ATLAS HA-601

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, BEAVER CREEK NEAR KENTWOOD, LOUISIANA

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Prepared in cooperation with the
DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
and the
LOUISIANA DEPARTMENT OF
TRANSPORTATION AND DEVELOPMENT

HYDROLOGIC INVESTIGATIONS ATLAS
Published by the U.S. Geological Survey, 1979
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BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS BEAVER CREEK NEAR KENTWOOD, LOUISIANA

INTRODUCTION

New techniques for predicting water-surface profiles, needed in the design of economical, structurally sound, and environmentally compatible stream crossings, are under investigation. The investigation has accelerated with the advent of digital computers capable of analyzing large quantities of data. Among the techniques is the development of two-dimensional (2-D) digital models. Field data are essential for development and evaluation of these techniques for predicting water-surface profiles. This atlas is one of a series that will provide a wide range of field data.

Since 1969 the U.S. Geological Survey has been collecting backwater data where wide, densely vegetated flood plains are crossed by highway embankments and single-opening bridges. This work was done in cooperation with the Federal Highway Administration Department of Transportation, the Alabama State Highway Department, the Louisiana Department of Transportation and Development, and the Mississippi State Highway Department. The objective of this cooperative project is to present the data in a format conducive to the development of improved models for predicting hydraulic responses of flow at highway crossings of streams in complex hydrologic and geographic settings.

Data were collected at the following 22 sites (fig. 1) for 35 floods; that is, 11 sites had 1 flood each; 9 sites, 2 floods each; and 2 sites, 3 floods each. Analysis of the data (Scheider and others, 1976) showed that backwater and discharge at these sites computed by methods presently in use, would be inaccurate. The floodflow data are unique in the range and detail in which information was collected and provide a base for evaluating digital models relating to open-channel flow. This atlas shows flood data obtained on Beaver Creek near Kentwood, Louisiana, one of 22 sites.

HYDROLOGIC INVESTIGATIONS ATLAS NUMBER

ALABAMA	
Buckhorn Creek near Shiloh	HA–607
Pea Creek near Louisville	608*
Poley Creek near Sanford	609
Yellow River near Sanford	610
Whitewater Creek near Tarantum	611
LOUISIANA	
Alexander Creek near St. Francisville	HA–600*
Beaver Creek near Kentwood	601
Comite River near Olive Branch	602
Cypress Creek near Downsville	603*
Flagon Bayou near Libuse	604
Little Bayou de Loutre near Truxno	605*
Tenmile Creek near Elizabeth	606*
MISSISSIPPI	
Bogue Chitto near Johnston Station	HA–591
Bogue Chitto near Summit	592
Coldwater River near Red Banks	593*
Lobutcha Creek at Zama	594
Okatoma Creek east of Magee	595
Okatoma Creek near Magee	596
Tallahala Creek at Waldrup	590
Thompson Creek near Clara	597*
West Fork Amite River near Liberty	598*
Yockanookany River near Thomastown	599*

* In press

DESCRIPTION OF DATA

TYPE OF DATA

Data collected at all study sites consist of (1) depths, velocities, and discharges measured through the bridge openings, and (2) peak water-surface elevations along the highway embankment and along cross sections. A minimum of eight valley cross sections were surveyed at approximately one valley-width intervals in the vicinity of the bridge at each site. Locations of the cross sections were alined perpendicularly to the assumed direction of flow. Cross sections were extended to intersect the edge of the valley at equal water-surface elevations. Surveying procedures described in the U.S. Geological Survey Techniques of Water-Resources Investigations series (Matthai, 1967; Benson and Dalrymple, 1967) were followed.

HIGH-WATER MARKS

Water-surface elevations were determined from high-water marks identified along the cross sections and the edges of the valley after each flood. During peak discharge measurements, water-surface elevations were marked with standard surveying stakes along the upstream and downstream sides of the highway embankment. For some floods additional high-water marks were identified in the valley adjacent to the bridge to define in detail the water surface in the approach and exit reaches.

BRIDGE GEOMETRY

Detailed bridge geometry was obtained at each site. The bridge cross section was surveyed at the most contracted section. Piers, spur dikes, wingwalls, abutment slopes, and other pertinent geometry were measured.

