FILE WITH MDDP'S

MONUMENT BRANCH
MODIFIED PRUDENT LINE CONCEPT
PRELIMINARY REPORT

J·R ENGINEERING
A Subsidiary of Westrian

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MONUMENT BRANCH
MODIFIED PRUDENT LINE CONCEPT
PRELIMINARY REPORT

February 2000

Prepared For:

PICOLAN, INC.
90 S. Cascade, Suite 1300
Colorado Springs, CO 80903
(719) 381-8441

Prepared By:

JR ENGINEERING
4310 ArrowsWest Drive
Colorado Springs, CO 80907
(719) 593-2593

Job No. 8896.55

MONUMENT BRANCH
MODIFIED PRUDENT LINE CONCEPT
PRELIMINARY REPORT

DRAINAGE REPORT STATEMENT

J·R ENGINEERING
A Subsidiary of Westrian

ENGINEER'S STATEMENT:
The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the City for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

COLORADO REGISTERED MIKE A. BRAMLETT 32314

Mike A. Bramlett, Colorado P.E. #32314
For and On Behalf of JR Engineering

4-25-00
Date

DEVELOPER'S STATEMENT:
I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: Picolan, Inc.

By: Steve L. Mayo

Title: Vice Pres

Address: 90 South Cascade, Suite 1300

Colorado Springs, CO 80903

CITY OF COLORADO SPRINGS ONLY:
Filed in accordance with Section 15-3-906 of the Code of the City of Colorado Springs, 1980, as amended.

City Engineer

April 27, 2000
Date

Conditions:

4310 ArrowsWest Drive, Colorado Springs, CO 80907
719-593-2593 • Fax: 719-528-6613 • www.jrengineering.com

MONUMENT BRANCH
MODIFIED PRUDENT LINE CONCEPT
PRELIMINARY REPORT

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MONUMENT BRANCH
MODIFIED PRUDENT LINE CONCEPT
PRELIMINARY REPORT

PURPOSE

This document is a compilation of our preliminary efforts to date on establishing a reasonable approach to improving the North and South Fork of the Monument Branch as it flows onto the Northgate property then on to the box culverts in Voyager Parkway. The Master Development Drainage Plan for Northgate Corporate Village North indicated that a modified prudent line approach would be utilized in these reaches as opposed to the partially lined channel concept presented in the Monument Branch D.B.P.S. This report will analyze the overall improvement plan for routing storm flows. In addition, the general location of private and regional detention facilities will be discussed. This report does not attempt to finalize the channel system due to the unknown nature of the ultimate land use and street configuration. The final design of these systems will be addressed in the Final Drainage Reports for the adjacent developments as they become better defined.

GENERAL DESCRIPTION

The study area is located in a portion of Section 8, Township 12 South, Range 66 West of the Sixth Principal Meridian in the City of Colorado Springs, County of El Paso. The site is bounded to the north and east by undeveloped county land, to the west by Voyager Parkway, and to the south by undeveloped residential property.

The entire site is located within the Monument Branch Basin. This area has been previously studied in the following reports: "Monument Branch Drainage Basin Planning Study (D.B.P.S.)", by URS Consultants, Inc. dated August 6, 1987; "Northgate Master Development Drainage Plan", by URS Consultants, Inc. dated June 27, 1988; "Master Development Drainage Plan for Northgate Software Campus (Monument Branch and Middle Tributary Basins)", by JR Engineering, dated January 28, 1999; the "Preliminary/Final Drainage Report for Northgate Filing No. 7 Voyager Parkway Phase 2 (2000' North of Middle Creek Parkway to Northgate

Road", by JR Engineering, dated February, 1999 and the "Northgate Corporate Village North Master Development Drainage Plan", by JR Engineering, dated February 2000.

The study area is proposed to be developed as both multi-family and single-family residential land uses and open space per the approved master plan.

The average soil condition reflects Hydrologic Group "B" (Tomah-Peyton-Pring Loamy Sands/Sandy Loams), and "D" (Kettle-Rock Outcrop Complex) as determined by the "Soil Survey of El Paso County Area," prepared by S.C.S. (see map in Appendix). The majority of the site (approximately 95%) is classified as the Tomah/Peyton/Pring. These soils are considered moderately erosive, but should allow for the modified prudent line approach being recommended by this report.

EXISTING ENVIRONMENTAL SITE RESTRICTIONS

Certain environmental constraints exist on the site due to the location of existing wetlands and a desire to maintain the natural characteristics of these channels. The Monument Branch D.B.P.S.'s proposed partially lined channels upstream of the two box culverts at Voyager Parkway (Reach 4 and 7-within Northgate), we propose that a modified prudent line approach utilizing check structures be implemented to minimize impacts to the existing wetlands and vegetation, maintain the natural channel to the extent possible, and protect future development from bank migration. These existing channels have not exhibited significant erosion due to historic flows and have established vegetative cover.

DETENTION OF DEVELOPED FLOWS

Currently the Northgate Corporate Village North MDDP proposes a regional detention pond both upstream and downstream of the improvements on the South Fork of the Monument Branch. Therefore the developments adjacent to this fork will release developed flows into the channel which will then be detained at the downstream pond.

The portion of the multi-family development adjacent to the North Fork propose to utilize an onsite detention pond to restrict developed flows to the 5 and 100-year historic rates from the site as it is developed. The on-site detention facility will be privately owned and maintained. Regional detention facilities will be constructed by Picolan, Inc. and then conveyed to the city for the city to own and maintain. Further, the ponds are proposed to be designed using the water quality capture technique to further protect the downstream properties.

PROPOSED DRAINAGE CHARACTERISTICS

This report proposes that a modified prudent line approach be utilized for improving the natural channel. The "Monument Branch Drainage Basin Planning Study (D.B.P.S.)," by URS, Inc., 1987, and the "Northgate Master Development Drainage Plan (M.D.D.P.)," by URS, Inc., 1988 have previously studied this area and recommended partially lined channels with drop structures. By utilizing the modified prudent line approach these reaches can be left in a more natural state while still providing for adequate streambed protection.

The existing stormwater runoff within the study area currently flows overland in a southwesterly and northwesterly direction from the land adjacent to each branch. The existing slopes vary from 1% to 25%, with most of the site at approximately 4%. The proposed conditions map, Figure I, identifies seven modified check structures in each fork of Monument Branch. Further, in the South Fork, slope protection is recommended in the oxbow section of the stream to limit horizontal migration.

The South Fork has a historic 100-year storm peak flow of 777 cfs, while the North Fork carries 1,312 cfs in the 100-year storm condition. The channel slopes range from 1% to 5% with typical peak velocities of 10 to 11 feet per second. While these channels have not exhibited significant erosion to date, it would be expected that the channels would attempt to stabilize at a lesser slope.

Based upon these assumptions, this report recommends that modified check structures be placed along the stream bed to allow the stream to erode to a nominal 0.5% profile. It is proposed that

these structures be placed 1' higher than the natural flowline to allow sediment to accumulate behind the structure to lessen the slope. On the downstream face, it is assumed that erosion will occur to create the "drop" structure. Typical sections are included in the Appendix. Figure II is a profile of the structure locations.

Since it is assumed that these streams will eventually erode to the lesser flowline slope, development will be setback a prudent distance to accommodate this natural erosion. No grading is proposed within the land between the prudent lines which will allow this area to maintain its natural appearance and vegetation. However, if high intensity storms occur, the streambed will be adequately stabilized so as to not encroach onto the developed acreage.

HYDROLOGIC/HYDRAULIC CALCULATIONS

This report utilizes the hydrologic information contained in the Monument Branch D.B.P.S. and the Northgate Corporate Village North's M.D.D.P. Hydraulic analysis of the channel was done utilizing a Mannings equation for irregular cross sections and these worksheets are included in the appendix.

FLOODPLAIN STATEMENT

No portion of this site is within a designated F.E.M.A. floodplain as determined by Flood Insurance Rate Map Community Panel Number 080060-0040B, effective December 18, 1986. See the Appendix for a Floodplain Information Map, which shows the location of the site.

REIMBURSABLE IMPROVEMENTS

It is proposed that drainage fees be calculated at the time of final drainage reports for the developments and that the channel improvements be considered reimbursable in the analysis. Based upon the D.B.P.S. fee estimates, the channel improvements in these reaches constitute $334,584 of reimbursable improvements. A conceptual estimate of the cost of the proposed improvements is approximately $166,000. Therefore, the drainage fees calculated for this basin

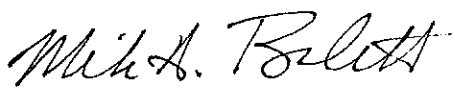
can be used to reimburse the cost of these improvements. Further it is proposed that the Regional Detention Pond downstream of these improvements on the South Fork will also be reimbursable. This value will not be known until the pond is analyzed as part of a final drainage report. Cost estimates and other information is found in the appendix of this report.

SUMMARY

Originally the M.D.D.P. and D.B.P.S. for this area recommended partially lined channels in this area. Due to environmental issues, this report now recommends a modified prudent line approach with check structures be utilized to stabilize these channels

PREPARED BY:

JR Engineering



Mike A. Bramlett, P.E.
Division Manager
Land Development

le/889655/Prudent Line Rpt-feb00

REFERENCES

1. "Monument Branch Drainage Basin Planning Study," URS, Inc., April 1987, revised August 6, 1987.

2. "Northgate Master Development Drainage Plan (Monument Branch and Middle Tributary Basins)," URS, Inc., December 1987, revised June 27, 1988.

3. "Northgate Phase 1 Drainage Plan," URS, Inc., October 6, 1987 (addendum date).

4. "Preliminary/Final Drainage Report for Northgate Filing No. 7 –Voyager Parkway Phase 2," JR Engineering, February 1999.

