Exercise 1. Hydrology: Flood Flows and Watershed Characteristics

Drainage area is the first and most important factor influencing the magnitude of flood flows at a particular site. But watershed characteristics and climatic conditions also have a dramatic effect on flood flows. The WI regression equation provide one method for estimating flood flows based on these factors. The table below provides watershed characteristics for several sites in WI including the two field sites for this course. Use the National Streamflow Statistics (NSS) program or the attached equations and the data provided in the table to estimate the Q_2 and Q_{100} for each site. Divide each calculated flow by the drainage area for that site to facilitate comparison among sites. How do flood flows vary across WI and what effect do climate and watershed conditions have on flood flows? For Unnamed Tributary to Rountree and Snowden Branch, how do differences in imperious and forest area affect estimated flood flows? How does your ability to accurately measure these variables affect your confidence in the estimated values?

Exercise 1. Estimating flood flows using WI regression equations and watershed characteristics.

Row	Flood Fre-quency Area	Site (stream and road)	Drainage Area (sq mi)	Imper-vious Area (%)	Forest Area (%)	25-yr, 24-hr Precip. (inches)	Main Channel Slope (ft/mi)	Soil Perme-ability (in/hr)	Storage (%)	Mean Annual Snowfall (inches)	Q_2		Q_{100}	
											(cfs)	(cfs/sqmi)	(cfs)	(cfs/sqmi)
1	1	Unt Rountree at W Main St	0.64	30.0										
2	1	Unt Rountree at W Main St	0.64	37.4										
3	1	Unt Rountree at W Main St	0.64	48.7										
4	1	Unt Rountree at W Main St	0.64		5.31	5.29	121							
5	1	Unt Rountree at W Main St	0.64		1.25	5.29	121							
6	1	Snowden Br at Rock Rd	3.48		2.41	5.29	41							
7	1	Snowden Br at Rock Rd	3.48		0.80	5.29	41							
8	3	Armstrong Cr at Milan Rd	8.37			4.24		2.22	30.8					
9	3	Shadow at Hwy 64	2.81			4.24		1.65	13.7					
10	3	Mosquito at FR2123	0.95			4.24		1.65	1.4					
11	4	Unt Marengo at FR196	0.69				55	1.65	24.1	80				
12	4	Unt Morgan at FR199	0.51				218	1.65	3.5	80				

Note: Use urban equations for first three rows, rural for all others.

Table 5. Flood-frequency equations for Wisconsin urban areas

Equation	Standard error of estimate (percent)
$Q_2 = 4.18A^{0.786}I^{1.02}$	37
$Q_5 = 9.97A^{0.739}I^{0.910}$	32
$Q_{10} = 14.7\ A^{0.723}I^{0.863}$	32
$Q_{25} = 21.5\ A^{0.712}I^{0.818}$	33
$Q_{50} = 27.0\ A^{0.707}I^{0.792}$	35
$Q_{100} = 32.8\ A^{0.704}I^{0.770}$	37

1. Drainage area (A), in square miles, is the area contributing to surface runoff into the stream. This area can be planimetered from topographic maps or obtained directly from the Wisconsin drainage-area report (Henrich, 1986). Special attention should be given to determining drainage area for storm-sewer networks that may not drain the same area as the natural drainage patterns. Failure to do this could result in inaccurate drainage-area determinations.

7. Impervious area (I), expressed as a percentage of the drainage area, represents the total impervious area of the basin. The method used to determine impervious area for single-family residential areas is to determine the average impervious area for each dwelling (including the rooftop, driveway, and sidewalks) and also to determine the average street width. The total number of dwellings is then counted and the total length of streets is measured. The total impervious area is calculated by multiplying the number of dwellings by the average impervious area per dwelling, and the total length of streets by the average street width.

Alternative Method for Determining Impervious Area

An alternative method involving population density and using a table of typical impervious areas can be used to expedite the determination of impervious area. The basin can be divided into single-family residential areas, multiple residential areas, industrial areas, commercial areas, park areas, and other areas. Centerlines of streets and lot lines can be used to determine the boundaries. These land-use areas can be measured with a planimeter or digitizer. This information along with typical values (table 7) of impervious area for various land-use categories can be used to determine the total impervious area.

Instead of using table 7 for single-family residential areas the following relation can also be used.

$$I = 9.41\,D + 7.4 \qquad (D \text{ from } 1 \text{ to } 8)$$

Where: D is dwellings per acre, and

I is total impervious area expressed as a percentage of the basin drainage area.

The values in table 7 represent average total impervious area for a specific land-use category. These values are based on general field observations, various urban flood-frequency reports, and values used by the Southeastern Wisconsin Regional Planning Commission.

Each urban area needs to be evaluated to ascertain the best procedure for determining impervious area. See the following application of equations for an example of determining percentage of total impervious area.

Table 7. Total impervious area (percent) within land-use categories

Land-use category	Typical values of total impervious area (percent)		
	Low	Intermediate	High
Single-family residential[1]	16	27	45
Multifamily residential[2]	50	60	70
Commercial[3]	80	88	95
Industrial[4]	50	75	90
Public facilities[5]	50	60	75
Parks and undeveloped land[6]	0	1	3

[1] Single-family residential—Single-family dwellings predominate.
[2] Multifamily residential—Multiple-family units predominate. These include duplexes, apartment buildings, and condominiums.
[3] Commercial—Zones consisting of various types of business.
[4] Industrial—Manufacturing complexes, railroad yards, and large utilities.
[5] Public facilities—Schools, hospitals, churches, airports, and other public buildings.
[6] Parks and undeveloped land—Parks, forests, and open undeveloped land.

Table 2. Flood-frequency equations for streams in Wisconsin

[A, contributing drainage area in square miles; S, main-channel slope in feet per mile; I_{25}, 25-year, 24-hour precipitation intensity, in inches minus 4.2; ST, storage, in percent of basin area plus 1.0; SP, soil permeability of the least-permeable soil horizon in inches per hour; SN, mean annual snowfall for 1961 through 1990 in inches; FOR, forest cover in percent of basin area plus 1; Q_n, peak flood discharge in cubic feet per second, with an *n*-year recurrence interval; SE, standard error of estimate of regression, in log units; ESE, equivalent standard error of estimate, in percent. Flood frequency areas are shown in figure 3.]

Best-fit equation							SE	ESE	Eq. no.
Area 1 (39 stations)									
Q_2	=	$99.9\ A^{0.652}$	$FOR^{-0.254}$	$I_{25}^{7.52}$			0.1803	43	1-1
Q_5	=	$190.0\ A^{0.634}$	$FOR^{-0.260}$	$I_{25}^{8.45}$			.1709	40	1-2
Q_{10}	=	$35.0\ A^{0.857}$	$S^{0.463}$	$FOR^{-0.302}$	$I_{25}^{6.92}$		.1631	38	1-3
Q_{25}	=	$38.1\ A^{0.876}$	$S^{0.518}$	$FOR^{-0.308}$	$I_{25}^{7.16}$		.1691	40	1-4
Q_{50}	=	$41.4\ A^{0.884}$	$S^{0.545}$	$FOR^{-0.310}$	$I_{25}^{7.36}$		.1764	42	1-5
Q_{100}	=	$44.2\ A^{0.893}$	$S^{0.571}$	$FOR^{-0.312}$	$I_{25}^{7.56}$		.1855	44	1-6
Area 2 (36 stations)									
Q_2	=	$13.0\ A^{0.884}$	$SP^{-0.630}$	$S^{0.382}$			.1091	25	2-1
Q_5	=	$15.4\ A^{0.900}$	$SP^{-0.682}$	$S^{0.486}$			.1086	25	2-2
Q_{10}	=	$16.3\ A^{0.910}$	$SP^{-0.710}$	$S^{0.541}$			.1086	25	2-3
Q_{25}	=	$17.3\ A^{0.922}$	$SP^{-0.740}$	$S^{0.600}$			.1100	26	2-4
Q_{50}	=	$17.9\ A^{0.929}$	$SP^{-0.758}$	$S^{0.636}$			.1118	26	2-5
Q_{100}	=	$18.3\ A^{0.936}$	$SP^{-0.775}$	$S^{0.669}$			.1153	27	2-6
Area 3 (57 stations)									
Q_2	=	$36.5\ A^{0.832}$	$SP^{-0.614}$	$ST^{-0.143}$	$I_{25}^{0.124}$		.1591	37	3-1
Q_5	=	$61.6\ A^{0.827}$	$SP^{-0.683}$	$ST^{-0.169}$	$I_{25}^{0.133}$		.1470	34	3-2
Q_{10}	=	$80.6\ A^{0.825}$	$SP^{-0.713}$	$ST^{-0.186}$	$I_{25}^{0.135}$		.1449	34	3-3
Q_{25}	=	$107.0\ A^{0.821}$	$SP^{-0.743}$	$ST^{-0.204}$	$I_{25}^{0.136}$		.1439	34	3-4
Q_{50}	=	$127.0\ A^{0.819}$	$SP^{-0.761}$	$ST^{-0.215}$	$I_{25}^{0.136}$		.1446	34	3-5
Q_{100}	=	$149.0\ A^{0.818}$	$SP^{-0.775}$	$ST^{-0.227}$	$I_{25}^{0.136}$		.1466	34	3-6
Area 4 (40 stations)									
Q_2	=	$2.69\ A^{0.864}$	$ST^{-0.296}$	$S^{0.279}$	$SP^{-0.250}$	$SN^{0.490}$	.1233	29	4-1
Q_5	=	$6.76\ A^{0.858}$	$ST^{-0.286}$	$S^{0.303}$	$SP^{-0.259}$	$SN^{0.370}$	.1131	26	4-2
Q_{10}	=	$9.74\ A^{0.856}$	$ST^{-0.286}$	$S^{0.321}$	$SP^{-0.255}$	$SN^{0.332}$	.1063	25	4-3
Q_{25}	=	$13.7\ A^{0.856}$	$ST^{-0.290}$	$S^{0.342}$	$SP^{-0.246}$	$SN^{0.299}$	.0995	23	4-4
Q_{50}	=	$16.6\ A^{0.857}$	$ST^{-0.293}$	$S^{0.357}$	$SP^{-0.238}$	$SN^{0.281}$	.0964	22	4-5
Q_{100}	=	$19.4\ A^{0.857}$	$ST^{-0.296}$	$S^{0.371}$	$SP^{-0.229}$	$SN^{0.269}$	.0954	22	4-6
Area 5 (28 stations)									
Q_2	=	$9.58\ A^{0.981}$	$ST^{-0.293}$	$S^{0.416}$			.1179	27	5-1
Q_5	=	$15.1\ A^{0.912}$	$ST^{-0.358}$	$S^{0.438}$			.1127	26	5-2
Q_{10}	=	$18.9\ A^{0.913}$	$ST^{-0.385}$	$S^{0.447}$			.1196	28	5-3
Q_{25}	=	$23.6\ A^{0.915}$	$ST^{-0.408}$	$S^{0.457}$			.1349	32	5-4
Q_{50}	=	$27.0\ A^{0.916}$	$ST^{-0.420}$	$S^{0.463}$			.1490	35	5-5
Q_{100}	=	$30.6\ A^{0.916}$	$ST^{-0.430}$	$S^{0.467}$			.1637	39	5-6

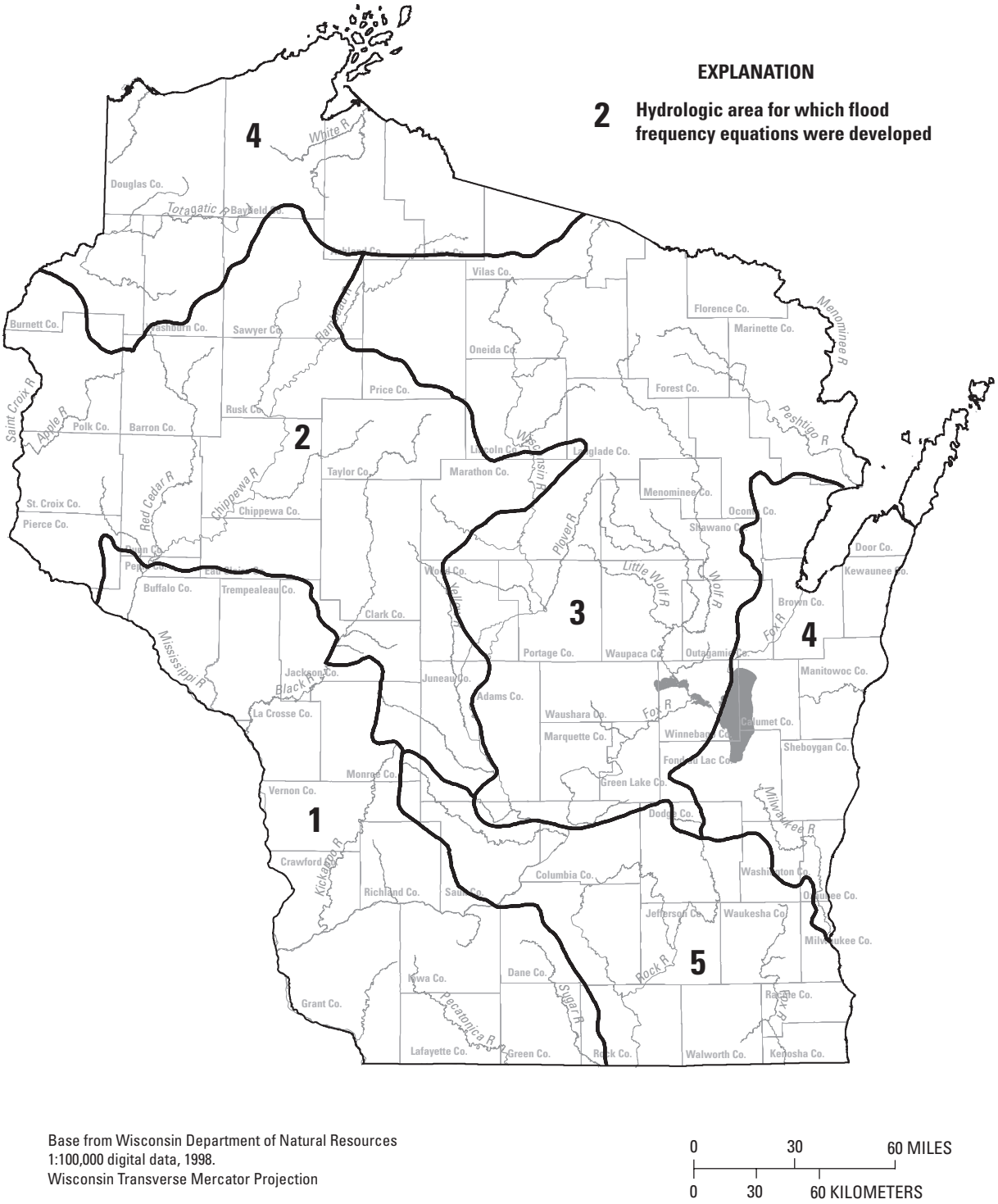


Figure 3. Flood-frequency areas in Wisconsin.

