DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, YOCKANOOKANY RIVER NEAR THOMASTOWN, MISSISSIPPI

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

Prepared in cooperation with the
DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
and the
MISSISSIPPI STATE HIGHWAY DEPARTMENT

HYDROLOGIC INVESTIGATIONS ATLAS
Published by the U.S. Geological Survey, 1979
W

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Prepared in cooperation with the
DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION
AND THE MISSISSIPPI STATE HIGHWAY DEPARTMENT

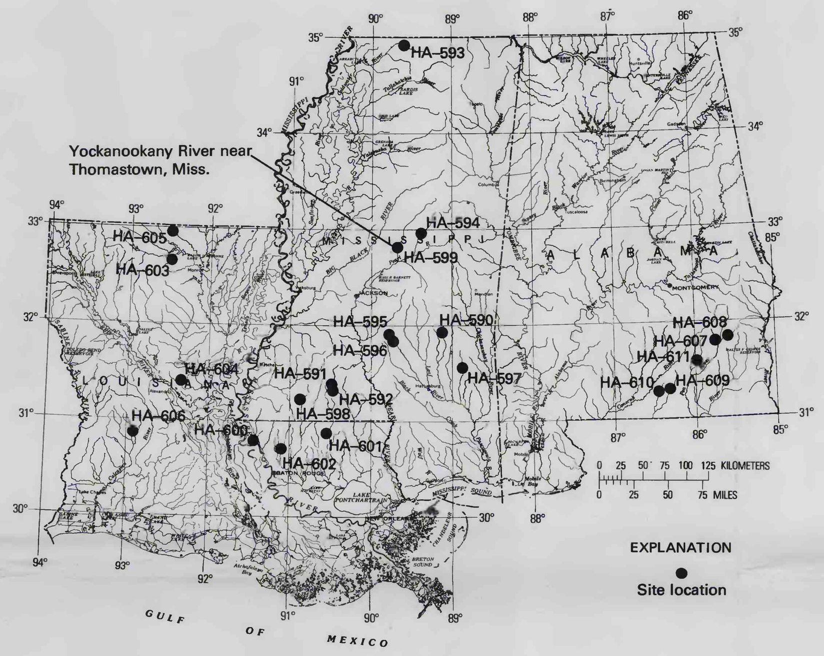

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

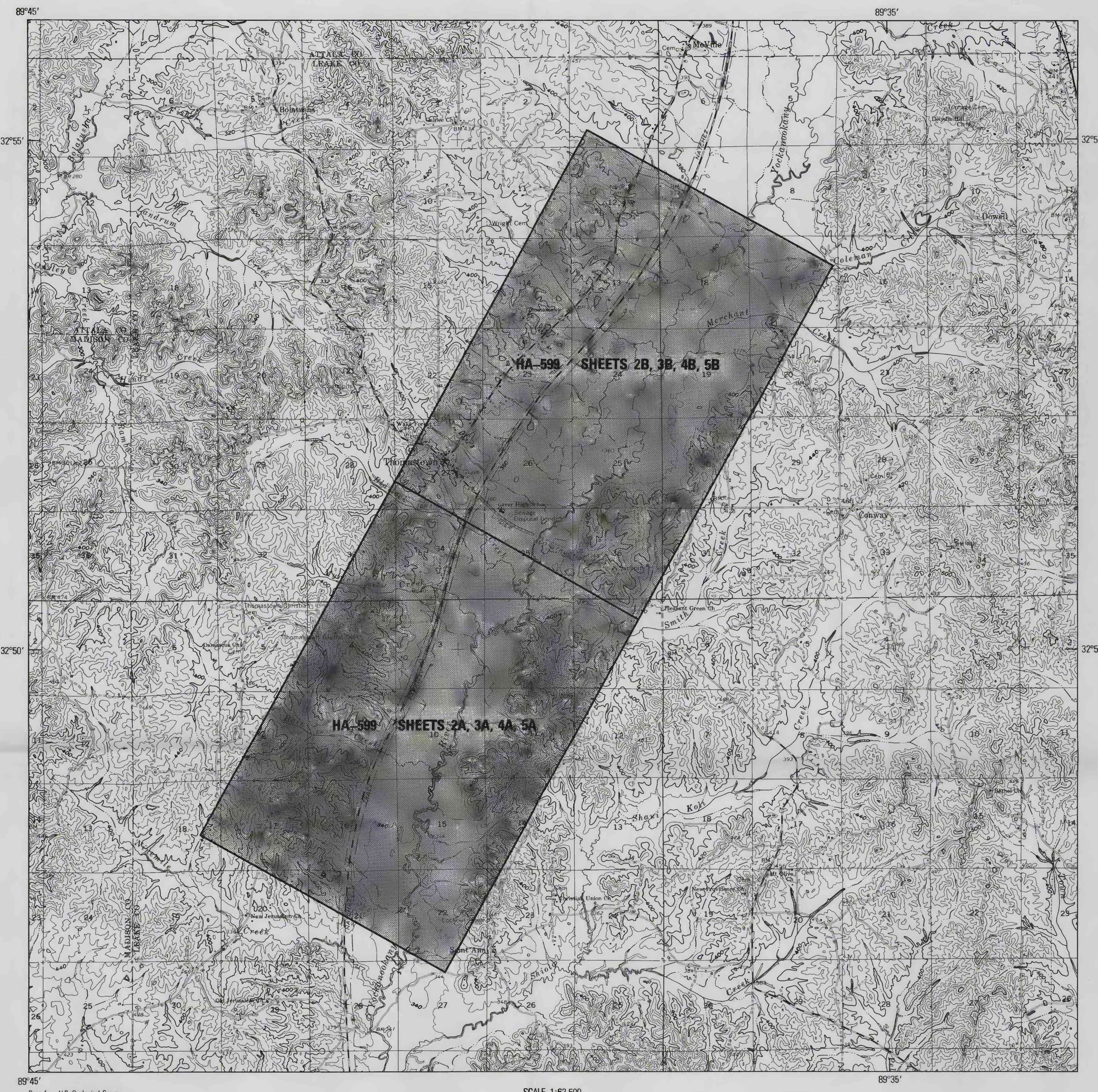

FIGURE 2—INDEX MAP SHOWING STUDY REACH, YOCKANOOKANY RIVER NEAR THOMASTOWN, MISSISSIPPI

FIGURE 3—AERIAL VIEW LOOKING DOWNSTREAM IN VICINITY OF BRIDGE ON STATE HIGHWAY 429 NEAR THOMASTOWN, MISSISSIPPI

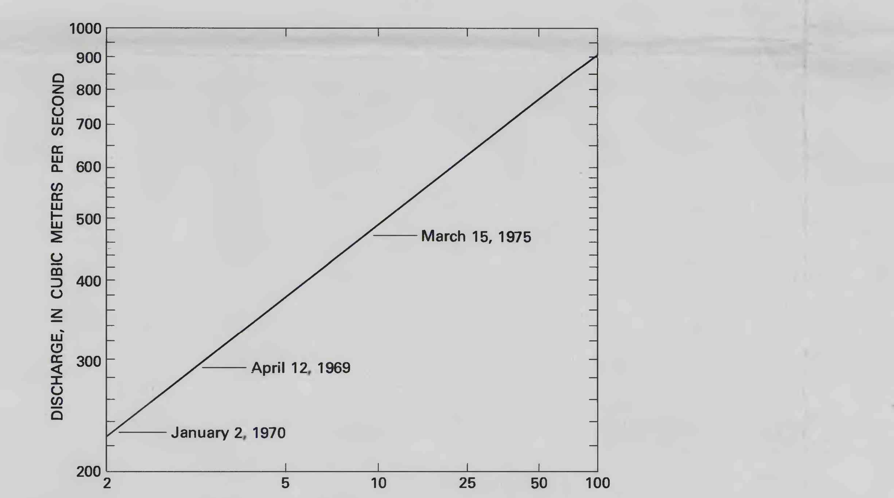

FIGURE 4—FREQUENCY OF FLOODS, YOCKANOOKANY RIVER NEAR THOMASTOWN, MISSISSIPPI

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS YOCKANOOKANY RIVER NEAR THOMASTOWN, MISSISSIPPI

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 Yockanookany River near Thomastown, Miss., 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 Colson and Hudson (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 YOCKANOOKANY RIVER NEAR THOMASTOWN, MISSISSIPPI

Data for Yockanookany River near Thomastown, Miss., obtained in an 11-kilometer reach crossed about midway by State Highway 429 are presented on nine sheets (fig. 2). Sheet 1 contains tables showing cross-section data (table 1) and discharge data (table 2). An aerial view looking downstream 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 elevations are shown on sheets 2A and 2B. These are points of significant changes in cross section elevation 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 2B as they existed at the time of the floods. 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 three floods on Yockanookany River are presented. The first flood occurred April 12, 1969, (sheets 3A and 3B). Ten valley cross sections were surveyed after this flood (sheets 2A and 2B). A survey of the old road fill upstream from the present roadway was made beginning at the right bank (facing downstream) of the low water channel (sheet 2B). The old road fill was removed completely during the fall of 1969. A second flood occurred on January 2, 1970 (sheets 4A and 4B). The third flood occurred March 15, 1975 (sheets 5A and 5B).

