Indirect Measurement Summary

Brier Creek near Langley, Arkansas
Ouchita River Basin
Miscellaneous Site
Q= 6,530 ft^3/s
Flood of June 11, 2010

Type of measurement: Slope Area

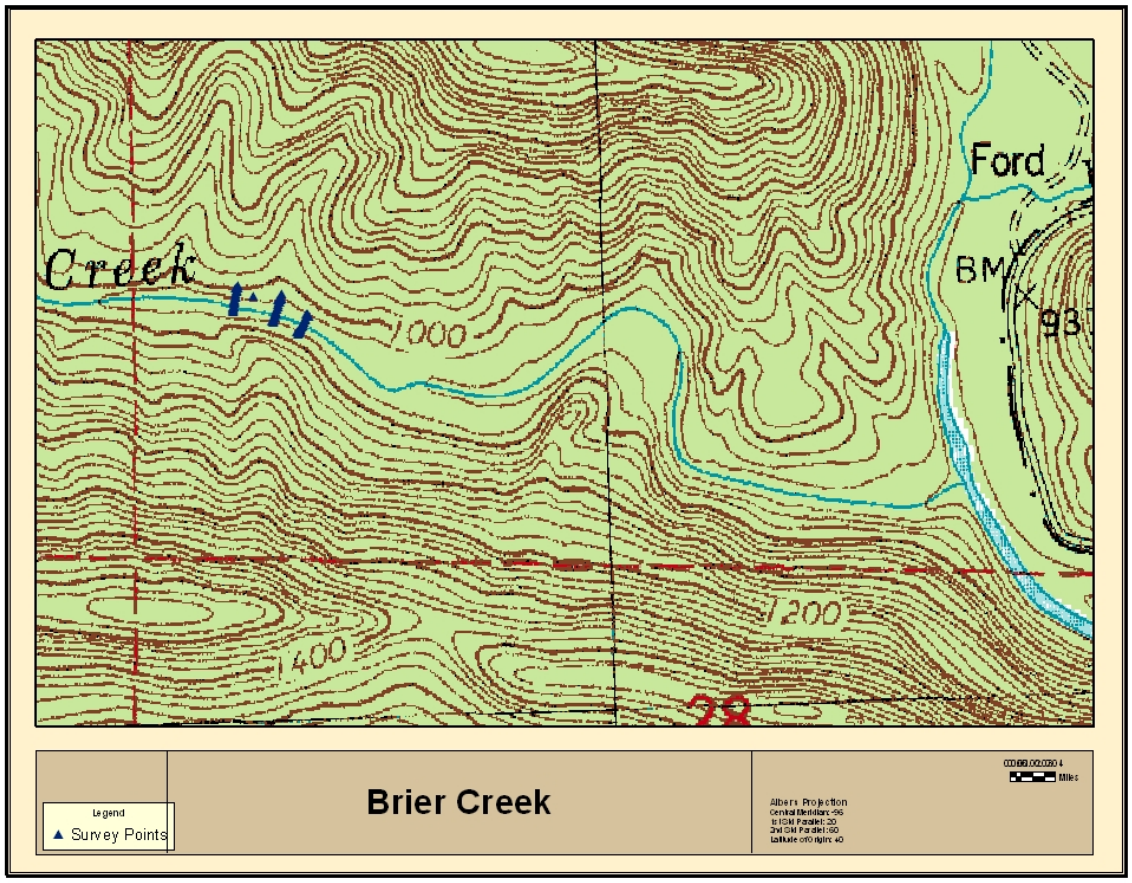
Location of site: A miscellaneous site on Brier Creek just upstream of its inflow into the Little Missouri River. Lat N 34˚22'51", Long W 93˚53'51" This site was selected because it was the straightest reach that nearest the mouth that was out of the backwater effect from the Little Missouri River. This reach runs in an east to southeast direction.

The site is Approximately 5.62 miles northwest of Langley, Arkansas, 13.34 miles southwest of Norman, Arkansas, and 29.55 miles east of Cove, Arkansas.

Survey of site: Site was selected on Thursday June 17, 2010 by Paul Rydlund and Larry Buschman. High water marks were flagged and survey conducted on the June 17, 2010 by Paul Rydlund and Larry Buschman. The initial occupation point (OC-1)was a pin driven into the trail road between the most upstream cross section and the middle cross section. An arbitrary Northing/Easting of 5000/5000 was assumed with an elevation of 100. The azimuth was established with a compass bearing of magnetic north. After the point was vacated by the total station survey, a Trimble GPS unit was setup to occupy the point for several hours to establish the horizontal (NAD83) and vertical position (NAVD88) of each survey point. The horizontal and vertical postion in UTM Zone 16 NAD 83 coordinates and NAVD88 elevation are as follows:

Elevation NAVD88	Northing (UTM Feet)	Easting (UTM Feet)
980.00	12482830.30	1369670.94

The Survey of the indirect measurement site was made using a Nikon DTM-450 2-second total station, serial number 111304.



Cross Section Locations

Discharge and Gage Height: 6,530 cfs. No Gage Height was determined as this is a miscellaneous site.

Drainage area: 3.32 mi^2 as determined by the following. Albert Rea of the USGS using NHD Plus determined the drainage area to the mouth of Brier Creek to be 3.58 mi^2. Robert Holmes using ArcMap determined the drainage area loss from the mouth to the site of the indirect to be 0.255 mi^2.

