

Appendix C – Hydraulic Calculations

- Normal Depth Calculations – Streets
- Normal Depth Calculations – Onsite
- Normal Depth Calculations – Swales
- Manning's N Calculation
- Curb Cut Calculations

Worksheet for Lake Mead - LM1-100 Yrs (EX/ULT)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.20 %
Discharge	1,415.00 cfs

Section Definitions

	Station (ft)	Elevation (ft)
	0+00.00	0.60
	0+05.00	0.50
	0+05.50	0.48
	0+05.50	0.00
	0+07.00	0.13
	0+07.00	0.17
	0+50.00	1.03
	0+93.00	0.17
	0+93.00	0.13
	0+94.50	0.00
	0+94.50	0.48
	0+95.00	0.50
	1+00.00	0.60

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+07.00, 0.13)	0.013
(0+07.00, 0.13)	(0+93.00, 0.13)	0.016
(0+93.00, 0.13)	(1+00.00, 0.60)	0.013

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	1.79 ft
Roughness Coefficient	0.016
Elevation	1.79 ft
Elevation Range	0.00 to 1.03 ft
Flow Area	121.4 ft ²
Wetted Perimeter	103.45 ft

Worksheet for Lake Mead - LM1-100 Yrs (EX/ULT)

Results

Hydraulic Radius	1.17 ft
Top Width	100.00 ft
Normal Depth	1.79 ft
Critical Depth	2.42 ft
Critical Slope	0.31 %
Velocity	11.66 ft/s
Velocity Head	2.11 ft
Specific Energy	3.90 ft
Froude Number	1.865
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

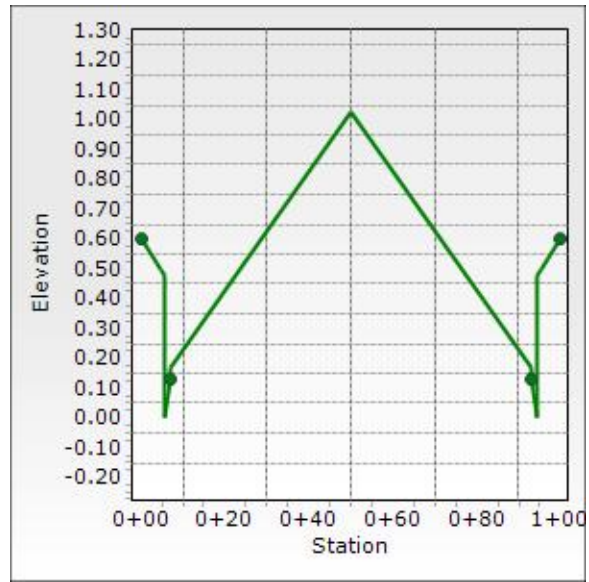
GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.79 ft
Critical Depth	2.42 ft
Channel Slope	1.20 %
Critical Slope	0.31 %

XS for Lake Mead - LM1-100 Yrs (EX/ULT)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.20 %
Normal Depth	1.79 ft
Discharge	1,415.00 cfs



Worksheet for Lake Mead - LM1-10 Yrs (EX)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.20 %
Discharge	52.00 cfs

Section Definitions

	Station (ft)	Elevation (ft)
	0+00.00	0.60
	0+05.00	0.50
	0+05.50	0.48
	0+05.50	0.00
	0+07.00	0.13
	0+07.00	0.17
	0+50.00	1.03
	0+93.00	0.17
	0+93.00	0.13
	0+94.50	0.00
	0+94.50	0.48
	0+95.00	0.50
	1+00.00	0.60

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+07.00, 0.13)	0.013
(0+07.00, 0.13)	(0+93.00, 0.13)	0.016
(0+93.00, 0.13)	(1+00.00, 0.60)	0.013

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	0.63 ft
Roughness Coefficient	0.015
Elevation	0.63 ft
Elevation Range	0.00 to 1.03 ft
Flow Area	13.5 ft ²
Wetted Perimeter	61.59 ft

Worksheet for Lake Mead - LM1-10 Yrs (EX)

