Little Spokane River Stream Gage Report: Deadman Creek, Dragoon Creek, and the West Branch of the Little Spokane River

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Spokane County Conservation District
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509/535-7274

1.0 Background
This project was to operate maintain three stream gages in the Little Spokane River watershed (Figure 1.) producing daily average flow values for Water Year 2010. The stream gages are listed in Table 1.

Table 1: Little Spokane River Stream Gages

Site	Years Operational	Flow Range (cfs)
WBLSR at Eloika Lake	3	2.09 – 185
Dragoon Creek at Mouth	10	11.7 - 834
Deadman Creek at Mouth	10	4.20 - 450

Notes:
1. cfs is cubic feet per second.
2. WBLSR is the West Branch of the Little Spokane River.
3. Years of operation and the flow range are as of Water Year 2007.

To maintain the stream gages and rating curves, the following activities were scheduled:

- Conduct routine stream measurements at each stream gage, approximately every six weeks
- Conduct stream measurements during flood events and low flow events
- Maintain data recording instruments
- Maintain survey bench marks and conduct water surface elevation surveys to verify stage elevation and data recording instrument calibration

The routine stream measurements were collected to better define the stage discharge relationship and any shifts from the base curve. Gage flow volumes were estimated from continuous stage-height records and stage-discharge curves. Pressure transducers measured stage height hourly. Stage data were downloaded every six to eight weeks. Staff gages were installed at each site.

The collection of accurate stream flow data is dependent on effective site selection, correct design and construction, and regular maintenance of the gage equipment. Site selection depends on several criteria, including the propose of the gage, hydraulic conditions, and access. The ideal gaging station sites include unchanging natural controls that promote a stable stage-discharge relation, a satisfactory reach for measuring discharge throughout the expected range of stage, and a means for efficient access to the gage and measuring locations (Rantz and others, 1982).

Measurement of Stage

Gaging stations in the Little Spokane River were operated for the purpose of determining daily discharge, instantaneous discharge, and annual extremes in stage and discharge. The goal of the stage data collecting equipment is to collect data with an accuracy of 0.01 feet. The currently installed equipment consists of pressure transducers directly connected to data logging equipment.