Valley cross sections as surveyed are considered valid for all floods.

Manning's roughness coefficient values and the 1975 flood boundaries are shown on sheets 2 to 5.

FLOOD OF APRIL 12, 1969

Peak water-surface elevations, the measured cross section, and velocities for the flood of April 12, 1969, are shown on sheets 3A and 3B. The flood crested at an elevation of 108.079 meters at the reference point located on the downstream guardrail 90 meters form the left abutment. The measured peak discharge was 289 cubic meters per second (m^3/s) (table 2). The measured cross section and velocity distribution for the discharge measurement April 12, 1969 are shown on sheet 3B. The recurrence interval of the peak discharge is 3 years (Colson and Hudson, 1976). See figure 4.

FLOOD OF JANUARY 2, 1970

Peak water-surface elevations for the flood of January 2, 1970, are shown on sheets 4A and 4B. The flood crested at an elevation of 107.869 meters at the reference point located on the downstream guardrail. The peak discharge was 229 m^3/s, from the stage-discharge relation for the site. A discharge of 148 m^3/s was measured at an elevation of 107.692 meters at the reference point on January 1, 1970 (table 2). The measured cross section and velocity distribution for the discharge measurement January 1, 1970 are shown on sheet 4B. The recurrence interval of the peak discharge is 2 years (Colson and Hudson, 1976). See figure 4.

FLOOD OF MARCH 15, 1975

Peak water-surface elevations for the flood of March 15, 1975, are shown on sheets 5A and 5B. The flood crested at an elevation of 108.545 meters at the reference point. The measured peak discharge was 470 m^3/s (table 2). The measured cross section and velocity distribution for the discharge measurement March 15, 1975, are shown on sheet 5B. The recurrence interval of the 1975 peak discharge is 10 years (Colson and Hudson, 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 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 Yockanookany River near Thomastown, Miss. Water depths, velocities, and discharges through bridge openings on Yockanookany River near Thomastown, Miss., for floods of April 12, 1969, January 2, 1970, and March 15, 1975, are 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 maps, 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.

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 YOCKANOOKANY RIVER NEAR THOMASTOWN, MISSISSIPPI. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM).

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	106.74
24	106.59
62	106.50
67	105.83
72	106.41
174	105.95
215	105.70
321	105.03
360	104.97
394	104.82
456	104.55
467	104.39
485	104.52
501	104.24
550	104.30
569	104.15
580	104.27
584	103.66
591	103.21
597	103.42
602	104.03
609	104.58
618	104.09
624	103.54
631	102.41
636	102.60
641	103.17
675	104.42
681	103.57
682	103.51
685	104.00
691	104.67
697	104.36
719	104.67
725	104.39
732	103.24
740	102.99
748	103.33
750	103.91
760	104.30
767	104.33
771	103.45
784	103.60
789	104.12
799	104.64
813	102.14
822	102.41
844	103.02
862	100.74
864	99.46
866	98.97
868	98.76
870	98.91
872	98.97
874	99.94
876	100.74
878	101.62
879	101.62
881	104.33
885	104.61
897	104.58
897	104.39
903	104.24
909	104.24
915	104.33
915	104.61
924	105.03
945	105.06
976	104.88
1006	104.73
1038	104.52
1061	104.61
1063	104.33
1064	104.33
1066	104.64
1070	104.67
1102	104.39
1125	104.30
1154	104.52
1171	104.45
1191	104.30
1216	104.09
1234	104.33
1252	104.30
1273	104.42
1296	104.42
1323	104.27
1354	104.24
1369	104.52
1380	104.18
1395	104.12
1400	104.45
1418	104.55
1440	104.36
1468	104.15
1744	104.52
1947	105.83
1954	107.29

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	107.23
8	106.53
23	105.89
30	104.73
39	104.73
40	103.11
42	101.80
43	101.50
45	101.38
46	101.32
47	101.19
48	101.41
48	101.53
49	101.47
50	101.65
51	102.02
52	102.38
54	102.90
55	103.02
59	103.66
62	104.24
82	104.58
91	104.27
106	104.27
128	104.79
137	104.55
143	104.39
147	104.39
151	103.85
155	103.91
158	104.82
165	104.97
179	104.70
185	104.18
199	104.58
206	104.39
219	104.35
226	103.57
226	102.14

