BACKWATER AT BRIDGES AND DENSELY WOODED
FLOOD PLAINS, FLAGON BAYOU NEAR
LIBUSE, 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
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HYDROLOGIC INVESTIGATIONS
ATLAS HA-604   SHEET 1

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

EXPLANATION
• Site location

FIGURE 2—INDEX MAP SHOWING STUDY REACH, FLAGON BAYOU NEAR LIBUSE, LOUISIANA

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS
FLAGON CREEK NEAR LIBUSE, 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 of field information 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 Flagon Bayou near Libuse, 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*

*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. 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 black 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.

MULTIPLY SI UNITS	BY	TO OBTAIN U.S. CUSTOMARY UNITS
LENGTH		
Meter (m)	3.281	Feet (ft)
AREA		
Square meter (m²)	10.76	Square feet (ft²)
VOLUME		
Cubic meter (m³)	35.31	Cubic feet (ft³)
VELOCITY		
Meter per second (m/s)	3.281	Feet per second (ft/s)
FLOW RATE		
Cubic meter per second (m³/s)	35.31	Cubic feet per second (ft³/s)

DATA FOR FLAGON BAYOU NEAR LIBUSE, LOUISIANA

Data for Flagon Bayou near Libuse obtained in a 4.6-kilometer reach crossed about midway by State Highway 116 are presented on 5 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 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 sheets 2A and 2B. These are points of significant changes in cross-section elevations or 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 2A 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 upstream side of the bridge during the discharge measurement.

Data for the flood of December 7, 1971, are presented. Eleven valley cross sections were surveyed after this flood (sheets 2A and 2B).

Manning's roughness coefficients and the 1971 flood boundaries are shown on sheets 2A, 2B, 3A, and 3B.

