Computation of Selected Hydraulic Variables for the Lower Yampa River in Northwestern Colorado

By J.E. Vaill

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
foot per mile (ft/mi)	0.1894	meter per kilometer
foot per second (ft/s)	0.3048	meter per second
inch	25.4	millimeter (mm)
mile (mi)	1.609	kilometer
square foot (ft^2)	0.0929	square meter

Computation of Selected Hydraulic Variables for the Lower Yampa River in Northwestern Colorado

By J.E. Vaill

Abstract

Computation of selected hydraulic variables was done for three reaches on the lower Yampa River that were identified as having natural or manmade barriers that might impede the migration of endangered Colorado squawfish. The three reaches included the Patrick Sweeney and the Maybell Canal diversion structures and Cross Mountain Canyon. Minimum stream depths and maximum stream velocities for a range of streamflows were computed using the Water-Surface PROfile computation program for cross sections in each of the three reaches. Cross-section information used as input to the computation program was determined from field surveys or from existing detailed topographic information. Output options in the program were used to generate tables of hydraulic variables for streamflows ranging from 50 to 400 cubic feet per second, including minimum depths and maximum velocities for 20 stream tubes in each of the cross sections selected for study.

INTRODUCTION

The Colorado squawfish has been identified as an endangered species (U.S. Fish and Wildlife Service, 1996) that inhabits the lower Yampa River from the mouth at the Green River upstream to near Juniper Hot Springs (fig. 1). The Colorado squawfish overwinters upstream from Maybell and migrates annually downstream to spawn in the part of the Yampa River located in Dinosaur National Monument. Depending on the water temperature of the river, the fish migrate in late-May to mid-June. The upstream return migration is in mid- to late-July after spawning is complete. During some years, streamflow in the Yampa River is very low as a result of low snowpack, early snowmelt runoff, minimal precipitation, and depletions by upstream water users. For example, in August 1994, a streamflow of less than 5 ft^3/s was measured in the Yampa River near Maybell. During periods of such low streamflow, irrigation structures and some stream reaches on the Yampa River may become barriers to the upstream return migration of Colorado squawfish (Hydrosphere Research Consultants, 1995).

The U.S. Geological Survey (USGS), in cooperation with the Colorado River Water Conservation District (CRWCD), began a study in 1996 to evaluate the hydraulic variables of minimum depth and maximum velocity for a range of streamflows at cross sections in three reaches of the lower Yampa River that have been identified as possible barriers to fish migration. A previous assessment of 119 potential barriers to migrating fish in the lower Yampa River indicated that the manmade structures most likely to impede migration of the Colorado squawfish during low-flow conditions were the Patrick Sweeney diversion structure downstream from Government Bridge and the Maybell Canal diversion structure in Juniper Canyon (Hydrosphere Research Consultants, 1995). An unresolved issue in that assessment was whether or not Cross Mountain Canyon (fig. 1) is a critical natural barrier to squawfish migration (Hydrosphere Research Consultants, 1995).

Cross-section geometry was obtained from field surveys or from available detailed topographic information for the diversion structures provided by CRWCD. Stream-channel geometry data were input to the Water-Surface PROfile (WSPRO) computation

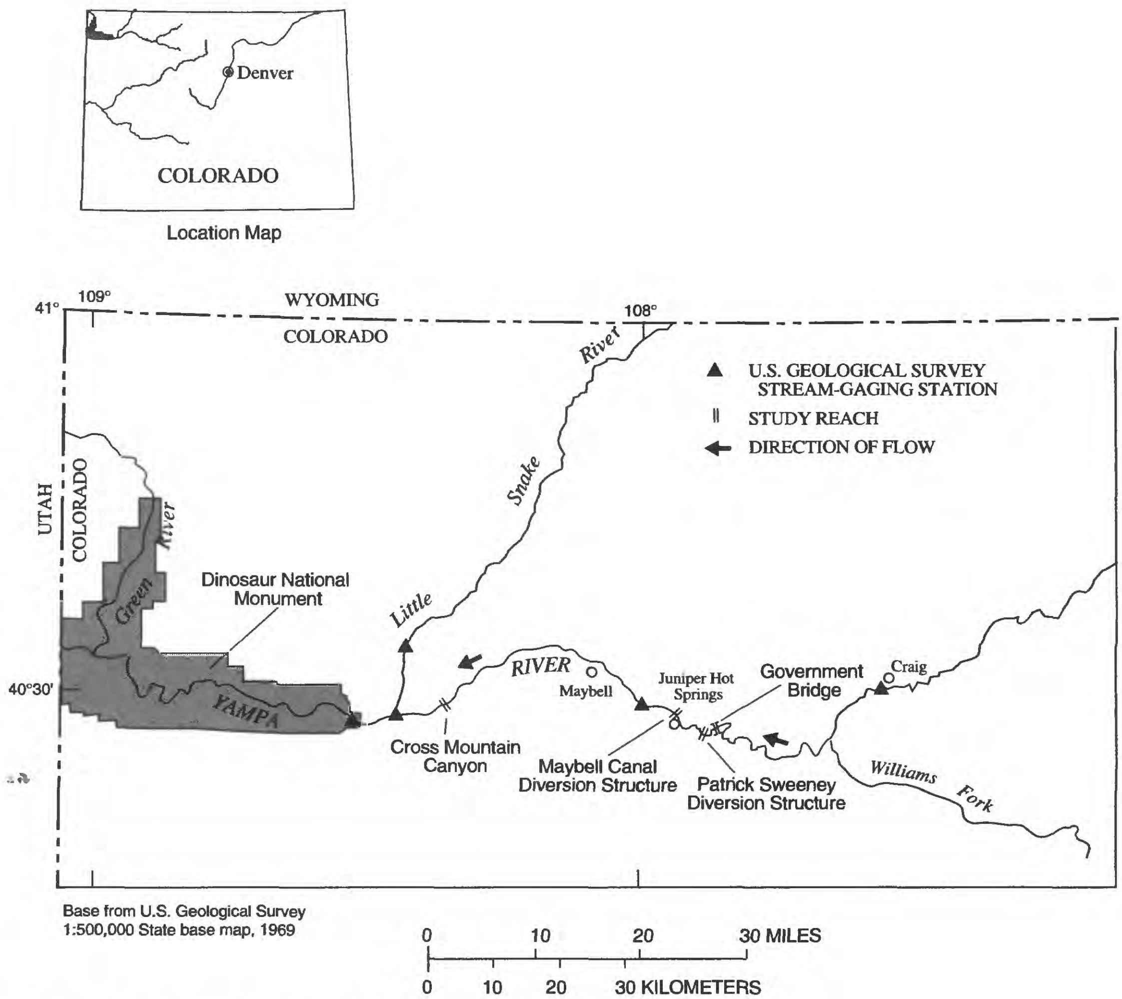


Figure 1. Location of the study area and study reaches.

program (Shearman, 1990). Output options of the program were used to generate depths and velocities for 20 separate stream tubes within each critical cross section for a range of streamflows from 50 to 400 ft^3/s. This report summarizes the hydraulic variables from the WSPRO computation output for cross sections in three reaches (Patrick Sweeney and Maybell Canal diversion structures and Cross Mountain Canyon) of the lower Yampa River.

The author extends his appreciation to Jeff B. Foster and Ken J. Leib, U.S. Geological Survey, Grand Junction, Colo., and David S. Mueller, U.S. Geological Survey, Louisville, Ky., for their technical knowledge and assistance in the difficult data-collection efforts within Cross Mountain Canyon. Ray Tenney, Colorado River Water Conservation District, Glenwood Springs, Colo., is gratefully acknowledged for his technical assistance and efforts in selecting the cross-section locations and for providing topographic data essential to the project.

DESCRIPTION OF THE STUDY REACHES

The three reaches selected for study are located on the lower segment of the Yampa River in northwestern Colorado (fig. 1). The Patrick Sweeney diversion structure is located about 8 mi upstream from the Maybell Canal diversion structure and about 28 mi upstream from Cross Mountain Canyon. The diversion structure is located in a broad valley, and the channel slope through this reach is less than 4.0 ft/mi. The vegetation consists of sparse grasses, sagebrush, and scattered willows.

The Maybell Canal diversion structure is located in Juniper Canyon about 20 mi upstream from Cross Mountain Canyon. Juniper Canyon is about 2 mi long, and the channel slope is less than 13.3 ft/mi. The canyon rim ranges in height from 200 to 400 ft above the river. Vegetation type and coverage is similar to that of the other study reaches.

Cross Mountain Canyon is the farthest downstream study reach and contains two subreaches. One subreach is located at the downstream end of the canyon and the other is located at the upstream end of the canyon. The Yampa River has a channel slope of about 4.0 ft/mi before entering the canyon and increases to about 57 ft/mi within the canyon. The canyon side slopes are very steep and are vertical in some places. The canyon is about 3.5 mi long, and the rim of the canyon ranges in height from 800 ft to more than 1,000 ft above the river. Vegetation within the canyon consists of sparse grasses, sagebrush, and occasional clumps of willows. The banks and streambed consist of rock fragments ranging in size from coarse gravel to room-sized boulders that create a very turbulent and irregular water surface at most streamflows.

METHODS OF DATA COLLECTION

Cross-section geometry of the reaches selected for study was obtained by using standard field-surveying techniques (Benson and Dalrymple, 1967), with modifications for the extreme velocities in Cross Mountain Canyon, or by using detailed topographic information for the Patrick Sweeney and the Maybell Canal diversion structures. Cross-section information used for WSPRO input at the Patrick Sweeney and the Maybell Canal diversion structures was obtained from 1-ft contour maps provided by CRWCD. The critical cross sections at the diversion structures were determined to be the cross sections along the top of the structures. This determination was based on the fact that diversion structures act as weirs and that shallower depths and greater velocities generally occur along the crest of the weir rather than in the natural stream channel. The critical cross section for the Patrick Sweeney diversion structure is shown in figure 2, and the critical cross section for the Maybell Canal diversion structure is shown in figure 3.

Aerial reconnaissance of Cross Mountain Canyon at a medium streamflow of about 2,500 ft^3/s and ground reconnaissance at a high streamflow of about 6,000 ft^3/s indicated that two subreaches located at the downstream and upstream ends of the canyon might impede squawfish migration. Within these two subreaches, critical cross sections having hydraulic properties of minimum depths and maximum velocities at lower streamflows that could impede squawfish migration were selected for detailed surveys. Selection was based on cross sections that had high velocities and large falls or drops in the water surface. Selection of the critical cross sections in Cross Mountain Canyon was verified during a ground reconnaissance at a streamflow of about 200 ft^3/s. The two subreaches within Cross Mountain Canyon were surveyed using a chart-recording fathometer and transducer mounted on a standard kneeboard used for water skiing. The kneeboard was suspended from one bank using 7-mm static rope and from the other bank using a Kevlar-wrapped transducer cable. The Kevlar wrapping provided the tensile strength to maintain the kneeboard on line during the cross-section traverse and prevented excessive strain on the transducer cable. The kneeboard was moved across the channel by hand, and stream depths were marked on the fathometer chart at known distances from the bank.