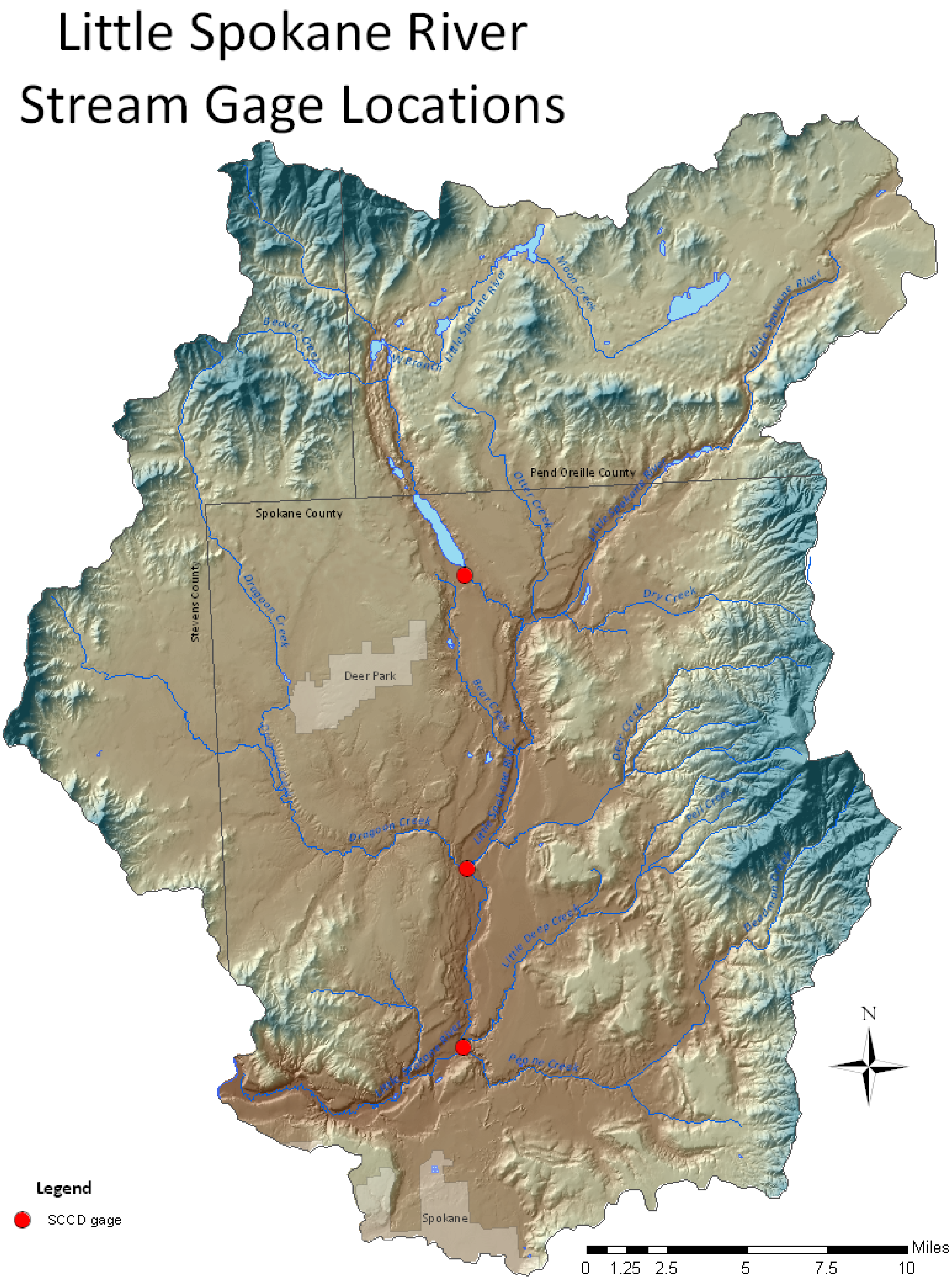

Figure 1. Locations of SCCD stream gages in the Little Spokane River Watershed.

Accurate stage measurement requires not only accurate instrumentation, but also proper installation and monitoring to ensure that the accuracy does not deteriorate with time. Reference gages (also known as staff gages) are installed at each location to ensure that gage-shelter instruments accurately record the water levels. The reference gage provides periodic independent water-surface elevations to monitor the accuracy of the primary gage, and allow for drift corrections.

Discharge Measurement using Current Meters

Discharge measurements are done using the current-meter method. In a current-meter measurement, the sum of the products of the subsection areas of the stream cross-section and their respective average velocities determines the discharge (Rantz and others, 1982).

The type of meter selected for the current-meter measurement is dependent on if a conventional meter (mechanical) or acoustic doppler meter is used. Conventional meters are selected based on criteria presented in Rantz and others, 1982. Generally speaking, a Price AA meter should be used at depths greater than 1.5 feet, and a Price pygmy meter for depths less than 1.5 feet. For mixed cross-sections, the meter most suited for most of the channel flow should be used. Handheld-ADVs® (Acoustic Doppler Velocimeter) were also used. ADV meters measure 2D or 3D currents and feature an automatic discharge computation using a variety of international methods, including ISO and USGS standards.

The spacing of observation verticals in the cross-section should be to ensure that no more than five percent of the total flow is measured in any one vertical. This usually requires approximately 30 verticals for each discharge measurement. Although no more than five percent in a vertical is the goal, the discharge computed for each vertical should not exceed 10 percent. These requirements may be waived under extreme conditions, such as rapidly changing stage. Because the measurement of discharge is a sampling process, the accuracy of sampling decreases markedly when the number of samples is less than 25. Procedures presented in Rantz and others (1982) will be used for computing mean gage height during a discharge measurement.

Spin tests were done on all meters prior to the start of the fieldwork. Spin tests and visual inspections are done to identify needed repairs. The meter was inspected before and after each measurement to ensure that the meter was in good condition, that the cups were not damaged and spin freely, and that the cups did not come to an abrupt stop. Periodic maintenance includes cleaning, oiling, and sharpening the vertical axis pivot pins. Handheld-ADV® meters were maintained following manufacture's specifications.

Data Quality Objectives

The data quality objective for the conventional current-meter measurement of discharge is that the discharge measurement plots within five percent of the established stage-discharge curve or plotted shift curves. If the measurement did not plot within five percent of the stage-discharge curve or an established shift curve, a second measurement was made to verify that a new shift occurred. For ADV instruments, data quality objectives were met if the manufacturer's tests, checks, and specifications were met.

