

MC
G. Grover
so file
bblky: 585435

TO: Sylvia Olivia
Natural Resources
Mesa Verde National Park, CO 81330
FROM: Scott Grover
DATE: October 21, 2002
SUBJECT: 2002 water year details

Hello Sylvia, et al:

Enclosed are the basics of the Mancos River gaging operations for the 2002 water year.

It was a very dry year – no news to anyone in the Mancos valley:

	<u>2001 WY</u>	<u>2002 WY</u>
total discharge	(~)17980 ac-ft	1790
daily average flow	49.26 ac-ft	4.90
Highest daily mean	210 cfs	25 cfs

So, everything is about 10% of what it was last year.

Enclosed are:

- Station Analysis for 2002 WY (just a summary of how gage operations went)
- Updated Station Description
- Table of Daily Mean Values (cfs)
- Daily Mean hydrograph (plot of daily values)
- Plot of Rating 2.0
- Table of Rating 2.0 (you may already have this)

Call me with any questions – hope all is well at MEVE. Still waiting to hear if installation of the cantilever gage is OK.

Sincerely,

Scott Grover
National Park Service - WRD
1201 Oakridge Drive, Ste.250, Fort Collins, CO 80525
(970) 225 3525, scott_grover@nps.gov

MEVE

Station Analysis – 2002 Water Year

Mancos River at Anitas Flat, CO (371508108212801)

Mesa Verde National Park

EQUIPMENT: Initially, the water level sensor was a Campbell Scientific CR510 connected to a Druck submersible pressure transducer. On 11/07/01 this unit was replaced with a Design Analysis – Waterlog H350/H355 bubbler system. A GOES transmitter was added to the H350 and began transmitting on 5/9/02. This unit is now considered the Data Collection Platform (DCP), but may also be referred to as the 'logger' or 'datalogger.' There is no backup recorder.

Gage height data is logged at 15 minute intervals, and transmitted via GOES every 3 hours. The NPS-WRD has a cooperative agreement with the Cheyenne, WY district of the USGS to use their Local Readout Ground Station (LRGS) for data retrieval. The unit value data is automatically decoded and entered into Cheyenne's ADAPS database.

The base gage is a series of enamelled outside vertical staff plates (OVS) mounted to adjustable planks and secured by two steel bars pounded into the ground, and located just streamward of the datalogger enclosure. The lower OVS reads from 0.00' to 3.32'. The Upper OVS reads from 3.33' to 6.74'. On 11/08/2001 (2002 WY), the upper OVS was moved to a more stable location (about 10' DS of lower OVS). The lower OVS requires significant shoveling to remove silt deposits to reestablish communication with the stream. On several occasions, line-level tape downs from the isolated OVS were used to establish the water level. A cantilever gage has been proposed for installation during the 2003 WY.

HYDROLOGIC CONDITIONS: Station has a drainage area of 160 mi² (based on GIS analysis of 1:100,000 USGS DLG data). Valley slopes are moderate ranging from about 0.2 to 2.0%. The channel bed is composed of moderately armored cobbles accompanied by smaller gravels and sands. The channel meanders, but is straight for about 200' in the reach of the gage. The right bank immediately upstream of the gage is steep and subject to being undercut.

A large (but unknown) portion of the upstream basin was impacted by the Bircher Wildfire which burned 7/20/2000 to 8/5/2000. Sediment loads have increased significantly following the fire. This was especially evident during the fall of 2002, as runoff from thunderstorms deposited large amounts of fine silts and sands throughout the Mancos channel. The 9/18/02 visit noted that the gage pool, formerly about 1.5' deep at baseflow conditions and 7' wide, was only 0.5' deep and narrowed. The silt has altered the thalweg at the gage, probably making it unstable and constantly shifting.

The entire four-corners area (including all of the Mancos valley) was severely impacted by drought during the 2002 WY. Spring runoff, which usually creates the annual peak and accounts for the bulk of the water year's runoff volume, was nonexistent this year.

The drought has probably increased the severity of the sedimentation problem noted above by removing potentially protective and stabilizing vegetation.

