Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona

09471000 San Pedro River near Charleston, Ariz.

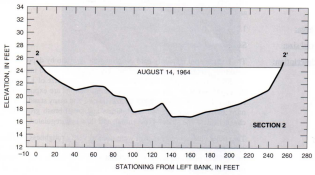


Figure 14A. Cross-section 2, San Pedro River near Charleston.

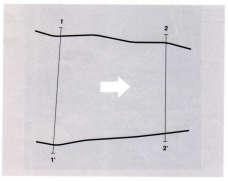


Figure 14B. Plan view, San Pedro River near Charleston.

Figure 14D. View from left bank looking downstream toward right bank of cross-section 1, October 8, 1964, San Pedro River near Charleston.

Figure 14E. View from left bank of cross-section 2 looking downstream, October 8, 1964, San Pedro River near Charleston.

Location.-- Lat 31°37'33", long 110°10'26", near Charleston, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Aug. 14, 1964	---	---	7550.0	1268.0	4.62	5.900	0.004800	0.048

09486500 Santa Cruz River at Cortaro, Ariz.

Figure 15*D*. View from cableway looking downstream, August 5, 1954, at a discharge of 7,000 cubic feet per second, Santa Cruz River at Cortaro.

Figure 15*E*. View from cableway looking downstream, October 2, 1964, Santa Cruz River at Cortaro.

Figure 15*F*. View from midchannel looking upstream toward right bank of cross-section 1 after flow of September 10, 1964, Santa Cruz River at Cortaro.

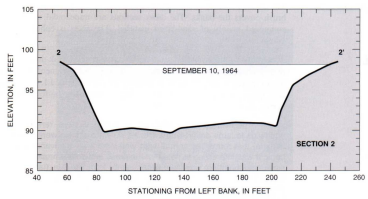


Figure 15*A*. Cross-section 2, Santa Cruz River at Cortaro.

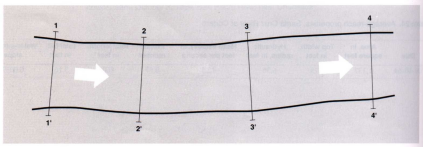


Figure 15*B*. Plan view, Santa Cruz River at Cortaro.

Location.-- Lat 32°21'04", long 111°05'38", near Cortaro, Arizona.

Description of channel.-- d_{50} = 1 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Sept. 10, 1964	---	---	14200.0	1137.0	6.36	12.500	0.003700	0.020

09502000 Salt River below Stewart Mountain Dam, Ariz.

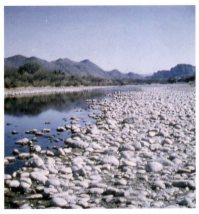


Figure 17*C*. View looking upstream along left bank below cross-section 6, Salt River below Stewart Mountain Dam.

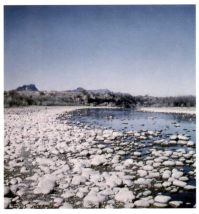


Figure 17*D*. View looking downstream along left bank from cross-section 2, Salt River below Stewart Mountain Dam.

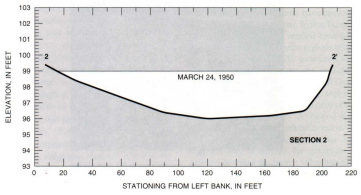


Figure 17*A*. Cross-section 2, Salt River below Stewart Mountain Dam.

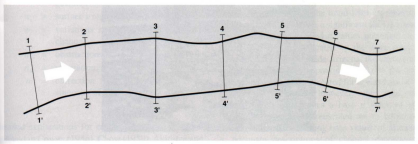


Figure 17*B*. Plan view, Salt River below Stewart Mountain Dam.

Location.-- Lat 33°33'00", long 111°34'31", near Stewart Mountain Dam, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Mar. 24, 1950	---	---	1280.0	405.0	2.14	3.220	0.001900	0.032

09503700 Verde River near Paulden, Ariz.

Figure 16C. View from top of reach looking downstream during low flow, Verde River near Paulden.

Figure 16D. View from top of reach looking downstream at time of verification measurement, April 16, 1965, Verde River near Paulden.

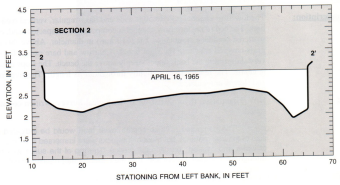


Figure 16A. Cross-section 2, Verde River near Paulden.

