Oregon Creek
Log Cabin Diversion Dam Reach
Celestial Valley Sub-Reach
Draft Hydraulic Calibration Results

Model Used

The hydraulic model for the Celestial Valley Sub-Reach PHABSIM study was calibrated by HDR using RHABSIM 3.0 (Riverine Habitat Simulation), a commercial software program written by Thomas R. Payne and Associates of Arcata, California. RHABSIM is a commercial version of the PHABSIM computer model (Milhous et al. 1984).

Model Files

The following RHABSIM file is associated with the Celestial Valley Sub-Reach:

CELEST_V.RHB

Modeling Methods

Water Surface Elevations (WSE)

For WSEs, these procedures included: the development of stage/discharge rating curves using log-log regression (IFG4); Manning's formula (MANSQ); and/or step backwater models (WSP); direct comparison of results; and selection of the most appropriate and accurate method. Log-log and MANSQ were run for each transect, with MANSQ set as the default modeling method. If individual transects did not calibrate sufficiently well using MANSQ, based on general guidelines of maximum Beta (5.0), and/or professional judgment, then log/log was selected. Data file construction, calibration, and simulation followed standard procedures and guidelines outlined in the PHABSIM Reference Manual Version II, Instream Flow Information Paper No.26 (Milhous, at al. 1989).

Modeling Guidelines

PHABSIM modeling guidelines considered for the Celestial Valley Sub-Reach were as follows:

1. The beta value (a measure of the change in channel roughness with changes in streamflow) must be between 2.0 and 4.5;
2. The mean error in calculated versus given discharges must be less than 10 percent;
3. There must be no more than a 25 percent difference for any calculated versus given discharge; and
4. There must be no more than a 0.1-foot (ft) difference between measured and simulated WSEs.

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5. To determine whether the MANSQ model accurately predicts measured values, the second through fourth of the above criteria must be met, and the beta value parameter used by MANSQ must be within the range of -5.0 to 5.0. The first IFG4 criterion is not applicable to MANSQ.

Habitat Summary for Celestial Valley Sub-Reach

A hydraulic model was developed for the 12 instream flow transects on the Celestial Valley Sub-Reach of the Log Cabin Diversion Dam Reach (Log Cabin) on the Oregon Creek above Englebright Reservoir. Meso-habitats represented in the Celestial Valley Sub-Reach are presented in Table 1. Final transect locations are presented in Figure 1.

Table 1. Habitat frequency based on ground-mapped data and target transects for the Celestial Valley Sub-Reach of Log Cabin.

PHABSIM Habitat	Length	Length Frequency	Adjusted Length Frequency
High gradient riffles	26	0%	0%
Low gradient riffles	1,934	33%	36%
Runs/Step-Runs	301	6%	6%
Glides	395	7%	7%
Pocket Water	0	0%	0%
Pools	3139	50%	50%
Total	**5,333**	**100%**	**100%**

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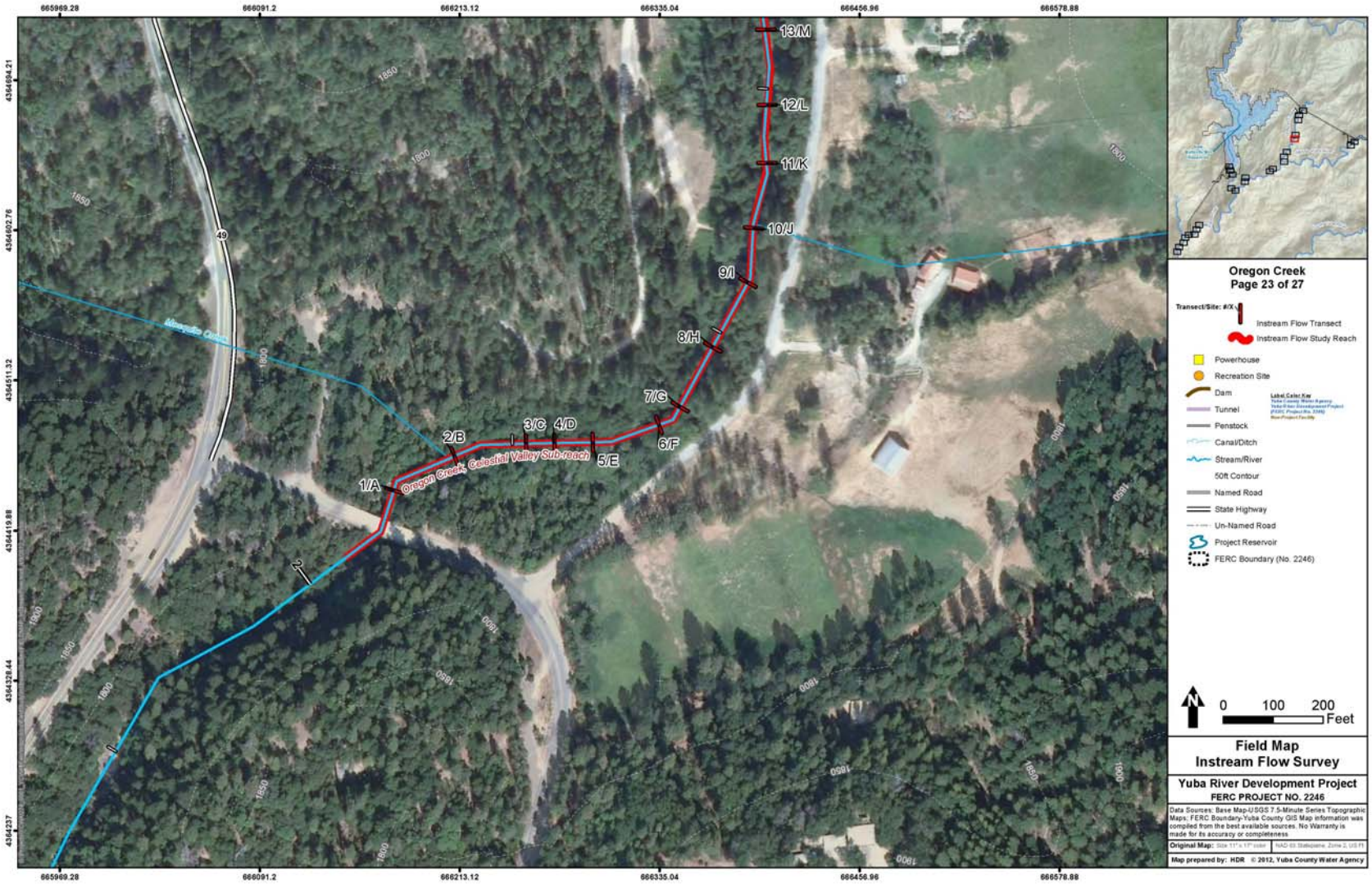

Figure 1. PHABSIM transects in the Celestial Valley Sub-Reach of the Log Cabin Reach on Oregon Creek.

Calibration Summary for Celestial Valley Sub-Reach

The Celestial Valley model was associated with three stage discharge pairs, and primary velocity calibration set at full channel flow of 106 cubic feet per second (cfs). When velocities couldn't be measured safely at 106 cfs, they were measured at 46 cfs. Each transect in the sub-reach had one velocity set measured, which is consistent with the "one-velocity" method.

Stage/discharge regressions were developed using the three calibration discharges: 106 cfs (high flow), 46 cfs (mid flow), and 15 cfs (low flow). Table 2 summarizes modeling statistics for each transect and modeling method, while Tables B-1 and B-2, in Appendix B, summarize the given calibration stage and the modeled stages for each flow, at each transect, using all modeling methods used on a given transect. Appendix C provides the calibration notes on each transect.

Cross Sections

Cross sectional profile graphs, with measured WSEs, have been included in Appendix A, in addition to transect photos.

