Flood of April 1987 in Maine

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Prepared in cooperation with the Maine Department of Transportation

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By RICHARD A. FONTAINE and JOSEPH P. NIELSEN

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
	Length	
inch (in.)	25.40	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Volume	
cubic foot (ft^3)	0.02832	cubic meter
gallon (gal)	3.785	liter
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
cubic foot per second per square mile ($ft^3/s/mi^2$)	0.01093	cubic meter per second per square kilometer

Temperature

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows:

$$°C=(°F-32)/1.8$$

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Flood of April 1987 in Maine

By Richard A. Fontaine *and* Joseph P. Nielsen

Abstract

Snowmelt and precipitation from two storms caused record flooding in April 1987 in central and southwestern Maine. Record peak streamflows were recorded at 13 streamflow-gaging stations. Several peaks were the highest known since the area was settled more than 200 years ago. Statewide damage exceeded $74 million, and 14 of Maine's 16 counties were declared Federal Disaster Areas; fortunately, no lives were lost.

The maximum flood peaks and precipitation were associated with the storm of March 30 through April 2. Precipitation from the storm was concentrated along the eastern side of Maine's western mountains. The two greatest amounts of storm precipitation, 8.36 and 7.33 inches, were observed at Pinkham Notch, N.H., and Blanchard, Maine. Runoff from the first storm was augmented by as much as 4 inches of meltwater from the residual snowpack. Maximum precipitation of 3–5 inches was associated with the storm of April 4–8, primarily in southern Maine.

Rainfall-runoff and storage analyses indicated that flood peaks were reduced by reservoir systems in headwaters of the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins. Flood-crest data obtained at 378 locations along 600 miles of rivers and streams were used to aid in the evaluation of the flood.

INTRODUCTION

Maine's annual spring flooding typically results from runoff of snowmelt accelerated by seasonally high temperatures, rainfall, or a combination of both. Spring floods are often intensified by frozen or saturated soils, lack of evapotranspiration, and ice jams. An additional variable is the influence of reservoir storage on flood peaks. Major reservoirs in Maine are operated primarily to meet commercial needs for hydropower and process water. During the spring runoff season, dam operators attempt to fill their reservoirs. As a result, their management of the reservoirs often helps to mitigate flooding.

The realization that spring flooding in Maine is a complex interaction of hydrologic factors led to the formation of the Maine River Flow Advisory Committee. The committee consists of representatives from operators of eight major reservoir systems, five State agencies, and three Federal agencies. The committee was formed after the spring flood of 1983 to improve the exchange of hydrologic information collected by the members of the committee and to provide information to emergency action agencies and the public. Much of the information contained in this report was obtained from members of the committee.

Data collected before, during, and after floods are valuable to those who must plan for the effects of flooding. Peak-stage, peak-discharge, and flood-frequency data are used in the design of hydraulic structures, such as bridges, culverts, and dams; in calibration of flow models used in flood insurance studies to establish insurance rates; and in local, State, and Federal plans for flood plain development. Snowpack, precipitation, temperature, and runoff data are used in reservoir operations and as advance warning of potential flooding. Analyses of rainfall-runoff relations increase the understanding of the complex interaction of these variables that affect spring flooding; this increased understanding, in turn, helps in planning for mitigation of flood damage.

Provisional rainfall, snow-survey, and peak-stage and discharge data for the April 1987 flood have been published by the U.S. Geological Survey (Fontaine, 1987). This study, done by the U.S. Geological Survey (USGS) in cooperation with the Maine Department of Transportation, updates the previous report and provides additional descriptive data.

Purpose and Scope

This report provides a detailed hydrometeorologic description of the flood of April 1987 in Maine. Precipitation, snow cover, temperature, streamflow, and reservoir storage before and during the flood are documented, and storm characteristics, including temporal and spatial variations of the storm precipitation, are described with reference to data from the statewide precipitation-gage networks and meteorological reports of the National Weather Service. Descriptive flood data include flood discharges and frequencies at 35 streamflow-gaging stations and miscellaneous sites; flood-crest elevations at 378 locations along 600 river miles; and analyses of the effects of reservoir storage, rainfall, and runoff in the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins. In addition, the relation of the April 1987 flood to historical records of previous floods in Maine is reviewed.

Acknowledgments

Precipitation, snow-survey, reservoir-storage, and selected flood-crest data were provided by the National Weather Service, the U.S. Army Corps of Engineers, Central Maine Power Company, Georgia-Pacific Corporation, Great Northern Paper Company, International Paper Company, Kennebec Water Power Company, Maine Public Service Company, Union Water Power Company, U.S. Soil Conservation Service, and Maine Department of Transportation.

HYDROMETEOROLOGIC SETTING

The quantity of runoff and the magnitude of flood peaks derived from a particular storm event depends on the physiography and geology of the watersheds, the antecedent hydrologic conditions within the watersheds, the characteristics of the storm in question, and the relations among these factors (Benson, 1962).

Physiography and Geology

Maine is in the New England physiographic province of the Appalachian Highlands. The diverse topography ranges from the Seaboard Lowlands in southwestern Maine to the White Mountain section in northwestern Maine (Fenneman, 1938). Maine's physiographic divisions are shown in figure 1. The White Mountain section is characterized by irregular uplands and numerous mountain peaks with elevations higher than 3,000 ft. Mount Katahdin, at an elevation of 5,267 ft, is Maine's highest peak and a principal feature in the section. The New England Upland section is an area of gently sloping highlands of as much as 500 ft in elevation, rising above valleys that are often wide and flat. The section is interspersed with some mountains. The Seaboard Lowland section is characterized by flat, plain-like areas and some low hills of as much as 500 ft in elevation.

Bedrock formations in Maine originated primarily as ocean sediments or molten rock from deep within the earth (Maine State Planning Office, 1987, p. 15). During the time when the Appalachian Mountains were formed, the sediments were subjected to intense pressures and temperatures. Resultant metamorphic rocks were subjected to folding, faulting, and uplift, accompanied by intense volcanic activity. Maine's igneous and metamorphic bedrocks are widely exposed in the mountainous and coastal areas of the State. A map of the bedrock geology of Maine was prepared by Osberg and others (1985).

The surficial geology of Maine is primarily the result of glacial erosion and deposition and subsequent marine sedimentation. Most of the State is blanketed by till and stratified drift deposited in irregular depths. In mountainous areas, thin layers of till predominate. In valleys, thick till deposits are commonly buried under marine deposits such as clay. Many areas of sorted sands and gravels are present along rivers and streams; these sorted sand and gravels form the principal aquifers in Maine. A map describing the surficial features of Maine was prepared by Thompson and Borns (1985).

The physiography and geology of the flood-study area are defining factors in the hydrologic response of the river basins. For example, steep headwater areas with little or no overburden lead to rapid rainfall-runoff response. The complexity of Maine's physiography and geology and the large

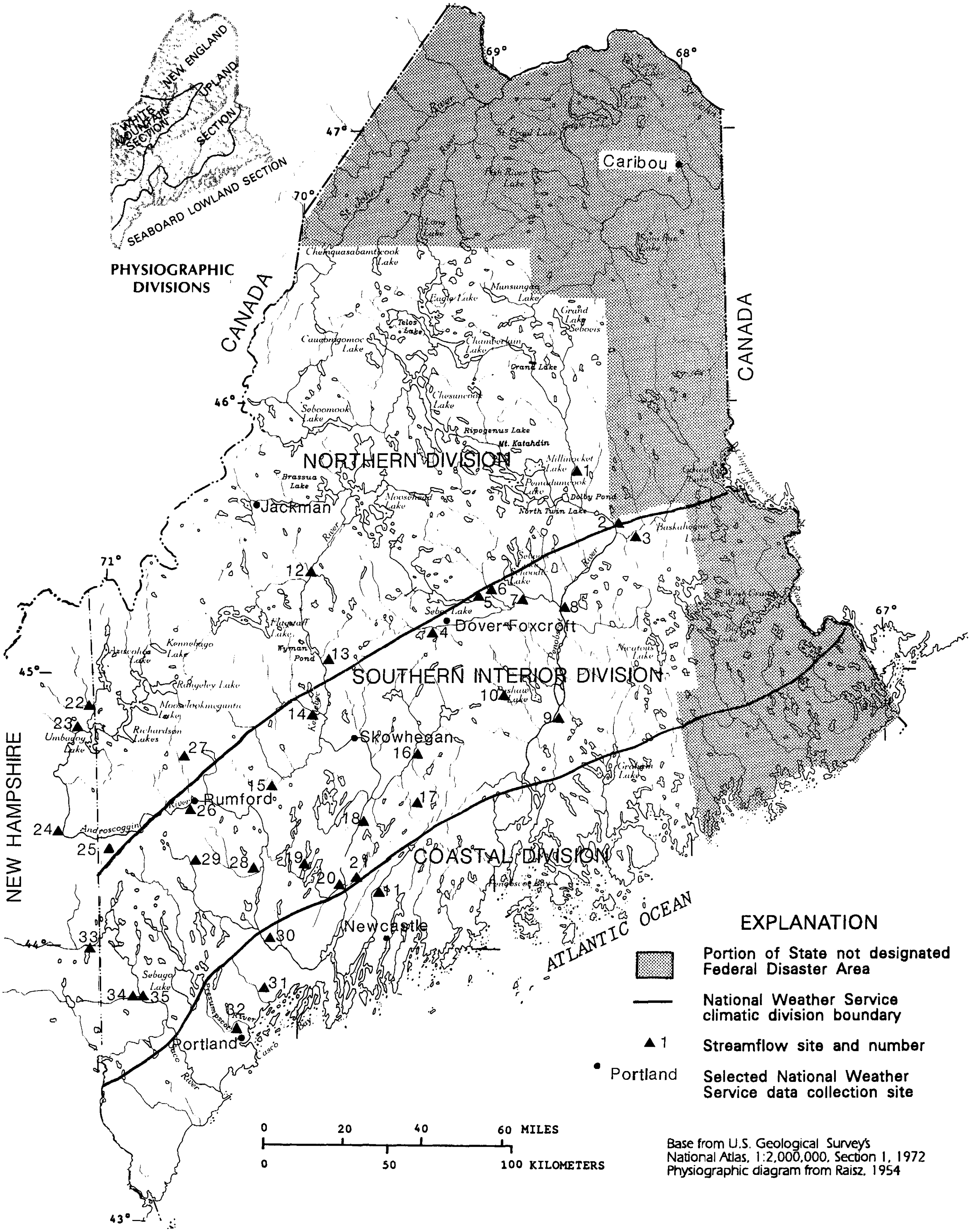

Figure 1. Locations of National Weather Service climatic divisions, physiographic divisions, and streamflow-data-collection sites in the flood-study area.

areal extent of the 1987 flood make presentation of detailed analyses impractical in this summary report. Readers are referred to cited references for greater detail.

Antecedent Hydrologic Conditions

For this study, the antecedent period was assumed to begin in December 1986. The primary source of meteorologic data for the analyses discussed in this report is the National Weather Service (NWS). Meteorologic variability in Maine is commonly summarized with reference to the three climatic divisions that the NWS has established for Maine: northern, southern interior, and coastal divisions. The areal extent of the three climatic divisions and locations of selected NWS data-collection sites discussed in this section are shown in figure 1.

Summaries of daily maximum and minimum air temperatures, snow depth, and daily precipitation data at four index sites are shown in figures 2–5 (National Oceanic and Atmospheric Administration 1986–87a). In addition, streamflow at nearby streamflow-gaging stations is shown in figures 3–5. These four NWS gages, at Jackman, Dover-Foxcroft, Rumford, and Newcastle, Maine, span the study area in terms of spatial coverage and climatic variability (fig. 1). Average precipitation and departures from normal for each climatic division are given for the period December 1986 through April 1987 in table 1, and average air temperatures and departures from normal are given in table 2 (National Oceanic and Atmospheric Administration, 1986–87b).

Average precipitation for December was below normal in the northern and southern interior divisions of the State and slightly above normal in the coastal division. Average temperatures for December were normal or slightly above normal statewide. As represented by the four index sites, the first substantial snowfall of the winter occurred December 9–10. The greatest accumulations were in the northern part of the State. Minor additional amounts of snow fell in December, but much of the snowpack had melted by the end of the month in the southern part of the State. Two noteworthy storms over the coastal and southern interior divisions of Maine in December resulted in 1.57–3.02 in. of rain at the index sites during December 3–4 and 0.63–2.20 in. of mixed precipitation during December 25–26. These storms were the last substantial storms consisting predominantly of rainfall to occur before the storms that caused the record flooding in late March and early April 1987.

Average precipitation for January continued to be below normal in the northern division. Average precipitation was slightly above normal in the southern interior and coastal divisions. Average temperatures in January were below normal statewide. At Jackman, the temperature exceeded 32°F only once in January when it reached a high of 35°F on the 15th. Consequently, most of the January precipitation was snow. Noteworthy snow accumulations occurred at each of the four index sites. In Portland, the 50.7 in. of snowfall in January was 31.5 in. above normal for the month. This snowfall was the fourth highest in Portland for any January in the last 100 years (Fontaine and Maloney, 1990, p. 41). The typical January thaw did not occur.

Average precipitation for February was well below normal statewide. Precipitation at the four index sites ranged from 0.14 in. at Rumford to 0.86 in. at Dover-Foxcroft. In comparison, normal precipitation in the northern, southern interior, and coastal divisions was 2.48, 3.24, and 3.84 in., respectively. In Portland, only 0.04 in. of precipitation fell in February, the lowest for any month since March 1871 when records began in Portland (Fred Ronco, National Weather Service, oral commun., 1987). Average temperatures for the month remained below normal statewide.

Average precipitation in March was below normal for the fourth consecutive month in the northern division. From December 1986 through March 1987, the cumulative departure from normal there was −4.87 in. The normal precipitation in the northern division from December through March is 11.29 in. Departures from normal precipitation in the southern interior and coastal divisions were +0.30 and −0.16 in., respectively. Precipitation data for March are deceiving because the storm that caused the flooding in late March and early April brought substantial precipitation to areas in all three climatic divisions on March 31. For example, rainfall on March 31 totaled 1.51 in. at Newcastle, and 4.42 in. at Rumford.

