CANNON RIVER STAGE-DISCHARGE RATING CURVE STUDY

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Cannon River Stage-Discharge rating curve study

ABSTRACT:

A rating curve was developed for the Cannon River in Northfield, MN. Flow velocities were measured from the 2nd street bridge using a rotating-element type current meter. Measurements were taken at 0.6 of the depth of the river every few days over a period of two months. A cross section was developed for the transect, which with calculated discharge values created a viable rating curve. This rating curve represents the maximum discharges for each stage.

INTRODUCTION:

This study had a number of objectives. The main purpose was to develop a rating curve that compares discharge and stage for the Cannon River using a rotating-element type velocity meter. Further objectives were to compare these readings to those obtained by an electric velocity meter, as well as to examine different methods of establishing average velocities on the Cannon River.

STUDY AREA:

The second street bridge traverses the Cannon river on the northern end of Northfield (Figure 1). This bridge was chosen as the site of our study because the river displays the following characteristics:

-a low-relief bed,

-a fairly strait reach both up and down-stream of the bridge,

-a relatively uniform in depth across the transect,

-devoid of bushes or grasses dragging in the water along the edges

-no weeds or large boulders within the channel,

-there are no apparent eddies or backcurrents.

These are favorable factors because they keep flow fairly constant across the transect. This minimizes the number of variables associated with taking velocity measurements.

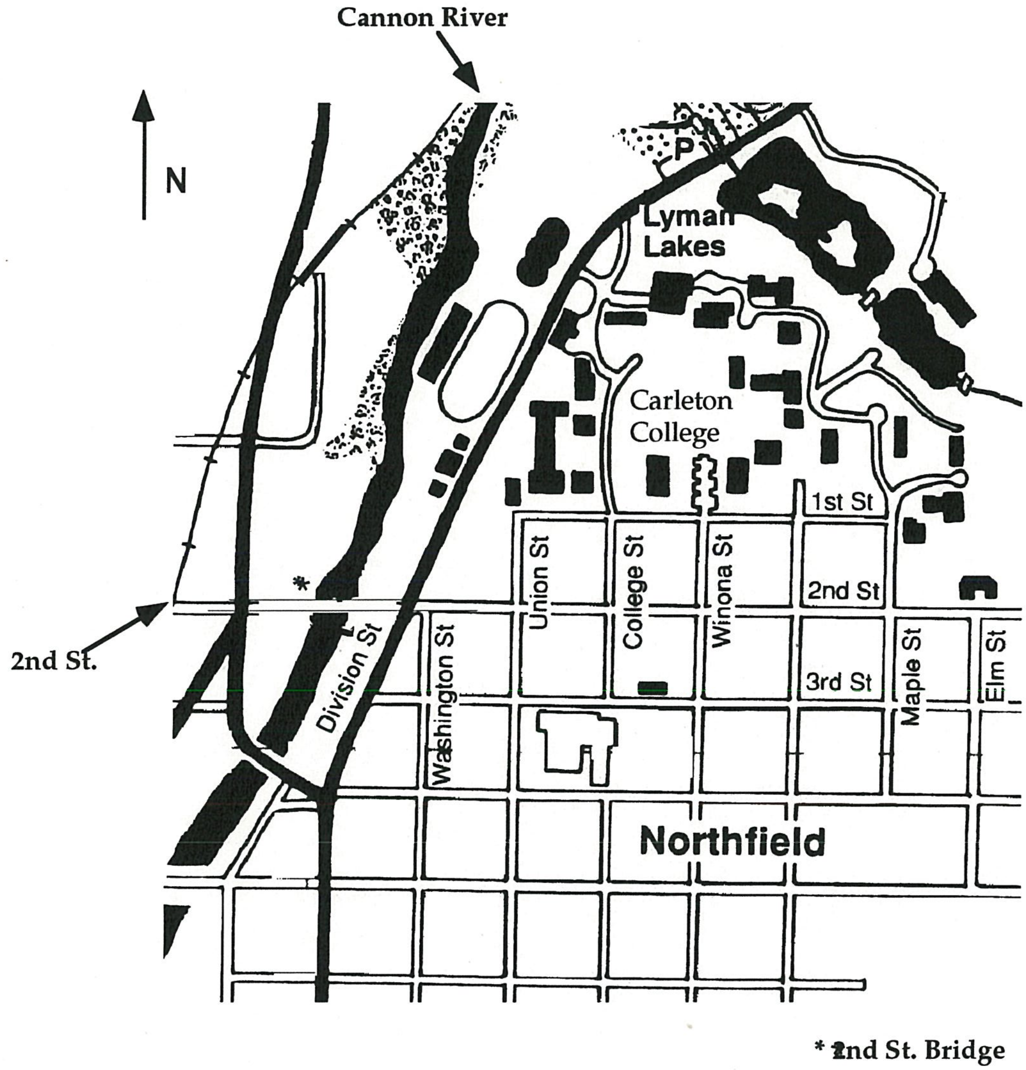


Figure 1: Map of the study area. Note the * at the 2nd St. Bridge where the data was collected.

Of course, the bridge is a very practical place to conduct velocity measurements, and an official river stage scale is mounted on the eastern bridge support. This is the scale we used to determine river stage every time we took velocity readings.

The bridge transacts the Cannon river at at 19.3° angle from the orthogonal, with respect to flow direction (Figure 2). This complicated our discharge calculations because a perpendicular cross section is necessary. Our solution to this quandary is described in the proceeding methods section.