Calibration Details for Celestial Valley Sub-Reach

Stage/Discharge Calibration

- All transects in the study sub-reach were calibrated using both Log/Log and MANSQ.
- For model calibration, water surface elevations were selected within the range of field collected data only.
- Cross-sectional geometry and a realistic rating curve fit were considered when choosing the primary modeling method.
- MANSQ was selected as the primary calibration method on T-01, T-02, T-03, T-08, T-09, T-10, and T-13 based on the modeling guidelines outlined above.
- Log/Log was chosen on T-04 through T-07 and T-11 and T-12.
- All Log/Log betas were between 2.0 and 4.5.
- All transects had MANSQ betas inside the range of -5.0 to 5.0.
- All MANSQ mean errors were less than 1.4 percent.
- Both MANSQ and Log/Log mean errors can be seen in Table 2. Refer to Table B-1 and B-2 in the Appendix for a comparison of measured versus modeled WSEs.
- 11 of the 13 calculated discharges were within 10 percent of given discharges.
  - T-02 through T-05, T-07 through T-13
  - T-06 was within 13 percent
  - T-01 was within 21 percent. This transect included a high velocity chute that was challenging to measure and contained a large percentage of the total discharge.

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Measurement errors in the chute, due to the conditions, may be the cause of the high percent error calculated flow.

Table 2. Percent Mean Error for Stage/Discharge Relationships.

	T-13	T-12	T-11	T-10	T-09	T-08	T-07
Log-Log	0.2602	0.4055	0.4841	0.1236	1.1826	1.5712	0.0383
MANSQ	0.0903	1.2477	0.7454	0.1541	0.7717	0.6132	1.7726
BETA	0.3248	0.3289	0.2099	0.3797	0.6186	0.4369	0.4862
	T-06	**T-05**	**T-04**	**T-03**	**T-02**	**T-01**	
Log-Log	0.6998	0.4188	0.2971	0.8849	0.0611	0.567	
MANSQ	0.9513	1.439	0.1499	0.6878	0.4854	0.3464	
BETA	0.6123	0.2049	0.1542	0.3351	0.3046	0.2073	

Velocity Calibration

All transect velocity measurements were collected at the highest target flow possible for that transect. Limiting physical parameters included deep swift water to deep to safely wade or deep water with entrained air which limited ADCP data collection.

- Velocity measurements were modeled at the highest flow possible for each transects.
  - High Flow: T-02 through T-06 and T-08 through T-13
  - Mid Flow: T-01 and T-07

Table 3and Figure 2 provide the velocity adjustment factor (VAF) for each calibration flow on each transect. VAF is the index of the difference between the requested simulation discharge and computed discharge derived from the velocity simulations (Waddle 2001). These velocity adjustments are used to prevent the model from over or under estimating the discharge at flows other than the velocity calibration discharge. Graphical representations can be found in Figure 2 and Figure 3.

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Table 3. Velocity adjustment factors (VAF) for Celestial Valley.

Transect 01				Transect 02				Transect 03			
WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF
89.4	6	12.53	0.4789	94.5	6	12.68	0.4732	93.43	6	17.93	0.3345
89.81	15	24.55	0.6109	94.77	15	25.19	0.5954	93.75	15	30.9	0.4854
90.52	46	50.25	0.9154	95.2	46	56.87	0.8088	94.29	46	60.58	0.7593
91.27	106	80.64	1.3145	95.63	106	101.18	1.0477	94.83	106	100.5	1.0547
92.37	265	136.05	1.9478	96.25	265	184.08	1.4396	95.6	265	173.92	1.5237
Transect 04				**Transect 05**				**Transect 06**			
WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF
93.75	6	8.58	0.6991	93.75	6	9	0.6667	90.85	6	60.86	0.0986
94.06	15	17.86	0.8398	94.13	15	20.37	0.7364	91.18	15	73.35	0.2045
94.58	46	51.04	0.9012	94.79	46	54.18	0.8491	91.73	46	96.29	0.4777
95.12	106	105.32	1.0065	95.46	106	105.29	1.0067	92.28	106	121.12	0.8751
95.9	265	218.89	1.2106	96.47	265	211.64	1.2521	93.06	265	156.1	1.6976
Transect 07				**Transect 08**				**Transect 09**			
WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF
90.85	6	22.61	0.2653	92.53	6	25.61	0.2343	93.23	6	47.48	0.1264
91.19	15	30.99	0.4840	92.77	15	40.67	0.3688	93.58	15	61.73	0.243
91.77	46	49.13	0.9363	93.23	46	72.20	0.6371	94.12	46	86.19	0.5337
92.36	106	75.04	1.4127	93.75	106	111.70	0.9490	94.61	106	111.74	0.9486
93.22	265	129.68	2.0435	94.56	265	181.37	1.4611	95.29	265	150.04	1.7662
Transect 10				**Transect 11**				**Transect 12**			
WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF	WSL	Calibration Flow	Calculated Flow	VAF
93.41	6	17.66	0.3397	91.81	6	9.92	0.6049	93.37	6	12.88	0.4657
93.76	15	32.81	0.4572	92.16	15	21.74	0.69	93.66	15	29.53	0.508
94.29	46	66.50	0.6918	92.75	46	53.84	0.8544	94.11	46	68.73	0.6693
94.8	106	108.78	0.9745	93.37	106	99.6	1.0642	94.52	106	118.91	0.8914
95.52	265	180.59	1.4434	94.26	265	187.05	1.4167	95.08	265	203.19	1.3042
Transect 13											
WSL	Calibration Flow	Calculated Flow	VAF								
89.93	6	11.99	0.5002								
90.14	15	23.32	0.6431								
90.46	46	55.60	0.8273								
90.76	106	105.25	1.0071								
91.16	265	206.39	1.2840								

