DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, CYPRESS CREEK NEAR DOWNSVILLE, LOUISIANA

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

HYDROLOGIC INVESTIGATIONS ATLAS
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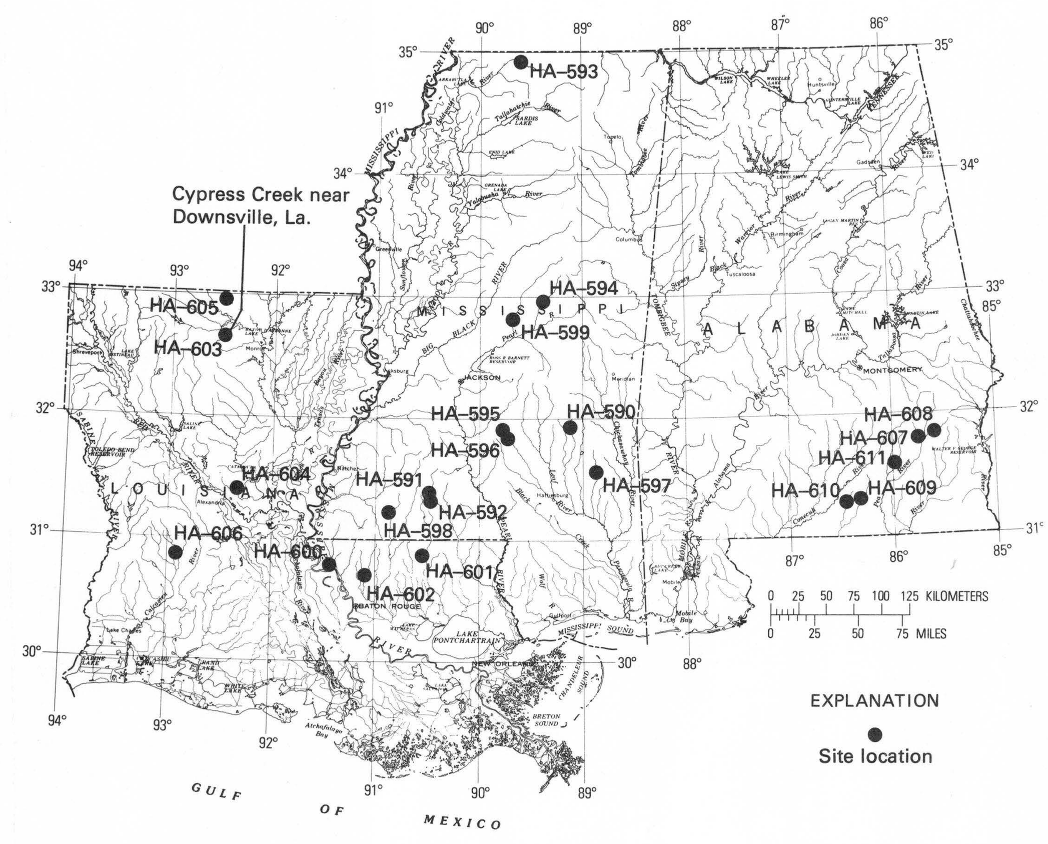