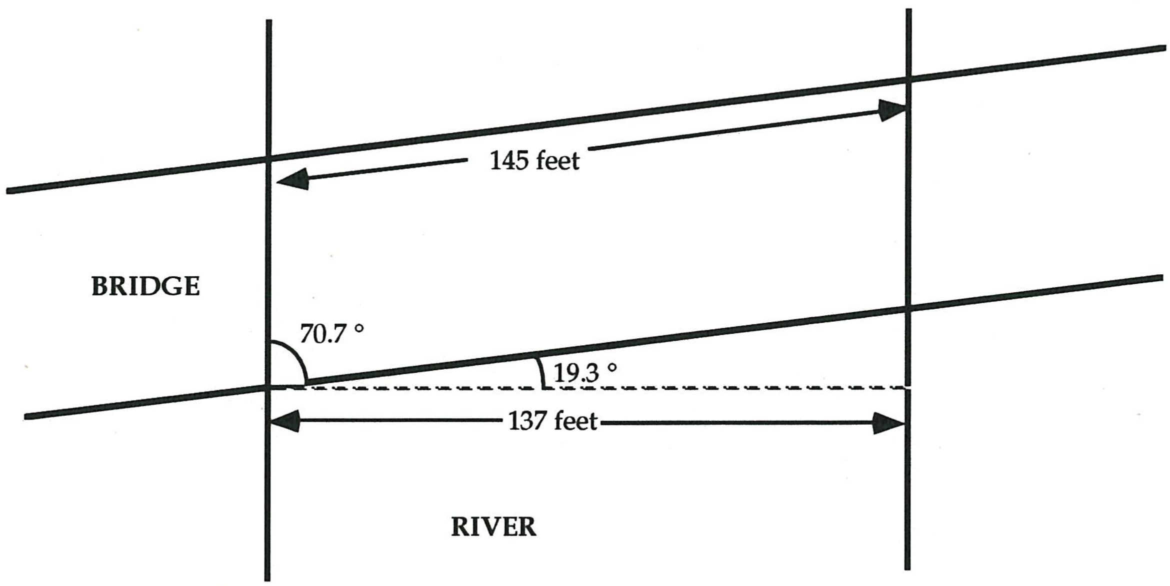


Figure 2: Schematic diagram of the relationship between 2nd street bridge and the Cannon River.

METHODS:

Since the object of the study was to develop a rating curve, we decided to take velocity readings that corresponded to approximately every half a foot in stage. The stage of the Cannon River was noted daily by Geology Dept. coordinator Tim Vick, and we ultimately conducted flow meter stations about twice a week.

The transect under the 2nd street bridge was divided into five sections, each approximately 30 feet wide, and a measurement was taken from the middle of each section. A rotating-element type current meter, consisting of a propeller about 3 inches in diameter attached to a vein that orients the meter perpendicular to flow, measured the flow velocity at these midpoints. The meter was weighted with a 20 lb streamlined weight and lowered from the bridge on a cable. A speaker wired to a cam inside the meter released an annoying click every 20 rotations of the propellor. Timing the number of clicks per minute with a digital stop-watch enabled us to calculate the velocity of the water, using an equation that accompanies the current meter:

$$v=0.227n - 0.01$$

where **v** is the velocity in meters/second and **n** is revolutions/second. Each velocity measurement was assumed to represent the flow rate of each respective section of the river.

We decided to implement the six-tenths depth method for most of our readings. This method assumes that a reading taken at 0.6 of the depth below the water surface represents an average velocity for that vertical water column (Figure 3).

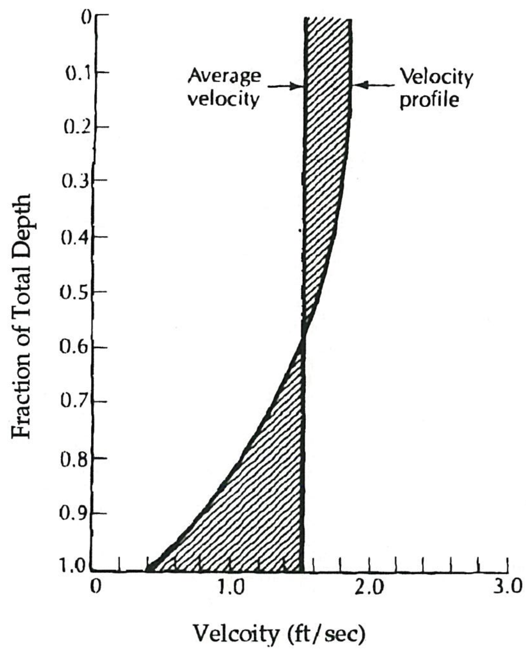


Figure 3: Typical parabolic velocity profile for a natural stream
(Source: Fetter, 1990)

Two other methods, the two- and three-point, were compared to six-tenths method to see if there was any variation. The two point method averages readings taken at 0.2 and 0.8 of the total depth for the average velocity. The three point method uses measurements taken at 0.2, 0.6 and 0.8 of the total depth. The average of 0.2 and 0.8 readings is averaged with the 0.6 reading to produce the average velocity.

Furthermore, for two days we took readings with both a rotating and electronic flow meter. The electronic meter simply utilized three electric nodes that can send bursts of electricity to one another and calculate the speed at which the flow is passing by them. The electric meter was clamped onto the cable about 10 cm above the rotating-element meter. A 6/10 reading was taken from the rotating-element meter, the cable was lowered 10 cm, and another reading from about the same point was taken from the electronic meter.

In order to attain a discharge value, we first had to make a cross section of the river bed. We originally intended to do this by wading in the water and taking a series of depth measurements. Instead, since the water was too deep, we lowered a steel cable with the streamlined weight on it from the bridge and measured the distance along the cable from where the weight touched the water surface to where it hit the bottom. Working east to west, depth measurements were taken at the midpoint of each section and two meters thereafter. This collection of measurements was then used to make an oblique cross-section of the river below the bridge.

This cross section was separated into five distinct sections corresponding to those established for measurement purposes. The discharge for each section was calculated by multiplying the section area and velocity. These discharges were then summed to obtain a total discharge.

Because we took velocity measurements along the bridge, we had to use the cross section along the bridge. Real discharges have to be based on a cross section perpendicular to flow. However, since the bridge was not perpendicular to flow, the total discharge was to high because the area of the cross section was too large. Therefore, it was necessary to adjust the discharge.