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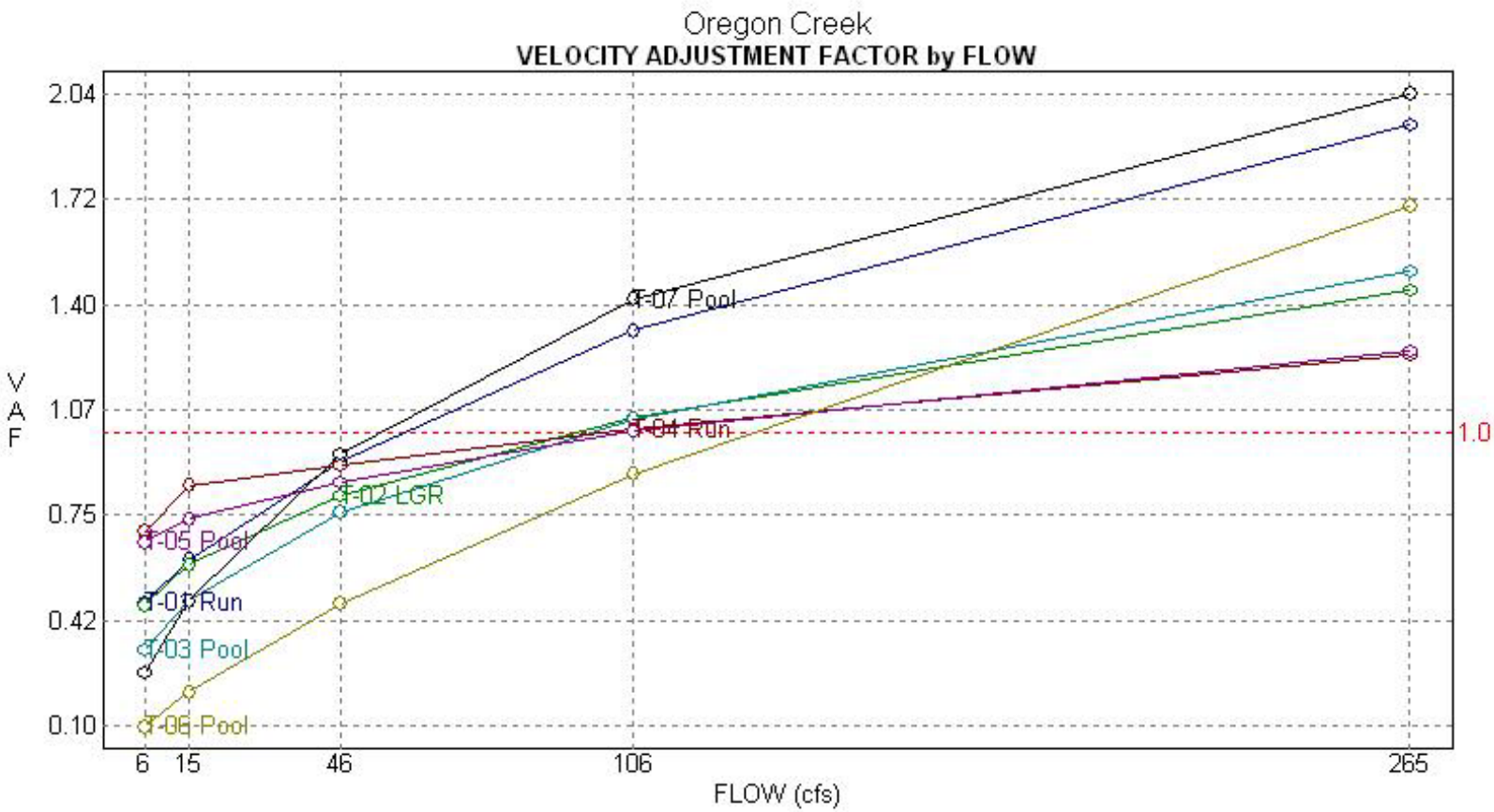

Figure 2. Velocity Adjustment Factor (VAF) by flow for transects T-01 through T-07.

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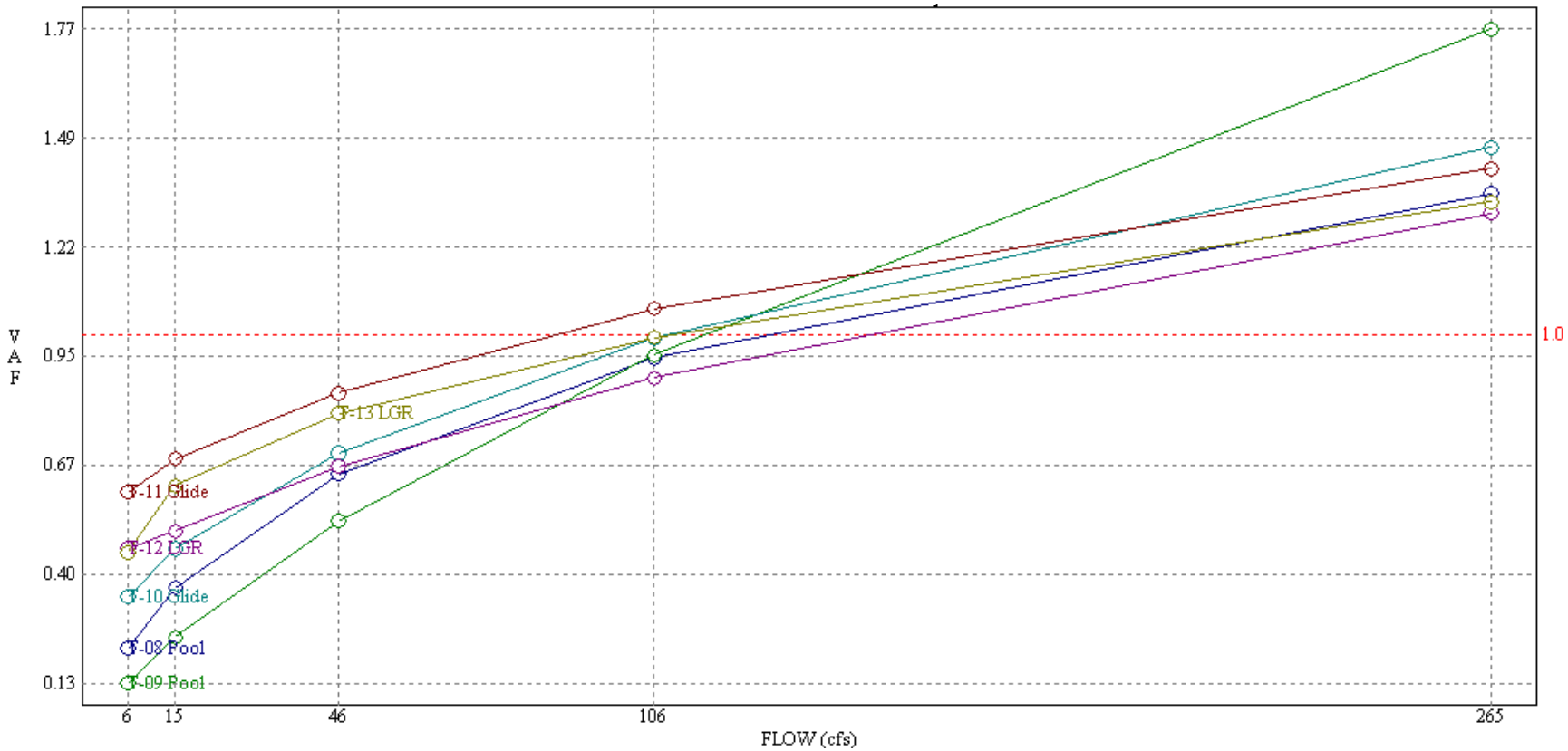

Figure 3. Velocity Adjustment Factor (VAF) by flow for transects T-08 through T-13.

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Target Discharge and Field Discharge

Average daily discharge calculated from all field measurements are summarized below in Table 4.

Table 4. Target and measured flows for the Celestial Valley Sub-Reach.

Transect	Type	Discharge					
		Low - Target 20 cfs		Mid - Target 50 cfs		High - Target 100 cfs	
		Measured (cfs)	Method	Measured (cfs)	Method	Measured (cfs)	Method
1	Run	--	--	60	Swoffer	--	--
2	Low gradient riffle	--	--	--	--	100	Swoffer
3	Pool	--	--	47	--	103	Swoffer
4	Run	--	--	--	--	103	Swoffer
5	Pool	--	--	--	--	95	Swoffer
6	Pool	--	--	--	--	122	ADCP/Swoffer
7	Pool	--	--	44	Swoffer	N/A	--
8	Pool	--	--	--	--	111	Swoffer
9	Pool	--	--	--	--	116	ADCP/Swoffer
10	Glide	15	Swoffer	--	--	109	Swoffer
11	Glide	--	--	49	Swoffer	100	Swoffer
12	Low gradient riffle	14	Swoffer	46	Swoffer	112	Swoffer
13	Low gradient riffle	--	--	--	--	101	Swoffer
Given Flow Averages using best transects		**15**	(T-10, T-12)	**46**	(T-03, T-07, T-11, T-12)	**106**	(T-02 through T-06, T-08 through T-13)

Discharge, like water surface elevation, is used to calibrate stage/discharge relationships in the PHABSIM hydraulic models. Modeled discharges used in the Log/Log and MANSQ routines were modified slightly from best estimates to improve model calibration. Discharge selections were within the range of flows observed during data collection if the average discharge for the day was not used.