Exercise 1. Estimating flood flows using WI regression equations and watershed characteristics.

Row	Flood Fre-quency Area	Site (stream and road)	Drainage Area (sq mi)	Imper-vious Area (%)	Forest Area (%)	25-yr, 24-hr Precip. (inches)	Main Channel Slope (ft/mi)	Soil Perme-ability (in/hr)	Storage (%)	Mean Annual Snowfall (inches)	Q_2		Q_{100}	
											(cfs)	(cfs/sqmi)	(cfs)	(cfs/sqmi)
1	1 - U	Unt Rountree at W Main St	0.64	30.0										
2	1 - U	Unt Rountree at W Main St	0.64	37.4										
3	1 - U	Unt Rountree at W Main St	0.64	48.7										
4	1	Unt Rountree at W Main St	0.64		5.31	5.29	121							
5	1	Unt Rountree at W Main St	0.64		1.25	5.29	121							
6	1	Snowden Br at Rock Rd	3.48		2.41	5.29	41							
7	1	Snowden Br at Rock Rd	3.48		0.80	5.29	41							
8	3	Armstrong Cr at Milan Rd	8.37			4.24		2.22	30.8					
9	3	Shadow at Hwy 64	2.81			4.24		1.65	13.7					
10	3	Mosquito at FR2123	0.95			4.24		1.65	1.4					
11	4	Unt Marengo at FR196	0.69				55	1.65	24.1	80				
12	4	Unt Morgan at FR199	0.51				218	1.65	3.5	80				

Exercise 1. Estimating flood flows using WI regression equations and watershed characteristics.

Row	Flood Fre-quency Area	Site (stream and road)	Drainage Area (sq mi)	Imper-vious Area (%)	Forest Area (%)	25-yr, 24-hr Precip. (inches)	Main Channel Slope (ft/mi)	Soil Perme-ability (in/hr)	Storage (%)	Mean Annual Snowfall (inches)	Q_2		Q_{100}	
											(cfs)	(cfs/sqmi)	(cfs)	(cfs/sqmi)
1	1 - U	Unt Rountree at W Main St	0.64	30.0							95	148	329	514
2	1 - U	Unt Rountree at W Main St	0.64	37.4							118	184	390	609
3	1 - U	Unt Rountree at W Main St	0.64	48.7							155	242	477	745
4	1	Unt Rountree at W Main St	0.64		5.31	5.29	121				89	140	495	773
5	1	Unt Rountree at W Main St	0.64		1.25	5.29	121				116	181	683	1067
6	1	Snowden Br at Rock Rd	3.48		2.41	5.29	41				315	91	1470	422
7	1	Snowden Br at Rock Rd	3.48		0.80	5.29	41				371	107	1800	517
8	3	Armstrong Cr at Milan Rd	8.37			4.24		2.22	30.8		54	6	134	16
9	3	Shadow at Hwy 64	2.81			4.24		1.65	13.7		29	10	83	29
10	3	Mosquito at FR2123	0.95			4.24		1.65	1.4		15	16	51	54
11	4	Unt Marengo at FR196	0.69				55	1.65	24.1	80	17	25	69	101
12	4	Unt Morgan at FR199	0.51				218	1.65	3.5	80	33	64	148	292

Exercise 2. Hydrology: By-Pass Flows

Snowden Branch at Rock Road

For Snowden Branch at Rock Road, assume a new structure such as aluminum or concrete box culvert can be placed in 1-2 days and that pumping is a viable alternative to pass flows around the construction site. Using the information provided below, determine the drainage area, the likely flow rate during construction and the pump capacity that would be needed to by-pass the flow. In this case, use the average of the 11 Platteville area streamflow gages. Decide whether to use the flow duration curve or the average monthly flows. For the flow duration curve use the 50 percent flow. For average monthly flows, use the highest monthly flow for the construction period. What additional pump capacity might you want to have readily available?

Drainage Area (sq mi): **3.5** Flow Est (circle one): Flow Duration / Ave Monthly Flow

Construction Period (months): **Aug 1 - Oct 30**

Baseflow During Construction Period, cfs/sq mi: **0.5** cfs: **1.75** gal/min: **750**

Ave monthly flow: 0.75 cfs/sqmi * 3.5 sq mi = 2.6 cfs = 1,150 gpm

Unnamed Tributary to Rountree at West Main Street

For Unnamed Tributary to Rountree at West Main Street, assume that construction of a new culvert will require several weeks and a diversion pipe with the capacity to pass Q_2 will need to be installed. From the information provided below, determine the drainage area, Q_2, culvert type (circular or pipe-arch) and culvert size (assuming inlet control). State your assumption regarding HW/D ratio keeping in mind the diversion dam (sheet piling, sand bags, etc) must allow for the planned headwater without overtopping.

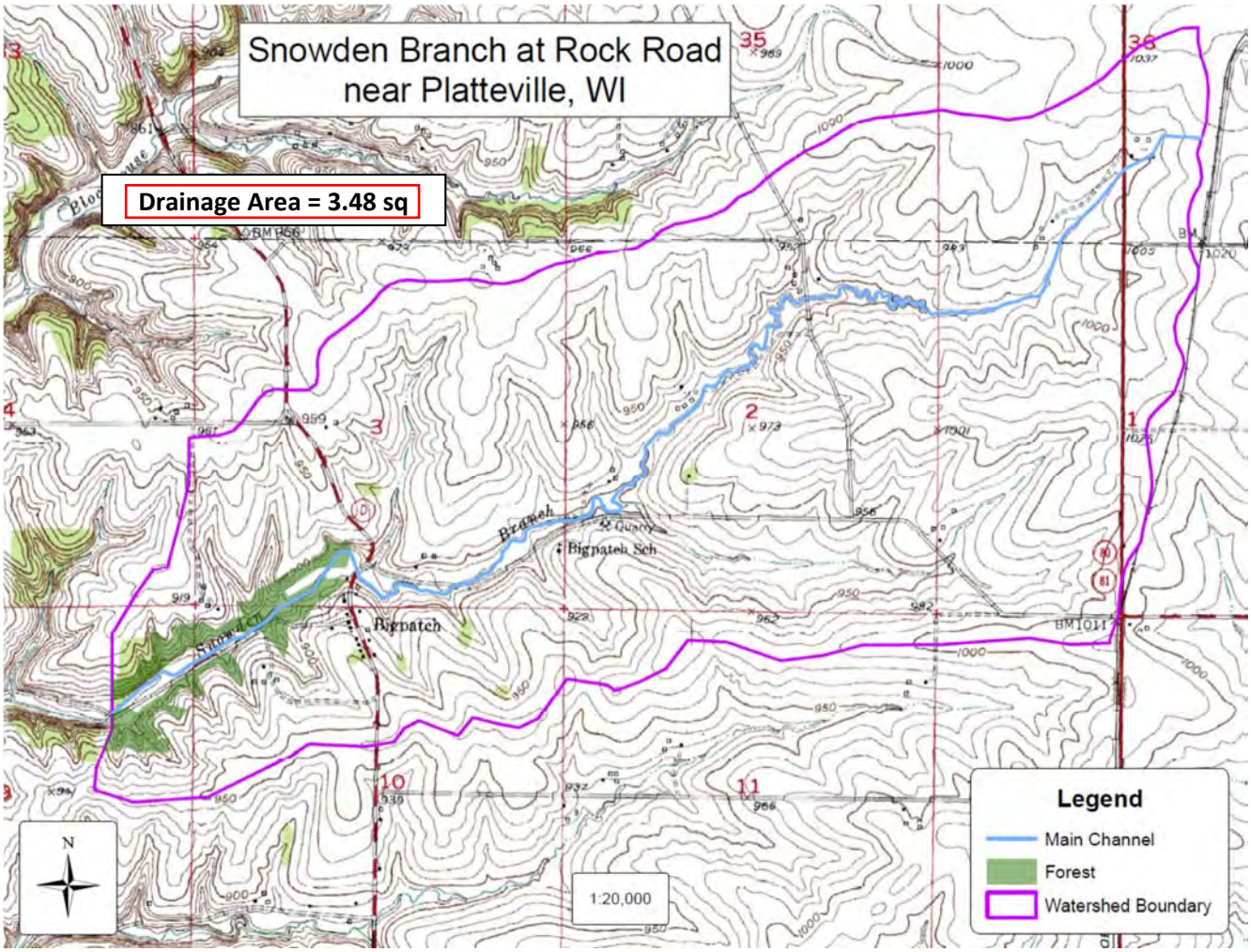
Drainage Area (sq mi): **0.64** Q_2 (cfs): **89.4** HW/D Ratio: **1.0**

Culvert Type (circle one): circular / pipe-arch Culvert Size (inches): **54"**

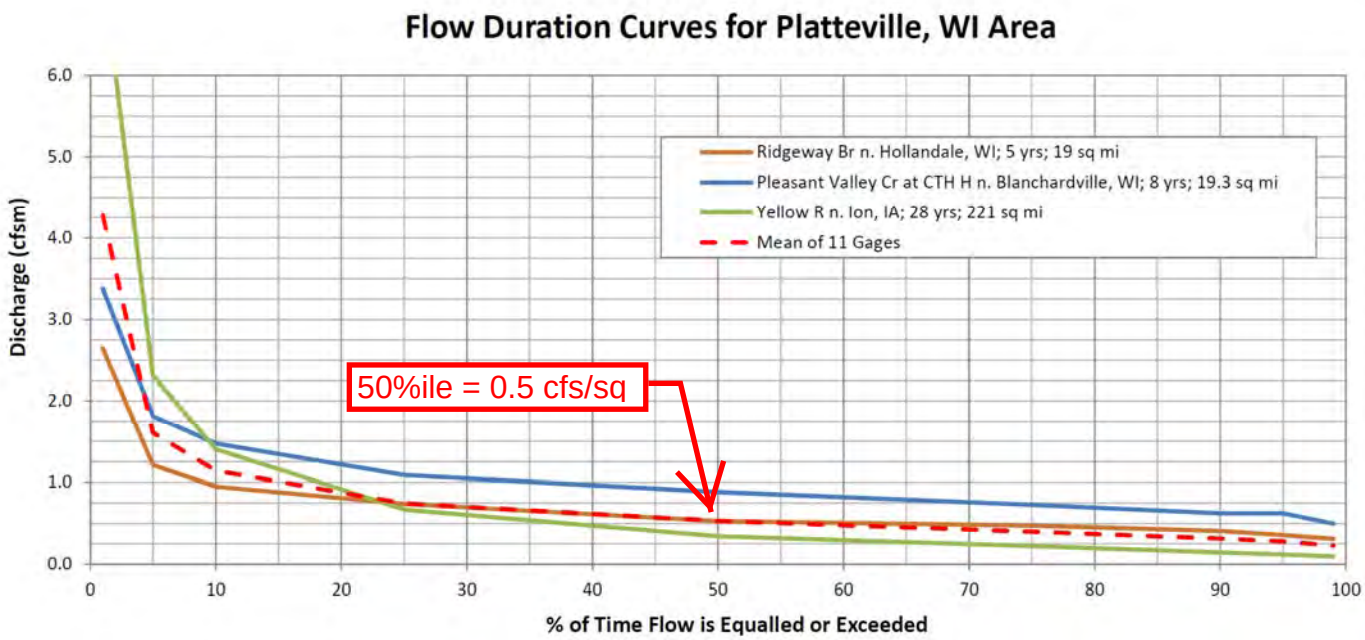
(top of sheet piling or coffer dam about 60" or 5' above invert)

(or a 72"x44" cmp pipe-arch with top of sheet piling or cofferdam about 48" or 4' above the invert)

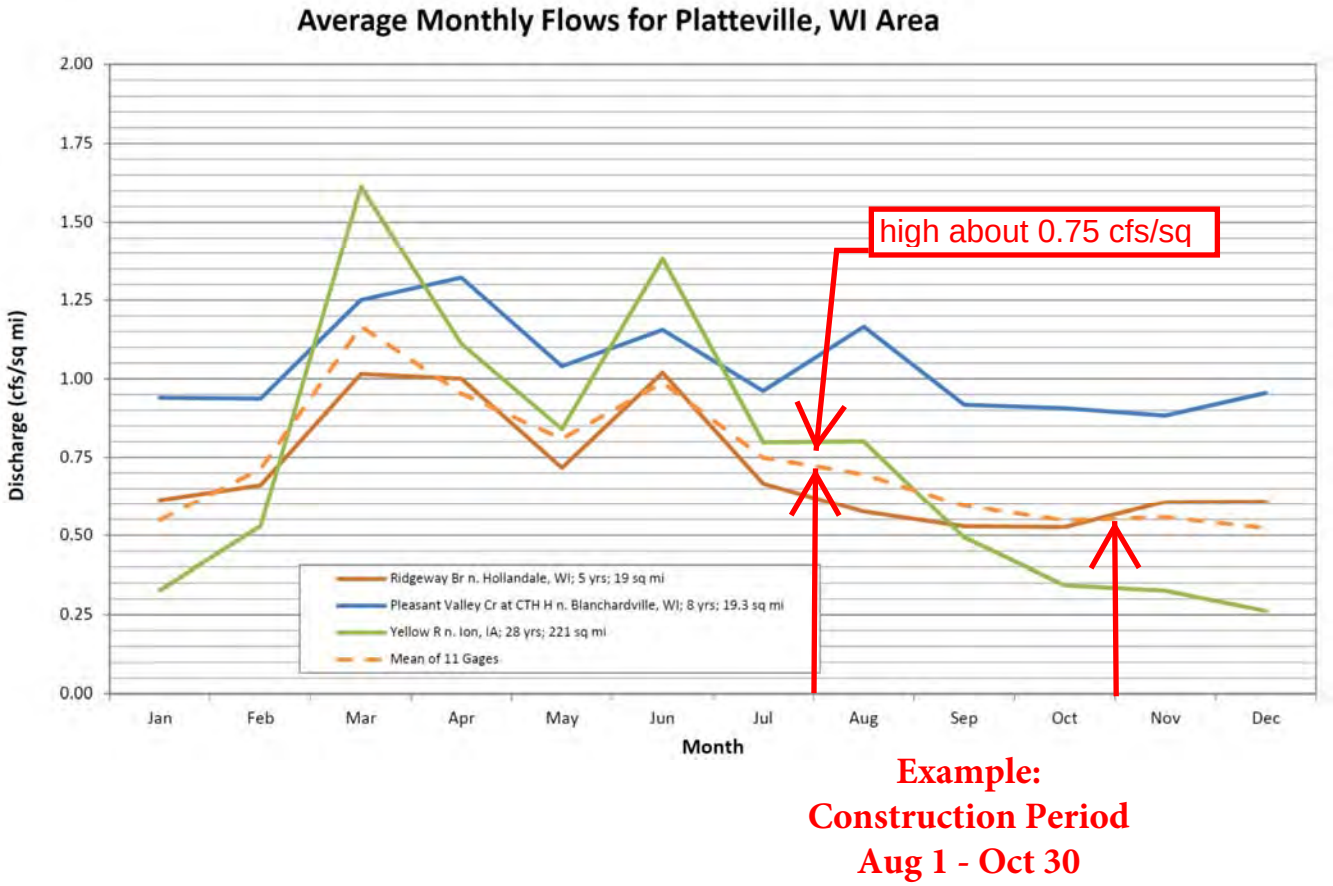
Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows

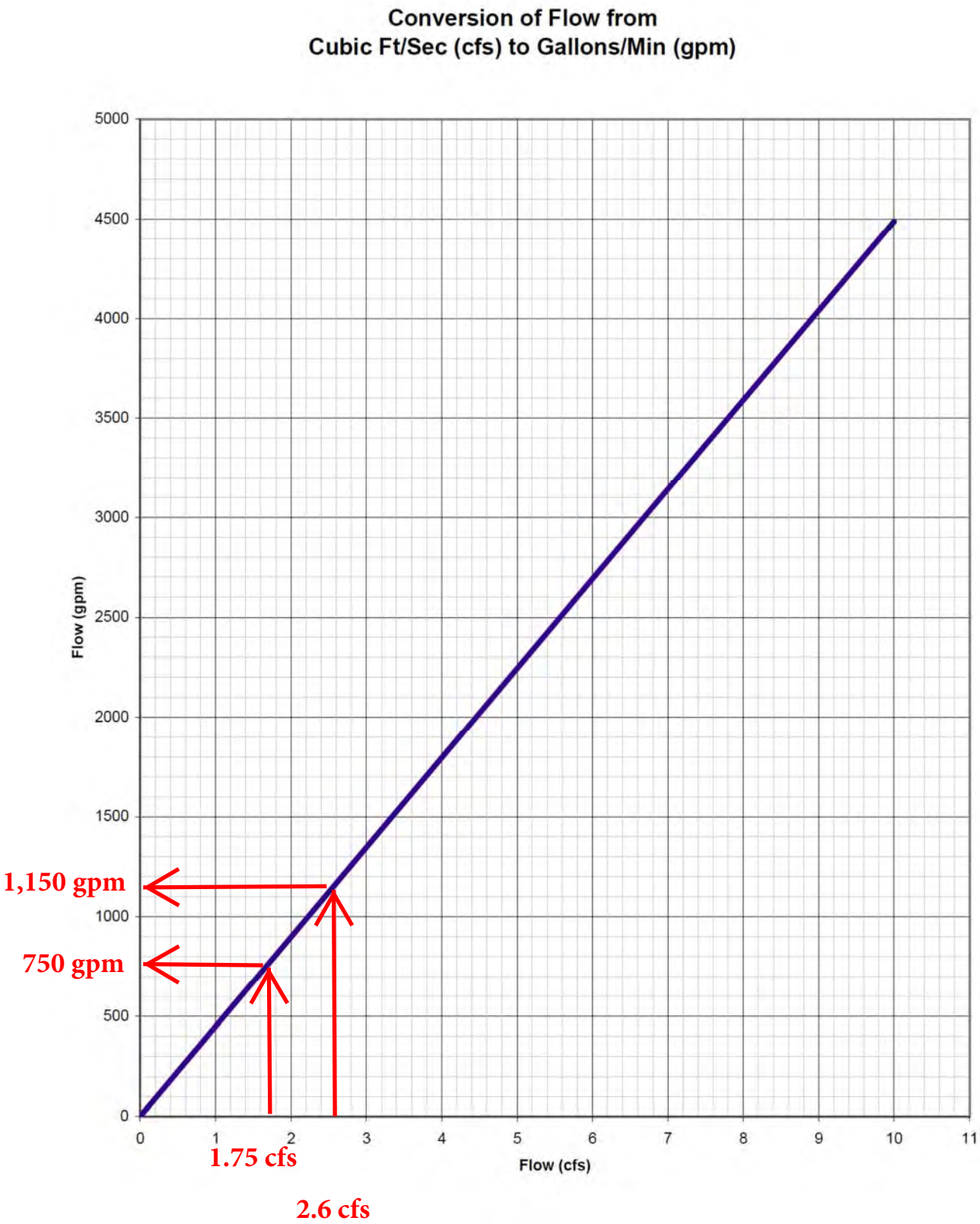


Exercise 2. Hydrology: By-Pass Flows



Example:
Construction Period
Aug 1 - Oct 30

Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows

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National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
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2010-5185

Site: Rountree Trib at W Main St, Platteville, WI, Wisconsin
User:
Date: Friday, February 19, 2016 09:15 PM

Equations for Wisconsin developed using English units

Rural Estimate: Rural 2
   Basin Drainage Area: 0.64 square miles
   1 Region

   Region: Area_1 (Walker, J.F., and Krug, W.R., 2003, Flood-Frequency
Characteristics of Wisconsin Streams: U.S. Geological Survey Water-Resources
Investigations Report 03-4250, 37 p.)
      Drainage_Area = 0.64 square miles
      24_Hour_25_Year_Precipitation = 5.29 inches
      Stream_Slope_10_and_85_Method = 121 feet per mi
      Percent_Forest = 5.31 percent
   Crippen & Bue Region 6


Results for:  Rural 2

Equations used:
PK2 = 99.9* (DRNAREA)^(0.652)* (I24H25Y-4.2)^(7.52)* (FOREST+1)^(-0.254)
PK5 = 190* (DRNAREA)^(0.634)* (I24H25Y-4.2)^(8.45)* (FOREST+1)^(-0.26)
PK10 = 35* (DRNAREA)^(0.857)* (I24H25Y-4.2)^(6.92)* (CSL10_85)^(0.463)*
(FOREST+1)^(-0.302)
PK25 = 38.1* (DRNAREA)^(0.876)* (I24H25Y-4.2)^(7.16)* (CSL10_85)^(0.518)*
(FOREST+1)^(-0.308)
PK50 = 41.4* (DRNAREA)^(0.884)* (I24H25Y-4.2)^(7.36)* (CSL10_85)^(0.545)*
(FOREST+1)^(-0.31)
PK100 = 44.2* (DRNAREA)^(0.893)* (I24H25Y-4.2)^(7.56)* (CSL10_85)^(0.571)*
(FOREST+1)^(-0.312)
PK500 = 0

                  Value,  Estimate
Statistic          cfs    Error, %
PK2                89.4      43
PK5               184        40
PK10              229        38
PK25              325        40
PK50              406        42
PK100             495        44
PK500             694 *
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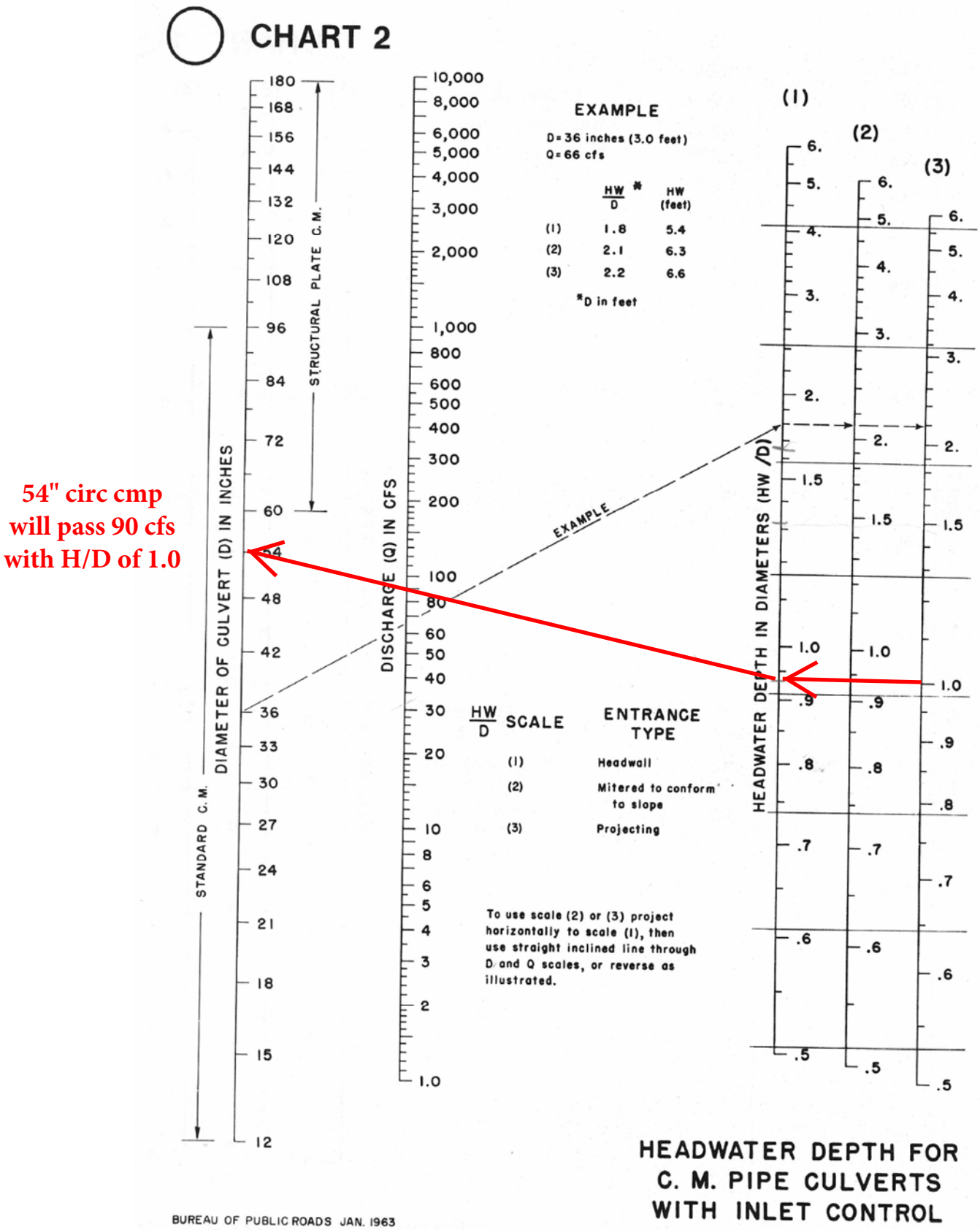
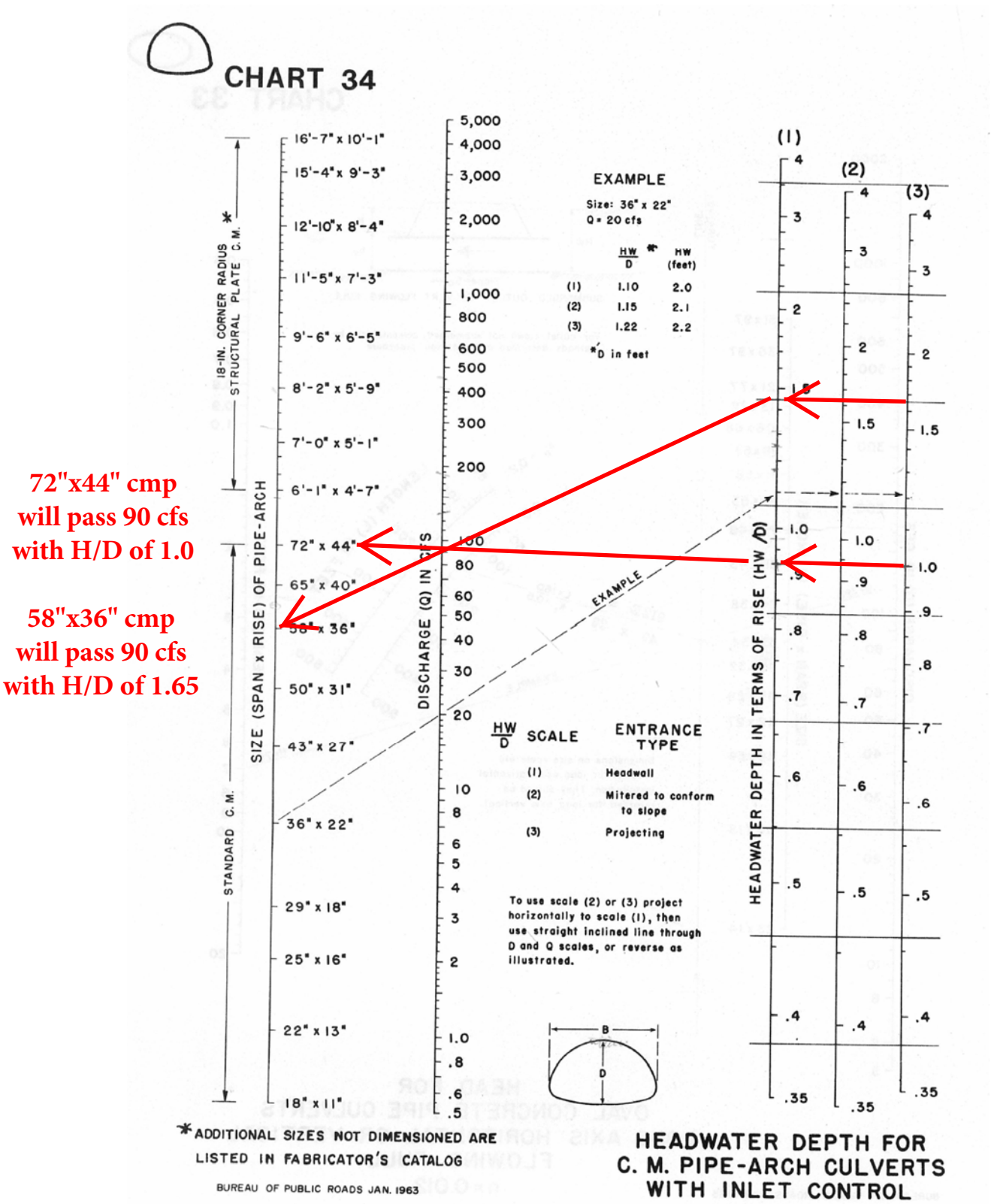
Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows

Snowden Branch at Rock Road

For Snowden Branch at Rock Road, assume a new structure such as aluminum or concrete box culvert can be placed in 1-2 days and that pumping is a viable alternative to pass flows around the construction site. Using the information provided below, determine the drainage area, the likely flow rate during construction and the pump capacity that would be needed to by-pass the flow. In this case, use the average of the 11 Platteville area streamflow gages. Decide whether to use the flow duration curve or the average monthly flows. For the flow duration curve use the 50 percent flow. For average monthly flows, use the highest monthly flow for the construction period. What additional pump capacity might you want to have readily available?

