.44	162.6%
7.72	1.31	3.26	149.1%
7.74	1.31	3.09	135.7%
7.76	1.31	2.91	122.4%
7.78	1.31	2.74	109.2%
7.80	1.31	2.57	96.1%
7.82	1.31	2.40	83.0%
7.84	1.31	2.23	70.0%
7.86	1.31	2.06	57.1%
7.88	1.31	1.89	44.3%
7.90	1.31	1.72	31.5%
7.91	1.31	1.64	25.2%
7.92	1.31	1.56	18.9%
7.93	1.31	1.47	12.6%
7.94	1.31	1.39	6.3%
7.95	1.31	1.31	0.0%
7.96	1.31	1.23	-6.2%
7.97	1.31	1.15	-12.3%
7.98	1.31	1.07	-18.3%
7.99	1.31	0.99	-24.2%
8.00	1.31	0.92	-30.0%
8.02	1.31	0.77	-41.3%
8.04	1.31	0.63	-52.2%
8.06	1.31	0.49	-62.3%
8.08	1.31	0.37	-71.4%
8.10	1.31	0.27	-79.6%
8.12	1.31	0.20	-85.0%
8.14	1.31	0.14	-89.5%
8.16	1.31	0.10	-92.4%
8.18	1.31	0.07	-94.5%
8.20	1.31	0.05	-96.3%

WATERLINE AT ZERO
AREA ERROR = 7.950

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.5 mile u/s from Timber Spring Subdiv.
XS NUMBER: 1 Constant Manning's n

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

	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	7.40	9.60	0.65	0.85	6.21	10.35	100.0%	0.60	15.12	2.44
	7.40	9.60	0.65	0.85	6.20	10.35	100.0%	0.60	15.12	2.44
	7.45	9.47	0.60	0.80	5.73	10.17	98.3%	0.56	13.38	2.34
	7.50	9.35	0.56	0.75	5.26	9.99	96.5%	0.53	11.74	2.23
	7.55	9.22	0.52	0.70	4.79	9.81	94.8%	0.49	10.19	2.13
	7.60	9.09	0.48	0.65	4.34	9.63	93.1%	0.45	8.72	2.01
	7.65	8.96	0.43	0.60	3.88	9.45	91.3%	0.41	7.36	1.89
	7.70	8.84	0.39	0.55	3.44	9.27	89.6%	0.37	6.08	1.77
	7.75	8.71	0.34	0.50	3.00	9.09	87.9%	0.33	4.91	1.64
	7.80	8.58	0.30	0.45	2.57	8.91	86.2%	0.29	3.84	1.49
	7.85	8.45	0.25	0.40	2.14	8.74	84.4%	0.25	2.88	1.34
	7.90	8.33	0.21	0.35	1.72	8.56	82.7%	0.20	2.03	1.18
WL	7.95	8.20	0.16	0.30	1.31	8.38	81.0%	0.16	1.30	0.99
	8.00	7.53	0.12	0.25	0.92	7.68	74.2%	0.12	0.76	0.83
	8.05	6.47	0.09	0.20	0.56	6.58	63.5%	0.08	0.37	0.66
	8.10	3.90	0.07	0.15	0.27	3.97	38.3%	0.07	0.15	0.57
	8.15	1.47	0.08	0.10	0.11	1.50	14.5%	0.08	0.07	0.61
	8.20	1.13	0.04	0.05	0.05	1.15	11.1%	0.04	0.02	0.41
	8.25	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.5 mile u/s from Timber Spring Subdiv.
XS NUMBER: 1

SUMMARY SHEET

MEASURED FLOW (Qm)=	1.30	cfs
CALCULATED FLOW (Qc)=	1.30	cfs
(Qm-Qc)/Qm * 100 =	0.0	%
MEASURED WATERLINE (WLm)=	7.95	ft
CALCULATED WATERLINE (WLc)=	7.95	ft
(WLm-WLc)/WLm * 100 =	0.0	%
MAX MEASURED DEPTH (Dm)=	0.30	ft
MAX CALCULATED DEPTH (Dc)=	0.30	ft
(Dm-Dc)/Dm * 100	0.0	%
MEAN VELOCITY=	0.99	ft/sec
MANNING'S N=	0.129	
SLOPE=	0.088	ft/ft
.4 * Qm =	0.5	cfs
2.5 * Qm=	3.3	cfs

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

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

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

____
____
____
____
____
____
____
____
____
____
____
____
____
____
____

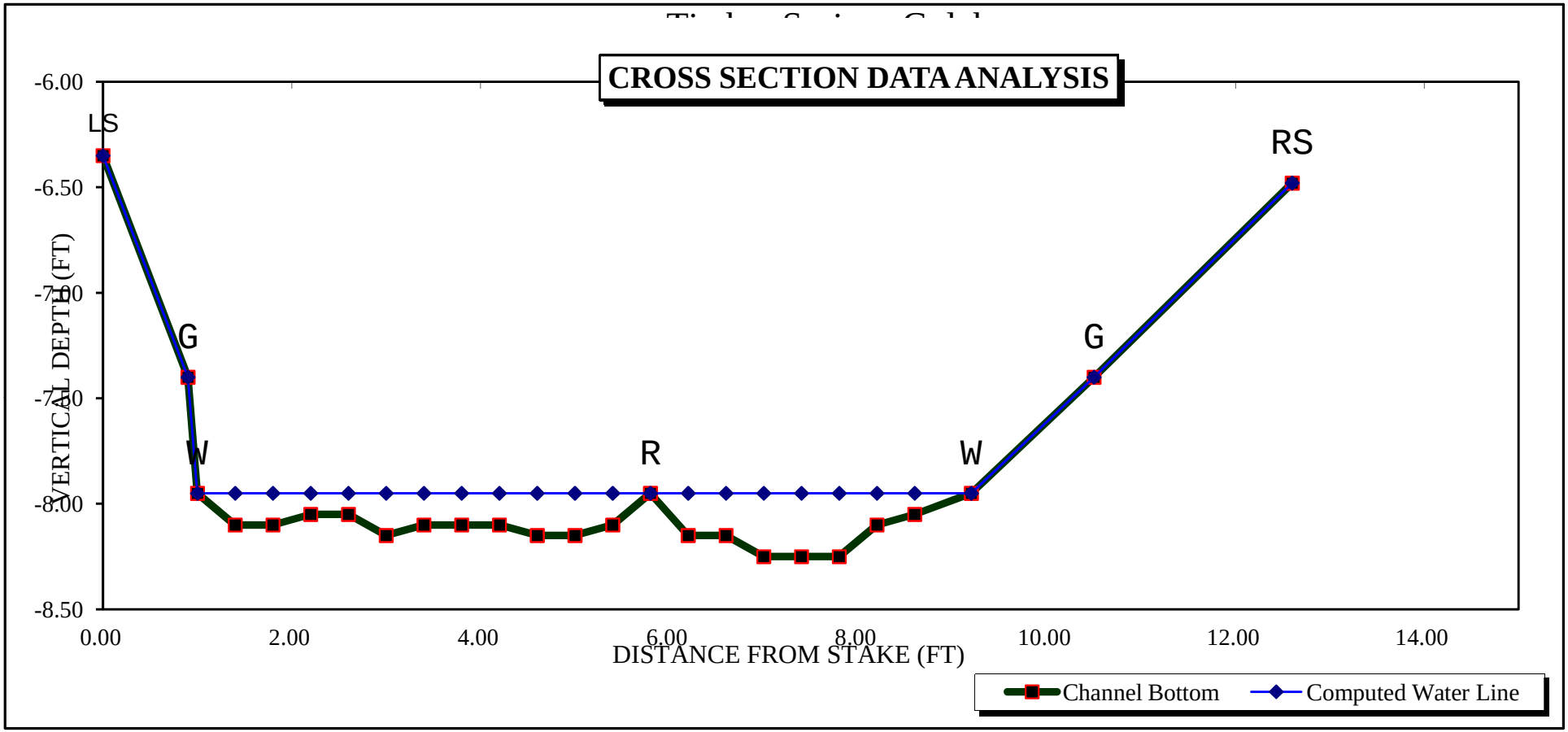
RECOMMENDATION BY: ………………...………..……............................... AGENCY..……………………......……....…....…........ DATE:......…...…......……………

