ATLAS HA-602

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, COMITE RIVER NEAR OLIVE BRANCH, LOUISIANA

By George J. Arcement, B. E. Colson, and C. O. Ming

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, 1978
W

ARCEMENT, COLSON, AND MING—BACKWATER, BRIDGES, AND FLOOD PLAINS, OLIVE BRANCH, LA. ATLAS HA-602

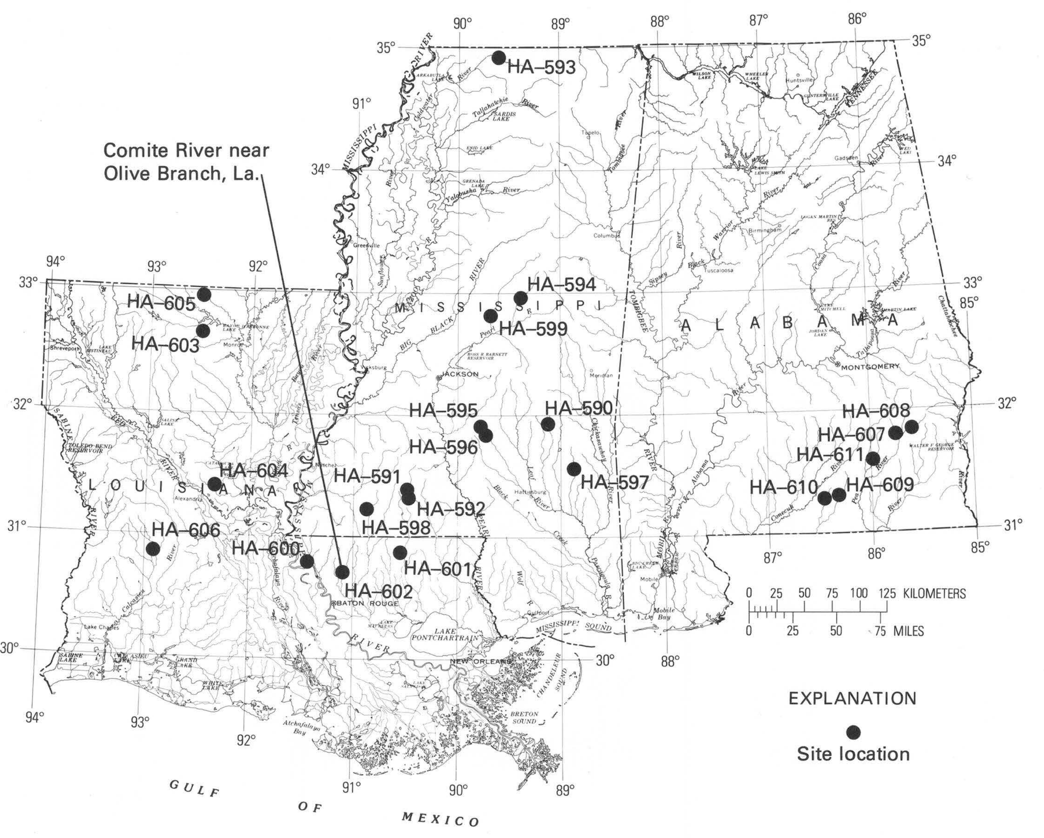

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

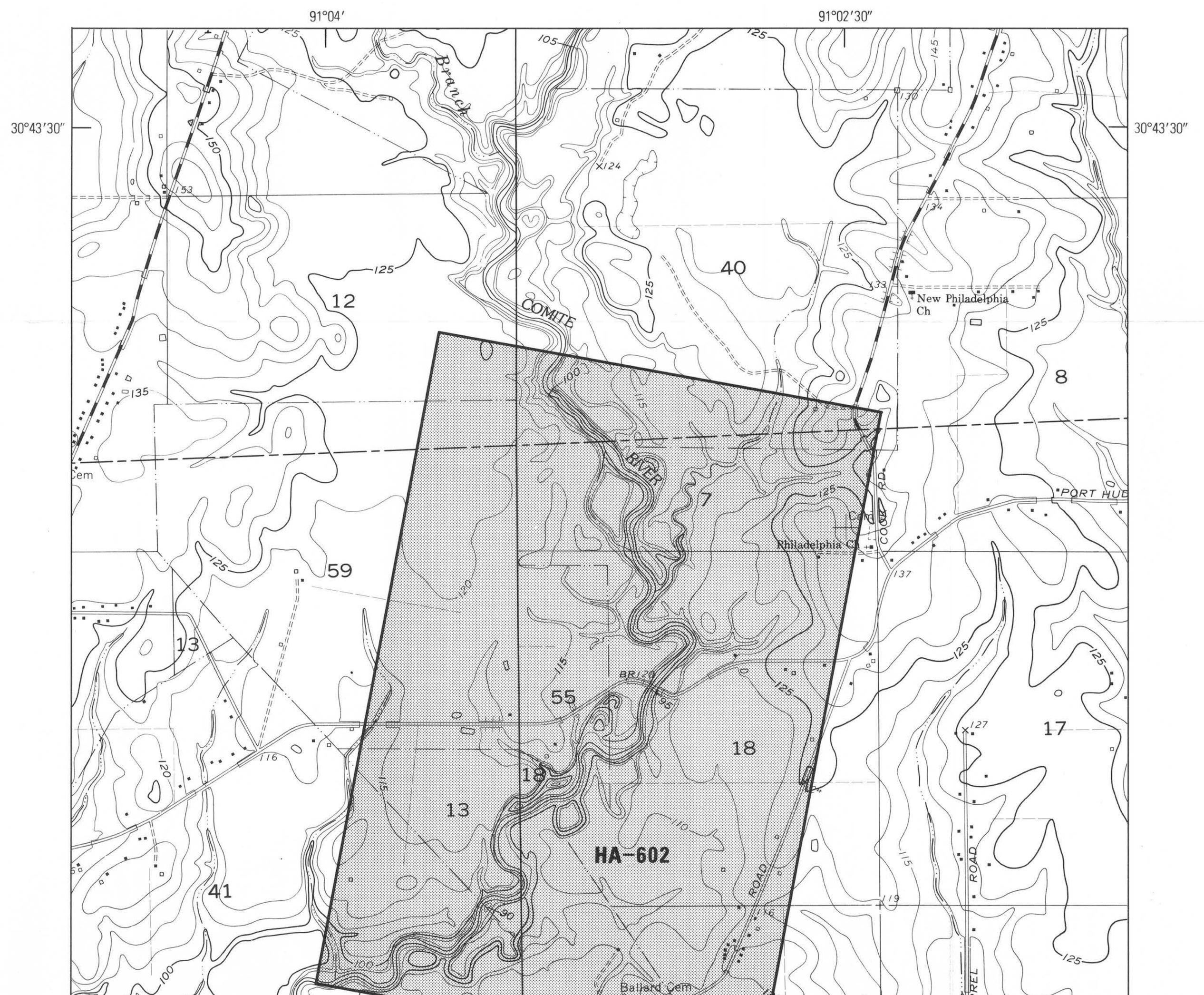