5. City of Colorado Springs/County of El Paso Drainage Criteria Manual, dated November 1991.

6. Soils Survey of El Paso County Area, Colorado Soil Conservation Service.

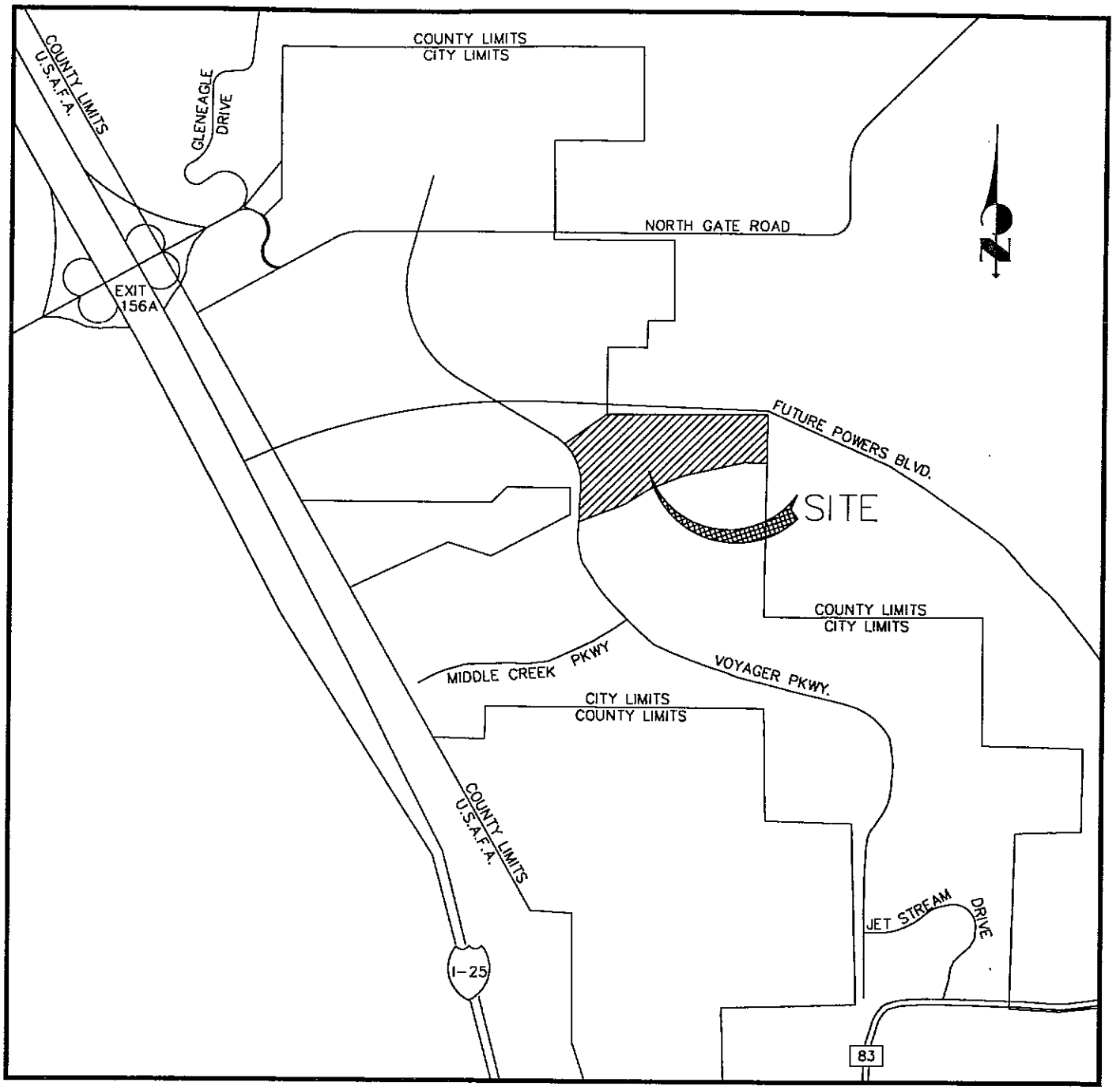
7. "Northgate Master Plan Amendment," NES, Inc., February 9, 1999.

8. "Master Development Drainage Plan for Northgate Software Campus (Monument Branch and Middle Tributary Basins)" JR Engineering, January 1999.

9. "Master Development Drainage Plan for Northgate Corporate Village North," JR Engineering, February 2000.

APPENDICES

VICINITY MAP



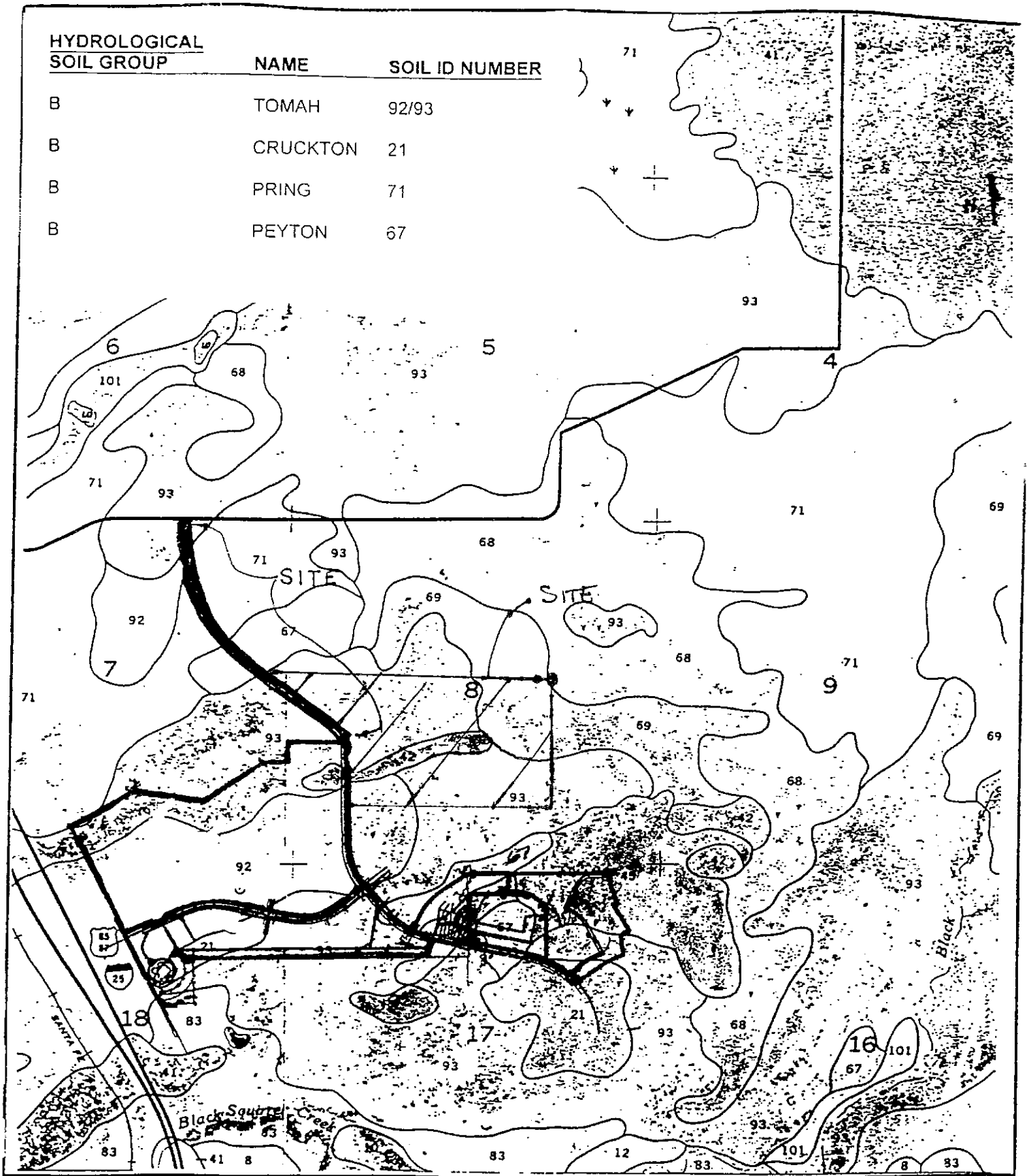
NOT TO SCALE

VICINITY MAP

JR Engineering, Ltd.
4310 ArrowsWest Drive
Colorado Springs, CO 80907-3449
(719) 593-2593 • FAX (719) 528-6613

SOIL MAP (S.C.S. SURVEY)

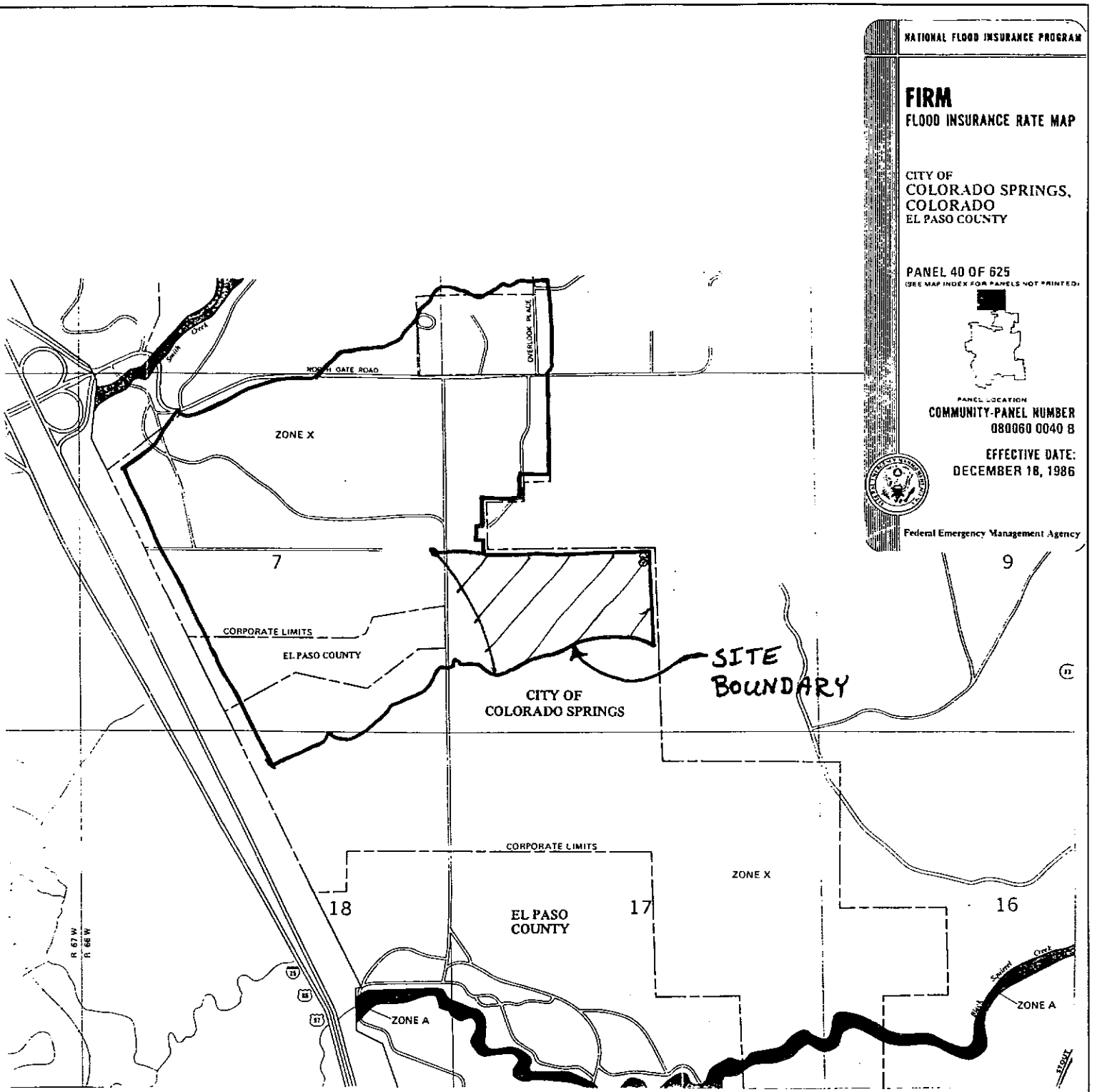
HYDROLOGICAL SOIL GROUP	NAME	SOIL ID NUMBER
B	TOMAH	92/93
B	CRUCKTON	21
B	PRING	71
B	PEYTON	67