CROSS SECTION 2 (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
227	101.89
229	101.83
229	101.80
230	101.77
230	101.96
231	102.26
233	102.53
235	103.21
237	103.69
239	104.12
242	104.09
246	104.70
251	104.55
264	104.12
267	103.85
269	102.69
272	101.93
273	101.83
274	101.93
275	102.02
276	102.57
277	103.05
277	104.27
279	104.76
286	105.16
295	105.37
298	105.37
307	105.34
316	105.00
322	104.70
326	104.33
329	104.33
336	104.70
347	105.22
374	105.55
386	105.40
393	105.28
394	105.00
396	104.85
399	105.22
408	105.28
431	105.37
449	105.28
476	105.22
479	105.06
498	105.09
539	105.09
591	104.85
592	104.73
649	104.79
662	104.88
697	104.91
714	105.16
737	105.22
914	105.16
1142	107.38
1188	108.20
1192	108.20
1194	108.45

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	107.59
30	106.80
35	106.65
45	106.62
102	105.86
132	105.64
151	105.67
173	105.46
209	105.49
252	105.64
272	105.77
285	105.55
290	105.22
294	105.09
298	105.58
319	105.52
349	105.89
383	105.98
391	105.37
405	105.64
409	105.34
411	105.03
411	104.70
412	104.55
413	104.70
415	105.58
435	105.83
447	105.70
458	104.55
465	104.39
479	104.85
495	105.03
504	103.51
512	103.24
517	103.72
522	104.82
539	105.03
559	105.34
564	105.34
568	104.64
571	103.60
574	103.69
585	104.82
603	105.22
632	105.16
632	105.16
636	104.06
638	102.44
640	101.53
643	100.89
646	100.92
649	101.32
650	101.65
652	101.53
653	101.89
657	102.44
657	102.66
661	102.69
664	102.75
668	102.90
672	103.57
675	104.15
680	104.91
694	105.16
716	104.67
734	105.03
750	104.73
753	103.85
756	103.27
758	103.14
761	102.23
764	101.77
769	102.69
772	103.14
776	103.60
779	104.67
781	105.67
783	105.86
795	105.86
820	105.83
849	105.70

CROSS SECTION 3 (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
878	105.34
928	105.52
957	105.40
982	105.22
1003	105.22
1033	105.34
1046	105.00
1062	105.28
1071	104.76
1088	104.85
1094	105.16
1103	104.97
1125	106.47
1137	106.56
1172	105.70
1175	105.61
1175	105.37
1176	105.37
1176	105.61
1179	105.77
1192	106.22
1222	106.47
1244	106.34
1266	106.31
1289	106.22
1329	106.22
1344	106.25
1372	106.38
1391	106.68
1410	106.59
1442	106.80
1494	107.59

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	108.51
6	107.62
7	107.50
9	106.44
14	105.77
16	105.70
18	105.92
27	106.19
41	106.34
47	105.74
58	105.83
70	105.92
84	106.38
97	106.10
99	104.64
102	103.75
103	103.45
105	103.02
106	103.14
108	102.72
109	102.41
111	101.77
112	101.74
114	102.29
115	103.14
116	103.39
117	103.51
117	103.75
118	104.49
118	105.83
119	106.13
126	106.31
131	106.38
157	106.31
159	106.31
161	106.07
162	104.06
169	104.06
175	104.79
177	106.07
180	106.01
187	106.38
209	106.07
215	105.89
216	104.97
216	104.79
218	104.73
219	105.09
221	105.40
222	105.77
226	106.01
237	106.07
241	106.31
253	106.44
268	106.44
320	106.38
344	106.59
357	106.34
375	106.19
390	106.07
393	105.74
394	105.31
395	105.19
397	105.28
398	105.46
401	105.86
418	106.44
452	106.22
478	106.22
499	106.19
527	106.28
562	105.95
569	105.92
575	105.83
576	105.34
579	105.06
581	105.19
584	105.46
593	105.49
596	106.10
606	106.07
619	106.07
623	105.74
627	105.58
631	105.64
644	106.01
659	106.19
699	106.07
738	105.89
740	105.58
742	105.40
743	105.34
744	105.34
744	105.40
745	105.70
750	105.83
1064	106.71
1086	106.86
1158	108.51

