SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, FEBRUARY, 1918.

By ALFRED J. HENRY, Meteorologist.

[Dated: River and Flood Division, Mar. 29, 1918.]

The severity of the winter of 1917–18 was reflected in the thickness and extent of ice on all streams in the Ohio and upper Mississippi basins and to a less degree on the Missouri River and on streams in the Atlantic Drainage north of the James River of Virginia.

Abnormally cold weather set in in the first decade of December and continued almost uninterruptedly until February 5, 1918, when thawing weather overspread the Ohio Valley and Atlantic coast districts. During the last days of January moderately heavy rains fell over the southern tributaries of the Ohio as already described in this REVIEW, **46**: p. 32, and in greater detail in the article on page 86 of this number of the REVIEW.

The weather during February, 1918, after the 5th, was made up of short warm spells separated by equally short intervals of rather severe cold, the night temperatures during nearly the whole month being so low as to check the rapidity of the run-off from the melting snow and moreover during the cold spells both day and night temperatures were low enough to hold in check the rising water in the principal rivers. On the whole there were very few floods in the ordinary sense but a great many flood stages were registered along the various streams by reason of ice gorges. The only rain floods of the month were experienced in the rivers of South Atlantic, East Gulf, and Pacific drainages and none of these were of exceptional character.

The details will be found in the tables below.

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for chartering are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland: Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

TABLE 1.—*Flood stages in Atlantic drainage during February, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
Hudson:	*Feet.*			*Feet.*	
Albany, N. Y.	12	.....	.....	11.5	21
Mohawk:					
Tribeshill, N. Y.	16	20	20	19.2	20
Schenectady, N. Y.	15	21	21	15.9	21
Delaware (East Branch):					
Fishs Eddy, N. Y.	10	20	20	16.0	20
Delaware (West Branch):					
Hale Eddy, N. Y.	12	20	20	13.4	20
Schuykill:					
Reading, Pa.	12	.....	.....	11.3	20

TABLE 1.—*Flood stages in Atlantic drainage during February, 1918*—Continued.

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
Susquehanna:	*Feet.*			*Feet.*	
Oneonta, N. Y.	12	20	20	14.0	20
		26	26	12.9	26
Bainbridge, N. Y.	11	20	23	18.4	21
		26	(**)	16.9	27
Selingsgrove, Pa.	17	.....	.....	15.5	21
Susquehanna (West Branch):					
Clearfield, Pa.	9	20	20	9.5	20
Renovo, Pa.	16	.....	.....	14.4	20
Williamsport, Pa.	20	20	20	21.4	20
Chenango:					
Sherburne, N. Y.	8	25	(**)	9.5	26–27
Potomac:					
Cumberland, Md.	8	20	20	9.0	20
		26	26	9.0	26
Washington, D. C.	8	13	18	13.8	14
James:					
Columbia, Va.	18	.....	.....	17.3	14
Roanoke:					
Weldon, N. C.	30	.....	.....	28.6	1
Tar:					
Rocky Mount, N. C.	9	.....	.....	8.2	2
Tarboro, N. C.	18	4	4	18.3	4
Fishing Creek:					
Enfield, N. C.	14	1	3	16.0	3
Neuse:					
Neuse, N. C.	14	(†)	2	15.6	1
Smithfield, N. C.	13	(†)	4	17.0	1
Cape Fear:					
Elizabethtown, N. C.	22	(†)	4	27.2	2
Fayetteville, N. C.	35	.....	.....	34.4	1
Peedee:					
Cheraw, S. C.	27	(†)	1	30.0	*31
Santee:					
Rimini, S. C.	12	1	11	16.2	5
Ferguson, S. C.	12	1	14	13.9	6
Wateree:					
Camden, S. C.	24	(†)	1	27.3	*31
Saluda:					
Chappell, S. C.	14	(†)	*31	14.5	*31
Ocmulgee:					
Abbeville, Ga.	11	6	10	11.8	8

**Continued into March. *January.
†Continued from January.

TABLE 2.—*Flood stages in East Gulf drainage during February, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
Alabama:	*Feet.*			*Feet.*	
Selma, Ala.	35	4	4	35.0	4
Coosa:					
Gadsden, Ala.	22	1	3	22.2	2
Lock No. 4, Ala.	17	(†)	4	18.8	*31
Oostanaula:					
Resaca, Ga.	25	.....	.....	23.4	1
Tombigbee:					
Demopolis, Ala.	39	1	9	47.1	6
Black Warrior:					
Tuscaloosa, Ala.	46	(†)	2	53.9	*31
West Pearl:					
Pearl River, La.	13	.....	.....	12.1	8

† Continued from January. * January.