The data quality objective for stage measurements is ± 0.02 feet. If the data-recording instrument estimated water surface elevation differs from the outside staff gage estimated water surface elevation by more than 0.05 feet, the true water surface elevation was surveyed and the proper correction applied to the data-recording instrument or staff gage, as needed.

All survey level loops included double shots on all benchmarks, reference marks, and water surface elevations. The level setup was broken and the instrument moved between the two shots. Surveyed elevations were within 0.02 feet. All level loops were closed on the starting benchmark within 0.02 feet.

Quality Control

Following the procedures in Rantz and others provides the quality control. Several factors affect the accuracy of a discharge measurement, and have been discussed on the sections above. The following is a brief list of the factors that can affect the quality of discharge measurements.

1) Equipment – the measurement equipment should be HIF (US Geological Survey Hydraulic Instrumentation Facility) approved and maintained in good condition.
2) Characteristics of the measurement section – the measurement section should be selected or modified to provide the best hydraulic conditions.
3) Spacing of observation verticals – twenty-five to 30 verticals should normally be used, and the verticals should be spaced so that each subsection will have approximately equal discharge.
4) Rapidly changing stage – when the stage changes rapidly during a discharge measurement, the computed discharge figure loses some of its significance, and there is uncertainty as to the appropriate gage height to apply to the discharge figure.
5) Measurement of depth and velocity – inaccuracies in the sounding and placement of the current meter are most likely to occur in those sections having great depths and velocities.
6) Ice in the measuring section – ice, especially slush ice interferes with the operation of the current-meter rotor and also causes difficulty in determining the effective depth of water.
7) Wind – wind may affect the accuracy of a discharge measurement by obscuring the angle of the current, by creating waves that make it difficult to sense the water surface, and by affecting the velocity at 0.2-depth in shallow streams.

Data Management Procedures

Stream stage data is downloaded from the data loggers into an Excel spreadsheet. The recorded hourly stage values are averaged for the day to estimate the daily average stage. Raw stage data were corrected for any instrument drift identified during routine discharge measurements. Routine discharge measurements were checked against the stage-discharge rating base curve. If a measurement did not plot along the base curve, associated logger data were corrected using the appropriate shift curve. After the data were corrected for instrument drift and stage-discharge shifts, the base curve was used to estimate the daily average flow (Appendix).

References

Rantz, S.E., and others, 1982. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. U.S. Geological Survey Water Supply Paper 2175. U.S. Government Printing Office, Washington, D.C.

SonTek FlowTracker manuals (v3.7; PDF) supplied with the instruments.