Five cross sections were surveyed in the subreach at the upstream end of Cross Mountain Canyon (fig. 4). Cross section 2 shown in figure 4 was located at the first major water-surface drop into the canyon and was determined to be the critical cross section, based on observation and verification by WSPRO computations. Three additional cross sections located downstream, about one channel width apart, were surveyed to aid in WSPRO computations and to verify selection of the critical cross section.

Two cross sections (6 and 7) were surveyed in the subreach at the downstream end of the canyon, about 0.25 mi upstream from the mouth of the canyon and are shown in figure 5. Cross section 7 (fig. 5) was determined to be the critical section in the downstream reach based on observation at the time of the survey. The WSPRO computations confirmed this determination.

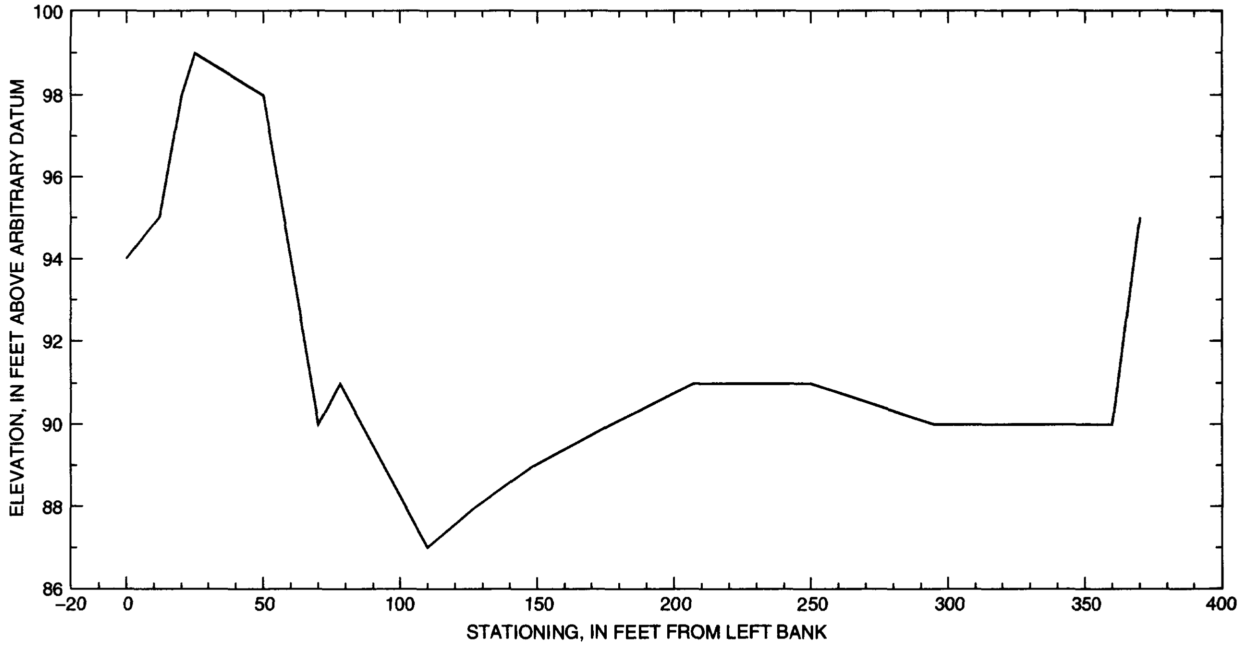


Figure 2. Cross-section geometry for the critical cross section at the Patrick Sweeney diversion structure.

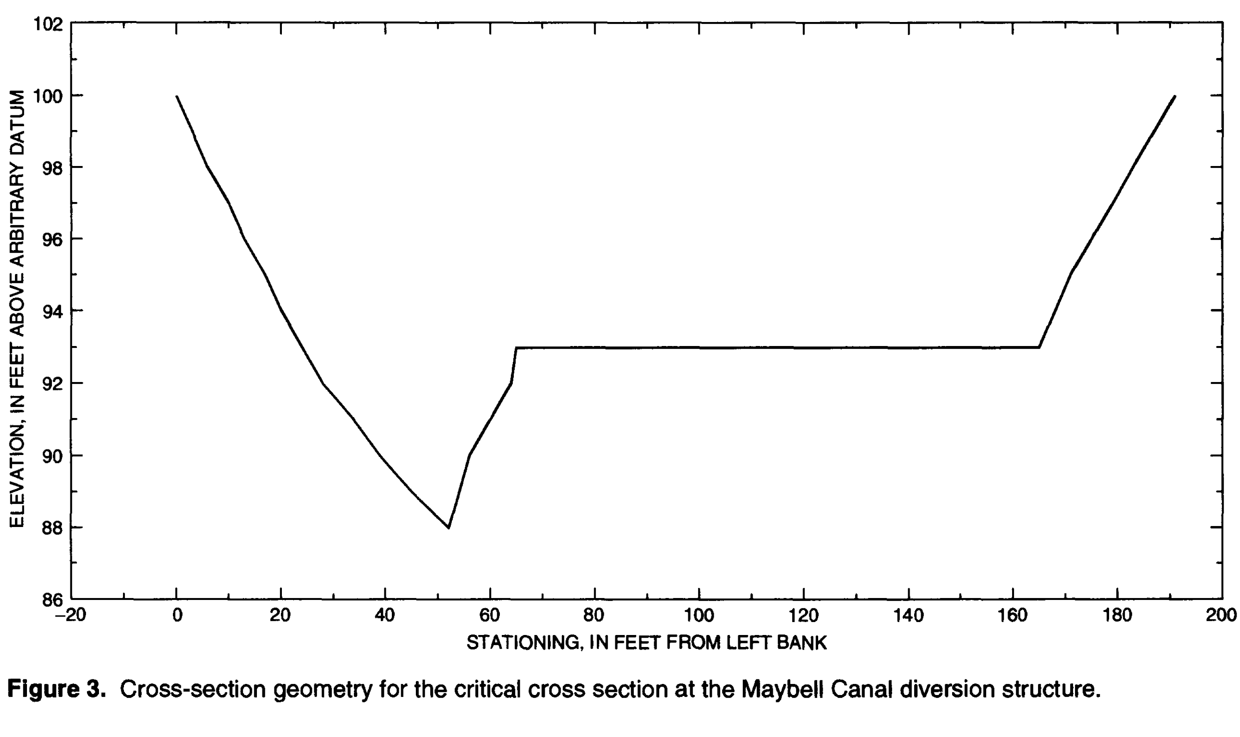


Figure 3. Cross-section geometry for the critical cross section at the Maybell Canal diversion structure.

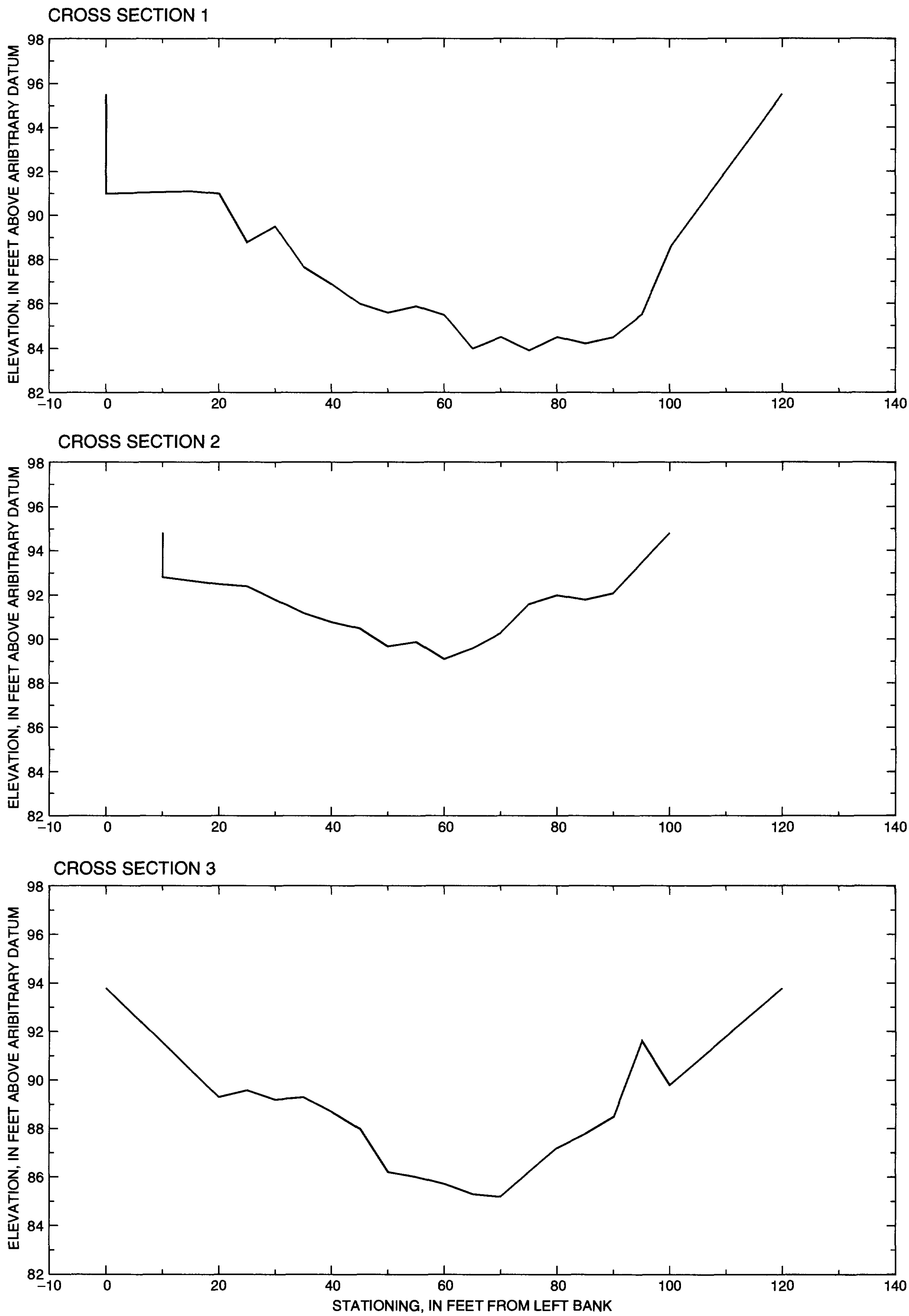
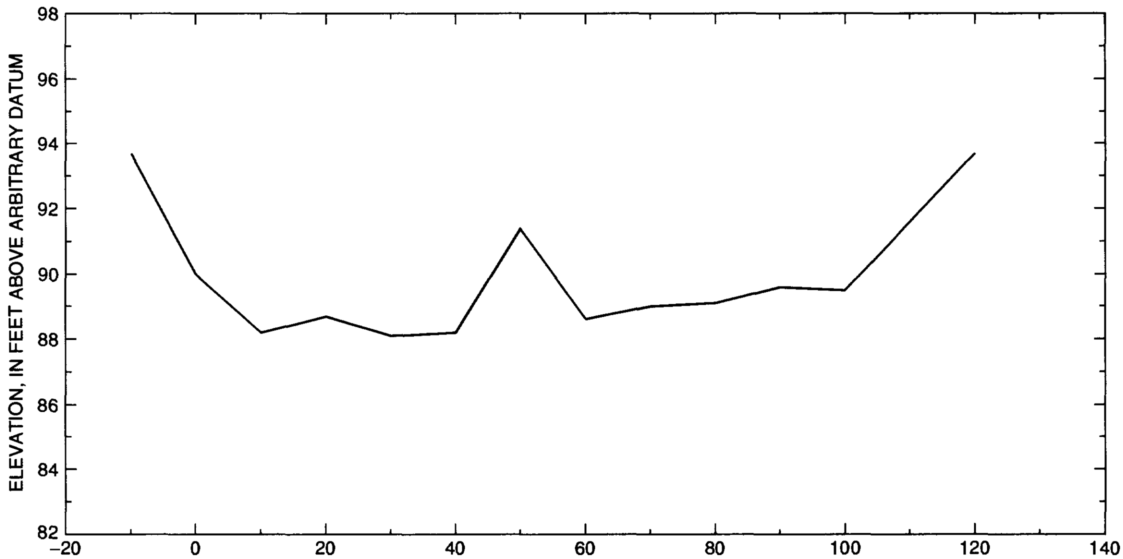


Figure 4. Cross-section geometry for the upstream cross sections in Cross Mountain Canyon.