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

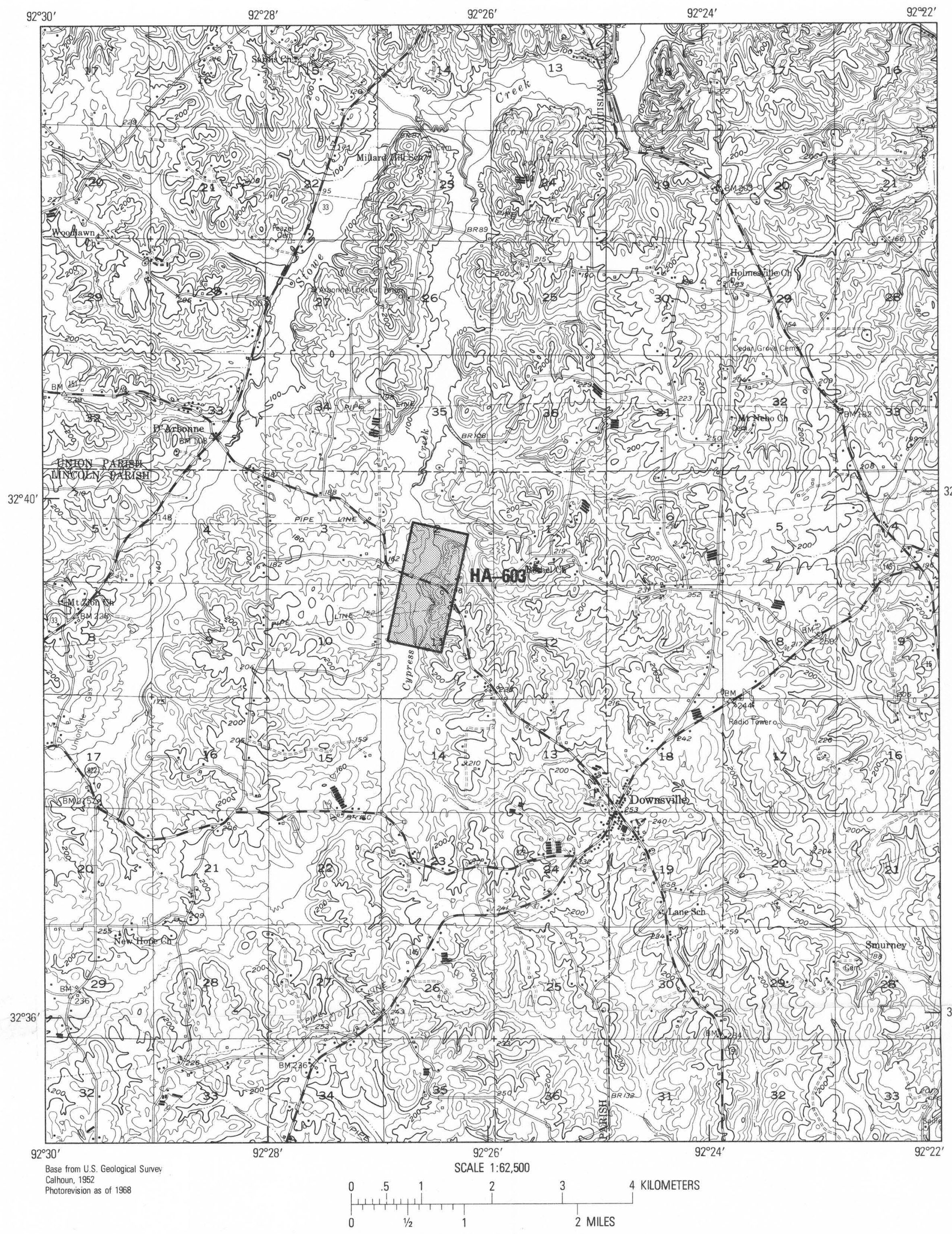

FIGURE 2—INDEX MAP OF STUDY REACH, CYPRESS CREEK NEAR DOWNSVILLE, LOUISIANA.