TABLE 3.—*Flood stages in Great Lakes drainage during February, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	To—	Crest. Stage.	Date.
Maumee:	*Feet.*			*Feet.*	
Fort Wayne, Ind.	15	13	18	20.5	15
		20	21	17.0	20
Napoleon, Ohio.	10	14	17	19.5	14
Sandusky:					
Upper Sandusky, Ohio.	13	12	13	14.3	13
Tiffin, Ohio.	7	.....	.....	6.3	15
Fremont, Ohio.	10	14	14	11.0	14
Saginaw:					
Saginaw, Mich.	19	.....	.....	18.5	28
Shiawassee:					
Owosso, Mich.	8	16	21	8.6	18–20
Flint:					
Fosters, Mich.	18	.....	.....	17.9	20
Pine:					
Alma, Mich.	7	.....	.....	6.4	26
Chippewa:					
Mount Pleasant, Mich.	11	.....	.....	10.0	28
Grand:					
Lansing, Mich.	11	15	18	13.5	16
		20	20	11.9	20
Portland, Mich.	12	7	9	12.4	8
Ionia, Mich.	21	16	18	21.6	17
		20	23	22.0	20
Eaton Rapids, Mich.	6	14	24	7.9	15
		26	(**)	7.0	28
Grand Rapids, Mich.	11	17	(**)	15.8	21

** Continued into March.

TABLE 4.—*Flood stages in Mississippi drainage during February, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	To—	Crest. Stage.	Date.
Ohio:	*Feet.*			*Feet.*	
Pittsburgh, Pa.	22	21	21	27.1	21
Davis Island Dam (Bellevue, Pa.).	25	21	21	26.0	21
Dam No. 2 (Coraopolis, Pa.).	26	21	21	28.2	21
Beaver Dam (Beaver, Pa.).	30	21	22	37.6	21
Dam No. 12 (near Wheeling, W. Va.).	36	11	11	36.2	11
Dam No. 13 (near Wheeling, W. Va.).	43	.....	.....	39.8	22
Marietta, Ohio.	33	22	23	34.5	23
Parkersburg, W. Va.	36	22	22	36.0	22
Dam No. 19 (near Tallman, W. Va.).	39	.....	.....	36.3	23
Dam No. 22 (near Ravenswood, W. Va.).	42	.....	.....	38.8	23
Point Pleasant, W. Va.	40	.....	.....	38.7	23
Portsmouth, Ohio.	50	.....	.....	44.7	17
Cincinnati, Ohio.	50	(†)	6	61.0	2
Do.	.....	10	13	61.8	12
Dam No. 37 (Fernbank, Ohio).	50	(†)	5	57.3	2
Do.	.....	11	13	60.1	12
Madison, Ind.	46	.....	.....	44.7	13
Louisville, Ky.	28	.....	.....	26.7	14
Cloverport, Ky.	40	3	3	42.5	3
Do.	.....	15	17	42.0	15
Henderson, Ky.	33	4	4	33.1	4
Do.	.....	6	6	36.5	6
Do.	.....	13	(**)	37.8	16–18
Mount Vernon, Ind.	35	5	5	36.0	5
Do.	.....	14	(**)	39.0	18
Evansville, Ind.	35	4	7	38.0	6
Do.	.....	11	(**)	39.8	17
Shawneetown, Ill.	35	8	8	36.8	8
Do.	.....	14	(**)	40.2	25
Allegheny:					
Warren, Pa.	12	20	20	12.8	20
Franklin, Pa.	15	.....	.....	14.7	21
Parkers Landing, Pa.	18	20	20	18.5	20
Mosgrove, Pa.	20	21	21	20.5	21
Freeport, Pa.	22	20	21	25.8	20
Dam No. 3 (Springdale, Pa).	27	20	21	30.9	20
Herrs Island Dam (Pittsburgh, Pa.).	22	21	21	27.9	21
Clarion:					
Clarion, Pa.	12	20	20	14.9	20
Riskiminetas:					
Saltsburg, Pa.	8	9	9	17.5	9
Do.	.....	13	13	8.0	13
Do.	.....	20	20	8.5	20
Stony Creek:					
Johnstown, Pa.	10	20	20	×11.7	20
Do.	.....	26	26	×10.8	26
Monongahela:					
Fairmont, W. Va.	25	.....	.....	23.2	26
Greensboro, Pa.	20	10	10	21.6	10
Lock No. 4, Pa.	31	.....	.....	29.7	21
Youghiogheny:					
Confluence, Pa.	10	12	12	13.6	12
Do.	.....	20	20	11.6	20
Do.	.....	26	26	10.5	26

† Continued from January. ** Continued into March.