FIGURE 2—INDEX MAP SHOWING STUDY REACH COMITE RIVER NEAR OLIVE BRANCH, LOUISIANA

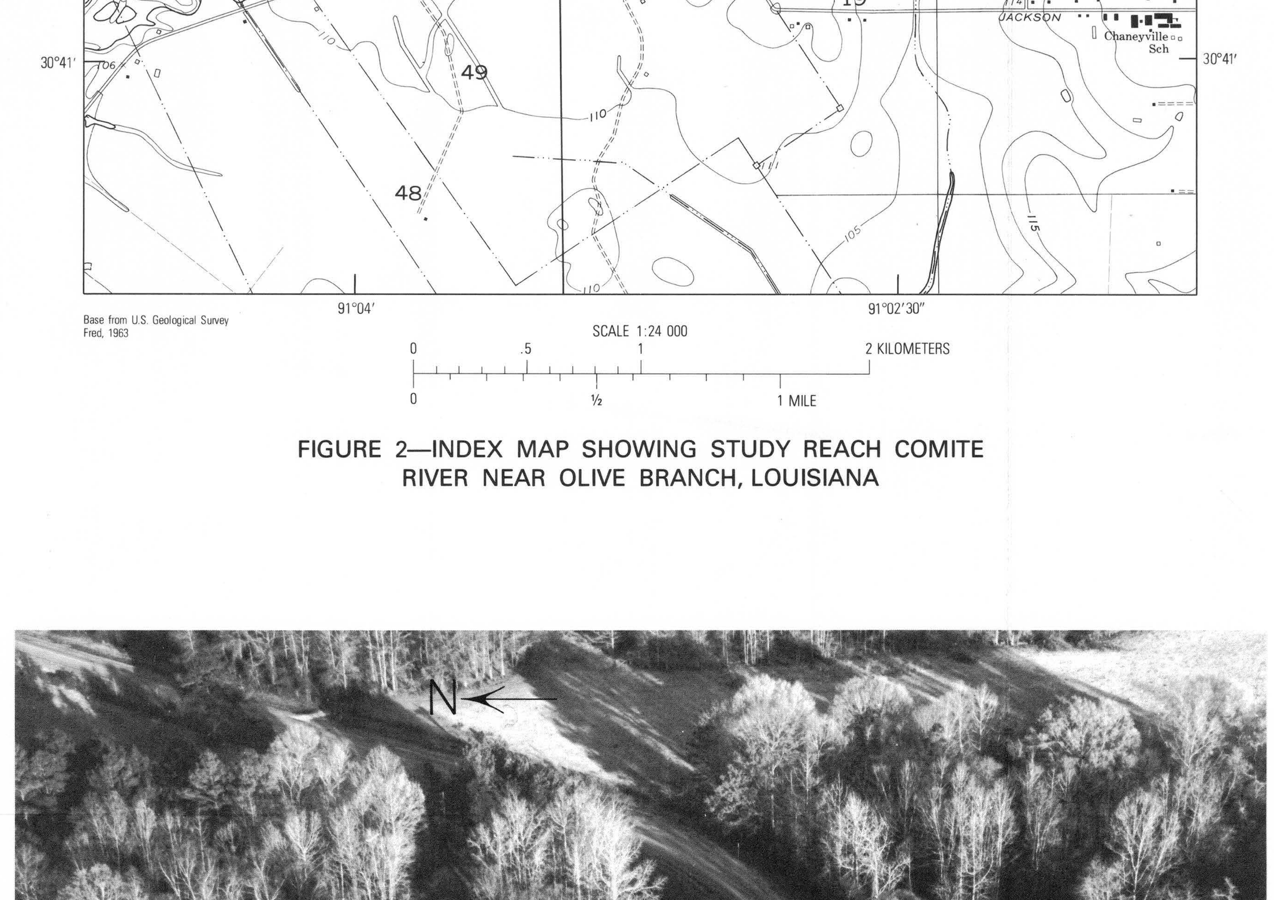

FIGURE 3—AERIAL VIEW LOOKING EASTWARD AT BRIDGE ON STATE HIGHWAY 866, NEAR OLIVE BRANCH, LOUISIANA

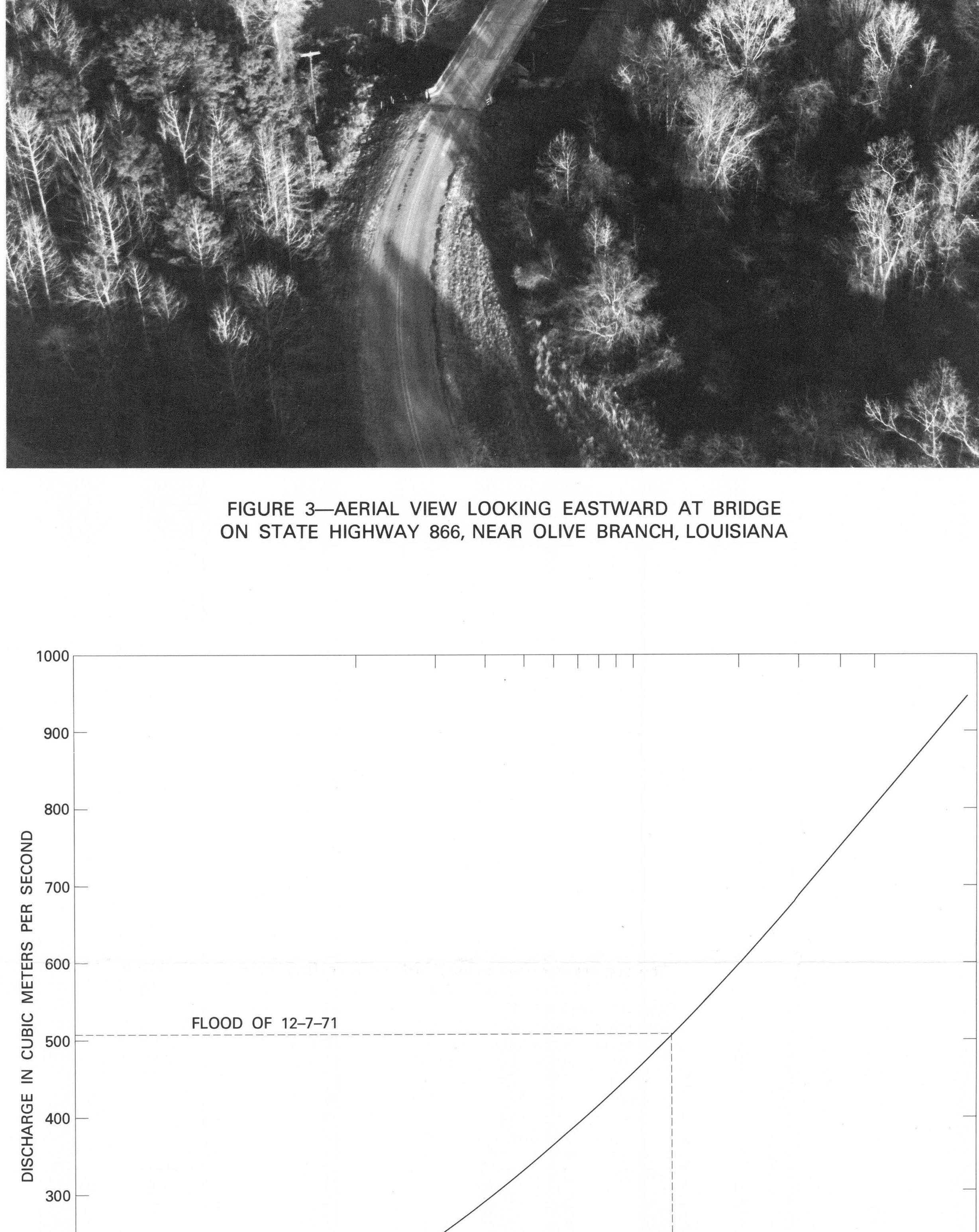

FIGURE 4—FREQUENCY OF FLOODS, COMITE RIVER NEAR OLIVE BRANCH, LOUISIANA

FLOOD-FLOW DATA COMITE RIVER NEAR OLIVE BRANCH, 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 (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. This atlas shows flood data obtained at Comite River near Olive Branch, La., one of 22 sites plotted in figure 1:

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 presented on topographic maps enlarged from standard 1:24,000 (or 1:62,500) scale 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 COMITE RIVER NEAR OLIVE BRANCH

Data for Comite River near Olive Branch obtained in a reach extending 1,400 meters downstream and 1,200 meters upstream of State Highway 866, are presented on three sheets (fig. 2). Sheet 1 contains tables showing cross-section data (table 1) and discharge data (table 2). An aerial view of the reach in the vicinity of State Highway 866 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 December 7, 1971, are presented. Ten valley cross sections were surveyed after this flood and additional ground elevations were surveyed in the vicinity of the bridge (sheet 2).

Manning's roughness coefficient values and the 1971 flood boundaries are shown on sheets 2 and 3.