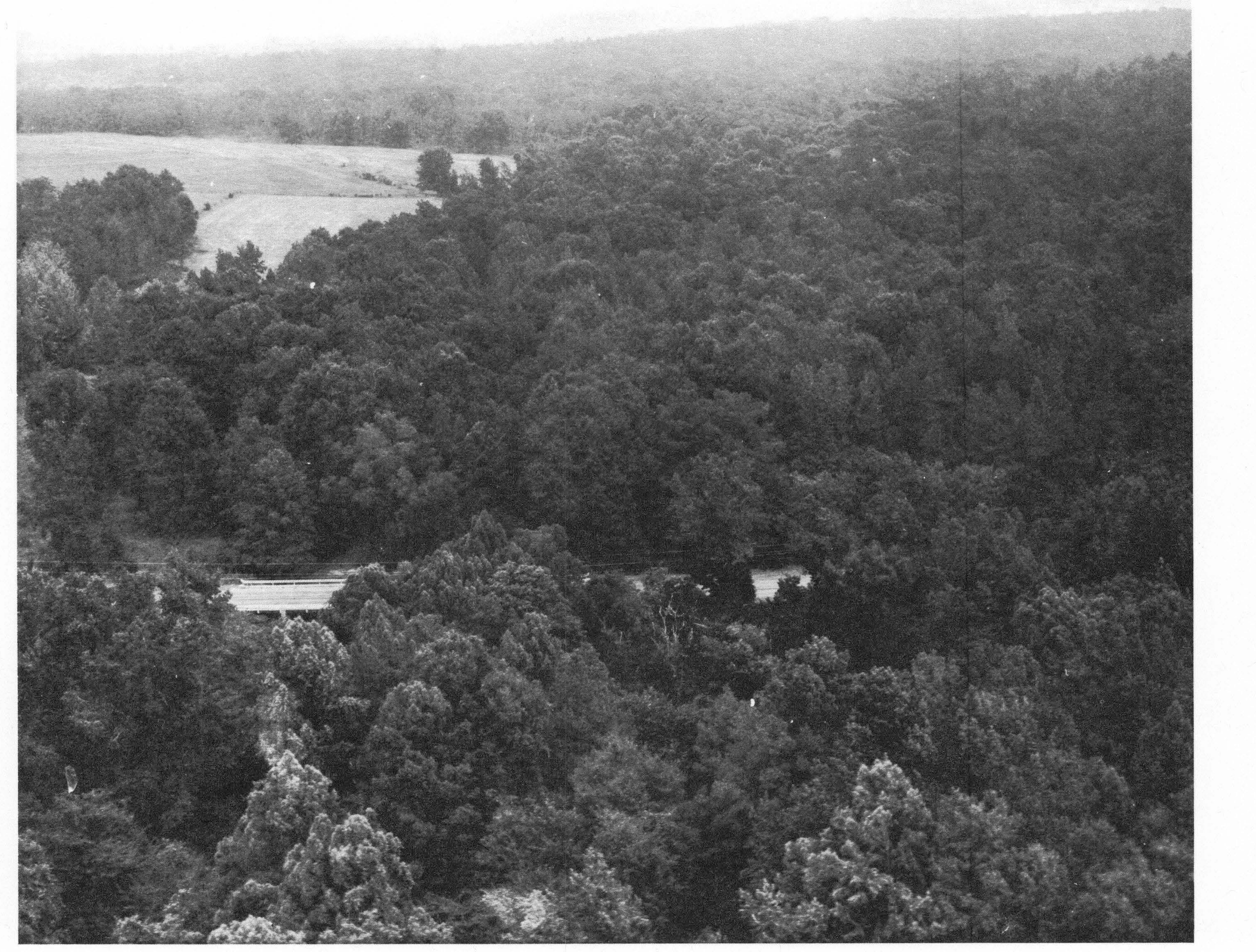

FIGURE 3—AERIAL VIEW LOOKING UPSTREAM AT BRIDGE ON STATE HIGHWAY 151, CYPRESS CREEK NEAR DOWNSVILLE, LOUISIANA.