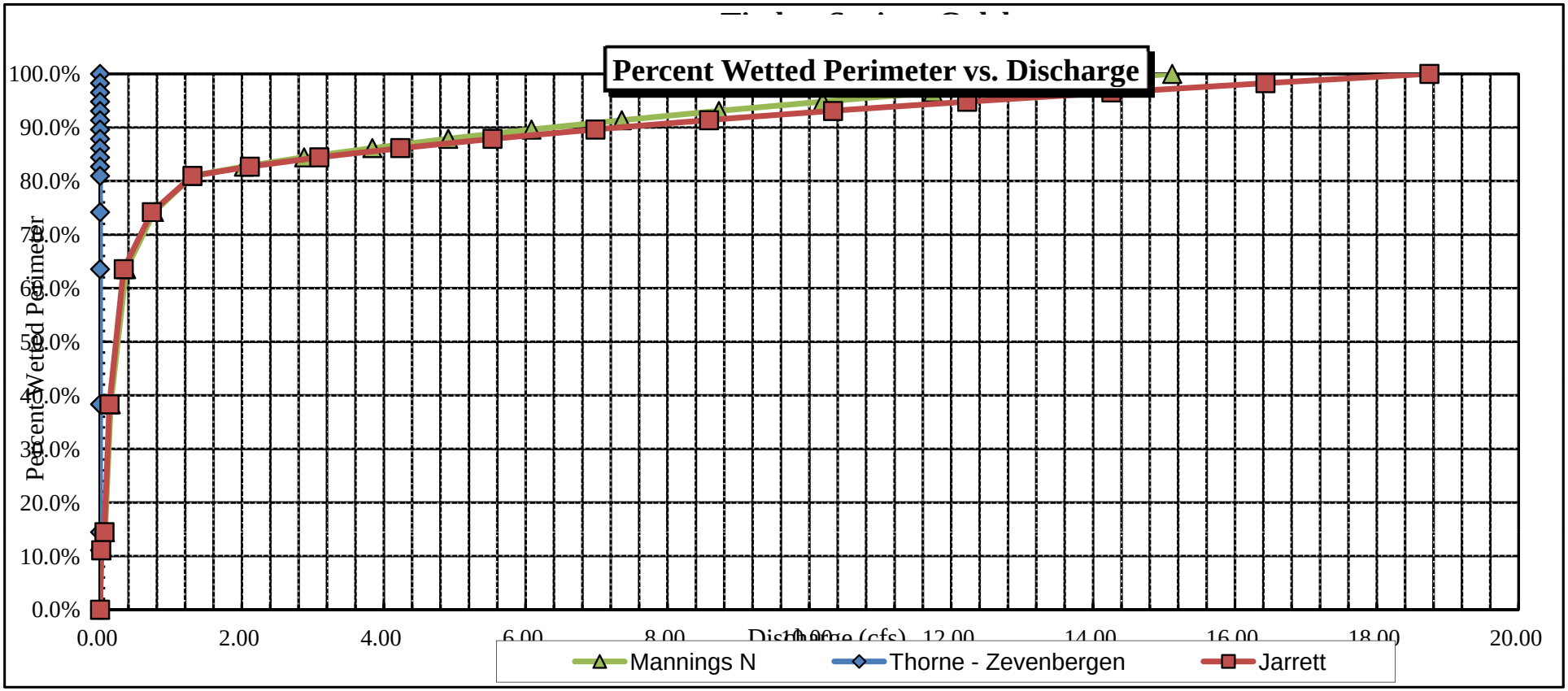
CWCB REVIEW BY: ..……………………….....………………………………………………..…............. DATE:.................…………….....

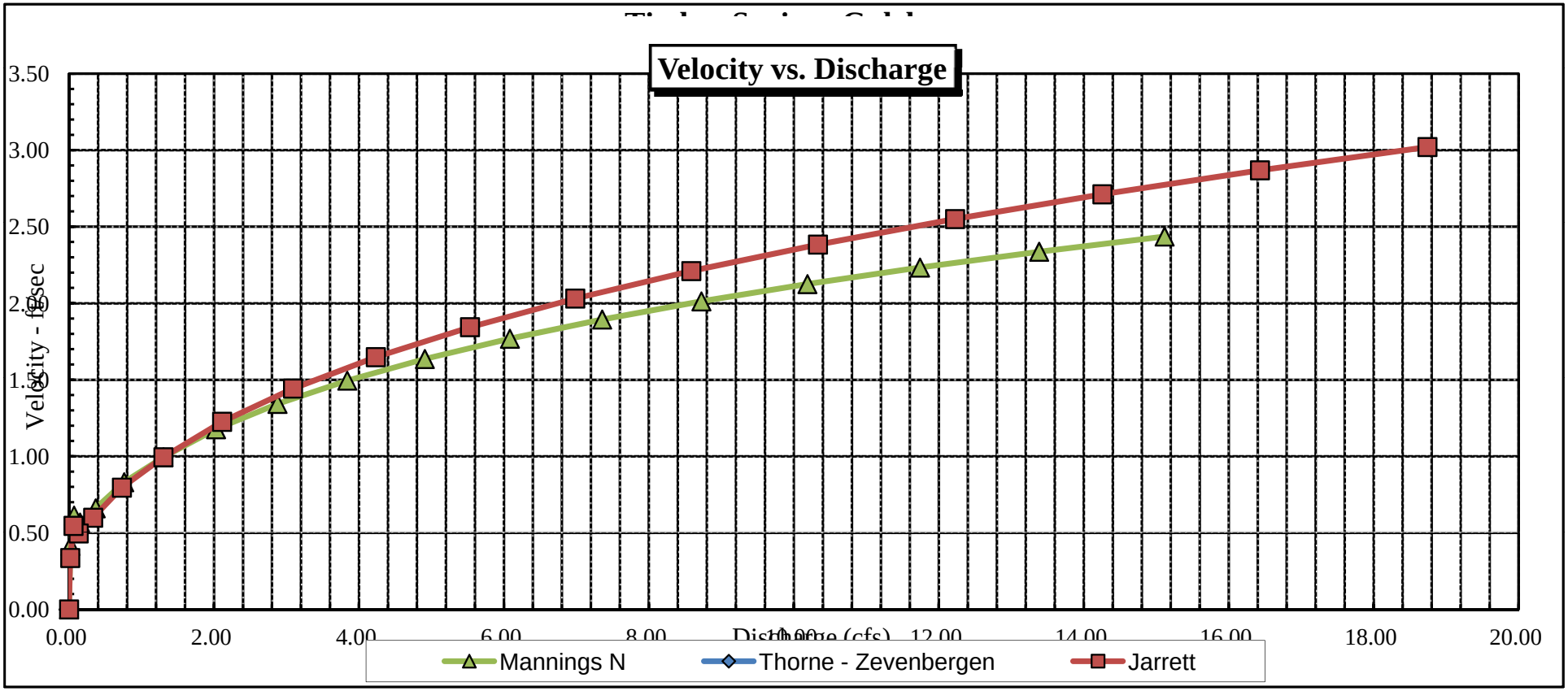
STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.5 mile u/s from Timber Spring Subdiv.
XS NUMBER: 1 Jarrett Variable Manning's n Correction Applied