References

Milhous, R. T., D. L. Wegner, and T. Waddle. 1984. User's Guide to the Physical Habitat Simulation System (PHABSIM). Instream Flow Information Paper No. 11. U.S. Fish and Wildlife Service. FWS/OBS-81/43.

Milhous, R. T., M. A. Updike, and D. M. Schneider. 1989. PHABSIM Reference Manual Version II, Instream Flow Information Paper No. 26. U.S. Fish and Wildlife Service Biological Report 89(16).

Waddle, T. J. (ed.) 2001. PHABSIM for Windows: User's Manual and Exercises. U.S. Geological Survey Open-File Report 2001-340.

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Appendix A
Celestial Valley Sub-Reach Cross Sectional Profiles and Photos

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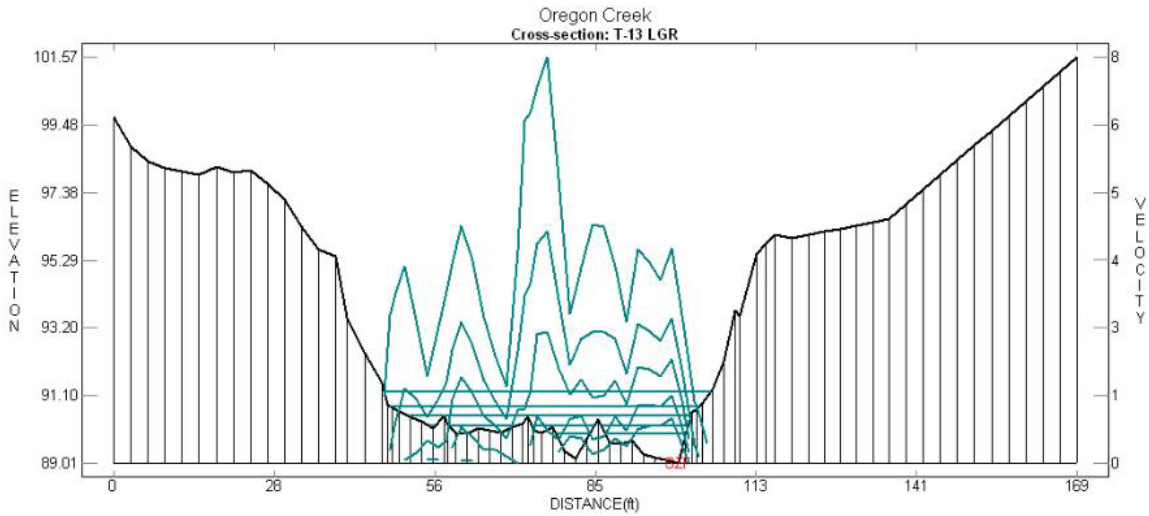

Figure A-1. Cross section for Transect 13 (Low Gradient Riffle).

Figure A-2. Transect 13-Looking from right bank to left bank at mid flow.

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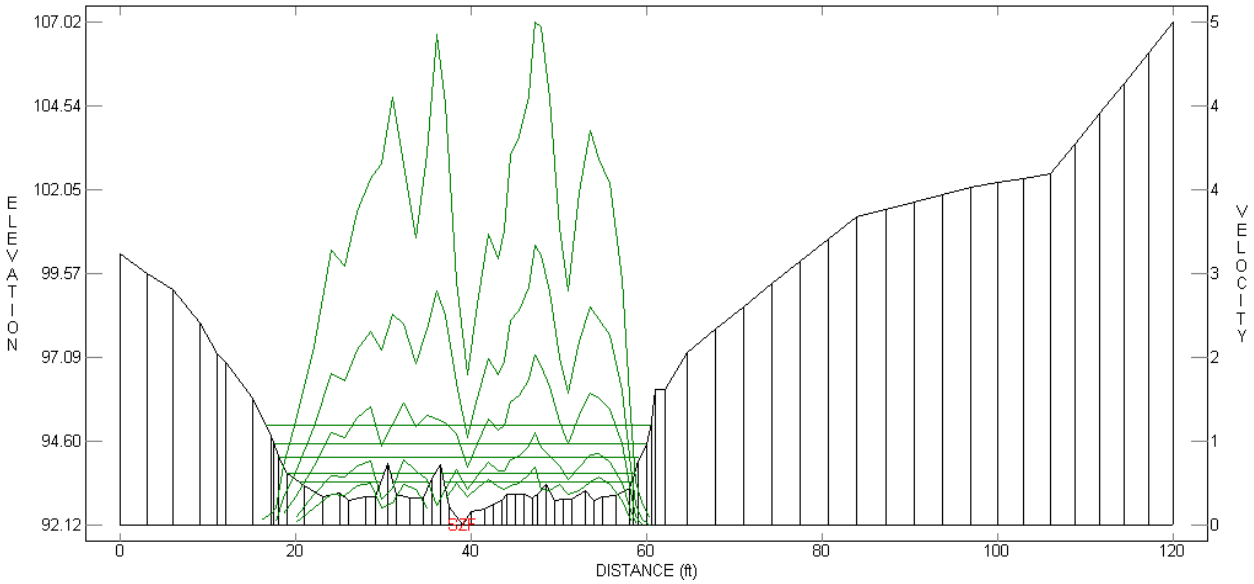

Figure A-3. Cross section for Transect 12 (Low Gradient Riffle).

Figure A-4. Transect 12-Looking from right bank to left bank at mid flow.

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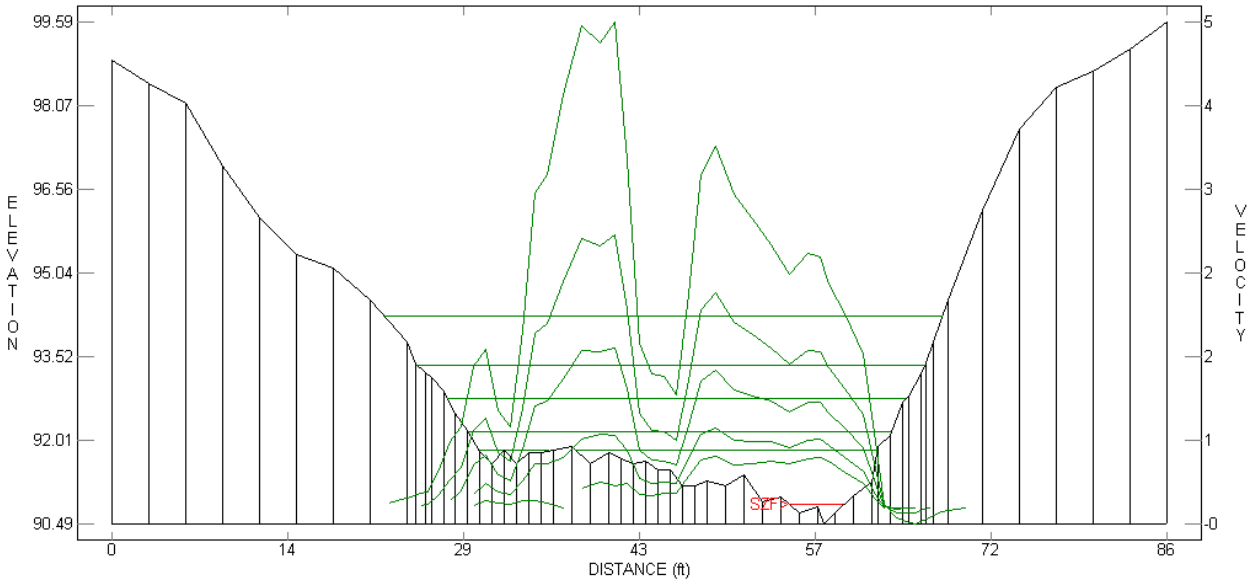

Figure A-5. Cross section for Transect 11 (Glide).