SCS SOIL SURVEY

JR Engineering, Ltd.
4935 North 30th Street
Colorado Springs, Colorado 80919
(719) 593-2593 o FAX (719) 528-6613

F.E.M.A. MAP



FEMA FIRM

JR Engineering, Ltd.
4310 ArrowsWest Drive
Colorado Springs, CO 80907-3449
(719) 593-2593 • FAX (719) 528-6613

HYDROLOGIC/HYDRAULIC CALCULATIONS

COST ESTIMATES

D.B.P.S.
FEE BASIS
MODIFIED PRUDENT LINE ANALYSIS

Original Scope:

N. Branch - 1,100 L.F. (Voyager Parkway – Property Line)		
40' x 4.5' Part Lined Channel @ $80.48/L.F.	=	$ 88,528.00
Drop Structures 6 total in 2,900 L.F. = 2 ea. in 1,100 L.F. @ $20,400	=	$ 40,800.00
Sub-total		$ 129,328.00
S. Branch – 1,500 L.F. (Voyager Parkway - Property Line)		
40' x 3.5' Part Lined Channel @ $70.41/L.F.	=	$ 105,615.00
Drop Structures 16 in 5,800 L.F. = 4 in 1,500 L.F. @ $14,000	=	$ 56,000.00
Sub-total		$ 161,615.00
Total Both Branches	=	$ 290,943.00
+5% Contingency	=	$ 14,547.00
+10% Engineering	=	$ 29,094.00
TOTAL D.B.P.S. DOLLARS (Unadjusted)		**$ 334,584.00**

Prudent Line Scope:

N. Branch		
Modified Check Structures 7 @ $11,500	=	$ 80,500.00
S. Branch		
Modified Check Structures 7 @ $11,500	=	$ 80,500.00
Riprap Slope Protection at Oxbow	=	$ 5,000.00
TOTAL		**$ 166,000.00**

COST ESTIMATE
MODIFIED CHECK STRUCTURE

Quanities:

Structure

Typical Design Width	=	50 L.F.		
Typical Height	=	6'		
Concrete Volume	=	6' x 1' x 50'	=	300 C.F.
Foundation	=	2.5' x 8" x 50'	=	84 C.F.
				384 C.F.
			=	14.22 C.Y.
			Say	15 C.Y.

Splash Pad

Riprap Volume				
10' x 40' x 2'	=	800 C.F.		
		x120#/C.F.		
		96,000#	=	48 tons

Riprap Slope Protection

Typical Height	=	6'		
Thickness	=	2'		
Length	=	50' both sides		
Riprap Volume				
6' x 2' x 50' x 2'	=	1,200 C.F.		
		x120#/C.F.		
		144,000#	=	70 tons

Cost:

Structure

Concrete			
15 C.Y @ $500/C.Y. in place		=	$ 7,500.00

Splash Pad

48 tons @ $40/ton/placed		=	$ 1,920.00
Final Grade and Reseed		=	$ 2,000.00
			$ 11,420.00
	Say		$ 11,500.00 EACH

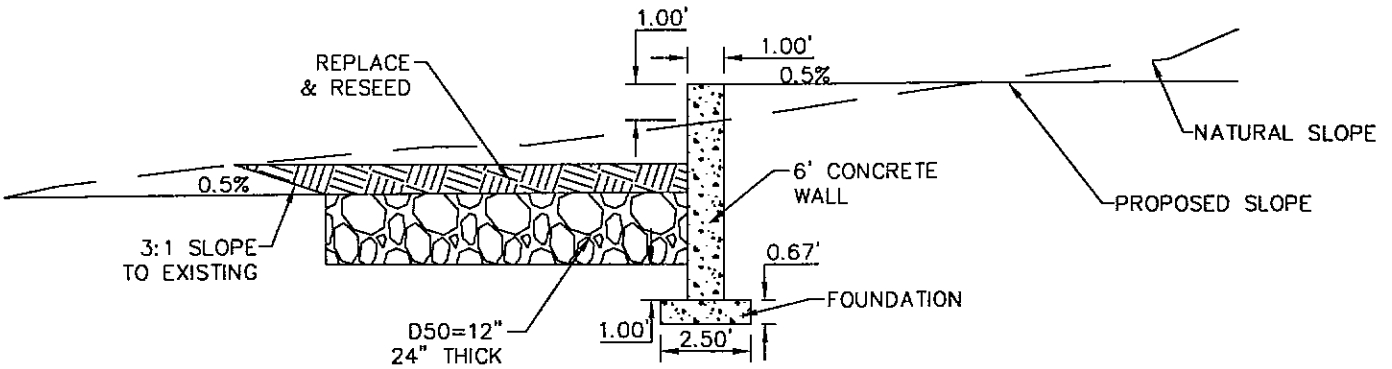
Riprap Slope Protection

72 tons @ $60/ton/placed		=	$ 4,320.00
	Say		$ 5,000.00

CHECK STRUCTURE CROSS SECTIONS

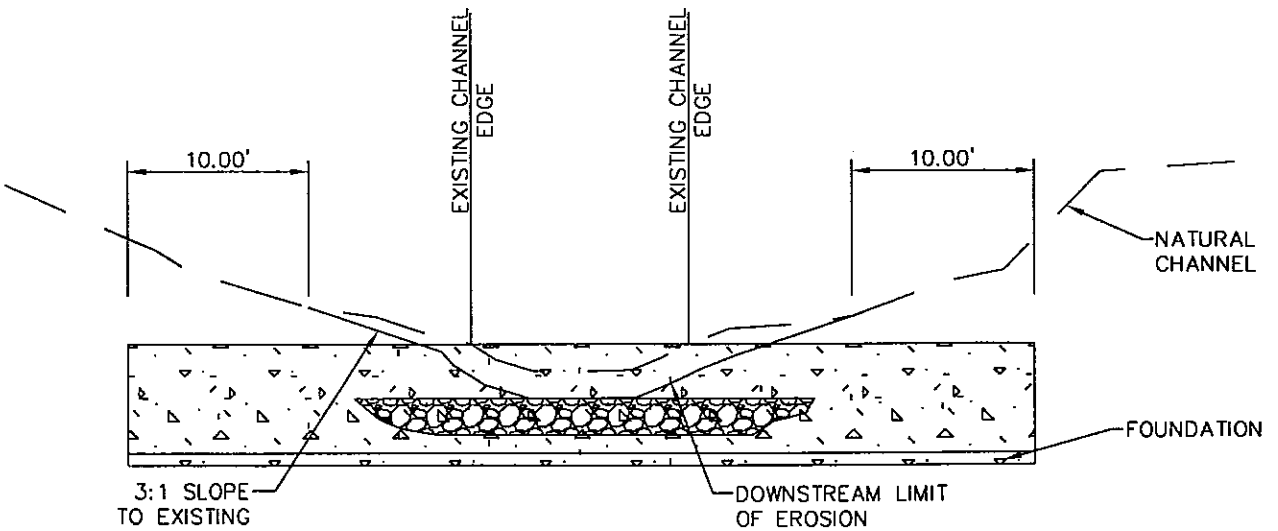
8896.56 / Blocks (Exhibits?) / DROP-DET

TYPICAL MODIFIED CHECK STRUCTURE



PROFILE VIEW

SCALE: 1"=5'



CROSS SECTION

SCALE: 1"=10'

Cross Section A - North Branch
Worksheet for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section A - North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

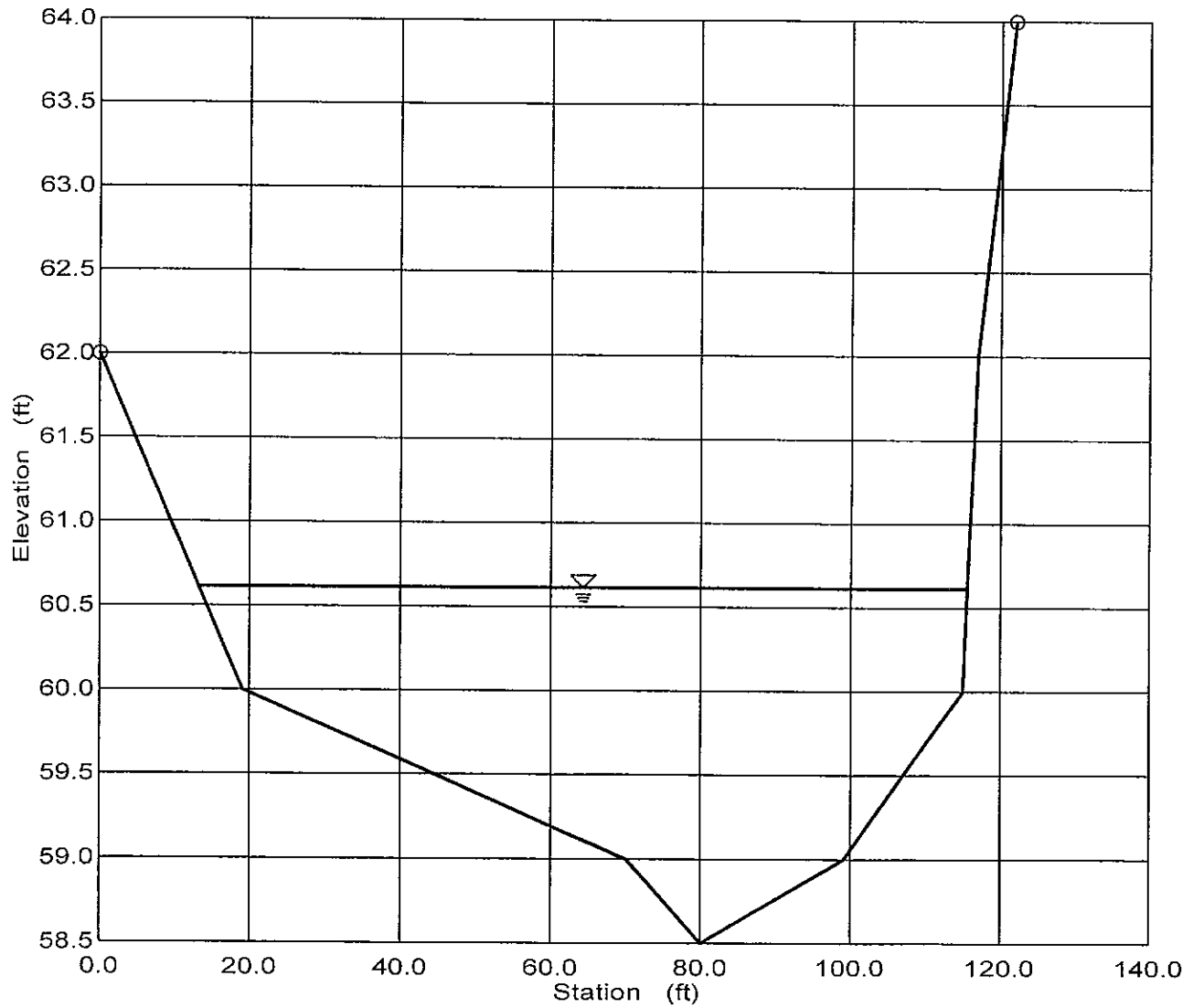
Input Data				
Channel Slope	0.030000 ft/ft			
Elevation range: 58.50 ft to 64.00 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	62.00	0.00	122.00	0.030
19.00	60.00			
70.00	59.00			
80.00	58.50			
99.00	59.00			
115.00	60.00			
117.00	62.00			
122.00	64.00			
Discharge	1,312.00 cfs			

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	60.61	ft
Flow Area	130.45	ft²
Wetted Perimeter	102.77	ft
Top Width	102.42	ft
Height	2.11	ft
Critical Depth	61.08	ft
Critical Slope	0.011134	ft/ft
Velocity	10.06	ft/s
Velocity Head	1.57	ft
Specific Energy	62.18	ft
Froude Number	1.57	
Flow is supercritical.		