MANNING'S ROUGHNESS COEFFICIENT

Schneider and others (1976) used composite Manning's roughness coefficient values (n) where frequent changes in roughness occurred. In their study, composite values of (n) were verified by matching step backwater computations of the water surface with actual water-surface profiles for measured discharges. The range of n values used in this report is based on values used by Schneider and others (1976). Roughness varies from open fields to dense forests. Roughness values or ranges of roughness values in different parts of the flood plain are shown on the maps.

PRESENTATION OF DATA

The data are represented on topographic maps enlarged from standard 1:24,000 or 1:62,500 scale U.S. Geological Survey topographic maps which comply with National Map Accuracy Standards. Accuracy limitations of the base maps are retained in the enlargements. Although positions may be scaled closely on the enlargements, they are not defined with greater accuracy than positions on the base maps.

Ground elevations are placed adjacent to solid squares. Elevations of floodmarks are indicated by numerical values adjacent to solid triangles. Floodmark elevations for separate floods are shown on separate sheets. Bridge geometry and road-embankment dimensions are shown with brief notations of pier spacing and configuration.

In addition to the data points shown on the maps, discharge measurements of selected floods, plots of cross sections, and velocity distribution diagrams are shown. Cross-section elevations are tabulated to define stream channels and flood-plain features in greater detail. Each cross section is referred to a zero station established at the extreme left edge (facing downstream) of the valley.

DATUM

All elevations presented in this report are referred to National Geodetic Vertical Datum of 1929 (NGVD).

FLOOD FREQUENCY

Flood-frequency relations are presented graphically. Techniques for deriving flood-frequency relations are those described by the U.S. Water Resources Council (1977), and by Neely (1976).

INTERNATIONAL SYSTEM OF UNITS (SI)

The International System of Units (SI) is used throughout this report. All data were measured in the U.S. customary units and converted to SI units. Ground elevations which were originally determined to the nearest tenth of a foot are rounded to the nearest 0.01 meter. Water-surface elevations which were surveyed to hundredths of a foot are rounded to millimeters. The same criteria apply to all other dimensions, except contour elevations which are shown to the nearest tenth of a meter.

The following factors may be used to convert SI units to the U.S. customary units:

MULTIPLY SI UNITS	*BY*	*TO OBTAIN U.S. CUSTOMARY UNITS*
	LENGTH	
Meter (m)	3.281	Feet (ft)
	AREA	
Square meter (m^2)	10.76	Square feet (ft^2)
	VOLUME	
Cubic meter (m^3)	35.31	Cubic feet (ft^3)
	VELOCITY	
Meter per second (m/s)	3.281	Feet per second (ft/s)
	FLOW RATE	
Cubic meter per second (m^3/s)	35.31	Cubic feet per second (ft^3/s)

DATA FOR BEAVER CREEK NEAR KENTWOOD, LOUISIANA

Data for Beaver Creek near Kentwood obtained in a 1.2-kilometer reach crossed about midway by State Highway 1049 are presented on three sheets. Sheet 1 contains tables showing cross-section data (table 1) and discharge data (table 2). A vicinity map showing the location of the site is shown in figure 2. An aerial view looking upstream in the vicinity of the bridge is shown in figure 3. Relative magnitudes of the floods are shown on the frequency curve (fig. 4).

The locations of representative ground elevation are shown on sheet 2. These are points of significant changes in cross-section elevations and alinement of axis. Plots of the cross section are graphic presentations of the tabular data.

Bridge geometry and road embankments are shown on sheet 2 as they existed at the time of the flood. The cross section surveyed at the downstream side of the bridge is tabulated on sheet 1. The cross section shown for velocity distribution was obtained by sounding from the downstream side of the bridge during the discharge measurement.

Data for the flood of May 22, 1974, are presented. Eight valley cross sections were surveyed after this flood (sheet 2).

Manning's roughness coefficients and the 1974 flood boundaries are shown on sheets 2 and 3.

FLOOD OF MAY 22, 1974

Peak water-surface elevations, measured cross section, and velocities for the flood of May 22, 1974, are shown on sheet 3. The flood crested at an elevation of 65.974 meters at the reference point located on the upstream guardrail 39.5 meters from the left abutment. The peak discharge from the stage-discharge relation was 396 cubic meters per second, of which 93 cubic meters per second flowed over the highway embankment. A discharge of 288 cubic meters per second was measured at an elevation of 65.639 meters at the reference point (table 2). The recurrence interval of the peak discharge is greater than 100 years (Neely, 1974). See figure 4.