CROSS SECTION 4



CROSS SECTION 5

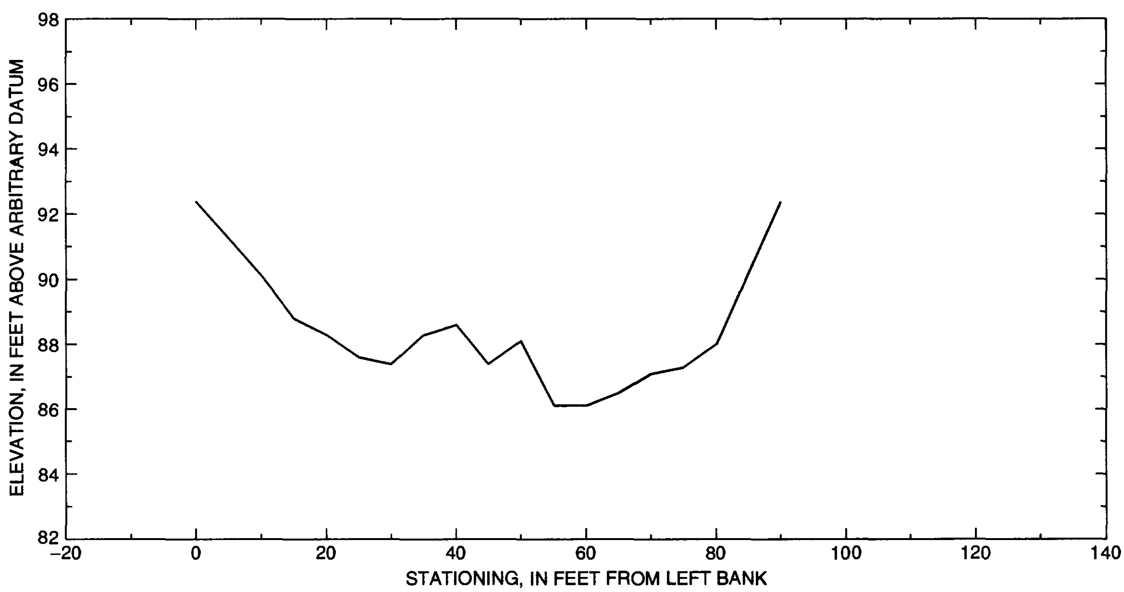


Figure 4. Cross-section geometry for the upstream cross sections in Cross Mountain Canyon—Continued.

MODEL DESCRIPTION AND APPLICATION

The WSPRO is a water-surface profile computer model that can be used to analyze one-dimensional, gradually varied, steady flow in an open channel. The model requires cross-section geometry and roughness characteristics determined from field surveys, contour maps, or other existing data. Roughness characteristics are specified by Manning's "*n*" values. Variable roughness coefficients can be specified to reflect roughness changes horizontally and vertically at any cross section. Roughness coefficients were assigned to each cross section based on experience of the field crew and guidelines from selected references (Barnes, 1967; Jarrett, 1985; Arcement and Schneider, 1989).

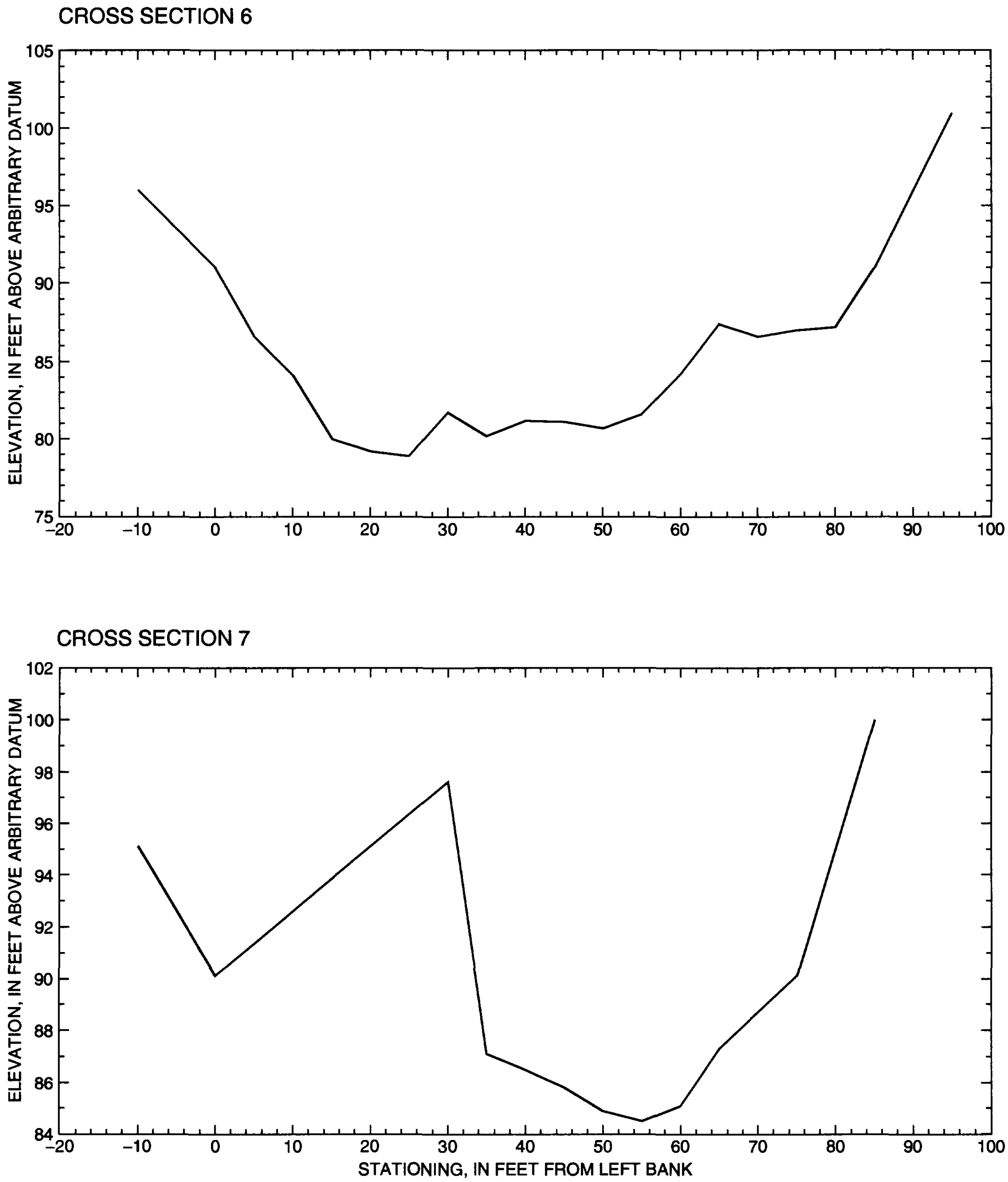


Figure 5. Cross-section geometry for the downstream cross sections in Cross Mountain Canyon.

The WSPRO computations were performed for cross sections in the three stream reaches (the Patrick Sweeney diversion structure, the Maybell Canal diversion structure, and the two subreaches in Cross Mountain Canyon) assuming streamflows ranging from 50 to 400 ft^3/s. This range of streamflows was chosen for analysis based on the assumption by State and Federal biologists (Modde and Smith, 1995) and CRWCD personnel that streamflows less than 50 ft^3/s would always present adverse conditions to squawfish migration and that streamflows greater than 400 ft^3/s would always present favorable conditions. Five percent of the streamflow being analyzed was assigned to a stream tube based on equal conveyance in accordance with the assumption of one-dimensional flow. Stream tubes are imaginary tubes bounded by streamlines. Because the streamflow between streamlines is constant, each stream tube carries a constant streamflow along its length. The WSPRO output data listed in the appendixes of this report include stationing, area, and velocity for 20 equal-conveyance stream tubes in the most critical cross section of each reach. Computed stream-tube depths are included in the WSPRO output as additional information. The depth of flow in each stream tube was determined by dividing the stream-tube area by the computed stream-tube width. The computed minimum stream-tube depth and maximum stream-tube velocity for each critical cross section in the Patrick Sweeney diversion structure, the Maybell Canal diversion structure, and the two subreaches of Cross Mountain Canyon are listed in table 1 for the single worst case

Table 1. Minimum stream-tube depths and maximum stream-tube velocities for the critical cross sections in the Patrick Sweeney diversion structure, the Maybell Canal diversion structure, and Cross Mountain Canyon

[ft^3/s, cubic feet per second; ft, feet; ft/s, feet per second. The velocity associated with the minimum depth and the depth associated with the maximum velocity are listed in parentheses. The two outside stream tubes are excluded]

Streamflow (ft^3/s)	Minimum depth (ft) and velocity (ft/s)	Maximum velocity (ft/s) and depth (ft)
	Critical section for the Patrick Sweeney diversion structure	
50	0.70 (3.51)	4.58 (1.00)
100	0.87 (3.82)	5.31 (1.29)
150	1.00 (3.80)	5.80 (1.62)
200	1.04 (4.08)	6.32 (1.60)
250	1.21 (4.27)	6.89 (1.80)
300	1.31 (4.43)	7.16 (2.10)
350	1.37 (4.69)	7.59 (2.09)
400	1.45 (4.77)	7.82 (2.36)
	Critical section for the Maybell Canal diversion structure	
50	0.50 (4.55)	4.67 (0.56)
100	0.80 (5.98)	6.01 (0.89)
150	1.10 (6.66)	6.76 (1.22)
200	1.27 (6.96)	7.40 (1.40)
250	1.42 (7.40)	7.91 (1.45)
300	1.46 (7.70)	8.31 (1.80)
350	1.69 (8.04)	8.78 (1.82)
400	1.67 (7.97)	9.09 (1.83)
	Critical upstream section in Cross Mountain Canyon	
50	0.71 (5.11)	6.20 (1.33)
100	0.87 (3.80)	6.54 (1.60)
150	1.05 (3.65)	6.45 (2.00)
200	1.27 (3.60)	6.08 (2.29)
250	1.31 (3.67)	5.05 (2.78)
300	1.48 (3.79)	5.18 (2.90)
350	1.62 (3.75)	5.12 (3.09)
400	2.00 (4.21)	4.95 (3.08)
	Critical downstream section in Cross Mountain Canyon	
50	0.50 (2.78)	5.01 (1.25)
100	0.86 (4.07)	5.67 (1.80)
150	1.23 (4.71)	6.21 (2.00)
200	1.58 (5.24)	6.60 (2.50)
250	1.69 (5.57)	7.03 (2.25)
300	1.86 (5.81)	7.56 (2.50)
350	1.94 (5.66)	7.96 (3.14)
400	2.12 (5.94)	8.16 (3.12)

stream tube (shallowest depth or fastest velocity) for the range of streamflows analyzed. The two outside stream tubes were not considered as having the minimum depth in the cross section. These stream tubes typically represent wide, shallow parts of the stream channel at the edges of the water.