Cross Section A - North Branch
Cross Section for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section A - North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.030000	ft/ft
Water Surface Elevation	60.61	ft
Discharge	1,312.00	cfs



Cross Section A - North Branch - Future
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.005000	ft/ft
Elevation range: 58.50 ft to 64.00 ft.		
Discharge	1,312.00	cfs

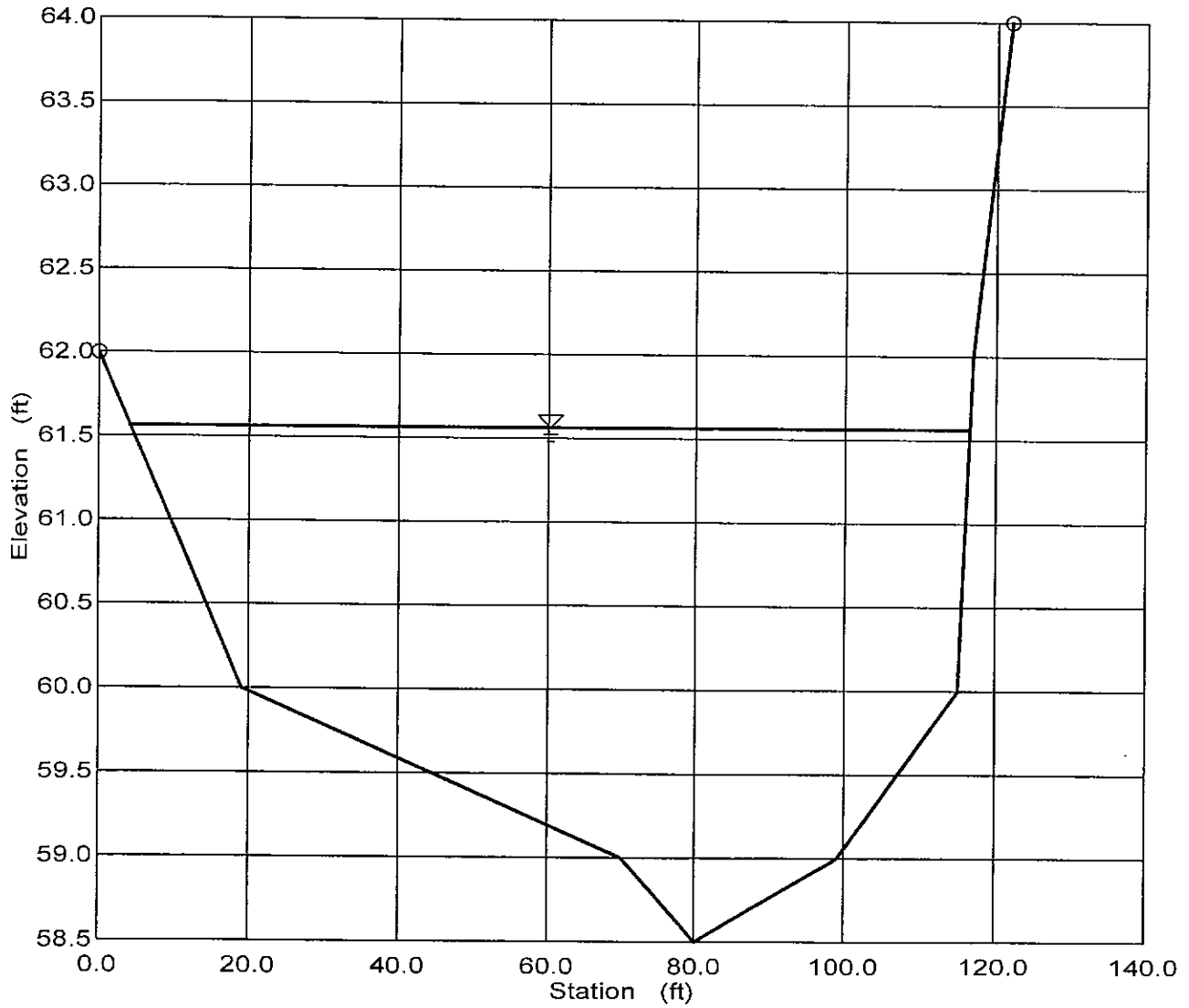
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	62.00	0.00	122.00	0.030
19.00	60.00			
70.00	59.00			
80.00	58.50			
99.00	59.00			
115.00	60.00			
117.00	62.00			
122.00	64.00			

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	61.56	ft
Flow Area	232.06	ft²
Wetted Perimeter	113.15	ft
Top Width	112.36	ft
Height	3.06	ft
Critical Depth	61.08	ft
Critical Slope	0.011134	ft/ft
Velocity	5.65	ft/s
Velocity Head	0.50	ft
Specific Energy	62.05	ft
Froude Number	0.69	
Flow is subcritical.		

Cross Section A - North Branch - Future
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	61.56	ft
Discharge	1,312.00	cfs



Cross Section B - North Branch
Worksheet for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section B - North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.038000	ft/ft

Elevation range: 49.00 ft to 54.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	54.00	0.00	134.00	0.030
21.00	52.00			
31.00	50.00			
36.00	49.50			
46.00	49.00			
58.00	49.50			
68.00	50.00			
122.00	52.00			
134.00	54.00			

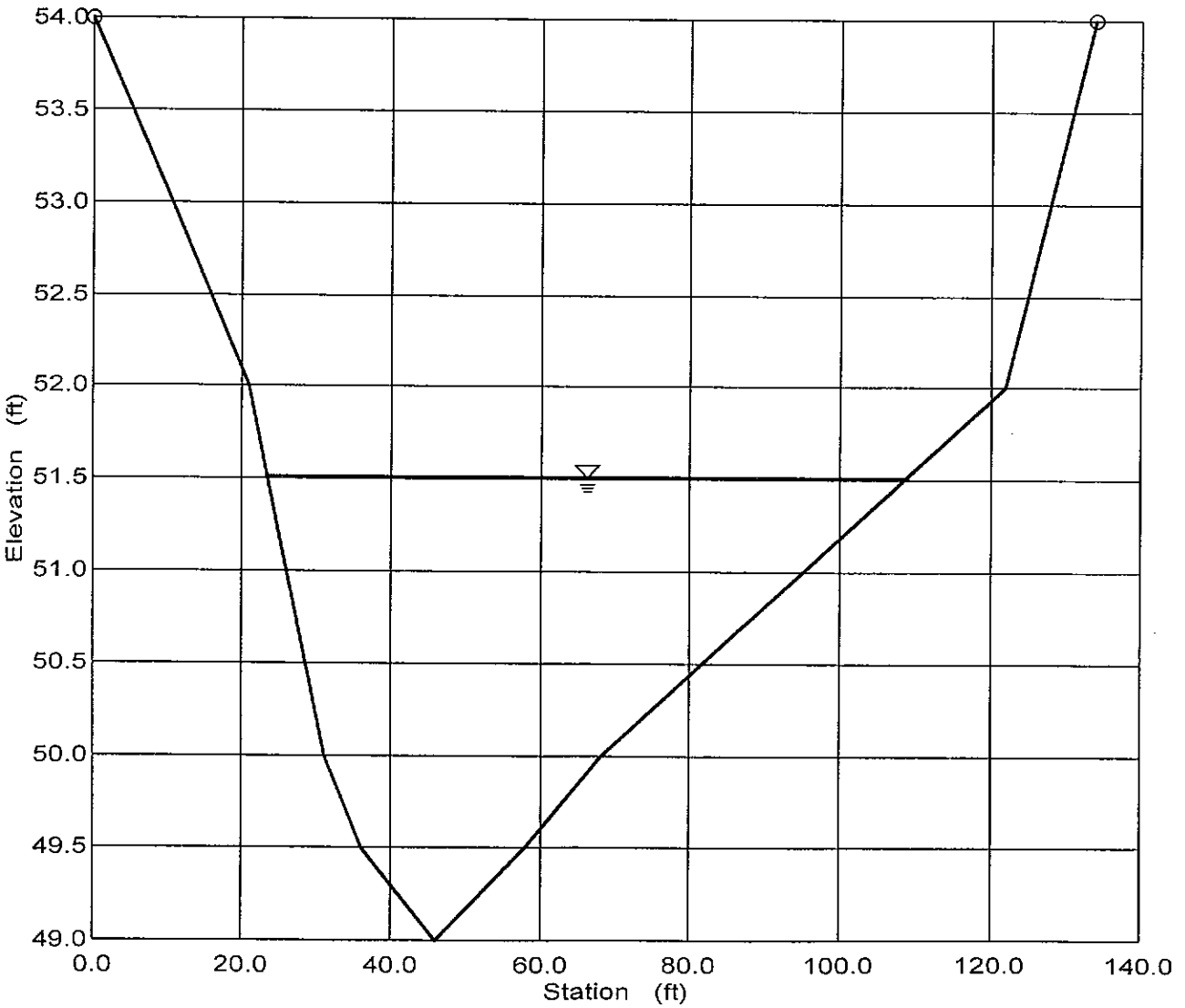
Discharge	1,312.00	cfs

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	51.51	ft
Flow Area	113.01	ft²
Wetted Perimeter	85.71	ft
Top Width	85.47	ft
Height	2.51	ft
Critical Depth	52.19	ft
Critical Slope	0.011026	ft/ft
Velocity	11.61	ft/s
Velocity Head	2.09	ft
Specific Energy	53.61	ft
Froude Number	1.78	
Flow is supercritical.		