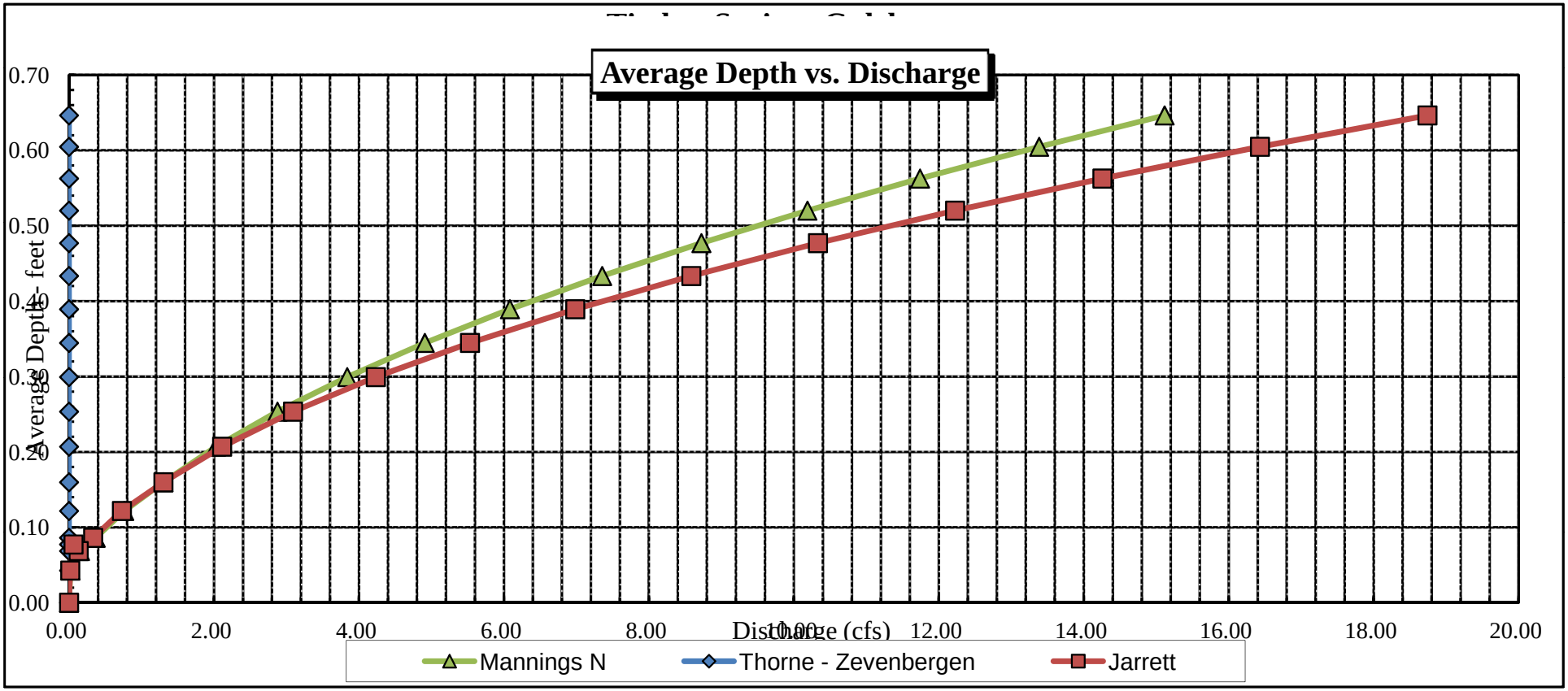
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

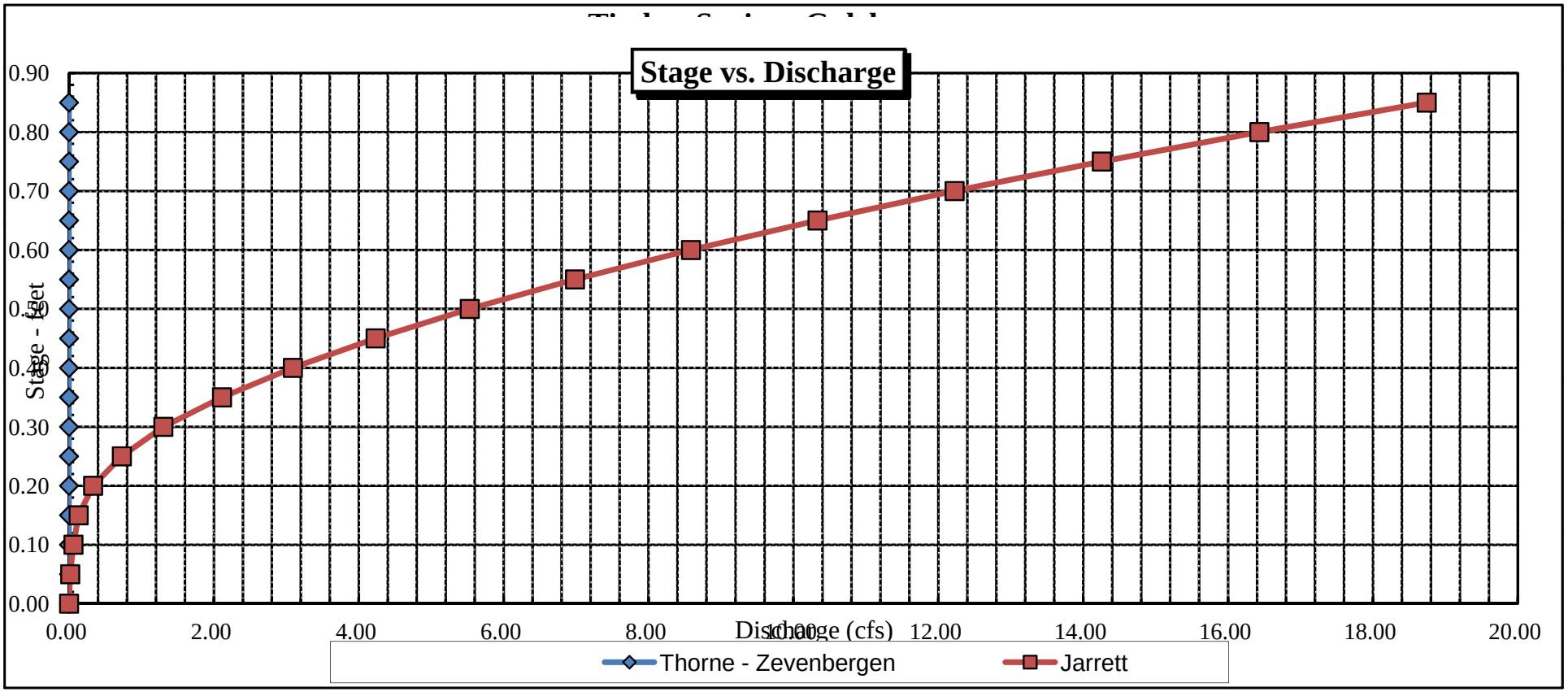
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	7.40	9.60	0.65	0.85	6.21	10.35	100.0%	0.60	18.74	3.02
	7.40	9.60	0.65	0.85	6.20	10.35	100.0%	0.60	18.74	3.02
	7.45	9.47	0.60	0.80	5.73	10.17	98.3%	0.56	16.43	2.87
	7.50	9.35	0.56	0.75	5.26	9.99	96.5%	0.53	14.26	2.71
	7.55	9.22	0.52	0.70	4.79	9.81	94.8%	0.49	12.22	2.55
	7.60	9.09	0.48	0.65	4.34	9.63	93.1%	0.45	10.33	2.38
	7.65	8.96	0.43	0.60	3.88	9.45	91.3%	0.41	8.59	2.21
	7.70	8.84	0.39	0.55	3.44	9.27	89.6%	0.37	6.98	2.03
	7.75	8.71	0.34	0.50	3.00	9.09	87.9%	0.33	5.53	1.84
	7.80	8.58	0.30	0.45	2.57	8.91	86.2%	0.29	4.23	1.65
	7.85	8.45	0.25	0.40	2.14	8.74	84.4%	0.25	3.09	1.44
	7.90	8.33	0.21	0.35	1.72	8.56	82.7%	0.20	2.11	1.23
WL	7.95	8.20	0.16	0.30	1.31	8.38	81.0%	0.16	1.30	0.99
	8.00	7.53	0.12	0.25	0.92	7.68	74.2%	0.12	0.73	0.80
	8.05	6.47	0.09	0.20	0.56	6.58	63.5%	0.08	0.33	0.60
	8.10	3.90	0.07	0.15	0.27	3.97	38.3%	0.07	0.13	0.50
	8.15	1.47	0.08	0.10	0.11	1.50	14.5%	0.08	0.06	0.55
	8.20	1.13	0.04	0.05	0.05	1.15	11.1%	0.04	0.02	0.34
	8.25	0.00	#DIV/0!	0.00	0.00	0.00	0.0%	#DIV/0!	#DIV/0!	#DIV/0!