SUMMARY

Flood-flow data that will provide a base for evaluating digital models relating to open-channel flow were obtained at 22 sites on streams in Alabama, Louisiana, and Mississippi. Thirty-five floods were measured. Analysis of the data indicated that backwater and discharges computed by standard indirect methods currently in use would be inaccurate where densely vegetated flood plains are crossed by highway embankments and single-opening bridges. This atlas presents flood information at the site on Beaver Creek near Kentwood, Louisiana. Water depths, velocities, and discharge through the bridge openings for the flood of May 22, 1974, on Beaver Creek near Kentwood were measured, together with peak water-surface elevations along embankments and along cross sections. Manning's roughness coefficients in different parts of the flood plain are shown on maps, and flood-frequency relations are shown on graphs.

ADDITIONAL INFORMATION

Other information pertaining to floods in Alabama, Louisiana, and Mississippi may be obtained at the offices of the U.S. Geological Survey listed below:

U.S. Geological Survey
Room 202, Oil and Gas Board Building (P.O. Box V)
University, Alabama 35486

U.S. Geological Survey
6554 Florida Boulevard (P.O. Box 66492)
Baton Rouge, Louisiana 70896

U.S. Geological Survey
430 Bounds Street
Jackson, Mississippi 39206

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HYDROLOGIC INVESTIGATIONS
ATLAS HA-601 (SHEET 1)

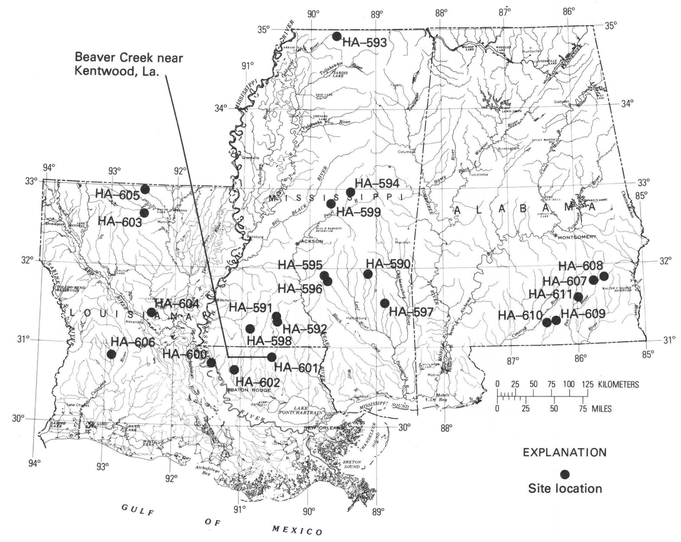

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

FIGURE 2—INDEX MAP SHOWING STUDY REACH, BEAVER CREEK NEAR KENTWOOD, LOUISIANA

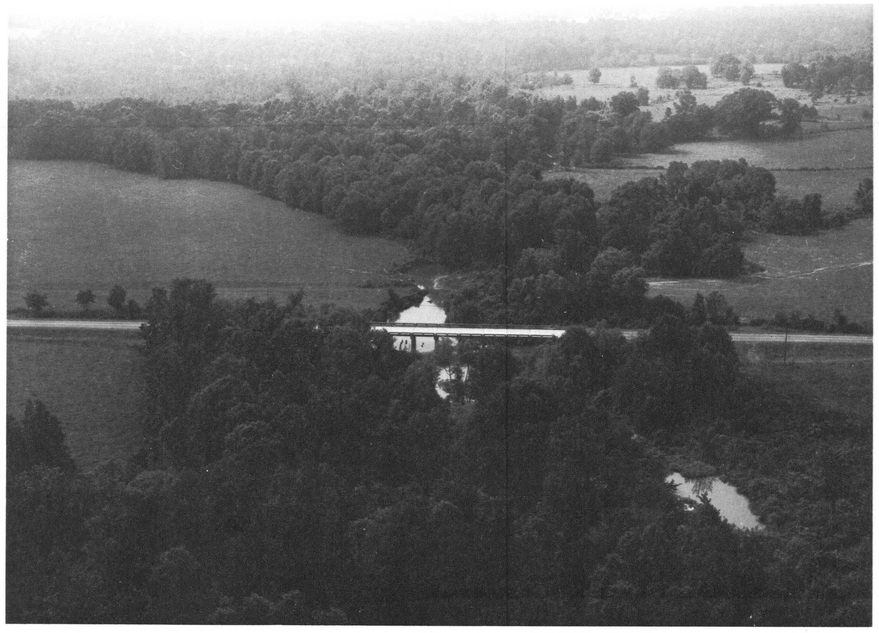

FIGURE 3—AERIAL VIEW LOOKING UPSTREAM AT BRIDGE ON STATE HIGHWAY 1049 NEAR KENTWOOD, LOUISIANA

SELECTED REFERENCES

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

Benson, M. A., and Dalrymple, T., 1967, General field and office procedures for indirect discharge measurements: U.S. Geological Survey Techniques Water-Resources Inv., book 3, chap. A1, 30 p.