GAGE HEIGHT RECORD: The gage height record was complete for the water year except for the following:

- Several hours were entered by hand for a gap on 3/20/02, created during equipment maintenance.
- Several hours were entered by hand for a gap on 8/18/02 of unknown origin.

DATUM CORRECTIONS: Levels were run three times this WY (11/8/01, 5/9/02 and 9/19/02). The levels of 5/9 determined that the lower OVS was unstable and had been moved by ice the previous winter. On 3/20/02 the datalogger was reset to the inaccurate OVS. A datum correction was used from that date to 5/9/02 when the logger was reset to a corrected OVS value.

Several corrections were required to correct for base gage / recorder differences during the first part of the WY (prior to the installation of the H350 bubbler). These discrepancies are believed to be due to moderate to heavy deposits of silt which buried the pressure transducer. In cases where the cause for the discrepancy could not be established (peak flows, etc), corrections were prorated to previous visit and gage height observation. All datum corrections are listed below.

DATE/TIME MM DD/TTTT	VALUE	
10 01 0001	.340	2002 WY begins with same correction that ended the 2001 WY
10 11 1045	.620	Site visit – observed DCP/OVS difference
11 07 1015	.540	Site visit – observed DCP/OVS difference
11 07 1016	.000	DCP replaced (H35) and reset – no further correction needed
03 20 1130	.000	Site visit – DCP/OVS agree
03 20 1135	.120	DCP reset to match ice-shifted OVS (OVS is incorrect)
05 09 1500	.120	DCP reset to match corrected OVS
05 09 1505	.000	Site visit – DCP/OVS agree
09 30 2400	.000	End of 2002 WY – no correction required

RATING: Bed material at the gage varies from moderately deep silt in the slow moving water of the gage pool (+/- 1.0') to embedded pebbles and small cobbles in the swifter flows. Beginning in the fall of 2002 silt deposits have formed in all but the swiftest flows. As noted earlier, the entire gage pool has been severely impacted. Moderate silt deposits were observed on the cobble-riffle control.

The low-flow and mid-flow control is a low-gradient cobble bar about 80' downstream from the gage. This bar appears to be relatively stable and free from sedimentation effects. Control at higher flows (> 3.5') is believed to be the channel, as water will enter a broad floodplain on the left bank. Bank-full width at the gage is about 70'.

The channel is straight for about 100' above the gage, where the flow exits from a sharp bend. At this point the bank is very steep, composed of moderately erodable silt and is being undercut. Below the gage, the channel is straight for about 100' and has

moderately sloping banks anchored by moderately heavy stands of willows and grasses.

Rating 2.0 was created this water year and remained in effect for the WY duration. It is based on several measurements made at the end of the 2001 WY and all 9 measurements made in 2002 WY. Measurements plotted from -5.6% (#13, rated fair) to +14.8% (#19, rated fair). #19 was countered by #20, made the same day, which plotted on the rating. Details about each measurement are listed on form 9-207.

DISCHARGE: Discharge was computed using Rating #1 direct from 10/1/01 to 9/7/02. Local thunderstorms on 9/1 brought over .8 inches of rain, and produced a peak stage of 1.83 ft. This flow deposited a significant amount of sediments which filled the gage pool. Fill in the pool increases the velocities through the pool, and thus changes the stage – discharge relationship. Based on the observed sediments, and measurement #21 (9/18/02), a +0.02 shift was developed for the lower end of rating 2.0. The shift begins 9/7/02 and remains in effect for the remainder of the water year. A shift analysis table and graph are also included with this review.

SPECIAL COMPUTATIONS: The gage height record was affected by ice during the following periods

- 11/27/01 to 12/02/01
- 12/7/01 to 01/01/02
- 1/14/02 to 1/28/02
- 1/31/02 to 2/15/02

Daily discharges for these days were estimated using NOAA climate data for Cortez, CO (daily max, min air temperature and precipitation), and the following nearby streamflow gaging stations:

- 09371492, Mud Creek at Highway 32 near Cortez: USGS, 33.6 mi², located about 17 miles west of MEVE Mancos gage.
- MANMANCO, Mancos River near Mancos, CO: CO-DWR, 72.6 mi², located about 12 river miles upstream of MEVE Mancos gage.