Appendix

West Branch Little Spokane River, Eloika Lk. Rd., Eloika Lk, WA												
Discharge, Cubic Feet Per Second Daily Mean Values July 01, 2009 - April 23, 2010												
Day	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
1	22.6	18.9	5.94	9.50	30.5	29.7	36.8	44.4	60.7	76.4	N/R	N/R
2	21.3	17.5	6.06	9.92	30.0	28.7	37.3	45.0	60.7	77.2	N/R	N/R
3	20.4	18.7	5.82	14.1	30.0	28.1	36.8	44.4	59.5	78.8	N/R	N/R
4	19.4	18.2	6.42	21.3	30.0	27.8	36.8	43.3	58.4	79.5	N/R	N/R
5	18.4	19.4	8.80	20.0	29.7	27.1	38.2	43.3	58.4	80.3	N/R	N/R
6	18.4	20.4	13.4	19.7	29.7	27.4	38.2	42.8	59.0	79.5	N/R	N/R
7	17.9	19.4	13.2	20.0	29.4	26.5	37.7	42.8	58.4	80.3	N/R	N/R
8	17.2	16.2	13.0	19.2	29.4	26.5	36.8	42.2	58.4	85.8	N/R	N/R
9	17.0	11.3	12.6	18.9	29.7	26.8	35.9	41.7	58.4	82.7	N/R	N/R
10	17.0	12.3	12.3	19.4	29.7	26.8	35.5	41.7	57.3	92.1	N/R	N/R
11	16.5	12.3	11.9	20.0	30.5	26.8	34.5	42.2	56.7	85.8	N/R	N/R
12	16.0	13.0	12.1	20.4	30.0	26.5	35.0	43.3	59.0	85.1	N/R	N/R
13	16.5	15.0	12.8	20.7	30.0	26.5	35.9	46.1	60.7	84.3	N/R	N/R
14	17.0	15.5	12.3	22.0	30.0	26.1	37.3	48.9	61.2	83.5	N/R	N/R
15	17.0	12.8	11.9	22.3	30.0	27.1	38.2	51.1	62.9	81.9	N/R	N/R
16	16.7	17.0	11.7	22.6	29.7	28.1	40.0	55.1	63.5	81.9	N/R	N/R
17	16.0	16.7	11.7	23.6	29.4	28.7	41.7	57.3	64.0	81.1	N/R	N/R
18	15.5	17.5	11.5	24.5	29.0	28.7	43.3	60.1	63.5	80.3	N/R	N/R
19	15.5	16.0	11.2	25.2	29.4	29.4	45.6	61.2	62.9	79.5	N/R	N/R
20	14.3	13.4	10.9	25.2	29.4	30.9	47.2	62.4	62.4	78.8	N/R	N/R
21	14.3	16.7	9.08	24.5	28.7	32.7	48.3	62.4	65.4	78.0	N/R	N/R
22	15.0	12.1	7.62	25.2	29.0	35.0	49.4	61.8	64.6	71.7	N/R	N/R
23	13.9	10.3	7.14	26.1	28.7	37.3	48.9	61.8	62.9	* 70.1	N/R	N/R
24	14.1	8.94	5.94	26.8	29.0	39.5	48.3	61.8	63.5	N/R	N/R	N/R
25	15.0	11.2	6.06	26.8	28.7	40.0	48.3	62.4	62.4	N/R	N/R	N/R
26	15.0	13.9	7.26	28.1	28.4	40.0	48.3	61.8	61.2	N/R	N/R	N/R
27	16.5	16.7	7.98	29.4	29.7	40.0	48.3	61.8	60.7	N/R	N/R	N/R
28	18.2	18.7	8.66	29.7	30.0	39.1	47.2	60.7	60.1	N/R	N/R	N/R
29	16.0	20.0	8.80	30.0	30.5	38.6	46.7		64.0	N/R	N/R	N/R
30	15.8	14.3	9.22	30.5	30.0	37.3	46.1		69.3	N/R	N/R	N/R
31	18.2	5.60		30.5		36.8	45.0		75.6		N/R	
Total:	**523**	**470**	**293**	**706**	**888**	**970**	**1294**	**1454**	**1916**	*** 1855**	**N/R**	**N/R**
Mean:	**16.9**	**15.2**	**9.77**	**22.8**	**29.6**	**31.3**	**41.7**	**51.9**	**61.8**	*** 80.6**	**N/R**	**N/R**
Max:	**22.6**	**20.4**	**13.4**	**30.5**	**30.5**	**40.0**	**49.4**	**62.4**	**75.6**	*** 92.1**	**N/R**	**N/R**
Min.:	**13.9**	**5.60**	**5.82**	**9.50**	**28.4**	**26.1**	**34.5**	**41.7**	**56.7**	*** 70.1**	**N/R**	**N/R**

Comments: N/R - Not Recorded, * - Incomplete Record, Peak discharge for current water year (cfs): NR

Dragoon Creek, Crescent Rd. near Chattaroy, WA.