CROSS SECTION DATA ANALYSIS
-6.00
-6.50
-7.00
-7.50
-8.00
-8.50
VERTICAL DEPTH (FT)
LS
G
W
R
W
G
RS
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
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
2.00
4.00
6.00
8.00
12.00
14.00
16.00
18.00
20.00
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
Velocity - ft/sec
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.00
2.00
4.00
6.00
8.00
18.00
20.00
Mannings N
Thorne - Zevenbergen
Jarrett


Average Depth vs. Discharge
Average Depth - feet
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Stage vs. Discharge
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

CROSS-SECTION NO.: 1

STREAM NAME: Timber Springs Gulch

CROSS-SECTION LOCATION: 0.5 mile upstream from Timber Springs Subdivision

DATE: 5-17-13 OBSERVERS: R. Smith, P. Adams

LEGAL DESCRIPTION	¼ SECTION	SECTION	TOWNSHIP	RANGE	PM
	SE SE	25	4 N (S)	83 E (W)	Sixth

COUNTY	WATERSHED	WATER DIVISION	DOW WATER CODE
Eagle	Eagle	5	not numbered

MAP(S): USGS: GPS Zone 13 39° 40' 13.95" N

USFS: 2,330 meters 106 37' 40.94" W

SUPPLEMENTAL DATA

SAG TAPE SECTION SAME AS DISCHARGE SECTION: (YES) NO

METER TYPE: M-M

METER NUMBER:

DATE RATED:

CALIB/SPIN _____ sec

TAPE WEIGHT _____ lbs/foot

TAPE TENSION: _____ lbs

CHANNEL BED MATERIAL SIZE RANGE: gravels

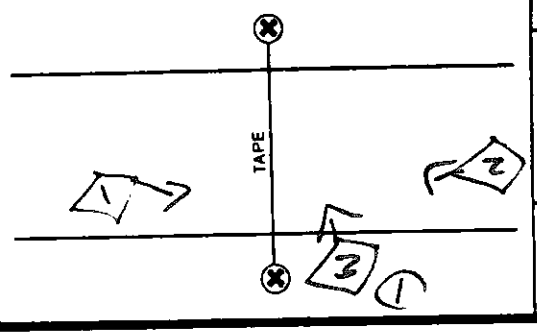
PHOTOGRAPHS TAKEN: YES/NO

NUMBER OF PHOTOGRAPHS: 3

CHANNEL PROFILE DATA

STATION	DISTANCE FROM TAPE (ft)	ROD READING (ft)
(X) Tape @ Stake LB	0.0	surveyed
(X) Tape @ Stake RB	0.0	surveyed
(1) WS @ Tape LB/RB	0.0	7.95/7.95
(2) WS Upstream	20.0	5.70
(3) WS Downstream	6.0	7.00
SLOPE	2.30/26.0 = .088	

SKETCH



LEGEND:
Stake (X)
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

COMMENTS

Temp = 11.5° C
Cond = 608
Salinity = 0.3 ppt
Ph = 8.35

Upper Terminus
N 39° 40' 26.90"
W 106° 37' 38.95"

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Timber Spgs. Gulch | CROSS-SECTION NO: 1 | DATE: 5-17-13 | SHEET ___ OF ___

BEGINNING OF MEASUREMENT | EDGE OF WATER LOOKING DOWNSTREAM: (0.0 AT STAKE) LEFT / RIGHT | Gage Reading: _____ ft | TIME: 11:50 am

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		6.35								
G	.9		7.40								
W	1.0		7.95								
	1.4		8.10	.15				0.23			
	1.8		8.10	.15				0.48			
	2.2		8.05	.10				1.32			
	2.6		8.05	.10				0.20			
	3.0		8.15	.20				1.78			
	3.4		8.10	.15				Ø			
	3.8		8.10	.15				1.01			
	4.2		8.10	.15				1.89			
	4.6		8.15	.20				1.48			
	5.0		8.15	.20				1.31			
	5.4		8.10	.15				1.14			
R	5.8		7.95	.00				Ø			
	6.2		8.15	.20				0.04			
	6.6		8.15	.20				0.43			
	7.0		8.25	.30				1.19			
	7.4		8.25	.30				1.66			
	7.8		8.25	.30				0.86			
	8.2		8.10	.15				1.23			
	8.6		8.05	.10				0.69			
W	9.2		7.95								
G	10.5		7.40								
RS	12.6		6.48								
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:	Timber Springs Gulch
XS LOCATION:	0.25 miles u/s fr Timber Spgs. Subdiv.
XS NUMBER:	2
DATE:	17-May-13
OBSERVERS:	R. Smith, P. Adams
1/4 SEC:	SE SE
SECTION:	25
TWP:	4S
RANGE:	83W
PM:	Sixth
COUNTY:	Eagle
WATERSHED:	Eagle River
DIVISION:	5
DOW CODE:	not numbered
USGS MAP:	0
USFS MAP:	0

SUPPLEMENTAL DATA

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

TAPE WT:	0.0106
TENSION:	99999

CHANNEL PROFILE DATA

SLOPE:	0.11

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

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

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.25 miles u/s fr Timber Spgs. Subdiv.
XS NUMBER: 2