Average temperatures were above normal statewide after two consecutive months when temperatures were below normal. The last days when the daily maximum temperature was less than 32°F were March 11 at Newcastle, March 12 at Dover-

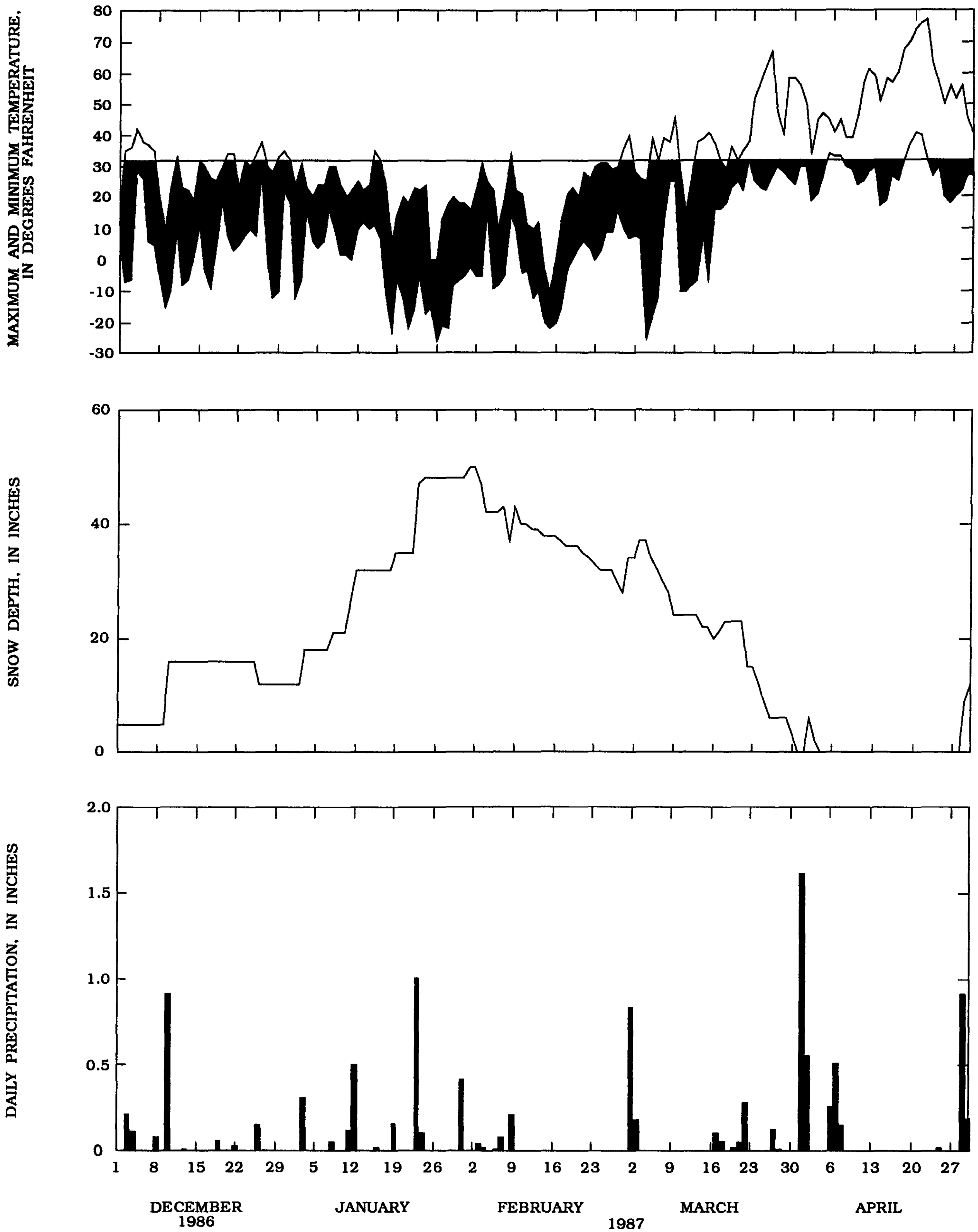

Figure 2. Daily maximum and minimum temperature, snow depth, and precipitation, December 1986 through April 1987, Jackman, Maine.

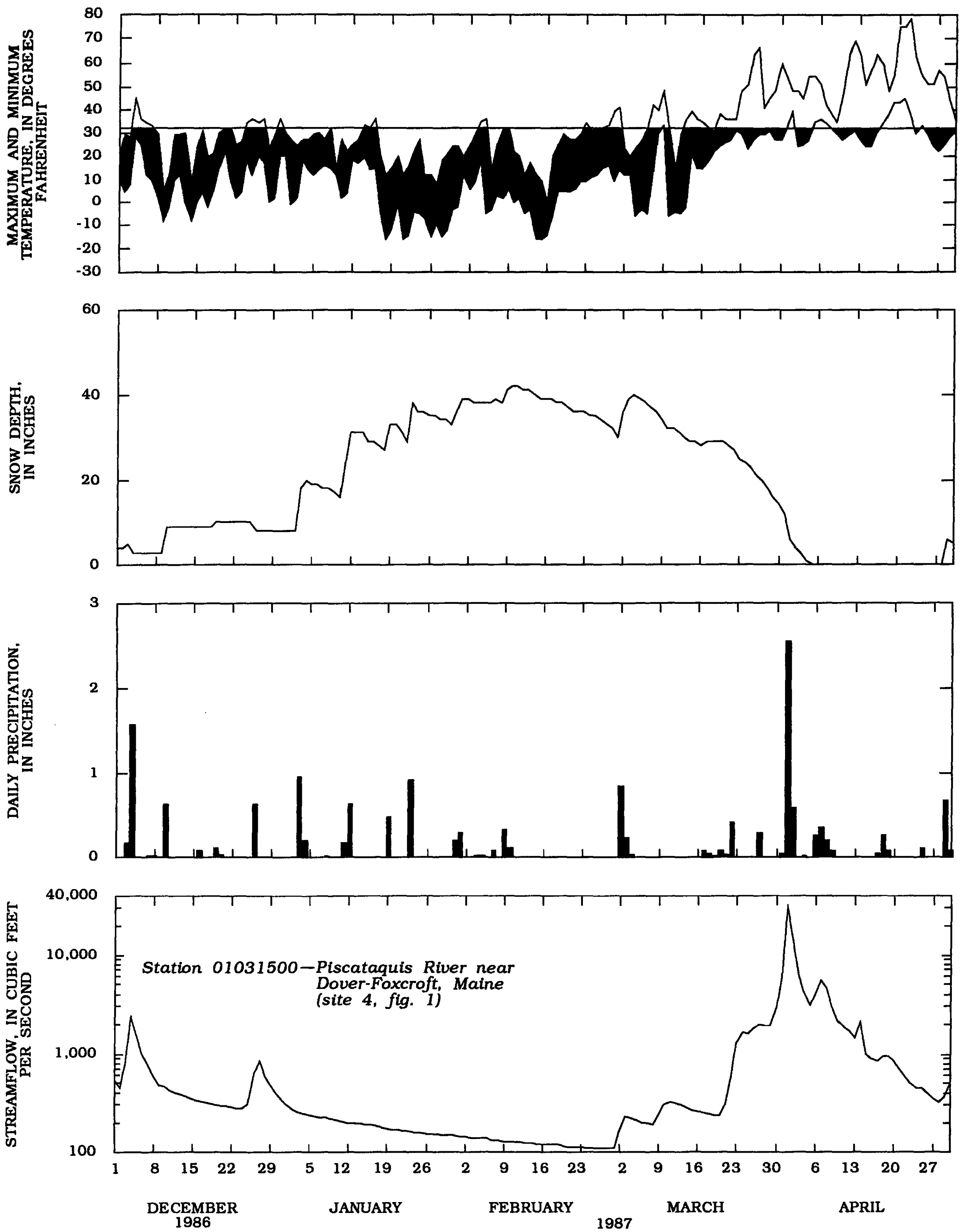

Figure 3. Daily maximum and minimum temperature, snow depth, precipitation, and streamflow, December 1986 through April 1987, Dover-Foxcroft, Maine.

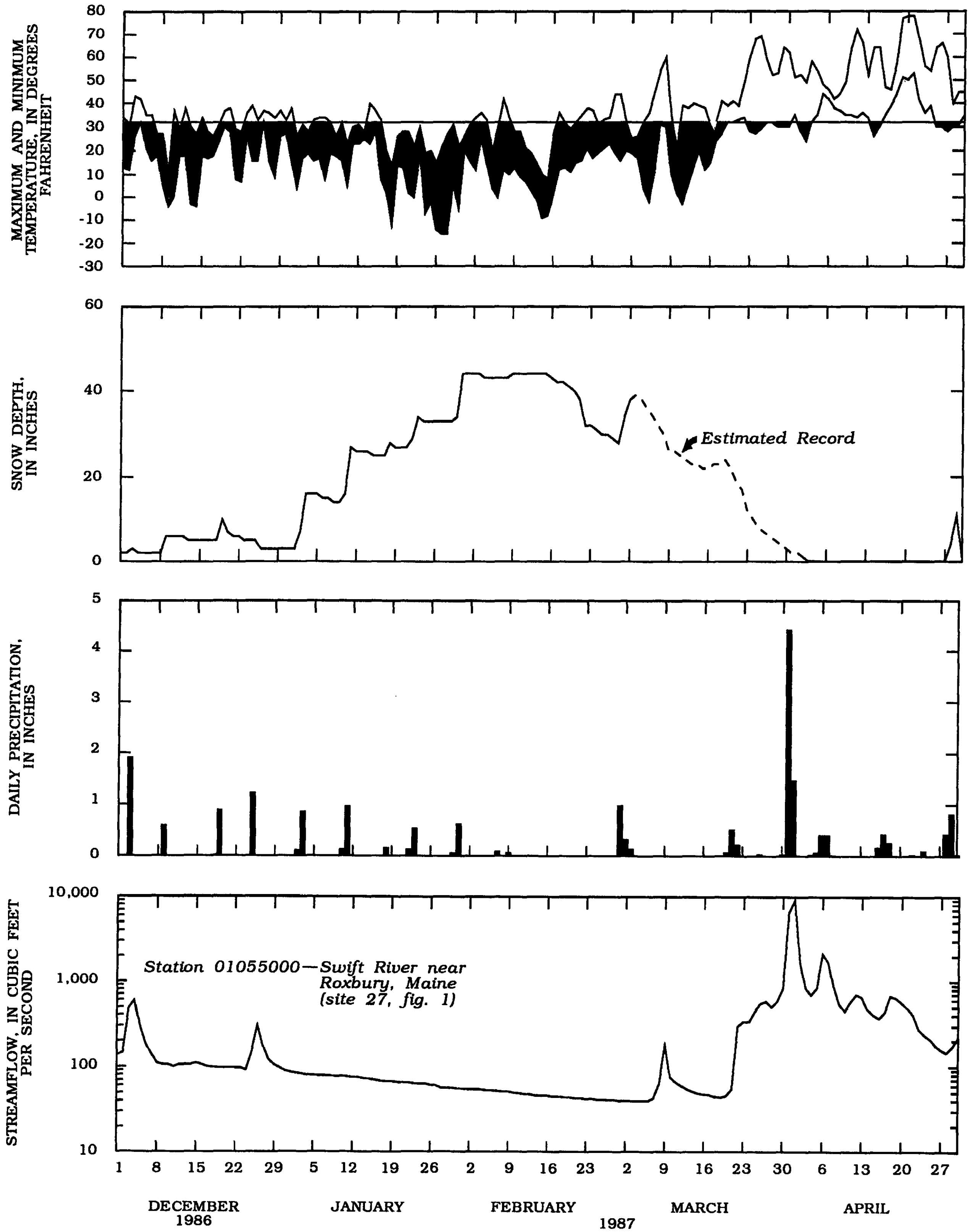

Figure 4. Daily maximum and minimum temperature, snow depth, precipitation, and streamflow, December 1986 through April 1987, Rumford, Maine.