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	109.64
34	108.45
55	107.75
95	107.81

CROSS SECTION 5 (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
138	109.85
166	110.15
184	109.39
222	107.96
239	107.72
259	106.77
287	107.05
304	106.95
329	106.65
335	106.22
340	106.83
488	106.38
494	105.80
503	105.46
513	106.34
546	106.16
555	105.83
560	105.89
561	104.67
562	101.96
579	103.08
583	104.67
588	106.28
596	106.95
609	106.89
618	105.77
626	106.95
669	106.86
678	106.86
682	106.19
687	106.16
696	106.65
723	107.05
758	107.08
776	107.08
784	105.92
793	106.68
826	106.31
867	106.77
883	106.77
898	106.85
903	106.44
911	106.86
938	106.56
973	106.71
996	106.50
999	106.16
1002	106.53
1017	107.11
1030	107.17
1064	106.92
1103	106.77
1135	106.80
1158	106.86
1199	107.02
1234	107.08
1273	107.20
1302	107.38
1331	107.59
1372	107.75
1406	107.66
1435	107.84
1461	107.96
1485	108.05
1485	108.11
1513	108.17
1538	108.33
1564	108.02
1583	108.33
1641	108.45
1655	108.51
1716	108.75

BRIDGE SECTION

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	107.90
3	106.68
7	106.13
14	105.64
16	105.70
30	105.52
35	105.55
39	103.97
45	102.69
49	102.75
56	103.91
62	105.31
66	105.28
71	107.69
74	103.81
77	103.72
84	103.94
88	104.79
91	104.55
94	105.55
99	105.86
104	105.80
128	106.07
155	106.41
165	106.56
168	108.05

SECTION ALONG FORMER ROAD FILL

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	105.54
0	108.47
6	108.74
18	108.68
28	108.71
49	108.59
62	108.59
73	107.19
83	106.18
98	106.06
108	105.48
121	105.24
125	105.57
130	107.58
131	108.95
134	108.86
141	108.71
147	108.77
155	108.95
156	107.73
160	106.25
163	106.30
168	108.71
172	108.80
185	108.50
204	108.47
220	108.41
230	108.37
250	108.56
261	108.68
262	106.94
264	106.52
267	106.52
270	106.48
271	108.62

SECTION ALONG FORMER ROAD FILL (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
276	108.50
290	108.25
302	108.28
313	108.25
327	108.31
345	108.31
357	108.62
369	108.56
382	108.92
394	109.87

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	109.18
23	108.39
43	107.78
67	107.62
119	107.26
149	107.17
180	107.17
201	107.26
234	107.38
269	107.53
286	107.62
309	107.56
325	106.44
329	106.50
334	106.86
347	106.95
354	106.31
365	106.38
376	107.05
402	107.20
412	107.02
425	105.46
437	105.40
453	107.02
465	106.98
472	106.95
480	104.97
482	104.36
483	103.75
489	103.24
496	103.14
497	104.97
497	106.19
515	106.59
536	106.95
564	106.65
584	106.74
611	106.47
615	105.40
619	105.43
623	106.19
630	106.44
649	106.68
682	107.23
693	107.17
717	106.92
720	106.68
730	106.34
743	106.92
771	106.65
787	106.74
799	106.85
842	107.02
866	106.95
887	106.98
900	106.25
906	106.74
921	106.95
958	107.29
971	107.17
982	106.77
1005	107.29
1013	107.26
1031	107.11
1042	107.29
1066	107.05
1089	107.05
1118	107.08
1151	107.50
1177	107.50
1207	107.56
1246	107.59
1278	107.59
1369	107.96
1402	108.20
1444	108.51

CROSS SECTION 7

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	109.73
24	108.69
33	108.30
45	107.96
59	107.29
80	107.17
89	107.47
91	107.47
92	105.89
95	105.28
96	104.70
97	103.97
98	103.39
98	103.14
99	102.69
101	102.32
102	102.05
104	101.77
105	101.77
109	103.17
109	104.06
111	104.70
115	106.04
117	106.80
123	107.23
128	107.23
137	107.23
166	107.47
198	107.44
199	106.95
203	106.98
207	106.98
208	107.44
268	107.59
274	107.17
313	107.75
329	107.69
378	107.62
403	107.38
429	107.59
485	107.53
524	107.50
549	107.53
571	107.41
604	107.44
629	107.62