There are many different ways to account for the oblique cross section. We reduced the oblique cross section to the scale it would have been if it was perpendicular to flow. We calculated the perpendicular length trigonometrically using the length of the bridge and the angle of intersection. The difference between the two lengths is the amount by which to reduce the horizontal scale. Then we adjusted the original area by subtracting out areas from each section based on the average depth and the horizontal scale reduction for each section. The ratio between the new area and the oblique area was used to adjust the discharge data for all stages.

Finally, an adjusted rating curve was constructed using the stage and adjusted discharge data.

RESULTS:

Table 1 compares the different methods of taking average velocity. Since each method produced similar velocities, no method was superior over another. Therefore, we implemented the sixth tenths method based on it's good press (Fetter, 1988; National Handbook of Recommended Methods for Water-Data Acquisition, 1977).

The original cross section is graphically displayed in the appendix. The riverbed had relatively low relief, except for one raised area, possibly a longitudinal bar, that rises about one foot off the bed in section four.

Section	**Six-tenth**	Two point	Three point
1	**4.81 f/s**	4.78 f/s	4.80 f/s
2	**4.76**	4.73	4.75
3	**4.66**	4.92	4.79
4	**4.36**	4.42	4.39
5	**4.19**	4.20	4.20

Table 1: Average velocities using the six-tenth, two point, and three point methods.

The adjusted rating curve is located in the appendix. It is compared to a rating curve based on the original data on the next page in the appendix. On the same page is a third curve incorporating data that we received from a U.S.G.S. stream gauging station located on the Cannon River in Welch Village, about 30 miles northeast of Northfield. Since Welch is downstream and there are a number of small tributaries, their discharge and stage values are much higher than ours.

We also found a difference in the velocities measured by the rotating and the electronic current meters (Table 2). The velocities read from the electric meter were systematically lower than those of the rotating meter.

Date	Section	Electric meter velocity	Rotating-element velocity
May 25	1	3.51 f/s	3.59 f/s
	2	3.51	4.26
	3	3.67	4.39
	4	3.58	4.06
	5	2.48	3.14
May 29	1	3.54	3.69
	2	3.64	3.94
	3	3.61	4.01
	4	3.90	3.94
	5	2.49	2.77

Table 2: Comparison of the different measurement devices.

DISCUSSION:

Some complications arose during the course of this study. One problem is that we based our 0.6 depth measurement on the "official" gauge. When we waded in the river one partly cloudy Saturday morning to take measurements in order to complete a cross-section, we found that the gauge did not accurately represent the depth of the river. The gauge read 1.7 feet; however, within five feet of the bank, Aron was swimming. The cross section shows the actual depth at a gauge reading of 1.7 feet. The gauge clearly provides a minimum depth and does not represent a true average depth.

Therefore, our 0.6 measurements are not true 0.6 velocities and are probably a little high since they were taken closer to the surface (Figure 3). Also, because there was drag on the meter in the water, a wire angle of not more than 15° occurred. The meter was then even closer to the surface, though this was not taken into account. The combination of stage and wire angle errors will shift the adjusted rating curve to the left by some amount because velocities were higher than the average.

Although these problems existed, the cross section that we created is fairly accurate. We believe that our methods were sound and produced decent results. Therefore, the magnitude of total discharge errors are not increased.

The adjusted discharge rating curve can be used in the future to determine discharges. Though the gauge on the bridge provides lower-than-actual stage readings, the adjusted rating curve is based on depths read from this gauge. Therefore, one needs only to read a depth off of the gauge, and a discharge value can be found via the adjusted rating curve.

Another interesting point is the Welch stage and discharge data. Notice the flattened slope of the Welch rating curve. We interpreted this to mean that the cross section where the USGS has set up there monitoring station is much broader, and the banks of the river may be less inclined. In this case, it would take higher discharges at Welch than at the 2nd Street bridge in Northfield to raise the stage by the same amount. This is exactly what we see in the two rating curves.

We found that the rotating and electronic flow meters gave different readings. The fact that the error was systematic shows that each meter is reliable, although at some point each meter should be tested to determine which one is correct. If the electronic meter proved to be more accurate, our discharge are too high and our rating curve would have to be shifted even more to the left.

CONCLUSION:

Overall, this study was a success. We were able to measure velocities through a stage range of over four feet and develop a useful rating curve. We had the opportunity to compare different methods of measuring flow, different meters, and even different data (USGS). The real challenge was to carry on a continuous conversation on the 2nd street bridge while counting clicks from the rotating-element meter.

The adjusted rating curve essentially determines maximum discharges for the Cannon River. This is true for at least two reasons. First, our velocity readings are high because they were taken shallower than 0.6 of the true depth. Second, if the electronic meter is more accurate, it is also probable that our velocity measurements are too high. The adjusted curve is therefore as far to the right as it could be, and real discharges might be represented by a slight shift to the left.