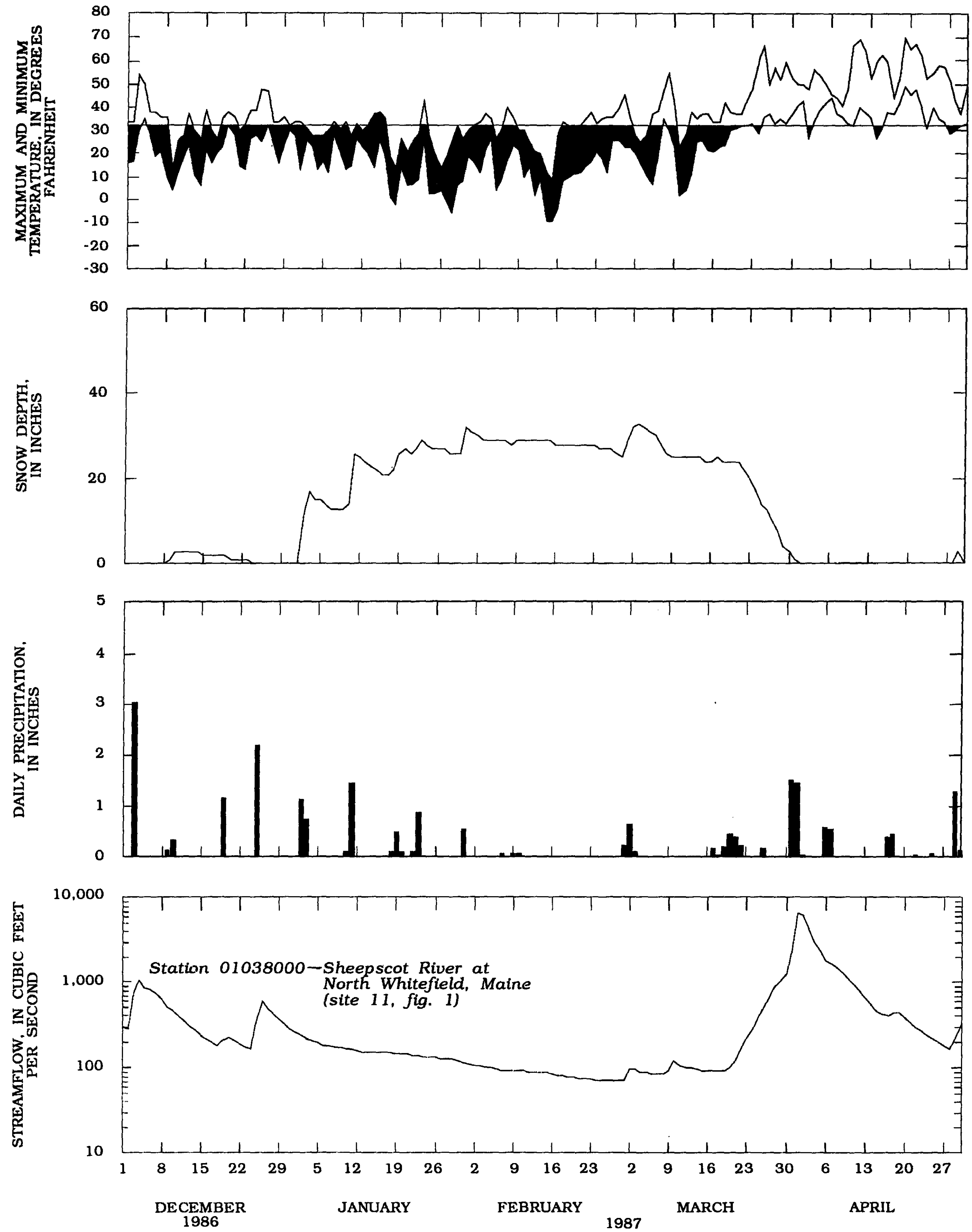

Figure 5. Daily maximum and minimum temperature, snow depth, precipitation, and streamflow, December 1986 through April 1987, Newcastle, Maine.

Table 1. Average precipitation and departures from normal in National Weather Service climatic divisions for Maine, December 1986 through April 1987

[Data in inches, furnished by National Weather Service]

Month	Northern			Southern interior			Coastal		
	Average precipitation	Departure from normal[a]	Cumulative departure from normal[a]	Average precipitation	Departure from normal[a]	Cumulative departure from normal[a]	Average precipitation	Departure from normal[a]	Cumulative departure from normal[a]
December	1.90	−1.54	−1.54	3.54	−0.66	−0.66	5.30	0.36	0.36
January	2.41	−.30	−1.84	3.99	.57	−.09	5.18	.98	1.34
February	.34	−2.14	−3.98	.63	−2.61	−2.70	.63	−3.21	−1.87
March	1.77	−.89	−4.87	3.76	.30	−2.40	3.83	−.16	−2.03
April	3.36	.50	−4.37	4.42	.87	−1.53	4.73	.74	−1.29

[a]Averaging period 1951–80.

Foxcroft, March 16 at Rumford, and March 18 at Jackman.

As depicted at the four index sites in figures 2–5, the accumulation and melting of the snowpack is a dynamic process that typically begins in December and ends in late March and April. In addition to snow depth, descriptive characteristics such as density and water content of the snowpack before the 1987 flood are factors affecting flood potential. Detailed compilations of snow-depth and water-content data have been made since 1941 in Maine. Unfortunately, budgetary constraints of the 1970's and the early 1980's greatly reduced the scope of the snow-survey program in Maine (Loiselle and Keezer, 1991). In 1987, data were only available at a few sites from the NWS and operators of hydroelectric storage reservoirs (Fontaine, 1987, table 1). No snow data were available for large areas of Maine. A detailed analysis of snowpack in Maine just before the 1987 flood was not done owing to the meager snowpack data.

The NWS publishes daily snow-depth and water-content data for two sites in Maine: Portland and Caribou (National Oceanic and Atmospheric Administration 1986–87a). These data are used to determine snow density, which is the ratio between the volume of melt water derived from a sample of snow and the initial volume of the sample (Langbein and Iseri, 1960). Daily average snow densities at Portland and Caribou are summarized in figure 6. The seasonal ripening or increasing density of the snowpack is evident from these plots.

Data from the historical snow-survey program are summarized in a report by Hayes (1972), which includes a map depicting average water content of snow cover on March 1. Conditions in 1987 were compared with these long-term (1941–65) averages by converting snow-depth data published by the NWS for selected sites in Maine to water content, in inches. The conversion was based on snow-depth data at the sites multiplied by snow-density data for either Caribou or Portland (fig. 6). Snow-density data from Caribou were assumed to be representative of average snow densities in the northern division and in the upland sections of the southern interior division. Snow-density data from Portland were

Table 2. Average temperatures and departures from normal in National Weather Service climatic divisions for Maine, December 1986 through April 1987

[Data in degrees Fahrenheit, furnished by National Weather Service]

Month	Northern		Southern interior		Coastal	
	Average temperature	Departure from normal[a]	Average temperature	Departure from normal[a]	Average temperature	Departure from normal[a]
December	16.9	−0.1	23.7	1.3	27.6	1.1
January	9.5	−2.3	16.0	−1.8	19.9	−2.3
February	11.8	−1.7	18.4	−1.1	20.8	−2.5
March	26.7	2.1	31.2	1.4	32.6	.3
April	42.9	5.7	45.4	3.8	44.4	1.7

[a]Averaging period 1951–80.

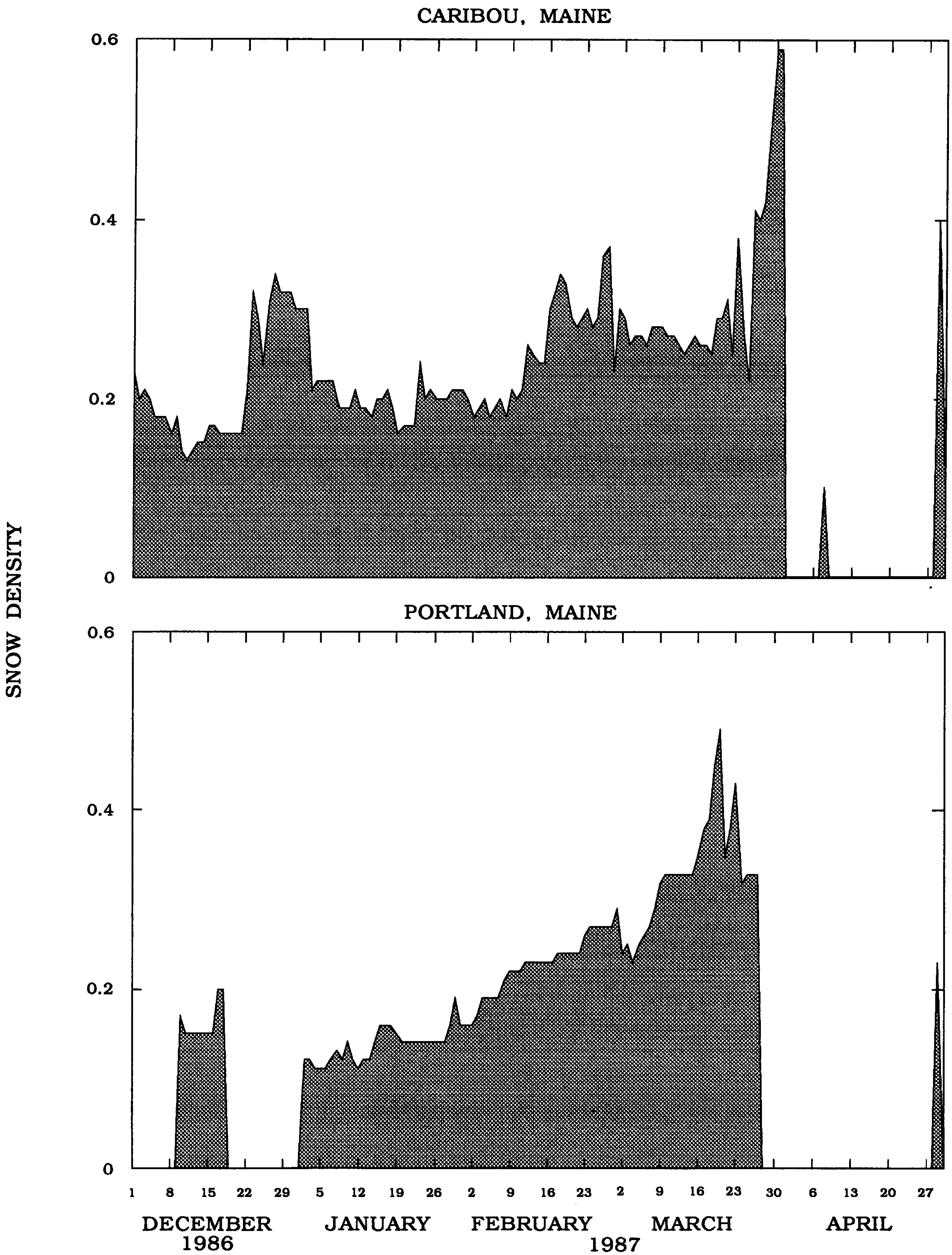

Figure 6. Daily average snow density, December 1986 through April 1987, Caribou and Portland, Maine.

Table 3. Depth, density, and water content of snow at National Weather Service snow-data sites in Maine

National Weather Service snow site (see fig. 7)	Snow depth[a] March 1 (inches)	Snow density	Water content		
			Estimated March 1, 1987 (inches)	Normal[d] for March 1 (inches)	Departure from normal (inches)
Northern division					
Caribou	23	0.23	5.3	6.2	−0.9
Fort Kent	16	[b].23	3.7	6.5	−2.8
Jackman	28	[b].23	6.4	7.7	−1.3
Squa Pan Dam	32	[b].23	7.4	6.5	.9
Southern interior division					
Augusta	18	[c].27	4.9	4.1	.8
Bangor	15	[c].27	4.0	4.1	−.1
Dover-Foxcroft	32	[b].23	7.4	6.1	1.3
Rumford	28	[b].23	6.4	6.0	.4
Springfield	42	[b].23	9.7	5.4	4.3
Vanceboro	19	[b].23	4.4	5.5	−1.1
Coastal division					
Newcastle	25	[c].27	6.8	2.8	4.0
Portland	18	.27	4.8	2.9	1.9

[a]Data furnished by National Weather Service.
[b]Density assumed equal to measured value at Caribou.
[c]Density assumed equal to measured value at Portland.
[d]From Hayes (1972).

assumed to be representative of average snow densities in the coastal division and in the lowland sections of the southern interior division. Snow-depth, snow-density, and water-content data are summarized in table 3. Although data are not extensive, water content at the selected sites seems to be below normal in the northern division, normal in the southern interior division, and above normal in the coastal division.

Hayes (1972) also prepared a figure that depicted the average date of maximum water content of the snowpack in Maine. In the area of major flooding in 1987 (fig. 1), the date of maximum water content ranges from March 10 to March 25. Available snow data were compiled, and a map showing water content of the snow as of March 18, 1987, was developed by the NWS (Federal Emergency Management Agency, 1987a, attachment II-4). The water-content map is reproduced in this report as figure 7. Water content of the snowpack as of mid-March, 1987 ranged from 4 to 6 in. along the coast and from 6 to 10 in. in upland areas of northern and western Maine.

In mid-March 1987, snow densities averaged 0.25 within the northern division and upland sections of the southern interior division and 0.30 within the coastal division and in lowland sections of the southern interior division (Fontaine, 1987, table 1). Average temperatures were above normal statewide (table 2). During an unusually warm period from mid- to late March, maximum daily temperatures in the 50's and 60's (°F) were common (fig. 2–5). The high (>0.35) snowpack densities and above-normal air temperatures combined to reduce the water content of the snowpack before the flooding. Detailed snow data are not available for the days just before the heavy rains that began on March 31. Bruce Budd of the NWS in Portland noted that the snow had virtually disappeared south of Skowhegan by the end of March. He also noted that depths less than 1 ft remained in the upper valleys, and depths greater than 1 ft remained in wooded areas and in higher terrain (Budd, 1988, p. 13). If snow densities are assumed to have been 0.35, more than 4 in. of snowpack water content could have been available for runoff in parts of the flood-stricken area.