Detailed output from each WSPRO computation at the critical cross sections in the three reaches is included in the appendixes. The stream tube that contained the maximum velocity did not always have the minimum depth. Graphs of the computed data were prepared as an aid to the users in determining the streamflows that would have the most adverse effect (minimum depths or maximum velocities, or both) on migrating squawfish. Individual stream-tube depths were plotted against the stream-tube velocities for various streamflows at each critical cross section. Relation of stream-tube depths to velocities are shown for the Patrick Sweeney diversion structure in figure 6, for the Maybell Canal diversion structure in figure 7, for the upstream reach in Cross Mountain Canyon in figure 8, and for the downstream reach in Cross Mountain Canyon in figure 9.

The scope of the study did not provide for field verification of the hydraulic conditions determined by WSPRO computations. Field verification of hydraulic conditions within the range of streamflows studied would be beneficial to water managers during the Colorado squawfish migration seasons. A streamflow-duration analysis of the lower Yampa River would provide biologists and water managers with time frames and streamflow magnitudes of depths and velocities that may impede the squawfish migrations.

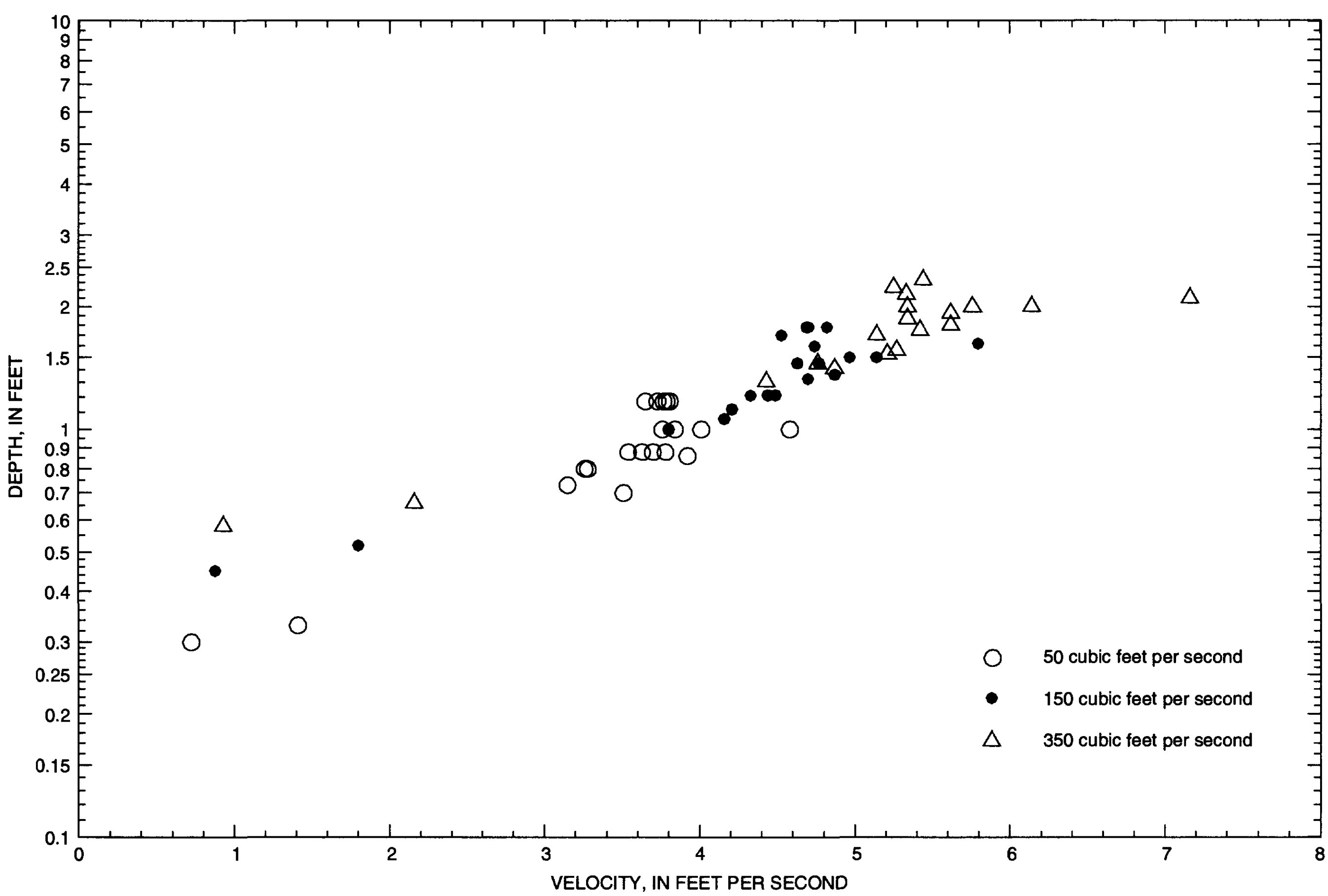


Figure 6. Relation of stream-tube depths to velocities at the critical cross section at the Patrick Sweeney diversion structure.

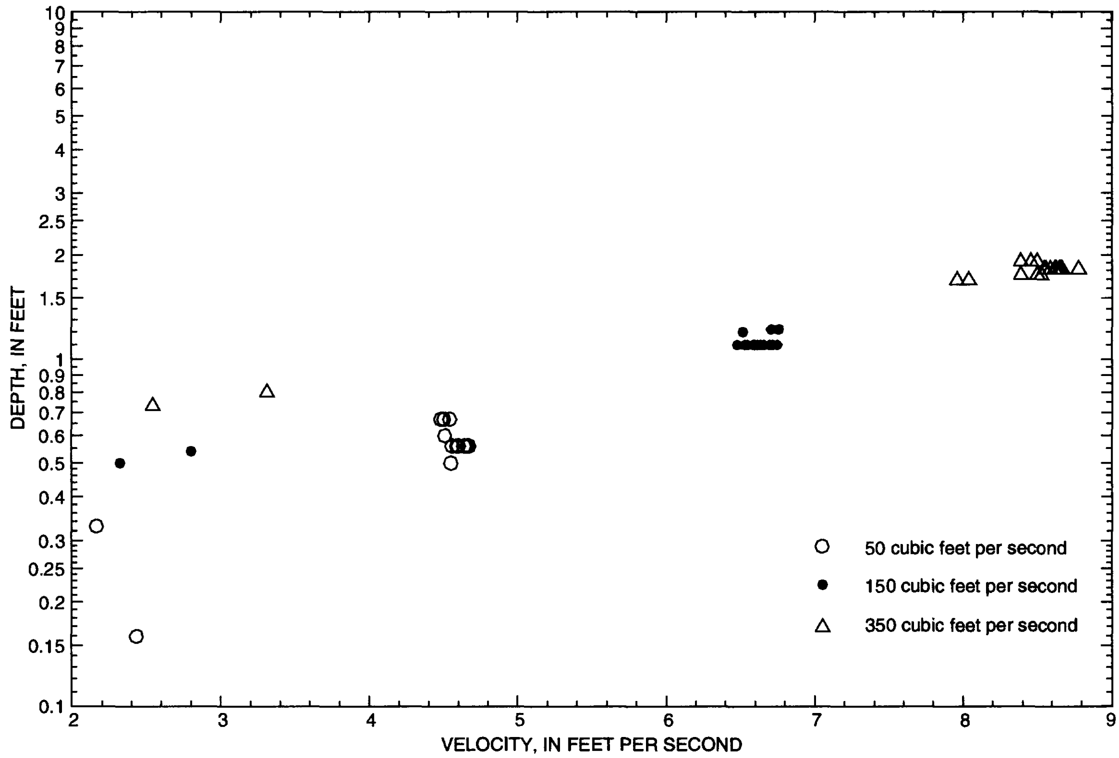


Figure 7. Relation of stream-tube depths to velocities at the critical cross section at the Maybell Canal diversion structure.

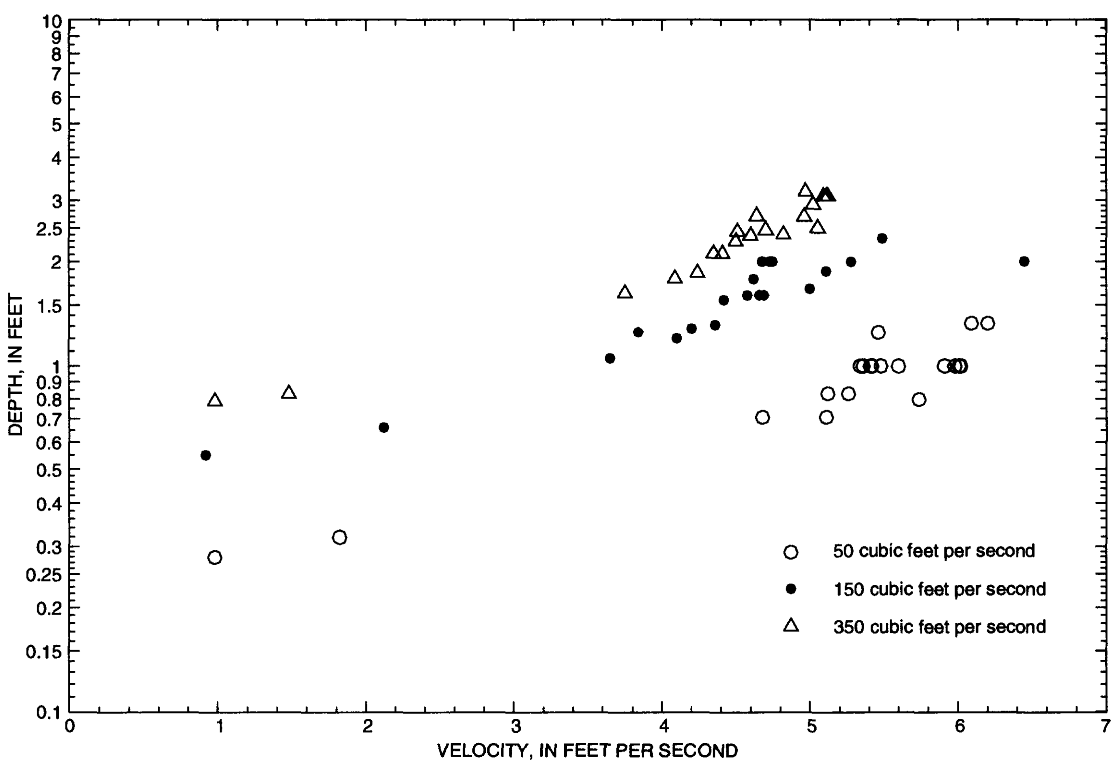


Figure 8. Relation of stream-tube depths to velocities at the critical upstream cross section in Cross Mountain Canyon.