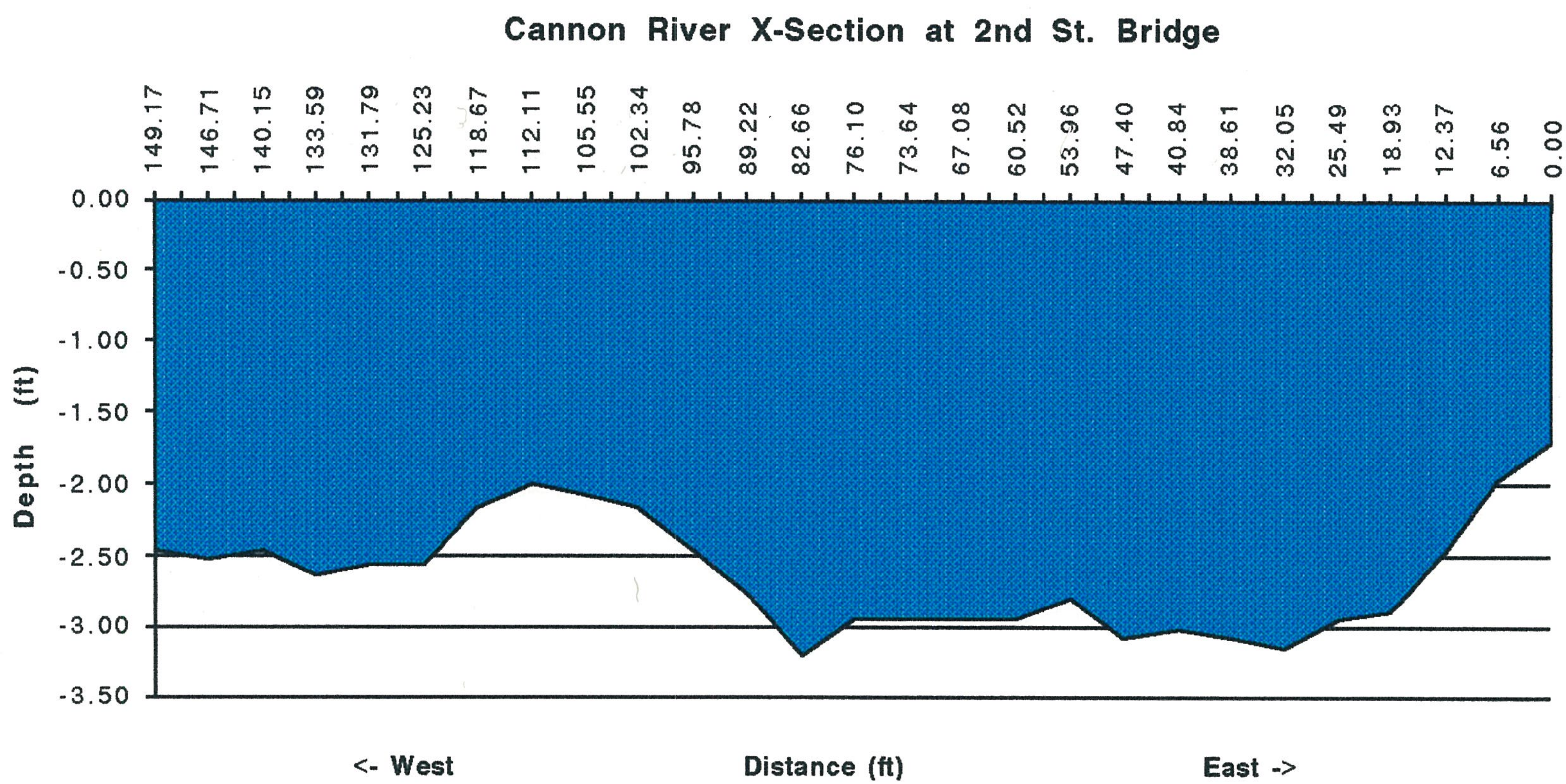
Also, the adjusted rating curve is probably reliable for a short period. The cross section could change from year to year, depending on the sedimentation and flow dynamics of the Cannon River. For instance, large floods can alter the cross section dramatically due to very high velocities and sediment loads. Perhaps annual cross sections and rating curves should be made in order to maintain the validity of discharge measurements.

References

Fetter, C.W. (1988) *Applied Hydrogeology.* Merrill Publishing Company: Columbus, Ohio.

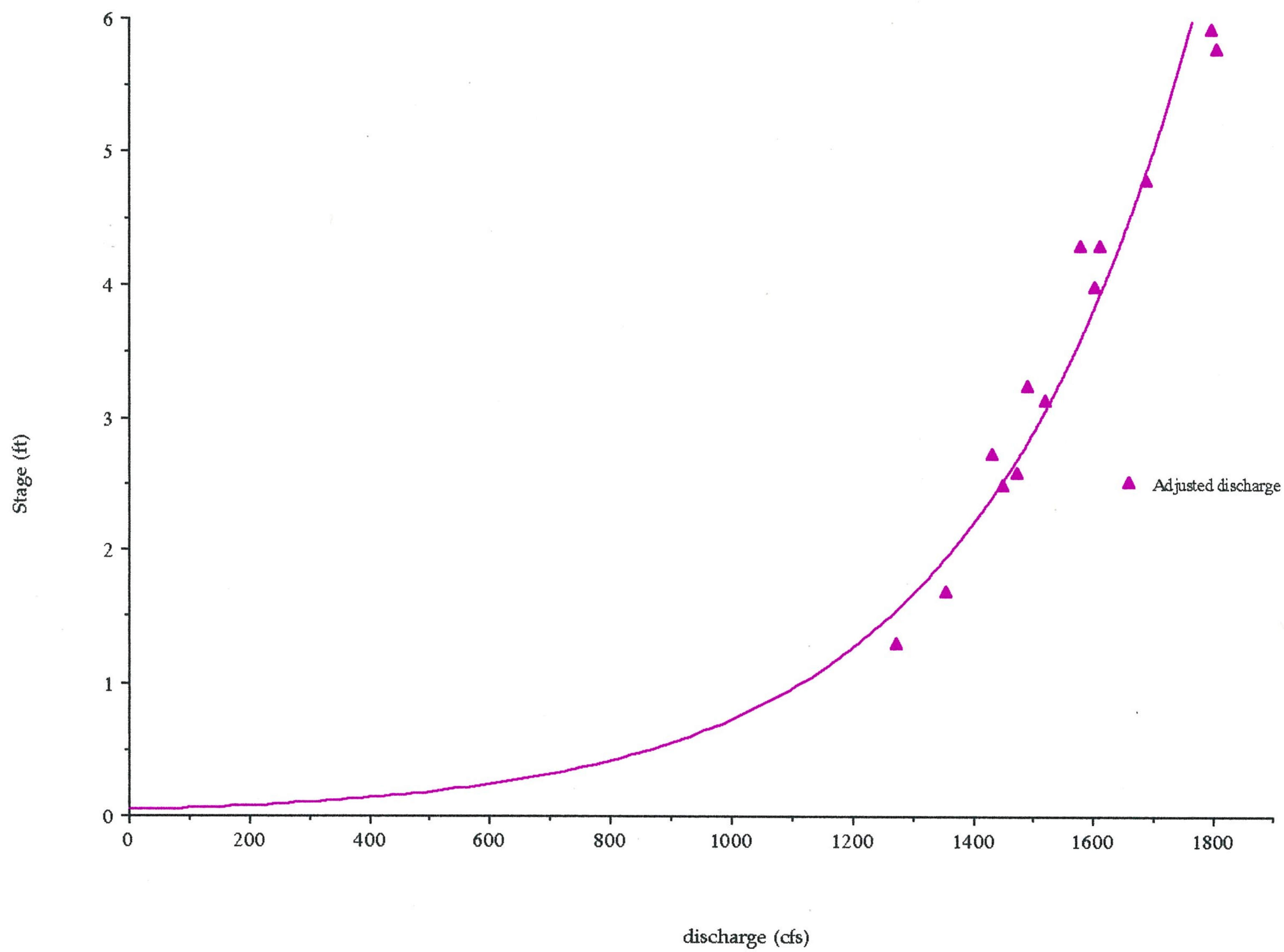
National Handbook of Recommended Methods for Water-Date Acquisition. (1977) USGS (US Dept. of the Interior, Office of Water Data Coordination: Reston, Virginia).