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
	LS	0.00	4.38			0.00		0.00	0.00	0.0%
1	G	0.40	4.65			0.00		0.00	0.00	0.0%
	W	0.60	5.00	0.00	0.00	0.00		0.00	0.00	0.0%
		0.90	5.10	0.10	0.46	0.32	0.10	0.03	0.01	1.0%
		1.20	5.15	0.15	1.20	0.30	0.15	0.05	0.05	4.0%
		1.50	5.15	0.15	0.81	0.30	0.15	0.05	0.04	2.7%
		1.80	5.10	0.10	1.68	0.30	0.10	0.03	0.05	3.8%
		2.10	5.15	0.15	2.22	0.30	0.15	0.05	0.10	7.4%
		2.40	5.20	0.20	2.32	0.30	0.20	0.06	0.14	10.4%
		2.70	5.20	0.20	1.73	0.30	0.20	0.06	0.10	7.7%
		3.00	5.20	0.20	1.24	0.30	0.20	0.06	0.07	5.5%
		3.30	5.15	0.15	1.19	0.30	0.15	0.05	0.05	4.0%
		3.60	5.10	0.10	1.44	0.30	0.10	0.03	0.04	3.2%
		3.90	5.10	0.10	0.90	0.30	0.10	0.03	0.03	2.0%
		4.20	5.10	0.10	0.87	0.30	0.10	0.03	0.03	1.9%
		4.50	5.10	0.10	0.56	0.30	0.10	0.03	0.02	1.3%
		4.80	5.05	0.05	0.22	0.30	0.05	0.02	0.00	0.2%
		5.10	5.05	0.05	0.34	0.30	0.05	0.02	0.01	0.4%
		5.40	5.10	0.10	0.81	0.30	0.10	0.03	0.02	1.8%
		5.70	5.10	0.10	1.04	0.30	0.10	0.03	0.03	2.3%
		6.00	5.10	0.10	1.43	0.30	0.10	0.03	0.04	3.2%
		6.30	5.20	0.20	1.33	0.32	0.20	0.06	0.08	5.9%
		6.60	5.20	0.20	1.65	0.30	0.20	0.06	0.10	7.4%
		6.90	5.25	0.25	1.52	0.30	0.25	0.08	0.11	8.5%
		7.20	5.30	0.30	1.26	0.30	0.30	0.09	0.11	8.4%
		7.50	5.30	0.30	0.88	0.30	0.30	0.11	0.09	6.9%
	W	7.90	4.95	0.00	0.00	0.53		0.00	0.00	0.0%
1	G	8.00	4.68			0.00		0.00	0.00	0.0%
	RS	8.60	4.46			0.00		0.00	0.00	0.0%
	TOTALS ----------					7.51	0.3 (Max.)	1.05	1.34	100.0%

Manning's n = 0.1038
Hydraulic Radius= 0.13990031

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.25 miles u/s fr Timber Spgs. Subdiv.
XS NUMBER: 2

WATER LINE COMPARISON TABLE

WATER LINE	MEAS AREA	COMP AREA	AREA ERROR
	1.05	1.22	16.5%
4.73	1.05	3.08	193.2%
4.75	1.05	2.93	178.8%
4.77	1.05	2.78	164.5%
4.79	1.05	2.63	150.3%
4.81	1.05	2.48	136.0%
4.83	1.05	2.33	121.8%
4.85	1.05	2.18	107.7%
4.87	1.05	2.03	93.5%
4.89	1.05	1.88	79.4%
4.91	1.05	1.74	65.4%
4.93	1.05	1.59	51.4%
4.94	1.05	1.52	44.4%
4.95	1.05	1.44	37.4%
4.96	1.05	1.37	30.4%
4.97	1.05	1.30	23.4%
4.98	1.05	1.22	16.5%
4.99	1.05	1.15	9.5%
5.00	1.05	1.08	2.6%
5.01	1.05	1.01	-4.3%
5.02	1.05	0.93	-11.1%
5.03	1.05	0.86	-17.9%
5.05	1.05	0.72	-31.5%
5.07	1.05	0.59	-44.3%
5.09	1.05	0.46	-56.3%
5.11	1.05	0.35	-67.0%
5.13	1.05	0.27	-74.7%
5.15	1.05	0.20	-81.2%
5.17	1.05	0.14	-86.4%
5.19	1.05	0.10	-90.8%
5.21	1.05	0.06	-94.2%
5.23	1.05	0.04	-95.9%

WATERLINE AT ZERO
AREA ERROR = 4.999

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.25 miles u/s fr Timber Spgs. Subdiv.
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	4.68	7.58	0.45	0.62	3.42	8.16	100.0%	0.42	9.09	2.66
	4.70	7.57	0.43	0.60	3.28	8.12	99.5%	0.40	8.50	2.59
	4.75	7.52	0.39	0.55	2.90	8.01	98.1%	0.36	6.99	2.41
	4.80	7.47	0.34	0.50	2.52	7.90	96.8%	0.32	5.61	2.22
	4.85	7.42	0.29	0.45	2.15	7.79	95.4%	0.28	4.34	2.02
	4.90	7.38	0.24	0.40	1.78	7.68	94.1%	0.23	3.20	1.79
	4.95	7.33	0.19	0.35	1.41	7.57	92.7%	0.19	2.20	1.55
WL	5.00	7.24	0.14	0.30	1.05	7.43	91.1%	0.14	1.35	1.29
	5.05	7.04	0.10	0.25	0.69	7.20	88.2%	0.10	0.69	1.00
	5.10	5.95	0.06	0.20	0.37	6.07	74.4%	0.06	0.28	0.74
	5.15	3.05	0.06	0.15	0.19	3.14	38.4%	0.06	0.13	0.72
	5.20	1.93	0.04	0.10	0.07	1.98	24.3%	0.03	0.03	0.50
	5.25	0.67	0.04	0.05	0.02	0.69	8.4%	0.04	0.01	0.52
	5.30	0.31	0.00	0.00	0.00	0.31	3.8%	0.00	0.00	0.05

STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.25 miles u/s fr Timber Spgs. Subdiv.
XS NUMBER: 2

SUMMARY SHEET

MEASURED FLOW (Qm)=	1.34	cfs
CALCULATED FLOW (Qc)=	1.35	cfs
(Qm-Qc)/Qm * 100 =	-0.6	%
MEASURED WATERLINE (WLm)=	4.98	ft
CALCULATED WATERLINE (WLc)=	5.00	ft
(WLm-WLc)/WLm * 100 =	-0.5	%
MAX MEASURED DEPTH (Dm)=	0.30	ft
MAX CALCULATED DEPTH (Dc)=	0.30	ft
(Dm-Dc)/Dm * 100	-0.4	%
MEAN VELOCITY=	1.29	ft/sec
MANNING'S N=	0.104	
SLOPE=	0.11	ft/ft
.4 * Qm =	0.5	cfs
2.5 * Qm=	3.4	cfs