Unit Discharge: 1,970 cfs/mi^2. Crippen and Bue (1977) envelope curve for this region (Region 8) is below, with this flood approximately plotted.

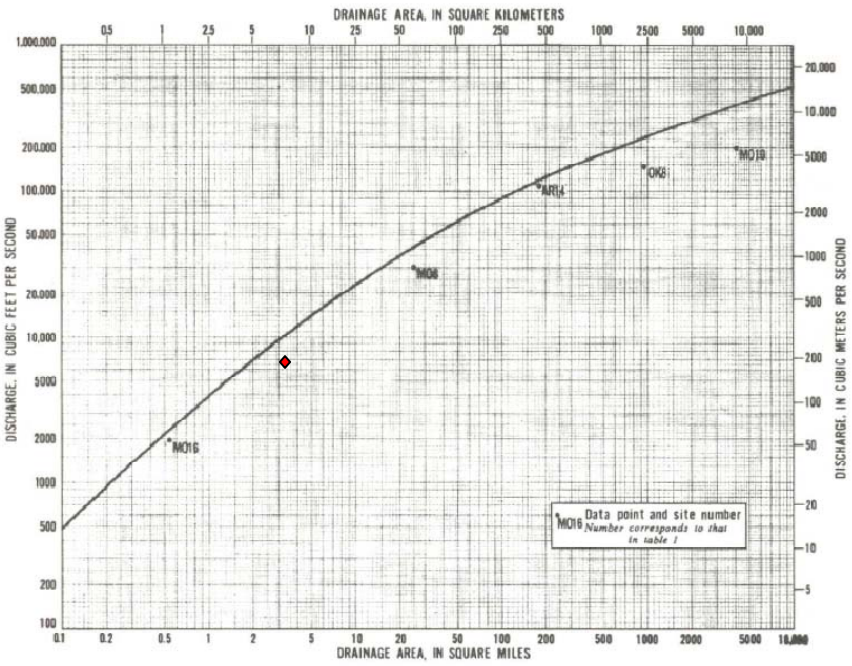


FIGURE 10.—Peak discharge versus drainage area, and envelope curve for region 8.

Nature of flood: This flood was a flash flood of extreme nature. As much as 7 inches of rain fell in a very short period of time starting just before or at midnight on June 10. Rates of rise at the USGS streamgage 10 miles downstream were as much as 8 ft/hour. Anecdotal accounts of the rates of rise of the Little Missouri River from survivors in the Albert Pike Campground indicate as much as 3 feet in a few minutes. The Ouachita mountains are a known "flood hotspot" in the United States.

Field conditions: The indirect reach is fairly straight and converging in the downstream direction. Each of the three cross sections was subdivided into 2 subsections.

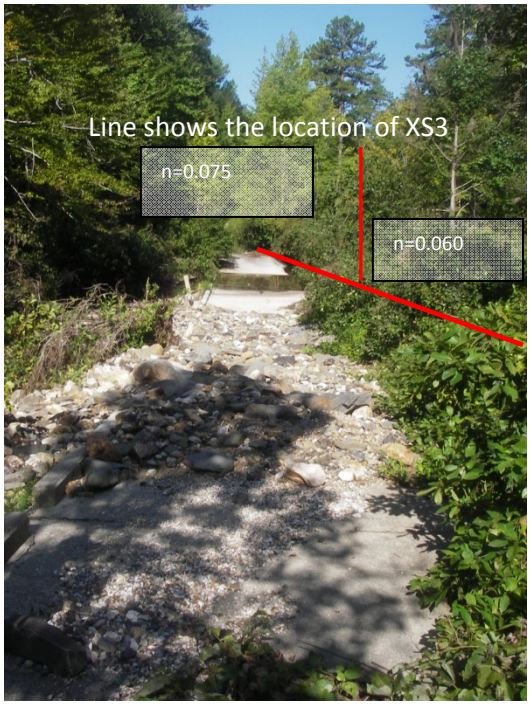
XS 3 (most upstream cross section)

Cross Section 3 was subdivided into 2 subsections.

The right overbank contains open timber, thick sprouts/brush, and some grass and concrete road slab. The composite n value for the right overbank was estimated to be 0.075 based on engineering judgment.

The main channel/left bluff has gravel and fairly open with no protrusions of trees in the main channel and the left bluff has considerable sprouts/brush very near the bank and open timber at the valley wall. The n value was estimated to be 0.060 based on engineering judgment.

Looking upstream from upstream low-water bridge toward XS 3. Note: bridge crosses stream immediately below XS3 and then the concrete slab is part of XS3.



Looking at an oblique angle from downstream left bank looking diagnolly across to upstream right overbank to XS3.

XS 2 (middle cross section)

This cross section was subdivided into 2 subsections. The left overbank and the main channel/right bluff.

The left overbank contains open timber and weeds/grasses. The n value was estimated to be 0.043 based on engineering judgment.

The main channel/right bluff consists of trees, dense sprouts, and sparse trees and boulders. The n value was estimated to be 0.065 based on engineering judgment.