Welch Village stage and discharge data from the Cannon River. (April - May, 1993) US Dept. of the Interior - Geological Survey - Water Resources Division.

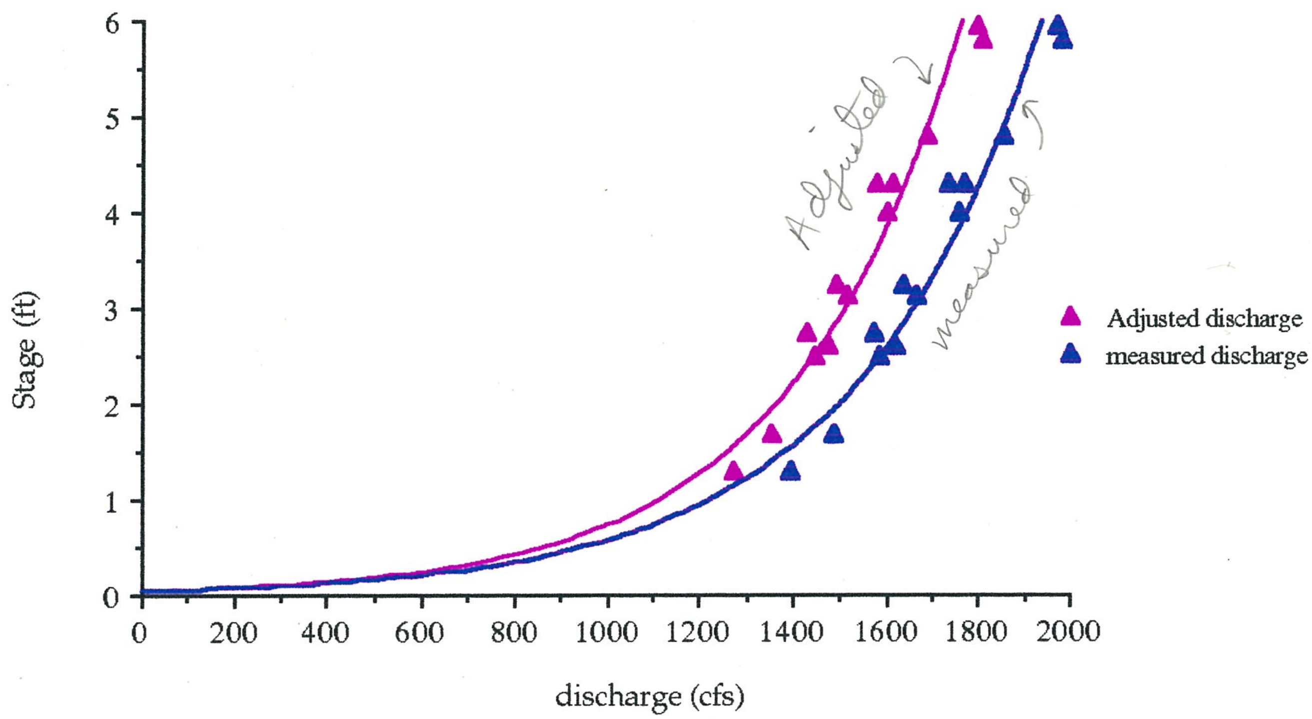


Cannon River X-Section at 2nd St. Bridge
149.17
146.71
140.15
133.59
131.79
125.23
118.67
112.11
105.55
102.34
95.78
89.22
82.66
76.10
73.64
67.08
60.52
53.96
47.40
40.84
38.61
32.05
25.49
18.93
12.37
6.56
0.00
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
Depth (ft)
<- West
Distance (ft)
East ->