Typically, the temperature records indicate periods of probable ice effect. Also, ice effects can often be observed on daily plots of gage height unit values. Daily values for ice days were calculated using estimates of gage heights with no ice effect, and hydrologic comparison with the stations listed above. There were no corroborative streamflow measurements made during the ice period.

Additionally, daily means were estimated for the period 8/22/02 to 9/18/02 (except for 9/7 and 9/8). Plots of the unit values for this period show that the bubbler orifice was covered and partially blocked by sediments. This was confirmed during the 9/18 site visit. This 'plugging' can create back pressure in the bubbler airline and artificially increase the sensed gage heights. The lower unit values are assumed to be correct, and those values were used to estimate adjusted gage heights, and discharges. An increased flow event occurred on 9/7 and 9/8; thus, these daily means were left

unchanged under the assumption that the increased flow velocities during these two days would keep the orifice clear. 'Painting' of the unit values was reduced on those days, confirming this assumption. During the 9/18 site visit, the orifice conduit was extended to a silt-free section of the channel, eliminating the need for further adjustments to the daily mean values. Overall, the adjusted daily means are about 15% lower than the original computed values.

Unit values from DD 1 (00065 GAGE HEIGHT from data file) were copied into DD 4 (00065 GAGE HEIGHT from DCP) using PR 13 (Merge/Replace Unit Values Data) for the period 10/01/01 to 5/9/02. On 5/9/02 data transmission began through the telemetry system, requiring the new Data Descriptor (DD).

REMARKS: Computed discharges for 2002 water year are considered 'fair' (within 8% of true), except for all estimated daily values which are considered 'poor' (over 8.0%).

The rating is poorly defined in the mid to high flow range. Perhaps some high flow measurements can be made in 2003 WY using a tethered ADCP.

Measurements during ice periods are invaluable in estimating ice effects, but access to the gage in poor weather is a known problem.

EXTREMES FOR 2002 WATER YEAR:

DATE	TIME	CFS	Gage Height in Feet
MAXIMUM INSTANTANEOUS DISCHARGE AND CORRESPONDING GAGE HEIGHT			
12/20/2001	01:15:00	380	2.75 (ICE AFFECTED)
12/21/2001	03:30:00	380	2.75 (ICE AFFECTED)
01/05/2002	04:30:00	380	2.75 (ICE AFFECTED)

Maximum Instantaneous Discharge and Gage Height free of ice effects:
 9/7/02 20:45 115 cfs 1.83 feet

MINIMUM INSTANTANEOUS DISCHARGE AND CORRESPONDING GAGE HEIGHT			
08/21/2002	20:00:00	.15	.38
08/22/2002	00:15:00	.15	.38

MAXIMUM INSTANTANEOUS GAGE HEIGHT AND CORRESPONDING DISCHARGE			
01/06/2002	23:30:00	.00	15.55 (ICE AFFECTED)

MINIMUM INSTANTANEOUS GAGE HEIGHT AND CORRESPONDING DISCHARGE			
08/21/2002	20:00:00	.15	.38
08/22/2002	00:15:00	.15	.38

MAXIMUM DAILY DISCHARGE			
09/08/2002		25	.71

MINIMUM DAILY DISCHARGE			
08/12/2002		.22	.01
08/13/2002		.22	.01
08/14/2002		.22	.01
08/15/2002		.22	.01
08/16/2002		.22	.01
08/17/2002		.22	.01
08/18/2002		.22	.01

Prepared by: J. S. Grover, 10/16/2002

STATION DESCRIPTION
Mancos River at Anitas Flat, CO (MEVE)

Prepared by J.S. Grover, December 4, 2001

Update 5/15/02, 10/21/02: JSG

STATION NUMBER (USGS): 371508108212801

LOCATION: N 37° 15' 08" , W 108° 21' 28" , HUC: 14080107, County: Montezuma, Elev: 6330 feet above MSL, as determined by GPS. Located on right bank about 1.05 miles inside MEVE boundary, 3.0 miles south of confluence with Mud Creek, 7.4 miles SSW of Mancos, CO.