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

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

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

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

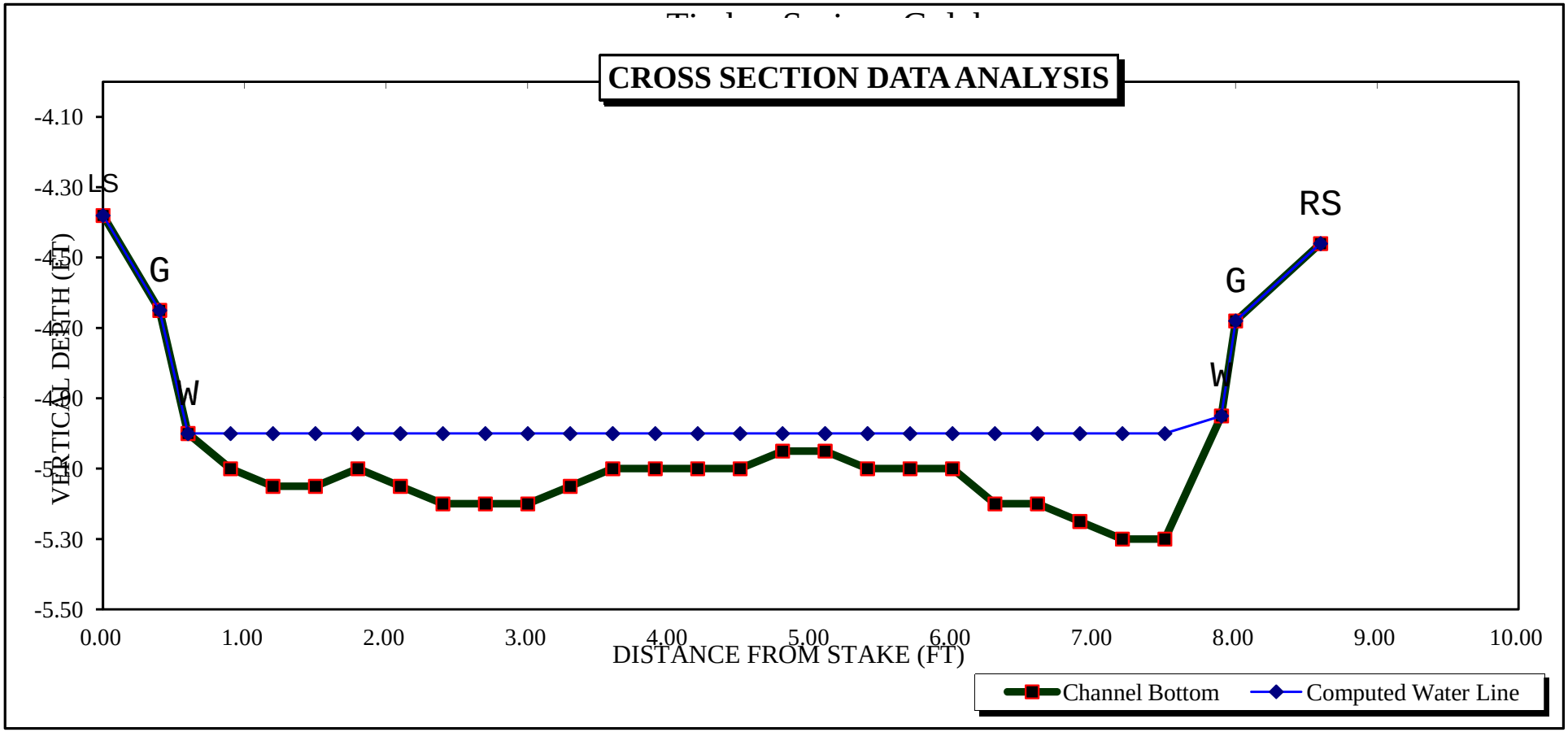
RECOMMENDATION BY: ..... AGENCY..... DATE:.....

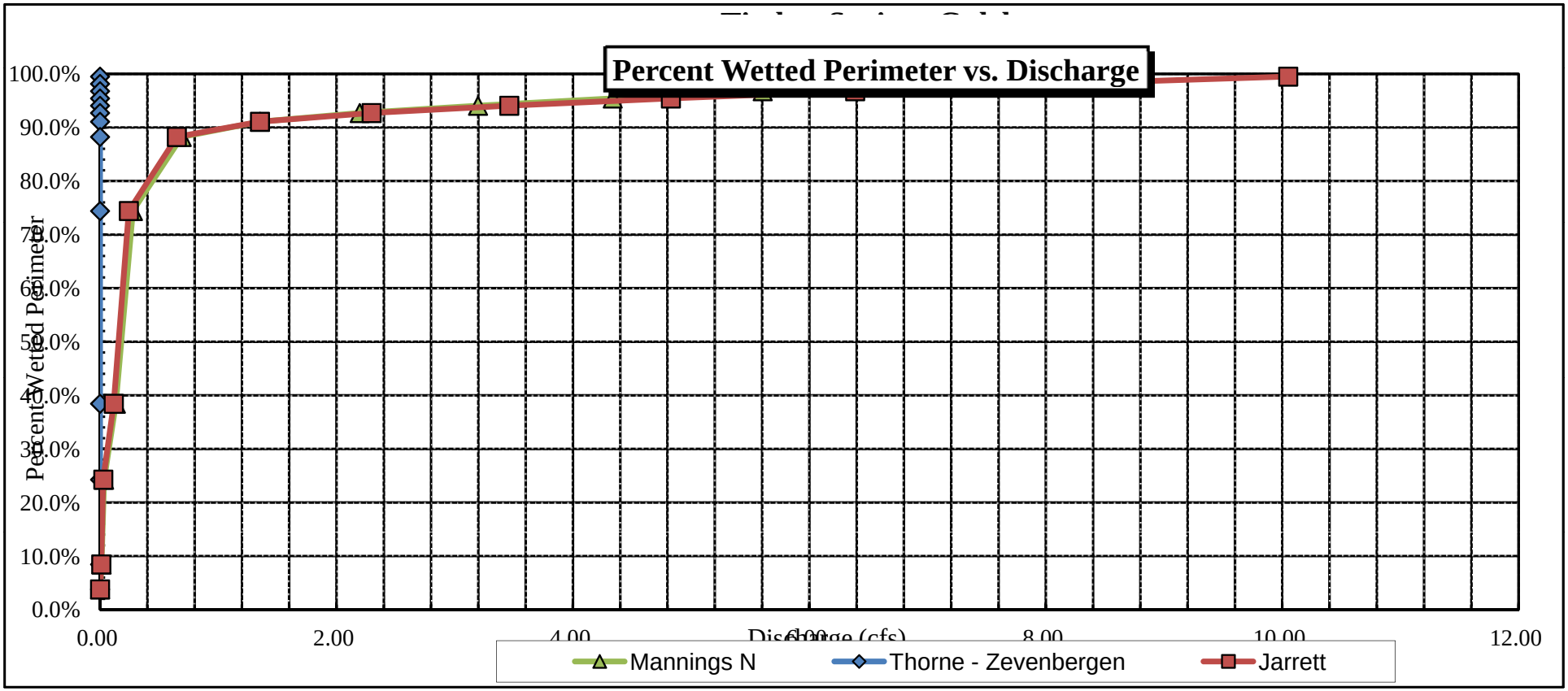
CWCB REVIEW BY: ..... DATE:.....