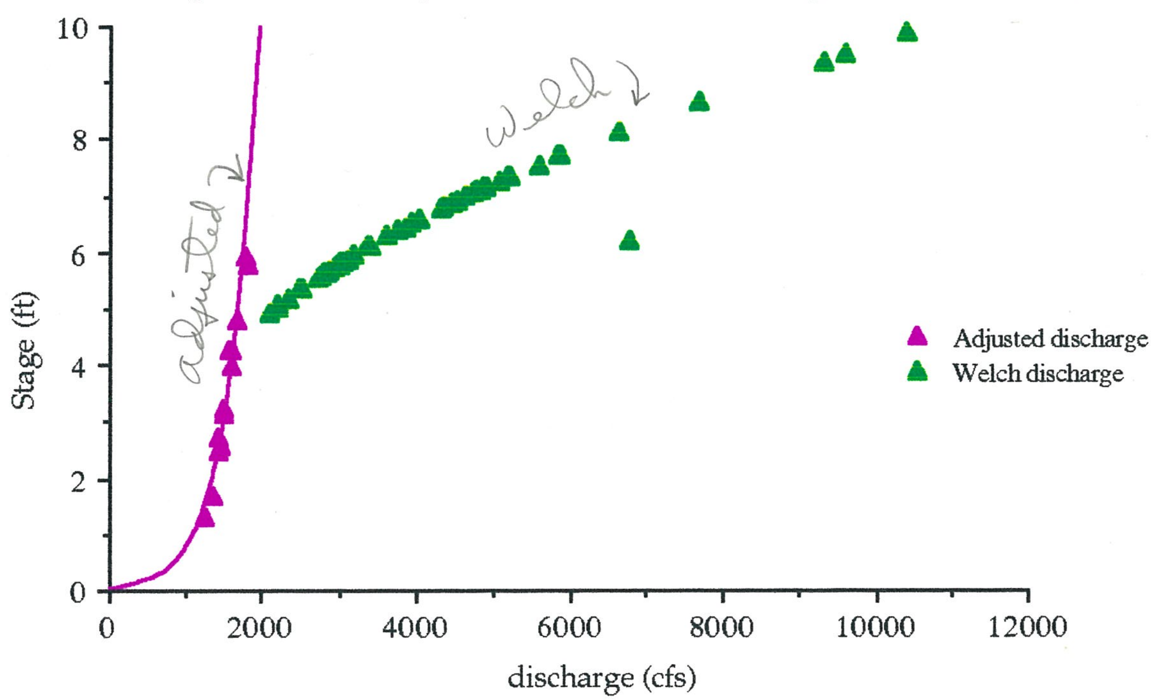
Adjusted Rating Curve



Comparison of Measured and Adjusted Rating Curves



Comparison of Adjusted and Welch Village (USGS) Rating Curves



Cannon River Stage vs. Discharge: Cathy O'Reilly and Aron Clymer

Date/Time	Stage (ft)	6/10 depth (cm) (below surface)	Sections: Distance from East Side of channel (m)	beeps/minute	rotations/sec.	velocity (m/s)	velocity (ft/s)	Section Area (sq. ft)	Discharge(cfs) per section	Total discharge (cfs)	Adjusted Discharge(cfs)
4/4/93	5.8	106	#1(4.4m)	23	7.67	1.73	5.68	65.85	373.83	**1984**	**1807**
(Aron's b-day)			#2(13.2m)	22	7.33	1.65	5.43	88.41	479.95		
			#3(22m)	21	7.00	1.58	5.18	87.7	454.33		
			#4(30.8m)	20	6.67	1.50	4.93	61.71	304.37		
			#5(39.2m)	20	6.67	1.50	4.93	75.37	371.74		
4/6/93	4.8	88	1	21	7.00	1.58	5.18	65.85	341.13	**1854**	**1688**
7:00 PM			2	19.8	6.60	1.49	4.88	88.41	431.67		
			3	21	7.00	1.58	5.18	87.7	454.33		
			4	19.2	6.40	1.44	4.73	61.71	292.11		
			5	18	6.00	1.35	4.44	75.37	334.32		
4/8/93	4.3	79	1	20	6.67	1.50	4.93	65.85	324.79	**1769**	**1611**
9:00 AM			2	19.5	6.50	1.47	4.81	88.41	425.08		
			3	20	6.67	1.50	4.93	87.7	432.55		
			4	17.8	5.93	1.34	4.39	61.71	270.66		
			5	17	5.67	1.28	4.19	75.37	315.61		
		% depth below s.									
4/10/93	4.3	80% = 104cm	1	17.3	5.77	1.30	4.26		0.00	**1733**	**1578**
10:30 AM		60% = 78cm		19.5	6.50	1.47	4.81	65.85	316.61		
(multiple depth		40% = 52cm		20	6.67	1.50	4.93		0.00		
stations)		20% = 26 cm		21.5	7.17	1.62	5.30		0.00		
		0% = 0 cm		20.8	6.93	1.56	5.13		0.00		
		0.8	2	18.4	6.13	1.38	4.53		0.00		
		0.6		19.3	6.43	1.45	4.76	88.41	420.69		
		0.4		20	6.67	1.50	4.93		0.00		
		0.2		20	6.67	1.50	4.93		0.00		
		0		19.6	6.53	1.47	4.83		0.00		
		0.8	3	18.9	6.30	1.42	4.66		0.00		
		0.6		19	6.33	1.43	4.68	87.7	410.78		
		0.4		21.2	7.07	1.59	5.23		0.00		
		0.2		21	7.00	1.58	5.18		0.00		
		0		21.1	7.03	1.59	5.21		0.00		
		0.8	4	16.9	5.63	1.27	4.16		0.00		