Drainage Area (sq mi): _____ Flow Est (circle one): Flow Duration / Ave Monthly Flow

Construction Period (months): _____

Baseflow During Construction Period, cfs/sq mi: _____ cfs: _____ gal/min: _____

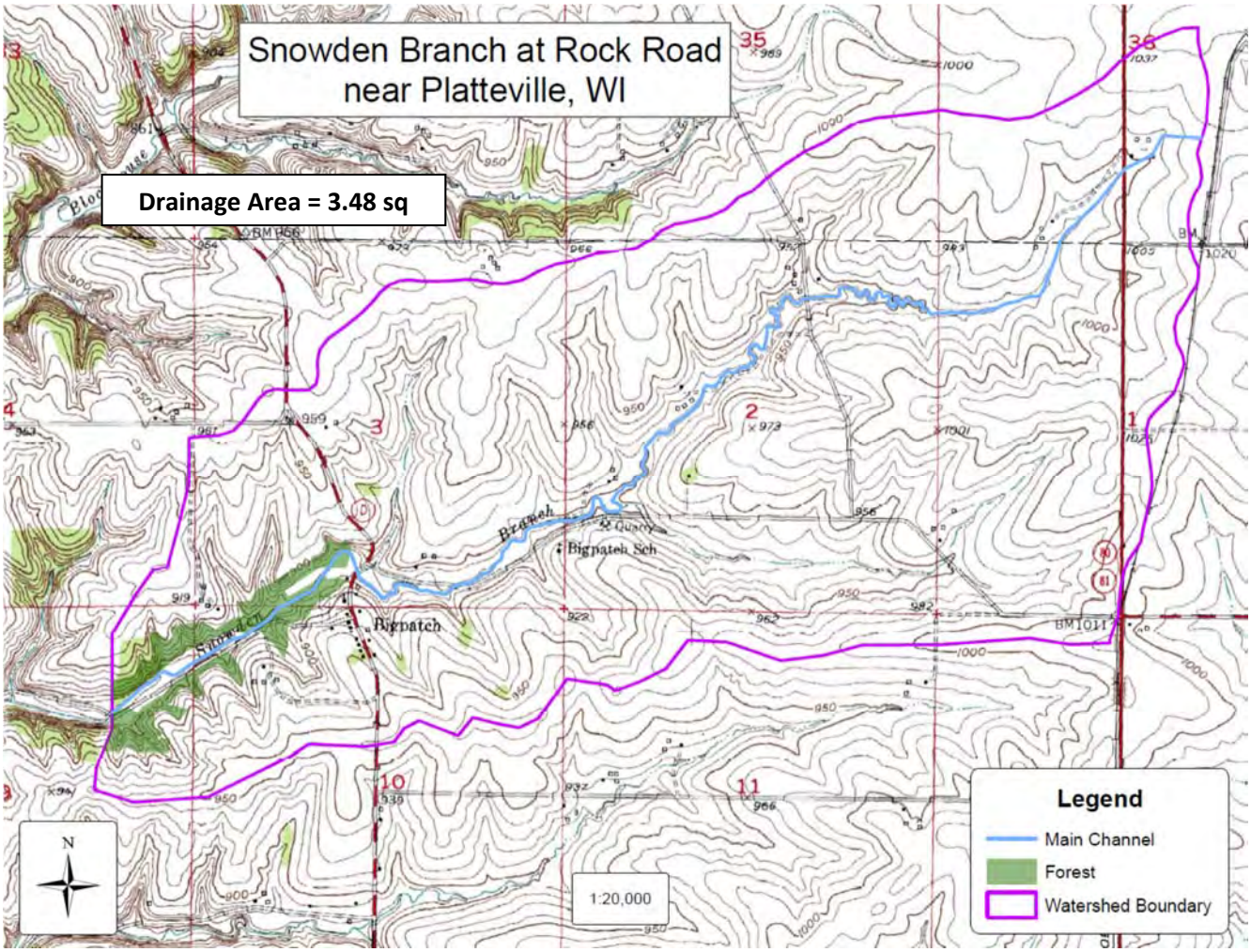
Unnamed Tributary to Rountree at West Main Street

For Unnamed Tributary to Rountree at West Main Street, assume that construction of a new culvert will require several weeks and a diversion pipe with the capacity to pass Q_2 will need to be installed. From the information provided below, determine the drainage area, Q_2, culvert type (circular or pipe-arch) and culvert size (assuming inlet control). State your assumption regarding HW/D ratio keeping in mind the diversion dam (sheet piling, sand bags, etc) must allow for the planned headwater without overtopping.

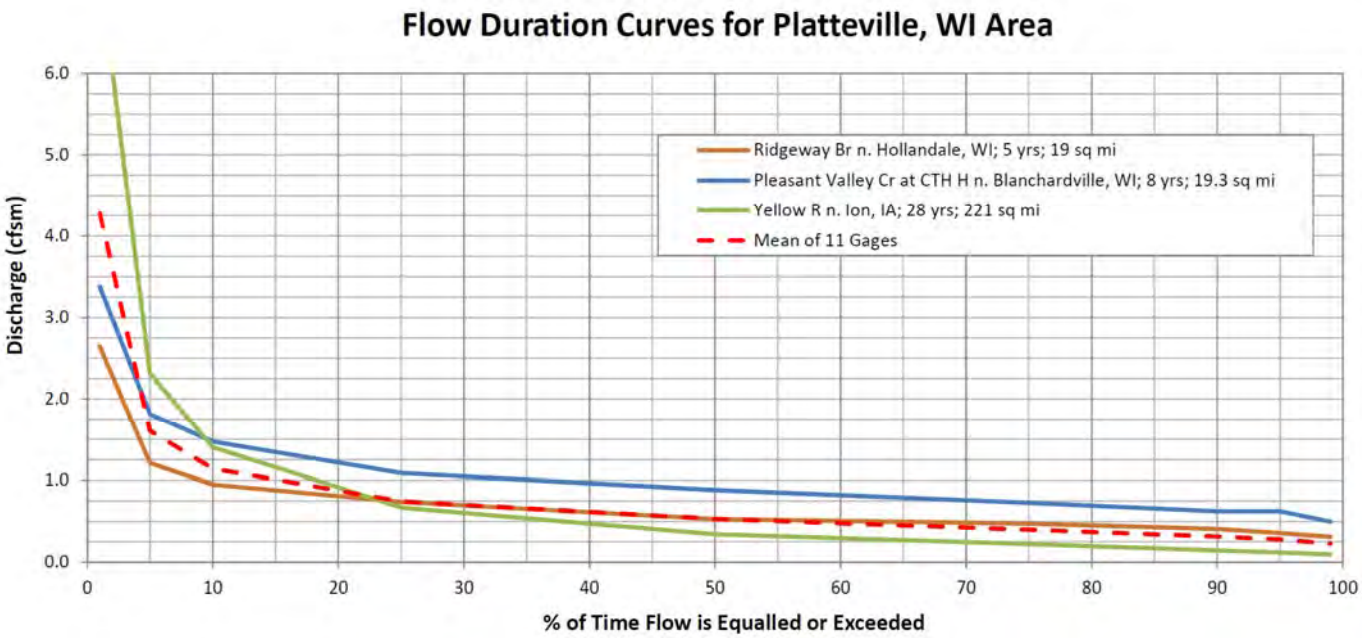
Drainage Area (sq mi): _____ Q_2 (cfs): _____ HW/D Ratio: _____

Culvert Type (circle one): circular / pipe-arch Culvert Size (inches): _____

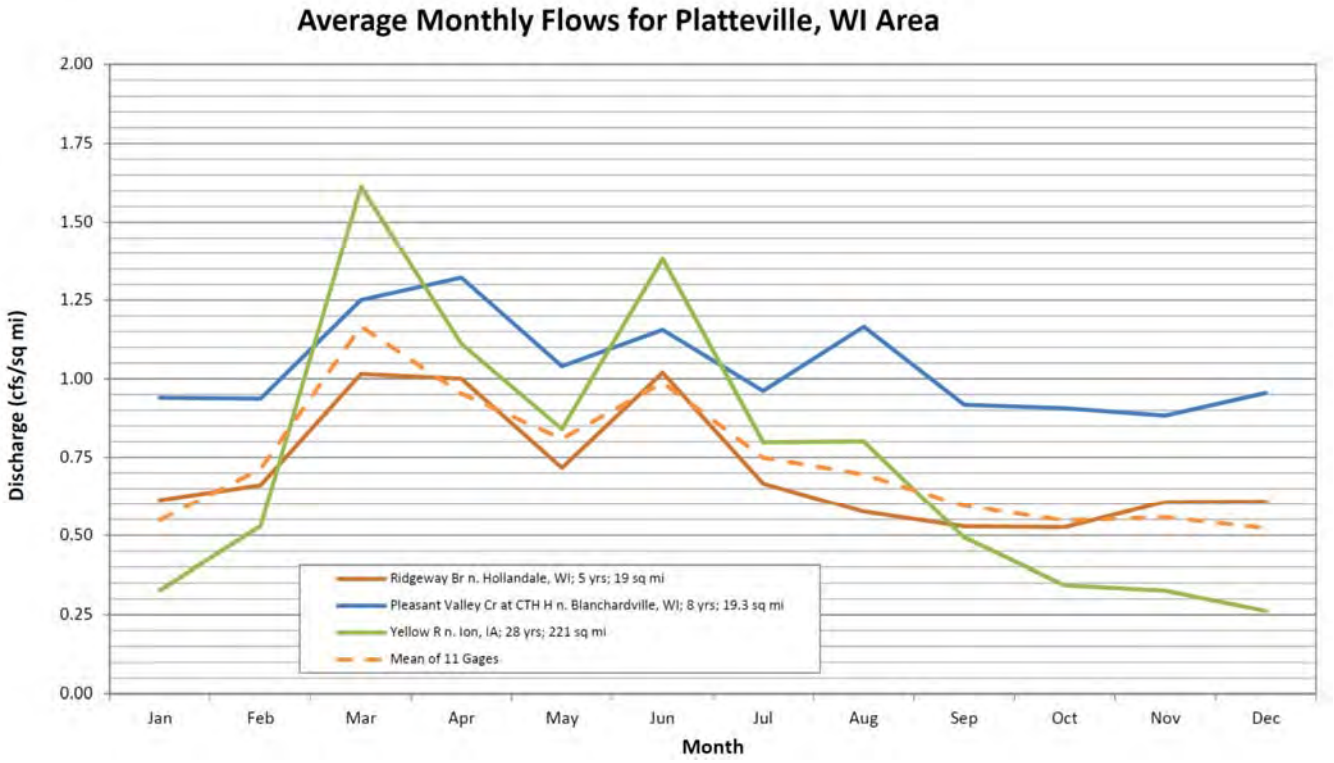
Exercise 2. Hydrology: By-Pass Flows



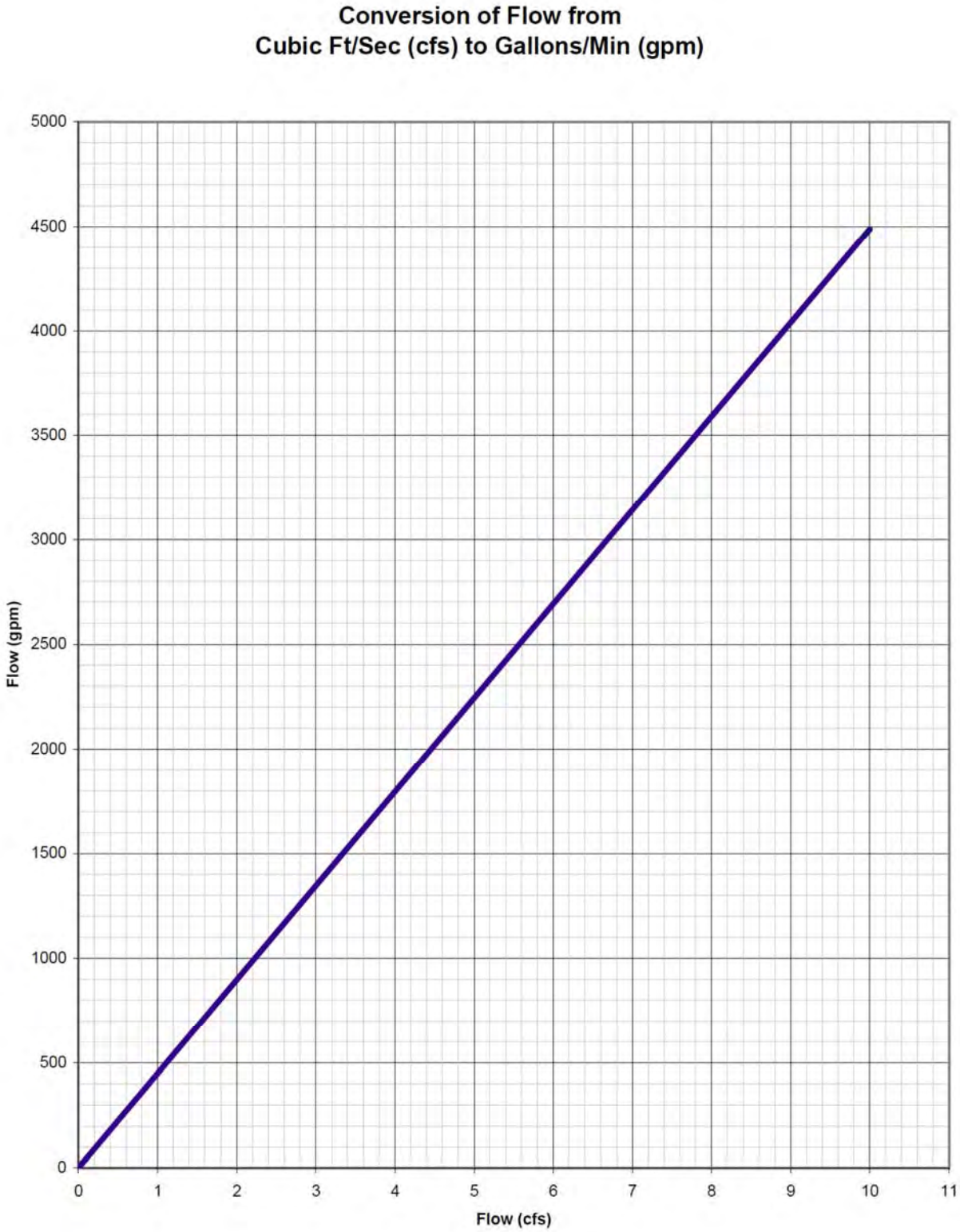
Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows

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National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Users\dhiggins\Documents\hydro\nss\NSS_v6_2014-10-07.mdb
Updated by tkoenig 10/7/2014 2:48:48 PM Add statlabels for MO 2013-5090 and WV
2010-5185

Site: Rountree Trib at W Main St, Platteville, WI, Wisconsin
User:
Date: Friday, February 19, 2016 09:15 PM

Equations for Wisconsin developed using English units

Rural Estimate: Rural 2
   Basin Drainage Area: 0.64 square miles
   1 Region

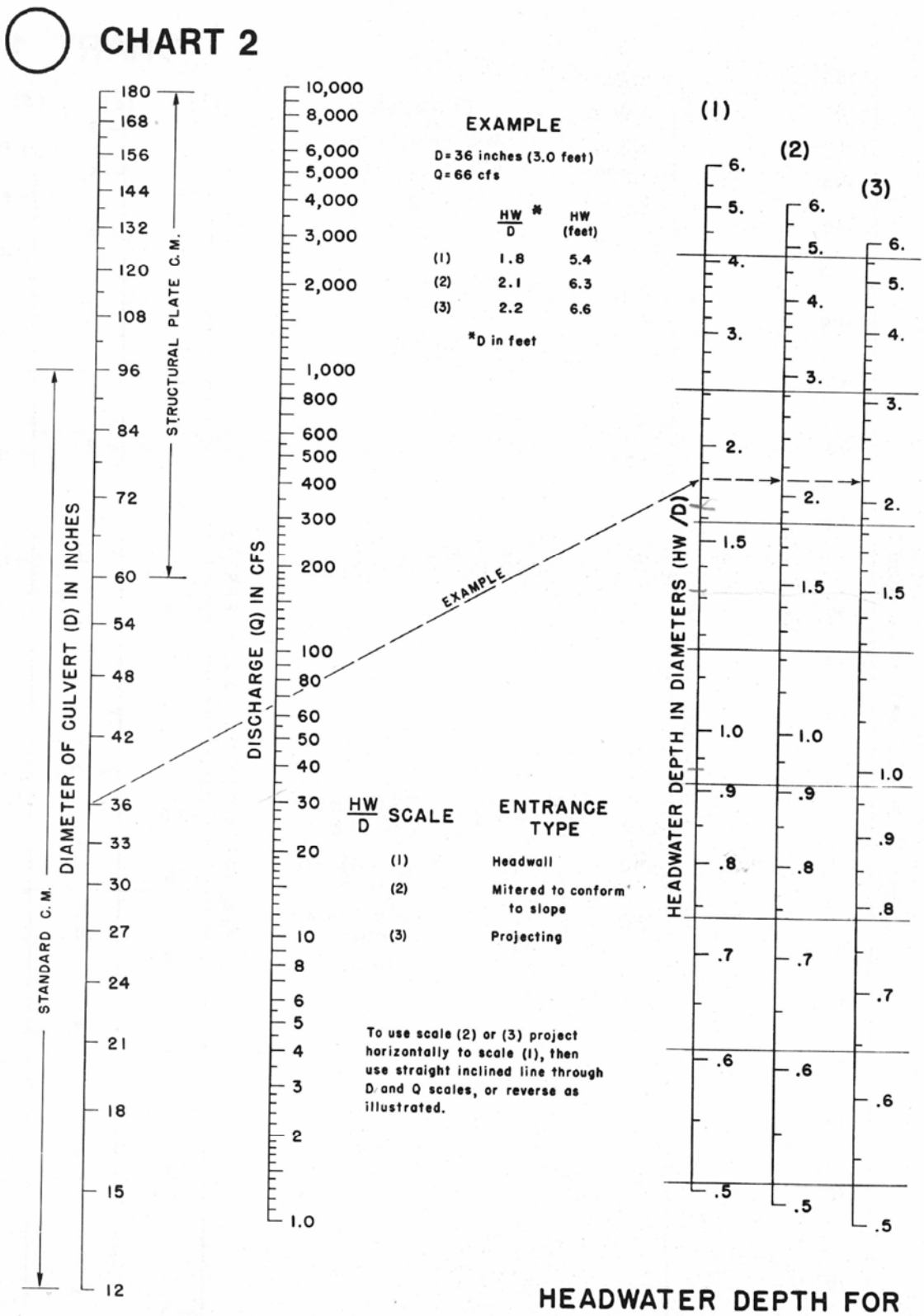
   Region: Area_1 (Walker, J.F., and Krug, W.R., 2003, Flood-Frequency
Characteristics of Wisconsin Streams: U.S. Geological Survey Water-Resources
Investigations Report 03-4250, 37 p.)
      Drainage_Area = 0.64 square miles
      24_Hour_25_Year_Precipitation = 5.29 inches
      Stream_Slope_10_and_85_Method = 121 feet per mi
      Percent_Forest = 5.31 percent
   Crippen & Bue Region 6


Results for:  Rural 2

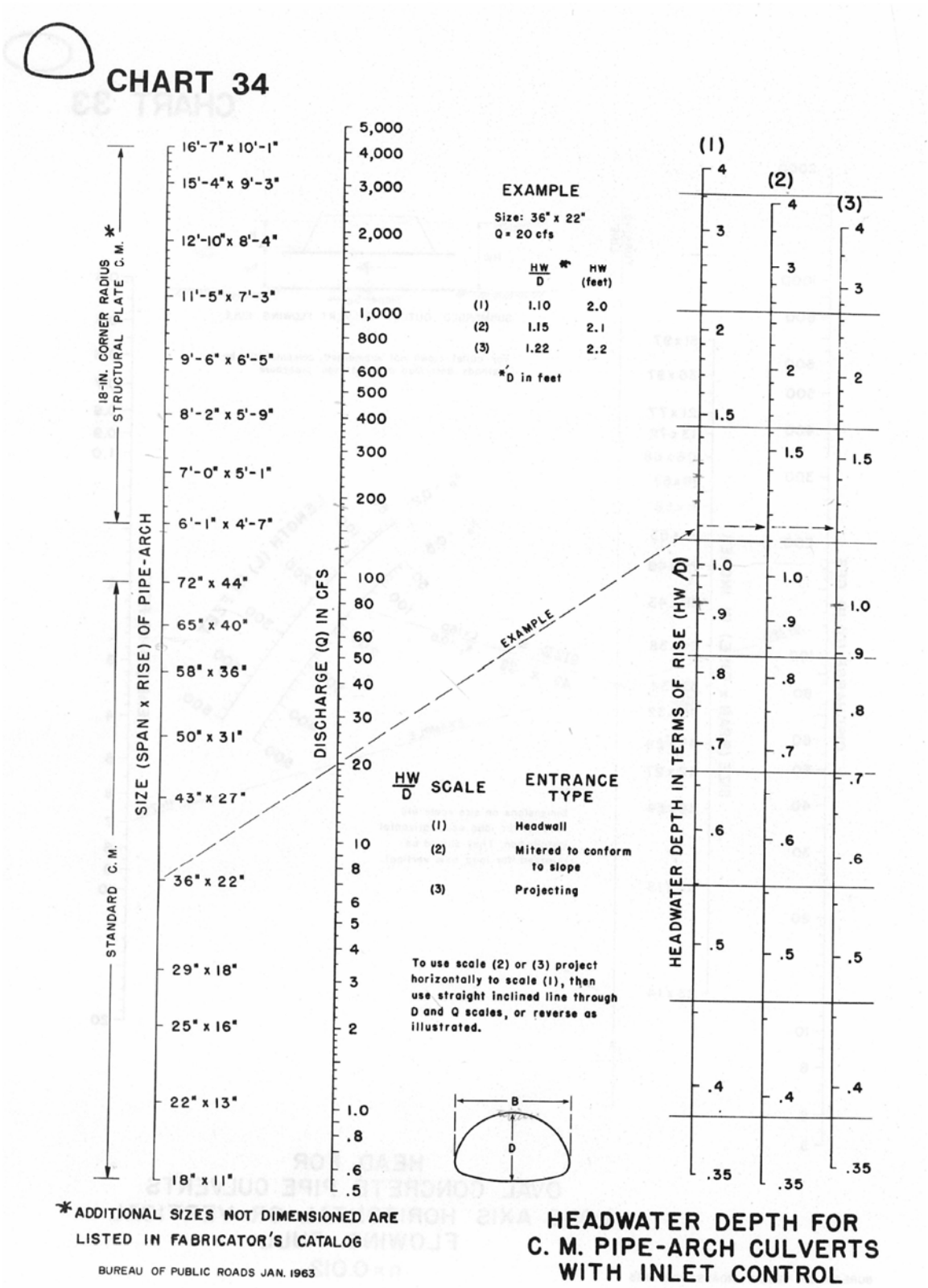
Equations used:
PK2 = 99.9* (DRNAREA)^(0.652)* (I24H25Y-4.2)^(7.52)* (FOREST+1)^(-0.254)
PK5 = 190* (DRNAREA)^(0.634)* (I24H25Y-4.2)^(8.45)* (FOREST+1)^(-0.26)
PK10 = 35* (DRNAREA)^(0.857)* (I24H25Y-4.2)^(6.92)* (CSL10_85)^(0.463)*
(FOREST+1)^(-0.302)
PK25 = 38.1* (DRNAREA)^(0.876)* (I24H25Y-4.2)^(7.16)* (CSL10_85)^(0.518)*
(FOREST+1)^(-0.308)
PK50 = 41.4* (DRNAREA)^(0.884)* (I24H25Y-4.2)^(7.36)* (CSL10_85)^(0.545)*
(FOREST+1)^(-0.31)
PK100 = 44.2* (DRNAREA)^(0.893)* (I24H25Y-4.2)^(7.56)* (CSL10_85)^(0.571)*
(FOREST+1)^(-0.312)
PK500 = 0