ESTABLISHED: 7/18/2000.

DRAINAGE AREA: Station has a drainage area of 160 mi² (based on GIS analysis of 1:100,000 USGS DLG data).

GAGE: Originally Basic Data Recorder (BDR) was a Campbell Scientific CR-510, with a 15-minute logging interval. This BDR was upgraded to a WaterLog H350XL/H355 bubbler system on 11/07/2001. A WaterLog H-222 satellite transmitter was added on 5/9/02. Transmitter information is:

- ID: FA4087CC
- Channel: 002 west
- Rate: 3 hrs
- Time offset: 00:25:00 (set to 00:25:08)
- Antenna direction: Azimuth from true north = 220 degrees, elevation = 40 degrees.

Base gage is an enameled outside vertical staff (OVS) in two sections reading from 0.00 to 6.74' gage datum, mounted on adjustable planks and secured to steel rods.

HISTORY: Gage has remained at original location since establishment. BDR upgraded on 11/7/01. Fire burned a significant portion of upstream drainage area from 7/20 to 8/5/2001. Sediment loads increased significantly following fire, but rating remained relatively stable. Noticeably increased sediment loads/deposits noted during final weeks of 2002 WY.

CHANNEL AND CONTROL: Bed material at the gage varies from moderately deep silt in the slow moving water of the gage pool (+/- 1.0') to embedded pebbles and small cobbles in the swifter flows. Silt deposits form in areas of slow water and eddies. Thus, the lower OVS often requires some shoveling to remove silt deposits and reestablish communication with the stream.

The low-flow and mid-flow control is a low-gradient cobble bar about 80' downstream from the gage. It appears to be relatively stable and free from siltation effects. Control at higher flows is the channel. Bank-full width at the

gage is about 70'. At very high stages (> 3.5'), water will enter a broad floodplain on the left bank.

Channel is straight for about 100' above the gage, where the flow exits from a sharp bend. At this point the bank is very steep, composed of moderately erodable silt and is being undercut. Below the gage, the channel is straight for about 100' and has moderately sloping banks anchored by moderately heavy stands of willows and grasses.

DISCHARGE MEASUREMENTS: Wading measurements can be made in the vicinity of the gage up to a stage of about 2.20. At higher stages, permission must be obtained to use a private bridge about 1.9 miles upstream for a bridge measurement or use a tethered ADCP.

FLOODS: None for period of record

POINT OF ZERO FLOW: From 11/8/2001 levels, 0.21'

WINTER FLOW: Stage can be affected by ice in the winter months

REGULATION: Many diversions upstream for irrigation. It is suspected that base flows in the summer months are primarily irrigation return flows.

ACCURACY: Pressure transducer problems yielded a poor record. The WaterLog bubbler gage appears to be yielding good data.

COOPERATION: Gage is maintained by joint efforts of WRB and MEVE staff. Most measurements are made by MEVE staff.

BENCHMARKS: as follows; all from 05/09/2002 level run:

STATION	5/9/02	9/19/02	DESCRIPTION
RM3 (BASE)	6.470	6.470	rebar – furthest upstream, east of enclosure
RM1	6.183	6.184	rebar-east of enclosure
RM2	6.062	6.072	rebar – closest to enclosure, east of enclosure
Grounding Rod for DCP	6.572	6.575	top of copper-plated steel rod
OVS 1	2.001	2.002	reference screw at 2.00 on OVS
OVS 2	5.202	5.204	reference screw at 5.20 on OVS
Orifice Cap	0.232	0.258	Top of cap (relocated on 9/19/02)
Top of orifice anchor	0.872	0.873	Top of steel fence post