XS 2 looking upstream

XS 2 looking at left bank from middle of cross section. Note the openness of the left overbank is not as apparent in this photograph as in the video for this cross section. See video "P6170040.mov"

XS2 looking downstream

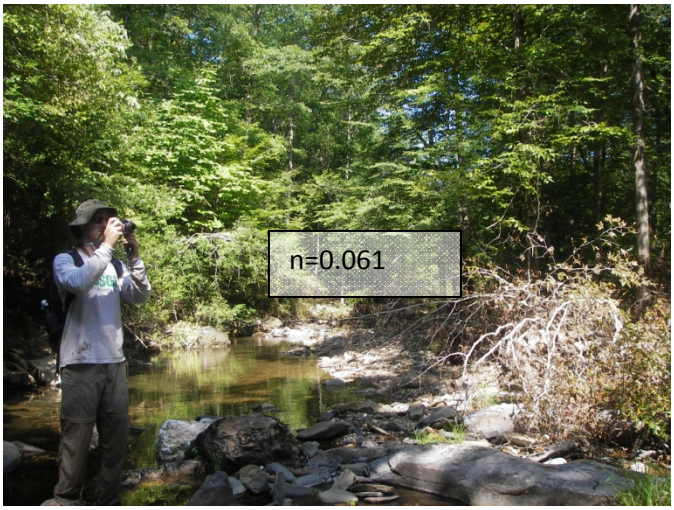
XS2 looking at right bank from middle of cross section

XS 1 (downstream cross section)

This cross section was subdivided into 2 subsections. The left overbank and the main channel/right bluff.

The left overbank was comprised of weeds and thin brush. An n value of 0.040 was estimated based on engineering judgment.

The main channel/right bluff was comprised on moderate sprouts and timber on the right edge and thick boulders in the main channel. An n value of 0.061 was estimated based on engineering judgment.



XS 1 looking upstream from middle of cross section

XS1 looking at right bank from middle of cross section

XS1 looking at left bank from middle of cross section

XS1 looking downstream from middle of cross section

See the following video clips to view the channel and floodplain conditions for the indirect reach for assistance in determining roughness.

P6170039.mov—video at X3 which is most upstream xs. Standing on right bank on top of concrete slab which parallels the creek at this point. Further downstream it crosses the creek, but is level with channel bed.

P6170040.mov—video at X2 (middle cross section). Standing on left bank in grass and looking around. Then walking to main channel. Note there is quite a bit of sprouts, trees growing up in the channel.

P6170041.mov—video at X1 (most downstream section). Standing on left bank in grassy area, looking toward left valley wall and then back to main channel. Note the grassy area is the road that parallels the creek. Lots of bent-over trees, etc in main channel area.

P6170042.mov—video just below XS3 (most upstream) looking upstream at the XS3.

The high water marks on the left bank were of poor condition. Those on the right bank were of poor conditions with a few fair to good marks.

Right Bank High Water Marks

Mark Name	Station	Elevation	MSL Elevation
RH-7-P	64.2	101.66	981.66
RH-9-P	68.3	101.66	981.66
RH-8-P	74.5	101.96	981.96
RH-6-P	201.6	104.36	984.36
RH-4-F	202.8	104.09	984.09
RH-5-P	205.6	104.09	984.09
RH-1-P	407.3	105.76	985.76
RH-2-F	407.5	106.15	986.15
RH-3-G	411.9	105.94	985.94

Left Bank High Water Marks

Mark Name	Station	Elevation	MSL Elevation
LH-7-P	45.4	101.8	981.8
LH-6-P	57.4	102.4	982.4
LH-5-P	196.6	104.4	984.4
LH-4-P	206.9	104.5	984.5
LH-3-VP	213.2	104.8	984.8
LH-1-P	414.9	106.4	986.4
LH-2-P	424.1	106.4	986.4

Computations:

SAM 2.1 was used to process the Total Station Survey data and ready it for input into the SAC program (Slope Area Computation). The discharge computed for this measurement was 6,550 cfs. The reach was contracting throughout the reach. Following are the output diagnostics from SAC.

Reach	dH,fall (ft)	length (ft)	Discharge (cfs)	Spread (%)	HF (ft)	CX	RC	RX	ER	
X3 - X2	1.70	214.	5950.	0	1.438	1.000	0.182	0.000		#
X2 - X1	2.50	150.	7030.	0	1.878	1.000	0.331	0.000		#
X3 - X1	4.20	364.	6526.	0	3.349	1.000	0.254	0.000		@#

Definitions:

Spread: the percent difference between discharge computed with no expansion loss (k=0) and discharge computed with full expansion loss (k=1.0), divided by the discharge computed with full expansion loss

HF: friction head which is the sum of Q*Q*L/(K1*K2) over subreaches
L: reach length; K1, upstream section conveyance;
K2: downstream section conveyance
CX: the computed discharge divided by the discharge computed with no expansion loss (k=0)
RC: velocity head change in contracting section divided by friction head
RX: velocity head change in expanding section divided by friction head
ER, warnings, *-fall <' 0.5ft, @-conveyance ratio exceeded, #-reach too short
error, 1-negative or 0 fall

Sensitivity Analysis

Sensitivity analysis was conducted on the n values for the reach, by changing the n values +/- 10%. The discharge changed by -7.7 % and +8.1% respectively.