TABLE 4.—*Flood stages in Mississippi drainage during February, 1918.*

River and station.	Flood stage.	Above flood stages—dates. From—	To—	Crest. Stage.	Date.
Beaver:	*Feet.*			*Feet*	
Beaver Falls, Pa.	11	20	20	11.1	20
Shenango:					
Sharon, Pa.	9	14	15	9.8	15
Do.	.....	20	21	9.9	20
Little Kanawha:					
Glenville, W. Va.	22	.....	.....	21.1	26
Muskingum:					
Zanesville, Ohio.	25	15	15	25.6	15
McConnelsville, Ohio.	22	14	16	24.9	15
Beverly, Ohio.	25	.....	.....	24.0	15
Marietta, Ohio.	32	16	17	32.4	17
Do.	.....	22	23	35.7	23
Tuscarawas:					
Norris Point, Ohio.	8	10	17	12.9	14
Do.	.....	20	22	11.2	21
Coshocton, Ohio.	8	12	16	13.2	13
Do.	.....	20	22	8.8	21
Walhonding:					
Walhonding, Ohio.	8	12	15	11.5	12
Do.	.....	20	21	10.4	20
Hocking:					
Athens, Ohio.	17	.....	.....	15.3	14
Scioto:					
Larue, Ohio.	11	12	13	12.0	13
Bellpoint, Ohio.	9	.....	.....	8.6	13
Dublin, Ohio.	8	12	12	11.5	12
Circleville, Ohio.	7	13	16	13.4	14
Do.	.....	20	21	10.4	21
Chillicothe, Ohio.	14	14	16	16.0	15
Licking:					
Farmers, Ky.	25	11	11	31.1	9
Falmouth, Ky.	28	9	9	28.1	9
Miami:					
Tadmore, Ohio.	12	12	13	13.0	13
West Milton, Ohio.	10	12	12	17.0	12
Kentucky:					
High Bridge, Ky.	30	(†)	* 31	31.2	*31
Frankfort, Ky.	31	1	1	32.3	1
Green:					
Lock No. 6 (Brownsville, Ky.).	30	(†)	1	30.1	1
Lock No. 4 (Woodbury, Ky.).	33	(†)	3	41.9	1
Lock No. 2 (Rumsey, Ky.).	34	5	7	34.9	6
Do.	.....	10	14	35.4	12–13
Wabash:					
Bluffton, Ind.	12	14	14	13.0	14
Lafayette, Ind.	11	12	18	21.6	14
Do.	.....	20	21	13.7	21
Terre Haute, Ind.	16	14	22	19.5	17
Mount Carmel, Ill.	15	13	27	21.0	21
Vincennes, Ind.	14	18	26	17.4	21–22
White:					
Decker, Ind.	18	17	21	19.6	20
Elliston, Ind.	19	12	17	22.2	12
Cumberland:					
Celina, Tenn.	45	(†)	4	55.2	1
Carthage, Tenn.	40	(†)	6	52.9	1
Dover, Tenn.	49	(†)	11	55.2	9
Nashville, Tenn.	40	(†)	9	49.9	5
Lock A (Fox Bluff, Tenn.).	43	(†)	9	47.0	6–7
Clarksville, Tenn.	46	(†)	10	51.8	7–8
Tennessee:					
Knoxville, Tenn.	12	1	1	15.0	1
Johnsonville, Tenn.	31	.....	.....	30.7	10
Chattanooga, Tenn.	33	(†)	3	42.5	3
Bridgeport, Ala.	24	(†)	4	28.5	3
Guntersville, Ala.	31	1	7	37.1	4
Florence, Ala.	18	1	8	21.8	6
Riverton, Ala.	32	(†)	10	42.0	7
Holston (North Fork):					
Mendota, Va.	8	28	29	14.0	29
Do.	.....	31	(**)	8.0	31
Clinch:					
Clinton, Tenn.	25	(†)	1	37.6	*30
Illinois:					
Morris, Ill.	13	13	20	17.9	15
Peru, Ill.	14	13	(**)	21.8	16
Henry, Ill.	7	13	(**)	13.7	18–19
Peoria, Ill.	16	16	(**)	19.7	20
Havana, Ill.	14	19	(**)	15.2	24–27
Beardstown, Ill.	12	17	(**)	15.7	28
Pearl, Ill.	12	.....	.....	11.8	28
Mississippi:					
Arkansas City, Ark. (Arkansas Basin.)	42	.....	.....	39.0	28
White:					
Clarendon, Ark.	30	.....	.....	23.6	24–25
Black:					
Black Rock, Ark.	14	13	15	15.3	13
Cache:					
Jelks, Ark.	9	.....	.....	8.7	25–27

