07360200 Little Missouri River near Langley, Arkansas

Flood Event of June 11, 2010

Type of Measurement: Slope Area using USGS slope-area program Version 97-01

Instrumentation: Sokkia 3C II Total Station #D20842. USGS ID: W# 599602; SN: 23110

Location of Site Lat 34°18'42", long 93°53'59", in NW1/4SW1/4 sec.16, T.5 S, R.27 W., Pike County, Hydrologic Unit 08040103, near center of channel on downstream side of bridge on State Highway 84, 3.3 mi west of Langley and 4.7 mi east of Athens.

Survey of Site: High-water marks (HWM's) were observed by Jaysson Funkhouser, Dan Wagner, Bill Baldwin and Kevin Hubbs on June 12, 2010 on a stretch of the Little Missouri River approximately ¼ of a mile upstream from the gaging station. Site was surveyed by Jaysson Funkhouser, Dan Wagner, Bill Baldwin and Kevin Hubbs on June 13 – 14, 2010. Additional cross sections were surveyed in November 2010 by W.F. Killion and A. Jones. Gage datum was not used for the survey rather an arbitrary datum of 100.00 feet was used instead. An arbitrary northing/easting of 5,000/5,000 was used for the horizontal.

The reach that was selected was expanding, but because of the meandering of the stream (see figure below) (numerous 90-degree bends are present) and the conditions of the stream at the gaging station (the area just downstream of the Highway 84 crossing was very densely vegetated with large amounts of debris), this was the most suitable location.

In addition to the indirect being surveyed, several high-water marks in the vicinity of the gaging station were flagged to verify the DCP reading.

HWM's were plotted each evening in the field to aid in locating the placement of the cross sections.

Discharge and Gage Height: 70,800 ft^3/sec. The DCP recorded a gage height of 23.46 ft. High water marks on the downstream side of the Highway 84 bridge measured 23.00 ft. Because of the likelihood that "standing waves" were present in the main channel during the flood, the DCP recorded gage height of 23.46 was used for this measurement.

Drainage area: 68.4 mi^2

Unit Discharge: 1,040 ft^3/sec per mi^2

Nature of Event: At the time of the flood, there was no raingage present at the gage. The National Weather Service reported that anywhere from 7 - 10 inches of rain fell in a 4 – 7 hour timeframe starting around 8:00 or 9:00 PM on June 10 and ending around 2:00 or 3:00 AM on June 11. Rates of rise reported by the DCP exceeded 8 ft/hour (Table 1). Slope Area Computation (SAC) outputs indicate that the velocity in the main channel was flowing near 14 – 17 feet per second. Surveyed high water marks indicated that the slope of the water surface through the reach was approximately 0.006 ft/ft.

Table 1. Date, time and gage-height of 07360200 Little Missouri River near Langley gaging station during the June 11, 2010 flood event.

Date / Time	Gage height, feet
06/11/2010 00:00 CDT	3.40
06/11/2010 00:15 CDT	3.41
06/11/2010 00:30 CDT	3.41
06/11/2010 00:45 CDT	3.41
06/11/2010 01:00 CDT	3.42
06/11/2010 01:15 CDT	3.48
06/11/2010 01:30 CDT	3.63
06/11/2010 01:45 CDT	3.73
06/11/2010 02:00 CDT	3.87
06/11/2010 02:15 CDT	4.71
06/11/2010 02:30 CDT	5.89
06/11/2010 02:45 CDT	7.64
06/11/2010 03:00 CDT	9.93
06/11/2010 03:15 CDT	12.69
06/11/2010 03:30 CDT	13.97

06/11/2010 03:45 CDT	15.72
06/11/2010 04:00 CDT	17.76
06/11/2010 04:15 CDT	19.04
06/11/2010 04:30 CDT	20.63
06/11/2010 04:45 CDT	21.52
06/11/2010 05:00 CDT	22.36
06/11/2010 05:15 CDT	23.16
06/11/2010 05:30 CDT	23.46
06/11/2010 05:45 CDT	23.19
06/11/2010 06:00 CDT	22.47
06/11/2010 06:15 CDT	21.25
06/11/2010 06:30 CDT	19.98
06/11/2010 06:45 CDT	18.62
06/11/2010 07:00 CDT	17.25