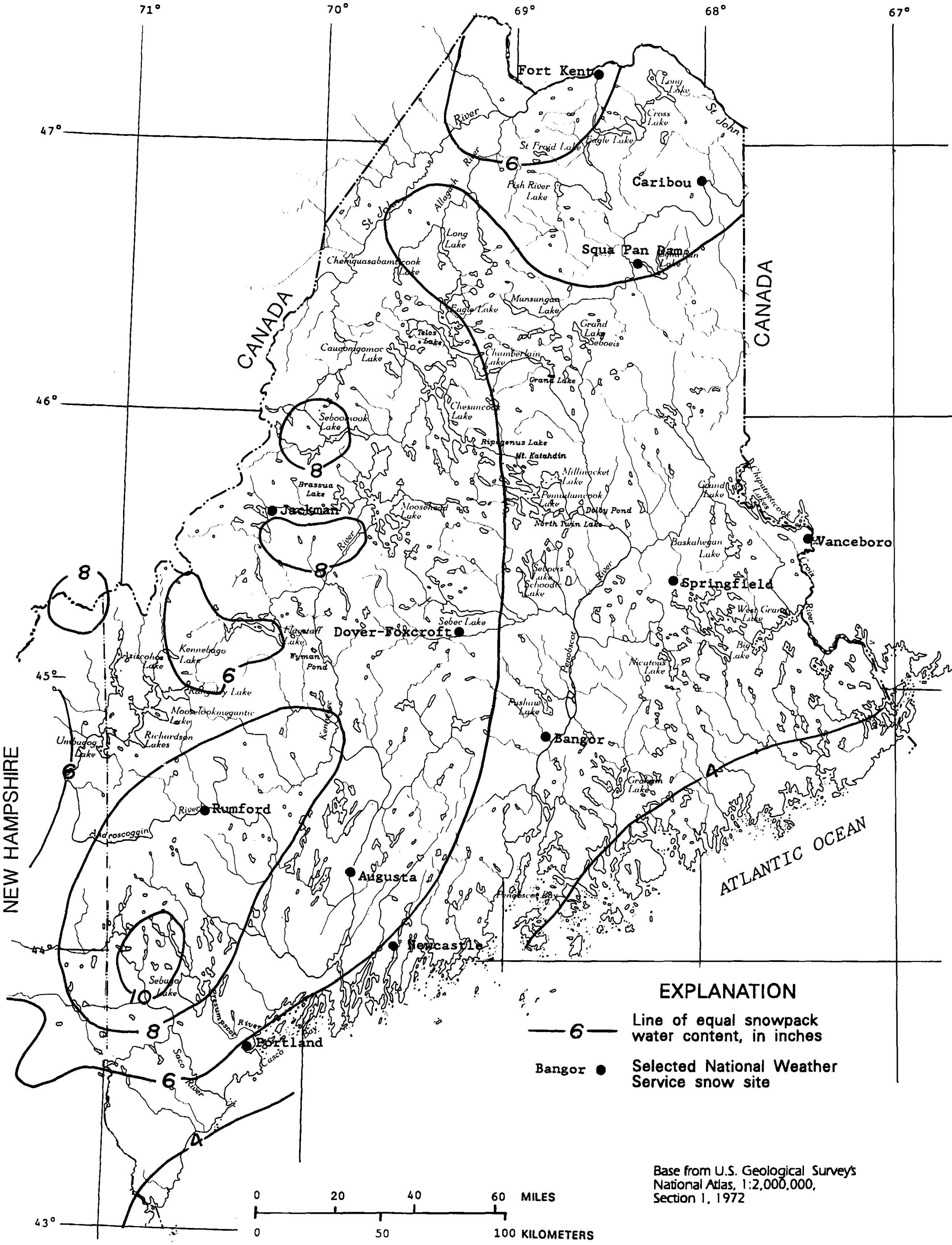

Figure 7. Water content of the snowpack in Maine as of March 18, 1987.

Table 4. Runoff and percentage of normal for December 1986 through April 1987 at index streamflow-gaging stations

Month	Piscataquis River near Dover-Foxcroft (site 4)		Sheepscot River at North Whitefield (site 11)		Swift River near Roxbury (site 27)	
	Runoff (inches)	Percentage of normal[a]	Runoff (inches)	Percentage of normal[b]	Runoff (inches)	Percentage of normal[c]
December	2.16	181	3.23	142	1.82	130
January	.75	76	1.28	86	.84	96
February	.44	66	.62	49	.51	79
March	3.33	213	2.55	88	4.66	332
April	12.03	155	9.79	169	10.33	140

[a]Based on period of record 1903–88 water years.
[b]Based on period of record 1939–88 water years.
[c]Based on period of record 1930–88 water years.

Runoff

Streamflow records for the months before the flood provide additional information on antecedent hydrologic conditions. The temporal relations between air temperature, snow depths, precipitation, and runoff are shown in figures 3–5. Monthly runoff at the three index streamflow sites shown in figures 3–5 and the relations between monthly runoff and normal flows are shown in table 4. Runoff index stations were selected to be unregulated flow sites near the NWS index sites. No runoff index station was available near Jackman (fig. 1).

Runoff in December was above normal at each of the three index sites, primarily as a result of rainstorms on December 3–4 and on December 25–26. Runoff from these two storms and the associated meltwater from snowpack depletion contributed to the above-normal runoff for the month. Resultant streamflow peaks for the storms clearly stand out on the hydrographs in figures 3–5.

Runoff during January and February was below normal at each of the three index sites. During these months, most precipitation was snow, and below-normal temperatures limited snowmelt. Discharge hydrographs for the sites clearly demonstrate normal winter streamflow recession and the lack of substantial rainfall or snowmelt runoff during January and February.

During March, runoff was well above normal at the Piscataquis and Swift River sites and slightly below normal at the Sheepscot River site. This is deceiving because runoff after the start of the flood on March 31 contributed 22, 54, and 25 percent of the monthly runoff totals at the Piscataquis, Swift, and Sheepscot River sites, respectively (U.S. Geological Survey, 1989, p. 59, 74, and 103). Except for the March 31 runoff, most of the runoff in March was derived from snowmelt. Above-normal runoff at the Piscataquis River and Swift River sites can be attributed to above-normal temperatures, which accelerated snowmelt. The Piscataquis and Swift Rivers drain upland areas along the divide between the northern and southern interior divisions. In contrast, virtually complete snowpack depletion common during March in the coastal division explains the near normal runoff at the Sheepscot River site. Runoff increased as a result of increased snowmelt at each of the three index sites in the days immediately before the onset of the 1987 flood. Daily mean discharges for March 30 at the Piscataquis, Swift, and Sheepscot River sites were compared to the maximum daily mean discharges during the flood. (March 30 was selected because it was the last day before the start of the storm.) March 30 streamflow was 9.1, 9.0, and 19.1 percent of the storm-peak daily streamflow at the Piscataquis, Swift, and Sheepscot River sites, respectively.

Storage

Significant regulation of large hydroelectric storage reservoirs takes place in the headwater reaches of several streams affected by the 1987 flood. Storage capacity is considerable in the headwaters of the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins (fig. 8). This storage is divided into systems of multiple reservoirs within each basin that act together to regulate flow in the basin. The primary function of these reservoir systems is to maximize hydropower generation at downstream dams (Hasbrouck, 1987, p. 3). Water for hydropower generation is stored during peak runoff and is released during subsequent low-flow

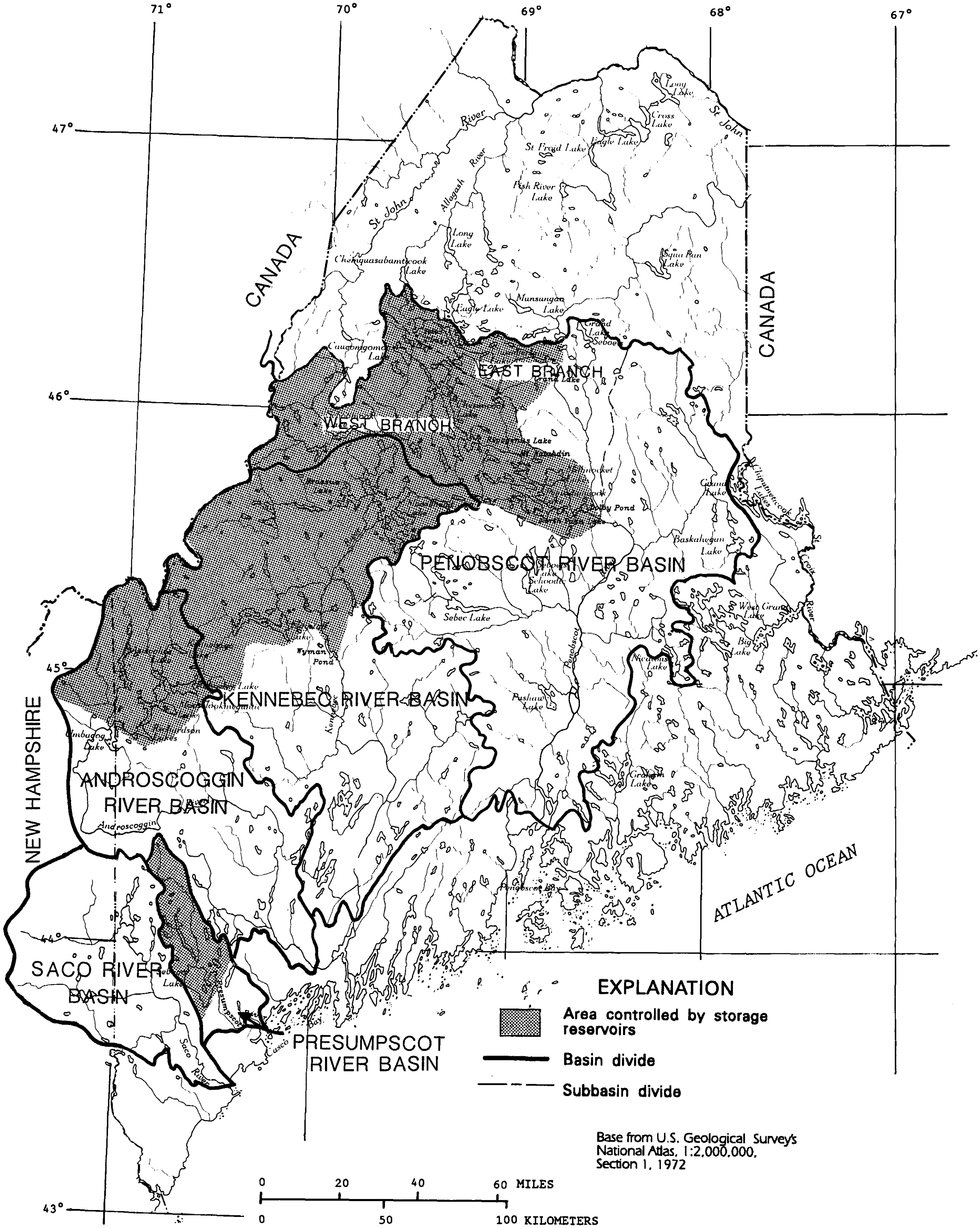

Figure 8. Major river-basin divides and area upstream from storage reservoirs.

periods. This basic operational format enables the storage systems to provide some measure of flood control because reservoirs are slowly drawn down through the winter and are refilled during the spring runoff.

In the Penobscot River basin, more than 90 percent of storage-reservoir capacity is in headwater areas of the East and West Branches (U.S. Army Corps of Engineers, 1990, p. 6). Storage capacity in the East Branch of the Penobscot River is controlled by the Bangor Hydro-Electric Company at dams at the outlets of Chamberlain, Telos, and Grand Lakes. Storage capacity in the West Branch of the Penobscot is controlled by the Great Northern Paper Co. (GNP). West Branch storage is controlled primarily by dams at the outlets of Ripogenus and North Twin Lakes. Numerous smaller lakes and ponds contribute additional storage capacity in the basin.

Storage capacity in the Kennebec River basin, primarily upstream from Wyman Lake (U.S. Army Corps of Engineers, 1987), is controlled by Central Maine Power Company or Kennebec Water Power Company. Major storage reservoirs include Brassua, Flagstaff, and Moosehead Lakes.

Storage capacity in the Androscoggin River basin, primarily upstream from Errol Dam in New Hampshire, is controlled by Union Water Power Company. Major storage reservoirs in the Androscoggin River basin include Rangely, Mooselookmeguntic, Upper and Lower Richardson, Aziscohos, and Umbagog Lakes (U.S. Army Corps of Engineers, 1989). Storage capacity in the Presumpscot River basin is primarily in Sebago Lake. Sebago Lake is controlled by the S.D. Warren Company. Human-controlled storage capacity in the Saco River basin is virtually nonexistent.

Drainage areas and usable storage capacities upstream from Grand Lake Dam (East Branch Penobscot River), Dolby Pond Dam (West Branch Penobscot River), Wyman Lake Dam (Kennebec River), Errol Dam (Androscoggin River), and Sebago Lake Dam (Presumpscot River) are shown in table 5. Inches of runoff is also shown as a relative indicator of the magnitude of usable storage capacities. Inches of runoff is the depth of water the usable storage capacity would represent if spread uniformly over the drainage basin. Drainage areas of the selected river basins also are given in table 5. Drainage-area data indicate that usable storage capacity controls runoff from approximately 30 percent of the Penobscot, 44 percent of the Kennebec, 30 percent of the Androscoggin, and 68 percent of the Presumpscot River basins.

Table 5. Usable storage capacity in the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins

[Mft^3, million cubic feet; dash indicates not computed]

Location	Drainage area (mi^2)	Usable storage capacity[a] (Mft^3)	Inches of runoff[b]
Penobscot River Basin			
Grand Lake Dam	[c]493	6,820	6.0
Dolby Pond Dam	[c]2,114	57,000	11.6
Penobscot River at mouth.	[c]8,592	—	—
Kennebec River Basin			
Wyman Lake Dam	[d]2,619	[g]46,308	7.6
Kennebec River at Inlet to Merrymeeting Bay.	[d]5,893	—	—
Androscoggin River Basin			
Errol Dam	[e]1,046	28,100	11.6
Androscoggin River at Inlet to Merrymeeting Bay.	[e]3,524	—	—
Presumpscot River Basin			
Sebago Lake Dam	[f]440	9,700	9.5
Presumpscot River at mouth.	[f]647	—	—

[a]Source, U.S. Geological Survey (1986–1987).
[b]Calculated as usable storage divided by drainage area.
[c]Source, Fontaine (1981).
[d]Source, Fontaine (1980).
[e]Source, Fontaine (1979).
[f]Source, Cowing and McNelly (1978).
[g]Does not include Indian Pond and Wyman Lake.

Human-controlled storage is typically released during the winter and is replenished during spring snowmelt. Monthend contents and long-term average monthend contents of reservoirs, expressed as percentages of usable storage capacity for individual river basins, are given in table 6 for December 1986 through April 1987 (U.S. Geological Survey, 1986–87). Monthend contents of reservoirs in Maine are summarized and are compared to long-term average monthend contents by the USGS in the monthly publication "Current Water Resources Conditions in Maine" (U.S. Geological Survey, 1986–87). Cumulative monthly totals for seven reservoir systems for December 1986 through April 1987 are plotted in figure 9. Data shown in figure 9

Table 6. Monthend contents and long-term average monthend contents of reservoirs, in percentage of usable storage capacity, for selected river basins in Maine, December 1986 through April 1987

[Data from U.S. Geological Survey, 1986–87]

Month	West Branch Penobscot River basin		East Branch Penobscot River basin		Kennebec River basin		Androscoggin River basin		Presumpscot River basin	
	Monthend	Average	Monthend	Average	Monthend	Average	Monthend	Average	Monthend	Average
December	61	53	47	58	54	65	56	58	54	45
January	52	45	31	48	39	56	43	48	42	45
February	40	38	27	30	18	44	29	38	31	44
March	35	31	32	17	26	39	35	33	39	54
April	84	59	86	54	88	76	80	67	92	79

indicate that the total volume of water in storage was consistently below the long-term average during winter 1986–87. At the end of February 1987, for example, long-term average storage for the seven systems was 41 percent of capacity, whereas actual storage was only 29 percent of capacity. The capacity to store greater amounts of runoff than normal was available before the start of the April 1987 flood.