		0.6		17.7	5.90	1.33	4.36	61.71	269.13		
		0.4		18.3	6.10	1.37	4.51		0.00		
		0.2		19	6.33	1.43	4.68		0.00		
		0		19.1	6.37	1.44	4.71		0.00		
		0.8	5	16.3	5.43	1.22	4.01				
		0.6		17	5.67	1.28	4.19	75.37	315.61		
		0.4		17.3	5.77	1.30	4.26				
		0.2		17.8	5.93	1.34	4.39				
		0		17.5	5.83	1.31	4.31				
4/17/93	4	73	1	19.3	6.43	1.45	4.76	65.85	313.34	**1758**	**1601**
10:00 AM			2	19.2	6.40	1.44	4.73	88.41	418.50		
			3	19.7	6.57	1.48	4.86	87.7	426.02		
			4	19.2	6.40	1.44	4.73	61.71	292.11		
			5	16.6	5.53	1.25	4.09	75.37	308.12		
4/19/93	3.25	59	1	17.4	5.80	1.31	4.29	65.85	282.28	**1637**	**1491**
10:45 AM			2	17.8	5.93	1.34	4.39	88.41	387.77		
			3	18.6	6.20	1.40	4.58	87.7	402.07		
			4	18.1	6.03	1.36	4.46	61.71	275.26		
			5	15.6	5.20	1.17	3.84	75.37	289.41		
4/21/93	5.95	109	1	23.1	7.70	1.74	5.70	65.85	375.46	**1974**	**1798**
			2	21.5	7.17	1.62	5.30	88.41	468.98		
			3	21.6	7.20	1.62	5.33	87.7	467.39		
			4	20.3	6.77	1.53	5.01	61.71	308.96		
			5	19	6.33	1.43	4.68	75.37	353.03		
4/26/93	3.15	58	1	18	6.00	1.35	4.44	65.85	292.09	**1667**	**1518**
3:30			2	18.5	6.17	1.39	4.56	88.41	403.13		
			3	18.8	6.27	1.41	4.63	87.7	406.43		
			4	18.5	6.17	1.39	4.56	61.71	281.39		
			5	15.3	5.10	1.15	3.77	75.37	283.80		
4/30/93	2.75	50	1	15.6	5.20	1.17	3.84	65.85	252.86	**1572**	**1432**
3:30			2	17.2	5.73	1.29	4.24	88.41	374.60		
			3	18.7	6.23	1.40	4.61	87.7	404.25		
			4	17.1	5.70	1.28	4.21	61.71	259.94		
			5	15.1	5.03	1.13	3.72	75.37	280.06		
5/6/99	2.6	48	1	16.1	5.37	1.21	3.96	65.85	261.03	**1617**	**1473**
9:30 AM			2	18.5	6.17	1.39	4.56	88.41	403.13		
			3	19	6.33	1.43	4.68	87.7	410.78		

			4	18.2	6.07	1.37	4.49	61.71	276.79		
			5	14.3	4.77	1.07	3.52	75.37	265.09		
		2/10 = 16 cm	*1	17.1	5.70	1.28	4.21				
			2	19.2	6.40	1.44	4.73				
			3	18.4	6.13	1.38	4.53				
			4	18.5	6.17	1.39	4.56				
			5	15.2	5.07	1.14	3.74				
5/17/93	2.5	46	1	16.1	5.37	1.21	3.96	65.85	261.03	**1590**	**1448**
7:30 PM			2	17.9	5.97	1.34	4.41	88.41	389.97		
			3	18.9	6.30	1.42	4.66	87.7	408.60		
			4	17.8	5.93	1.34	4.39	61.71	270.66		
			5	14	4.67	1.05	3.44	75.37	259.48		
5/25/93	1.7	31	1	14.6	4.87	1.09	3.59	65.85	236.51	**1486**	**1353**
3:30 PM			2	17.3	5.77	1.30	4.26	88.41	376.80		
			3	17.8	5.93	1.34	4.39	87.7	384.66		
			4	16.5	5.50	1.24	4.06	61.71	250.75		
			5	12.8	4.27	0.96	3.14	75.37	237.02		
		electronic data	1			1.07	3.51				
			2			1.07	3.51				
			3			1.12	3.67				
			4			1.09	3.58				
			5			0.74	2.43				
5/29/93	1.3	24	1	15	5.00	1.13	3.69	65.85	243.05	**1395**	**1271**
12:30 PM			2	16	5.33	1.20	3.94	88.41	348.26		
			3	16.3	5.43	1.22	4.01	87.7	352.00		
			4	16	5.33	1.20	3.94	61.71	243.09		
			5	11.3	3.77	0.85	2.77	75.37	208.96		
		electronic data	1			1.08	3.54				
			2			1.11	3.64				
			3			1.1	3.61				
			4			1.19	3.90				
			5			0.76	2.49				

Cannon River Stage vs. Discharge: Cathy O'Reilly and Aron Clymer					
			Sections:		
Date/Time	Stage (ft)	6/10 depth (cm)	Distance from East	beeps/minute	rotations/sec.
		(below surface)	Side of channel (m)		
4/4/93	5.8	106	#1(4.4m)	23	7.67
(Aron's b-day)			#2(13.2m)	22	7.33
			#3(22m)	21	7.00
			#4(30.8m)	20	6.67
			#5(39.2m)	20	6.67
4/6/93	4.8	88	1	21	7.00
7:00 PM			2	19.8	6.60
			3	21	7.00
			4	19.2	6.40
			5	18	6.00
4/8/93	4.3	79	1	20	6.67
9:00 AM			2	19.5	6.50
			3	20	6.67
			4	17.8	5.93
			5	17	5.67
		% depth below s.			
4/10/93	4.3	80% = 104cm	1	17.3	5.77
10:30 AM		60% = 78cm		19.5	6.50
(multiple depth		40% = 52cm		20	6.67
stations)		20% = 26 cm		21.5	7.17
		0% = 0 cm		20.8	6.93
		0.8	2	18.4	6.13
		0.6		19.3	6.43
		0.4		20	6.67
		0.2		20	6.67
		0		19.6	6.53
		0.8	3	18.9	6.30
		0.6		19	6.33
		0.4		21.2	7.07
		0.2		21	7.00
		0		21.1	7.03
		0.8	4	16.9	5.63
		0.6		17.7	5.90