Bradley, J. N., 1970, Hydraulics of bridge waterways: Federal Highway Admin., Hydraulic Design Ser. No. 1, 111 p.

Colson, B. E., and Hudson, J. W., 1976, Flood frequency of Mississippi streams: Mississippi State Highway Dept., 34 p.

Hains, C. F., 1973, Floods in Alabama, magnitude and frequency: Alabama Highway Dept., 37 p.

Hedman, E. R., 1964, Effects of spur dikes on flow through constrictions: Am. Soc. Civil Engineers Proc., Jour. Hydraulics Div., v. 91, no. HY4, July 1965, p. 155–165.

Matthai, H. F., 1967, Measurement of peak discharge at width contractions by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A4, 44 p.

Neely, B. L., Jr., 1976, Floods in Louisiana, magnitude and frequency, 3d ed.: Louisiana Dept. Highways, 340 p.

Schneider, V. R., Board, J. W., Colson, B. E., Lee, F. N., and Druffel, L., 1976, Computation of backwater and discharge at width constrictions of heavily vegetated flood plains: U.S. Geol. Survey Water-Resources Inv. 76–129, 64 p.

U.S. Water Resources Council, 1977, Guidelines for determining flood flow frequency: Washington, D.C., U.S. Water Resources Council Bull. 17A, 163 p.

TABLE 1—VALLEY CROSS SECTION DATA FOR BEAVER CREEK NEAR KENTWOOD, LOUISIANA, ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM)

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	64.85
5	64.63
17	64.05
18	63.78
62	63.72
76	63.20
120	62.74
124	62.56
125	61.28
127	60.94
130	61.25
132	62.04
158	63.69
173	63.47
178	62.16
180	60.52
182	62.13
194	63.20
217	62.99
223	62.83
234	62.77
240	62.99
251	63.32
255	63.35
263	63.02
268	62.86
275	63.14
282	63.69
321	64.15
336	63.99
344	63.93
361	63.90
367	63.69
373	63.63
411	63.57
454	63.72
468	63.75
470	63.32
475	63.78
535	63.96
564	64.02
600	64.69
606	65.03

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	65.88
57	61.55
60	60.94
62	61.55
62	62.74
65	63.47
80	63.63
85	63.23
91	63.63
108	63.66
109	63.69
123	63.14
126	62.62
128	62.53
131	62.56
134	63.14
151	62.65
155	62.41
160	62.86
178	63.63
207	63.78
289	64.02
290	64.08
299	64.48
306	64.66
378	64.94
414	65.12
476	64.94
516	65.09
545	65.52

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	65.88
2	65.55
30	63.54
43	63.54
49	63.14
58	63.14
60	63.69
68	63.87
75	63.63
80	63.05
80	62.13
81	61.80
83	63.08
85	63.90
100	63.69
112	63.78
130	63.90
135	63.78
147	63.69
184	63.93
206	64.15
233	63.72
238	63.11
240	62.83
260	63.93
283	64.36
307	64.94
312	65.27
388	65.33
437	65.33
487	65.43
516	65.97

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	66.07
27	65.09
64	64.36
87	64.24
112	64.57
135	64.24
147	64.05
154	63.87
160	62.35
171	61.74
183	62.35
187	63.35
189	65.24
211	64.57
251	64.85
273	65.00
293	64.97
317	64.60
333	64.51
340	63.99
379	64.33
399	64.08
418	64.45
433	64.51
453	65.00
475	65.12
506	65.43
525	65.64
556	66.16

BRIDGE SECTION

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	65.75
0	65.06
2	64.88
3	64.51
5	64.05
6	63.78
8	63.66
9	63.57
11	63.60
12	63.38
14	63.63
15	63.57
17	63.35
18	63.29
20	63.05
21	62.26
23	62.07
24	62.01
26	61.92
27	61.83
29	61.86
30	61.77
32	61.89
34	62.29
35	62.13
37	61.86
38	61.83
40	62.07
41	62.19
43	62.38
44	62.74
46	62.93
47	63.26
49	63.41
50	63.60
52	63.69
53	63.78
55	63.90
56	64.39
58	64.69
59	64.94
60	65.06
60	65.75