FLOOD OF DECEMBER 7, 1971

Peak water-surface elevations, measured cross section, and velocities for the flood of December 7, 1971, are shown on sheet 3. The flood crested at an elevation of 34.156 meters at the reference point located on the downstream guardrail 39 meters from the left abutment. The peak discharge was 518 cubic meters per second, from a stage-discharge relation developed for the site. A discharge of 474 cubic meters per second was measured including 27 cubic meters per second over the highway embankment at an elevation of 34.034 meters at the reference point (table 2). The recurrence interval of the peak discharge is 14 years (Neely, 1976, fig. 3).

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 Comite River near Olive Branch, La. Water depths, velocities, and discharge through bridge openings for the flood of December 7, 1971, on the Comite River near Olive Branch 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 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. 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 COMITE RIVER NEAR OLIVE BRANCH, LOUISIANA. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM)

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	33.13
16	32.58
37	32.13
63	31.91
74	31.06
116	30.33
117	31.09
120	30.21
124	29.78
125	31.21
127	31.42
128	31.88
132	32.25
154	32.06
190	31.61
201	31.58
213	32.13
257	32.40
265	32.25
296	32.37
317	32.40
325	29.26
334	28.68
355	27.71
376	28.62
377	29.26
381	29.81
384	32.46
418	32.49
479	32.25
539	32.00
576	32.31
596	33.01

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	33.19
29	32.40
160	32.28
197	32.22
200	31.09
205	30.75
207	29.26
210	29.26
214	32.46
334	32.77
430	32.49
436	31.21
453	30.60
461	29.32
483	29.41
489	30.36
506	30.54
517	30.27
522	30.85
529	31.06
544	30.82
552	31.15
573	31.67
588	31.88
605	32.10
632	31.97
636	31.46
640	31.85
652	32.00
654	30.72
657	29.17
674	28.25
695	29.17
697	33.50
698	35.08

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	33.77
43	32.55
46	31.88
49	31.67
51	33.01
87	33.38
118	32.52
126	31.09
133	31.09
138	31.58
151	33.89
196	33.07
262	33.07
272	29.05
300	28.13
330	29.29
338	28.99
360	33.13
395	33.07
418	32.46
436	33.99

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	34.11
4	33.99
11	32.98
15	33.38
16	33.28
20	31.33
21	31.24
27	29.54
47	29.29
51	28.80
66	27.89
81	28.80
105	31.61
141	31.55
172	30.91
190	30.69
198	32.06
201	32.34
203	30.05
205	32.34
207	31.76
224	31.06
244	30.91
256	29.90
271	29.90
311	33.28
328	32.80
335	32.83
344	32.74
357	32.98
369	33.04
381	33.80
390	34.38

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	34.63
20	33.41
25	32.80
64	33.44
83	34.87
97	28.59
114	27.68
131	28.77
131	31.97
147	30.91
157	33.59
192	33.62
209	33.50
287	33.99
311	33.22
326	33.86
358	34.23
437	33.44
440	33.19
449	33.80

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	34.78
3	33.95
8	33.16
22	33.68
25	32.49
27	31.03
28	28.68
42	27.77
56	28.71
63	31.27
66	33.50
91	31.85
99	31.46
109	33.77
121	33.89
170	33.83
179	33.62
211	33.35
231	33.71
279	33.89
331	34.41

CROSS SECTION 6 (Cont.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
348	34.32
398	33.95
425	33.86
450	33.99
452	33.44
453	32.83
456	32.83
458	33.47
460	33.95
470	33.95
479	33.44
489	33.95
490	33.47
503	33.95
523	34.26
549	34.53

CROSS SECTION 7

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.05
4	31.79
6	28.77
23	27.86
40	28.86
45	31.85
73	33.71
163	33.83
192	33.92
209	33.44
243	32.40
250	33.25
256	33.59
265	33.99
280	33.38
297	33.22
301	34.14
316	34.32
336	33.89
348	32.58
354	32.92
363	32.22
368	32.58
371	33.53
494	33.77
496	33.13
505	33.47
508	33.71
514	33.92
519	34.59
549	35.20