STATION NUMBER 371508108212801 MANCOS RIVER AT ANITAS FLAT, CO STREAM SOURCE AGENCY USGS

LATITUDE 371508 LONGITUDE 1082128 DRAINAGE AREA 0.00 DATUM STATE 08 COUNTY 083

PROVISIONAL DATA

from dcp

SUBJECT TO REVISION

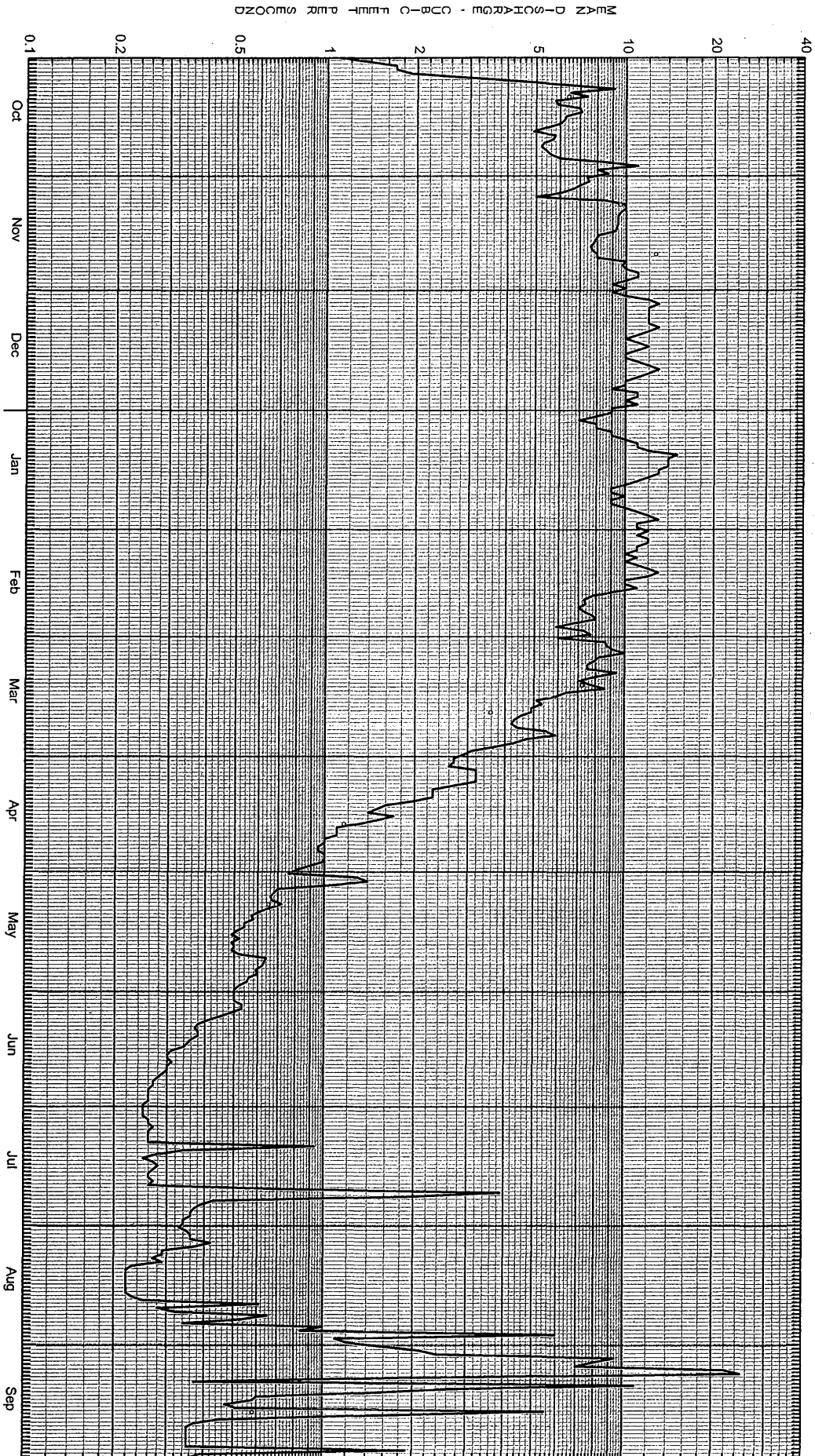
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 2001 TO SEPTEMBER 2002
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	1.1	7.4	e9.0	e9.0	e12	6.0	2.7	.76	.50	.25	.33	e1.4
2	1.4	7.5	e10	e8.0	e11	8.6	2.7	1.3	.50	.25	.35	e1.8
3	1.7	7.0	12	e7.0	e12	8.7	2.6	1.4	.50	.25	.36	e2.0
4	1.7	6.6	13	e8.0	e12	9.1	3.2	1.1	.53	.26	.36	e8.0
5	1.9	6.0	12	e8.0	e11	10	3.2	.70	.53	.26	.42	e6.8
6	2.8	5.0	12	e9.0	e11	8.2	3.2	.68	.49	.27	.37	e5.9
7	4.3	8.5	e12	e9.0	e10	7.9	3.2	.66	.45	.26	.29	22
8	6.2	9.9	e12	e10	e11	7.5	2.7	.67	.41	.26	.29	25
9	9.1	10	e12	e11	e10	7.5	2.3	.72	.38	.26	.27	e1.5
10	6.5	9.6	e13	e11	e11	9.4	2.3	.66	.37	.26	.29	e.31
11	7.4	9.4	e12	12	e12	8.0	2.3	.61	.38	.93	.23	e9.4
12	5.8	9.4	e11	15	13	7.1	2.0	.57	.38	.34	.22	e2.2
13	5.9	9.4	e10	14	e12	7.7	1.6	.58	.36	.28	.22	e1.2
14	7.0	9.3	e11	e14	e10	8.6	1.5	.54	.35	.25	.22	e.51
15	7.1	9.2	e12	e14	e10	6.4	1.4	.54	.34	.27	.22	e.49