FLOOD OF DECEMBER 7, 1971

Peak water-surface elevations, measured cross section, and velocities for the flood of December 7, 1971, are shown on sheets 3A and 3B. The flood crested at an elevation of 23.308 meters at the reference point located on the downstream guardrail 34 meters from the left abutment. The peak discharge was 134 cubic meters per second, from a stage-discharge relation developed for the site. A discharge of 132 cubic meters per second was measured at an elevation of 23.265 meters at the reference point (table 2). The recurrence interval of the peak discharge is 4 years (Neely, 1976). 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 discharge 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 Flagon Bayou near Libuse, Louisiana. Water depths, velocities, and discharge through the bridge openings for the flood of December 7, 1971, on Flagon Bayou near Libuse 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
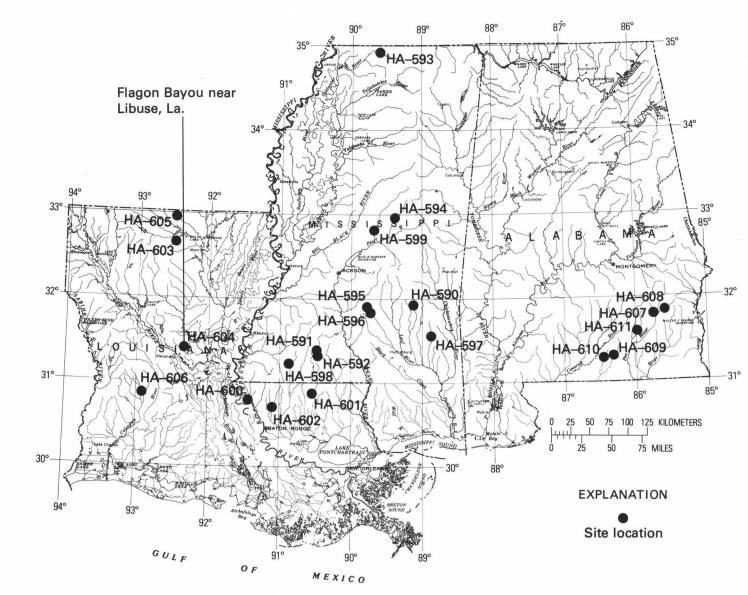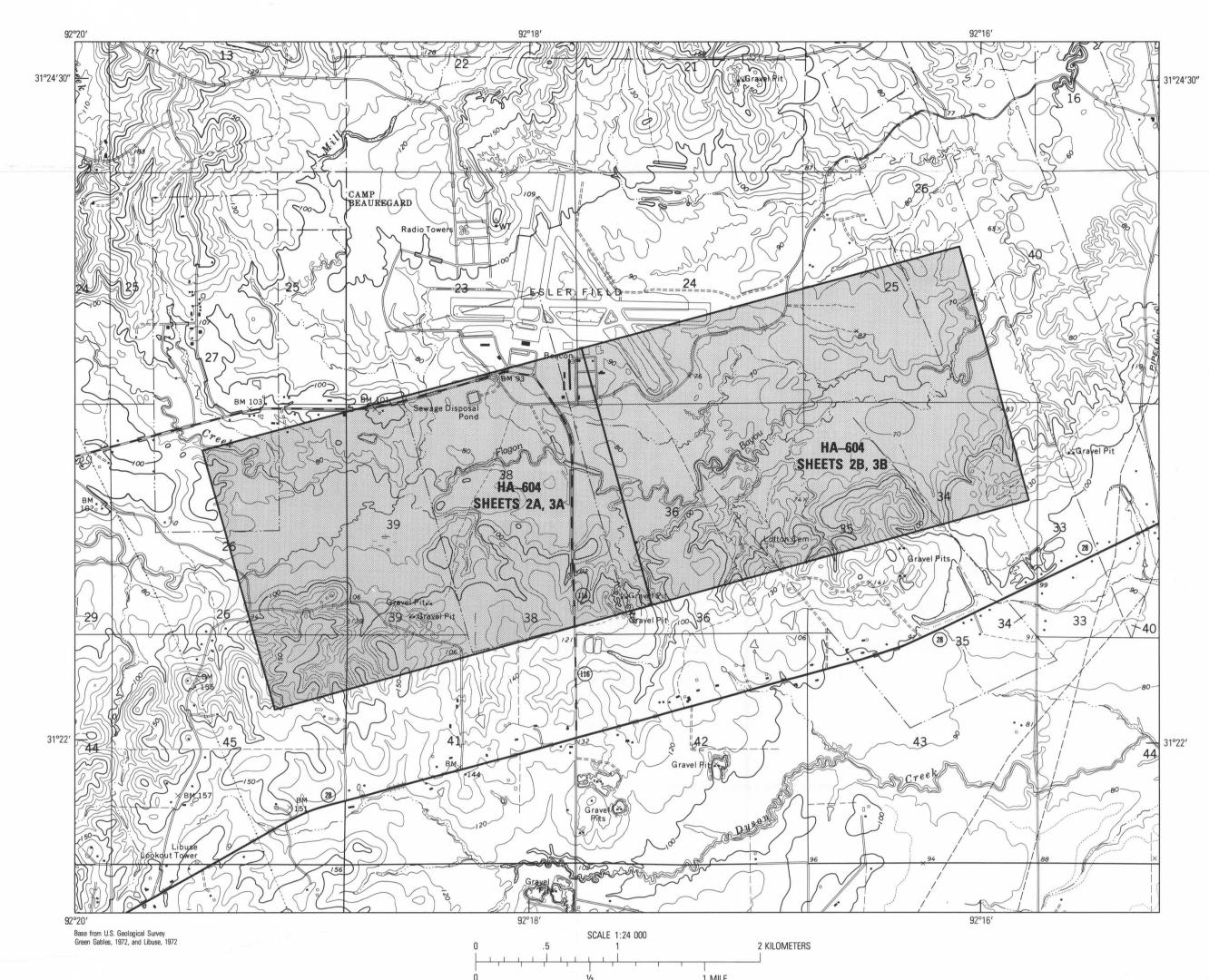Jackson, Mississippi 39206

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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.

FIGURE 3—AERIAL VIEW LOOKING UPSTREAM AT BRIDGE ON STATE HIGHWAY 116 NEAR LIBUSE, LOUISIANA

FIGURE 4—FREQUENCY OF FLOODS, FLAGON BAYOU NEAR LIBUSE, LOUISIANA

TABLE 1—VALLEY CROSS SECTION DATA FOR FLAGON BAYOU NEAR LIBUSE, LOUISIANA. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM).