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	66.52
3	65.76
10	65.06
41	64.21
97	64.82
110	63.72
111	64.11
129	64.05
153	63.75
156	62.99
163	62.71
164	62.16
172	62.29
180	63.63
181	64.15
196	64.30
228	65.06
248	65.18
270	65.09
292	65.06
308	64.85
330	64.63
354	64.63
378	65.03
404	65.21
419	65.39
440	65.36
473	65.46
506	65.67
563	66.00
564	67.59

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	66.61
25	66.25
61	65.43
144	64.60
149	63.78
154	63.44
158	64.63
193	64.42
221	64.08
253	63.84
255	63.47
255	62.29
257	62.32
261	62.96
262	63.93
279	63.75
286	63.81
290	63.26
295	63.38
306	63.60
306	64.30
340	65.21
363	65.12
404	65.03
428	65.00
458	65.24
509	65.52
552	65.85
583	66.07
618	66.52
624	66.61

CROSS SECTION 7

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	66.67
5	66.46
12	65.97
26	65.09
80	64.91
107	65.36
119	64.27
123	62.90
129	62.47
136	64.51
140	64.45
144	64.05
149	64.57
165	64.60
167	64.82
203	65.18
215	65.18
218	65.18
222	65.18
230	65.18
241	65.18
248	65.18
254	65.18
276	65.33
288	65.18
296	65.06
299	63.75
302	63.87
314	64.08
329	65.52
335	63.84
335	64.11
344	64.11
347	64.08
378	64.54
381	64.60
406	63.69
415	65.09
439	65.39
446	65.21
453	65.27
511	66.19
550	66.71

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	67.35
2	67.13
11	66.03
40	66.03
71	66.07
86	66.00
107	65.94
158	65.85
180	65.00
191	64.97
211	63.69
216	64.82
219	63.81
225	62.44
229	64.24
235	64.85
243	65.12
250	64.48
264	65.46
268	65.21
274	64.05
284	63.96
289	66.03
308	66.46
324	66.67
333	66.77
365	66.58
391	66.49
470	66.55
477	66.46
540	66.46
546	66.55
558	66.71
575	67.16
582	67.28

TABLE 2—DISCHARGE MEASUREMENT MAY 22, 1974, BEAVER CREEK NEAR KENTWOOD, LOUISIANA. ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM)

(WATER-SURFACE ELEVATION=65.639 METERS)
TOTAL DISCHARGE=288 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
0.0	0.45	0	0.6	0.832
3.0	0.61	0	0.6	0.607
6.1	1.37	0	0.6	0.607
9.1	2.29	0	0.6	0.832
12.2	3.51	0	0.6	0.634
15.2	4.57	0	0.6	0.741
18.3	5.03	0	0.6	1.258
21.3	6.10	0	0.6	1.585
24.4	6.55	0	0.6	1.950
27.4	6.10	0	0.6	1.478
30.5	6.55	0	0.6	2.173
33.5	5.64	0	0.6	1.332
30.6	5.13	0	0.6	0.792
39.6	4.72	0	0.6	1.183
42.7	3.51	8	0.6	1.332
45.7	3.66	16	0.6	1.783
48.8	3.20	25	0.6	0.832
51.8	1.22	0	0.6	1.664
57.9	0.45	0	0.6	1.332
59.4	0.23	0	0.6	0.664

[1]Observation depth is the ratio of the velocity—observation depth to the total depth at the station.

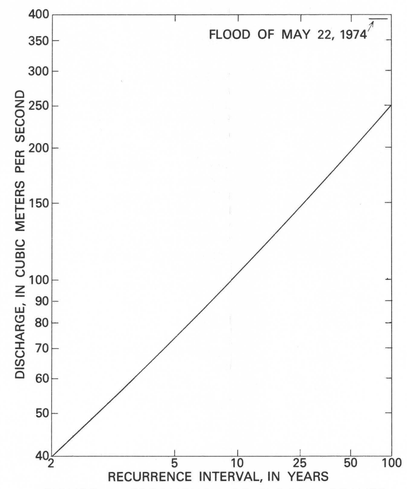

FIGURE 4—FREQUENCY OF FLOODS, BEAVER CREEK NEAR KENTWOOD, LOUISIANA

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