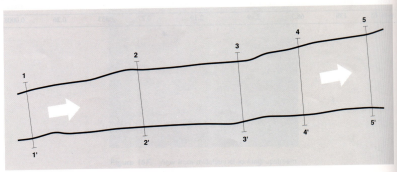


Figure 16B. Plan view, Verde River near Paulden.

Location.-- Lat 34°53'40", long 112°20'32", near Paulden, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Apr. 16, 1965	---	---	313.0	139.0	2.19	2.190	0.000800	0.029

09510120 West Fork Sycamore Creek near Sunflower, Ariz.

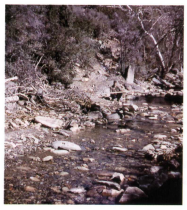


Figure 13D. View from midreach looking upstream toward right bank of cross-section 1, February 25, 1963, West Fork Sycamore Creek near Sunflower.

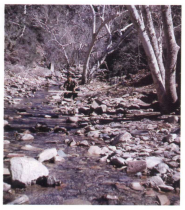


Figure 13E. View from bottom of reach looking upstream toward cross-section 3, February 25, 1963, West Fork Sycamore Creek near Sunflower.

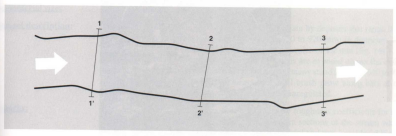


Figure 13B. Plan view, West Fork Sycamore Creek near Sunflower.

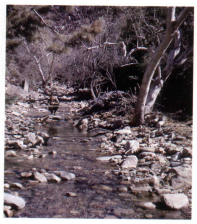


Figure 13C. View from bottom of reach looking upstream toward cross-section 2, February 25, 1963, West Fork Sycamore Creek near Sunflower.

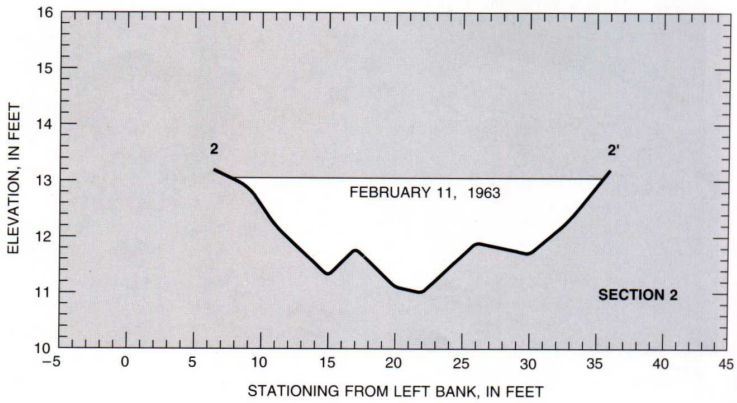


Figure 13A. Cross-section 2, West Fork Sycamore Creek near Sunflower.

Location.-- Lat 33°57'20", long 111°29'25", near Sunflower, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Feb. 11, 1963	---	---	117.0	36.2	1.21	3.290	0.018100	0.067

09511300 Verde River near Scottsdale, Ariz.

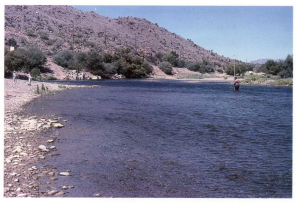


Figure 12F. View from right bank and midreach looking upstream during flow of September 14, 1989, Verde River below Beeline Highway.

Figure 12G. View from cableway looking downstream during flow of March 28, 1991, Verde River below Beeline Highway.

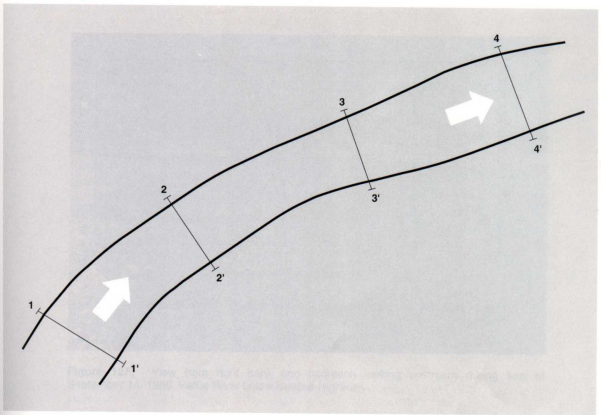


Figure 12B. Plan view for flow of March 28, 1991, Verde River below Beeline Highway. The reach in which the low-flow verification measurement was made is between cross-sections 1 and 2.