Availability of above-average storage capacity at the end of February 1987 varied by basin. As noted in table 6, storage levels in the Penobscot River basin were nearly normal. In the Kennebec, Androscoggin, and Penobscot basins, storage was below normal. For example, in the Kennebec basin, long-term average storage at the end of February is 44 percent of capacity. In February 1987, storage was only 18 percent of capacity.

Storm Characteristics

On March 28, 1987, a storm system formed over Oklahoma (Budd, 1988). This storm system brought high winds and heavy snow to an area that extended from the Dakotas south to the Texas Panhandle. During the next 2 days, the storm moved northeast to Ohio and brought heavy snow with it. On March 31, the storm continued to travel northeast toward Quebec. An extended cold front trailed southward from the storm. Over Virginia, a new area of low pressure formed along the cold front. This area of low pressure moved slowly northeast and brought heavy rain to Maine on March 31. The slowness of the low-pressure center caused an extended period of southeast winds over Maine. The southeast winds moved almost perpendicular to the mountain ranges in western Maine (Fontaine, 1987). The slowness of the storm and orographic effects combined to cause extremely high rainfall in the mountainous headwaters of rivers in southwestern and central Maine. Rainfall from the storm started early on March 31 and continued over most areas until the early evening hours of April 1 (National Oceanic and Atmospheric Administration, 1987). Rainfall distribution in the study area from March 30 through April 2 is shown in figure 10.

While the rain from the first storm was ending, another area of low pressure was developing

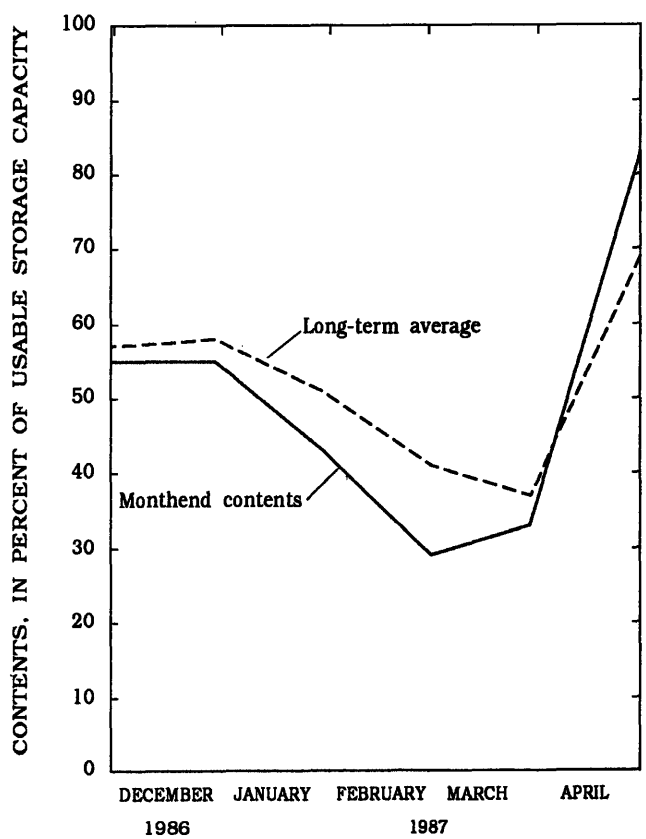

Figure 9. Monthend contents and long-term average monthend contents for seven reservoir systems in Maine, December 1986 through April 1987.

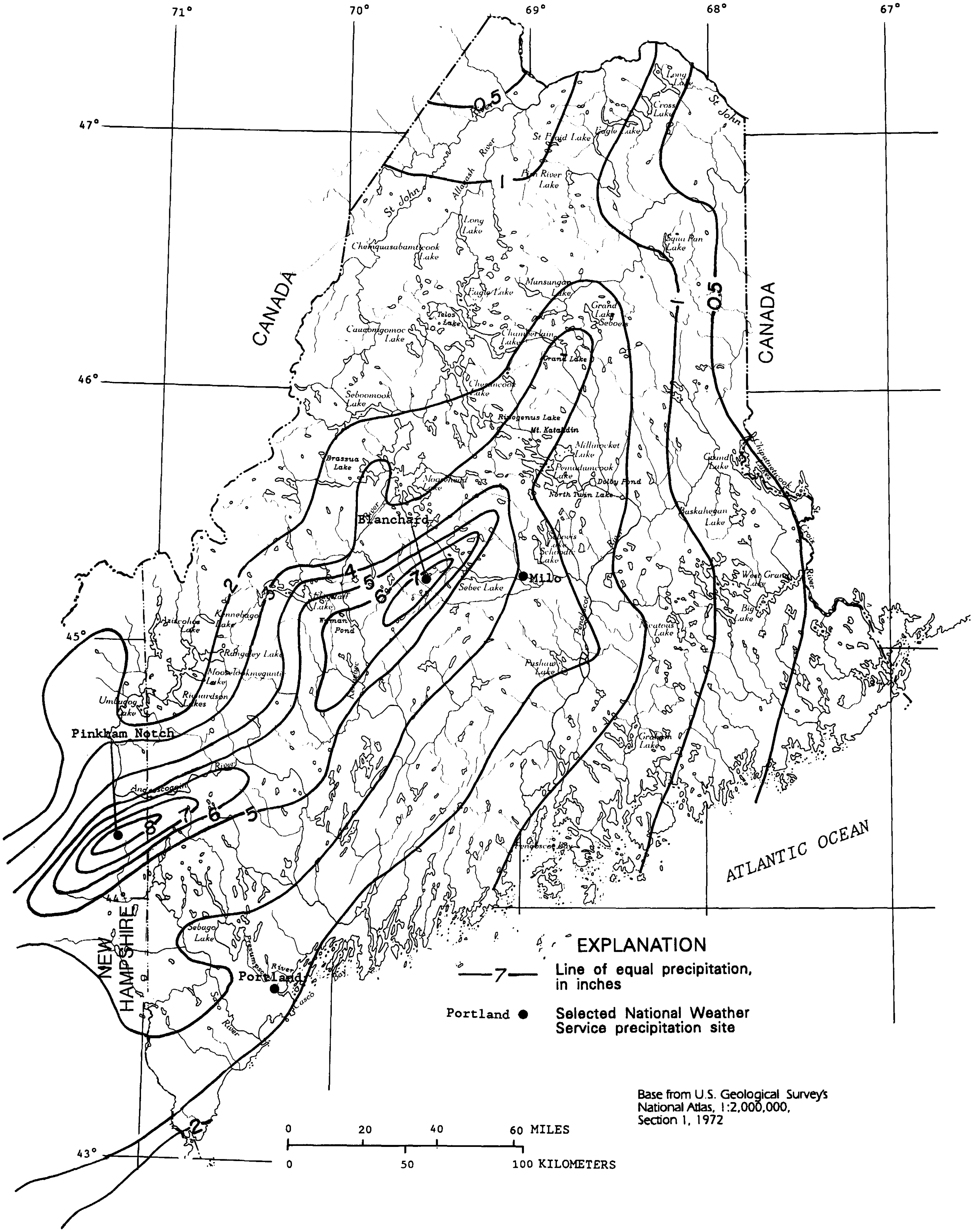

Figure 10. Distribution of precipitation for the storm of March 30 through April 2, 1987.

over the Carolinas. This low-pressure area also moved slowly to the northeast toward New England (Fred Ronco, National Weather Service, written commun., 1987). Rain from this second storm fell over the study area primarily during April 5–7. The storm track and wind direction associated with the April 5–7 storm differed from those of the first storm. Large amounts of rain fell in parts of southern Maine that were not greatly affected by the first storm. Rainfall distribution over the study area for April 4–9 is illustrated in figure 11.

A detailed meteorologic account of the flood of April 1987 has been written by Budd (1988).

Precipitation

The magnitude and distribution of precipitation over time and area are critical in flood analysis. The 1987 flood was associated with two storms. Precipitation from the first storm was concentrated along the windward or ocean sides of the mountains of western Maine (fig. 10). Two distinct centers of extreme precipitation, Pinkham Notch, N.H., and Blanchard, Maine, recorded 8.36 and 7.33 in. of precipitation (Budd, 1988, p. 7). Along the southeastern side of the mountains between Pinkham Notch and Blanchard, precipitation ranged from 5 to 7 in. Along the leeward, or northwestern sides of the mountains, precipitation ranged from 2 to 4 in. Precipitation from the second storm, concentrated primarily in southern Maine (fig. 11), ranged from 3 to 5 in. Precipitation in most of the mountainous area between Pinkham Notch and Blanchard was less than 2 in. during the second storm. Neither of the two storms produced sufficient precipitation to cause flooding in extreme northern and southeastern Maine. Cumulative rainfall totals for the two storms at selected stations were summarized by Fontaine (1987, table 2).

Cumulative precipitation curves for Portland and Milo, Maine, and Pinkham Notch, N.H., were developed to illustrate the variability of rainfall accumulation with time (fig. 12). Portland received roughly equal precipitation during both storms. The NWS gage at Portland recorded the greatest precipitation total of any hourly gage in Maine during the second storm, and the NWS gage at Pinkham Notch recorded the greatest total precipitation during the first storm and also during the combined storm periods from March 30 to April 9. The NWS hourly gage at Milo was closest to the extreme precipitation center surrounding Blanchard, Maine.

Hourly precipitation data for Portland and Milo, Maine, and Pinkham Notch, N.H., (plotted in fig. 12) were analyzed. Maximum rainfall for selected durations and times of occurrence are summarized in table 7.

At Portland, maximum precipitation intensities occurred in the morning and early afternoon of March 31. In the upland areas represented by Pinkham Notch and Milo, maximum precipitation intensities occurred in the evening of March 31 and early morning of April 1.

Rainfall-frequency relations for storms of selected durations at Portland and Milo, Maine, and Pinkham Notch, N.H., are summarized in table 8. Comparison of data in tables 7 and 8 indicates that the maximum short-duration precipitation intensities during the storms of March 30 to April 9 were not unusual. In fact, one could expect the maximum precipitation for periods of 3–6 hours duration, which occurred during the 1987 flood, to be equalled or exceeded, on average, as frequently as once a year. Maximum precipitation at Portland for periods as much as 48 hours in duration never reached recurrence intervals as high as 2 years. At Milo, recurrence intervals of maximum precipitation totals for 24 and 48 hours were approximately 5 years; however, the precipitation distribution at Milo, shown in figure 12, indicates that most of the precipitation during the first storm was in the 48 hours including March 31 and April 1. This same pattern probably occurred in the area near Milo. As illustrated in figure 10, the area just west of Milo received more than 6 in. of precipitation, and Blanchard received 7.33 in. If most of this precipitation is assumed to have fallen in a 48-hour period, the recurrence interval for these rainfall totals can be estimated. At Milo, 6.0 in. of precipitation in 48 hours represents a 50-year storm, and 6.5 in. of precipitation in 48 hours represents a 100-year storm. At Pinkham Notch, recurrence intervals of the maximum 12-, 24- and 48-hour precipitation were about 10 year, 25–50 years, and 50–100 years, respectively.

Temperature

During spring floods in Maine, air temperature is an important variable. Air temperature affects the state of incoming precipitation (snow or rain) and the rate at which a snowpack melts. The state of

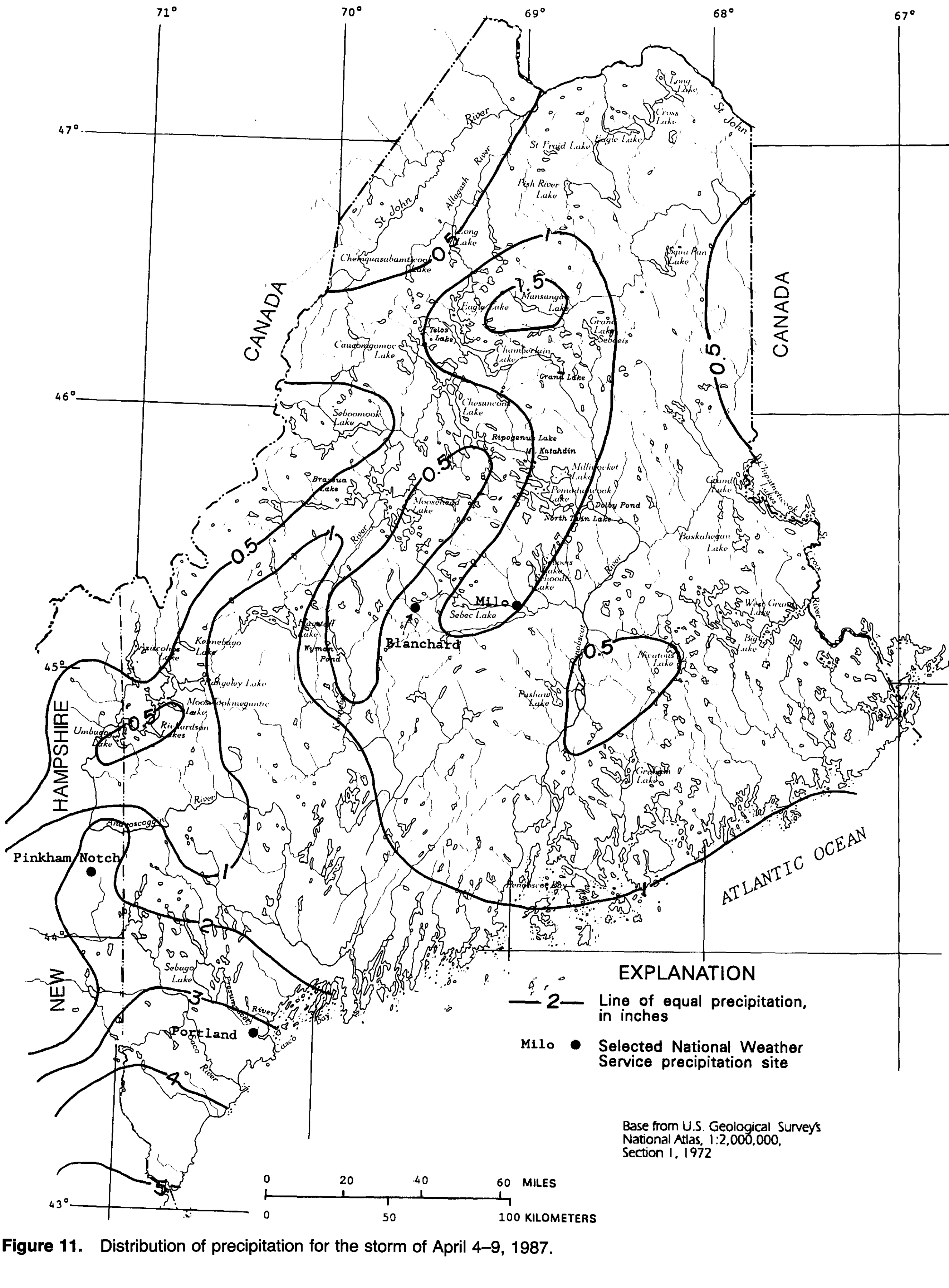

Figure 11. Distribution of precipitation for the storm of April 4–9, 1987.