                  Value,  Estimate
Statistic          cfs    Error, %
PK2                89.4      43
PK5               184        40
PK10              229        38
PK25              325        40
PK50              406        42
PK100             495        44
PK500             694 *
```

Exercise 2. Hydrology: By-Pass Flows



Exercise 2. Hydrology: By-Pass Flows



Exercise 3. Site Assessment: Survey Considerations

Unnamed Tributary to Rountree at W Main Street

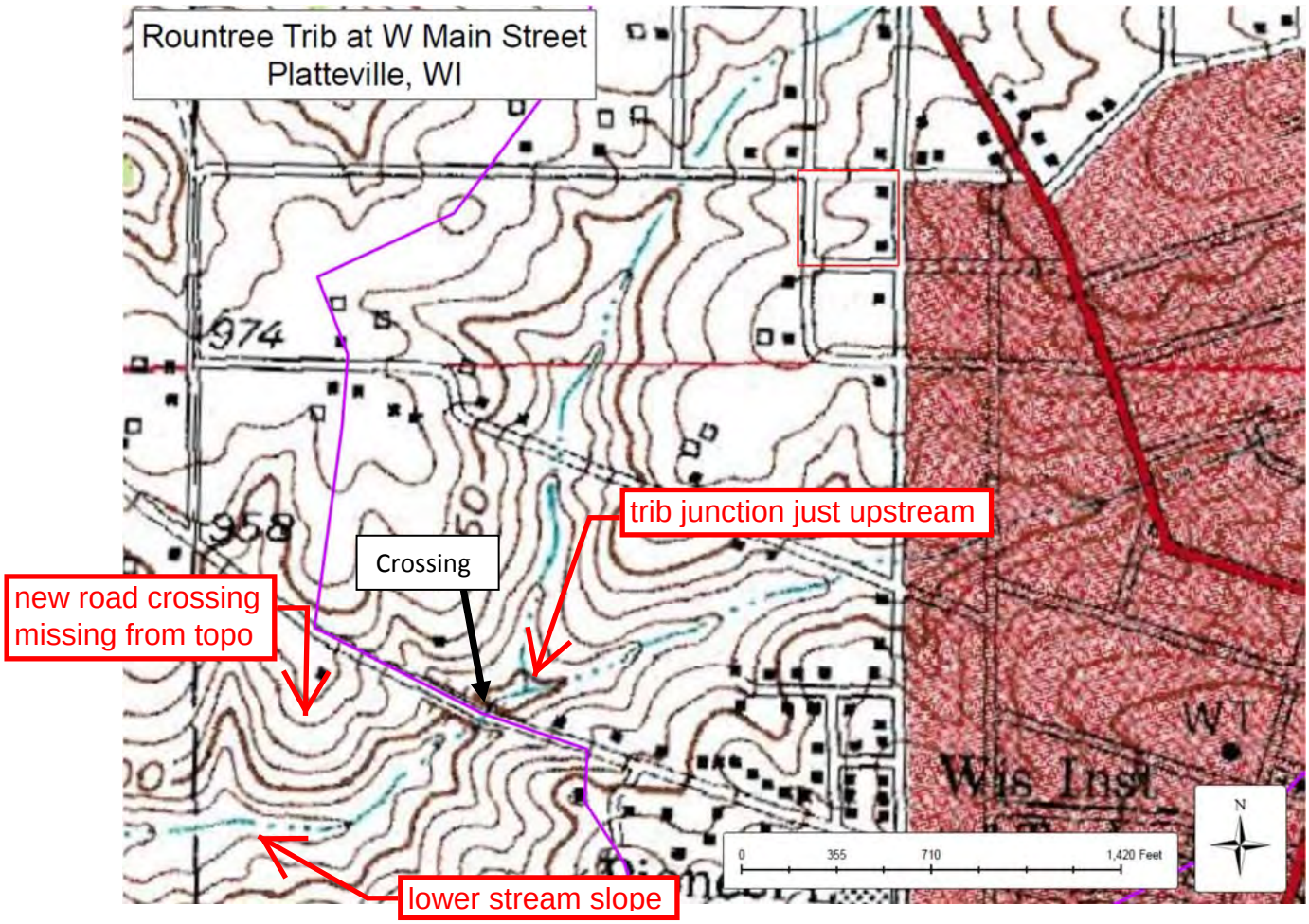
For Unnamed Tributary to Roundtree at W Main Street, use the aerial photo and topographic map provided below to help plan the site survey and identify any important site considerations that these resources provide. Although final determinations can be made in the field, where might you locate a reference reach and why? Identify one or more locations on the map or photo. What length would you survey for the profile and where might you locate cross-sections? Draw the approximate locations on the photo or map. Are the any connectivity issues or other considerations?

Potential location for reference reach: **downstream but above influence of downstream crossing**

Reference considerations: **can't be upstream with trib junction,**

Survey considerations: **slope less through lower xing, short distance to tribs, pvt lands**

Connectivity considerations: **only 1 xing below on trib and 1 on Rountree, numerous xings upstream on both tribs**



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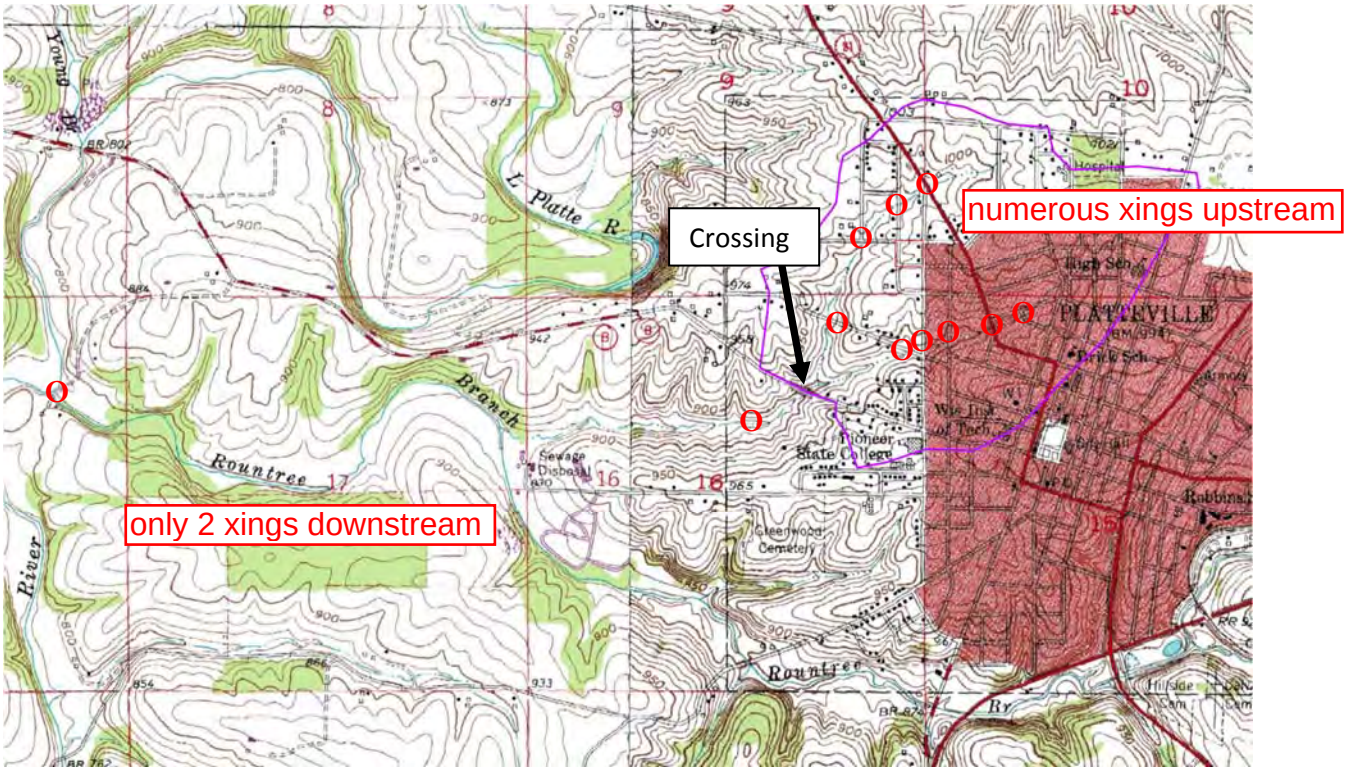

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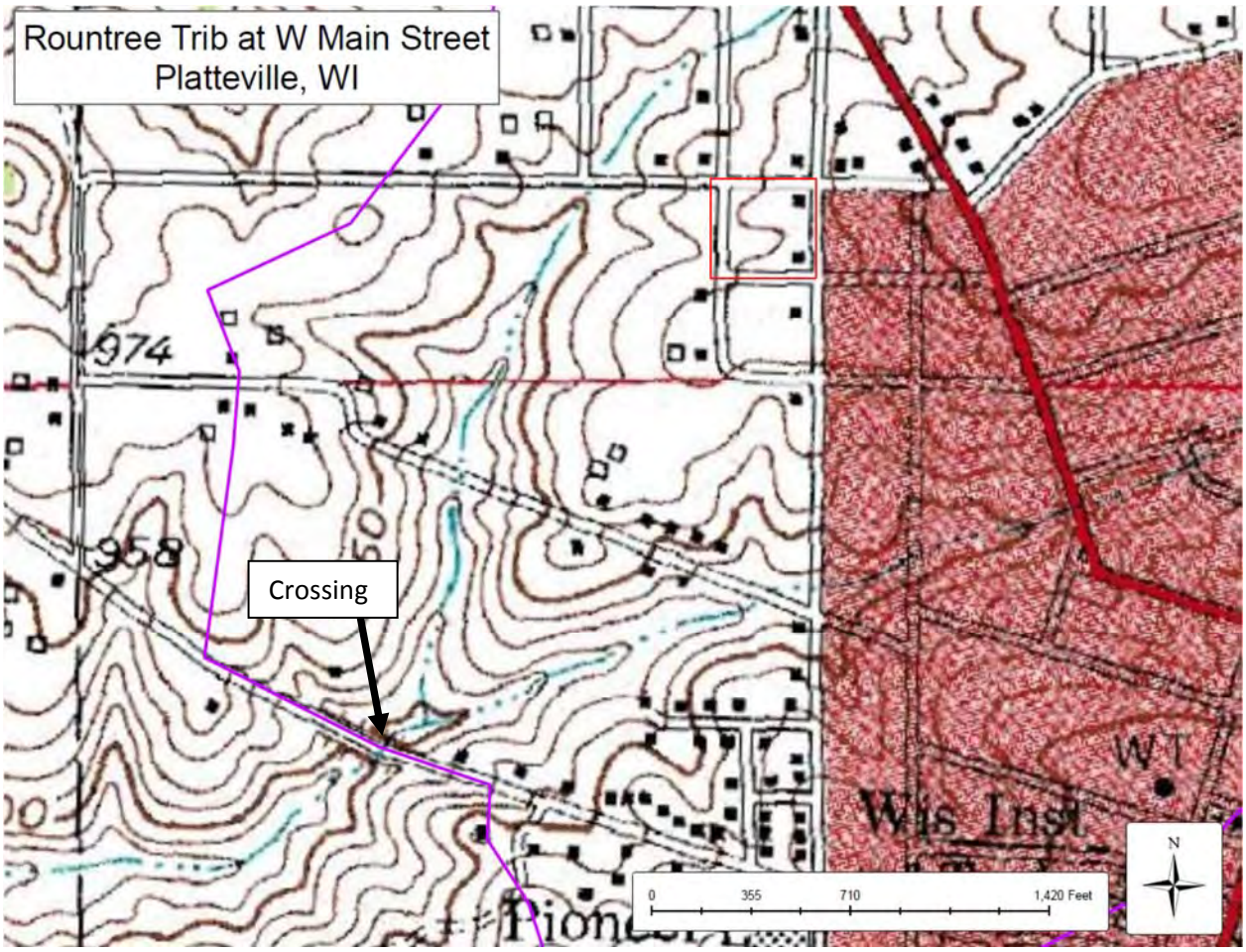
Potential location for reference reach: _____