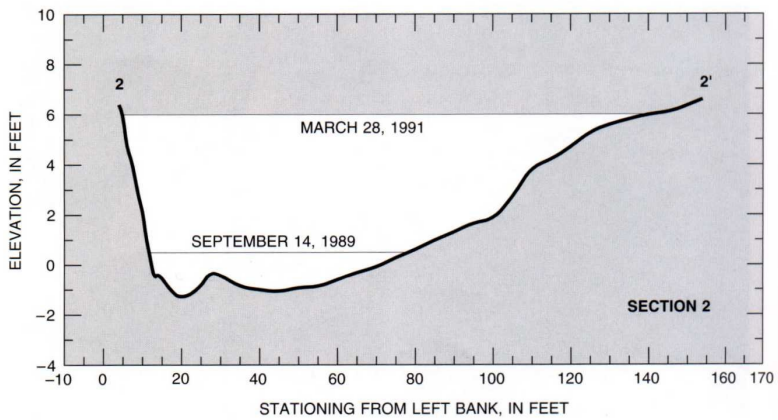


Figure 12A. Cross-section 2, Verde River below Beeline Highway.

Location.-- Lat 33°33'31", long 111°40'07", near Scottsdale, Arizona.

Description of channel.-- d_{50} = 110 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Mar. 28, 1991	---	---	2860.0	610.0	3.94	4.690	0.001300	0.030
Sept. 14, 1989	---	---	225.0	87.9	1.00	2.570	0.003800	0.036

09512162 Indian Bend Wash at Curry Road, Ariz.

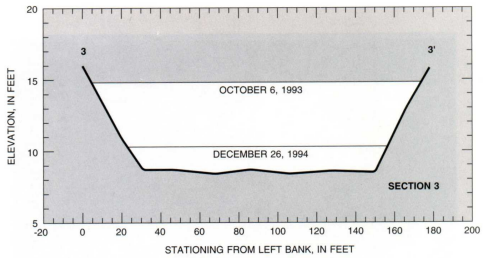


Figure 10*A*. Cross-section 3, Indian Bend Wash above Curry Road.

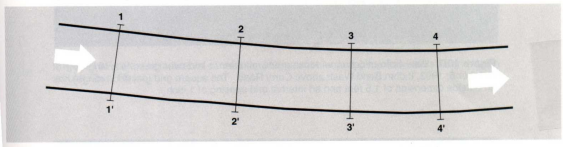


Figure 10*B*. Plan view, Indian Bend Wash above Curry Road.

Figure 10*E*. View from midreach looking upstream following flow of October 6, 1993, Indian Bend Wash above Curry Road.

Figure 10*F*. View from bottom of reach looking upstream during low flow, Indian Bend Wash above Curry Road.

Figure 10*G*. View from midchannel looking upstream before flow of December 26, 1994, Indian Bend Wash above Curry Road.

Location.-- Lat 33°26'50", long 111°54'55", near Curry Road, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Oct. 06, 1993	---	---	6480.0	905.0	5.36	7.160	0.001400	0.024
Dec. 26, 1994	---	---	449.0	200.0	1.52	2.250	0.001600	0.036

09513860 Skunk Creek near Phoenix, Ariz.

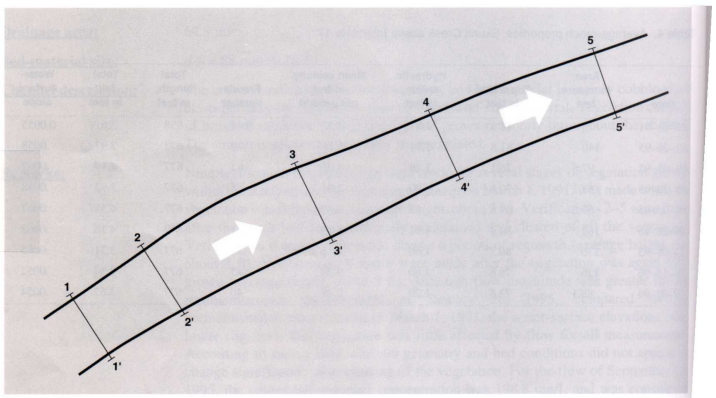


Figure 5*B*. Plan view, Skunk Creek above Interstate 17.