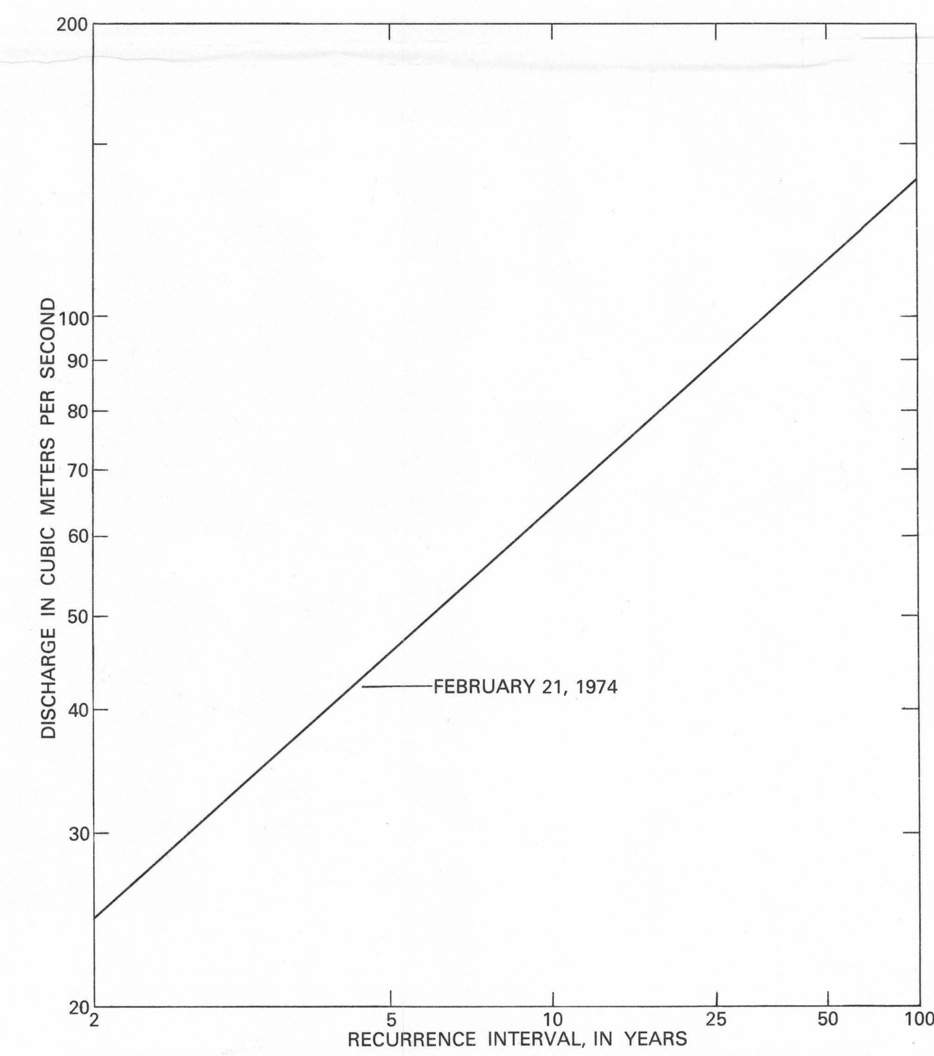

FIGURE 4—FREQUENCY OF FLOODS, CYPRESS CREEK NEAR DOWNSVILLE, LOUISIANA.

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS CYPRESS CREEK NEAR DOWNSVILLE, 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 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.

Backwater data were obtained at 22 sites for 35 floods; that is, 11 sites had 1 flood each; 9 sites, 2 floods each; and 2 sites, 3 floods each. Analysis of data (Schneider 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.

The data sites (fig. 1) are listed below. This atlas shows flood data obtained on Cypress Creek near Downsville, Louisiana, one of the 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 Tarentum 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

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 seven 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 downstreams 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. The values shown are based on water depth. The high value is the value where water depth is less than 0.6 meter and the low value applies where water depth is greater than 1.0 meter. A linear relation of roughness to water depth is assumed for water depths between 0.6 and 1.0 meter.

PRESENTATION OF DATA

The data are presented 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 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 CYPRESS CREEK NEAR DOWNSVILLE, LOUISIANA

Data for Cypress Creek near Downsville, La., obtained in a 1,400-meter reach crossed about midway by State Highway 151 are presented on three sheets (fig. 2). 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 of the reach in the vicinity of the bridge is shown in figure 3. Relative magnitude of the flood is shown on the frequency curve (fig. 4).