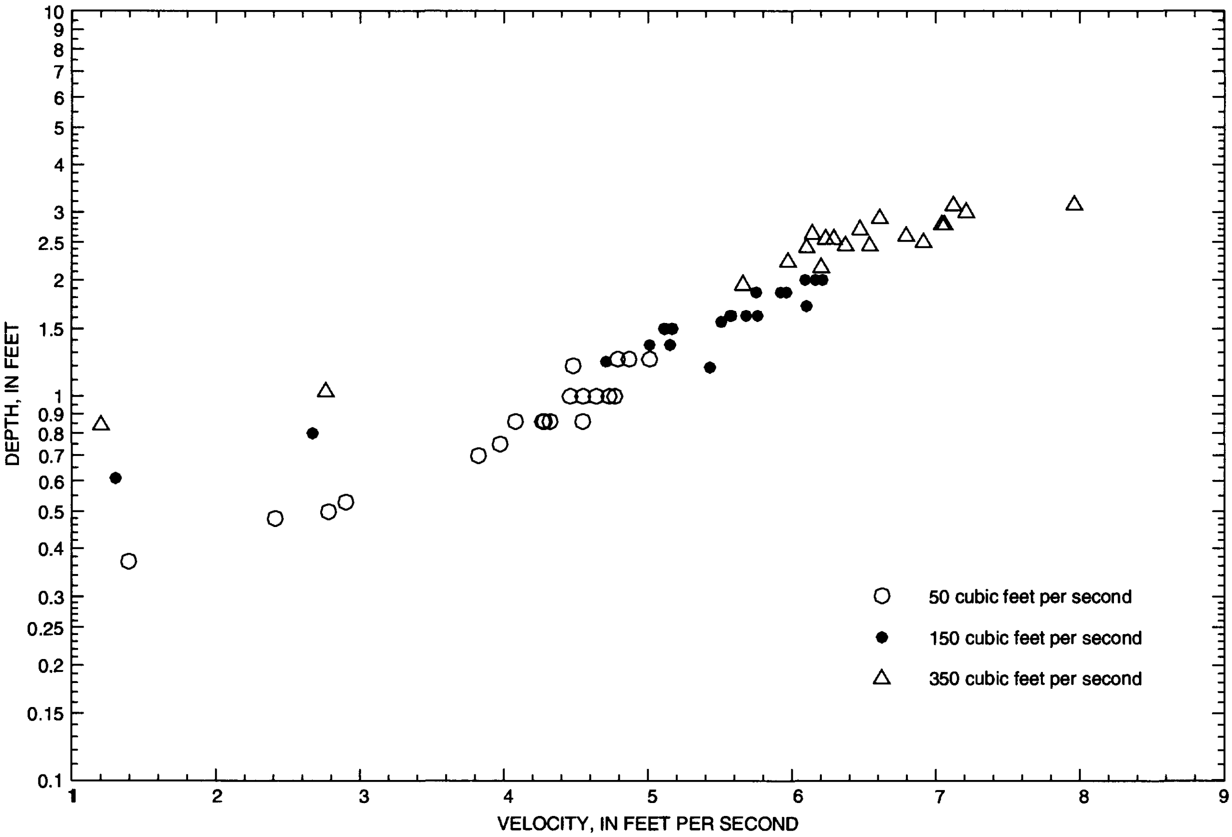


Figure 9. Relation of stream-tube depths to velocities at the critical downstream cross section in Cross Mountain Canyon.

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APPENDIXES

List of Abbreviations for Appendixes

Abbreviation	Definition
AREA (A)	Flow area of a cross section for a specified streamflow, in square feet.
DEPTH	Depth of flow, in feet.
K	Conveyance of a cross section for a specified streamflow, in feet.
LEW	Left edge of water in a cross section for a specified streamflow, in feet.
Q	Streamflow specified for the stream-tube velocity and area distribution, in cubic feet per second.
REW	Right edge of water in a cross section for a specified streamflow, in feet.
SECID	Cross-section identifier or name.
VEL (V)	Velocity in a cross section for a specified streamflow, in feet per second.
WSEL	Computed water-surface elevation in a cross section for a specified streamflow, in feet.
WSPRO	Water-Surface PROfile.
X STA.	Cross-section stationing of the edges of the individual stream tubes from left bank to right bank, in feet.

APPENDIX 1. WSPRO OUTPUT FOR THE CRITICAL SECTION OF THE PATRICK SWEENEY DIVERSION STRUCTURE

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

         WSPRO COMPUTATIONS FOR PATRICK SWEENEY DIVERSION -- YAMPA RIVER
          ENDANGERED FISH RECOVERY PROGRAM


     VELOCITY DISTRIBUTION:              SECID = SEC3

          WSEL      LEW      REW     AREA         K         Q     VEL
         88.16    100.7    131.4     17.5      298.       50.   2.86

 X STA.        100.7       106.1       107.1       107.9       108.7       109.3
   A(I)               1.8         0.8         0.7         0.7         0.7
   V(I)              1.41        3.26        3.54        3.70        3.79
 Depth               0.33        0.80        0.88        0.88        1.17

 X STA.        109.3       109.9       110.5       111.1       111.7       112.3
   A(I)               0.7         0.7         0.7         0.7         0.6
   V(I)              3.77        3.81        3.73        3.65        4.01
 Depth               1.17        1.17        1.17        1.17        1.00

 X STA.        112.3       112.8       113.5       114.2       114.9       115.7
   A(I)               0.5         0.6         0.7         0.7         0.7
   V(I)              4.58        3.92        3.84        3.76        3.78
 Depth               1.00        0.86        1.00        1.00        0.88

 X STA.        115.7       116.5       117.5       118.5       119.7       131.4
   A(I)               0.7         0.7         0.8         0.8         3.5
   V(I)              3.63        3.51        3.28        3.15        0.72
 Depth               0.88        0.70        0.80        0.73        0.30


     VELOCITY DISTRIBUTION:              SECID = SEC3

          WSEL      LEW      REW     AREA         K         Q     VEL
         88.52     97.8    138.9     30.3      615.      100.   3.30

 X STA.         97.8       104.9       106.2       107.3       108.2       109.1
   A(I)               3.1         1.3         1.2         1.2         1.1
   V(I)              1.63        3.88        4.21        4.16        4.38
 Depth               0.44        1.00        1.09        1.33        1.22

 X STA.        109.1       109.9       110.7       111.4       112.3       113.1
   A(I)               1.1         1.2         1.2         1.2         1.1
   V(I)              4.36        4.34        4.34        4.25        4.67
 Depth               1.38        1.50        1.71        1.33        1.22
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```
X STA.       113.1      113.8      114.6      115.5      116.5      117.5
  A(I)             0.9        1.1        1.1        1.1        1.2
  V(I)            5.31       4.55       4.46       4.54       4.25
Depth             1.29       1.38       1.22       1.10       1.20

X STA.       117.5      118.6      119.8      121.3      122.9      138.9
  A(I)             1.2        1.2        1.3        1.4        6.2
  V(I)            4.23       4.09       3.82       3.58       0.81
Depth             1.09       1.00       0.87       0.88       0.39


    VELOCITY DISTRIBUTION:                SECID = SEC3

        WSEL      LEW      REW     AREA          K         Q     VEL
       88.78     95.8    144.4     41.9       944.      150.    3.58

X STA.        95.8      103.9      105.5      106.9      108.0      109.0
  A(I)             4.2        1.8        1.7        1.6        1.6
  V(I)            1.80       4.21       4.33       4.63       4.74
Depth             0.52       1.12       1.21       1.45       1.60

X STA.       109.0      109.9      110.8      111.7      112.7      113.7
  A(I)             1.6        1.6        1.6        1.7        1.5
  V(I)            4.82       4.69       4.70       4.53       5.14
Depth             1.78       1.78       1.78       1.70       1.50

X STA.       113.7      114.5      115.5      116.6      117.7      118.9
  A(I)             1.3        1.5        1.5        1.6        1.6
  V(I)            5.80       4.97       4.87       4.77       4.70
Depth             1.62       1.50       1.36       1.45       1.33

X STA.       118.9      120.3      121.7      123.4      125.4      144.4
  A(I)             1.7        1.7        1.8        2.0        8.6
  V(I)            4.49       4.44       4.16       3.80       0.88
Depth             1.21       1.21       1.06       1.00       0.45


    VELOCITY DISTRIBUTION:                SECID = SEC3

        WSEL      LEW      REW     AREA          K         Q     VEL
       88.98     94.2    148.6     52.2      1262.      200.    3.83

X STA.        94.2      103.3      105.1      106.5      107.8      108.9
  A(I)             5.2        2.2        2.1        2.0        2.0
  V(I)            1.93       4.50       4.75       4.95       5.06
Depth             0.57       1.22       1.50       1.54       1.82

X STA.       108.9      109.9      110.9      112.0      113.1      114.1
  A(I)             1.9        2.0        2.0        2.1        1.8
  V(I)            5.14       5.02       5.04       4.85       5.51
Depth             1.90       2.00       1.82       1.91       1.80

X STA.       114.1      115.1      116.2      117.4      118.7      120.1
  A(I)             1.6        1.9        1.9        2.0        2.0
  V(I)            6.32       5.25       5.22       5.12       5.05
Depth             1.60       1.73       1.58       1.54       1.43
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X STA.       120.1       121.6       123.2       125.2       127.5       148.6
  A(I)             2.1         2.1         2.3         2.4        10.6
  V(I)            4.83        4.66        4.35        4.08        0.95
Depth             1.40        1.31        1.15        1.04        0.50
```

```
    VELOCITY DISTRIBUTION:              SECID = SEC3

         WSEL      LEW      REW     AREA          K         Q     VEL
        89.17     92.6    153.8     63.1      1603.      250.    3.96

X STA.        92.6       102.6       104.5       106.1       107.5       108.8
  A(I)             6.1         2.7         2.5         2.4         2.4
  V(I)            2.04        4.69        4.94        5.14        5.14
Depth             0.61        1.42        1.56        1.71        1.85

X STA.       108.8       109.9       111.0       112.2       113.4       114.5
  A(I)             2.3         2.4         2.4         2.5         2.2
  V(I)            5.35        5.21        5.11        5.10        5.79
Depth             2.09        2.18        2.00        2.08        2.00

X STA.       114.5       115.5       116.7       118.0       119.4       120.9
  A(I)             1.8         2.3         2.3         2.3         2.4
  V(I)            6.89        5.54        5.40        5.41        5.21
Depth             1.80        1.92        1.77        1.64        1.60

X STA.       120.9       122.5       124.3       126.4       128.8       153.8
  A(I)             2.5         2.6         2.7         2.9        13.4
  V(I)            5.07        4.89        4.67        4.27        0.93
Depth             1.56        1.44        1.29        1.21        0.54
```