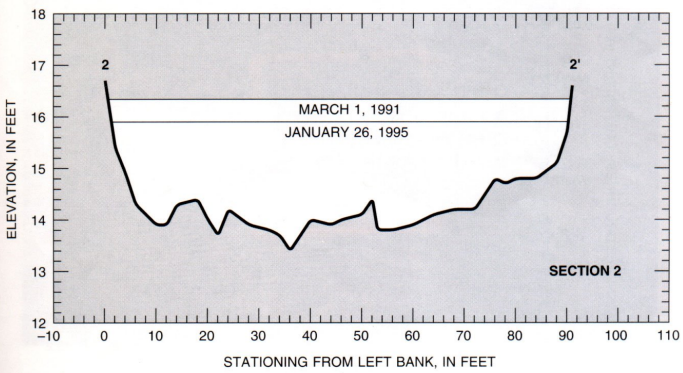


Figure 5*A*. Cross-section 2, Skunk Creek above Interstate 17.

Figure 5*I*. View from midchannel looking upstream during flow of January 5, 1995, Skunk Creek above Interstate 17.

Skunk Creek above Intersta

Skunk Creek above Interstate 17—Continued

Figure 5*F*. View from left bank and bottom of reach looking upstream during flow of March 1, 1991, Skunk Creek above Interstate 17.

Figure 5*G*. View from midchannel looking upstream following flow of March 1, 1991, Skunk Creek above Interstate 17. Vegetation was little affected by flow.

Figure 5*J*. View from midchannel looking upstream at regrowth of vegetation, Skunk Creek above Interstate 17. The brush is about 2 feet in height and was little affected by flow.

20 Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona

Location.-- Lat 33°43'56", long 112°06'57", near Phoenix, Arizona.

Description of channel.-- d_{50} = 88 mm.

							Slope	

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)		Coefficient of roughness *n*
Mar. 01, 1991	---	---	618.0	176.0	1.97	3.520	0.005500	0.048
Jan. 26, 1995	---	---	723.0	140.0	1.71	5.180	0.005800	0.031
Jan. 05, 1995	---	---	393.0	97.5	1.28	4.060	0.006200	0.034
Jan. 26, 1995	---	---	180.0	63.2	0.90	2.910	0.005800	0.035
Jan. 05, 1995	---	---	168.0	57.6	0.83	3.070	0.006700	0.037
Sept. 28, 1995	---	---	822.0	162.0	1.91	5.090	0.006200	0.035
Nov. 01, 1995	---	---	500.0	130.0	1.60	3.160	0.005500	0.039
Aug. 14, 1996	---	---	403.0	126.0	1.60	3.240	0.005200	0.048
Sept. 02, 1996	---	---	215.0	88.1	1.20	2.480	0.005400	0.052

09516500 Hassayampa River near Morristown, Ariz.

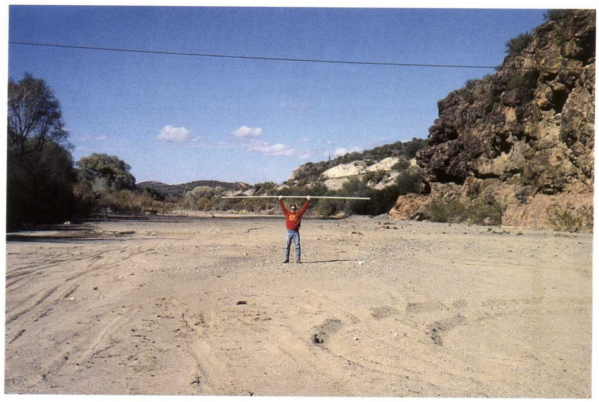


Figure 9*E*. View upstream from midchannel during no-flow period, Hassayampa River near Morristown. Rod indicates water-surface elevation for the peak flow of January 8, 1993.

Figure 9*F*. View from cableway looking upstream during flow of February 9, 1993, Hassayampa River near Morristown. Disturbance is a wave propagating slowly downstream and is indicative of hydraulic characteristics in alluvial channels during upper-regime flow conditions.