The locations of representative ground elevations are shown on sheet 2. These are points of significant changes in cross-section elevations and alinement of the axis. Plots of the cross-sections 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 upstream side of the bridge is tabulated on sheet 1. The cross section shown for velocity distribution was obtained by sounding from the upstream side of the bridge during the discharge measurement.

Data for the flood of February 21, 1974, are presented. Eight valley cross sections were surveyed after this flood (sheet 2).

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

FLOOD OF FEBRUARY 21, 1974

Peak water-surface elevations, measured cross section, and velocities for the flood of February 21, 1974, are shown on sheet 3. The flood crested at an elevation of 35.012 meters at the reference point located on the upstream guardrail 23 meters from the left abutment. The peak discharge was 42.5 cubic meters per second, from a stage-discharge relation developed for the site. A discharge of 42.2 cubic meters per second (table 2) was measured at an elevation of 35.005 meters, 0.007 meters below the crest elevation. The measured cross section and velocity distribution are shown on sheet 3. The recurrence interval of the peak discharge is 4 years (Neely, 1976). See figure 4.

SUMMARY

Floodflow 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 Cypress Creek near Downsville, La. Water depths, velocities, and discharges through bridge openings on Cypress Creek near Downsville, La., for the flood of February 21, 1974, shown, together with peak water surface elevations along embankments and along cross sections. Manning's roughness coefficient values in different parts of the flood plain are shown on a map, and flood-frequency relations are shown on a graph.

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

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. Geol. 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.

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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 CYPRESS CREEK NEAR DOWNSVILLE, LOUISIANA. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM).

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	34.45
11	33.60
18	33.26
21	32.83
22	32.68
24	32.95
30	33.14
36	33.14
47	32.92
61	33.11
73	33.35
84	33.17
89	33.08
95	32.68
96	32.28
98	31.67
99	31.37
100	32.28
100	32.77
103	33.23
109	33.20
121	33.23
132	32.92
149	32.89
155	32.77
169	33.17
176	33.05
185	33.23
194	33.17
203	33.44
206	34.69

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	34.81
4	34.60
15	33.84
30	33.66
46	33.72
58	33.84
60	32.62
64	31.92
68	33.41
82	33.60
88	32.53
101	33.69
111	33.20
114	32.53
119	31.89
126	32.53
136	33.72
180	33.44
184	32.47
188	33.50
203	33.66
212	33.38
228	33.38
233	33.38
236	33.08
242	33.50
256	33.72
265	34.02
274	34.88

CROSS SECTION 3 (con't. continued)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.45
8	34.97
20	34.30
30	33.84
42	34.14
47	34.11
52	31.98
53	32.86
58	34.02
73	33.81
96	33.96
103	34.02
128	33.87
148	33.90
151	32.80
155	33.69
161	33.29
166	33.75
170	33.78
173	33.17
176	33.53
184	33.72
194	34.11
204	33.87
209	33.60
212	34.05
233	34.11
255	35.09
258	35.42

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.30
6	34.88
12	34.51
28	34.20
36	34.11
46	33.78
49	33.75
55	34.20
71	34.30
78	33.63
79	32.99
82	32.56
83	33.72
84	33.96
87	34.39
94	34.51
112	34.36
121	34.36
130	33.32
135	33.69
139	33.87
143	33.53
144	33.29
146	33.41
148	34.42
149	34.57
155	34.51
167	34.48
174	34.66
180	35.27
183	35.58

BRIDGE SECTION

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	36.55
0	36.31
2	35.88
3	35.85
3	34.81
5	34.36
6	34.08
8	34.08
9	34.20
11	34.20
12	34.17
14	34.11
15	34.05
17	33.69
18	33.44
20	33.56
21	33.69
22	33.66
22	33.08
23	32.95
24	32.99
24	33.23
25	33.23
26	33.11
27	33.20
28	33.56
29	33.75
30	34.33
32	34.39
34	34.33
35	34.27
37	34.57
38	35.00
38	35.58
39	35.94
40	36.34
40	36.34
40	36.83