CROSS SECTION 7 (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
660	107.38
687	107.66
693	107.26
693	106.92
696	106.53
708	106.53
711	106.80
711	107.29
714	107.53
730	107.35
746	107.29
767	107.32
801	107.17
830	107.29
870	107.23
896	107.17
910	107.11
920	106.86
927	106.74
936	106.71
943	107.20
974	107.17
1014	107.32
1053	107.23
1096	107.08
1114	107.14
1144	107.11
1155	107.14
1156	106.71
1162	106.53
1165	106.92
1166	107.29
1175	107.26
1207	107.29
1232	107.17
1237	106.95
1242	106.89
1246	107.14
1266	107.05
1280	107.17
1318	107.29
1324	107.26
1325	107.11
1326	107.20
1327	107.50
1338	107.35
1340	107.32
1365	107.32
1399	107.17
1426	107.29
1469	107.41
1477	107.53
1578	109.21
1609	109.73

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	110.34
61	109.94
121	109.61
143	109.30
158	109.21
197	109.00
240	109.00
301	108.87
317	109.12
342	109.24
370	109.30
395	109.15
414	109.21
440	109.03
460	108.63
476	108.51
498	108.36
544	108.54
580	108.57
610	108.48
625	108.42
640	108.39
674	108.26
683	108.23
683	106.80
701	106.74
707	108.20
779	108.17
784	105.67
784	105.25
785	105.13
787	104.97
789	104.45
790	104.76
791	104.61
792	104.70
793	105.06
794	105.67
806	108.57
810	108.72
822	108.54
845	108.48
845	109.12
881	108.45
898	108.48
900	107.78
903	107.69
905	108.57
924	108.45
962	108.57
988	108.69
1031	108.30
1054	108.30
1085	108.33
1127	108.36
1161	108.57
1191	108.45
1199	108.23
1200	108.05
1202	108.11
1204	108.26
1231	108.14
1247	108.08
1260	108.11
1279	108.17
1304	108.08
1328	108.14
1344	108.20
1348	107.78
1378	108.08
1381	107.69
1382	107.66
1383	107.81
1383	108.23
1387	108.39
1417	108.36
1435	108.36
1449	108.36
1467	108.17
1487	108.26
1512	108.20
1518	107.47
1532	107.35
1535	107.41
1539	108.02

CROSS SECTION 8 (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
1546	108.20
1579	107.99
1614	108.08
1616	107.78
1625	107.78
1661	107.75
1697	107.90
1705	107.72
1714	107.50
1722	108.14
1728	108.17
1742	108.20
1874	109.12
1957	110.03
1980	110.19

CROSS SECTION 9

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	110.89
27	110.22
52	110.03
84	109.85
113	110.00
136	109.76
157	109.45
186	109.33
195	109.30
218	109.21
256	109.27
314	109.24
359	108.97
386	108.97
419	109.30
452	109.00
481	109.09
490	108.51
493	108.08
499	108.08
502	108.60
509	108.97
526	109.18
560	109.12
578	108.90
600	109.00
619	109.61
641	110.70
669	110.55
672	110.19
679	108.42
684	107.93
714	108.23
727	108.57
737	108.51
752	107.56
752	107.02
754	106.86
755	107.62
769	107.78
772	107.81
782	108.23
789	108.57
807	106.98
809	106.53
811	106.10
813	105.86
814	105.13
814	105.13
815	105.13
816	105.16
817	105.09
818	105.28
818	105.83
820	106.10
821	106.59
823	108.14
835	108.02
849	108.72
855	108.81
871	108.94
877	108.94
879	107.26
882	107.17
889	106.68
895	107.99
902	109.27
927	109.33
957	109.21
982	109.15
991	109.05
1019	109.12
1035	109.05
1049	108.94
1059	108.57
1064	108.08
1067	107.78
1070	107.75
1076	108.54
1089	109.03
1113	108.97
1151	108.87
1164	108.51
1167	108.30
1170	107.81
1172	107.29
1178	107.47
1180	108.66
1195	109.06
1202	109.03
1240	108.69
1284	108.63
1329	108.69
1346	108.33
1370	108.48
1406	108.63
1421	108.69
1431	107.96
1437	108.14
1448	108.39
1462	108.51
1497	108.60
1535	108.72
1577	108.78
1590	108.75
1658	108.97
1692	109.09
1722	109.30
1744	109.91
1745	109.18
1754	109.12
1755	109.61
1779	109.51
1814	109.82
1837	109.61
1906	109.73
1999	109.73
2005	109.91
2006	108.97
2007	108.78
2010	109.91
2037	109.79
2102	110.15
2195	110.95