Figure 9*G*. View from cableway looking upstream during flow of February 9, 1993, Hassayampa River near Morristown. Disturbance is a wave propagating slowly downstream and is indicative of hydraulic characteristics in alluvial channels during upper-regime flow conditions. Photograph taken soon after photograph shown in figure 9*F*.

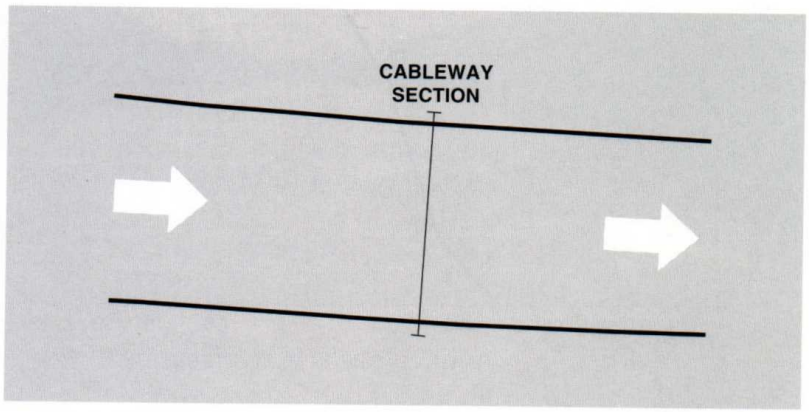
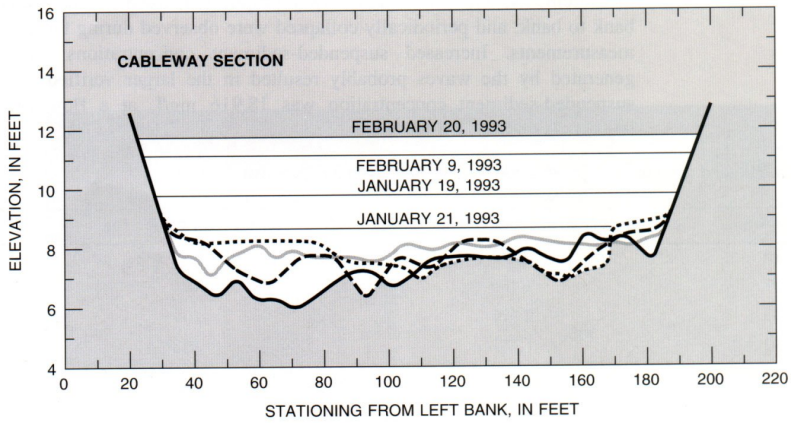


Figure 9*B*. Plan view, Hassayampa River near Morristown.



Location.-- Lat 33°53'06", long 112°39'41", near Morristown, Arizona.

Description of channel.-- d_{50} = 0 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Feb. 20, 1993	---	---	7330.0	652.0	3.80	11.200	0.006200	0.025

09517000 Hassayampa River near Arlington, Ariz.

Figure 4G. View looking upstream from midreach of low-flow channel, Hassayampa River near Arlington.

Figure 4H. View from right bank and midreach looking downstream following flow of February 9, 1993, Hassayampa River near Arlington.

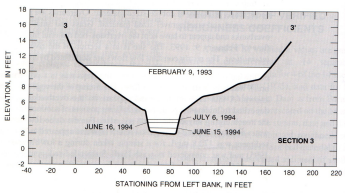


Figure 4A. Cross-section 3, Hassayampa River near Arlington.

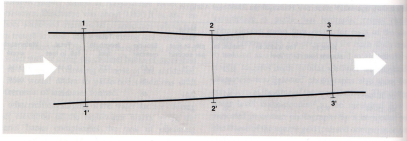


Figure 4B. Plan view, Hassayampa River near Arlington.