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	20.02
4	19.45
9	18.81
15	18.81
19	18.50
23	18.81
30	19.72
39	18.56
48	19.06
89	17.40
92	19.90
123	19.75
141	19.69
166	19.72
206	19.90
227	20.06
271	19.87
288	19.45
289	18.53
291	17.71
294	18.53
296	19.42
352	19.99
365	20.24
390	21.15
397	21.37
400	21.52

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	21.72
12	21.43
20	20.42
24	19.42
30	20.21
37	19.42
48	21.15
55	20.85
61	20.82
91	22.25
102	19.51
108	21.82
113	20.45
118	20.39
122	20.20
140	20.76
154	20.79
183	20.21
189	19.51
197	19.93
203	20.82
210	20.96
233	20.76
237	18.26
243	17.25
249	18.17
255	19.75
256	20.60
258	21.00
263	21.03
276	20.67
293	20.67
311	20.97
321	20.72
335	21.43
351	21.03
376	20.60
408	20.51
435	18.99
437	18.38
439	18.99
441	20.42
449	21.46
453	21.67

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	21.39
18	21.61
36	21.58
41	20.79
47	19.87
53	20.79
71	20.79
91	21.64
102	21.93
126	21.48
164	21.51
242	21.36
292	21.24
304	20.82
309	21.54
317	19.91
335	20.67
340	21.18
363	21.46
378	21.55
408	21.49
422	21.49
454	21.85
457	20.97
464	20.30
474	20.15
476	21.18
537	20.98
574	20.62

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	23.34
15	23.23
20	23.06
91	22.52
113	22.37
123	23.83
129	23.23
134	22.56
142	22.10
146	21.75
156	21.82
190	21.88
194	21.09
201	21.37
207	20.76
215	21.34
239	21.49
240	20.73
243	19.84
257	20.33
258	20.85
261	21.76
264	22.30
274	22.34
296	22.34
321	22.10
333	21.81
351	22.19
365	22.22
376	21.49
408	21.46
409	20.82
410	20.85
418	21.79
424	21.60
460	21.58
478	21.60
490	22.22
498	22.82

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	21.48
44	21.48
60	21.70
78	22.10
96	22.42
105	22.01
114	21.67
158	21.85
169	21.88
197	21.95
200	18.14
202	18.90
206	19.23
209	20.21
213	19.81
220	20.09
224	18.32
235	21.52
241	22.65
258	22.01
276	22.20
284	21.00
297	22.65
343	21.55
350	20.33
355	19.29
356	20.12
369	20.28
383	22.06
418	22.34
448	22.19
474	21.97
501	21.73
532	21.88
536	21.76
540	20.76
542	19.84
543	20.76
548	23.64

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	22.97
30	22.07
45	21.97
120	22.43
139	22.77
148	22.45
151	22.46
154	22.30
160	22.83
167	22.43
170	20.48
173	20.56
176	20.15
179	19.14
182	17.83
185	17.56
188	17.56
191	17.31
194	17.13
197	17.62
210	21.18
224	22.28
230	22.22
265	21.81
288	21.24
305	22.40
343	21.24
358	22.71
369	22.86
393	21.95
422	22.25
437	21.37
494	22.07
518	21.95
570	21.76
593	21.67
600	23.13

CROSS SECTION 7

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	23.64
15	21.98
18	21.31
24	21.37
32	21.34
70	22.40
74	22.12
77	21.37
114	21.37
122	21.37
137	21.76
139	20.54
140	21.85
169	20.18
177	22.70
186	22.52
204	22.16
255	22.45
287	22.68
334	22.30
338	21.88
357	21.88
364	21.88
378	23.44

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	23.37
37	23.60
183	22.85
204	22.95
221	22.80
227	22.10
230	21.85
235	22.13
258	22.16
262	20.51
271	20.54
273	21.76
277	22.28
305	22.80
323	22.13
334	21.92
339	23.86
347	24.02
351	21.61
361	21.73
370	23.06
387	22.86
408	22.62
427	22.89
443	22.83
452	22.83
463	22.28
468	22.07
474	22.31
507	22.18
520	22.10
552	21.37
558	21.70
569	22.65
594	24.92

CROSS SECTION 9

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	24.22
4	23.82
23	23.75
35	22.25
52	23.38
62	23.59
68	23.38
75	22.43
86	21.85
93	22.46
103	23.86
128	22.86
142	23.44
146	22.16
148	23.53
160	23.90
180	23.87
198	23.58
274	23.58
280	23.26
302	23.80
319	23.71
323	22.56
326	23.16
363	22.65
363	20.70
363	19.17
369	20.70
416	22.98
423	23.71
430	23.13
459	21.03
462	23.07
529	23.28
538	23.59
591	24.92

CROSS SECTION 10

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	25.12
35	23.90
69	23.80
82	23.86
107	24.02
120	24.37
162	24.35
177	24.29
186	23.16
197	23.99
235	24.35
241	21.46
248	20.85
256	21.49
262	23.90
351	24.53
369	24.44
375	23.56
384	23.65
387	24.17
431	24.48
467	24.05
572	23.09
579	23.84
582	23.04
610	24.02
613	23.71
619	22.74
620	23.39
623	24.11
654	24.51
674	24.32
689	24.14
693	23.53
725	24.13
732	24.02
741	24.54
744	25.21