16	6.3	8.1	e11	e13	11	5.9	1.7	.51	.31	.28	.22	e.40
17	6.2	7.9	e10	e13	9.2	5.1	1.5	.49	.30	.27	.22	e.43
18	6.0	7.8	e10	e12	7.8	5.3	1.3	.52	.30	.26	.22	e4.7
19	5.4	7.6	e11	e11	7.3	4.9	1.1	.49	.31	.26	.23	1.4
20	4.9	7.7	e12	e10	7.4	4.9	1.1	.50	.30	.27	.25	.45
21	5.8	8.0	e13	e9.0	7.0	4.5	1.1	.49	.30	.26	.61	.37
22	5.7	8.0	e12	e9.0	7.3	4.3	1.0	.52	.29	.72	e.24	.35
23	5.3	10	e11	e10	7.8	4.2	1.0	.64	.28	3.9	e.27	.35
24	5.2	9.7	e10	e9.0	8.0	4.4	.95	.63	.27	1.9	e.55	.35
25	5.4	10	e10	e9.0	6.8	5.5	.95	.62	.27	.43	e.45	.35
26	5.6	11	e9.0	e10	5.9	5.9	1.0	.59	.26	.39	e.29	.35
27	6.0	e11	e11	e11	7.3	4.7	1.0	.60	.26	.37	e.84	.35
28	8.4	e10	e11	e12	7.7	4.3	.98	.56	.26	.36	e.71	1.9
29	11	e9.0	e10	13	---	3.7	.89	.55	.26	.36	e5.1	.39
30	8.0	e10	e11	11	---	3.1	.81	.52	.25	.34	e.94	.35
31	8.7	---	e9.0	e11	---	2.9	---	.50	---	.34	e1.0	---
TOTAL	173.8	260.0	344.0	332.0	268.5	194.3	53.28	20.22	10.69	15.36	16.58	101.00
MEAN	5.61	8.67	11.1	10.7	9.59	6.27	1.78	.65	.36	.50	.53	3.37
MAX	11	11	13	15	13	10	3.2	1.4	.53	3.9	5.1	25
MIN	1.1	5.0	9.0	7.0	5.9	2.9	.81	.49	.25	.25	.22	.31
AC-FT	345	516	682	659	533	385	106	40	21	30	33	200