Reference considerations: _____

Survey considerations: _____

Connectivity considerations: _____



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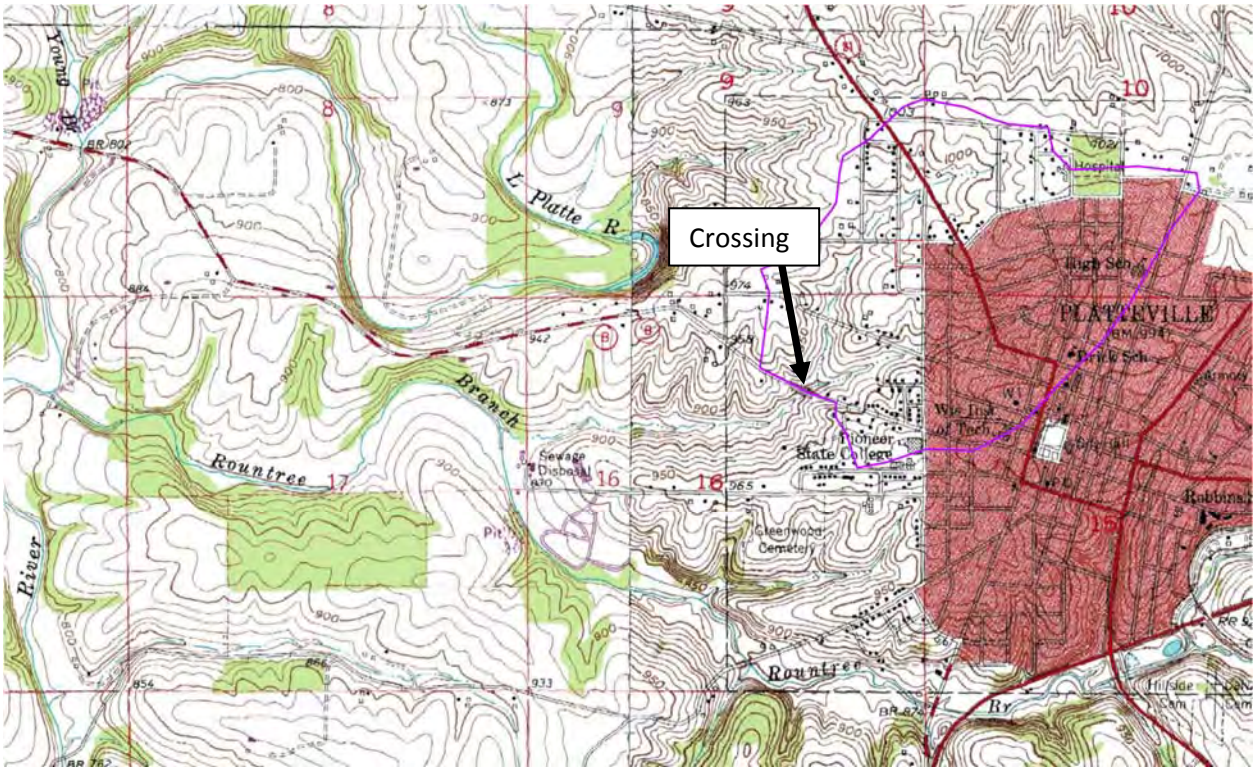


Exercise 4. Alignment and Profile: Rountree Tributary

For Unnamed Tributary to Rountree at W Main Street, use the site survey and topographic map provided below to determine the current alignment and whether to propose a new alignment. How might the alignment affect the slope of the proposed structure? Using the longitudinal profile, determine the design profile and vertical adjustment potential (VAP) lines and sketch them on the graph. The lower VAP line is the depth of the deepest residual pool depth, ignoring the plunge pool, adjusted downward to reflect scour and fill processes using criteria provided below. The upper VAP is above a line connecting the top of the riffles up to the bankfull elevation or the elevation of any expected local aggradation. Sketch the proposed lower elevation for a new structure on the profile graph. It should be below the lower VAP line and the minimum depth of fill in the culvert should be at least 2.0 ft and >D_{100} (25.4 mm/~~ft~~).in 305 mm/ft

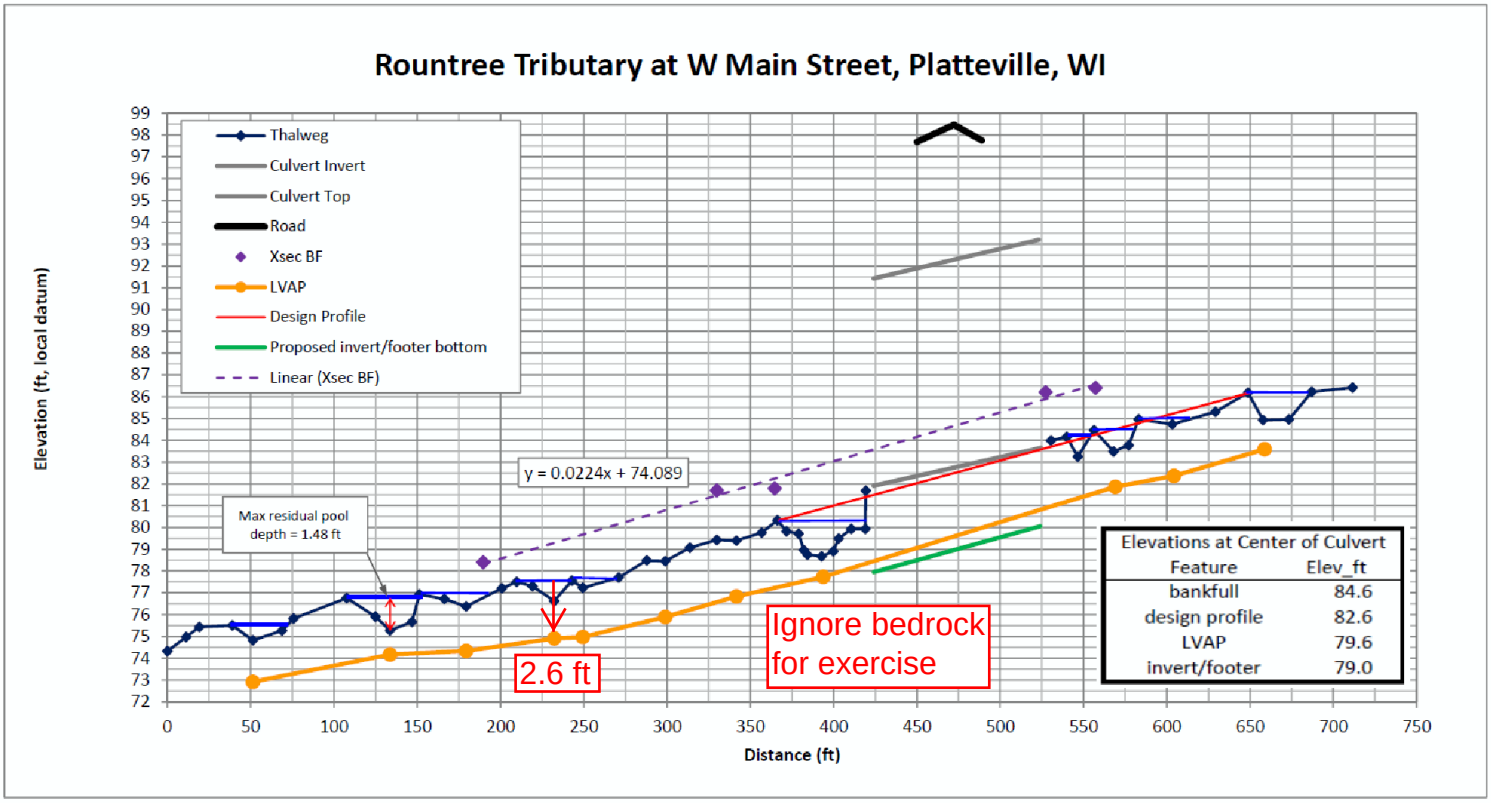
Alignment (degrees from 90° to road facing downstream): Existing **20°** Proposed **20°**

Maximum residual pool depth: **1.5** ft LVAP adjustment factor: **1.75** D100: **1.6** (ft) **(500 mm)**

LVAP distance below design profile: **2.6** ft (max residual pool depth x LVAP adj factor)

Slope of Design Profile (ft/ft or %): **2.1%** Slope of Lower VAP Line (ft/ft or %): **2.1% (same)**

Distance from bottom of design profile to bottom of structure or footer (ft): **3.0**