```
    VELOCITY DISTRIBUTION:              SECID = SEC3

         WSEL      LEW      REW     AREA          K         Q     VEL
        89.33     91.4    158.2     73.3      1937.      300.    4.09

X STA.        91.4       101.9       104.1       105.8       107.3       108.7
  A(I)             6.9         3.2         2.9         2.8         2.8
  V(I)            2.16        4.76        5.14        5.34        5.34
Depth             0.66        1.45        1.71        1.87        2.00

X STA.       108.7       109.9       111.1       112.4       113.7       114.9
  A(I)             2.8         2.8         2.8         2.9         2.4
  V(I)            5.44        5.44        5.33        5.25        6.14
Depth             2.33        2.33        2.15        2.23        2.00

X STA.       114.9       115.9       117.2       118.6       120.1       121.7
  A(I)             2.1         2.6         2.7         2.7         2.8
  V(I)            7.16        5.76        5.62        5.62        5.42
Depth             2.10        2.00        1.93        1.80        1.75

X STA.       121.7       123.5       125.4       127.6       130.2       158.2
  A(I)             2.8         2.9         3.1         3.4        16.1
  V(I)            5.27        5.21        4.87        4.43        0.93
Depth             1.56        1.53        1.41        1.31        0.58
```

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
89.47	90.2	162.2	83.0	2269.	350.	4.22

X STA.	90.2		101.5		103.7		105.6		107.2		108.6
A(I)		7.8		3.5		3.4		3.2		3.1	
V(I)		2.23		5.05		5.17		5.52		5.64	
Depth		0.69		1.59		1.79		2.00		2.21	
X STA.	108.6		109.9		111.2		112.5		114.0		115.2
A(I)		3.1		3.1		3.2		3.2		2.8	
V(I)		5.61		5.61		5.50		5.41		6.34	
Depth		2.38		2.38		2.46		2.13		2.33	
X STA.	115.2		116.3		117.7		119.2		120.8		122.5
A(I)		2.3		3.0		3.0		3.0		3.1	
V(I)		7.59		5.91		5.85		5.85		5.64	
Depth		2.09		2.14		2.14		1.88		1.82	
X STA.	122.5		124.3		126.4		128.8		131.5		162.2
A(I)		3.2		3.3		3.6		3.7		18.5	
V(I)		5.49		5.29		4.93		4.69		0.95	
Depth		1.78		1.57		1.50		1.37		0.60	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
89.61	89.1	166.1	93.4	2640.	400.	4.28

X STA.	89.1		100.9		103.4		105.3		107.0		108.5
A(I)		8.6		4.0		3.7		3.6		3.6	
V(I)		2.31		5.01		5.40		5.60		5.59	
Depth		0.73		1.60		1.95		2.12		2.40	
X STA.	108.5		109.9		111.3		112.8		114.3		115.6
A(I)		3.4		3.5		3.7		3.6		3.1	
V(I)		5.82		5.69		5.45		5.56		6.51	
Depth		2.43		2.50		2.47		2.40		2.38	
X STA.	115.6		116.7		118.2		119.8		121.5		123.3
A(I)		2.6		3.3		3.3		3.4		3.5	
V(I)		7.82		6.09		6.02		5.80		5.76	
Depth		2.36		2.20		2.07		2.00		1.94	
X STA.	123.3		125.3		127.5		130.0		132.9		166.1
A(I)		3.6		3.8		3.9		4.2		21.1	
V(I)		5.60		5.27		5.14		4.77		0.95	
Depth		1.80		1.73		1.56		1.45		0.64	

APPENDIX 2. WSPRO OUTPUT FOR THE CRITICAL SECTION OF THE MAYBELL CANAL DIVERSION STRUCTURE

```
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        WSPRO COMPUTATIONS FOR MAYBELL CANAL DIVERSION -- YAMPA RIVER
        ENDANGERED FISH RECOVERY PROGRAM


    VELOCITY DISTRIBUTION:              SECID = SEC3

         WSEL      LEW      REW     AREA         K          Q     VEL
        90.69     35.6     58.8     12.0      210.        50.    4.16

X STA.        35.6        39.2        40.1        41.0        41.9        42.8
  A(I)             1.2         0.5         0.5         0.5         0.6
  V(I)            2.16        4.67        4.59        4.66        4.54
Depth             0.33        0.56        0.56        0.56        0.67

X STA.        42.8        43.8        44.7        45.6        46.5        47.4
  A(I)             0.6         0.5         0.5         0.5         0.5
  V(I)            4.51        4.60        4.67        4.56        4.56
Depth             0.60        0.56        0.56        0.56        0.56

X STA.        47.4        48.3        49.2        50.2        51.1        52.0
  A(I)             0.5         0.5         0.6         0.5         0.6
  V(I)            4.56        4.56        4.51        4.64        4.48
Depth             0.56        0.56        0.60        0.56        0.67

X STA.        52.0        52.9        53.8        54.8        55.7        58.8
  A(I)             0.5         0.6         0.5         0.5         1.0
  V(I)            4.64        4.50        4.55        4.64        2.43
Depth             0.56        0.67        0.50        0.56        0.16

    VELOCITY DISTRIBUTION:              SECID = SEC3

         WSEL      LEW      REW     AREA         K          Q     VEL
        91.03     33.8     60.1     19.3      426.       100.    5.18

X STA.        33.8        38.8        39.7        40.7        41.6        42.6
  A(I)             2.1         0.8         0.9         0.9         0.8
  V(I)            2.36        6.01        5.88        5.81        5.98
Depth             0.42        0.89        0.90        1.00        0.80

X STA.        42.6        43.6        44.5        45.4        46.4        47.4
  A(I)             0.9         0.8         0.8         0.9         0.9
  V(I)            5.78        5.89        5.99        5.85        5.85
Depth             0.90        0.89        0.89        0.90        0.90

X STA.        47.4        48.3        49.3        50.2        51.2        52.2
  A(I)             0.9         0.9         0.9         0.8         0.9
  V(I)            5.85        5.85        5.78        5.95        5.74
Depth             1.00        0.90        1.00        0.80        0.90
```

X STA.	52.2	53.1	54.1	55.0	56.0	60.1
A(I)	0.8	0.8	0.9	0.9	1.9	
V(I)	5.94	5.96	5.87	5.74	2.70	
Depth	0.89	0.80	1.00	0.90	0.46	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
91.32	32.1	61.3	26.3	663.	150.	5.71

X STA.	32.1	38.5	39.5	40.5	41.4	42.4
A(I)	3.2	1.1	1.1	1.1	1.1	
V(I)	2.32	6.66	6.66	6.76	6.75	
Depth	0.50	1.10	1.10	1.22	1.10	

X STA.	42.4	43.4	44.4	45.4	46.4	47.4
A(I)	1.2	1.1	1.1	1.1	1.1	
V(I)	6.52	6.64	6.75	6.59	6.59	
Depth	1.20	1.10	1.10	1.10	1.10	

X STA.	47.4	48.4	49.4	50.3	51.3	52.3
A(I)	1.1	1.1	1.1	1.1	1.2	
V(I)	6.55	6.55	6.71	6.60	6.48	
Depth	1.10	1.10	1.22	1.10	1.10	

X STA.	52.3	53.3	54.3	55.3	56.3	61.3
A(I)	1.1	1.1	1.1	1.1	2.7	
V(I)	6.70	6.72	6.62	6.53	2.80	
Depth	1.10	1.10	1.10	1.10	0.54	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
91.56	30.6	62.2	32.6	901.	200.	6.14

X STA.	30.6	38.1	39.2	40.2	41.2	42.2
A(I)	4.2	1.4	1.4	1.4	1.4	
V(I)	2.37	6.96	7.29	7.40	7.21	
Depth	0.55	1.27	1.40	1.40	1.40	

X STA.	42.2	43.2	44.3	45.3	46.3	47.3
A(I)	1.4	1.4	1.4	1.4	1.4	
V(I)	7.31	7.27	7.39	7.21	7.21	
Depth	1.40	1.27	1.40	1.40	1.40	

X STA.	47.3	48.3	49.4	50.4	51.4	52.5
A(I)	1.4	1.4	1.4	1.4	1.4	
V(I)	7.18	7.18	7.10	7.30	7.05	
Depth	1.40	1.27	1.40	1.40	1.27	

X STA.	52.5	53.5	54.5	55.5	56.6	62.2
A(I)	1.4	1.4	1.4	1.4	3.5	
V(I)	7.30	7.32	7.20	7.24	2.89	
Depth	1.40	1.40	1.40	1.27	0.62	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
91.77	29.4	63.1	38.5	1140.	250.	6.49

X STA.	29.4	37.7	38.9	39.9	41.0	42.0
A(I)	5.2	1.7	1.6	1.6	1.6	
V(I)	2.41	7.40	7.79	7.91	7.71	
Depth	0.63	1.42	1.60	1.45	1.60	

X STA.	42.0	43.1	44.1	45.2	46.2	47.3
A(I)	1.6	1.6	1.6	1.6	1.6	
V(I)	7.81	7.77	7.89	7.71	7.71	
Depth	1.45	1.60	1.45	1.60	1.45	

X STA.	47.3	48.3	49.4	50.5	51.5	52.6
A(I)	1.6	1.6	1.6	1.6	1.6	
V(I)	7.62	7.62	7.80	7.68	7.72	
Depth	1.60	1.45	1.45	1.60	1.45	

X STA.	52.6	53.6	54.7	55.8	56.9	63.1
A(I)	1.6	1.6	1.6	1.6	4.2	
V(I)	7.62	7.82	7.70	7.61	3.00	
Depth	1.60	1.45	1.45	1.45	0.68	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
91.97	28.2	63.9	44.5	1396.	300.	6.74

X STA.	28.2	37.3	38.6	39.7	40.8	41.8
A(I)	6.2	1.9	1.8	1.9	1.8	
V(I)	2.42	7.70	8.22	8.07	8.31	
Depth	0.68	1.46	1.64	1.73	1.80	

X STA.	41.8	42.9	44.0	45.0	46.1	47.2
A(I)	1.8	1.8	1.8	1.9	1.9	
V(I)	8.18	8.14	8.27	8.08	8.08	
Depth	1.64	1.64	1.80	1.73	1.73	

X STA.	47.2	48.3	49.4	50.5	51.6	52.7
A(I)	1.9	1.9	1.9	1.9	1.8	
V(I)	8.04	8.04	7.95	8.01	8.25	
Depth	1.73	1.73	1.73	1.73	1.64	

X STA.	52.7	53.8	54.9	55.9	57.1	63.9
A(I)	1.9	1.8	1.9	1.9	4.9	
V(I)	7.98	8.19	8.07	7.86	3.06	
Depth	1.73	1.64	1.90	1.58	0.72	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
92.12	27.5	64.1	49.2	1621.	350.	7.11

X STA.	27.5		37.0		38.3		39.5		40.6		41.7
A(I)		6.9		2.2		2.1		2.0		2.0	
V(I)		2.54		8.04		8.50		8.78		8.55	
Depth		0.73		1.69		1.75		1.82		1.82	

X STA.	41.7		42.8		43.9		45.0		46.1		47.2
A(I)		2.0		2.0		2.0		2.0		2.0	
V(I)		8.67		8.62		8.56		8.66		8.66	
Depth		1.82		1.82		1.82		1.82		1.82	

X STA.	47.2		48.3		49.5		50.6		51.7		52.8
A(I)		2.1		2.1		2.0		2.1		2.1	
V(I)		8.39		8.39		8.59		8.46		8.50	
Depth		1.91		1.75		1.82		1.91		1.91	

X STA.	52.8		53.9		55.0		56.2		57.5		64.1
A(I)		2.0		2.0		2.1		2.2		5.3	
V(I)		8.63		8.65		8.53		7.96		3.31	
Depth		1.82		1.82		1.75		1.69		0.80	

VELOCITY DISTRIBUTION: SECID = SEC3

WSEL	LEW	REW	AREA	K	Q	VEL
92.28	26.9	64.3	54.4	1881.	400.	7.36

X STA.	26.9		36.6		38.1		39.2		40.4		41.5
A(I)		7.6		2.5		2.2		2.2		2.3	
V(I)		2.62		7.97		8.93		9.09		8.86	
Depth		0.78		1.67		2.00		1.83		2.09	

X STA.	41.5		42.6		43.8		44.9		46.0		47.2
A(I)		2.2		2.2		2.3		2.2		2.2	
V(I)		8.98		8.93		8.86		8.97		8.97	
Depth		2.00		1.83		2.09		2.00		1.83	

X STA.	47.2		48.3		49.5		50.6		51.8		53.0
A(I)		2.3		2.3		2.3		2.3		2.3	
V(I)		8.67		8.67		8.87		8.73		8.78	
Depth		2.09		1.92		2.09		1.92		1.92	

X STA.	53.0		54.1		55.2		56.4		57.8		64.3
A(I)		2.2		2.2		2.3		2.5		5.7	
V(I)		8.91		8.93		8.85		8.15		3.51	
Depth		2.00		2.00		1.92		1.79		0.88	

APPENDIX 3. WSPRO OUTPUT FOR THE CRITICAL UPSTREAM SECTION OF CROSS MOUNTAIN CANYON

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WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

WSPRO COMPUTATIONS FOR THE YAMPA RIVER -- CROSS MTN. CANYON UPSTREAM REACH
          ENDANGERED FISH RECOVERY PROGRAM
```