Evaluation:

Use 6,530 cfs and consider it poor reliability. The indirect is graded at poor based on the following:

1. The high water marks were flagged and surveyed within 4 days of the flood, however most of the high water marks were poor. Velocities were high causing there to be a lack of "good" and even "fair" high water marks.
2. The reach was contracting, with a warning error for conveyance ratios exceeding the limit between XS3 and XS1.
3. Overall the diagnostics were good.
4. The velocity head change from XS2 to XS1 was 38 % of the friction head in this reach. The lower this ratio the more accurate the measurement per Kirby (1987).
5. There is little evidence that the reach cross section main channel has changed much during the flood. The channel is remarkably stable.
6. There is no evidence that this flood was a debris flow based on evidence left behind such as scouring and deposition.

Previous computations:

None

Remarks:

Response to selected review comments of Rodney Southard. Southard comments as numbered item, Holmes response in *italics*:

1. The photographs taken at the cross sections indicate the main channel is noticeably rougher from upstream to downstream (XS3 to XS1). However, the n-values for the main channel was lowered from cross section 2 to 1 (.065 to .061).

   *I do not see the same "noticeably rougher" going from upstream to downstream in XS2 to XS1. A review of the video (**P6170040.mov and P6170041.mov**) shows approximately similar sized bed material (boulders) in both XS 2 and XS1, but denser vegetation XS2 as opposed to XS1. Thus XS2 was given a main channel n = 0.065 with XS1 n = 0.061. XS3.*

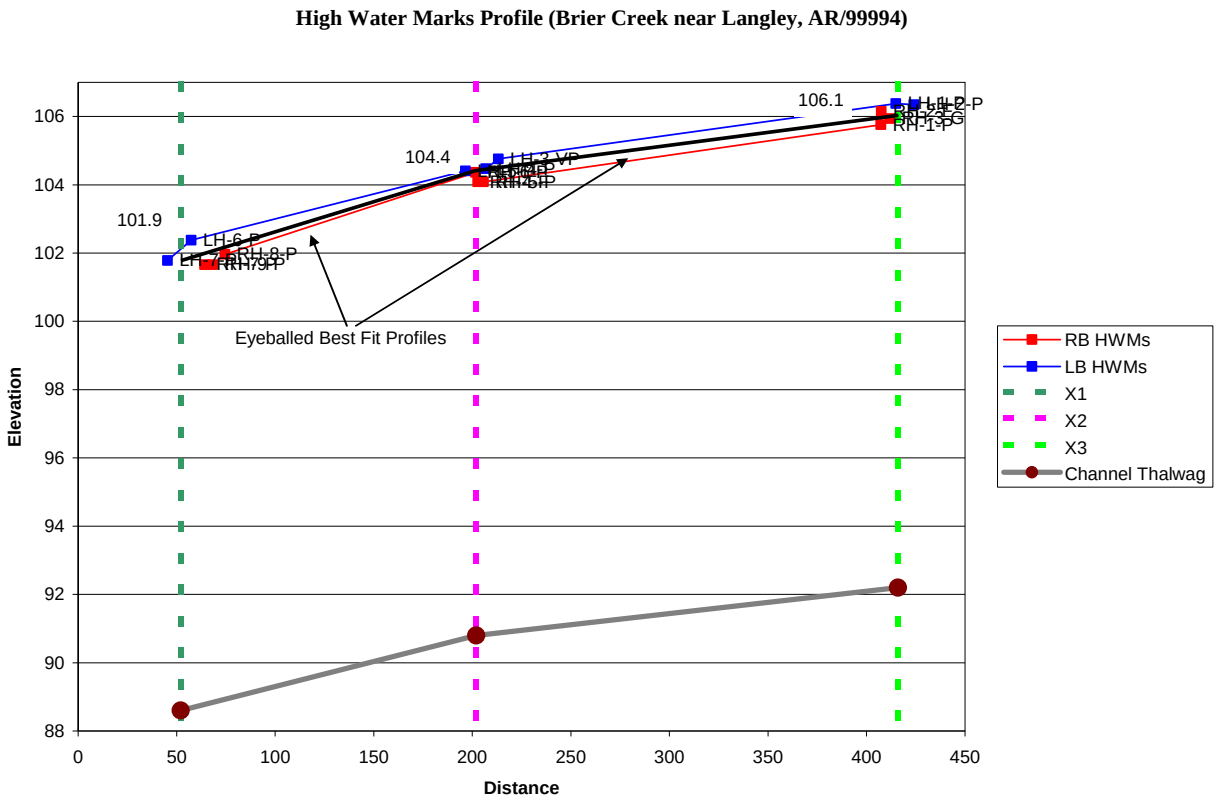
2. The photographs indicate the main channel is reasonably free of vegetation, while the overbanks have substantial vegetation. Suggest using distinct n-values on left overbank, main channel, and right overbank to better represent the hydraulic characteristics of the reach.

   Photographs were shot more than a month after the indirect was surveyed. The videos were taken the day of the survey. Main channel edges are not free of vegetation, while the left overbank of XS 2 and XS1 are mainly grass (as observed in video). Subdivision of the cross sections with associated distinct values of the roughness were already being used in the computation.

3. Were high-water profiles on the banks established for the indirect? High-water marks were only plotted at the immediate ends of the cross sections. It is best to establish high-water marks a considerable distance above and below the reach of interest according to the TWRI's (Book 3, Chapter A1). The high-water marks at cross section 1 appear to be low compared to upstream marks and thalweg elevations. Suggest using a water-surface elevation of 102.0 ft or 102.1 ft instead of 101.7 ft for cross section 1.