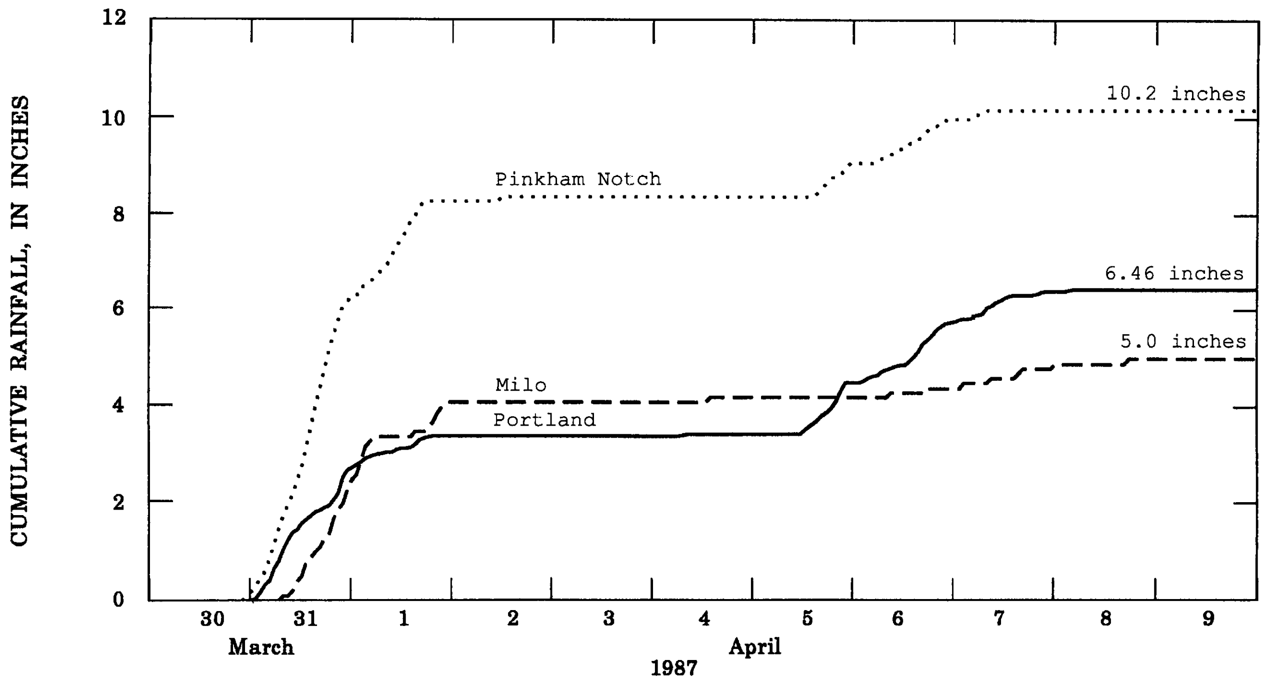

Figure 12. Cumulative rainfall, March 30 through April 9, 1987, Portland and Milo, Maine, and Pinkham Notch, N.H.

incoming precipitation and rate of snowpack melting are directly related to runoff volumes and magnitudes.

In figures 2–5, daily maximum and minimum temperatures at the four index sites during the period December 1 through April 30 are graphically summarized. Daily maximum and minimum temperatures at the index sites for the period March 30 through April 9 are listed in table 9. Jackman is on the northwestern or inland side of the mountains of western Maine. Dover-Foxcroft and Rumford are both along the axis of extreme precipitation that extended from Pinkham Notch, N.H., to Blanchard, Maine. Newcastle is in the coastal zone.

On March 30, temperatures at the index sites were typical of those several days before the flood. Daily highs were in the 50's and 60's (°F), and lows were slightly below freezing in the upland areas and above freezing along the coast. During the storm of March 31 through April 1, highs remained in the 50's (°F). Minimum temperatures were slightly higher than those on previous days, and most were

Table 7. Maximum rainfall depths for selected durations and times of occurrence at Portland and Milo, Maine, and Pinkham Notch, N.H., during the storm of March 30 through April 9, 1987

[Hourly data from National Oceanic and Atmospheric Administration]

Duration (hours)	Portland		Milo		Pinkham Notch	
	Depth (inches)	Time of occurrence	Depth[a] (inches)	Time of occurrence	Depth[a] (inches)	Time of occurrence
3	0.64	0600 to 0900 hours March 31.	0.7	0100 to 0400 hours April 1.	1.2	1300 to 1600 hours March 31.
6	1.07	0500 to 1100 hours March 31.	1.3	2100 hours March 31 to 0300 hours April 1.	2.4	1300 to 1900 hours March 31.
12	1.70	0300 to 1500 hours March 31.	2.3	1500 hours March 31 to 0300 hours April 1.	4.1	1000 to 2200 hours March 31.
24	2.90	0300 hours March 31 to 0300 hours April 1.	3.4	0800 hours March 31 to 0800 hours April 1.	6.3	March 31
48	3.41	March 31 and April 1	4.1	March 31 and April 1	8.3	March 31 and April 1

[a]Hourly precipitation totals at Milo and Pinkham Notch published to nearest tenth of an inch.

Table 8. Rainfall-frequency relations for storms of selected durations, Portland and Milo, Maine, and Pinkham Notch, N.H.
[Data from U.S. Department of Commerce, 1961 and 1964]

Recurrence interval (years)	Depth, in inches, for the specified duration				
	3 hours	6 hours	12 hours	24 hours	48 hours
Portland, Maine					
2	1.7	2.1	2.5	3.0	3.7
5	2.1	2.6	3.2	3.8	4.5
10	2.4	3.1	3.7	4.4	5.4
25	2.7	3.5	4.3	5.1	6.1
50	3.1	4.0	4.7	5.6	6.7
100	3.4	4.4	5.4	6.2	7.5
Milo, Maine					
2	1.4	1.8	2.3	2.6	3.2
5	1.8	2.4	2.9	3.4	3.9
10	2.1	2.6	3.3	4.0	4.7
25	2.4	3.1	3.8	4.6	5.2
50	2.8	3.5	4.2	5.1	6.0
100	3.0	3.9	4.8	5.6	6.5
Pinkham Notch, New Hampshire					
2	1.8	2.6	3.1	3.6	4.0
5	2.3	3.1	3.6	4.6	5.1
10	2.6	3.6	4.2	5.1	6.2
25	3.1	4.0	5.1	6.1	7.2
50	3.6	4.5	5.5	6.5	8.0
100	3.8	5.1	6.1	7.1	8.5

above freezing. An exception was at Jackman, where minimum temperatures on March 31 and April 1 were 30°F. Some of the precipitation at Jackman during this period fell as snow. At Rumford, the minimum temperature was 28°F on April 1; however, no evidence of snow accumulation during the storm was noted.

Between the storms, from April 2 through 4, daily high temperatures were primarily in the upper 40's and 50's (°F), and low temperatures were below freezing at each of the index sites. From April 5 through 9, daily high temperatures generally decreased to the 40's (°F). Daily low temperatures were generally in the mid-30's (°F).

Table 9. Daily maximum and minimum temperatures, March 30 through April 9, 1987, Jackman, Dover-Foxcroft, Rumford, and Newcastle, Maine
[Data, in degrees Fahrenheit, from National Oceanic and Atmospheric Administration, 1986–1987a]

Day	Jackman		Dover-Foxcroft		Rumford		Newcastle	
	Maximum temperature	Minimum temperature	Maximum temperature	Minimum temperature	Maximum temperature	Minimum temperature	Maximum temperature	Minimum temperature
March 30	58	24	60	27	62	30	53	37
31	56	30	54	32	51	35	50	41
April 1	50	30	48	39	52	28	50	43
2	34	19	48	24	49	24	48	27
3	45	21	45	25	58	32	56	34
4	47	27	54	27	54	35	54	39
5	45	34	54	35	48	44	50	42
6	41	33	51	36	46	42	46	44
7	45	33	42	34	42	38	44	37
8	39	30	38	32	44	37	41	36
9	45	24	35	30	49	35	48	33

DESCRIPTION OF FLOOD

No single observation or simple index could have adequately described hydrologic conditions in Maine before the 1987 flood. Factors such as water content of the snowpack, runoff, and available storage capacity in major reservoir systems in March 1987 were inconclusive and often conflicting. In early March, snow totals were below normal in northern Maine, normal in southern interior areas, and above normal in coastal areas. By the end of March, virtually all of the snow south of Skowhegan had melted; water equivalent in the remaining snowpack in wooded and upland terrain was as much as 4 in. Runoff was above normal in upland areas of western Maine and was normal over most of the remainder of the State. Storage was below long-term averages in the major reservoir systems. However, these conditions, in combination with the storms of March 30 through April 9, resulted in one of the most significant floods in Maine's history.

Precipitation from the storms of March 30 to April 9 and snowmelt runoff resulted in record flood peaks. Recurrence intervals of peak discharges exceeded 100 years at eight streamflow-gaging stations. Record peaks occurred at 13 of 35 USGS stream-flow gaging stations in the flood-affected area of Maine (fig. 1). In addition, 14 of Maine's 16 counties were declared Federal disaster areas (Federal Emergency Management Agency, 1987a). Only Aroostook County in extreme northern Maine and Washington County in extreme eastern Maine were not declared disaster areas.

Hasbrouck (1987, p. 10), using data primarily from the Maine Emergency Management Agency, estimated losses to individuals, small businesses, farms, and governments, as a result of the 1987 flood, to be $74.5 million. Flood-damage estimates, in 1987 dollars, are summarized by category and river basin in table 10. Data in table 10 do not include damages to paper mills and other large industries. The true extent of damages resulting from the 1987 flood will probably never be known; however, total damage could have exceeded $100 million.

In addition to damage from high-water levels, flood damage to water quality was considerable throughout much of central Maine (Fontaine and Maloney, 1990, p. 43) and coastal areas, such as Casco Bay. The flood damaged 26 sewage-treatment plants. Plants in the Anson-Madison area and in Augusta, Brunswick, Farmington, and Skowhegan incurred severe damage, which resulted in the release of untreated sewage into receiving water bodies for as long as 3 months (Dennis Keshel, Maine Department of Environmental Protection, oral commun., 1987). The amount of petroleum spilled into receiving water bodies was estimated to be at least 100,000 gal in the Kennebec River basin, more than 8,500 gal in the Androscoggin River basin, and at least 15,000 gal in the Piscataquis River basin (Fred Brann, Maine Department of Environmental Protection, oral commun., 1987).

Table 10. Estimates of flood damage in Maine, April 1987
[Data, in millions of 1987 dollars, from Hasbrouck (1987)]

Category	Flood damage	River basin	Flood damage
Families and individuals.	19.4	Androscoggin	14.9
Businesses	44.7	Kennebec	44.6
Farms	.4	Penobscot	10.6
Local Government	8.2	Presumpscot	.2
County Government	.9	Saco	1.6
State Government	.9	Other rivers	.4
		General	2.2
Total	74.5	Total	74.5

Flood Discharge and Frequency

Provisional 1987 peak stages, discharges, and recurrence intervals were published by Fontaine (1987, table 3). Final revisions of these data are listed in table 11. Site numbers are the same as those in figure 1. Flood peaks at all the stations in table 11 are from the storm of March 30 through April 2.