2002 Water Year - Montezuma River at Anitas Flat, CO - Mean Yearly Natural Flow

2002 Water Year Montezuma River at Anitas Flat - MEVE Annual Hydrograph of Daily Mean Flow

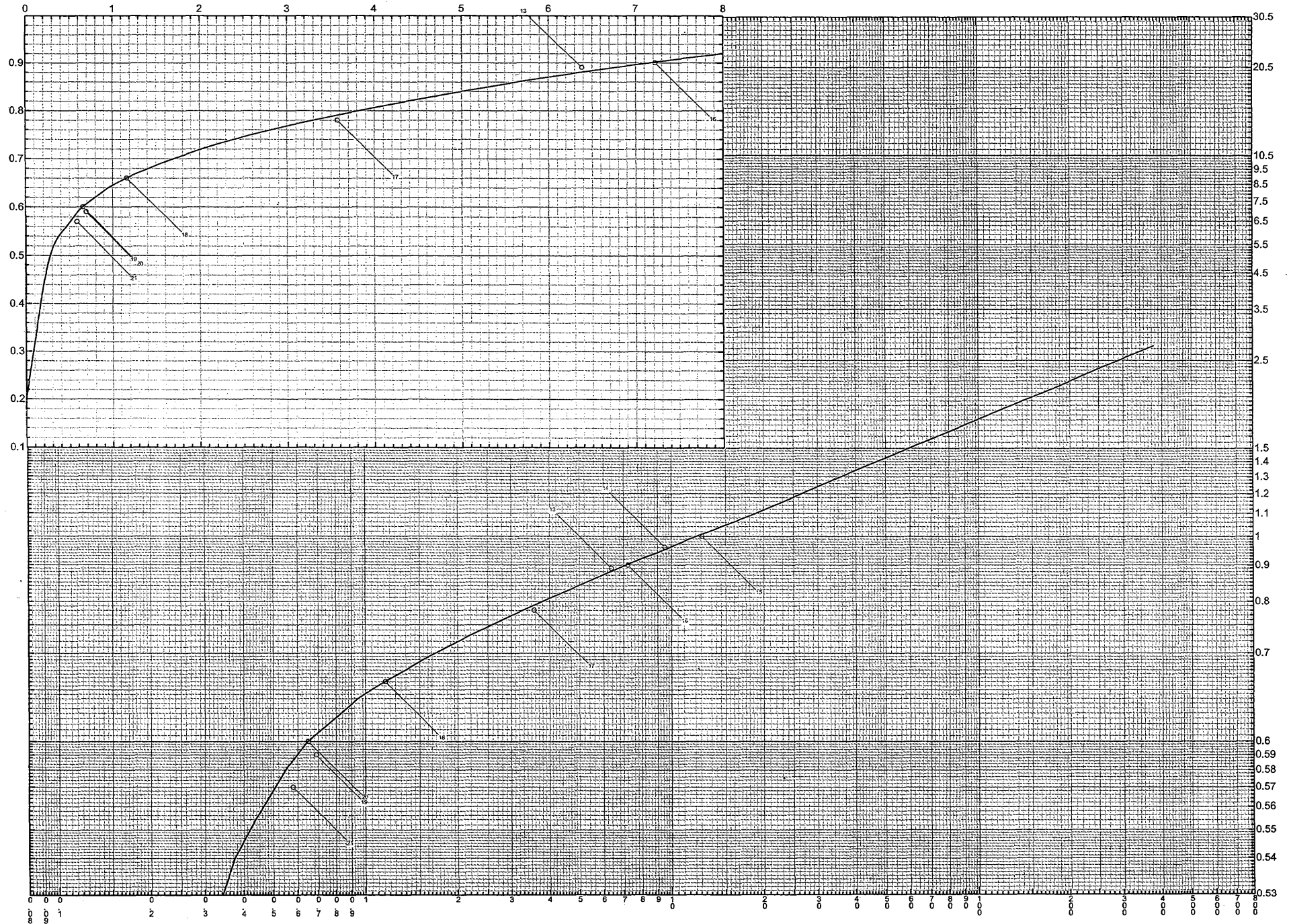
— Measurements



Rating 2.0

371508108 "MANCOS RIVER AT ANITAS FLAT, CO"
RATING ID="0002" BEGIN=20011001 OFFSET USED: 0.5

National Park Service, Water Resources Division



UNITED STATES DEPARTMENT OF INTERIOR - GEOLOGICAL SURVEY - WATER RESOURCES DIVISION

PAGE 1

EXPANDED RATING TABLE

TYPE: LOG

371508108212801

DATE PROCESSED: 05-15-2002 @ 15:05 BY sgrover

MANCOS RIVER AT ANITAS FLAT, CO

DD: 4 TYPE: 001 RATING NO: 0002

OFFSET: .50

START DATE/TIME: 10-01-2001 (0001)