Cross Section B - North Branch
Cross Section for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section B - North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.038000	ft/ft
Water Surface Elevation	51.51	ft
Discharge	1,312.00	cfs



Cross Section B - North Branch - Future
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

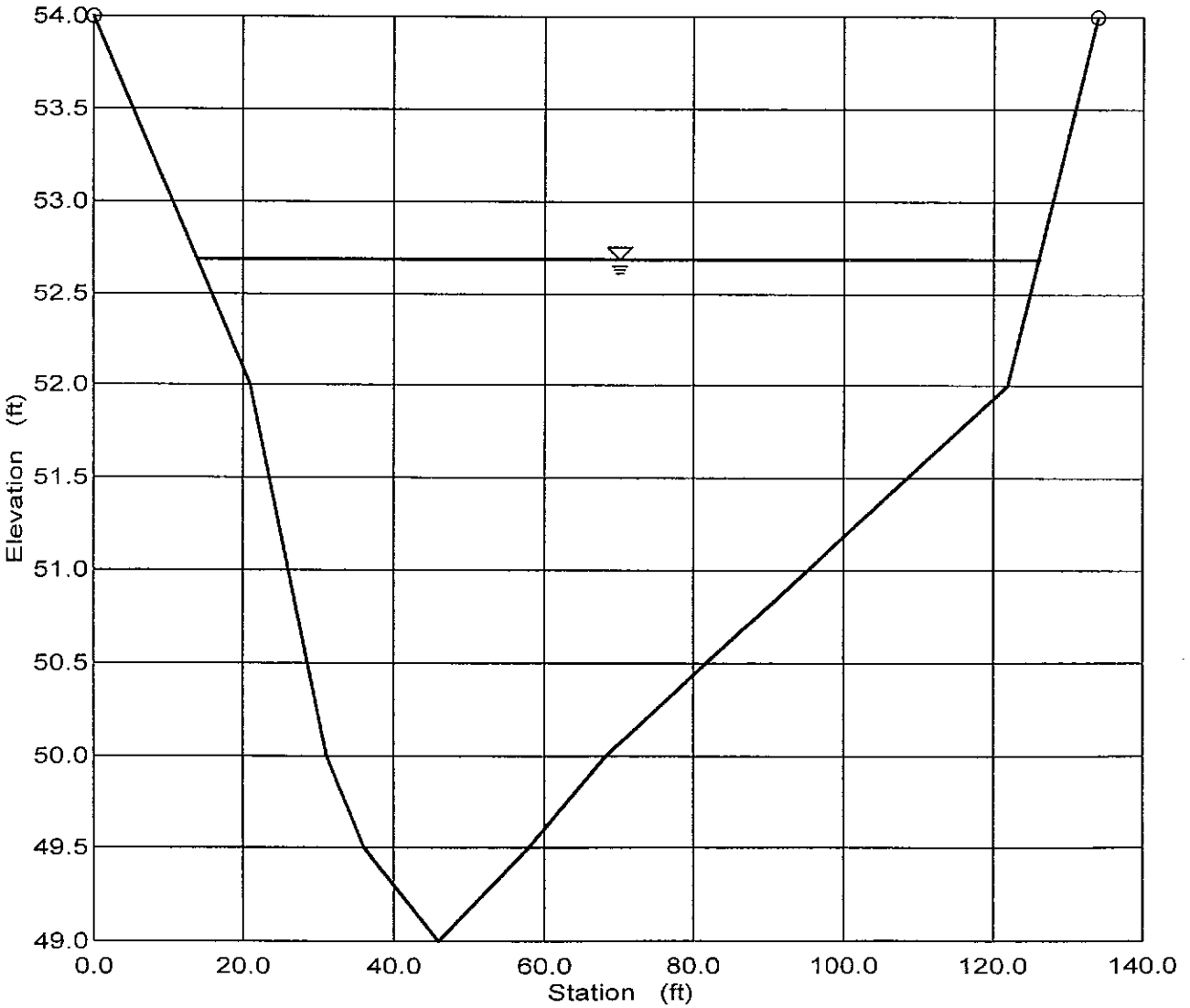
Input Data					
Channel Slope	0.005000 ft/ft				
Elevation range: 49.00 ft to 54.00 ft.					
Station (ft)	Elevation (ft)		Start Station	End Station	Roughness
0.00	54.00		0.00	134.00	0.030
21.00	52.00				
31.00	50.00				
36.00	49.50				
46.00	49.00				
58.00	49.50				
68.00	50.00				
122.00	52.00				
134.00	54.00				
Discharge	1,312.00	cfs			

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	52.69	ft
Flow Area	231.74	ft²
Wetted Perimeter	112.75	ft
Top Width	112.37	ft
Height	3.69	ft
Critical Depth	52.19	ft
Critical Slope	0.011026	ft/ft
Velocity	5.66	ft/s
Velocity Head	0.50	ft
Specific Energy	53.19	ft
Froude Number	0.70	
Flow is subcritical.		

Cross Section B - North Branch - Future
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	52.69	ft
Discharge	1,312.00	cfs



Cross Section C - North Branch
Worksheet for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section C - North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.020000	ft/ft
Elevation range: 37.00 ft to 44.00 ft.		

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	44.00	0.00	110.00	0.030
8.00	42.00			
16.00	40.00			
22.00	38.00			
30.00	37.50			
36.00	37.00			
44.00	37.50			
51.00	38.00			
68.00	40.00			
110.00	42.00			

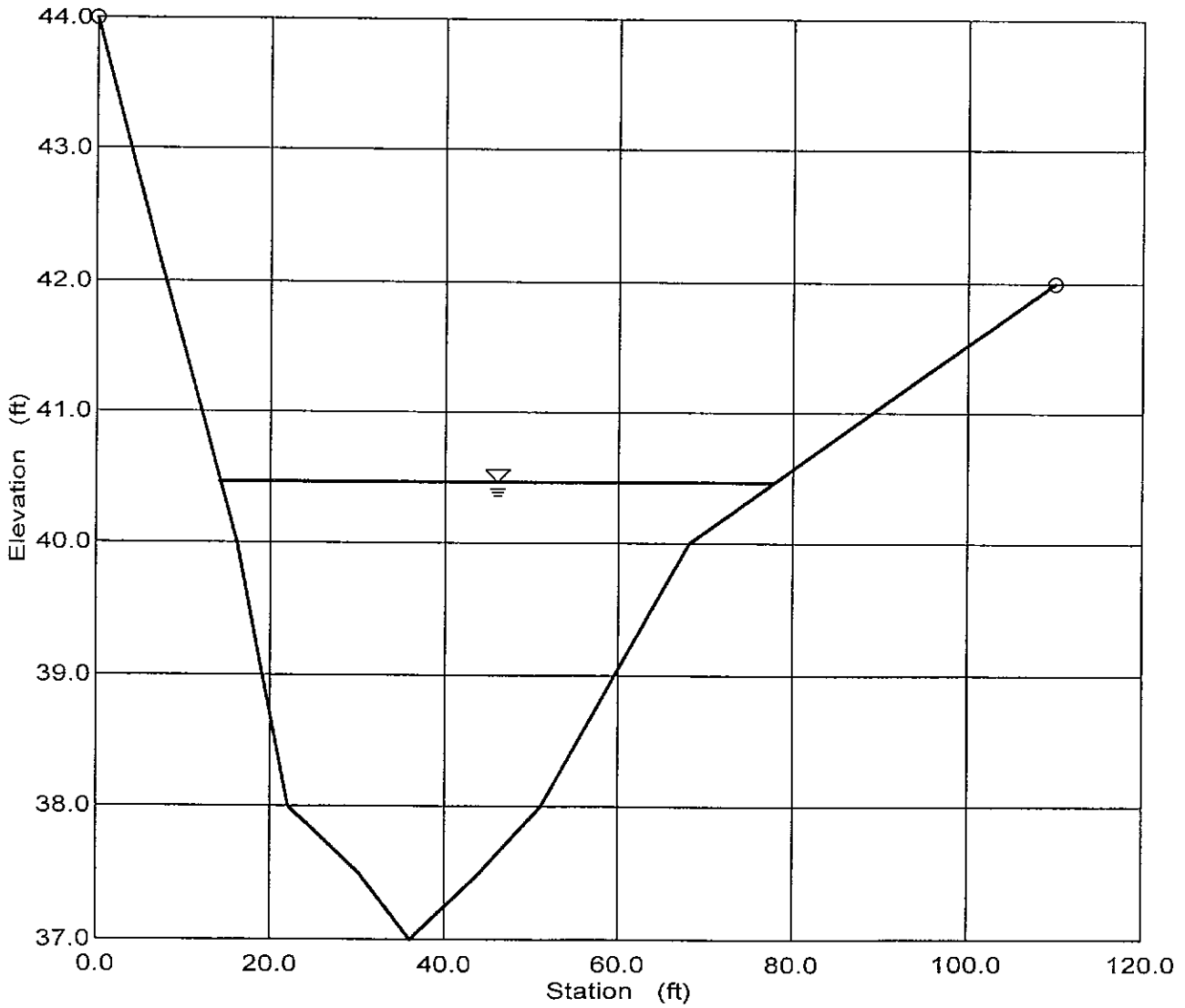
Discharge	1,312.00	cfs

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	40.46	ft
Flow Area	122.02	ft²
Wetted Perimeter	64.16	ft
Top Width	63.58	ft
Height	3.46	ft
Critical Depth	41.01	ft
Critical Slope	0.010395	ft/ft
Velocity	10.75	ft/s
Velocity Head	1.80	ft
Specific Energy	42.26	ft
Froude Number	1.37	
Flow is supercritical.		