VELOCITY DISTRIBUTION: SECID = SEC2

WSEL	LEW	REW	AREA	K	Q	VEL
90.31	48.2	70.0	12.1	100.	50.	4.15

X STA.	48.2		57.0		57.6		58.1		58.6		59.0
A(I)		2.5		0.5		0.5		0.4		0.4	
V(I)		0.98		5.26		5.48		5.74		5.91	
Depth		0.28		0.83		1.00		0.80		1.00	
X STA.	59.0		59.4		59.8		60.1		60.5		60.8
A(I)		0.4		0.4		0.4		0.4		0.4	
V(I)		5.98		6.01		6.09		6.02		6.20	
Depth		1.00		1.00		1.33		1.00		1.33	
X STA.	60.8		61.2		61.6		62.1		62.6		63.1
A(I)		0.4		0.5		0.5		0.5		0.5	
V(I)		5.60		5.46		5.42		5.41		5.36	
Depth		1.00		1.25		1.00		1.00		1.00	
X STA.	63.1		63.6		64.2		64.9		65.6		70.0
A(I)		0.5		0.5		0.5		0.5		1.4	
V(I)		5.34		5.12		5.11		4.68		1.82	
Depth		1.00		0.83		0.71		0.71		0.32	

VELOCITY DISTRIBUTION: SECID = SEC2

WSEL	LEW	REW	AREA	K	Q	VEL
90.86	39.3	72.2	27.2	296.	100.	3.68

X STA.	39.3		53.1		54.6		55.8		56.7		57.5
A(I)		6.0		1.3		1.2		1.1		1.0	
V(I)		0.84		3.80		4.10		4.63		4.91	
Depth		0.43		0.87		1.00		1.21		1.25	
X STA.	57.5		58.2		58.8		59.4		59.9		60.4
A(I)		1.0		0.9		0.9		0.9		0.8	
V(I)		5.09		5.31		5.31		5.53		6.54	
Depth		1.43		1.50		1.50		1.80		1.60	
X STA.	60.4		60.9		61.6		62.2		62.9		63.7
A(I)		0.9		1.1		1.1		1.1		1.0	
V(I)		5.53		4.75		4.66		4.76		4.77	
Depth		1.80		1.57		1.83		1.57		1.25	

```
 X STA.        63.7       64.5       65.3       66.3       67.6       72.2
   A(I)              1.1        1.1        1.1        1.2        2.4
   V(I)             4.63       4.53       4.49       4.10       2.09
Depth               1.38       1.38       1.10       0.92       0.52


     VELOCITY DISTRIBUTION:              SECID = SEC2

          WSEL      LEW      REW     AREA         K         Q     VEL
         91.24     34.7     73.6     40.9      521.      150.    3.67

 X STA.        34.7       49.5       51.5       53.1       54.5       55.8
   A(I)              8.1        2.1        2.0        1.8        1.7
   V(I)             0.92       3.65       3.84       4.20       4.36
 Depth              0.55       1.05       1.25       1.28       1.31

 X STA.        55.8       56.8       57.7       58.5       59.2       59.8
   A(I)              1.6        1.5        1.5        1.4        1.2
   V(I)             4.69       5.00       5.11       5.28       6.45
 Depth              1.60       1.67       1.88       2.00       2.00

 X STA.        59.8       60.4       61.2       62.0       62.8       63.7
   A(I)              1.4        1.6        1.6        1.6        1.6
   V(I)             5.49       4.68       4.75       4.73       4.62
 Depth              2.33       2.00       2.00       2.00       1.78

 X STA.        63.7       64.7       65.7       66.8       68.3       73.6
   A(I)              1.6        1.6        1.7        1.8        3.5
   V(I)             4.66       4.58       4.42       4.10       2.12
 Depth              1.60       1.60       1.55       1.20       0.66


     VELOCITY DISTRIBUTION:              SECID = SEC2

          WSEL      LEW      REW     AREA         K         Q     VEL
         91.56     32.0     74.8     53.9      777.      200.    3.71

 X STA.        32.0       46.6       48.8       50.8       52.5       54.0
   A(I)              9.6        2.8        2.6        2.5        2.3
   V(I)             1.04       3.60       3.82       4.01       4.30
 Depth              0.66       1.27       1.30       1.47       1.53

 X STA.        54.0       55.3       56.5       57.5       58.5       59.2
   A(I)              2.2        2.1        2.0        2.0        1.6
   V(I)             4.45       4.71       4.91       5.02       6.08
 Depth              1.69       1.75       2.00       2.00       2.29

 X STA.        59.2       60.0       60.9       61.8       62.7       63.7
   A(I)              1.9        2.1        2.1        2.1        2.1
   V(I)             5.38       4.70       4.78       4.74       4.67
 Depth              2.38       2.33       2.33       2.33       2.10

 X STA.        63.7       64.7       65.8       67.1       68.7       74.8
   A(I)              2.1        2.1        2.2        2.4        4.8
   V(I)             4.73       4.67       4.50       4.14       2.06
 Depth              2.10       1.91       1.69       1.50       0.79
```

VELOCITY DISTRIBUTION: SECID = SEC2

WSEL	LEW	REW	AREA	K	Q	VEL
91.87	29.4	86.2	68.2	1012.	250.	3.66

X STA.	29.4		42.9		45.5		47.6		49.5		51.2
A(I)		9.5		3.4		3.1		3.1		2.9	
V(I)		1.31		3.67		4.00		4.09		4.34	
Depth		0.70		1.31		1.48		1.63		1.71	
X STA.	51.2		52.8		54.3		55.6		56.8		57.9
A(I)		2.8		2.8		2.7		2.6		2.5	
V(I)		4.47		4.50		4.64		4.79		5.01	
Depth		1.75		1.87		2.08		2.17		2.27	
X STA.	57.9		58.9		59.9		60.8		61.7		62.7
A(I)		2.6		2.6		2.5		2.5		2.5	
V(I)		4.84		4.85		5.05		5.00		5.01	
Depth		2.60		2.60		2.78		2.78		2.50	
X STA.	62.7		63.7		64.8		66.0		67.3		86.2
A(I)		2.5		2.5		2.5		2.7		9.9	
V(I)		4.97		4.93		4.98		4.64		1.26	
Depth		2.50		2.27		2.08		2.08		0.52	

VELOCITY DISTRIBUTION: SECID = SEC2

WSEL	LEW	REW	AREA	K	Q	VEL
92.14	27.2	90.1	84.1	1261.	300.	3.57

X STA.	27.2		40.4		43.1		45.4		47.5		49.4
A(I)		9.9		4.0		3.7		3.6		3.4	
V(I)		1.52		3.79		4.01		4.16		4.36	
Depth		0.75		1.48		1.61		1.71		1.79	
X STA.	49.4		51.1		52.7		54.3		55.8		57.1
A(I)		3.4		3.3		3.3		3.3		3.2	
V(I)		4.42		4.50		4.51		4.53		4.71	
Depth		2.00		2.06		2.06		2.20		2.46	
X STA.	57.1		58.2		59.3		60.2		61.2		62.2
A(I)		3.1		3.0		2.9		2.9		2.9	
V(I)		4.86		5.00		5.16		5.18		5.17	
Depth		2.82		2.73		3.22		2.90		2.90	
X STA.	62.2		63.3		64.4		65.6		66.8		90.1
A(I)		2.9		3.0		2.9		3.0		16.4	
V(I)		5.19		5.05		5.08		5.02		0.92	
Depth		2.64		2.73		2.42		2.50		0.70	

VELOCITY DISTRIBUTION: SECID = SEC2

WSEL	LEW	REW	AREA	K	Q	VEL
92.35	25.4	90.9	97.6	1574.	350.	3.59

X STA.	25.4		39.7		42.6		45.0		47.2		49.1
A(I)		11.8		4.7		4.3		4.1		4.0	
V(I)		1.48		3.75		4.09		4.24		4.35	
Depth		0.83		1.62		1.79		1.86		2.11	

X STA.	49.1		51.0		52.7		54.3		55.9		57.3
A(I)		4.0		3.9		3.9		3.8		3.8	
V(I)		4.41		4.50		4.51		4.60		4.64	
Depth		2.11		2.29		2.44		2.38		2.71	

X STA.	57.3		58.5		59.6		60.7		61.8		63.0
A(I)		3.6		3.5		3.4		3.4		3.5	
V(I)		4.82		4.97		5.12		5.09		5.02	
Depth		2.40		3.18		3.09		3.09		2.92	

X STA.	63.0		64.1		65.4		66.8		68.3		90.9
A(I)		3.4		3.5		3.5		3.7		17.8	
V(I)		5.11		4.96		5.05		4.70		0.98	
Depth		3.09		2.69		2.50		2.47		0.79	

VELOCITY DISTRIBUTION: SECID = SEC2

WSEL	LEW	REW	AREA	K	Q	VEL
92.58	17.3	91.8	113.6	1862.	400.	3.52

X STA.	17.3		41.7		44.1		46.3		48.4		50.3
A(I)		19.5		4.8		4.7		4.5		4.4	
V(I)		1.02		4.21		4.27		4.47		4.51	
Depth		0.80		2.00		2.24		2.14		2.32	