BASED ON _____ DISCHARGE MEASUREMENTS, NOS _____, AND _____, AND IS _____ WELL DEFINED BETWEEN _____ AND _____ CFS

COMP BY _____ DATE _____ CHK. BY _____ DATE _____

Based on #2 - #20; same as rating 001 abv 0.81'

GAGE HEIGHT (FEET)	DISCHARGE IN CUBIC FEET PER SECOND (EXPANDED PRECISION)										DIFF IN Q PER TENTH FT
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
.20	.000*	.008	.017	.025	.033	.042	.050	.058	.067	.075	.083
.30	.083	.092	.100*	.108	.117	.125	.133	.142	.150	.158	.084
.40	.167	.175	.183	.192	.200*	.212	.225	.238	.250*	.265	.113
.50	.280	.295*	.315*	.342*	.375*	.420*	.466	.509	.550*	.601	.370
.60	.650*	.724	.798	.874	.950*	1.053	1.160*	1.285	1.415	1.550*	1.053
.70	1.703	1.862	2.028	2.200*	2.396	2.600*	2.824	3.057	3.300*	3.556	2.120
.80	3.823	4.100*	4.389	4.689	5.000*	5.322	5.656	6.000*	6.374	6.761	3.338
.90	7.161	7.574	8.000*	8.491	9.000*	9.479	9.972	10.48	11.00*	11.57	4.989
1.00	12.15	12.75	13.37	14.00*	14.66	15.34	16.03	16.75	17.48	18.23	6.850
1.10	19.00*	19.71	20.44	21.18	21.94	22.71	23.50*	24.29	25.09	25.90	7.730
1.20	26.73	27.57	28.43	29.30	30.19	31.09	32.00*	32.97	33.96	34.96	9.250
1.30	35.98	37.02	38.07	39.14	40.23	41.33	42.45	43.59	44.74	45.91	11.12
1.40	47.10	48.30	49.53	50.77	52.02	53.30	54.59	55.90	57.22	58.57	12.83
1.50	59.93	61.31	62.70	64.12	65.55	67.00	68.46	69.95	71.45	72.98	14.58
1.60	74.51	76.07	77.65	79.24	80.85	82.49	84.13	85.80	87.49	89.19	16.40
1.70	90.91	92.66	94.41	96.19	97.99	99.81	101.6	103.5	105.4	107.3	18.29
1.80	109.2	111.1	113.0	115.0	117.0*	119.1	121.2	123.3	125.4	127.6	20.50
1.90	129.7	131.9	134.2	136.4	138.7	141.0	143.3	145.6	147.9	150.3	23.00
2.00	152.7	155.1	157.6	160.0	162.5	165.0*	167.5	170.0	172.5	175.0*	24.80
2.10	177.5	180.0	182.5	185.0	187.5	190.1	192.7	195.3	197.9	200.5	25.70
2.20	203.2	205.9	208.6	211.3	214.0	216.8	219.6	222.4	225.2	228.0	27.70
2.30	230.9	233.7	236.6	239.5	242.5	245.4	248.4	251.4	254.4	257.4	29.60
2.40	260.5	263.6	266.7	269.8	272.9	276.1	279.2	282.4	285.6	288.9	31.60
2.50	292.1	295.4	298.7	302.0	305.3	308.7	312.0	315.4	318.8	322.3	33.60
2.60	325.7	329.2	332.7	336.2	339.8	343.3	346.9	350.5	354.1	357.7	35.70
2.70	361.4	365.1	368.8	372.5	376.2	380.0*					