Location.-- Lat 33°20'50", long 112°20'30", near Arlington, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Feb. 09, 1993	---	---	5580.0	725.0	4.12	7.750	0.003400	0.027
July 06, 1994	---	---	80.5	24.8	1.29	3.260	0.003900	0.034
June 16, 1994	---	---	45.5	17.5	0.97	2.610	0.003900	0.036
June 15, 1994	---	---	17.0	9.3	0.58	1.860	0.003900	0.036

_____ Agua Fria River below New Waddell Dam, Ariz.

Agua Fria River below New Waddell Dam—Continued

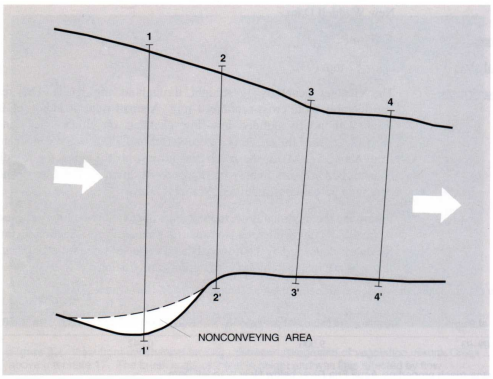


Figure 6B. Plan view, Agua Fria River below New Waddell Dam.

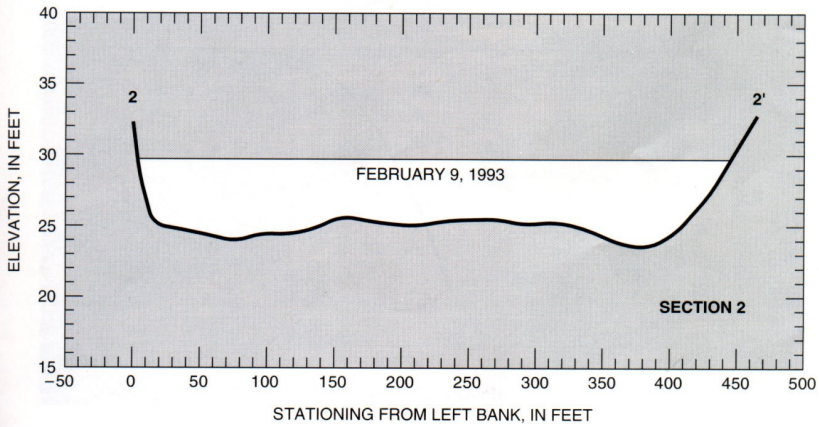


Figure 6*A*. Cross-section 2, Agua Fria River below New Waddell Dam.

Figure 6*E*. View from bottom of reach looking upstream on March 10, 1993, Agua Fria River below New Waddell Dam.

Figure 6*F*. View from midchannel looking toward left bank of cross-section 4, Agua Fria River below New Waddell Dam.

Figure 6*G*. View from midchannel in cross-section 2 of typical vegetation in the reach, Agua Fria River below New Waddell Dam. Length of measuring rod, 6 feet. Photograph taken at time of survey on May 19, 1993.

Location.-- Lat 33°50'03", long 112°16'33", near New Waddell Dam, Arizona.

Description of channel.-- d_{50} = 82 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Feb. 09, 1993	---	---	9000.0	1978.0	4.78	4.600	0.002500	0.042

_____ Cave Creek above Deer Valley Road, Ariz.

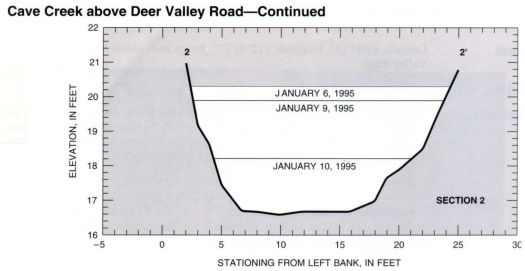


Figure 7A. Cross-section 2, Cave Creek above Deer Valley Road.

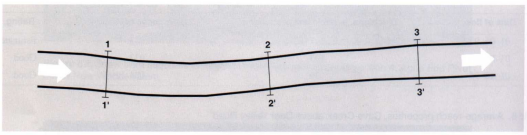


Figure 7B. Plan view, Cave Creek above Deer Valley Road.

Figure 7F. View from bottom of reach looking upstream during flow of January 9, 1995, Cave Creek above Deer Valley Road.

Figure 7G. View from top of reach looking downstream, Cave Creek above Deer Valley Road. Rod indicates water-surface elevation for the peak flow of January 6, 1995.

Location.-- Lat 33°41'13", long 112°03'32", near Deer Valley Road, Arizona.

Description of channel.-- d_{50} = 91 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Jan. 06, 1995	---	---	297.0	58.2	2.33	5.130	0.004600	0.033
Jan. 09, 1995	---	---	193.0	48.9	2.07	3.960	0.002900	0.033
Jan. 10, 1995	---	---	39.0	17.5	0.98	2.320	0.002400	0.034

Cave Creek below Cave Buttes Dam, Ariz.