† Continued from January. * January.
** Continued into March. × Estimated.

TABLE 5.—*Flood stages in Pacific drainage during February, 1918.*

River and station.	Flood stage.	Above flood stages—dates.		Crest.	
		From—	To—	Stage.	Date.
Merced:	*Feet.*			*Feet.*	
Merced Falls, Cal.	7			6.5	24
Willamette:					
Eugene, Oreg.	10	7	7	11.5	7
Oregon City, Oreg.	10	7	10	12.2	8–9
Portland, Oreg.	15			13.8	8–9
Santiam:					
Jefferson, Oreg.	10	7	7	10.5	7

ICE IN RIVERS, 1917–1918.

By ALFRED J. HENRY and others.

[Dated: River and Flood Division, Weather Bureau, Mar. 25, 1918.]

The severe and long-continued cold of the winter of 1917–18 caused heavy ice to form on northern rivers, as was to be expected, and pushed the southern limit of heavy ice a little farther south than usual.

Ice began to form on the Ohio as early as December and navigation on the upper and middle stretches of that stream was practically suspended by the middle of the month. The weather during January, 1918, continued unseasonably cold and there was practically no ice movement in any of the streams.

In December the ice in the Ohio had gorged at many places, the most extensive on the upper river being in the tortuous bends immediately above Sugar Creek, an insignificant stream that empties into the Ohio between Warsaw, Ky., and Rising Sun, Ind. (see fig. 1.). A second extensive gorge formed in the vicinity of Evansville, Ind.

The termination of the cold weather came in the closing days of January when a day or so of thawing weather with rain was the occasion of a break-up of the ice in the southern tributaries of the Ohio, the ice passing into the trunk stream on fairly high stages. Short periods of cold weather with night temperatures considerably below freezing were the rule until about February 5, when a decided rise in temperature set in over the Ohio Valley and mild temperatures for the season continued for nearly 10 days.

The most serious gorge in the Ohio, as above stated, was the one that formed above Sugar Creek between Cincinnati and Louisville. Fortunately this gorge did not wholly prevent the flow of water beneath it and as a consequence the channel below the gorge was open and the river was at a comparatively low stage when the gorge finally broke on February 12, after holding firm for 58 days. The history of this gorge is fully set forth in the report of Meteorologist W. C. Devereaux, in charge of the Cincinnati district, page 86.

Recognizing the importance of preserving an account of the ice blockade along the Ohio and Mississippi, the following details are presented by the Weather Bureau officials in charge of respective districts, Pittsburgh, Pa., to Cairo, Ill., on the Ohio and St. Paul, Minn., to Vicksburg, Miss., on the Mississippi.

MISSISSIPPI DRAINAGE.

OHIO RIVER.

Pittsburgh, Pa., river district.

Low temperatures set in on December 1 and continued almost uninterruptedly to February 5, a period of 67 days, with only 6 days when the temperature was above the normal. The accumulated deficiency for December was 317°; for January, 268°; and for the 5 days in February, 88°; or a total deficiency of 673°. The accumulation of snow on the ground ranged from 5 to 10 inches over the Monongahela watershed and from 10 to 30 inches over the Allegheny watershed. Ice formed in the rivers from 1 foot to nearly 3 feet in thickness.