Figure A-6. Transect 11-Looking upstream from mid-channel at low flow.

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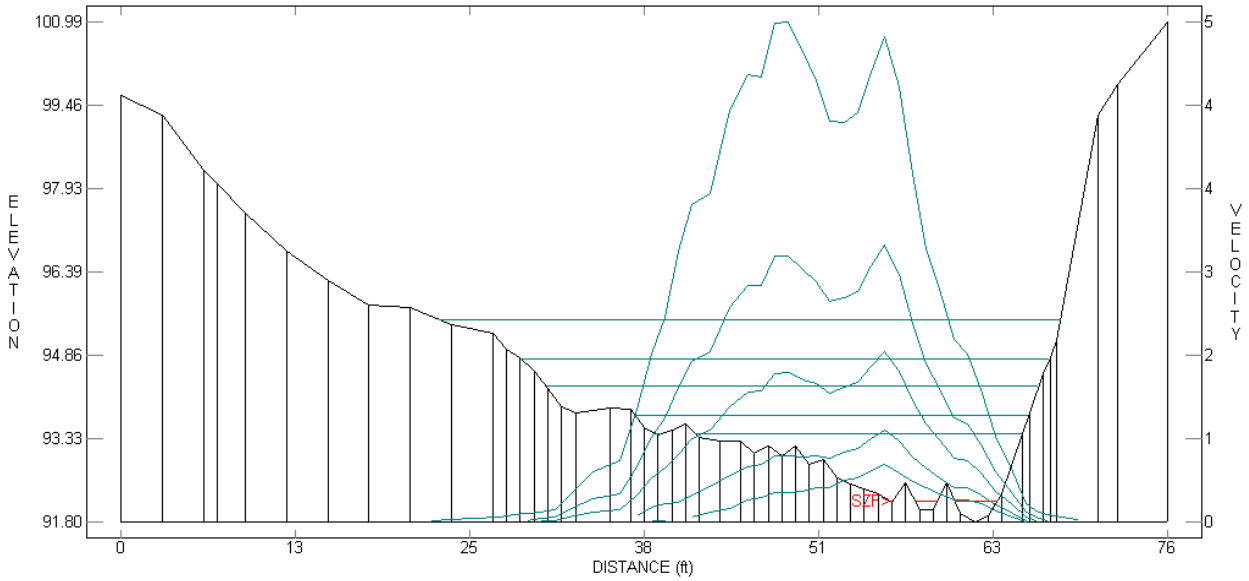

Figure A-7. Cross section for Transect 10 (Glide).

Figure A-8. Transect 10-Looking upstream at mid flow.

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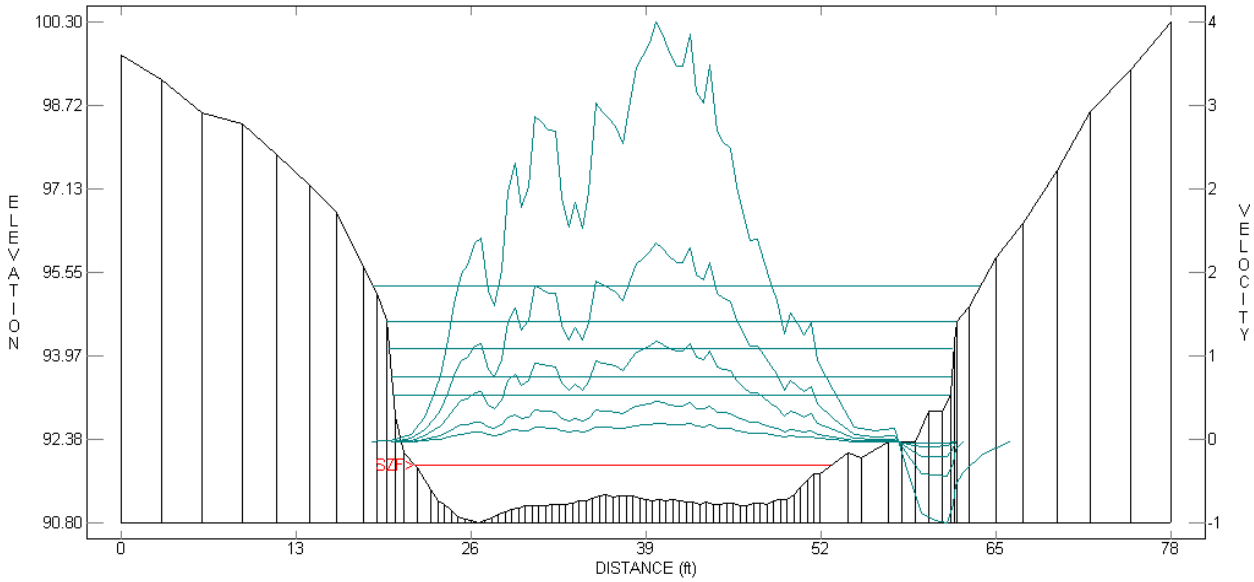

Figure A-9. Cross section for Transect 09 (Pool).

Figure A-10. Transect 09-Looking upstream at low flow.

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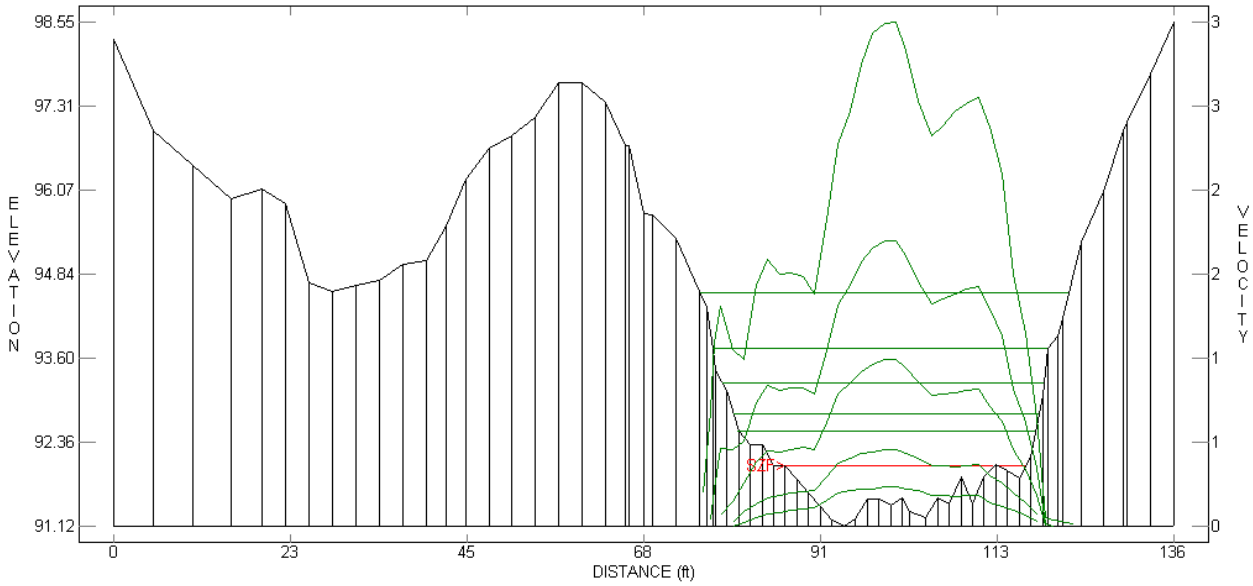

Figure A-11. Cross section for Transect 08 (Pool).

Figure A-12. Transect 08-Looking upstream at low flow.