   No high water marks other than what are plotted in the profile plot are available. I will raise the downstream the water surface elevation at XS1 to 101.9 to better reflect the average of the left bank and right bank high water marks at that section. With this change, slope area computation lowers the peak streamflow from 6550 ft^3/s to 6,530 ft^3/s, a change of -0.3 %.

   Below I have plotted the channel thalwag profile which shows an increase in channel slope downstream of XS2 as opposed to upstream. This is increase in slope is reflected in the water surface profile



4. The velocity at cross section 1 is 21% higher than cross section 2 even with a rougher main channel based on the photographs. This seems to indicate the n-values or the water surface elevation is too low for cross section 1.

   The velocity at XS1 would be higher than XS2 because of the increased water surface slope. See response to comment 1 regarding roughness.

Computed By: Robert R. Holmes, Jr. PhD, P.E., D.WRE
National Flood Specialist

Date: August 3, 2010

Check/Review By: Rodney Southard
Missouri WSC Surface Water Specialist

Date: September 16, 2010

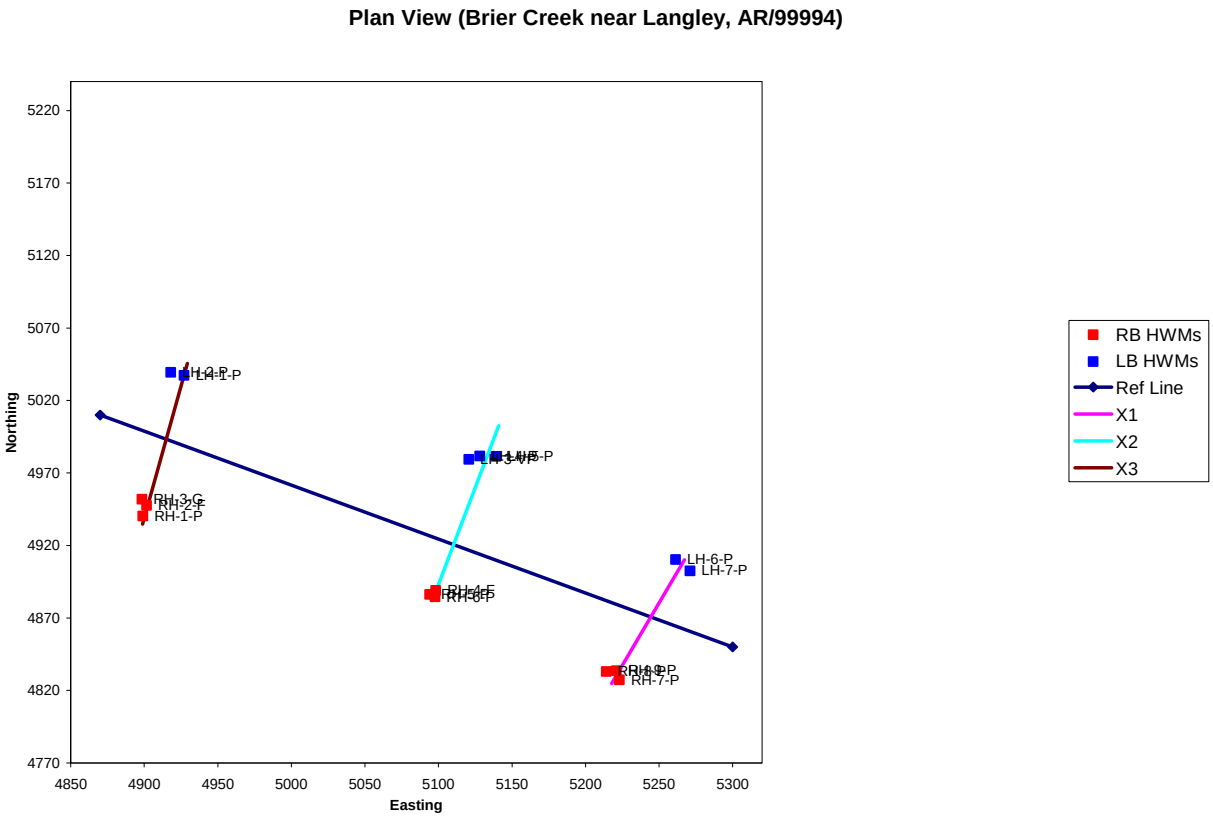
Approval: Mark E. Smith
Surface Water Specialist,
Central Water Science Field Team
Date: January 21, 2011