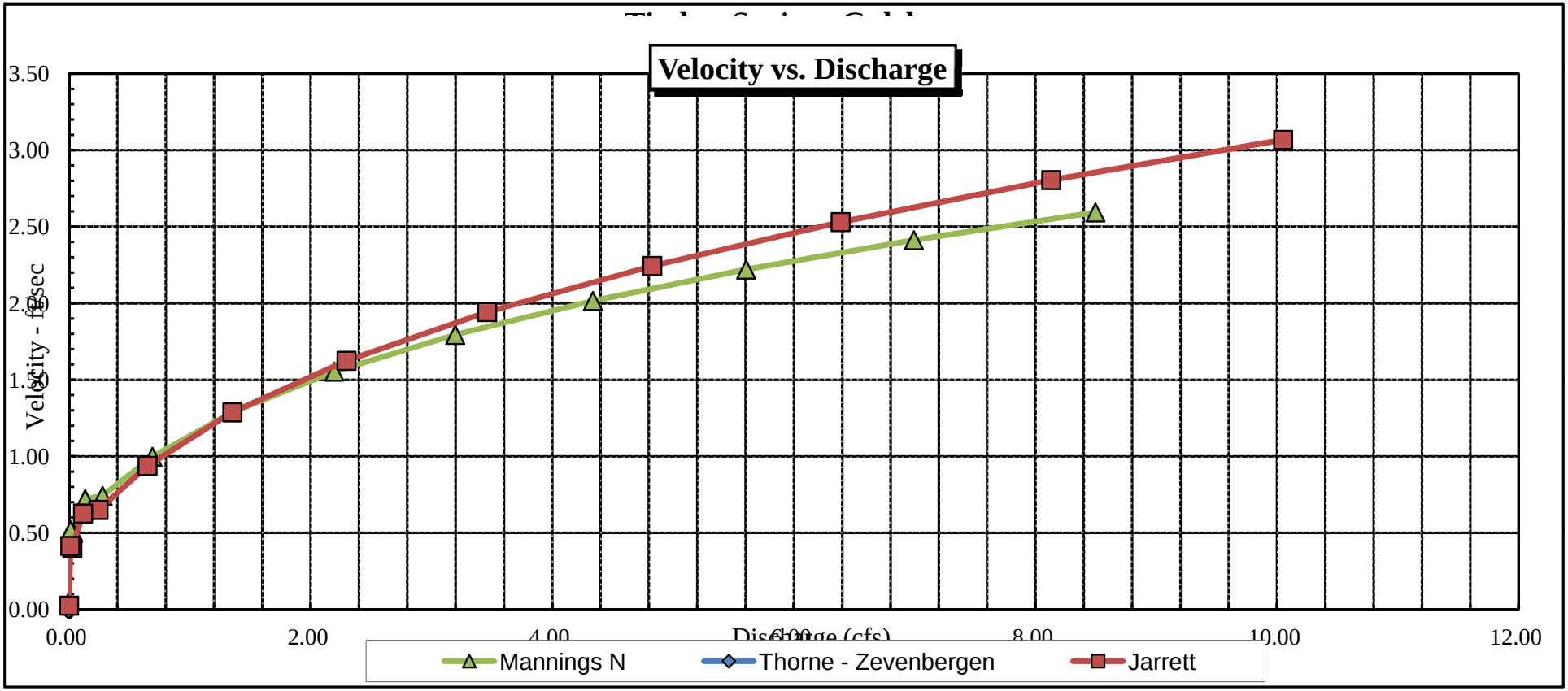
STREAM NAME: Timber Springs Gulch
XS LOCATION: 0.25 miles u/s fr Timber Spgs. Subdiv.
XS NUMBER: 2 Jarrett Variable Manning's n Correction Applied

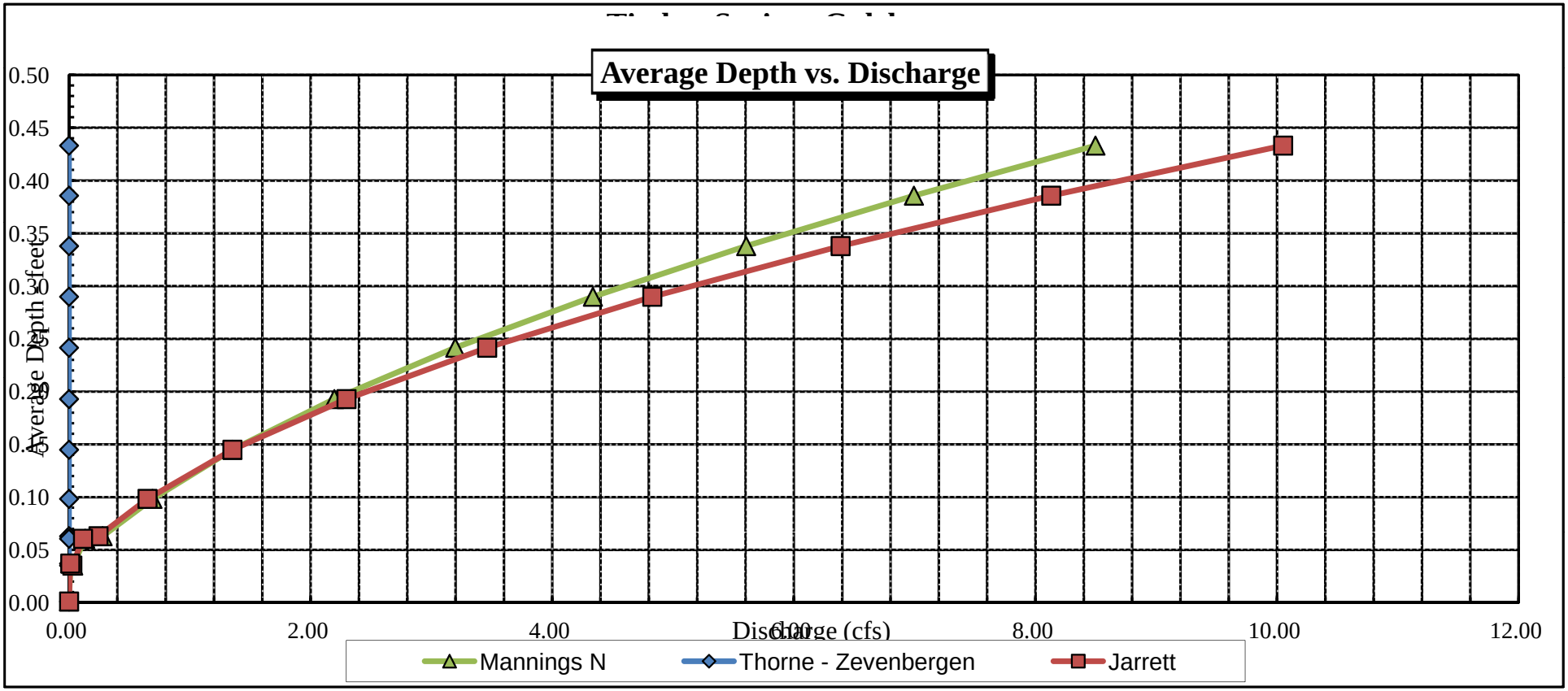
GL = lowest Grassline elevation corrected for sag
STAGING TABLE *WL* = Waterline corrected for variations in field measured water surface elevations and sag