Page 4 →

		0.4		18.3	6.10
		0.2		19	6.33
		0		19.1	6.37
		0.8	5	16.3	5.43
		0.6		17	5.67
		0.4		17.3	5.77
		0.2		17.8	5.93
		0		17.5	5.83
4/17/93	4	73	1	19.3	6.43
10:00 AM			2	19.2	6.40
			3	19.7	6.57
			4	19.2	6.40
			5	16.6	5.53
4/19/93	3.25	59	1	17.4	5.80
10:45 AM			2	17.8	5.93
			3	18.6	6.20
			4	18.1	6.03
			5	15.6	5.20
4/21/93	5.95	109	1	23.1	7.70
			2	21.5	7.17
			3	21.6	7.20
			4	20.3	6.77
			5	19	6.33
4/26/93	3.15	58	1	18	6.00
3:30			2	18.5	6.17
			3	18.8	6.27
			4	18.5	6.17
			5	15.3	5.10
4/30/93	2.75	50	1	15.6	5.20
3:30			2	17.2	5.73
			3	18.7	6.23
			4	17.1	5.70
			5	15.1	5.03
5/6/99	2.6	48	1	16.1	5.37
9:30 AM			2	18.5	6.17
			3	19	6.33
			4	18.2	6.07

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			5	14.3	4.77
		2/10 = 16 cm	*1	17.1	5.70
			2	19.2	6.40
			3	18.4	6.13
			4	18.5	6.17
			5	15.2	5.07
5/17/93	2.5	46	1	16.1	5.37
7:30 PM			2	17.9	5.97
			3	18.9	6.30
			4	17.8	5.93
			5	14	4.67
5/25/93	1.7	31	1	14.6	4.87
3:30 PM			2	17.3	5.77
			3	17.8	5.93
			4	16.5	5.50
			5	12.8	4.27
		electronic data	1		
			2		
			3		
			4		
			5		
5/29/93	1.3	24	1	15	5.00
12:30 PM			2	16	5.33
			3	16.3	5.43
			4	16	5.33
			5	11.3	3.77
		electronic data	1		
			2		
			3		
			4		
			5		

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velocity (m/s)	velocity (ft/s)	Section Area (sq. ft)	Discharge(cfs) per section	Total discharge (cfs)	Adjusted Discharge(cfs)
1.73	5.68	65.85	373.83	**1984**	**1807**
1.65	5.43	88.41	479.95		
1.58	5.18	87.7	454.33		
1.50	4.93	61.71	304.37		
1.50	4.93	75.37	371.74		
1.58	5.18	65.85	341.13	**1854**	**1688**
1.49	4.88	88.41	431.67		
1.58	5.18	87.7	454.33		
1.44	4.73	61.71	292.11		
1.35	4.44	75.37	334.32		
1.50	4.93	65.85	324.79	**1769**	**1611**
1.47	4.81	88.41	425.08		
1.50	4.93	87.7	432.55		
1.34	4.39	61.71	270.66		
1.28	4.19	75.37	315.61		
1.30	4.26		0.00	**1733**	**1578**
1.47	4.81	65.85	316.61		
1.50	4.93		0.00		
1.62	5.30		0.00		
1.56	5.13		0.00		
1.38	4.53		0.00		
1.45	4.76	88.41	420.69		
1.50	4.93		0.00		
1.50	4.93		0.00		
1.47	4.83		0.00		
1.42	4.66		0.00		
1.43	4.68	87.7	410.78		
1.59	5.23		0.00		
1.58	5.18		0.00		
1.59	5.21		0.00		
1.27	4.16		0.00		
1.33	4.36	61.71	269.13		

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1.37	4.51		0.00		
1.43	4.68		0.00		
1.44	4.71		0.00		
1.22	4.01				
1.28	4.19	75.37	315.61		
1.30	4.26				
1.34	4.39				
1.31	4.31				
1.45	4.76	65.85	313.34	**1758**	**1601**
1.44	4.73	88.41	418.50		
1.48	4.86	87.7	426.02		
1.44	4.73	61.71	292.11		
1.25	4.09	75.37	308.12		
1.31	4.29	65.85	282.28	**1637**	**1491**
1.34	4.39	88.41	387.77		
1.40	4.58	87.7	402.07		
1.36	4.46	61.71	275.26		
1.17	3.84	75.37	289.41		
1.74	5.70	65.85	375.46	**1974**	**1798**
1.62	5.30	88.41	468.98		
1.62	5.33	87.7	467.39		
1.53	5.01	61.71	308.96		
1.43	4.68	75.37	353.03		
1.35	4.44	65.85	292.09	**1667**	**1518**
1.39	4.56	88.41	403.13		
1.41	4.63	87.7	406.43		
1.39	4.56	61.71	281.39		
1.15	3.77	75.37	283.80		
1.17	3.84	65.85	252.86	**1572**	**1432**
1.29	4.24	88.41	374.60		
1.40	4.61	87.7	404.25		
1.28	4.21	61.71	259.94		
1.13	3.72	75.37	280.06		
1.21	3.96	65.85	261.03	**1617**	**1473**
1.39	4.56	88.41	403.13		
1.43	4.68	87.7	410.78		
1.37	4.49	61.71	276.79		

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1.07	3.52	75.37	265.09		
1.28	4.21				
1.44	4.73				
1.38	4.53				
1.39	4.56				
1.14	3.74				
1.21	3.96	65.85	261.03	**1590**	**1448**
1.34	4.41	88.41	389.97		
1.42	4.66	87.7	408.60		
1.34	4.39	61.71	270.66		
1.05	3.44	75.37	259.48		
1.09	3.59	65.85	236.51	**1486**	**1353**
1.30	4.26	88.41	376.80		
1.34	4.39	87.7	384.66		
1.24	4.06	61.71	250.75		
0.96	3.14	75.37	237.02		
1.07	3.51				
1.07	3.51				
1.12	3.67				
1.09	3.58				
0.74	2.43				
1.13	3.69	65.85	243.05	**1395**	**1271**
1.20	3.94	88.41	348.26		
1.22	4.01	87.7	352.00		
1.20	3.94	61.71	243.09		
0.85	2.77	75.37	208.96		
1.08	3.54				
1.11	3.64				
1.1	3.61				
1.19	3.90				
0.76	2.49				

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