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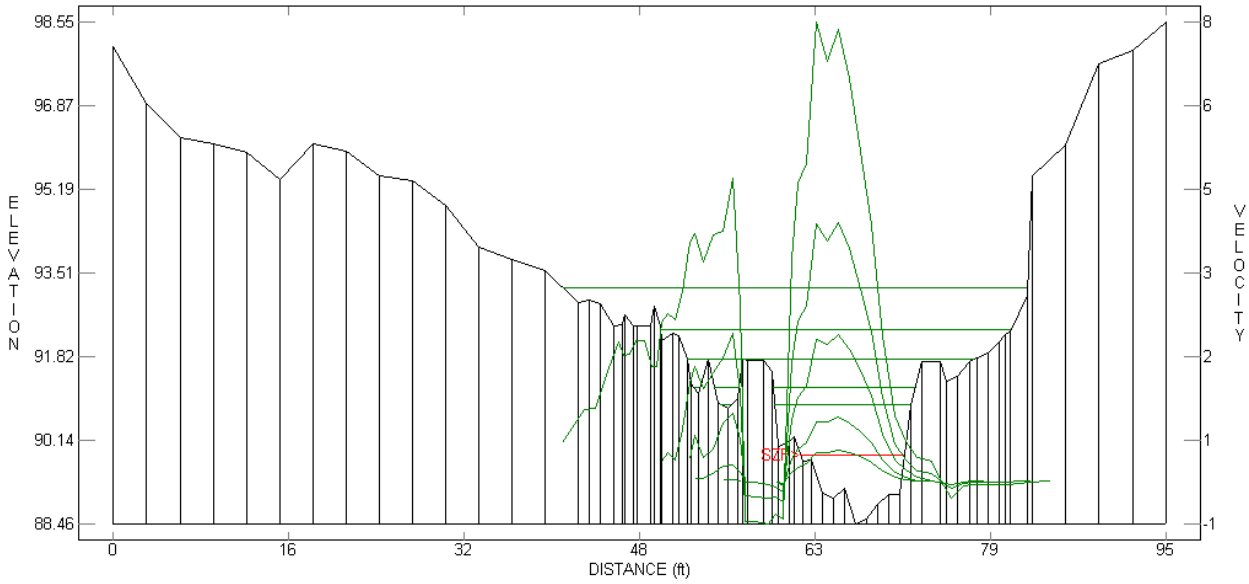

Figure A-13. Cross section for Transect 07 (Pool).

Figure A-14. Transect 07-Looking from right bank to left bank at mid flow.

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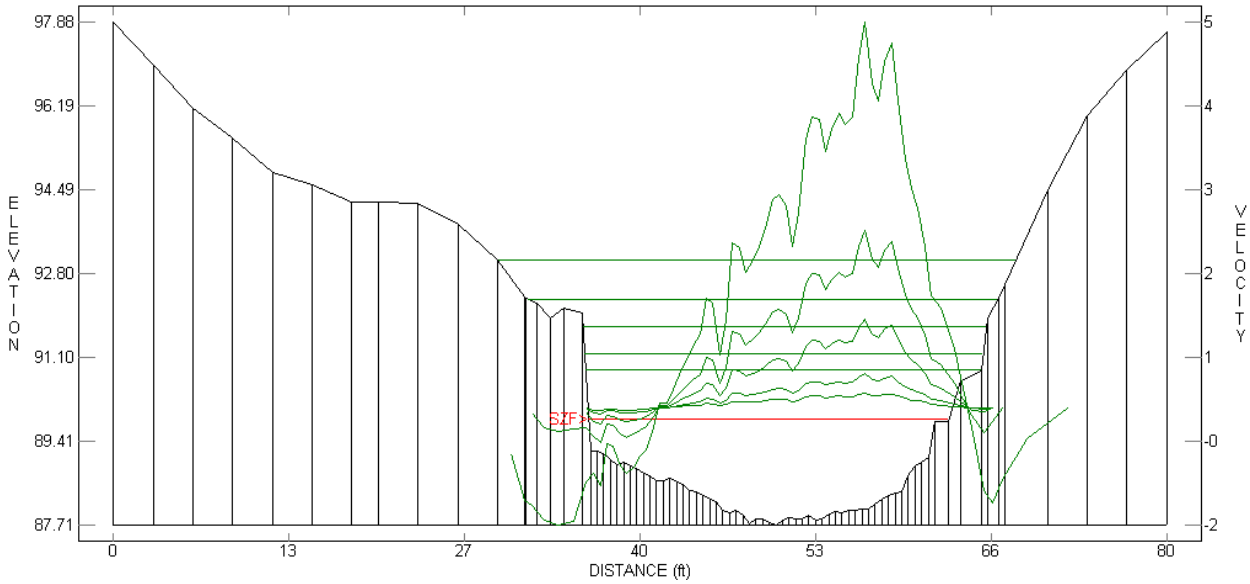

Figure A-15. Cross section for Transect 06 (Pool).

Figure A-16. Transect 06-Looking from right bank to left bank at mid flow.

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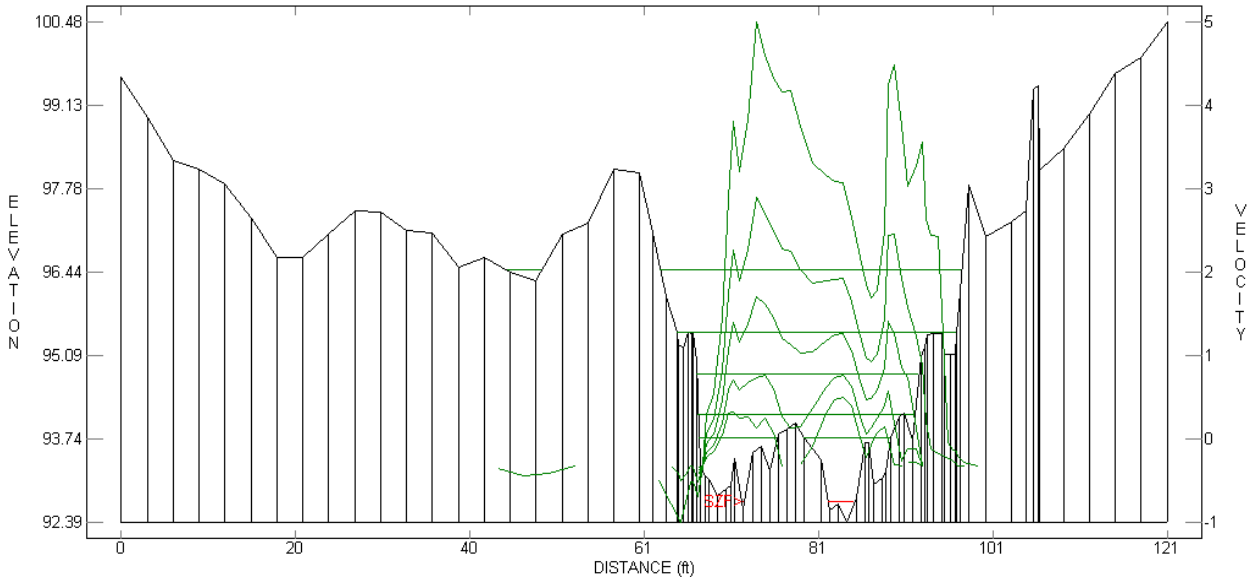

Figure A-17. Cross section for Transect 05 (Pool).

Figure A-18. Transect 05 (Pool Head)-Looking upstream at mid flow.