Results

Hydraulic Radius	0.22 ft
Top Width	60.45 ft
Normal Depth	0.63 ft
Critical Depth	0.70 ft
Critical Slope	0.55 %
Velocity	3.86 ft/s
Velocity Head	0.23 ft
Specific Energy	0.87 ft
Froude Number	1.439
Flow Type	Supercritical

GVF Input Data

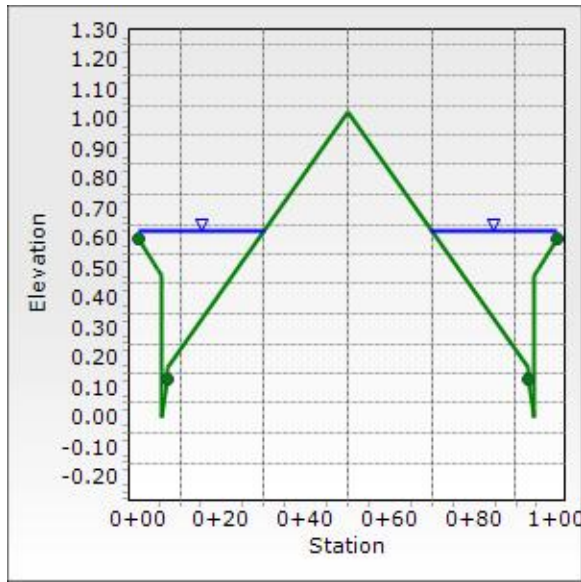
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.63 ft
Critical Depth	0.70 ft
Channel Slope	1.20 %
Critical Slope	0.55 %

XS for Lake Mead - LM1-10 Yrs (EX)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	1.20 %
Normal Depth	0.63 ft
Discharge	52.00 cfs



Worksheet for Lake Mead - LM1-10 Yrs (ULT)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.20 %
Discharge	53.00 cfs

Section Definitions

	Station (ft)	Elevation (ft)	
	0+00.00		0.60
	0+05.00		0.50
	0+05.50		0.48
	0+05.50		0.00
	0+07.00		0.13
	0+07.00		0.17
	0+50.00		1.03
	0+93.00		0.17
	0+93.00		0.13
	0+94.50		0.00
	0+94.50		0.48
	0+95.00		0.50
	1+00.00		0.60

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+07.00, 0.13)	0.013
(0+07.00, 0.13)	(0+93.00, 0.13)	0.016
(0+93.00, 0.13)	(1+00.00, 0.60)	0.013

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	0.64 ft
Roughness Coefficient	0.015
Elevation	0.64 ft
Elevation Range	0.00 to 1.03 ft
Flow Area	13.7 ft ²
Wetted Perimeter	61.87 ft

Worksheet for Lake Mead - LM1-10 Yrs (ULT)

Results

Hydraulic Radius	0.22 ft
Top Width	60.73 ft
Normal Depth	0.64 ft
Critical Depth	0.71 ft
Critical Slope	0.54 %
Velocity	3.88 ft/s
Velocity Head	0.23 ft
Specific Energy	0.87 ft
Froude Number	1.443
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

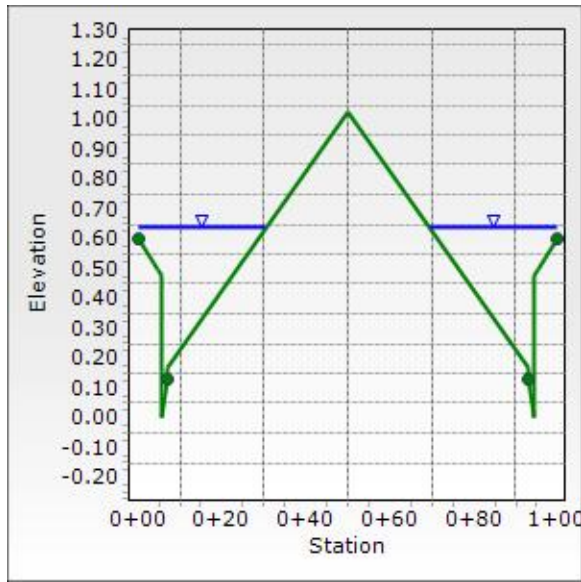
GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.64 ft
Critical Depth	0.71 ft
Channel Slope	1.20 %
Critical Slope	0.54 %