Figure 8D. View from cross-section 7 looking upstream toward transition from subcritical to supercritical flow, Cave Creek below Cave Buttes Dam.

Figure 8F. View from top of reach looking downstream, Cave Creek below Cave Buttes Dam.

Figure 8E. View from cross-section 4 looking upstream toward subcritical flow reach during survey of the water surface, November 2, 1995, Cave Creek below Cave Buttes Dam.

Figure 8G. View from midchannel looking downstream, Cave Creek below Cave Buttes Dam.

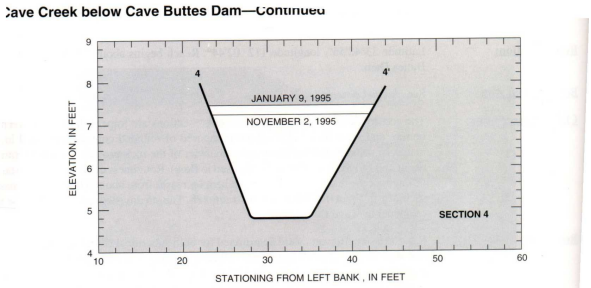


Figure 8A. Cross-section 4, Cave Creek below Cave Buttes Dam.

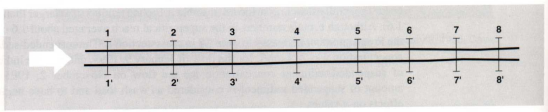


Figure 8B. Plan view, Cave Creek below Cave Buttes Dam.

Location.-- Lat 33°42'55", long 112°02'44", near Cave Buttes Dam, Arizona.

Description of channel.--

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Jan. 09, 1995	---	---	197.0	46.6	2.03	4.360	0.003000	0.025
Jan. 09, 1995	1.00	---	197.0	21.9	1.12	9.210	0.014800	0.017
Nov. 02, 1995	---	---	165.0	42.0	1.91	4.060	0.003100	0.025
Nov. 02, 1995	---	---	165.0	18.1	0.99	9.160	0.013000	0.017

_____ Hassayampa River near Morristown, Ariz.

Figure 9*E*. View upstream from midchannel during no-flow period, Hassayampa River near Morristown. Rod indicates water-surface elevation for the peak flow of January 8, 1993.

Figure 9*F*. View from cableway looking upstream during flow of February 9, 1993, Hassayampa River near Morristown. Disturbance is a wave propagating slowly downstream and is indicative of hydraulic characteristics in alluvial channels during upper-regime flow conditions.

Figure 9*G*. View from cableway looking upstream during flow of February 9, 1993, Hassayampa River near Morristown. Disturbance is a wave propagating slowly downstream and is indicative of hydraulic characteristics in alluvial channels during upper-regime flow conditions. Photograph taken soon after photograph shown in figure 9*F*.

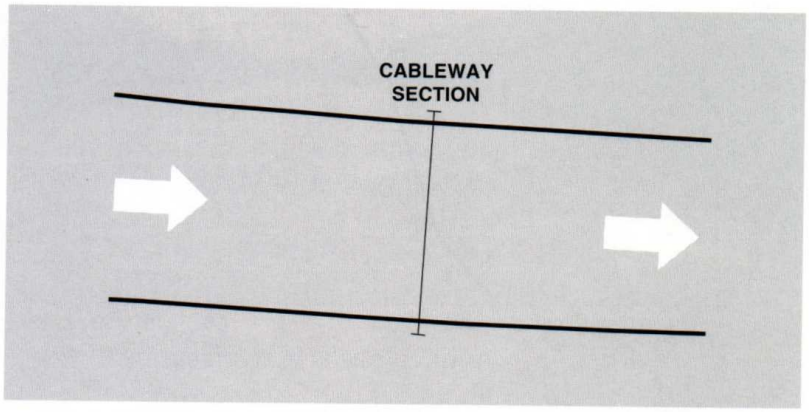
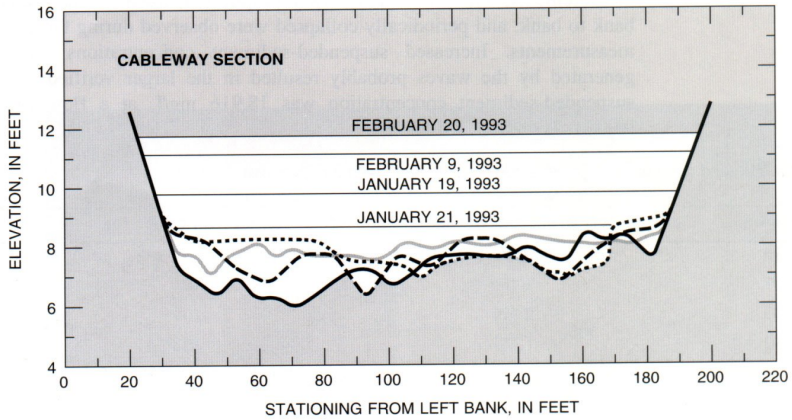