Appendix

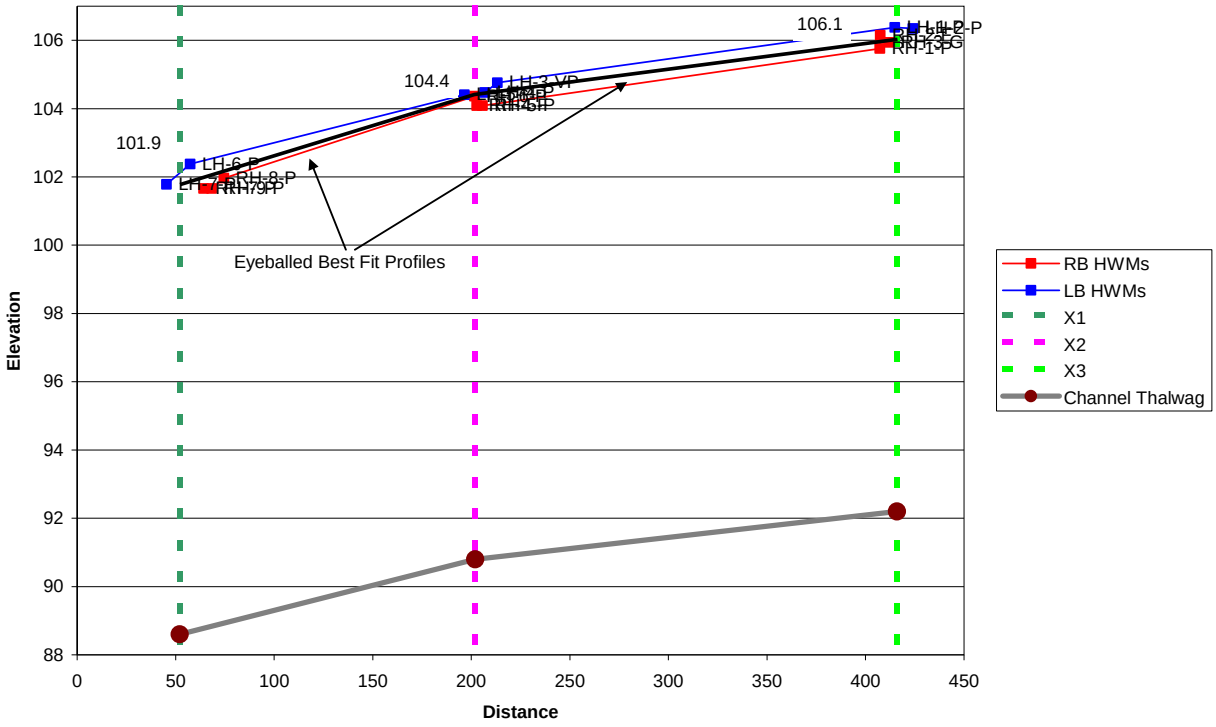
Brier Creek near Langley, Arkansas

Flood of June 11, 2010

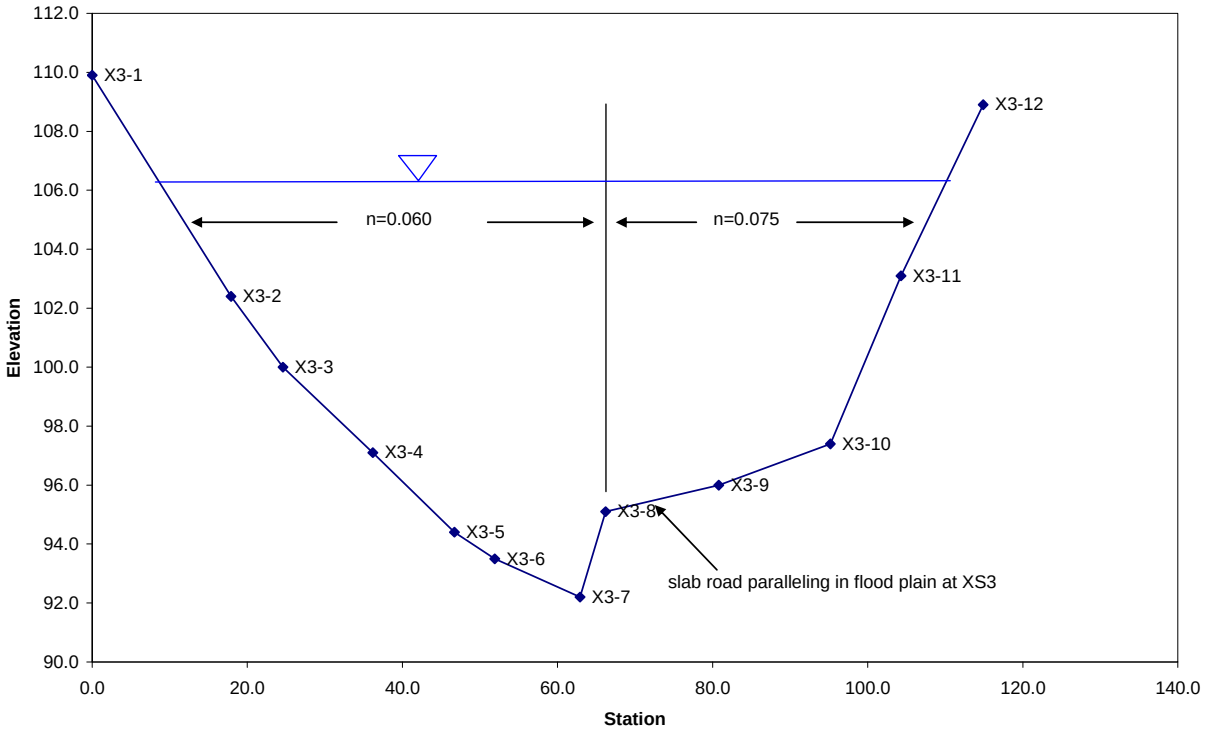