Cross Section C - North Branch
Cross Section for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section C - North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.020000	ft/ft
Water Surface Elevation	40.46	ft
Discharge	1,312.00	cfs



Cross Section C - North Branch - Future
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.005000	ft/ft
Elevation range: 37.00 ft to 44.00 ft.		
Discharge	1,312.00	cfs

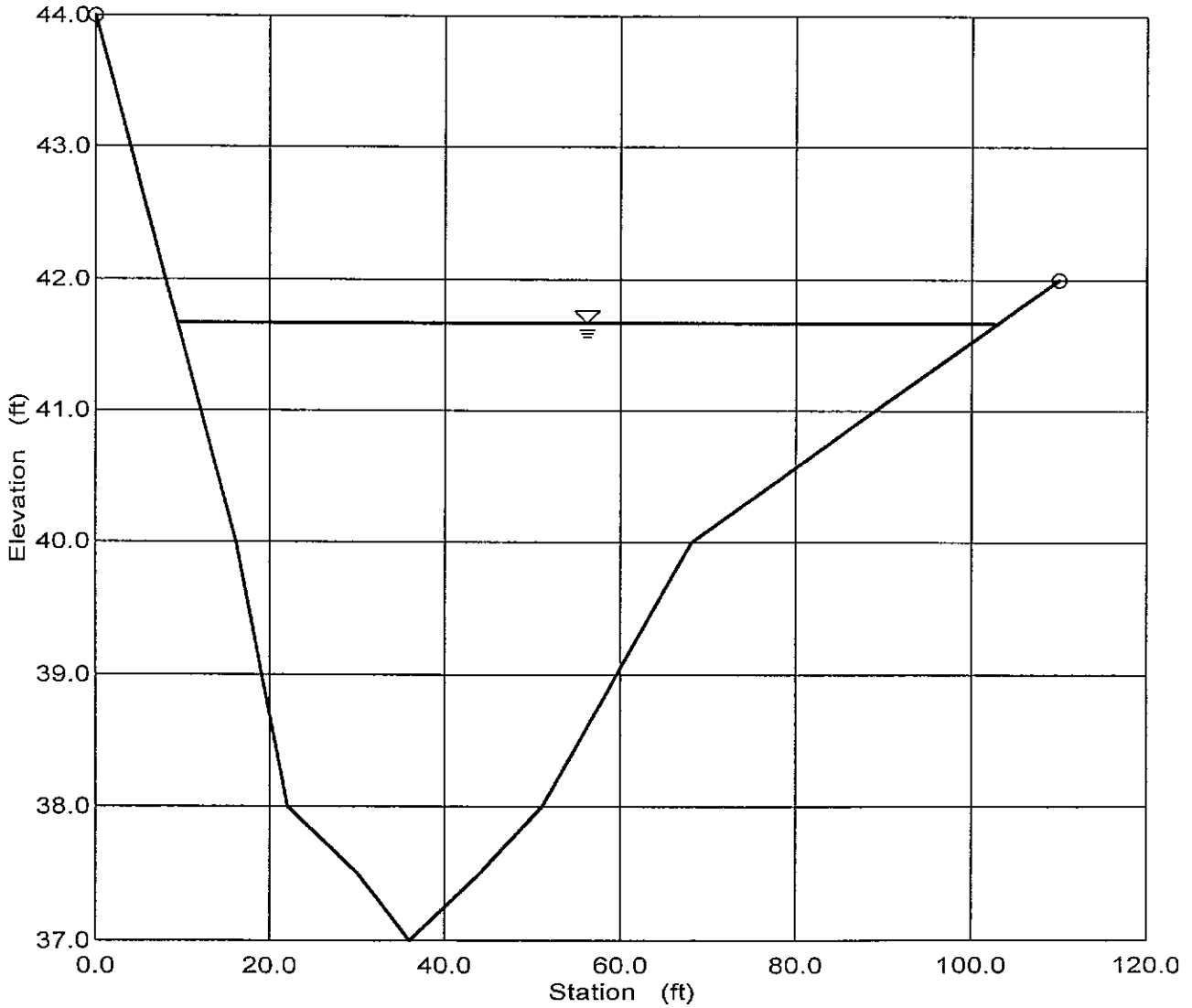
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	44.00	0.00	110.00	0.030
8.00	42.00			
16.00	40.00			
22.00	38.00			
30.00	37.50			
36.00	37.00			
44.00	37.50			
51.00	38.00			
68.00	40.00			
110.00	42.00			

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	41.66	ft
Flow Area	215.61	ft²
Wetted Perimeter	94.15	ft
Top Width	93.39	ft
Height	4.66	ft
Critical Depth	41.01	ft
Critical Slope	0.010395	ft/ft
Velocity	6.09	ft/s
Velocity Head	0.58	ft
Specific Energy	42.23	ft
Froude Number	0.71	
Flow is subcritical.		

Cross Section C - North Branch - Future
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	North Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	41.66	ft
Discharge	1,312.00	cfs



Cross Section A - South Branch
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Monument Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.019000	ft/ft

Elevation range: 79.00 ft to 88.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	88.00	0.00	53.00	0.030
8.00	86.00			
13.00	84.00			
18.00	82.00			
23.00	80.00			
25.00	79.50			
30.00	79.00			
36.00	79.50			
38.00	80.00			
43.00	82.00			
47.00	84.00			
51.00	86.00			
53.00	88.00			

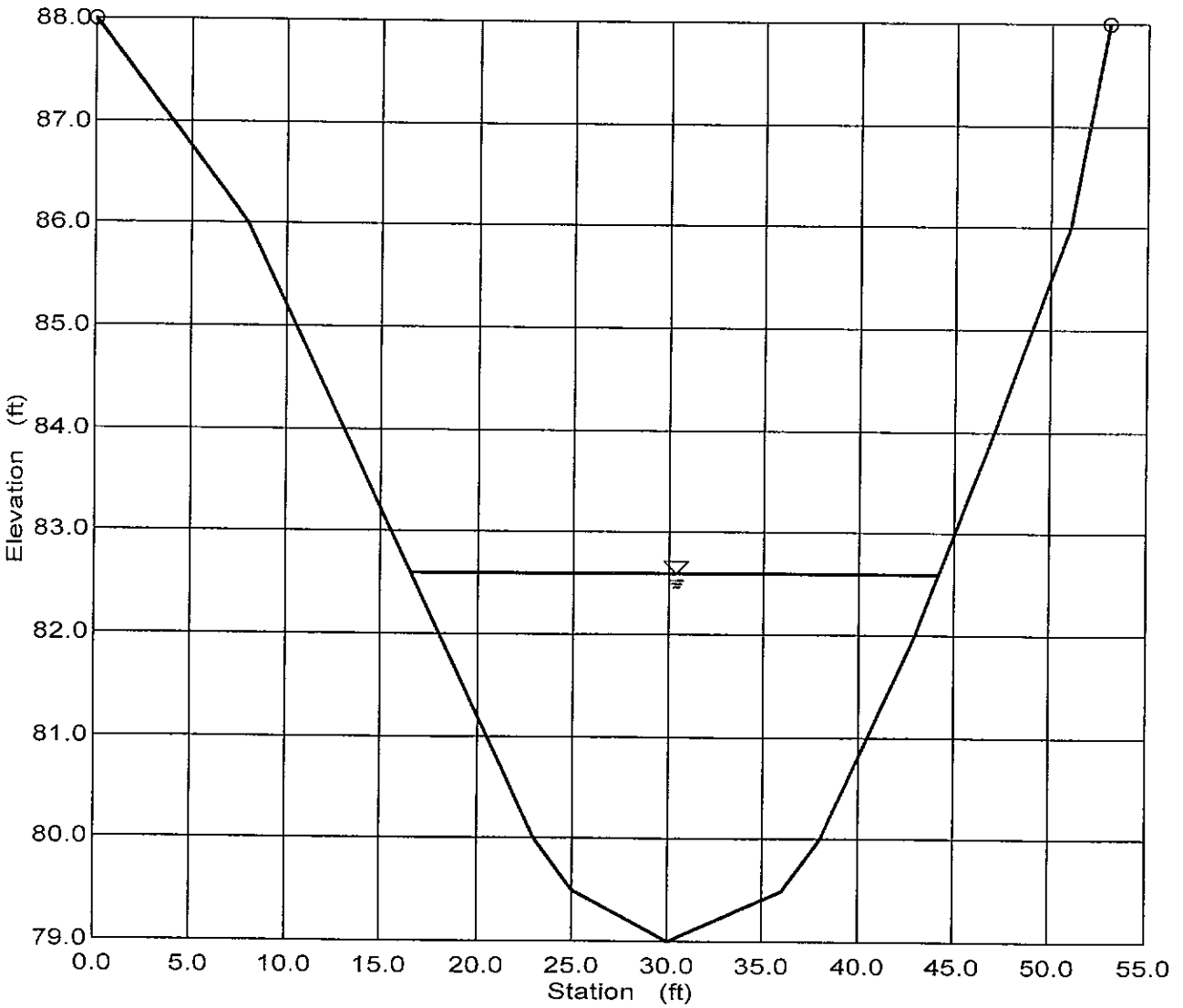
Discharge	757.00	cfs

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	82.59	ft
Flow Area	64.69	ft^2
Wetted Perimeter	28.83	ft
Top Width	27.64	ft
Height	3.59	ft
Critical Depth	83.16	ft
Critical Slope	0.010031	ft/ft
Velocity	11.70	ft/s
Velocity Head	2.13	ft
Specific Energy	84.71	ft
Froude Number	1.35	
Flow is supercritical.		

Cross Section A - South Branch
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Monument Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.019000	ft/ft
Water Surface Elevation	82.59	ft
Discharge	757.00	cfs



Cross Section A - South Branch - Future
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Cross Section A - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

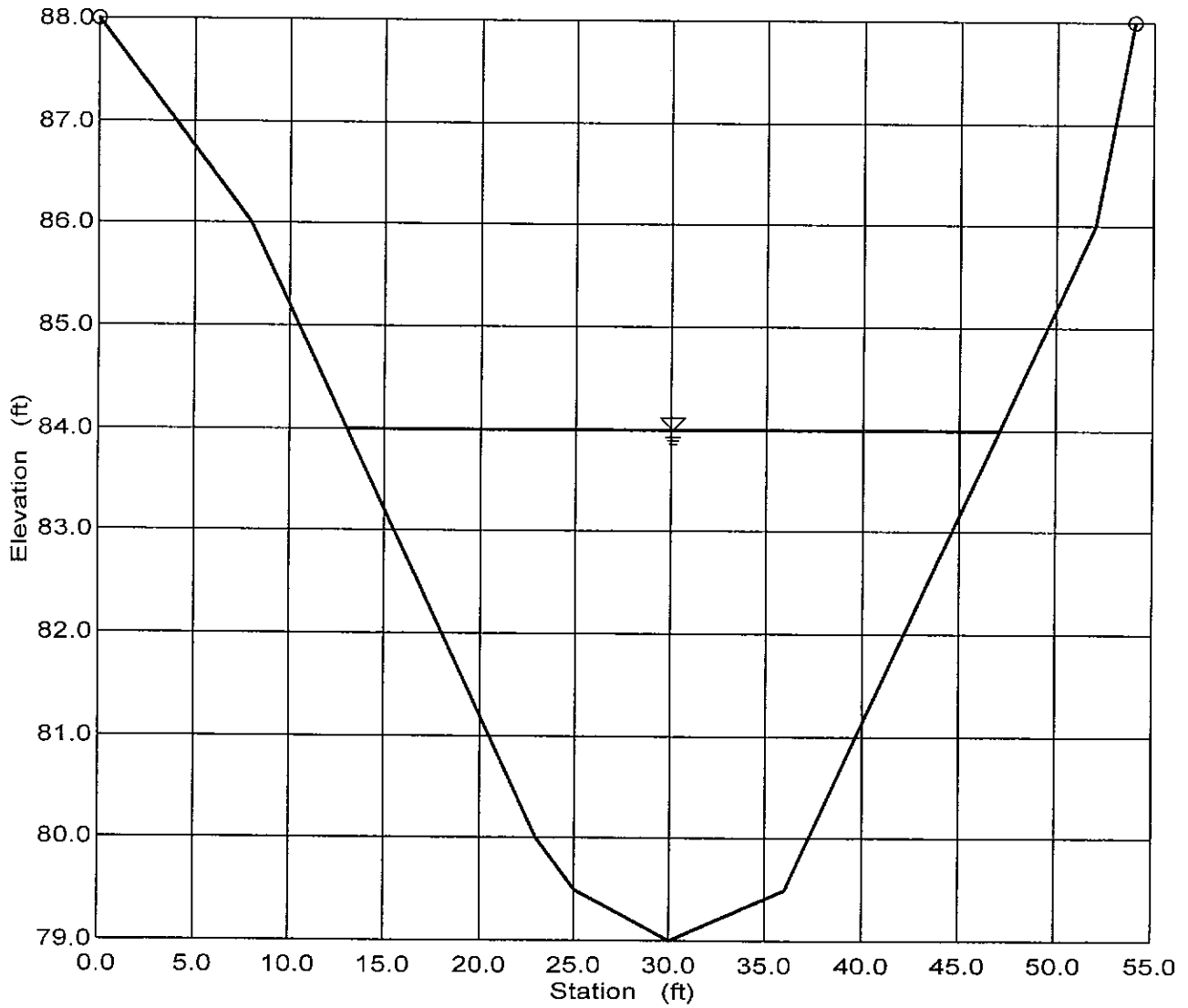
Input Data					
Channel Slope	0.005000 ft/ft				
Elevation range: 79.00 ft to 88.00 ft.					
Station (ft)	Elevation (ft)		Start Station	End Station	Roughness
0.00	88.00		0.00	54.00	0.030
8.00	86.00				
23.00	80.00				
25.00	79.50				
30.00	79.00				
36.00	79.50				
52.00	86.00				
54.00	88.00				
Discharge	757.00	cfs			