Field Conditions: Most HWM's were rated fair to poor. The HWM's consisted of a combination of a seed line, mud line, and a debris line that followed both the right and left side of the channel along the entire length of the reach. HWM's were plotted in plan view and the HWM's nearest each of the cross sections were used as the water surface elevation (on the left and right side) of the cross sections. The average of the left and right side were taken at each cross section and was assigned as the water-surface elevation (HP) in SAC. The plan view was used in Excel and the scales of the x and y axes were adjusted accordingly.

Four cross sections (fig 1) were surveyed with a total change in channel elevation of approximately 1.0 ft and approximately 3.78 ft change of water surface elevation occurring over a reach length of 629 ft. The reach section surveyed for this measurement flowed from the north to the south. Because of the expansion occurring at the most downstream cross section (XS1), additional cross sections were surveyed (XS1a and XS3a) in November 2010.

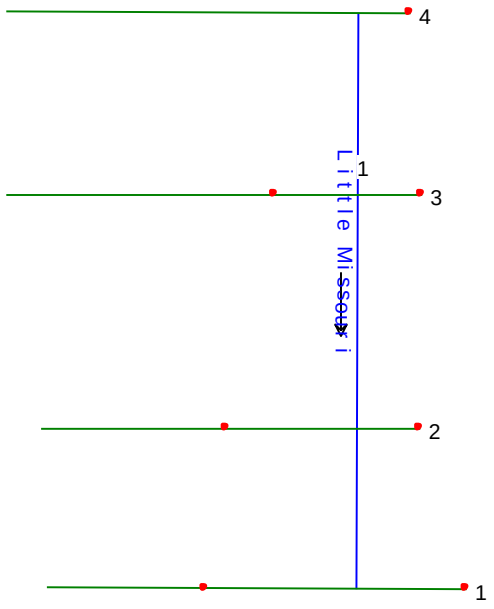

Figure 1. Graphic to illustrate the surveyed reach.

The indirect reach is straight with fairly uniform boundary roughness through the reach. Three of the four cross sections were subdivided into two subsections: 1) the main channel, which included the left bank areas with the trees, and 2) the right overbank. The most upstream cross section, XS3a, was not subdivided. All Manning's N values were assigned by J.E. Funkhouser and were based on other indirect discharge measurements that have been made in the Ouachita Mountains, engineering judgment and examination of photos from Barnes (1967, http://pubs.usgs.gov/wsp/wsp_1849/pdf/wsp_1849.pdf),

XS1a is the most downstream cross section, XS2 and XS 3 are the middle cross sections, and XS3a is the most upstream cross section. Numerous digital pictures were taken to verify all Manning's N values. A detailed description of the three cross sections are as follows:

Cross Section 1(a): Cross section 1(a) (fig 2) consisted of a wooded left bank with large oaks (8 – 12" diameter) and a steep slope (2:1 slope); a channel with no debris or obstructions but a few large boulders and a bedrock bottom, and a shallow sloping right bank (1:5 slope). The left bank and main channel were assigned a Manning's value of 0.045 by J.E. Funkhouser. The main channel consisted of a bedrock bottom with large boulders present (1' – 3' diameter). The main channel appeared to have approximately 25 feet of water flowing over it during the June 11 event. A Manning's value of 0.055 was assigned to the right bank by J.E. Funkhouser. The right bank consisted of densely vegetated debris and a field opening on the far right. Approximately 12 feet of water was flowing over the right bank during the June 11 event. Surveyed HWM found the water surface elevation (WSE) on the left to be near 103.08 ft and 103.73 ft on the right. The WSE elevation that was chosen to use for the indirect measurement was 103.40 ft (average of both).

The original cross section 1 was later found to be an expanding reach when the flow computations were being made. To try to handle this, XS1a was surveyed in November 2010 upstream of XS1 because of expansion problems. This new cross section was labeled XS1a and was used for the indirect.