CROSS SECTION 11

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	25.60
18	23.07
24	24.78
54	25.27
61	26.33
67	25.33
72	23.23
76	24.41
84	25.09
100	24.11
112	24.60
120	25.05
155	25.24
164	24.29
236	25.12
250	24.38
267	24.57
274	22.22
286	21.31
297	22.22
300	23.84
303	25.27
325	25.18
336	24.84
362	25.21
375	25.73
378	25.97

BRIDGE SECTION

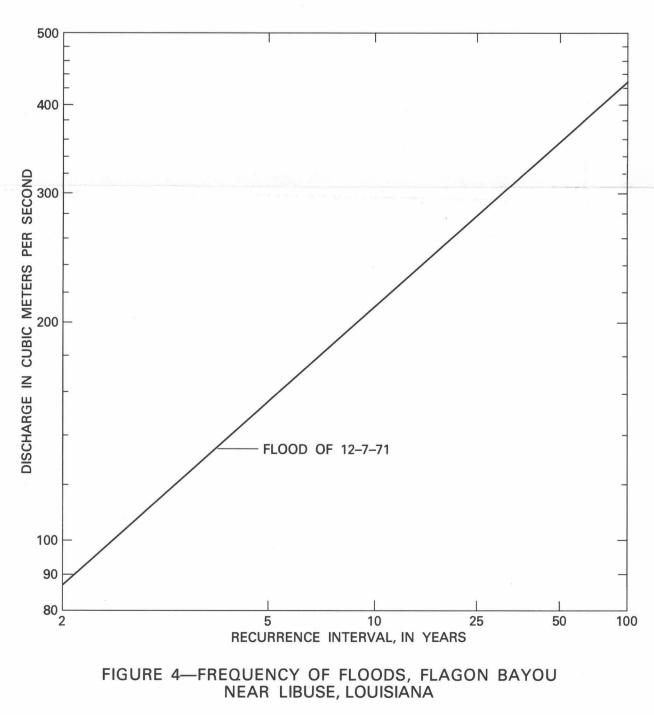| STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	25.39
3	24.69
8	23.29
12	22.25
16	20.48
20	20.15
27	17.56
31	17.13
35	17.31
37	17.13
39	17.56
42	17.62
46	18.17
49	20.27
52	22.38
54	23.44
57	24.66
60	25.13
61	25.73

TABLE 2—DISCHARGE MEASUREMENT OF DECEMBER 6, 1971. FLAGON BAYOU NEAR LIBUSE, LOUISIANA ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM). (WATER-SURFACE ELEVATION =23.265 METERS) TOTAL DISCHARGE=132 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
6.4	0	0	0	0
12.2	1.01		0.6	0.037
15.2	1.40	8	0.8	0.037
			0.2	0.037
18.3	1.95	25	0.8	0.954
			0.2	0.634
19.8	2.96	24	0.8	1.000
			0.2	1.091
21.3	3.66	23	0.8	0.725
			0.2	1.024
22.9	4.79	23	0.8	0.994
			0.2	1.024
23.8	5.24	16	0.8	0.975
			0.2	0.930
25.0	5.55	0	0.8	1.216
			0.2	0.911
27.4	5.76	0	0.8	1.244
			0.2	1.222
29.0	5.79	0	0.8	1.305
			0.2	1.375
29.9	5.94	0	0.8	1.000
			0.2	1.030
31.1	6.00	0	0.8	1.030
			0.2	1.000
32.0	5.76	8	0.8	1.012
			0.2	1.094
33.5	5.67	16	0.8	1.094
			0.2	1.094
35.1	5.36	19	0.8	1.030
			0.2	0.911
36.0	5.39	19	0.8	0.816
			0.2	1.024
37.2	5.43	27	0.8	1.024
			0.2	1.244
38.1	4.94	28	0.8	1.189
			0.2	1.244
39.6	4.63	18	0.8	1.116
			0.2	1.116
41.1	4.15	11	0.2	1.094
			0.8	1.094
44.2	3.23	0	0.6	0.500
47.2	2.35	0	0.2	0.872
			0.8	0.517
50.3	1.01	16	0.6	0.201
54.6	0.0		0.6	0.177

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