CROSS SECTION 10

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	111.86
30	111.50
69	111.40
118	111.65
164	111.22
203	111.01
231	111.07
290	110.79
325	110.67
372	110.34
424	110.25
467	110.22
507	110.12
554	110.00
598	109.82
642	109.82
669	109.88
715	109.70
755	109.91
777	109.85
803	109.67
830	109.67
899	109.70
956	109.70
996	109.75
998	109.79
1007	109.88
1032	109.48
1040	107.25
1041	106.47
1042	106.22
1042	105.98
1043	105.92
1044	106.04
1045	106.19
1046	106.25
1047	106.53
1048	106.50
1049	106.41
1050	106.59
1051	106.74
1052	106.95

CROSS SECTION 10 (CONT.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
1053	107.26
1057	107.84
1060	109.21
1061	109.33
1078	109.55
1099	109.51
1131	109.64
1137	109.79
1151	109.70
1169	109.45
1183	109.21
1189	109.61
1213	109.79
1245	109.67
1261	109.70
1292	109.73
1320	109.55
1341	109.58
1341	109.51
1383	109.55
1398	109.70
1433	109.58
1464	109.61
1487	109.70
1504	109.55
1515	109.15
1528	109.00
1534	109.15
1543	109.51
1551	109.76
1583	109.73
1631	109.64
1654	109.51
1684	109.58
1723	109.79
1746	109.64
1771	109.79
1803	109.97
1828	109.88
1838	110.43
1858	110.64
1878	111.01
1900	111.40
1907	111.43
1920	111.86

TABLE 2.—DISCHARGE MEASUREMENTS APRIL 12, 1969, JANUARY 1, 1970, AND MARCH 15, 1975, YOCKANOOKANY RIVER NEAR THOMASTOWN, MISS. ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM).

DISCHARGE MEASUREMENT APRIL 12, 1969, YOCKANOOKANY RIVER AT STATE HIGHWAY 429 NEAR THOMASTOWN, MISS. (WATER-SURFACE ELEVATION=108.079 METERS) TOTAL DISCHARGE=289 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
5.7	0.0	0	0.0	0.0
8.2	1.34	0	0.6	0.942
12.8	1.95	0	0.2	1.314
			0.8	1.350
17.4	2.16	0	0.2	1.643
			0.8	1.530
21.9	2.41	0	0.2	0.988
			0.8	0.588
26.5	2.38	0	0.2	0.472
			0.8	0.357
31.1	2.44	0	0.2	0.677
			0.8	0.533
35.7	2.56	0	0.2	0.661
			0.8	0.689
40.2	2.53	0	0.2	0.378
			0.8	0.207
44.8	4.11	0	0.2	0.555
			0.8	0.152
50.9	5.39	0	0.2	0.152
			0.8	0.226
55.5	5.33	0	0.2	0.305
			0.8	0.326
61.6	4.21	0	0.2	0.198
			0.8	0.387
67.7	2.77	0	0.2	0.408
			0.8	0.588
72.2	2.83	0	0.2	0.509
			0.8	0.750
76.8	3.44	0	0.2	0.899
			0.8	0.805
79.9	4.27	0	0.2	1.125
			0.8	1.100
82.9	4.36	0	0.2	1.347
			0.8	1.000
86.0	4.24	0	0.2	1.433
			0.8	0.899
89.0	4.15	0	0.2	1.530
			0.8	0.826
90.5	3.90	0	0.2	1.433
			0.8	0.521
93.6	3.29	0	0.2	1.375
			0.8	0.454
96.6	3.57	0	0.2	1.100
			0.8	0.677
99.7	2.53	0	0.2	0.689
			0.8	0.326
104.2	2.23	0	0.2	0.616
			0.8	0.393
108.8	2.29	0	0.2	0.661
			0.8	0.543
113.4	2.19	0	0.2	0.110
			0.8	0.080
118.0	2.13	0	0.2	0.183
			0.8	0.104
124.1	2.07	0	0.2	0.497
			0.8	0.408
128.6	2.04	0	0.2	0.677
			0.8	0.588
133.2	2.04	0	0.2	0.555
			0.8	0.341
137.8	1.98	0	0.2	0.533
			0.8	0.469
142.3	1.86	0	0.2	0.646
			0.8	0.393
146.9	1.83	0	0.2	0.719
			0.8	0.472
151.5	1.74	0	0.2	0.811
			0.8	0.942
156.1	1.71	0	0.6	0.704
160.6	1.68	0	0.2	0.646
			0.8	0.546
165.2	2.32	0	0.2	1.253
			0.8	1.146
170.1	1.52	0	0.2	1.463
			0.8	0.826
174.3	0.40	0	0.0	0.719