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	34.93
91	33.89
130	34.23
142	32.43
149	33.53
160	33.62
160	29.54
169	28.62
178	29.41
191	30.60
210	31.82
280	32.46
262	32.06
291	31.70
318	31.09
321	33.68
355	33.41
367	34.32
370	34.93

CROSS SECTION 9

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.27
12	34.66
24	34.05
46	33.92
62	34.02
110	33.99
124	32.95
135	33.04
144	33.86
158	33.99
188	33.01
195	32.95
200	31.24
201	30.94
204	31.94
213	32.52
224	33.10
255	33.92
287	34.23
332	34.20
340	32.92
341	29.78
351	28.86
361	29.78
419	32.83
450	31.97
466	30.78
478	31.61
480	33.80
486	32.25
489	33.62
515	33.41
520	33.25
536	34.29
541	34.32
575	34.14
600	33.53
604	32.40
611	31.91
619	35.63

CROSS SECTION 10

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.08
8	33.99
24	34.11
67	34.99
76	33.13
101	33.10
107	33.65
111	34.84
137	34.35
174	34.59
178	31.15
179	30.60
199	29.69
221	30.60
224	32.92
240	33.47
248	33.19
263	34.69
270	34.26
272	34.66
277	35.33

CONTRACTED OPENING AT UPSTREAM SIDE OF BRIDGE. ZERO STATION AT THE LEFT ABUTMENT (FACING DOWNSTREAM)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	35.81
0	35.30
3	34.17
6	33.13
8	32.43
10	31.70
12	30.69
15	28.74
17	28.19
19	27.74
21	27.43
24	26.82
27	26.27
30	25.91
31	25.97
31	28.59
33	28.59
34	28.59
37	28.59
37	26.70
40	26.40
43	27.58
46	28.29
48	29.99
50	31.15
52	32.28
55	32.49
58	32.92
59	33.28
61	33.59
64	34.17
67	35.63
67	35.81

TABLE 2—DISCHARGE MEASUREMENT OF DECEMBER 7, 1971, ON COMITE RIVER AT STATE HIGHWAY 866 NEAR OLIVE BRANCH, LOUISIANA, (WATER-SURFACE ELEVATION=34.034 METERS), FLOW THROUGH BRIDGE=447 CUBIC METERS PER SECOND, OVERFLOW RIGHT OF BRIDGE=28.6 CUBIC METERS PER SECOND, TOTAL DISCHARGE=474 CUBIC METERS PER SECOND. ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM)

FLOW THROUGH BRIDGE

STATION (METERS)	DEPTH (METERS)	ANGLE (COEFFICIENT)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
3.0	0.0	0	0.0	0.0
6.1	1.01	0	0.6	0.567
9.1	1.98	0	0.6	0.786
12.2	3.44	0	0.6	0.567
15.2	5.36	0	0.6	1.247
18.3	6.31	0	0.6	1.865
21.3	6.71	0	0.6	2.530
24.4	7.32	0.16	0.6	2.679
27.4	7.80	0.19	0.6	2.679
30.5	8.26	0	0.6	2.393
33.5	7.80	0	0.6	2.280
36.6	7.32	0	0.6	2.164
39.6	7.77	0	0.6	1.637
42.7	6.55	0	0.6	2.231
45.7	5.85	0	0.6	1.612
48.8	3.44	0	0.6	0.988
51.8	1.89	0	0.6	0.533
54.9	1.62	0	0.6	0.469
57.9	1.16	0	0.6	0.567
61.0	0.52	0	0.6	0.326
63.4	0.0	0	0.0	0.0

OVERFLOW RIGHT OF BRIDGE

STATION (METERS)	DEPTH (METERS)	ANGLE (COEFFICIENT)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
253.0	0.0	0	0.0	0.0
292.6	0.12	0	0.6	1.201
373.7	0.12	0	0.6	1.250
413.9	0.15	0	0.6	0.902
454.2	0.15	0	0.6	0.634
494.7	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

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1978—W78438

For sale by Branch of Distribution, U.S. Geological Survey 1200 South Eads Street, Arlington, VA 22202 and Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225