XS for Lake Mead - LM1-10 Yrs (ULT)

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.20 %
Normal Depth	0.64 ft
Discharge	53.00 cfs



Worksheet for Section UON1-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.30 %
Discharge	14.00 cfs

Section Definitions

Station (ft)		Elevation (ft)
	0+00.00	0.60
	0+05.00	0.50
	0+05.50	0.48
	0+05.50	0.00
	0+07.00	0.13
	0+07.00	0.17
	0+30.00	0.72
	0+30.00	1.22
	0+30.50	1.22

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+30.50, 1.22)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.68 ft
Roughness Coefficient	0.016
Elevation	0.68 ft
Elevation Range	0.00 to 1.22 ft
Flow Area	7.0 ft ²
Wetted Perimeter	28.85 ft
Hydraulic Radius	0.24 ft
Top Width	28.24 ft
Normal Depth	0.68 ft
Critical Depth	0.62 ft
Critical Slope	0.65 %
Velocity	1.99 ft/s

Worksheet for Section UON1-A

Results

Velocity Head	0.06 ft
Specific Energy	0.74 ft
Froude Number	0.701
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.68 ft
Critical Depth	0.62 ft
Channel Slope	0.30 %
Critical Slope	0.65 %

Worksheet for Section UON1-A

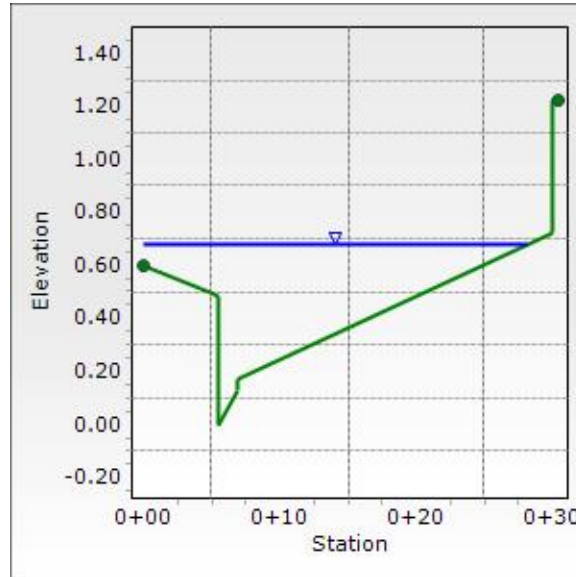
Messages:

Water Surface Elevation exceeds lowest end station by 0.0778339494182869ft.

XS for Section UON1-A

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.30 %
Normal Depth	0.68 ft
Discharge	14.00 cfs



Worksheet for Section UON1-B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.60 %
Discharge	4.50 cfs

Section Definitions

Station (ft)		Elevation (ft)
	0+00.00	0.60
	0+05.00	0.50
	0+05.50	0.48
	0+05.50	0.00
	0+07.00	0.13
	0+07.00	0.17
	0+30.50	0.44
	0+30.50	0.94
	0+31.00	0.94

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+31.00, 0.94)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.39 ft
Roughness Coefficient	0.016
Elevation	0.39 ft
Elevation Range	0.00 to 0.94 ft
Flow Area	2.5 ft ²
Wetted Perimeter	20.88 ft
Hydraulic Radius	0.12 ft
Top Width	20.44 ft
Normal Depth	0.39 ft
Critical Depth	0.38 ft
Critical Slope	0.78 %
Velocity	1.77 ft/s

Worksheet for Section UON1-B

Results

Velocity Head	0.05 ft
Specific Energy	0.44 ft
Froude Number	0.883
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