Moderately heavy rains in West Virginia, together with higher temperatures on January 27 to 29, melted most of the snow in the Monongahela Valley, causing a break-up in the Monongahela River. The ice formed an immense gorge below Morgantown and another near Brownsville, the water backing up over the Baltimore & Ohio Railroad tracks at Morgantown, with a stage of 39 feet at Lock No. 10, and 25 feet at Fairmont at 2 p. m. of January 29. The gorge at Brownsville backed up the water over the low ground of that place and shut down many mines in that vicinity, reaching a stage of 21.6 at Greensboro, Pa., on February 10. As the ice in gorge formation moved along it carried away and sunk quite a number of barges and three steamboats. Ice also gorged in the Ohio River near Steubenville, Ohio, and below Wheeling, W. Va., backing up the water at Wheeling to 37.8 feet on February 11. A portion of the ice from the Kiskiminetas lodged in the Allegheny River below Freeport, Pa., but the Allegheny remained frozen throughout.

After the thaw in the latter part of January another period of cold weather set in, with more snow, and the Monongahela again froze over with new ice. Higher temperatures and moderate rains on February 19 caused a break-up in the ice in the Monongahela. The gorges at Morgantown and Brownsville broke up, the ice floated a short distance and disappeared, probably sinking from the weight of sand and mud. None of this ice reached Pittsburgh. The Allegheny ice broke up, beginning in the lower river, and coming out in patches to above Warren, Pa. A gorge formed below Corydon, Pa., a short distance above Warren, backing the water over the town of Corydon, and causing much damage. The gorges in the Ohio also moved out on February 19.

Reports at 8 a. m. of Wednesday, February 20, showed that heavy rain had occurred throughout the watersheds of the Allegheny and Monongahela Rivers, with high temperatures melting the snow and ice in the mountains, causing rapid rises in all streams. At 10 a. m. a flood warning was issued for a stage of 28 feet at Pittsburgh by the next morning. After further reports were received the stage for Pittsburgh was reduced to 27 feet, and a warning issued for 37.5 feet at Wheeling Thursday night. The crest of the flood passed Pittsburgh at 6 a. m. on Thursday, the 21st, with a stage of 27.1 feet, and Wheeling at midnight, Thursday, with a stage of 37.9 feet.

Never before have the conditions as to the accumulated depth of snow on the ground and the heavy formation of ice in the rivers assumed such threatening and dangerous character. The water equivalent of the snow on the ground ranged from about 1 inch over the Monongahela Valley; about 2 inches over the Youghiogheny; and from 2 to 3.50 inches over the Allegheny Valley. Owing to the small amount of rain during January and during the first part of February, and with rising temperatures after February 5, the snow gradually became less and the ice more or less rotten and honeycombed. The ice all moved out of the Youghiogheny without loss, as did also the ice in the Allegheny, with the exception of the gorge formation near Corydon. The destruction of the property along the Monongahela was caused by immense ice gorges with moderate stages of water. The flood of February 20–21 was caused by heavy rain and melting snow; it passed without material loss, and completely cleared all streams of ice.

The direct loss to property due to ice gorges as estimated was one coal tipple destroyed; five tipples damaged; three steamers sunk—but salvaged—and about 20 coal flats sunk. A great loss was entailed by suspension of mining and shipping of coal. Many mines were closed by high water and owing to railroad congestion the shipment of coal was curtailed very little, being shipped by water for several weeks.

SUMMARY OF ESTIMATED LOSSES.

Money loss due to destruction of property	$100,000
Money loss due to suspension of business	200,000
Money saved by warnings	500,000

—*Henry Pennywitt, Meteorologist in Charge.*

Parkersburg, W. Va., river district.

A gorge formed on January 31, 1918, 8 miles below Dam 14, Ohio River, extending 20 miles down the river. This gorge went out at 5.30 a. m., February 11, breaking at a stage of 35 feet. The thickness of the gorge was about 12 feet. Resulting damage, about $1,500.

At Dam 15, Ohio River, the gorge moved at 5 a. m., February 11, and gorged again 3 miles below the dam, when the river at the dam rose from 15 feet to 26.6 feet. The gorge broke again at 2:20 p. m. the same day, and the river was clear at 4 p. m. The thickness of the gorge was about 12 feet. Resulting damage was about $1,500.

Packed ice formed in the Ohio from Dam 19, Ohio River, to Parkersburg, a distance of about 7 miles, on January 12, 1918, and held until 6:10 p. m., February 9, when a movement of 600 feet took place, with a stage of 17 feet at Dam 19. No damage resulted. The ice moved again at 6 a. m., February 10, with a stage of 23 feet at Dam 19, and