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	83.99	ft
Flow Area	105.25	ft²
Wetted Perimeter	35.77	ft
Top Width	34.02	ft
Height	4.99	ft
Critical Depth	83.25	ft
Critical Slope	0.010049	ft/ft
Velocity	7.19	ft/s
Velocity Head	0.80	ft
Specific Energy	84.79	ft
Froude Number	0.72	
Flow is subcritical.		

Cross Section A - South Branch - Future
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Cross Section A - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	83.99	ft
Discharge	757.00	cfs



Cross Section B - South Branch
Worksheet for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section B - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.020000	ft/ft
Elevation range: 65.50 ft to 72.00 ft.		

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	72.00	0.00	75.00	0.030
14.00	70.00			
25.00	68.00			
46.00	66.00			
49.00	65.75			
56.00	65.50			
60.00	66.00			
62.00	66.50			
67.00	68.00			
72.00	70.00			
75.00	72.00			

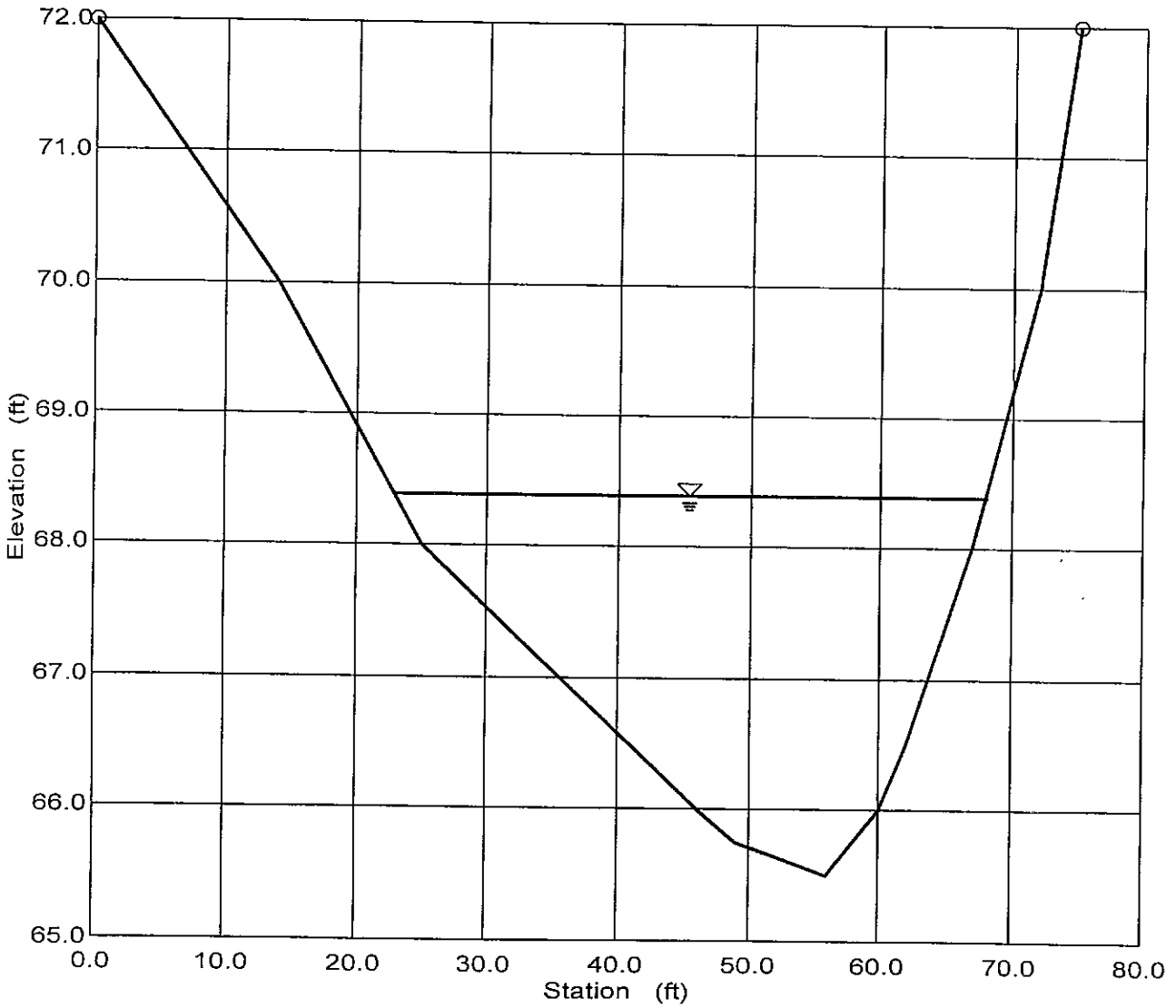
Discharge	767.00	cfs

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	68.39	ft
Flow Area	77.16	ft²
Wetted Perimeter	45.64	ft
Top Width	45.11	ft
Height	2.89	ft
Critical Depth	68.79	ft
Critical Slope	0.010620	ft/ft
Velocity	9.94	ft/s
Velocity Head	1.54	ft
Specific Energy	69.92	ft
Froude Number	1.34	
Flow is supercritical.		

Cross Section B - South Branch
Cross Section for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section B - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

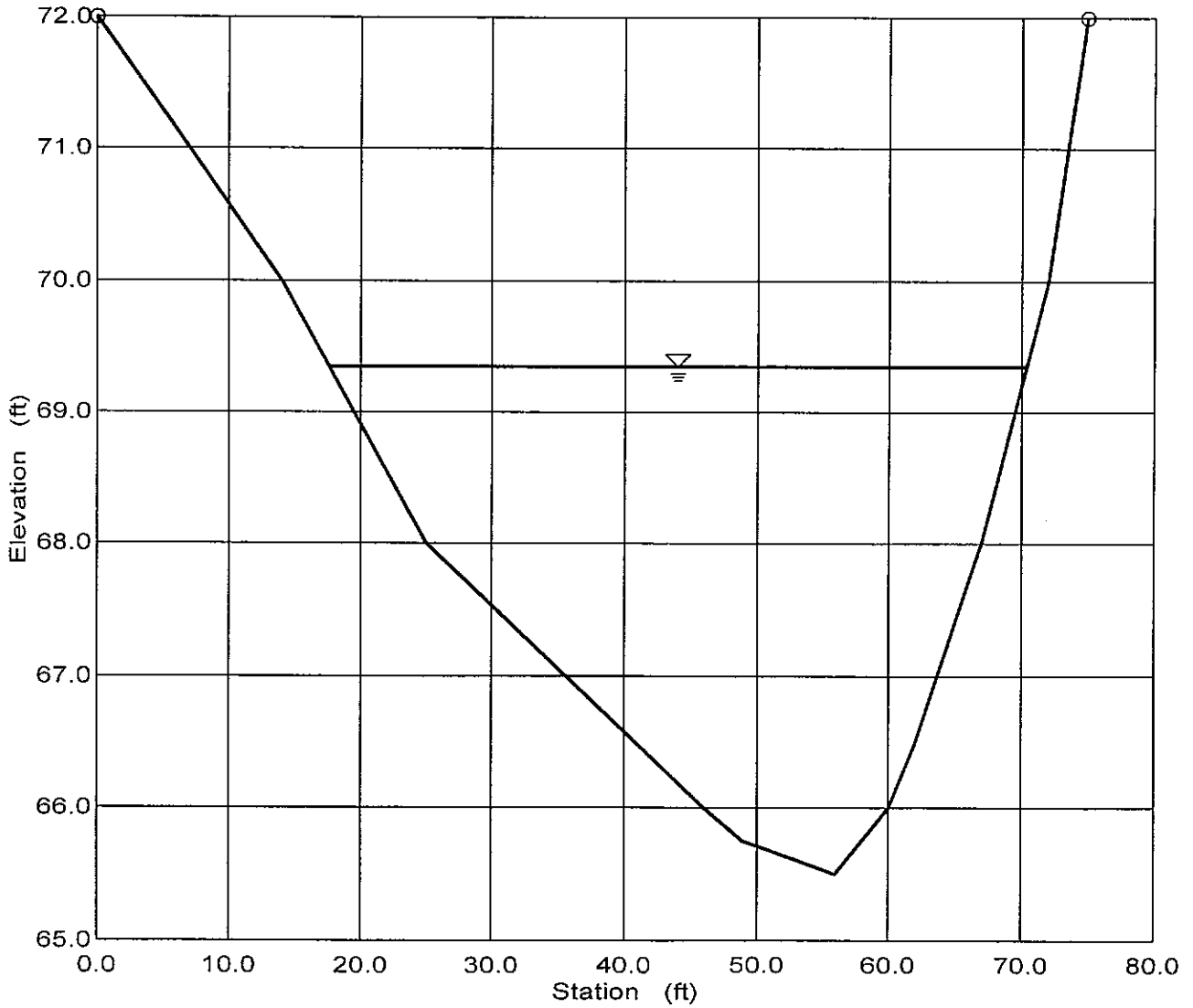
Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.020000	ft/ft
Water Surface Elevation	68.39	ft
Discharge	767.00	cfs



Cross Section B - South Branch - Future
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Cross Section A - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	69.34	ft
Discharge	757.00	cfs



Cross Section B - South Branch - Future
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Cross Section A - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data				
Channel Slope	0.005000 ft/ft			
Elevation range: 65.50 ft to 72.00 ft.				
Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	72.00	0.00	75.00	0.030
14.00	70.00			
25.00	68.00			
46.00	66.00			
49.00	65.75			
56.00	65.50			
60.00	66.00			
62.00	66.50			
67.00	68.00			
72.00	70.00			
75.00	72.00			
Discharge	757.00 cfs			

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	69.34	ft
Flow Area	123.66	ft²
Wetted Perimeter	53.51	ft
Top Width	52.71	ft
Height	3.84	ft
Critical Depth	68.77	ft
Critical Slope	0.010643	ft/ft
Velocity	6.12	ft/s
Velocity Head	0.58	ft
Specific Energy	69.92	ft
Froude Number	0.70	
Flow is subcritical.		