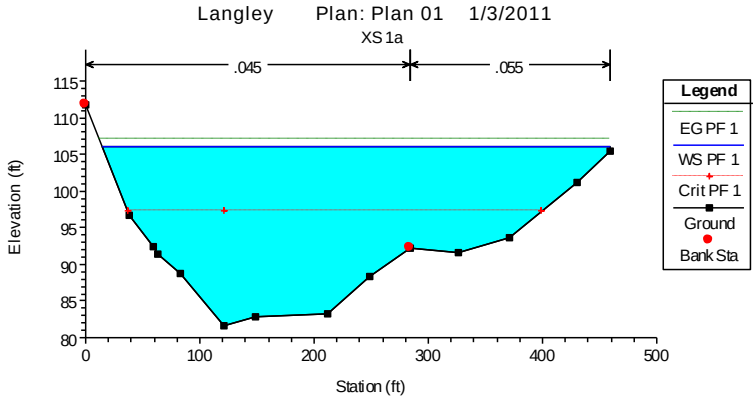

Figure 2. Graphic to illustrate cross section 1(a).

XS1. Left bank. Looking downstream. N=0.045

XS1. Main channel. Looking upstream. N=0.045

XS1. Main channel. Looking downstream. N=0.045

XS1. Right bank. Looking streamward. N=0.055

Cross Section 2: Cross section 2 (fig 3) consisted of a wooded left bank with large oaks (8 – 12" diameter) and a steep slope (2:1 slope); a channel with no debris or obstructions but a few large boulders and a bedrock bottom, and a shallow sloping right bank (1:5 slope). The left bank and main channel were assigned a Manning's value of 0.045 by J.E. Funkhouser. The main channel consisted of a bedrock bottom with large boulders present (1' – 3' diameter). The main channel appeared to have approximately 23 feet of water flowing over it during the June 11 event. A Manning's value of 0.053 was assigned to the right bank by J.E. Funkhouser. The right bank consisted of densely vegetated debris and a large field opening on the far right. Approximately 15 feet of water was flowing over the right bank during the June 11 event. Surveyed HWM found the water surface elevation (WSE) on the left to be near 103.67 ft and 103.87 ft on the right. The WSE elevation that was chosen to use for the indirect measurement was 103.77 ft (average of both).

For determining the distance from XS1a to XS2, the coordinates from the centermost point in XS1a and XS2 were used (using Pythagorean's Theorem). The coordinates used were:

XS1a: E 5296.955 N 4963.656
XS2: E 5417.260 N 4836.082

Calculated distance: 175 ft

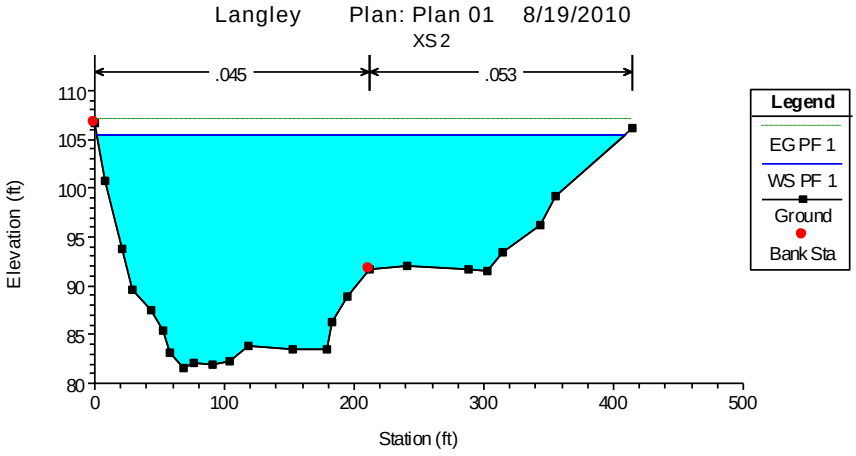

Figure 3. Graphic to illustrate cross section 2.