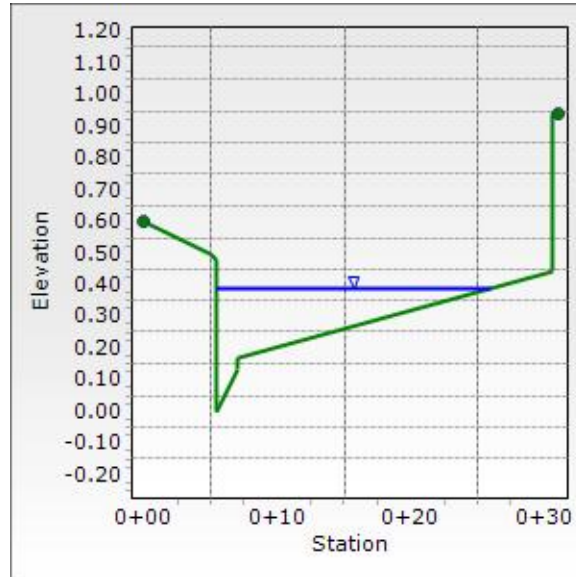
GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.39 ft
Critical Depth	0.38 ft
Channel Slope	0.60 %
Critical Slope	0.78 %

XS for Section UON1-B

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.60 %
Normal Depth	0.39 ft
Discharge	4.50 cfs



Worksheet for Section FD1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.50 %
Discharge	1.00 cfs

Section Definitions

	Station (ft)	Elevation (ft)
	0+00.00	0.60
	0+05.00	0.50
	0+05.50	0.48
	0+05.50	0.00
	0+07.00	0.13
	0+07.00	0.17
	0+30.50	0.99
	0+30.50	1.49
	0+31.00	1.49

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 0.60)	(0+31.00, 1.49)	0.016

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.31 ft
Roughness Coefficient	0.016
Elevation	0.31 ft
Elevation Range	0.00 to 1.49 ft
Flow Area	0.7 ft ²
Wetted Perimeter	5.93 ft
Hydraulic Radius	0.11 ft
Top Width	5.57 ft
Normal Depth	0.31 ft
Critical Depth	0.29 ft
Critical Slope	0.85 %
Velocity	1.52 ft/s

Worksheet for Section FD1

Results

Velocity Head	0.04 ft
Specific Energy	0.35 ft
Froude Number	0.778
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

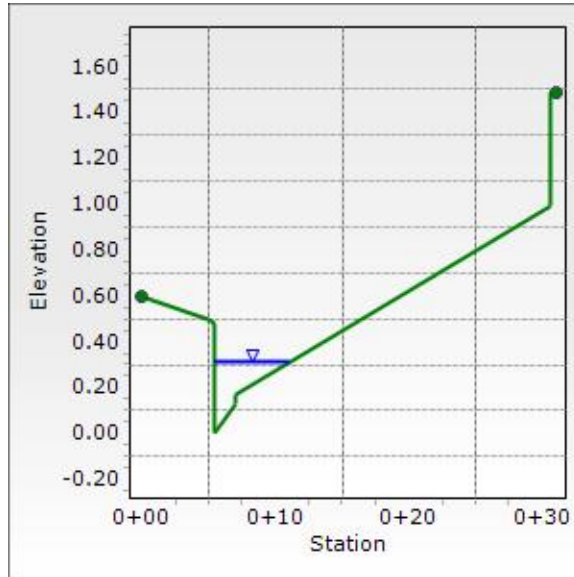
GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.31 ft
Critical Depth	0.29 ft
Channel Slope	0.50 %
Critical Slope	0.85 %

XS for Section FD1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.50 %
Normal Depth	0.31 ft
Discharge	1.00 cfs



Worksheet for SW

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.00 %
Discharge	8.00 cfs

Section Definitions

	Station (ft)	Elevation (ft)	
	0+00.00		1.25
	0+00.00		0.75
	0+03.00		0.00
	0+06.00		0.75
	0+06.00		1.25

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00.00, 1.25)	(0+00.00, 0.75)	0.013
(0+00.00, 0.75)	(0+06.00, 0.75)	0.035
(0+06.00, 0.75)	(0+06.00, 1.25)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	0.88 ft
Roughness Coefficient	0.034
Elevation	0.88 ft
Elevation Range	0.00 to 1.25 ft
Flow Area	3.0 ft ²
Wetted Perimeter	6.45 ft
Hydraulic Radius	0.47 ft
Top Width	6.00 ft
Normal Depth	0.88 ft
Critical Depth	0.76 ft
Critical Slope	2.48 %
Velocity	2.62 ft/s
Velocity Head	0.11 ft
Specific Energy	0.99 ft