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

DISCHARGE MEASUREMENT JANUARY 1, 1970, YOCKANOOKANY RIVER AT STATE HIGHWAY 429 NEAR THOMASTOWN, MISS. (WATER-SURFACE ELEVATION=107.692 METERS) TOTAL DISCHARGE=148 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
10.1	2.68	0	0.2	1.676
			0.8	1.594
17.7	2.87	0	0.2	1.219
			0.8	0.674
25.3	2.80	0	0.2	1.073
			0.8	0.747
32.9	3.05	0	0.2	1.006
			0.8	0.674
40.5	3.84	0	0.2	0.451
			0.8	0.424
45.1	5.12	0	0.2	0.256
			0.8	0.317
52.7	5.43	0	0.2	0.658
			0.8	0.090
57.3	5.05	0	0.2	0.341
			0.8	0.674
61.9	3.78	0	0.2	0.802
			0.8	0.747
66.4	3.23	0	0.2	0.917
			0.8	1.073
71.0	3.47	0	0.2	1.167
			0.8	1.219
75.6	4.57	0	0.2	1.524
			0.8	1.247
80.2	4.69	0	0.2	1.341
			0.8	1.341
84.7	4.69	0	0.2	1.277
			0.8	1.006
87.8	4.69	0	0.2	1.426
			0.8	1.006
90.8	4.39	0	0.2	1.558
			0.8	1.167
93.9	4.15	0	0.2	1.594
			0.8	0.701
100.0	2.62	0	0.2	0.981
			0.8	0.341
106.1	2.74	0	0.2	0.765
			0.8	0.765
115.2	2.56	0	0.2	0.256
			0.8	0.173
124.4	2.50	0	0.2	0.732
			0.8	0.539
133.5	2.44	0	0.2	1.006
			0.8	0.451
142.6	2.55	0	0.2	1.006
			0.8	0.878
151.8	3.23	0	0.2	1.167
			0.8	1.457
160.9	2.41	0	0.2	1.006
			0.8	0.917
170.1	1.16	0	0.6	1.219
174.3	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.

DISCHARGE MEASUREMENT MARCH 15, 1975, YOCKANOOKANY RIVER AT STATE HIGHWAY NEAR THOMASTOWN, MISS. (WATER-SURFACE ELEVATION=108.545 METERS) TOTAL DISCHARGE=470 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
5.8	0.0	0	0.0	0.0
8.5	1.16	0	0.6	0.594
11.6	1.55	0	0.2	0.972
			0.8	0.930
16.2	1.83	0	0.2	1.064
			0.8	0.832
20.7	2.01	14	0.2	0.457
			0.8	0.402
29.9	2.07	0	0.2	0.329
			0.8	0.209
39.0	2.16	8	0.2	0.137
			0.8	0.090
48.2	4.60	78	0.2	0.080
			0.8	0.110
57.3	4.79	31	0.2	0.049
			0.8	0.178
63.4	3.51	8	0.2	0.123
			0.8	0.301
69.5	2.29	8	0.2	0.323
			0.8	0.549
75.6	3.32	11	0.2	0.725
			0.8	0.582
78.6	3.96	11	0.2	0.869
			0.8	0.850
81.7	3.90	11	0.2	0.951
			0.8	0.741
84.7	3.93	14	0.2	0.908
			0.8	0.725
87.8	3.84	0	0.2	0.972
			0.8	0.652
90.8	3.20	0	0.2	0.908
			0.8	0.402
93.9	3.38	0	0.2	0.869
			0.8	0.402
96.9	2.90	0	0.2	0.710
			0.8	0.351
103.0	1.77	16	0.2	0.194
			0.8	0.120
109.1	1.89	0	0.2	0.308
			0.8	0.198
118.3	1.71	19	0.2	0.110
			0.8	0.070
127.4	1.62	0	0.2	0.238
			0.8	0.178
136.6	1.58	0	0.2	0.430
			0.8	0.277
145.7	1.37	0	0.6	0.375
151.8	1.37	0	0.6	0.479
157.9	1.16	0	0.6	0.582
164.0	1.74	0	0.2	0.570
			0.8	0.479
169.5	1.25	0	0.6	0.570
173.1	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.—1979—W79532

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