Cross Section C - South Branch
Worksheet for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section C - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.018000	ft/ft
Elevation range: 56.50 ft to 62.00 ft.		

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	62.00	0.00	96.00	0.030
22.00	60.00			
30.00	58.00			
58.00	57.00			
66.00	56.50			
77.00	57.00			
82.00	58.00			
90.00	60.00			
96.00	62.00			

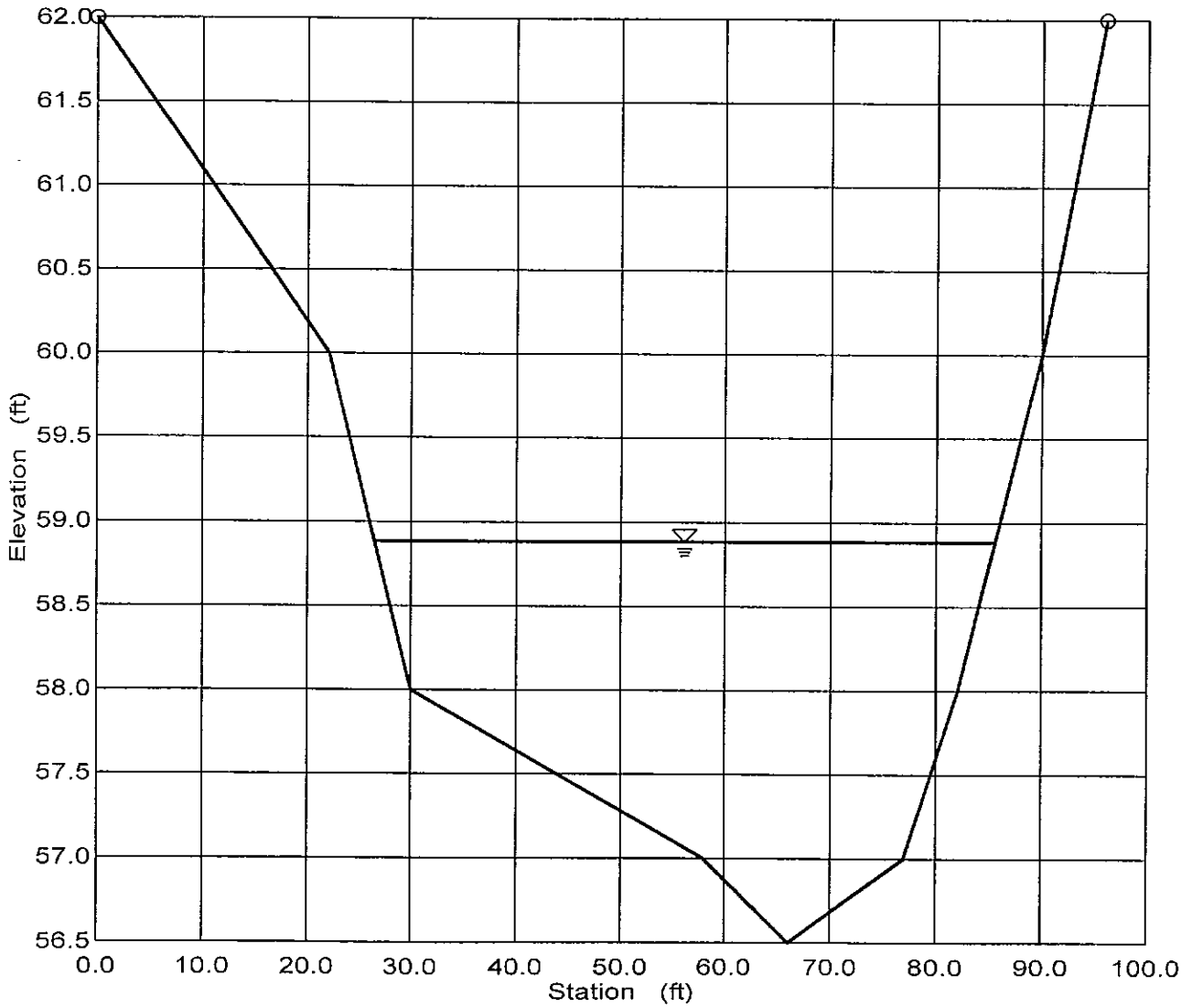
Discharge	777.00	cfs

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	58.88	ft
Flow Area	89.19	ft²
Wetted Perimeter	59.41	ft
Top Width	59.05	ft
Height	2.38	ft
Critical Depth	59.14	ft
Critical Slope	0.011063	ft/ft
Velocity	8.71	ft/s
Velocity Head	1.18	ft
Specific Energy	60.06	ft
Froude Number	1.25	
Flow is supercritical.		

Cross Section C - South Branch
Cross Section for Irregular Channel

Project Description	
Project File	h:\fmw\monument.fm2
Worksheet	Cross Section C - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.018000	ft/ft
Water Surface Elevation	58.88	ft
Discharge	777.00	cfs



Cross Section C - South Branch - Future
Worksheet for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Cross Section A - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Input Data		
Channel Slope	0.005000	ft/ft

Elevation range: 56.50 ft to 62.00 ft.

Station (ft)	Elevation (ft)	Start Station	End Station	Roughness
0.00	62.00	0.00	96.00	0.030
22.00	60.00			
30.00	58.00			
58.00	57.00			
66.00	56.50			
77.00	57.00			
82.00	58.00			
90.00	60.00			
96.00	62.00			

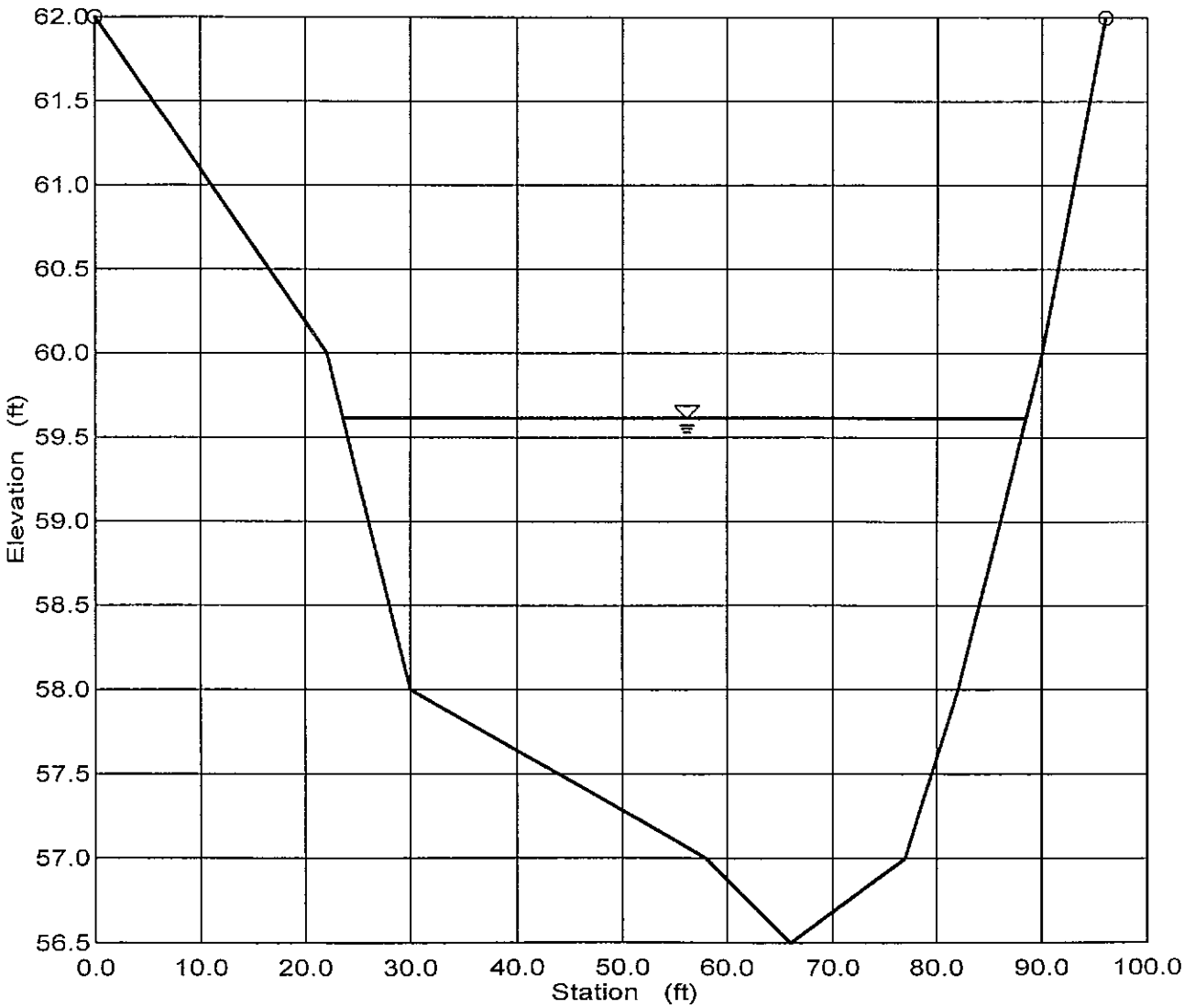
Discharge	757.00	cfs

Results		
Wtd. Mannings Coefficient	0.030	
Water Surface Elevation	59.60	ft
Flow Area	133.97	ft²
Wetted Perimeter	65.37	ft
Top Width	64.83	ft
Height	3.10	ft
Critical Depth	59.11	ft
Critical Slope	0.011115	ft/ft
Velocity	5.65	ft/s
Velocity Head	0.50	ft
Specific Energy	60.10	ft
Froude Number	0.69	
Flow is subcritical.		

Cross Section C - South Branch - Future
Cross Section for Irregular Channel

Project Description	
Project File	untitled.fm2
Worksheet	Cross Section A - South Branch
Flow Element	Irregular Channel
Method	Manning's Formula
Solve For	Water Elevation

Section Data		
Wtd. Mannings Coefficient	0.030	
Channel Slope	0.005000	ft/ft
Water Surface Elevation	59.60	ft
Discharge	757.00	cfs



DRAINAGE MAPS