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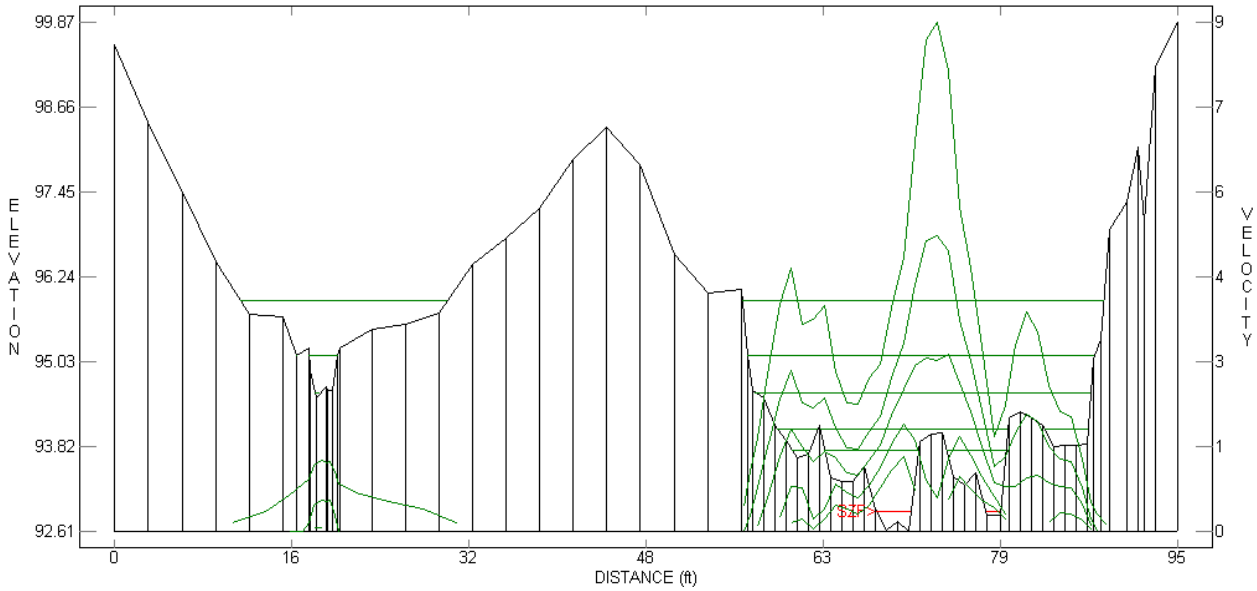

Figure A-19. Cross section for Transect 04 (Run).

Figure A-20. Transect 04-Looking upstream at mid flow.

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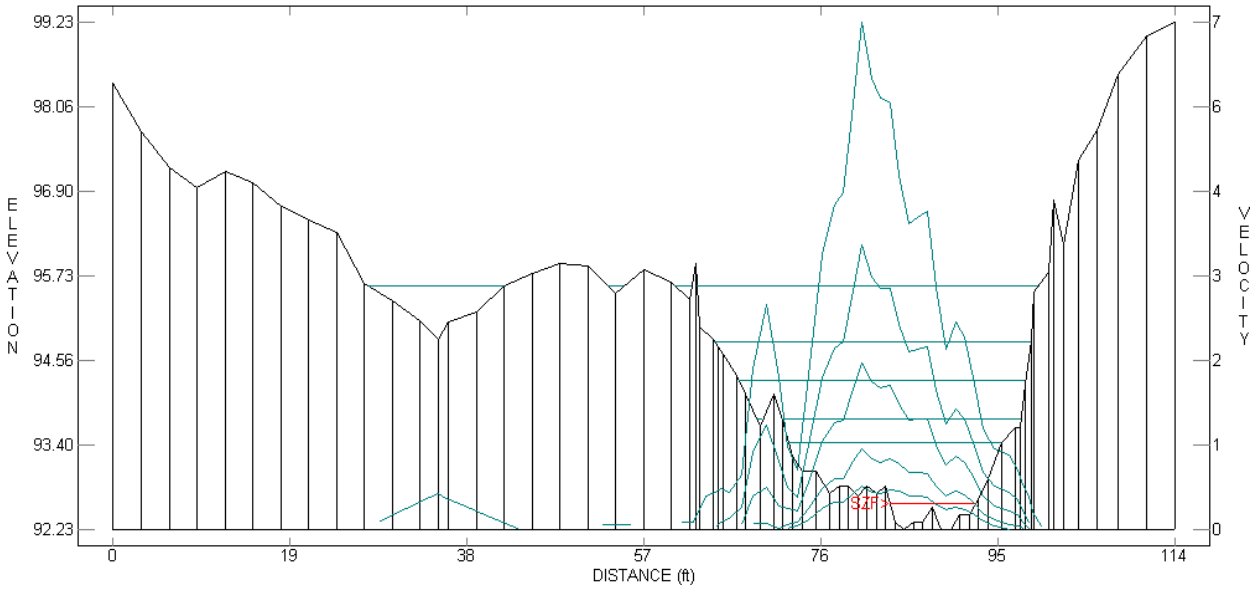

Figure A-21. Cross section for Transect 03 (Pool).

Figure A-22. Transect 03-Looking upstream at mid flow.

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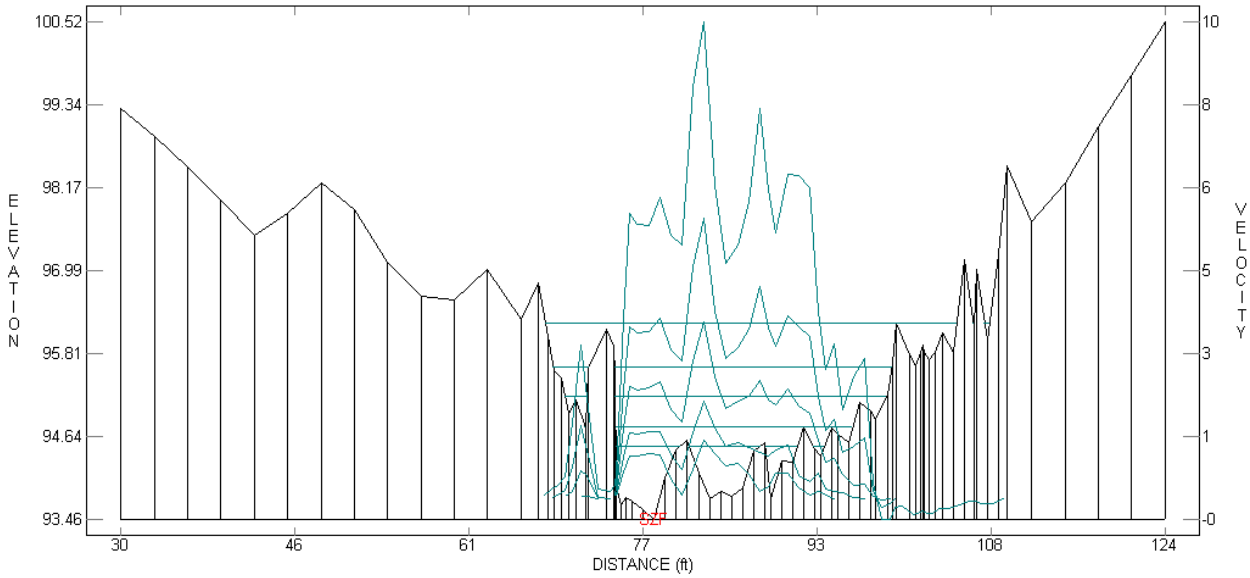

Figure A-23. Cross section for Transect 02 (Low Gradient Riffle).

Figure A-24. Transect 02-Looking from right bank to left bank at mid flow.