Graphical relations of discharge and gage height, commonly called rating curves (Rantz and others, 1982), often require adjustment as a direct result of extreme floods. These adjustments, generally of two types, include revisions dictated by changing control conditions (caused by either scour or fill during the flood) and the need for high-end extensions of the rating curve (because the magnitude of the flood far exceeds anything previously recorded at the streamflow-gaging station). Peak-discharge measurements or indirect determinations of discharge are required to redefine or extend rating curves. Often these data are unavailable or analyses are incomplete when preliminary peak-discharge estimates are needed; therefore, provisional

Table 11. Summary of peak stage and discharge data for April 1987 flood and previous floods in Maine

[dash indicates not computed]

Site number (see fig. 1)	Station number	Stream and place of determination	Drainage area (square miles)	Period of record or period of known floods	Maximum flood previously known: Date	Maximum flood previously known: Gage height (feet)	Maximum flood previously known: Discharge (cubic feet per second)	Maximum during April 1987 flood: Date	Maximum during April 1987 flood: Gage height (feet)	Discharge: Cubic feet per second	Discharge: Cubic feet per second per square mile	Estimated recurrence interval (years)	Exceedance probability
		PENOBSCOT RIVER BASIN											
1	[a]01029500	East Branch, Penobscot River at Grindstone, Maine.	1,086	1903–	4–30–23	16.9	37,000	—	[b]13.97	27,000	25	25	0.040
2	01030000	Penobscot River near Mattawamkeag, Maine.	3,356	1941–	4–29–73	16.89	66,000	4–02–87	12.90	55,400	17	25	.040
3	01030500	Mattawamkeag River near Mattawamkeag, Maine.	1,418	1935–	3–23–36	15.34	29,200	4–05–87	13.10	23,300	16	10	.111
4	01031500	Piscataquis River near Dover-Foxcroft, Maine.	298	1903–	11–04–66	17.89	22,800	4–01–87	22.62	[c,d]37,300	[d]125	>100	<.010
5	[a]01033000	Sebec River at Sebec, Maine.	326	1925–82 1985–	3–20–36	14.46	14,300	4–02–87	12.89	[d]11,000	[d]34	[d]85	.012
6	01033500	Pleasant River near Milo, Maine.	323	1921–	11–04–66	15.46	28,600	—	[b]15.18	27,900	86	45	.022
7	01034000	Piscataquis River at Medford, Maine.	1,162	1925–82	11–04–66	15.58	60,100	—	[b]18.65	[c,d]85,000	73	>100	<.010
8	01034500	Penobscot River at West Enfield, Maine.	6,671	1902–	5–01–23	25.15	153,000	4–02–87	23.53	[d]147,000	22	[d]65	.015
9	[a]01036390	Penobscot River at Eddington, Maine.	7,764	1979–	6–04–84	20.60	136,000	4–03–87	23.53	[c,d]159,000	20	[d]10	.100
10	01036500	Kenduskeag Stream near Kenduskeag, Maine.	176	1942–79	9–12–54	14.83	6,400	—	[b]15.84	[c]7,400	42	[d]45	.022
		SHEEPSCOT RIVER BASIN											
11	01038000	Sheepscot River at North Whitefield, Maine.	145	1939–	12–18–73	12.52	6,420	4–01–87	13.71	[c,d]7,350	[d]51	[d]75	.013
		KENNEBEC RIVER BASIN											
12	[a]01042500	Kennebec River at The Forks, Maine.	1,590	1902–	6–01–84	13.78	30,300	4–01–87	9.87	20,400	13	[d]10	.100
13	[a]01046500	Kennebec River at Bingham, Maine.	2,715	1908–09 1931–	6–01–84	15.61	65,200	4–01–87	15.46	63,400	23	[d]75	.013

Table 11. Summary of peak stage and discharge data for April 1987 flood and previous floods in Maine—Continued

Site number (see fig. 1)	Station number	Stream and place of determination	Drainage area (square miles)	Period of record or period of known floods	Maximum flood previously known: Date	Maximum flood previously known: Gage height (feet)	Maximum flood previously known: Discharge (cubic feet per second)	Maximum during April 1987 flood: Date	Maximum during April 1987 flood: Gage height (feet)	Discharge: Cubic feet per second	Discharge: Cubic feet per second per square mile	Estimated recurrence interval (years)	Exceedance probability
		KENNEBEC RIVER BASIN—Continued											
14	01047000	Carrabassett River near North Anson, Maine.	353	1926–	3–19–36	21.17	30,800	4–01–87	26.66	[c,d]50,700	[d]144	[d]>100	<0.010
15	01048000	Sandy River near Mercer, Maine.	514	1929–79	3–19–36	16.75	38,600	4–01–87	19.25	[c,d]51,100	[d]99	>100	<.010
16	01049000	Sebasticook River near Pittsfield, Maine.	572	1929–	3–22–36	13.18	14,400	4–03–87	15.53	[c,d]17,600	31	>100	<.010
17	01049130	Johnson Brook at South Albion, Maine.	2.92	1981–	4–25–83	11.60	159	4–01–87	12.34	[c,d]178	[d]61	[d]20	.050
18	[a]01049265	Kennebec River at North Sidney, Maine.	5,403	1979–	6–01–84	26.60	113,000	4–02–87	39.31	[c,d]232,000	[d]43	>100	<.010
19	01049373	Mill Stream at Winthrop, Maine.	32.7	1978–	6–02–84	4.76	671	4–02–87	6.16	[c,d]1,330	[d]41	[d]35	.029
20	[a]01049500	Cobbosseecontee Stream at Gardiner, Maine.	217	1891–1964 1977–	3–21–36	—	5,020	4–01–87	10.04	4,240	20	[d]45	.022
21	01049550	Togus Stream at Togus, Maine.	23.7	1982–	4–25–83	6.92	850	4–01–87	7.50	[c]1,010	43	—	—
		ANDROSCOGGIN RIVER BASIN											
22	01052500	Diamond River near Wentworth Location, N.H.	152	1942–	6–16–43	10.66	8,630	4–01–87	10.31	[d]8,330	55	[d]50	.020
23	[a]01053500	Androscoggin River at Errol, N.H.	1,046	1905–	5–22–69	—	16,500	4–02–87	6.69	8,780	8.4	[d]4	.250
24	[a]01054000	Androscoggin River at Gorham, N.H.	1,361	1914–	6–18–17	—	20,000	4–01–87	9.15	[d]16,000	12	10	.100
25	01054200	Wild River at Gilead, Maine	69.6	1959–	10–24–59	15.6	18,100	3–31–87	13.03	[d]13,600	[d]195	[d]10	.100
26	[a]01054500	Androscoggin River at Rumford, Maine.	2,068	1892–	3–20–36	—	74,000	4–01–87	23.22	[d]63,900	[d]31	[d]>100	<.010
27	01055000	Swift River near Roxbury, Maine.	96.9	1930–	10–24–59	12.87	16,800	4–01–87	12.54	15,900	164	25	.040
28	01055500	Nezinscot River at Turner Center, Maine.	169	1942–	3–27–53	11.18	13,900	4–01–87	10.20	[d]11,600	[d]69	[d]60	.017

Site number (see fig. 1)	Station number	Stream and place of determination	Drainage area (square miles)	Period of record or period of known floods	Maximum flood previously known			Maximum during April 1987 flood					
										Discharge			
					Date	Gage height (feet)	Discharge (cubic feet per second)	Date	Gage height (feet)	Cubic feet per second	Cubic feet per second per square mile	Estimated recurrence interval (years)	Exceedance probability
		ANDROSCOGGIN RIVER BASIN—Continued											
29	01057000	Little Androscoggin River near S. Paris, Maine.	73.5	1914–25 1932–	[e]3–27–53	[e]12.41	[e]8,000	4–01–87	12.22	[c,d]9,340	127	>100	<0.010
30	[a]01059000	Androscoggin River near Auburn, Maine.	3,263	1929–	3–20–36	27.57	135,000	4–02–87	23.71	[d]103,000	[d]32	[d]75	.013
		ROYAL RIVER BASIN											
31	01060000	Royal River at Yarmouth, Maine.	141	1950–	3–13–77	8.46	11,500	4–01–87	7.83	8,440	60	[d]25	.040
		PRESUMPSCOT RIVER BASIN											
32	[a]01064118	Presumpscot River at Westbrook, Maine.	577	1976–	[f]3–14–77	[f]21.11	[f]12,500	4–01–87	20.83	[d]7,360	[d]13	[d]3	.333
		SACO RIVER BASIN											
33	01064500	Saco River near Conway, N.H.	385	1904–09 1929–	3–27–53	17.20	47,200	4–01–87	17.04	[d]46,600	[d]121	[d]35	.029
34	01065500	Ossipee River at Cornish, Maine.	452	1917–	3–21–36	16.32	17,200	4–02–87	10.90	9,460	21	[d]20	.050
35	01066000	Saco River at Cornish, Maine	1,293	1917–	3–21–36	21.90	45,000	4–03–87	16.54	31,300	24	[d]35	.029

[a]Site with greater then 4.5 million cubic feet of regulated storage volume per square mile of basin area.
[b]From floodmarks.
[c]1987 flood discharge exceeded maximum flood discharge previously known.
[d]Update to provisional information published in Fontaine (1987).
[e]At former site located just downstream in South Paris, drainage area equals 75.8 mi^2 (different datum).
[f]At former site located just downstream in West Falmouth, drainage area equals 598 mi^2 (different datum).

estimates, which eventually require updates, are made. Indirect determinations of the 1987 peak-flood discharge were made for sites 4, 14, 15, and 29 (table 11) by use of the slope-area method (Dalrymple and Benson, 1967).

The recurrence interval or frequency of the flood (table 11) is the average number of years between floods equal to or greater than the April 1987 flood. Because recurrence interval is an average number of years, it is not an indication of when a flood of a given magnitude will be repeated. In fact, floods of equal or greater magnitude can occur within the same year. The reciprocal of the recurrence interval is the probability that such a flood will occur in any one year. For instance, a 100-year flood has a 0.01 probability, or a 1-percent chance, of occurring in any year. A 10-year flood has a 0.10 probability, or a 10-percent chance, of occurring in any year. Log Pearson type III procedures, described by the Water Resources Council (1981), were used to compute individual station frequency curves. According to Benson (1962, p. 8), when usable storage in a basin exceeds 4.5 million ft^3 (103 acre-ft) per mi^2, peak discharges may be affected by more than 10 percent. Stations where this criterion is exceeded are footnoted in table 11. Frequency analyses at these sites are based on the station skew coefficient.

Data from the St. John and St. Croix River basins and from eastern coastal basins are not included in table 11. Precipitation in northern and eastern Maine was minor during both storms. Recurrence intervals for all April 1987 flood peaks at St. John River basin stations were less than 10 years. Recurrence intervals for all April 1987 flood peaks at downeast coastal and St. Croix River basin stations were less than 5 years.

Most of the significant flood peaks in the Penobscot River basin were in the Piscataquis River basin. New peaks of record and floods whose recurrence intervals were greater than 100 years were noted at two of the four stations (sites 4 and 7) in the basin. Peaks during the 1987 flood were 64 and 41 percent higher than the previous maximum peaks at the Dover-Foxcroft and Medford stations, respectively. Lows Bridge, built in 1857 across the Piscataquis River at the Dover-Foxcroft gage and declared a National Historic Landmark, was destroyed during the flood (Fontaine and Maloney, 1990, p. 42). The Piscataquis River basin has a total drainage area of 1,453 mi^2 (Fontaine, 1981, p. 83), which represents about 22 and 19 percent of Penobscot River basin upstream from the West Enfield gaging station (site 8) and the Eddington gaging station (site 9), respectively. According to a U.S. Army Corps of Engineers study (1990, p. A–31), the Piscataquis basin contributed 53 and 44 percent of the flood peaks at the West Enfield and Eddington gages, respectively, during the 1987 flood. New peaks of record also were established at two gaging stations: Eddington (site 9) and Kenduskeag Stream near Kenduskeag (site 10).

The USGS currently (1992) operates only one gaging station in the coastal basins between the mouths of the Penobscot and Kennebec Rivers: the Sheepscot River at North Whitefield (site 11). During the 1987 flood, a new peak of record was established at the North Whitefield gage, which has been in operation since 1939.

Flooding during 1987 was most extreme in the Kennebec River basin. About 60 percent of the flood damage took place in the Kennebec basin (table 10). New peaks of record were recorded at 7 of the 10 gaging stations located in the basin. The most significant sources of runoff contributing to the flood peak in Augusta were the intervening drainages between Bingham and Waterville, most notably the Sandy and Carrabassett Rivers. The intervening drainages represent 31 percent of the total Kennebec watershed area at Augusta but contributed about 60 percent of the peak-flood flow (U.S. Army Corps of Engineers, 1987, p. 19). Flood peaks at the Carrabassett (site 14) and Sandy River (site 15) gages were 65 and 32 percent higher than the previous maximum peaks (March 1936). Crippen and Bue (1977, fig. 3) prepared an envelope curve relating maximum flood flows to drainage area for sites in New England. The gaging station in Maine that came the closest to the envelope curve (the theoretical maximum potential flood flow) during the 1987 flood was the Kennebec River at North Sidney (site 18).

In the Androscoggin River basin, flood peaks in 1987 were within 25 percent of previous maximum floods at all but one of the nine stations. The 1987 flood peak on the Little Androscoggin River near South Paris (site 29) was 17 percent greater than the previous maximum, and the recurrence interval was greater than 100 years. The peak runoff rate of 195 $ft^3/s/mi^2$ recorded at the Wild River station (site 25) was the highest for any station in Maine during the 1987 flood.

Flooding in the Royal, Presumpscot, and Saco River basins was generally not as severe as that noted in the preceding discussions; however, recurrence intervals of 1987 floods on the Saco River near Conway and Cornish (sites 33 and 35) were 35 years. The peak flow at the Conway gaging station was within 600 ft^3/s (1.3 percent) of the previous maximum peak recorded in March 1953.

Flood Crests

Peak-stage determinations were made at 378 additional locations to supplement the streamflow-gaging station data presented in table 11. During or immediately after the 1987 flood, peak stages were identified and marked along approximately 600 mi of rivers and streams in the flood-affected area. Peak-stage determinations were based primarily on highwater marks or other evidence of the highest stage reached by the flood (Benson and Dalrymple, 1967, p. 11). Identification was based on evidence such as seed, mud, and oil lines, debris, and wash-lines. Identified marks were later surveyed to sea level datum.

Flood-crest stages for the April 1987 flood are summarized in table 12 (at back of report). Elevations included in table 12 were based primarily on high-water marks identified and surveyed by USGS personnel. Data provided by other sources are identified in the table. Unless otherwise noted, USGS elevations are the average of two or more individual marks. The reliability of flood-crest elevations was evaluated by comparison with data from previous floods (Grover, 1937), flood-insurance studies, observations of individuals, and photographic documentation of the flood.