X STA.	50.3		52.0		53.7		55.3		56.7		58.1
A(I)		4.3		4.2		4.3		4.1		4.1	
V(I)		4.62		4.75		4.68		4.84		4.93	
Depth		2.53		2.47		2.69		2.93		2.93	

X STA.	58.1		59.3		60.6		61.8		63.0		64.3
A(I)		4.2		4.2		4.1		4.1		4.0	
V(I)		4.76		4.82		4.89		4.89		4.95	
Depth		3.50		3.23		3.42		3.42		3.08	

X STA.	64.3		65.7		67.2		68.9		70.9		91.8
A(I)		4.1		4.2		4.3		4.6		17.1	
V(I)		4.90		4.80		4.63		4.39		1.17	
Depth		2.93		2.80		2.53		2.30		0.82	

APPENDIX 4. WSPRO OUTPUT FOR THE CRITICAL DOWNSTREAM SECTION OF CROSS MOUNTAIN CANYON

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

  WSPRO COMPUTATIONS FOR THE YAMPA RIVER -- CROSS MTN. CANYON DOWNSTREAM
        ENDANGERED FISH RECOVERY PROGRAM


    VELOCITY DISTRIBUTION:  SECID = SEC7

         WSEL     LEW     REW    AREA        K        Q    VEL
        86.17    42.4    62.4    13.6     192.       50.   3.68

X STA.        42.4        47.3        48.0        48.6        49.1        49.5
  A(I)              1.8         0.6         0.5         0.5         0.5
  V(I)             1.39        4.27        4.55        4.73        4.79
Depth              0.37        0.86        0.86        1.00        1.25

X STA.        49.5        49.9        50.3        50.8        51.3        51.8
  A(I)              0.5         0.5         0.5         0.5         0.6
  V(I)             5.01        4.87        4.77        4.64        4.48
Depth              1.25        1.25        1.00        1.00        1.20

X STA.        51.8        52.5        53.3        55.1        56.8        57.8
  A(I)              0.6         0.6         0.9         0.9         0.7
  V(I)             4.32        3.97        2.78        2.90        3.82
Depth              0.86        0.75        0.50        0.53        0.70

X STA.        57.8        58.5        59.2        59.7        60.3        62.4
  A(I)              0.6         0.6         0.5         0.6         1.0
  V(I)             4.08        4.28        4.55        4.46        2.41
Depth              0.86        0.86        1.00        1.00        0.48


    VELOCITY DISTRIBUTION:  SECID = SEC7

         WSEL     LEW     REW    AREA        K        Q    VEL
        86.62    39.0    63.5    23.6     422.      100.   4.24

X STA.        39.0        46.4        47.3        48.1        48.7        49.3
  A(I)              3.8         1.0         1.0         0.9         0.9
  V(I)             1.33        4.91        5.14        5.40        5.66
Depth              0.51        1.11        1.25        1.12        1.50

X STA.        49.3        49.8        50.3        50.9        51.5        52.2
  A(I)              0.9         0.9         0.9         0.9         1.0
  V(I)             5.55        5.67        5.64        5.43        5.20
Depth              1.80        1.80        1.50        1.50       1.43

X STA.        52.2        53.0        54.0        55.4        56.6        57.6
  A(I)              1.0         1.1         1.2         1.2         1.1
  V(I)             4.91        4.54        4.07        4.30        4.63
Depth              1.25        1.10        0.86        1.00        1.10
```

X STA.	57.6	58.4	59.2	59.8	60.5	63.5
A(I)	1.0	1.0	0.9	1.0	2.0	
V(I)	4.88	5.06	5.29	5.24	2.55	
Depth	1.25	1.25	1.50	1.43	0.67	

VELOCITY DISTRIBUTION: SECID = SEC7

WSEL	LEW	REW	AREA	K	Q	VEL
86.97	36.1	64.2	32.8	665.	150.	4.57

X STA.	36.1	45.6	46.7	47.5	48.3	49.0
A(I)	5.8	1.5	1.3	1.3	1.2	
V(I)	1.30	5.15	5.58	5.76	6.10	
Depth	0.61	1.36	1.62	1.62	1.71	
X STA.	49.0	49.6	50.2	50.8	51.5	52.2
A(I)	1.2	1.2	1.2	1.3	1.3	
V(I)	6.09	6.21	6.16	5.92	5.96	
Depth	2.00	2.00	2.00	1.86	1.86	
X STA.	52.2	53.1	54.1	55.4	56.5	57.5
A(I)	1.4	1.5	1.6	1.5	1.5	
V(I)	5.51	5.11	4.71	5.01	5.17	
Depth	1.56	1.50	1.23	1.36	1.50	
X STA.	57.5	58.4	59.2	59.9	60.7	64.2
A(I)	1.4	1.3	1.3	1.3	2.8	
V(I)	5.43	5.57	5.75	5.68	2.67	
Depth	1.27	1.62	1.86	1.62	0.80	

VELOCITY DISTRIBUTION: SECID = SEC7

WSEL	LEW	REW	AREA	K	Q	VEL
87.28	33.2	65.0	42.1	930.	200.	4.75

X STA.	33.2	44.8	46.0	47.0	47.9	48.6
A(I)	7.9	1.9	1.8	1.7	1.6	
V(I)	1.26	5.35	5.68	6.05	6.32	
Depth	0.68	1.58	1.80	1.89	2.29	
X STA.	48.6	49.4	50.0	50.7	51.4	52.1
A(I)	1.6	1.5	1.5	1.6	1.5	
V(I)	6.41	6.60	6.48	6.32	6.52	
Depth	2.00	2.50	2.14	2.29	2.14	
X STA.	52.1	53.0	54.1	55.3	56.5	57.5
A(I)	1.7	1.8	1.9	1.9	1.8	
V(I)	5.98	5.45	5.23	5.24	5.67	
Depth	1.89	1.64	1.58	1.58	1.80	
X STA.	57.5	58.4	59.3	60.0	60.9	65.0
A(I)	1.8	1.7	1.7	1.7	3.6	
V(I)	5.66	5.94	5.96	5.93	2.76	
Depth	2.00	1.89	2.43	1.89	0.88	

```
    VELOCITY DISTRIBUTION:  SECID = SEC7

         WSEL      LEW      REW     AREA        K         Q    VEL
        87.54     30.6     65.9     50.8    1188.      250.   4.92

 X STA.       30.6        44.0        45.3        46.5        47.4        48.3
   A(I)            10.0         2.2         2.1         2.0         1.9
   V(I)            1.25        5.66        5.91        6.32        6.49
 Depth             0.75        1.69        1.75        2.22        2.11

 X STA.       48.3        49.0        49.8        50.5        51.2        52.0
   A(I)             1.9         1.9         1.8         1.9         1.8
   V(I)            6.67        6.74        6.99        6.65        7.03
 Depth             2.71        2.38        2.57        2.71        2.25

 X STA.       52.0        52.9        53.9        55.1        56.4        57.4
   A(I)             2.0         2.2         2.2         2.2         2.1
   V(I)            6.39        5.75        5.64        5.57        5.86
 Depth             2.22        2.20        1.83        1.69        2.10

 X STA.       57.4        58.4        59.2        60.1        61.0        65.9
   A(I)             2.0         2.0         2.0         2.1         4.5
   V(I)            6.13        6.24        6.35        5.95        2.76
 Depth             2.00        2.50        2.22        2.33        0.92


    VELOCITY DISTRIBUTION:  SECID = SEC7

         WSEL      LEW      REW     AREA        K         Q    VEL
        87.79     27.7     66.8     60.0    1469.      300.   5.00

 X STA.       27.7        43.3        44.7        45.9        47.0        47.9
   A(I)            12.4         2.6         2.5         2.4         2.2
   V(I)            1.21        5.81        6.00        6.30        6.82
 Depth             0.79        1.86        2.08        2.18        2.44

 X STA.       47.9        48.7        49.5        50.3        51.0        51.8
   A(I)             2.2         2.2         2.1         2.2         2.0
   V(I)            6.76        6.94        7.03        6.97        7.56
 Depth             2.75        2.75        2.62        3.14        2.50

 X STA.       51.8        52.7        53.8        55.0        56.2        57.4
   A(I)             2.2         2.5         2.6         2.5         2.5
   V(I)            6.68        5.96        5.78        5.93        6.04
Depth              2.44        2.78        2.16        2.08        2.08

 X STA.       57.4        58.4        59.3        60.2        61.2        66.8
   A(I)             2.4         2.4         2.3         2.5         5.5
   V(I)            6.29        6.34        6.43        6.11        2.75
 Depth             2.40        2.67        2.56        2.50        0.98
```

VELOCITY DISTRIBUTION: SECID = SEC7

WSEL	LEW	REW	AREA	K	Q	VEL
88.01	25.1	67.5	69.0	1752.	350.	5.07

X STA.	25.1		42.5		44.1		45.4		46.5		47.5
A(I)		14.6		3.1		2.8		2.7		2.6	
V(I)		1.20		5.66		6.20		6.54		6.79	
Depth		0.84		1.94		2.15		2.45		2.60	
X STA.	47.5		48.4		49.3		50.1		50.9		51.6
A(I)		2.5		2.5		2.4		2.5		2.2	
V(I)		7.06		7.04		7.21		7.12		7.96	
Depth		2.78		2.78		3.00		3.12		3.14	
X STA.	51.6		52.6		53.7		54.9		56.2		57.3
A(I)		2.5		2.9		2.9		2.9		2.8	
V(I)		6.91		6.14		6.10		5.97		6.29	
Depth		2.50		2.63		2.42		2.23		2.55	
X STA.	57.3		58.4		59.3		60.3		61.4		67.5
A(I)		2.7		2.6		2.7		2.8		6.3	
V(I)		6.37		6.61		6.47		6.23		2.76	
Depth		2.45		2.89		2.70		2.55		1.03	

VELOCITY DISTRIBUTION: SECID = SEC7

WSEL	LEW	REW	AREA	K	Q	VEL
88.21	22.7	68.3	77.8	2043.	400.	5.14

X STA.	22.7		41.8		43.4		44.8		46.0		47.1
A(I)		16.9		3.4		3.2		3.0		2.9	
V(I)		1.19		5.94		6.33		6.58		6.86	
Depth		0.88		2.12		2.29		2.50		2.64	
X STA.	47.1		48.1		49.0		49.8		50.7		51.5
A(I)		2.8		2.7		2.7		2.7		2.5	
V(I)		7.04		7.33		7.34		7.33		8.16	
Depth		2.80		3.00		3.38		3.00		3.12	
X STA.	51.5		52.4		53.6		54.8		56.1		57.3
A(I)		2.8		3.2		3.2		3.2		3.1	
V(I)		7.13		6.31		6.24		6.17		6.37	
Depth		3.11		2.67		2.67		2.46		2.58	
X STA.	57.3		58.4		59.4		60.4		61.6		68.3
A(I)		3.1		2.9		3.0		3.2		7.2	
V(I)		6.40		6.81		6.72		6.30		2.77	
Depth		2.82		2.90		3.00		2.67		1.07	