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.70
6	35.42
13	35.24
22	35.03
23	34.63
24	35.12
31	34.97
45	34.84
66	34.81
67	34.81
75	34.72
78	34.57
82	34.69
92	34.66
106	34.63
111	34.51
115	34.48
119	34.51
133	34.30
147	34.02
161	34.24
174	34.39
176	34.02
182	33.84
187	34.02
201	34.20
208	33.05
211	33.63
212	34.05
217	33.99
222	33.81
224	34.24
236	34.24
237	33.66
241	33.23
243	33.66
243	34.27
248	34.57
255	33.66
260	35.33
267	36.70

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	36.16
5	35.36
25	35.09
29	34.91
37	35.00
46	34.78
55	34.81
65	34.66
73	34.51
82	34.54
89	34.75
93	34.69
97	34.48
138	34.24
154	34.24
167	34.30
173	33.38
176	34.30
192	34.36
205	34.54
211	33.26
217	34.42
228	34.51
230	33.50
242	34.20
250	34.48
266	34.54
280	34.60
282	33.53
287	33.84
290	34.42
292	35.27
301	36.25

CROSS SECTION 7 (con't). continued

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	36.19
20	35.55
41	35.12
61	35.12
77	34.63
82	34.60
103	34.57
121	34.54
133	34.78
136	33.99
140	34.63
153	34.57
172	34.51
192	34.60
221	34.81
244	34.84
262	34.75
294	34.97
308	35.12
320	34.81
324	33.99
327	34.94
329	36.58

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.88
10	35.33
15	35.24
18	34.97
19	34.75
23	34.33
29	34.36
31	34.81
34	35.24
40	35.30
51	35.06
66	34.97
91	34.81
136	35.27
145	35.12
179	35.00
198	35.00
215	35.24
232	35.21
247	35.21
256	34.97
257	34.54
260	34.02
261	34.54
262	35.18
264	35.18
273	35.82
276	36.58

CROSS SECTION 9

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	36.98
9	36.64
15	36.34
22	35.70
29	35.91
31	34.75
33	33.63
38	35.85
48	35.91
62	36.00
80	35.67
86	35.12
88	35.73
99	35.64
148	35.91
172	36.03
206	36.00
207	34.91
212	34.20
216	36.06
219	36.16
232	35.76
237	34.91
238	34.75
243	36.00
255	36.03
265	36.37
271	37.22

TABLE 2—DISCHARGE MEASUREMENT FEBRUARY 21, 1974, CYPRESS CREEKNEAR DOWNSVILLE, LOUISIANA. ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM).

DISCHARGE MEASUREMENT FEBRUARY 21, 1974, CYPRESS CREEK NEAR DOWNSVILLE, LA. (WATER-SURFACE ELEVATION=35.005 METERS) TOTAL DISCHARGE=42.2 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
3.0	0.0	0	0.0	0.0
4.6	0.61	36	0.5	0.527
6.1	0.91	36	0.6	1.478
7.6	0.88	31	0.5	1.298
9.1	0.85	31	0.5	1.113
10.7	0.82	25	0.5	1.067
12.2	0.85	18	0.5	1.213
13.7	0.94	18	0.6	1.158
15.2	0.94	11	0.6	1.045
16.8	1.49	0	0.6	0.933
18.3	1.52	0	0.6	0.655
19.8	1.49	0	0.6	1.134
21.3	1.74	0	0.6	1.213
22.9	2.07	0	0.6	1.298
24.4	2.04	0	0.6	1.000
25.9	1.74	0	0.6	0.954
27.4	1.77	18	0.6	1.298
29.0	1.80	25	0.6	1.298
30.5	1.01	25	0.6	1.268
32.0	0.64	25	0.5	1.241
33.5	0.70	18	0.5	1.045
35.1	0.76	18	0.5	1.134
36.6	0.61	18	0.5	1.134
37.5	0.0	0	0.0	0.0

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

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