Discharge, Cubic Feet Per Second
Daily Mean Values
July 14, 2009 - May 26, 2010

Day	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
1	N/R	9.55	12.2	17.1	26.2	13.5	193	39.4	47.0	58.8	59.7	N/R
2	N/R	8.91	12.2	20.0	23.8	10.8	115	42.0	44.3	55.1	53.3	N/R
3	N/R	8.91	11.5	25.4	23.0	23.8	70.1	43.8	42.9	59.7	49.6	N/R
4	N/R	8.29	10.8	23.0	23.0	46.1	63.5	47.9	43.8	56.9	43.8	N/R
5	N/R	8.29	11.5	20.0	23.0	53.3	65.4	54.2	42.9	54.2	40.3	N/R
6	N/R	8.91	12.8	20.0	24.6	57.9	56.9	64.4	41.2	56.0	37.7	N/R
7	N/R	10.8	13.5	20.8	24.6	69.2	73.1	58.8	39.4	59.7	36.9	N/R
8	N/R	11.5	15.6	20.8	23.0	81.9	107	51.4	39.4	65.4	35.2	N/R
9	N/R	11.5	15.6	20.8	22.3	129	123	47.0	38.6	76.0	35.2	N/R
10	N/R	10.8	15.6	21.5	23.0	170	74.0	44.3	36.9	66.3	36.0	N/R
11	N/R	10.2	14.9	21.5	21.5	189	33.5	46.1	37.7	60.6	34.3	N/R
12	N/R	10.8	14.2	21.5	19.3	211	39.4	67.3	46.1	56.9	33.5	N/R
13	N/R	12.8	14.2	22.3	18.5	225	150	80.9	65.4	57.9	31.8	N/R
14	* 20.0	12.8	13.5	27.8	18.5	220	282	71.1	71.1	56.9	31.0	N/R
15	17.8	12.8	13.5	32.7	17.8	227	157	79.9	57.9	53.3	30.2	N/R
16	15.6	13.5	14.2	27.8	17.1	260	158	77.0	52.3	48.7	29.4	N/R
17	13.5	13.5	15.6	26.2	19.3	266	146	74.0	49.6	46.1	28.6	N/R
18	12.8	12.8	16.3	27.8	19.3	267	170	65.4	46.1	44.3	28.6	N/R
19	11.5	12.2	16.3	27.8	19.3	265	116	57.9	43.8	42.9	29.4	N/R
20	10.8	12.2	15.6	26.2	20.0	324	82.9	54.2	42.0	41.2	29.4	N/R
21	10.2	12.8	15.6	25.4	19.3	367	65.4	49.6	42.0	38.6	27.8	N/R
22	10.2	12.8	15.6	25.4	19.3	252	54.2	46.1	44.3	37.7	26.2	N/R
23	10.2	11.5	15.6	27.8	19.3	113	47.0	42.9	44.3	37.7	25.4	N/R
24	10.2	11.5	16.3	36.0	18.5	89.0	42.9	42.9	42.0	35.2	24.6	N/R
25	10.2	10.8	16.3	30.2	17.8	114	42.0	47.9	40.3	33.5	23.0	N/R
26	10.2	10.8	15.6	33.5	17.1	165	44.3	48.7	39.4	32.7	22.3	N/R
27	10.8	10.2	14.9	51.4	27.0	207	42.9	50.5	37.7	37.7	N/R	N/R
28	10.2	10.2	15.6	36.9	30.2	214	39.4	50.5	36.9	56.0	N/R	N/R
29	10.2	10.2	15.6	29.4	20.0	215	37.7		55.1	67.3	N/R	N/R
30	10.2	11.5	16.3	28.6	16.3	199	37.7		94.1	68.2	N/R	N/R
31	9.55	12.2		29.4		196	37.7		75.0		N/R	
Total:	*** 214**	**346**	**438**	**824**	**632**	**5240**	**2766**	**1546**	**1480**	**1561**	*** 883**	**N/R**
Mean:	*** 11.9**	**11.2**	**14.6**	**26.6**	**21.1**	**169**	**89.2**	**55.2**	**47.7**	**52.0**	*** 34.0**	**N/R**
Max:	*** 20.0**	**13.5**	**16.3**	**51.4**	**30.2**	**367**	**282**	**80.9**	**94.1**	**76.0**	*** 59.7**	**N/R**
Min.:	*** 9.55**	**8.29**	**10.8**	**17.1**	**16.3**	**10.8**	**33.5**	**39.4**	**36.9**	**32.7**	*** 22.3**	**N/R**

Comments: N/R - Not Recorded, * - Incomplete Record, Peak discharge for current water year (cfs): NR