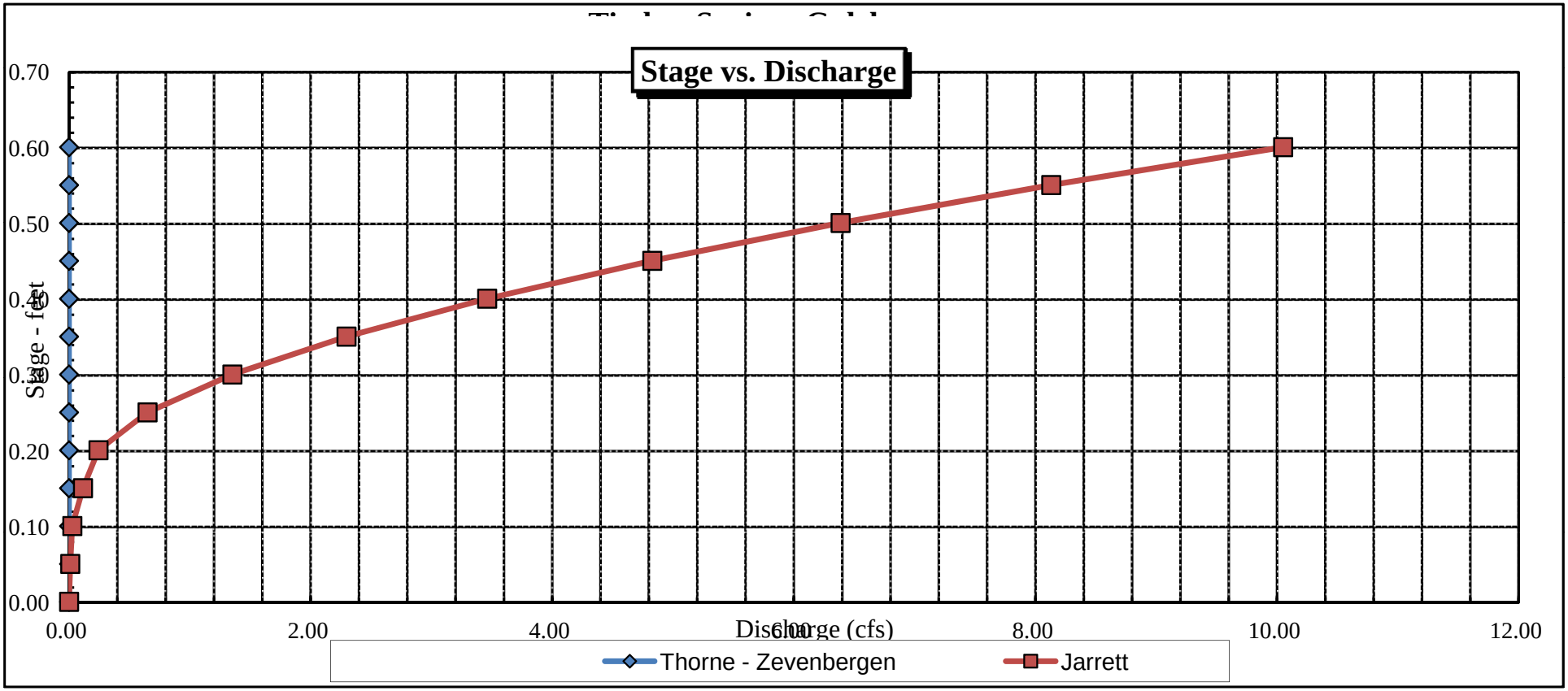
	DIST TO WATER (FT)	TOP WIDTH (FT)	AVG. DEPTH (FT)	MAX. DEPTH (FT)	AREA (SQ FT)	WETTED PERIM. (FT)	PERCENT WET PERIM (%)	HYDR RADIUS (FT)	FLOW (CFS)	AVG. VELOCITY (FT/SEC)
GL	4.68	7.58	0.45	0.62	3.42	8.16	100.0%	0.42	10.82	3.16
	4.70	7.57	0.43	0.60	3.28	8.12	99.5%	0.40	10.05	3.07
	4.75	7.52	0.39	0.55	2.90	8.01	98.1%	0.36	8.13	2.80
	4.80	7.47	0.34	0.50	2.52	7.90	96.8%	0.32	6.39	2.53
	4.85	7.42	0.29	0.45	2.15	7.79	95.4%	0.28	4.83	2.24
	4.90	7.38	0.24	0.40	1.78	7.68	94.1%	0.23	3.46	1.94
	4.95	7.33	0.19	0.35	1.41	7.57	92.7%	0.19	2.30	1.62
WL	5.00	7.24	0.14	0.30	1.05	7.43	91.1%	0.14	1.35	1.29
	5.05	7.04	0.10	0.25	0.69	7.20	88.2%	0.10	0.65	0.94
	5.10	5.95	0.06	0.20	0.37	6.07	74.4%	0.06	0.24	0.65
	5.15	3.05	0.06	0.15	0.19	3.14	38.4%	0.06	0.12	0.63
	5.20	1.93	0.04	0.10	0.07	1.98	24.3%	0.03	0.03	0.40
	5.25	0.67	0.04	0.05	0.02	0.69	8.4%	0.04	0.01	0.41
	5.30	0.31	0.00	0.00	0.00	0.31	3.8%	0.00	0.00	0.02


CROSS SECTION DATA ANALYSIS
-4.10
-4.30
-4.50
-4.70
-4.90
-5.10
-5.30
-5.50
VERTICAL DEPTH (FT)
LS
G
W
W
G
RS
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
DISTANCE FROM STAKE (FT)
Channel Bottom
Computed Water Line


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
2.00
4.00
8.00
10.00
12.00
Mannings N
Thorne - Zevenbergen
Jarrett


Velocity vs. Discharge
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Velocity - ft/sec
0.00
2.00
4.00
8.00
10.00
12.00
Mannings N
Thorne - Zevenbergen
Jarrett


Average Depth vs. Discharge
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Average Depth (feet)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Discharge (cfs)
Mannings N
Thorne - Zevenbergen
Jarrett


Stage vs. Discharge
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Stage - feet
0.00
2.00
4.00
6.00
8.00
10.00
12.00
Discharge (cfs)
Thorne - Zevenbergen
Jarrett

COLORADO WATER CONSERVATION BOARD

FIELD DATA FOR INSTREAM FLOW DETERMINATIONS

COLORADO DIVISION OF WILDLIFE

LOCATION INFORMATION

STREAM NAME: Timber Springs Gulch | CROSS-SECTION NO.: 2

CROSS-SECTION LOCATION: 0.25 miles upstream from Timber Spgs. Subdivision

DATE: 5-17-13 | OBSERVERS: R. Smith, P. Adams

LEGAL DESCRIPTION: ¼ SECTION: SE SE | SECTION: 25 | TOWNSHIP: 4 N (S) | RANGE: 83 E (W) | PM: 6th

COUNTY: Eagle | WATERSHED: Eagle | WATER DIVISION: 5 | DOW WATER CODE: not numbered

MAP(S): USGS: GPS 39° 40' 07.85" | USFS: 106° 37' 40.48"

SUPPLEMENTAL DATA

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

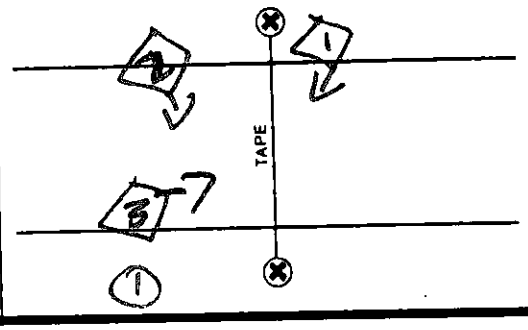
METER NUMBER: | DATE RATED: | CALIB/SPIN: ____ sec | TAPE WEIGHT: surveyed ____ lbs/foot | TAPE TENSION: surveyed ____ lbs

CHANNEL BED MATERIAL SIZE RANGE: gravels & encrusted branches | 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 0.6/7.9	0.0	5.00/4.95
② WS Upstream	7.5'	3.42
③ WS Downstream	25.0	7.02
SLOPE	3.6 / 32.5' = .110	

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

Temp =
pH =
Cond =
Salinity =

Spruce - Alder Riparian

First Headgate = 360363 4392044

DISCHARGE/CROSS SECTION NOTES

STREAM NAME: Timber Springs Gulch | CROSS-SECTION NO.: 2 | DATE: 5-17-13 | 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		4.38								
G	0.4		4.65								
W	0.6		5.00								
	0.9		5.10	.10				0.46			
	1.2		5.15	.15				1.20			
	1.5		5.15	.15				0.81			
	1.8		5.10	.10				1.68			
	2.1		5.15	.15				2.22			
	2.4		5.20	.20				2.32			
	2.7		5.20	.20				1.73			
	3.0		5.20	.20				1.24			
	3.3		5.15	.15				1.19			
	3.6		5.10	.10				1.44			
	3.9		5.10	.10				0.90			
	4.2		5.10	.10				0.87			
	4.5		5.10	.10				0.56			
	4.8		5.05	.05				0.22			
	5.1		5.05	.05				0.34			
	5.4		5.10	.10				0.81			
	5.7		5.10	.10				1.04			
	6.0		5.15	.15				1.43			
	6.3		5.20	.20				1.33			
	6.6		5.20	.20				1.65			
	6.9		5.25	.25				1.52			
	7.2		5.30	.30				1.26			
	7.5		5.30	.30				0.88			
W	7.9		4.95								
G	8.0		4.68								
RS	8.6		4.46								
TOTALS											

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