Graphs from SAM

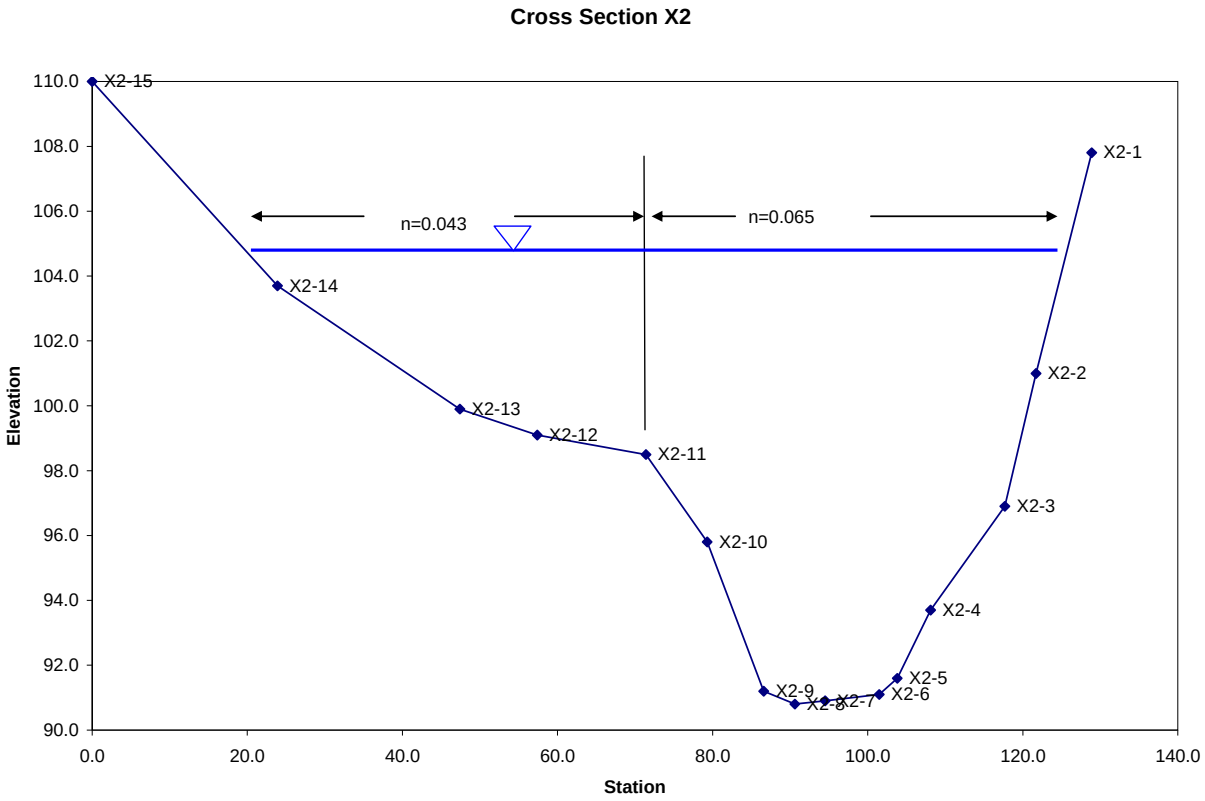


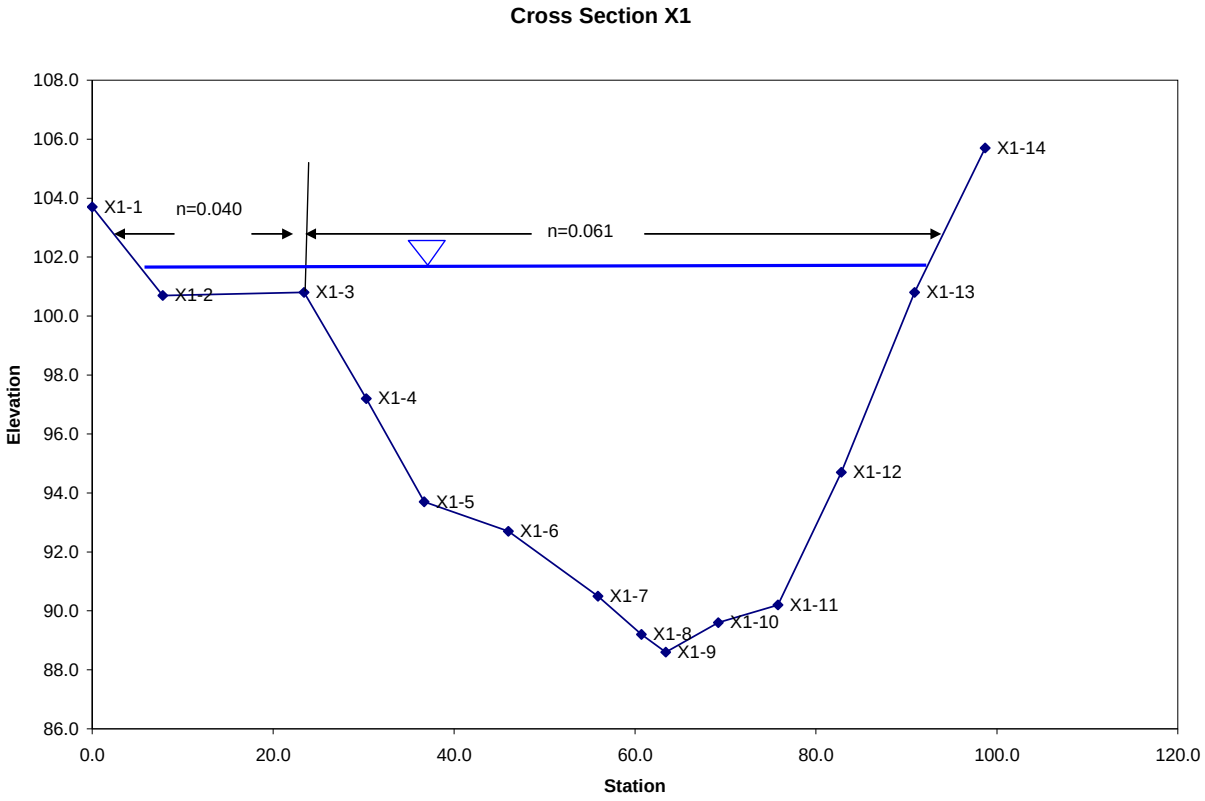
High Water Marks Profile (Brier Creek near Langley, AR/99994)