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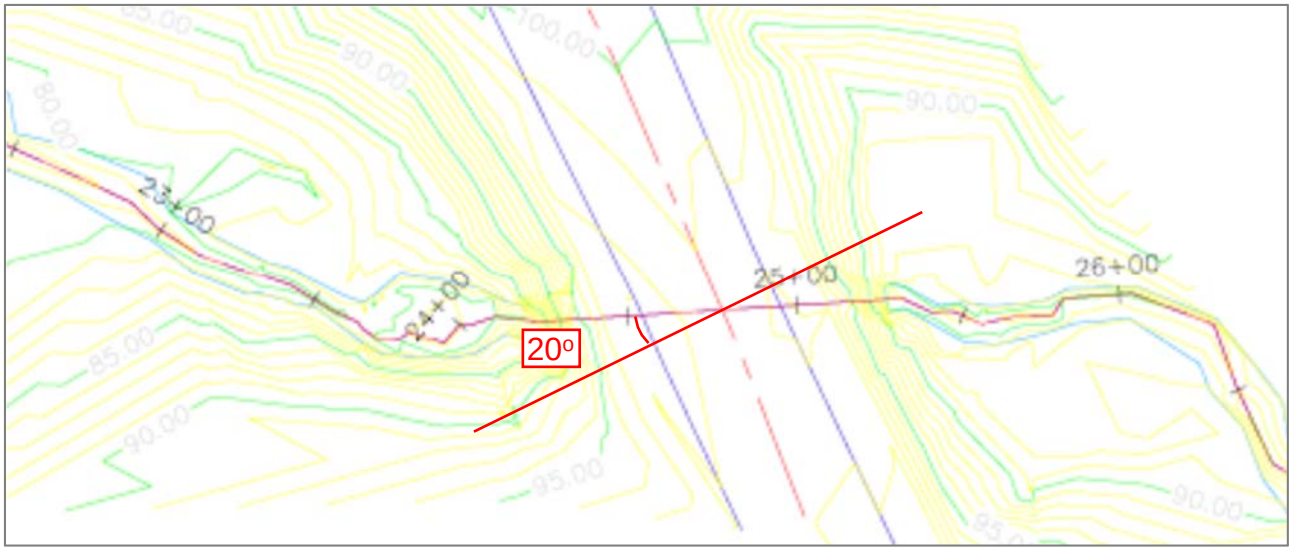

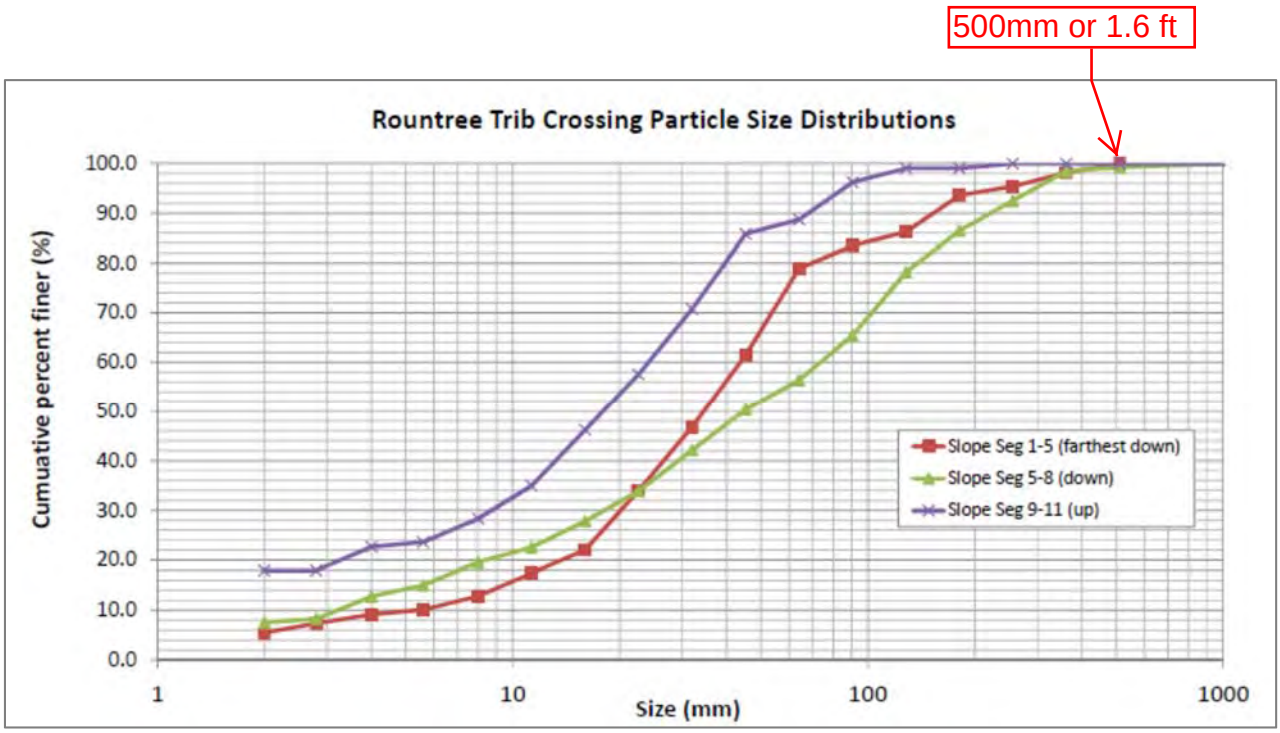

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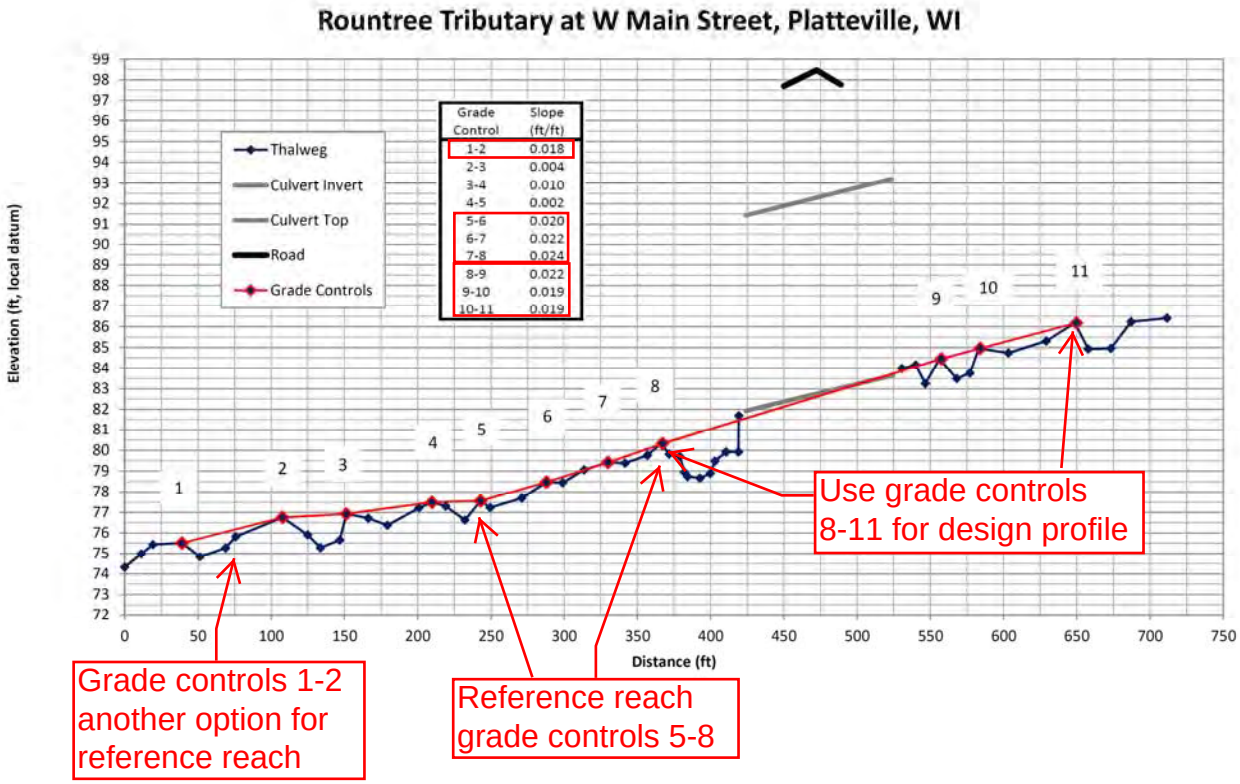
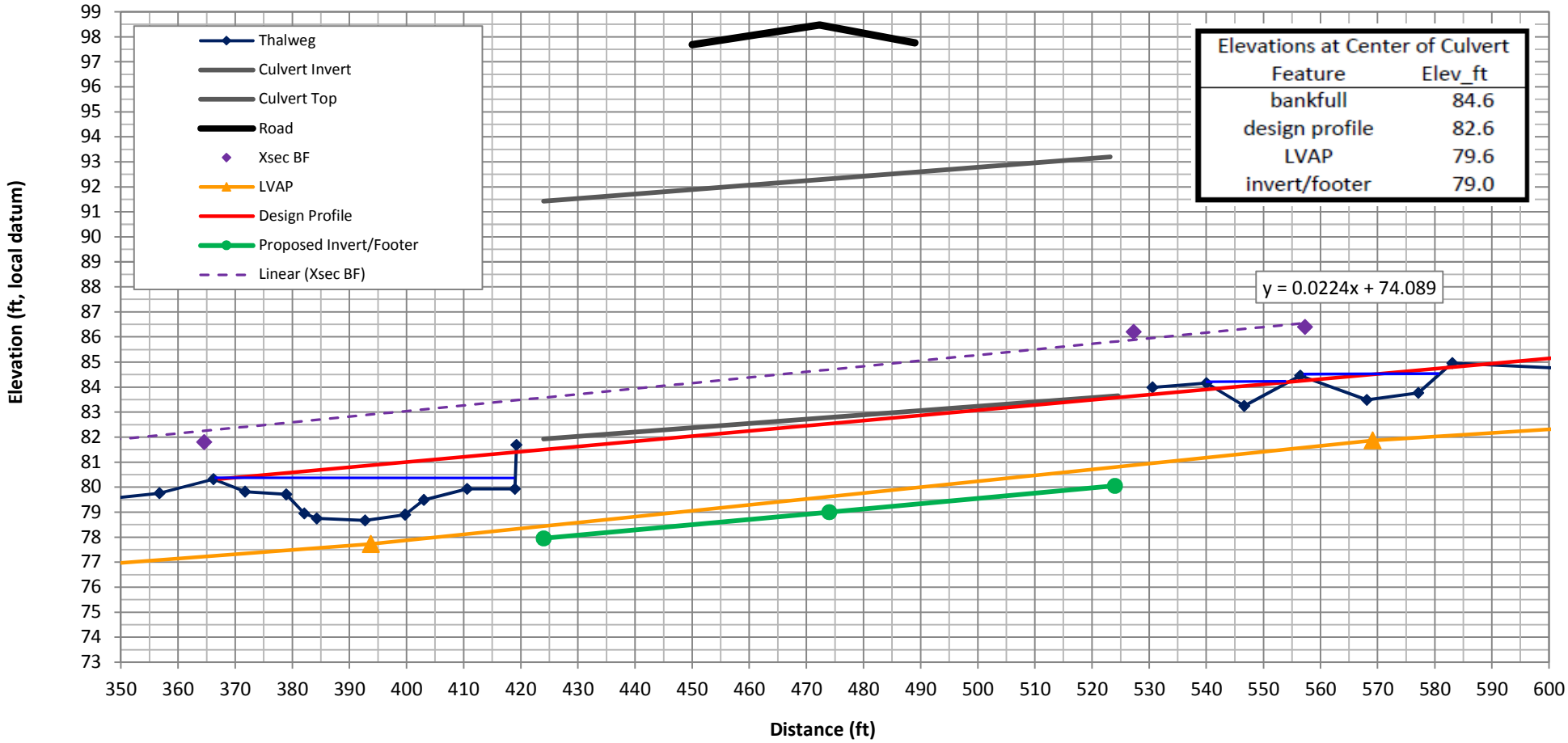


LVAP adjustment factors to reflect scour/fill processes that occur during floods. Recommended criteria:

- 1.00 x Pool Max Depth (PMD): Step-pool channels, S > 5%, boulder-cobble boundaries.
- 1.25 x PMD: Step-pool channels with S < 5%, cobble-gravel boundaries.
- 1.50 x PMD: Steep riffles with ribs, cobble-gravel boundaries.
- 1.75 x PMD: Riffles, gravel-cobble boundaries.
- 2.00 x PMD: Rffles, sand-fine gravel boundaries.
- No adjustment for bedrock.

Rountree Tributary at W Main Street, Platteville, WI



Elevations at Center of Culvert	
Feature	Elev_ft
bankfull	84.6
design profile	82.6
LVAP	79.6
invert/footer	79.0

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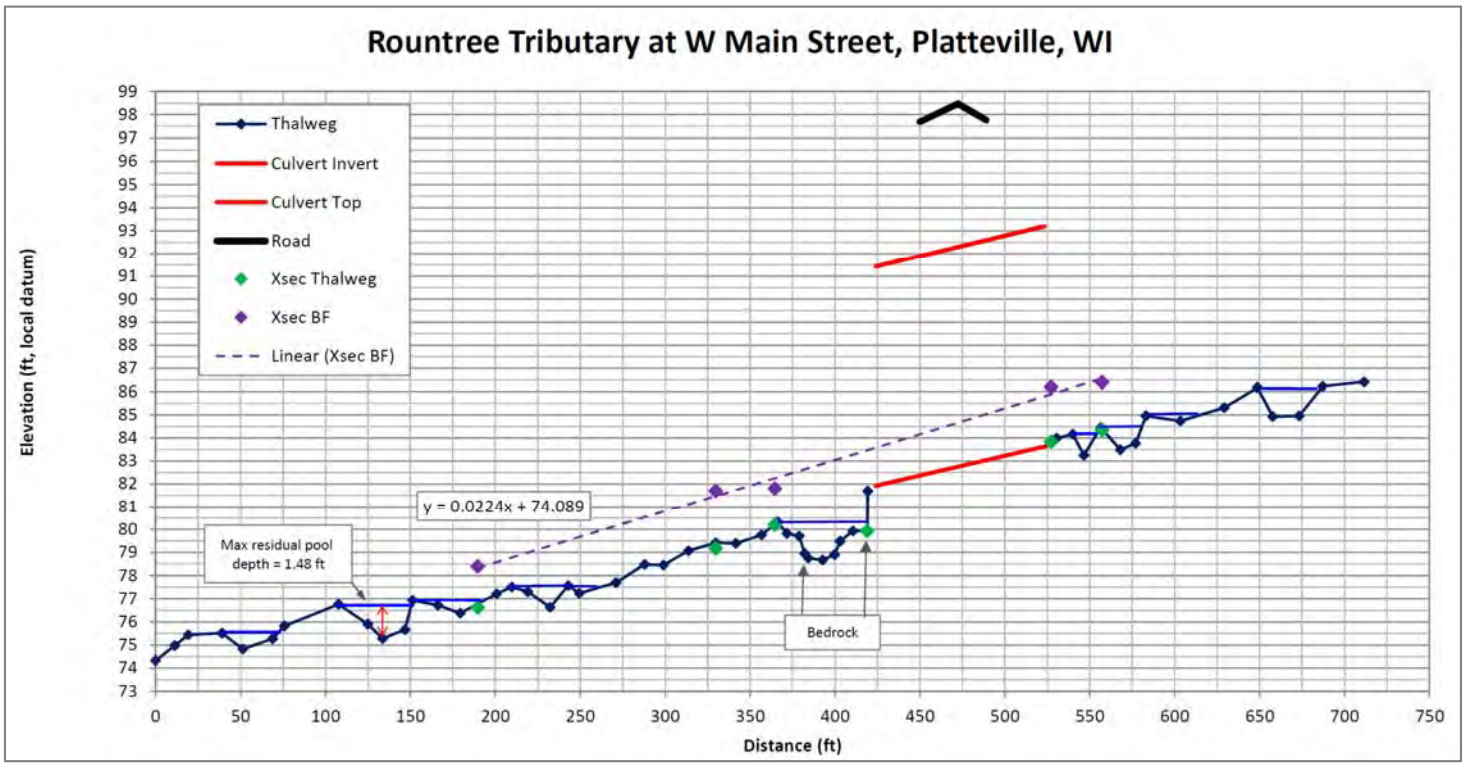
Alignment (degrees from 90° to road facing downstream): Existing _____ Proposed _____

Maximum residual pool depth: ____ ft LVAP adjustment factor: ____ D100:_____ (ft)

LVAP distance below design profile: ____ ft (max residual pool depth x LVAP adj factor)

Slope of Design Profile (ft/ft or %): _____ Slope of Lower VAP Line (ft/ft or %): _____

Distance from bottom of design profile to bottom of structure or footer (ft): _____



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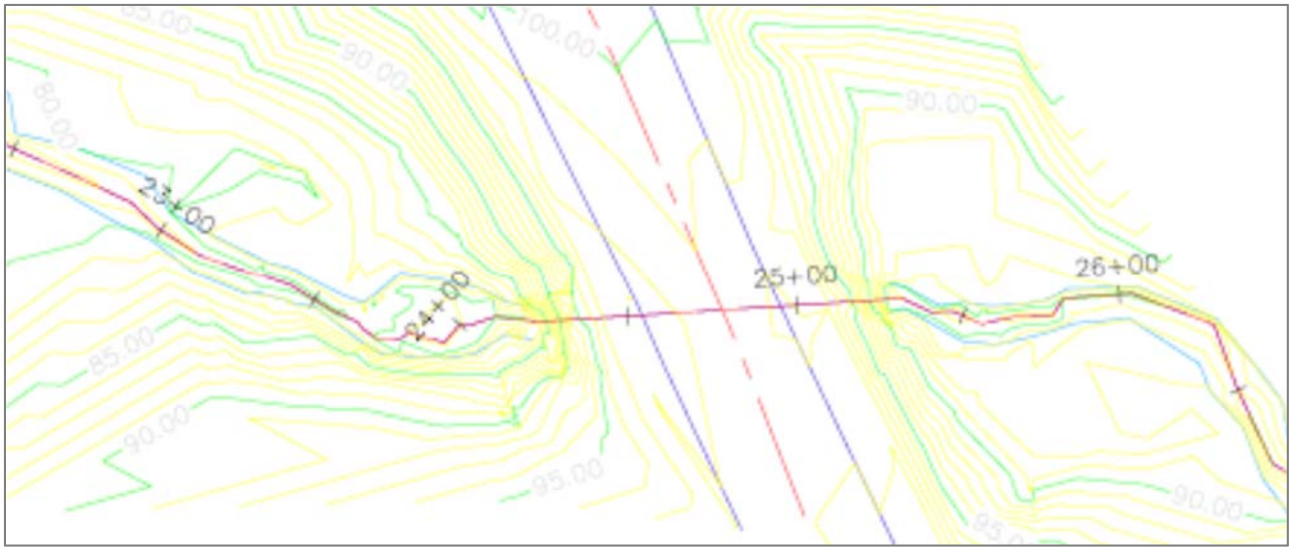

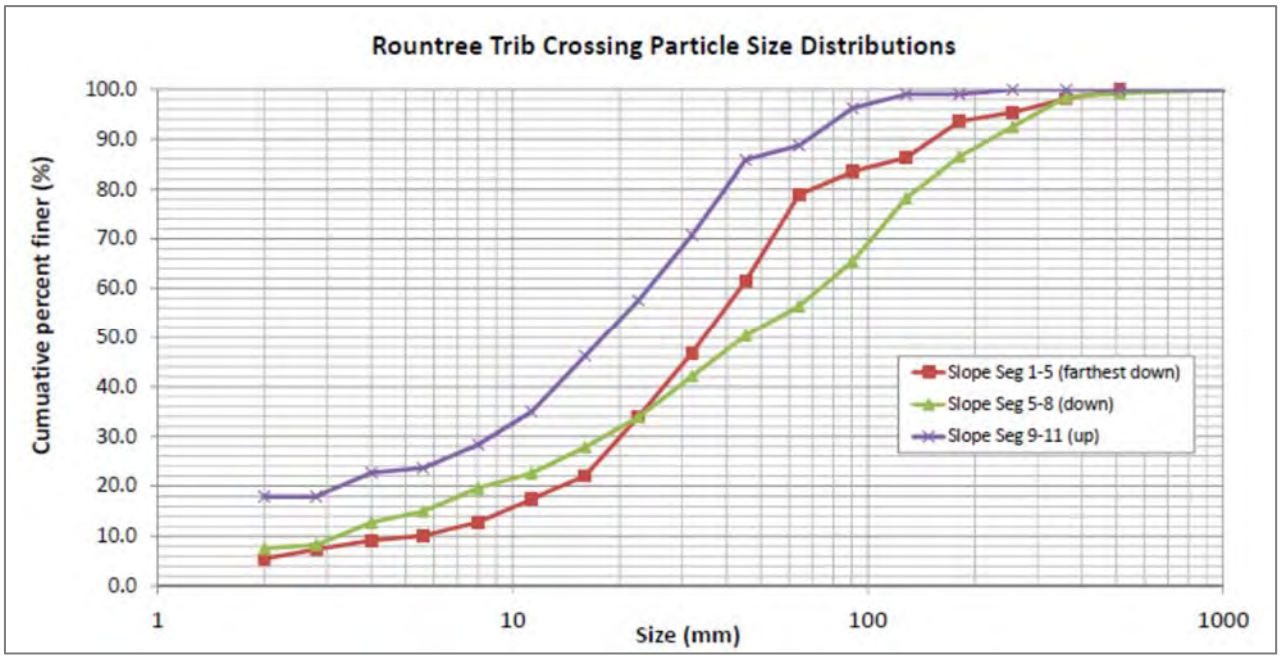

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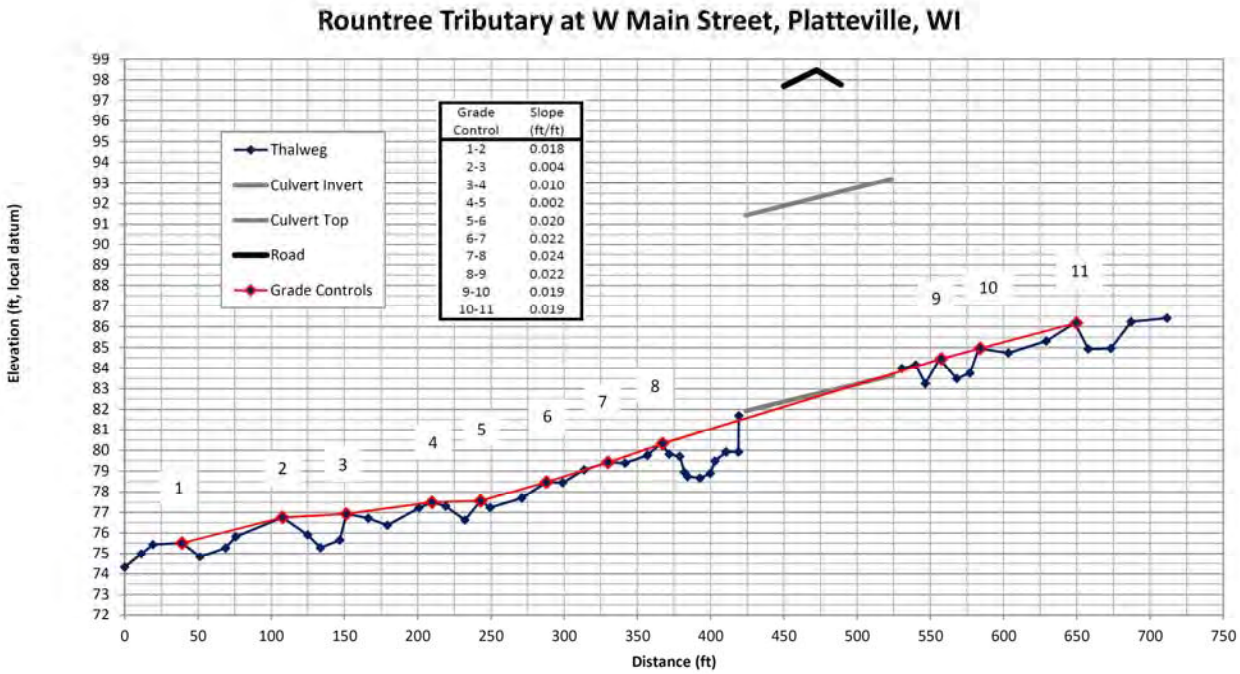

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