Deadman Creek Little Spokane River Dr. near Mead, WA												
Discharge, Cubic Feet Per Second Daily Mean Values July 01, 2009 - May 31, 2010												
Day	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
1	13.1	8.02	8.02	8.52	13.6	12.5	16.8	23.2	37.0	58.1	54.6	N/R
2	12.5	8.02	8.02	9.43	13.6	11.6	37.0	24.6	35.6	57.2	60.8	N/R
3	12.0	7.86	7.86	9.43	13.1	10.7	34.2	27.3	35.6	58.1	58.1	N/R
4	12.0	7.86	7.86	9.43	12.5	10.3	40.2	26.0	35.6	53.7	57.2	N/R
5	11.6	7.86	8.02	9.86	12.5	9.86	153	26.7	34.2	51.2	53.7	N/R
6	11.6	7.86	8.02	10.3	12.5	9.86	66.1	31.5	32.9	51.2	* 52.8	N/R
7	11.6	7.86	8.28	10.3	12.0	9.43	28.7	31.5	32.9	52.8	N/R	N/R
8	12.0	8.02	8.28	9.86	12.5	8.52	22.0	27.3	32.2	53.7	N/R	N/R
9	11.6	8.02	8.52	9.86	12.0	8.28	19.7	26.0	32.9	56.3	N/R	N/R
10	11.1	8.02	8.52	10.3	11.6	8.02	19.1	24.6	31.5	50.4	N/R	N/R
11	11.1	7.86	8.28	10.3	11.6	7.86	19.1	25.3	30.8	48.1	N/R	N/R
12	10.7	8.02	8.28	10.3	12.0	8.02	19.1	31.5	35.6	47.3	N/R	N/R
13	11.6	8.28	8.02	10.7	11.6	7.86	65.2	44.9	43.3	45.7	N/R	N/R
14	12.5	8.52	8.02	11.6	11.6	7.86	112	41.7	44.1	45.7	N/R	N/R
15	15.7	9.43	8.02	11.1	11.1	8.02	55.5	52.0	39.4	44.1	N/R	N/R
16	13.1	9.43	8.02	11.6	10.7	9.00	67.0	63.4	37.8	41.0	N/R	N/R
17	11.6	9.43	8.52	13.1	10.7	31.5	76.5	63.4	37.0	39.4	N/R	N/R
18	10.7	9.43	8.52	12.5	10.7	27.3	59.9	57.2	37.0	40.2	N/R	N/R
19	9.86	9.00	8.52	11.6	11.6	22.6	49.6	52.0	35.6	39.4	N/R	N/R
20	9.43	8.52	8.52	11.6	12.0	33.6	42.5	48.1	34.9	38.6	N/R	N/R
21	9.00	8.52	8.52	11.6	11.6	69.6	37.8	44.1	34.9	39.4	N/R	N/R
22	9.00	8.28	8.28	11.1	12.0	93.3	32.2	40.2	41.0	40.2	N/R	N/R
23	9.00	8.28	8.28	12.5	11.6	41.0	32.2	37.8	43.3	41.7	N/R	N/R
24	8.52	8.28	8.52	13.1	11.6	23.9	28.7	38.6	38.6	41.0	N/R	N/R
25	8.52	8.02	8.52	13.6	11.1	19.7	28.0	42.5	37.0	40.2	N/R	N/R
26	8.52	8.02	8.28	17.9	10.7	17.9	28.0	43.3	37.0	40.2	N/R	N/R
27	8.52	8.02	8.02	16.8	13.6	16.8	26.7	41.7	36.3	41.0	* 32.2	N/R
28	8.28	8.02	8.52	20.8	15.2	15.7	23.9	41.0	35.6	49.6	e 35.6	N/R
29	8.02	8.02	8.52	17.3	15.7	14.7	23.9		47.3	53.7	e 33.6	N/R
30	8.28	8.02	8.52	14.7	14.1	14.7	23.2		73.5	59.0	e 34.2	N/R
31	8.02	8.02		13.6		14.7	23.2		62.5		e 37.0	
Total:	**329**	**257**	**248**	**374**	**367**	**604**	**1311**	**1077**	**1203**	**1418**	*** 510**	**N/R**
Mean:	**10.6**	**8.28**	**8.27**	**12.1**	**12.2**	**19.5**	**42.3**	**38.5**	**38.8**	**47.3**	*** 46.3**	**N/R**
Max:	**15.7**	**9.43**	**8.52**	**20.8**	**15.7**	**93.3**	**153**	**63.4**	**73.5**	**59.0**	*** 60.8**	**N/R**
Min.:	**8.02**	**7.86**	**7.86**	**8.52**	**10.7**	**7.9**	**16.8**	**23.2**	**30.8**	**38.6**	*** 32.2**	**N/R**

Comments: N/R - Not Recorded, * - Incomplete Record, e – estimated, Peak discharge for current water year (cfs): NR