Cross Section X3




Cross Section X2
Elevation
Station
110.0
108.0
106.0
104.0
102.0
100.0
98.0
96.0
94.0
92.0
90.0
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
n=0.043
n=0.065
X2-15
X2-14
X2-13
X2-12
X2-11
X2-10
X2-9
X2-8
X2-7
X2-6
X2-5
X2-4
X2-3
X2-2
X2-1



Roughness Estimates

There was quite a bit of roughness change through the reach of the indirect. As such, each xsection and subsection will have a different n values. A sensitivity analysis will be performed to look at the max, min, and estimated values for the subsections. Four videos taken by Paul Rydlund

XS 3 (most upstream cross section)

Cross Section 3 was subdivided into 2 subsections.

The right overbank contains open timber, thick sprouts/brush, and some grass and concrete road slab. The composite n value for the right overbank was estimated to be 0.075 based on engineering judgment.

The main channel/left bluff has gravel and fairly open with no protrusions of trees in the main channel and the left bluff has considerable sprouts/brush very near the bank and open timber at the valley wall. The n value was estimated to be 0.060 based on engineering judgment.

XS 2 (middle cross section)

This cross section was subdivided into 2 subsections. The left overbank and the main channel/right bluff.

The left overbank contains open timber and weeds/grasses. The n value was estimated to be 0.043 based on engineering judgment.

The main channel/right bluff consists of trees, dense sprouts, and sparse trees and boulders. The n value was estimated to be 0.065 based on engineering judgment.

XS 1 (downstream cross section)

This cross section was subdivided into 2 subsections. The left overbank and the main channel/right bluff.

The left overbank was comprised of weeds and thin brush. An n value of 0.040 was estimated based on engineering judgment.

The main channel/right bluff was comprised on moderate sprouts and timber on the right edge and thick boulders in the main channel. An n value of 0.061 was estimated based on engineering judgment.

SAC INPUT DATA

```
T1       SAC/WSPRO Input for Brier Creek near Langley, AR  (99994)
T2
Q
WS       101.7
XS   X1   52
GR       0,103.7 7.8,100.7 23.4,100.8 30.3,97.2 36.7,93.7 46,92.7 55.9,90.5
GR       60.7,89.2 63.4,88.6 69.2,89.6 75.8,90.2 82.8,94.7 90.9,100.8
GR       98.7,105.7
N        0.040   0.061
SA       23.4
HP 4 X1   101.7
XS   X2   202
GR       0,110 23.9,103.7 47.4,99.9 57.4,99.1 71.4,98.5 79.3,95.8 86.6,91.2
GR       90.6,90.8 94.5,90.9 101.5,91.1 103.8,91.6 108.1,93.7 117.7,96.9
GR       121.7,101 128.9,107.8
N        0.043   0.065
SA       71.4
HP 4 X2   104.4
XS   X3   416
GR       0,109.9 17.9,102.4 24.6,100 36.2,97.1 46.7,94.4 51.9,93.5 62.9,92.2
GR       66.2,95.1 80.8,96 95.2,97.4 104.3,103.1 114.9,108.9
N        0.060 0.075
SA       66.2
HP 4 X3   106.1
```

SAC OUTPUT

DISCHARGE COMPUTATIONS

Reach	dH,fall (ft)	length (ft)	Discharge (cfs)	Spread (%)	HF (ft)	CX	RC	RX	ER
X3 - X2	1.70	214.	5950.	0	1.438	1.000	0.182	0.000	#
X2 - X1	2.70	150.	7032.	0	1.955	1.000	0.381	0.000	#
X3 - X1	4.40	364.	6548.	0	3.437	1.000	0.280	0.000	@#

Definitions:

Spread, the percent difference between discharge computed with no expansion loss (k=0) and discharge computed with full expansion loss (k=1.0), divided by the discharge computed with full expansion loss

HF, friction head- HF = sum of Q*Q*L/(K1*K2) over subreaches; Q, discharge; L, reach length; K1, upstream section conveyance; K2, downstream section conveyance

CX, the computed discharge divided by the discharge computed with no expansion loss (k=0)

RC, velocity head change in contracting section divided by friction head

RX, velocity head change in expanding section divided by friction head

ER, warnings, *-fall <' 0.5ft, @-conveyance ratio exceeded, #-reach too short error, 1-negative or 0 fall

******, terms that can not be computed because' of strong expansion in reach