Figure 9*B*. Plan view, Hassayampa River near Morristown.



Location.-- Lat 33°53'06", long 112°39'41", near Morristown, Arizona.

Description of channel.-- d_{50} = 0 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Feb. 09, 1993	---	---	6180.0	518.0	3.40	11.930	0.006200	0.026
Jan. 19, 1993	---	---	2470.0	300.0	1.80	8.230	0.005000	0.019
Jan. 21, 1993	---	---	787.0	155.0	0.90	5.080	0.004300	0.018

_____ Salt River above Interstate 10, Ariz.

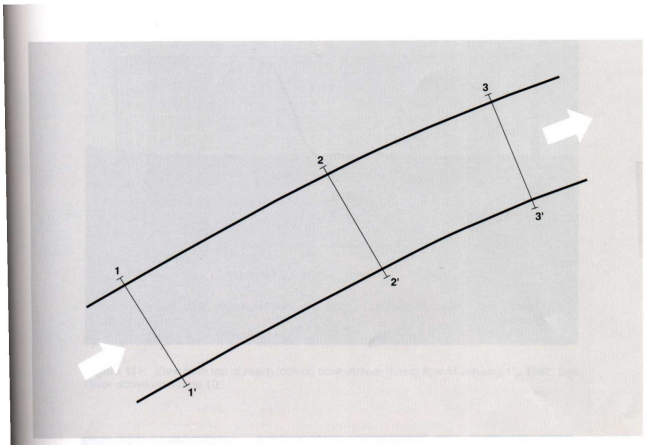


Figure 11*B*. Plan view, Salt River above Interstate 10.

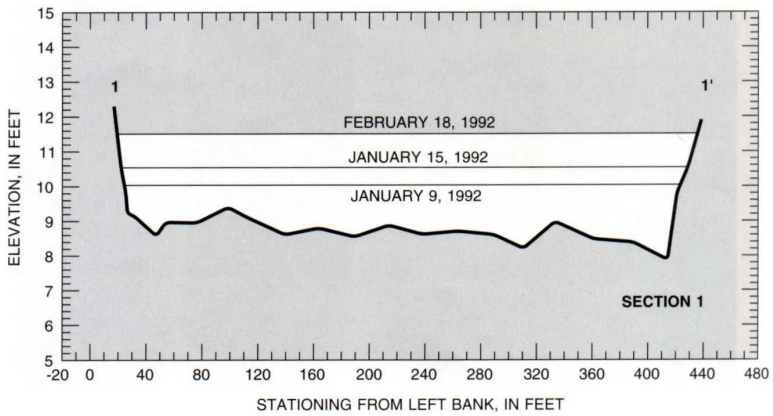


Figure 11*A*. Cross-section 1, Salt River above Interstate 10.

Figure 11*F*. View from top of reach looking downstream during flow of January 15, 1992, Salt River above Interstate 10.

Figure 11*G*. View from top of reach looking downstream, Salt River above Interstate 10.

Location.-- Lat 33°25'53", long 111°59'16", near Interstate 10, Arizona.

Description of channel.-- d_{50} = 94 mm.

Date of observation	Average depth (ft)	Average surface width (ft)	Discharge (ft^3/s)	Average cross section area (ft^2)	Hydraulic radius (ft)	Mean velocity (ft/s)	Slope	Coefficient of roughness *n*
Feb. 18, 1992	---	---	4900.0	1090.0	2.61	4.500	0.002500	0.030
Jan. 15, 1992	---	---	2070.0	665.0	1.64	3.130	0.002700	0.034
Jan. 09, 1992	---	---	1000.0	462.0	1.16	2.180	0.002600	0.038