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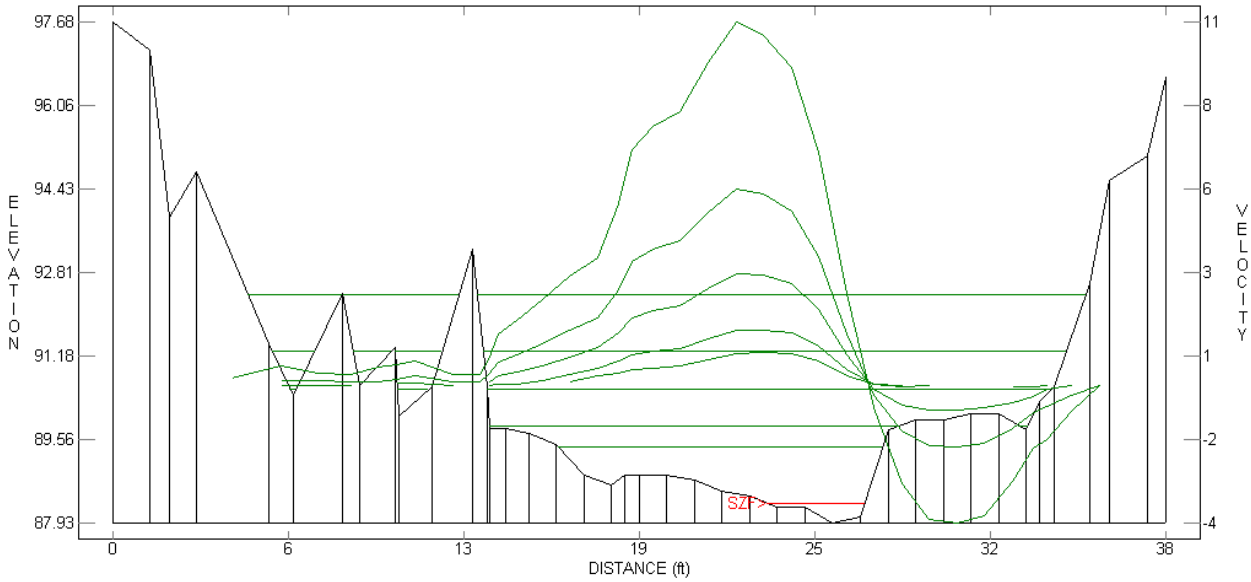

Figure A-25. Cross section for Transect 01 (Run).

Figure A-26. Transect 01-Looking from right bank to left bank at mid flow.

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Appendix B
Celestial Valley Sub-Reach Water Surface Elevation Comparison Tables

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Table B-1. Measured and Modeled WSEs (Q in cfs, all other values in ft) for Celestial Valley.

Transect 01				Transect 02				Transect 03			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	89.81	89.81	89.81	**15**	94.77	94.77	94.77	**15**	93.75	93.75	93.75
46	90.53	90.52	90.53	**46**	95.21	95.21	95.20	**46**	94.27	94.28	94.29
106	91.26	91.27	91.26	**106**	95.63	95.63	95.63	**106**	94.83	94.82	94.83
Transect 04				**Transect 05**				**Transect 06**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	94.06	94.06	94.06	**15**	94.13	94.13	94.13	**15**	91.18	91.18	91.18
46	94.58	94.58	94.58	**46**	94.79	94.79	94.76	**46**	91.72	91.73	91.74
106	95.12	95.12	95.12	**106**	95.46	95.46	95.46	**106**	92.28	92.28	92.27
Transect 07				**Transect 08**				**Transect 09**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	91.19	91.19	91.19	**15**	92.77	92.77	92.77	**15**	93.58	93.58	93.58
46	91.77	91.77	91.81	**46**	93.24	93.25	93.25	**46**	94.1	94.11	94.12
106	92.36	92.36	92.36	**106**	93.74	93.73	93.74	**106**	94.62	94.62	94.61
Transect 10				**Transect 11**				**Transect 12**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	93.76	93.76	93.76	**15**	92.16	92.16	92.16	**15**	93.66	93.66	93.66
46	94.29	94.29	94.29	**46**	92.75	92.75	92.73	**46**	94.11	94.11	94.08
106	94.80	94.80	94.80	**106**	93.37	93.37	93.37	**106**	94.52	94.52	94.52
Transect 13											
Q	**Cal Stage**	**Log/Log**	**MANSQ**								
15	90.14	90.14	90.14								
46	90.46	90.46	90.46								
106	90.76	90.76	90.76								

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Table B-2. Differences Between Measured and Modeled WSEs (Q in cfs, all other values in ft) for Celestial Valley.

Transect 01				Transect 02				Transect 03			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	89.81	0.00	0.00	**15**	94.77	0.00	0.00	**15**	93.75	0.00	0.00
46	90.53	-0.01	0.00	**46**	95.21	0.00	-0.01	**46**	94.27	0.01	0.02
106	91.26	0.01	0.00	**106**	95.63	0.00	0.00	**106**	94.83	-0.01	0.00
Transect 04				**Transect 05**				**Transect 06**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	94.06	0.00	0.00	**15**	94.13	0.00	0.00	**15**	91.18	0.00	0.00
46	94.58	0.00	0.00	**46**	94.79	0.00	-0.03	**46**	91.72	0.01	0.02
106	95.12	0.00	0.00	**106**	95.46	0.00	0.00	**106**	92.28	0.00	-0.01
Transect 07				**Transect 08**				**Transect 09**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	91.19	0.00	0.00	**15**	92.77	0.00	0.00	**15**	93.58	0.00	0.00
46	91.77	0.00	0.04	**46**	93.24	0.01	0.00	**46**	94.1	0.01	0.02
106	92.36	0.00	0.00	**106**	93.74	0.01	0.00	**106**	94.62	0.00	-0.01
Transect 10				**Transect 11**				**Transect 12**			
Q	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**	**Q**	**Cal Stage**	**Log/Log**	**MANSQ**
15	93.76	0.00	0.00	**15**	92.16	0.00	0.00	**15**	93.66	0.00	0.00
46	94.29	0.00	0.00	**46**	92.75	0.00	-0.02	**46**	94.11	0.00	-0.03
106	94.8	0.00	0.00	**106**	93.37	0.00	0.00	**106**	94.52	0.00	0.00
Transect 13											
Q	**Cal Stage**	**Log/Log**	**MANSQ**								
15	90.14	0.00	0.00								
46	90.46	0.00	0.00								
106	90.76	0.00	0.00								

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Appendix C
Model Calibration Notes

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T-01

- Stations 21.00 to 25.00-Adjusted N values to dampen a velocity spike.
- Stations 28.00 to 33.00-Adjusted N values to dampen a negative velocity spike.

T-02

- Stations 0.00 through 27.00 were removed from the transect. These stations were all much higher than high flow, and formed a completely horizontal platform going from station 0.00 to station 30.00.
- Stations 80.00 and 85.00-Adjusted N values to lessen mid-channel velocity troughs.

T-03

- Station 71.00-Adjusted N value to dampen an edge velocity spike.
- Abrupt topographic spike on left bank is a real rock.

T-04

- Left bank-increased N value to limit flow through low elevations on bank. Bank was not wetted during data collection.
- Station 66.00-Adjusted N value to lessen a velocity trough; averaged with an adjacent value.
- Station 79.20-Adjusted N value to lessen a velocity trough; based on an adjacent value.

T-05

- Stations 82.00 and 87.00-Adjusted N values to lessen velocity troughs; based on adjacent cells.

T-06

- Stations 34.00 and 35.40-Adjusted N values to dampen a negative velocity spike; based on adjacent cell.

T-07

- Modified N values at various stations to better match the observed velocity measured at the High calibration discharge.
- Large velocity trough due to a mid-channel boulder which is barely topped at high flow.

T-08

- No changes made.

T-09

- No changes made.

T-10

- No changes made.

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T-11

- No changes made.

T-12

- Station 39.00-Adjusted N value to lessen a velocity trough; averaged with an adjacent value.

T-13

- Stations 68.00, 70.00, 79.00-Adjusted N values to lessen velocity troughs; based on adjacent cells.

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