XS2. Left bank. Looking streamward. N=0.045

XS2. Main channel. Looking downstream. N=0.045

XS2. Right bank. Looking upstream. N=0.053

XS2. Right bank. Looking bankward. N=0.053

Cross Section 3: Cross section 3 (fig 4) consisted of a wooded left bank with large oaks (8 – 12" diameter) and a steep slope (2:1 slope); a channel with no debris or obstructions but a few large boulders and a bedrock bottom, and a very shallow sloping right bank (1:20 slope). The left bank and main channel were assigned a Manning's value of 0.045 by J.E. Funkhouser. The main channel consisted of a bedrock bottom with large boulders present (1' – 3' diameter). The main channel appeared to have approximately 25 feet of water flowing over it during the June 11 event. A Manning's value of 0.052 was assigned to the right bank by J.E. Funkhouser. The right bank consisted of densely vegetated debris and a large field opening on the far right. Approximately 18 feet of water was flowing over the right bank during the June 11 event. Surveyed HWM found the water surface elevation (WSE) on the left to be near 105.88 ft and 105.97 ft on the right. The WSE elevation that was chosen to use for the indirect measurement was 105.93 ft (average of both).

For determining the distance from XS2 to XS3, the coordinates from the centermost point in XS2 and XS3 were used (using Pythagorean's Theorem). The coordinates used were:

XS2: E 5417.260 N 4836.082
XS3: E 5591.853 N 4650.083

Calculated distance: 255 ft

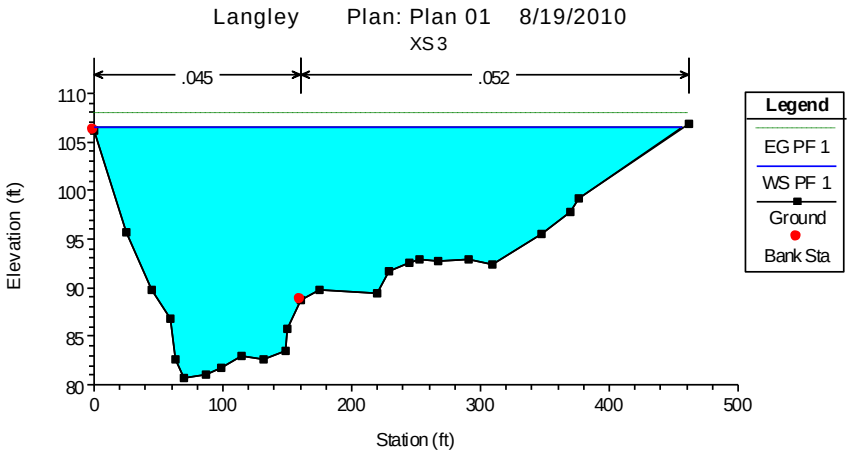

Figure 4. Graphic to illustrate cross section 3.

XS3. Left bank. Looking downstream. N=0.045

XS3. Main channel. Looking downstream. N=0.045

XS3. Right bank. Looking downstream. N=0.052

XS3. Right bank. Looking streamward. N=0.052

Cross Section 3a: Cross section 3a (fig 5) consisted of a wooded left bank with large oaks (8 – 12" diameter) and a steep slope (2:1 slope); a channel with no debris or obstructions but a few large boulders and a bedrock bottom, and a very shallow sloping right bank (1:20 slope). The left bank, main channel and right bank were assigned a Manning's value of 0.052 by J.E. Funkhouser. The main channel consisted of a bedrock bottom with large boulders present (1' – 3' diameter). The main channel appeared to have approximately 25 feet of water flowing over it during the June 11 event. The right bank consisted of densely vegetated debris and a large field opening on the far right. Approximately 18 feet of water was flowing over the right bank during the June 11 event. Surveyed HWM found the water surface elevation (WSE) on the left to be near

108.16 ft and 106.20 ft on the right. The WSE elevation that was chosen to use for the indirect measurement was 107.18 ft (average of both).