Worksheet for SW

Results

Froude Number	0.649
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0

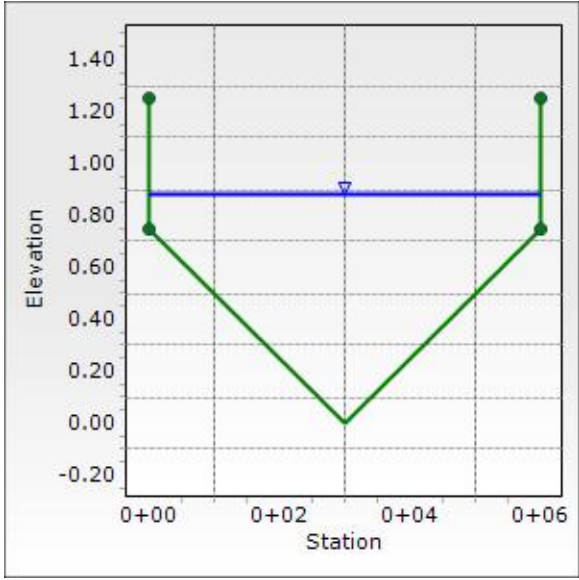
GVF Output Data

Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	0.88 ft
Critical Depth	0.76 ft
Channel Slope	1.00 %
Critical Slope	2.48 %

XS for SW

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	1.00 %
Normal Depth	0.88 ft
Discharge	8.00 cfs



Mannings N Calculator Using Equation 732 in the HCDDM			
Channel	d_{50} (in)	d_{50} (ft)	n
SW1	6	0.5	0.035

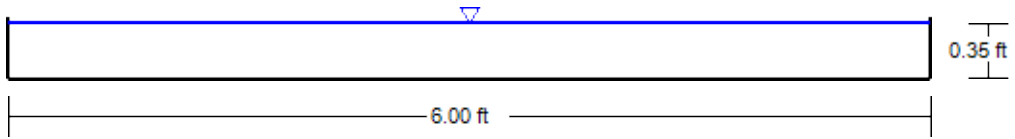
Worksheet for CH-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.50 %
Bottom Width	6.00 ft
Discharge	8.00 cfs
Results	
Normal Depth	0.35 ft
Flow Area	2.1 ft ²
Wetted Perimeter	6.71 ft
Hydraulic Radius	0.32 ft
Top Width	6.00 ft
Critical Depth	0.38 ft
Critical Slope	0.40 %
Velocity	3.76 ft/s
Velocity Head	0.22 ft
Specific Energy	0.57 ft
Froude Number	1.114
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.35 ft
Critical Depth	0.38 ft
Channel Slope	0.50 %
Critical Slope	0.40 %

XS for CH-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	0.50 %
Normal Depth	0.35 ft
Bottom Width	6.00 ft
Discharge	8.00 cfs



V: 1
H: 1

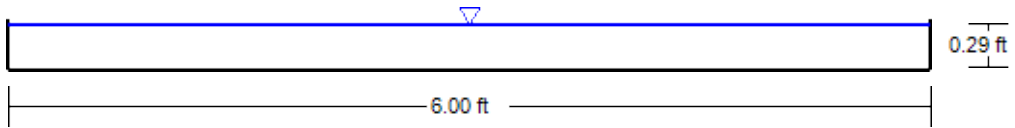
Worksheet for CH-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	1.00 %
Bottom Width	6.00 ft
Discharge	8.00 cfs
Results	
Normal Depth	0.29 ft
Flow Area	1.7 ft ²
Wetted Perimeter	6.57 ft
Hydraulic Radius	0.26 ft
Top Width	6.00 ft
Critical Depth	0.38 ft
Critical Slope	0.40 %
Velocity	4.67 ft/s
Velocity Head	0.34 ft
Specific Energy	0.62 ft
Froude Number	1.539
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.00 ft
Length	0.00 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.00 ft
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	0.29 ft
Critical Depth	0.38 ft
Channel Slope	1.00 %
Critical Slope	0.40 %

XS for CH-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.013
Channel Slope	1.00 %
Normal Depth	0.29 ft
Bottom Width	6.00 ft
Discharge	8.00 cfs



V: 1
H: 1