For determining the distance from XS3 to XS3a, the coordinates from the centermost point in XS3 and XS3a were used (using Pythagorean's Theorem). The coordinates used were:

XS3: E 5591.853 N 4650.083
XS3a: E 5738.922 N 4515.551

Calculated distance: 199 ft

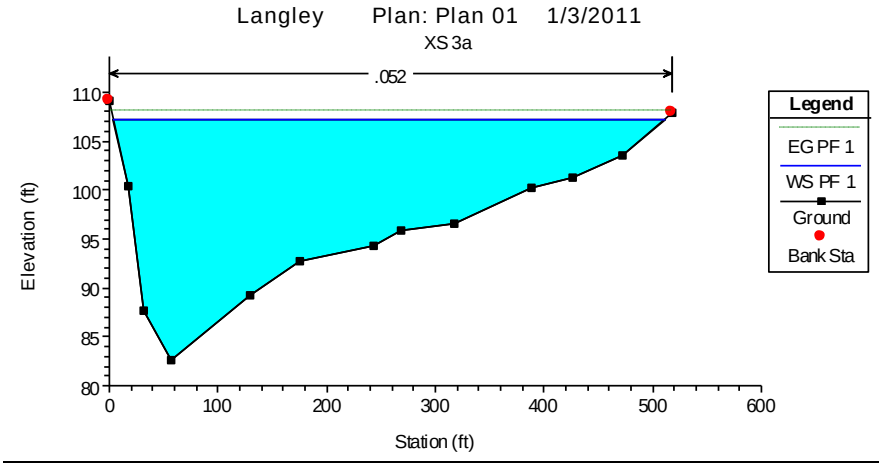

Figure 5. Graphic to illustrate cross section 3a.

XS3a. Left bank. Looking streamward. N=0.048

XS3a. Main channel. Looking upstream. N=0.048

XS3a. Right bank. Looking bankward. N=0.048

XS3a. Right bank. Looking streamward. N=0.048

Survey Closure: 28 temporary hub points were established for the closure of this survey over a length of 2,050 feet of surveyed reach (left and right banks). The closures for the survey are listed in the *.pdf file “little mo 2_rawfile_withclosures2”. Vertical closures for these hub points ranged anywhere from -0.02’ – 0.07’. The average closure was 0.02’. The double hub closure procedure was not used for the survey.

Computations: The measurement was computed by Jaysson Funkhouser using the USGS slope-area program Version 97-01 flow model on July 30, 2010 and re-computed on January 4, 2011 using additional surveyed cross sections.

Evaluation: Use 70,800 cfs and consider it of poor reliability because of 1) expansion between XS2 and XS1a; and 2) the large variability in computed sub-reach discharges. Profiles were fairly well defined. Some evidence of scour and fill was present. The measured section was located in a fairly straight stretch. Due to field circumstances, the section of river used to compute this indirect was located in the “best suitable” location, meaning there were no other suitable reaches to run the indirect within the vicinity of the gage. The output from SAC indicated that the reach lengths were too short and that there was substantial expansion between XS2 and XS1a. A 90 degree bend upstream of the indirect location and expansion just downstream prevented the reach length from being any longer than was used for the indirect and prevented the reach from extending much further upstream. Two additional cross sections were surveyed in November 2010 (XS1a and XS3a) to help reduce the substantial expansion that occurred. As a result, the expansion between the two cross sections was reduced from 71 to 29 percent.

Remarks: Prior to this measurement, flows ranging from 9.2 to 7,300 cfs had been measured at the station. In 1996, an indirect measurement was made by A.P. Hall. This indirect, however, used the one-cross section slope-conveyance method and should not be used in comparison to this indirect measurement. This measurement was used to develop the upper end of the rating curve for the station and to establish the peak-of-record discharge and gage height for the gaging station.

Errors and Warnings from SAC: Messages from SAC indicated that the reach lengths are too short and expansion occurred between XS2 and XS1a. This is addressed in the Evaluation Section above.

References:

Barnes, Jr. H. H., 1967, Roughness characteristics of natural channels, U.S. Geological Survey Water Supply Paper 1849, 213 p

Computed By: Jaysson Funkhouser
Date: September 1, 2010
Revised: October 12, 2010
Revised: January 4, 2011

Checked By: Bob Holmes
Date: September 16, 2010

Reviewed By: Mark Smith
Date: October 25, 2010 and January 14, 2011