Flood-crest data should be used with an understanding of the methods used to obtain them and their relation to the river profile. For instance, some flood marks may be affected by pileup near bridges or other hydraulic structures. Floodmark elevations near the river channel and those in the flood plain can differ for a variety of reasons. Moreover, the potential for surveying errors must be recognized in work done under difficult conditions. Interpolation of water levels between locations with flood-crest stages should not be done without further investigation.

In contrast to the 1936 flood, during which backwater from ice jams was common, peak stages for the 1987 flood reflect primarily free-flowing conditions. According to Hasbrouck (1987, p. 4), downstream sections of all major rivers were free of ice before the onset of the 1987 flood. The only ice jams of significance during the April 1987 flood occurred on the upper Piscataquis River and other headwater tributaries. As far as could be determined, none of the elevations given in table 12 were the result of backwater caused by ice jams.

Reservoir Storage

Capture of rainfall and snowmelt runoff in storage reservoirs in the headwaters of the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins affected the flooding in April 1987. In table 13, runoff and storage data associated with only the first storm (March 30–April 2) are analyzed. Discharge hydrographs for the closest downstream gaging stations were reviewed to identify the period when runoff associated with the first storm took place. Contents of the reservoir systems and percentages of usable capacity were tabulated for the starting and the ending dates of the runoff period. Contents of the reservoir systems, at the start of the runoff period ranged from 13.0 percent of usable capacity in the Kennebec River basin to 40.4 percent in the Presumpscot River basin. Contents in four of the five reservoir systems at the end of the runoff period were in the range of 56.2 to 60.7 percent of usable capacity. Storage in reservoirs of the West Branch of the Penobscot River was 73.3 percent of usable capacity at the end of the runoff period.

Daily-storage and discharge data were analyzed to determine the effect of the five reservoir systems on peak flows during the 1987 flood. For the reservoir systems,

$$\text{Inflow} = \text{outflow} + \text{change in storage.} \qquad (1)$$

For each of the five reservoir systems, change in contents during the first storm period was converted to equivalent inches of runoff for the entire upstream basin. Where possible, inches of runoff released from the reservoir systems during the first storm was calculated. Application of equation 1, given outflow and storage data, allows determination of inflow during the flood. Reservoirs in the West Branch of the Penobscot, Kennebec, Androscoggin, and Presumpscot Rivers stored 81, 59, 75, and 95 percent of the total storm inflows, respectively. The computed runoff capture efficiency of 59

Table 13. Storage data for selected reservoir systems during the April 1987 flood
[Mft^3, million cubic feet; in. inches]

Reservoir system	Date	Contents[a] (Mft^3)	Percent of usable capacity	Change in contents (Mft^3)	Runoff stored (in.)	Runoff released (in.)
East Branch Penobscot River[b]	3–30–87	2,072	30.4			
at Grand Lake Dam.	4–10–87	3,987	58.5	1,915	1.68	[c]—
West Branch Penobscot River[d]	3–30–87	16,958	29.8			
at Dolby Pond Dam.	4–10–87	41,767	73.3	24,809	5.07	[e]1.16
Kennebec River at Wyman Dam[f]	3–30–87	[g]6,035	13.0			
	4–07–87	[g]26,269	56.7	20,234	3.33	[h]2.31
Androscoggin River at[i]	3–30–87	6,942	24.7			
Errol Dam.	4–08–87	17,057	60.7	10,115	4.16	[j]1.41
Presumpscot River[k]	3–30–87	[l]3,920	40.4			
at Sebago Lake Dam.	4–04–87	[l]5,450	56.2	1,530	1.49	[k].08

[a]Readings at about 0700 hours.
[b]Records furnished by Bangor Hydro Electric Company.
[c]Not calculated.
[d]Records furnished by Great Northern Paper Company.
[e]U.S. Army Corps of Engineers (1990, pl. 6).
[f]Records furnished by Kennebec Water Power Company.
[g]Does not include Indian Pond and Wyman Lake.
[h]Data from USGS station 01046500 at Bingham.
[i]Records furnished by Union Water Power Company.
[j]Data from USGS station 01053500 at Errol.
[k]Records furnished by S.D. Warren Paper Company.
[l]Based on linear interpolation between weekly readings.

percent for the Kennebec reservoir system is low because outflow calculations were based on data collected at the USGS gaging station at Bingham. Runoff data at Bingham include large volumes of water from areas not controlled by reservoir systems in the basin.

Reduction in the magnitudes of peak-flow rates is another measure of the effect of reservoir systems. For the West Branch of the Penobscot River and the Androscoggin River reservoir system, daily changes in storage and outflow data were combined to determine the day of maximum inflow to the systems. Peak-daily-outflow reduction rates were then calculated as the change in storage divided by the inflow. Peak-daily outflows were reduced 91.8 percent and 75.2 percent in the West Branch of the Penobscot and Androscoggin reservoir systems. On the day of the flood peak on the Presumpscot River, discharge from Sebago Lake was reduced to only leakage through the dam. Data were not available to calculate instantaneous flow rates for all the reservoir systems.

Hydrologic modeling of the 1987 flood in the Kennebec River basin by the U.S. Army Corps of Engineers (1987) provides strong evidence of the effect of individual reservoirs on peak flows. The modeling results indicate that the approximate peak-inflow rate to Moosehead Lake was 24,500 ft^3/s during the flood and that the outflow rate was 100 ft^3/s (U.S. Army Corps of Engineers, 1987, pl. 10). Approximate peak-inflow rate to Flagstaff Lake was 30,000 ft^3/s and outflow was 180 ft^3/s (U.S. Army Corps of Engineers, 1987, pl. 11). The operation of these reservoirs was a major factor in reducing flood peaks in the Kennebec River basin during the 1987 flood.

RAINFALL AND RUNOFF ANALYSES

Rainfall and runoff relations during the 1987 flood are examined in this section of the report to improve the understanding of these floods. Such understanding is critical for officials who must plan for the recurrence of damaging floods.

To simplify the explanation of rainfall and runoff relations only the data for the storm of March 30 through April 2 were used in the analysis. Flood peaks at all gaging stations discussed in this report were a result of runoff from this storm. (See figs. 3–5 and table 11.) Increased runoff as a result of snowmelt occurred primarily during this storm. Inclusion of data for the April 4–9 storm in the rainfall-runoff analysis would mask the contributions of snowmelt to the previous maximum flood peaks.

Rainfall and runoff data for the storm of March 30 through April 2 are presented in table 14. All 35 stations listed in the summary of peak stage and discharge (table 11) are included in table 14.

Average precipitation data were based on application of the isohyetal method (Linsley and others, 1982, p. 71). Lines of equal storm precipitation (isohyetals), shown on figure 10, were overlain on maps of watershed boundaries. The average precipitation for a given basin was computed by weighting the average precipitation between successive isohyets by the area between them, adding these products, and dividing the sum by the watershed area. Isohyets were constructed in 1-in. increments. Average precipitation within the innermost isohyets was considered to be 0.5 in. greater than that of the last isohyet.

Storm-runoff hydrographs were separated into two basic components: direct runoff and base runoff (Chow, 1964, p. 14–10). Although hydrograph separation can be considered more of an art than a science, it nevertheless provides valuable information (Freeze, 1974, p. 629). Direct runoff includes overland flow and interflow or subsurface flow that reaches stream channels in a relatively short period of time. Direct runoff was expressed as inches of depth over the river basin in question. Direct runoff is a measure of streamflow directly attributed to a specific storm and not that before or after the storm of interest. Direct runoff in each basin was adjusted to account for reservoir storage, if storage data were available (See previous section.) This adjustment allows direct runoff to be estimated for a site as if no reservoir storage of runoff had taken place.

The highest totals of average basin precipitation were 7.60 in. for the Wild River at Gilead (site 25) and 6.20 in. for the Saco River near Conway (site 33). If point precipitation totals recorded during the event are assumed to be representative, small basin (less than 50 mi^2) average precipitation could have exceeded 8.0 in. near Pinkham Notch.

Analysis of storm precipitation typically includes consideration of rainfall-area relations (Uhl, 1937, fig. 2). Rainfall-area relations that are also analyzed by watersheds are of greater hydrological importance than relations for larger areas. An example of the importance of the concept can be illustrated by the precipitation distribution from the storm of March 30 through April 2. A conventional rainfall-area analysis would have indicated a large area of greater-than-8-inch precipitation near Pinkham Notch. In reality, the Pinkham Notch area is along the divide of the Saco, Merrimack, and Androscoggin River basins. As a result, this area of intense precipitation contributed runoff to several basins rather than to a single basin. If the intense precipitation had been isolated in one basin, resultant flooding would have been substantially greater.

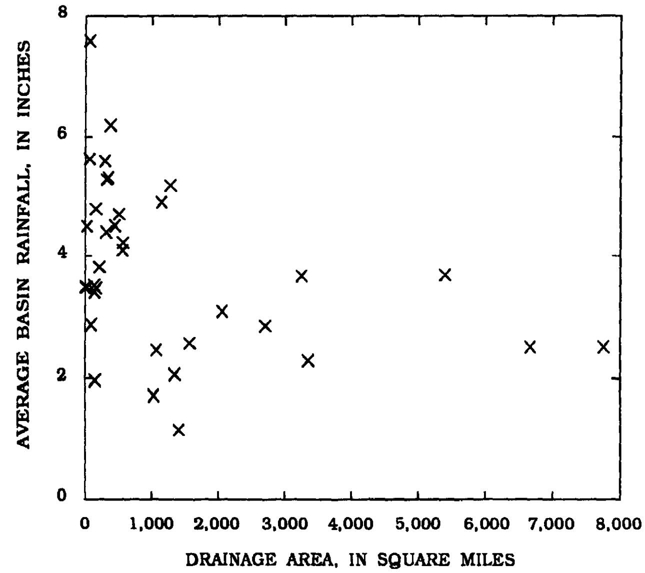

Figure 13. Scatterplot of average basin rainfall and drainage area, storm of March 30 through April 2, 1987.

Average basin precipitation was plotted against drainage area to analyze rainfall-area relationships by watershed (fig. 13). Although no specific trend line could be drawn, the plot indicates that precipitation variability in basins smaller than about 1,500 mi^2 is greater than in larger basins. Average precipitation in the eight basins larger than 1,500 mi^2 was less than 4.0 inches of rainfall; averages fell in a narrow range, from 2.29 to 3.68 in., and the mean was 2.91 in. For a 100-year rainfall covering an area approximately equal to the combined areas of the eight basins larger than 1,500 mi^2, Bean and others (1929, p. 21) estimated that at least 4.00 in. of rain could be expected from a 2-day storm. Bean and others (1929, p. 20) also estimated that the probable maximum average rainfall for the entire State would be 5.50 in. for a 2-day storm.

The accuracy of estimates of average basin precipitation for the 1987 flood (table 14) is generally inversely related to basin size. In mountainous or hilly areas, where precipitation is highly variable over small distances, accuracy is even less.

Results of hydrograph separations for the storm of March 30 through April 2 are given in table 15. Included in table 15 are total runoff associated with the storm and subdivision of total runoff into direct runoff and base flow (no adjustments made for storage). Also computed are ratios of direct to total runoff for the basins.

Table 14. Rainfall and runoff data for the storm of March 30 through April 2, 1987

Site number (see fig. 1)	Station number	Stream and place of determination	Drainage area (square miles)	Precipitation (inches)	Direct basin runoff: Unadjusted[a] (inches)	Direct basin runoff: Adjusted for[b] storage (inches)	Direct runoff minus precipitation (inches)
		PENOBSCOT RIVER BASIN					
1	01029500	East Branch Penobscot at Grindstone, Maine.	1,086	2.47	—	—	—
2	01030000	Penobscot River near Mattawamkeag, Maine.	3,356	2.29	1.91	[c]3.97	1.68
3	01030500	Mattawamkeag River near Mattawamkeag, Maine.	1,418	1.16	2.54	—	1.38
4	01031500	Piscataquis River near Dover-Foxcroft, Maine.	298	5.61	6.01	—	.40
5	01033000	Sebec River at Sebec, Maine	326	5.30	5.41	—	.11
6	01033500	Pleasant River near Milo, Maine	323	4.40	—	—	—
7	01034000	Piscataquis River at Medford, Maine	1,162	4.91	—	—	—
8	01034500	Penobscot River at West Enfield, Maine	6,671	2.52	2.96	[c]3.98	1.46
9	01036390	Penobscot River at Eddington, Maine	7,764	2.52	3.01	[c]3.89	1.37
10	01036500	Kenduskeag Stream near Kenduskeag, Maine.	176	3.48	—	—	—
		SHEEPSCOT RIVER BASIN					
11	01038000	Sheepscot River at North Whitefield, Maine.	145	3.43	4.12	—	.69
		KENNEBEC RIVER BASIN					
12	01042500	Kennebec River at The Forks, Maine	1,590	2.58	.91	[d]3.21	.63
13	01046500	Kennebec River at Bingham, Maine	2,715	2.87	1.61	[e]3.99	1.12
14	01047000	Carrabassett River near North Anson, Maine.	353	5.32	4.87	—	−.45
15	01048000	Sandy River near Mercer, Maine	514	4.70	—	—	—
16	01049000	Sebasticook River near Pittsfield, Maine.	572	4.10	4.18	—	.08
17	01049130	Johnson Brook at South Albion, Maine.	2.92	3.50	3.21	—	−.29
18	01049265	Kennebec River at North Sidney, Maine.	5,403	3.70	2.85	[e]3.91	.21
19	01049373	Mill Stream at Winthrop, Maine	32.7	4.50	5.07	—	.57
20	01049500	Cobbosseecontee Stream at Gardiner, Maine.	217	3.82	1.83	—	−1.99
21	01049550	Togus Stream at Togus, Maine	23.7	3.50	2.83	—	−.67
		ANDROSCOGGIN RIVER BASIN					
22	01052500	Diamond River near Wentworth Location, N.H.	152	1.97	2.68	—	.71
23	01053500	Androscoggin River at Errol, N.H.	1,046	1.72	.83	[f]3.74	2.02
24	01054000	Androscoggin River at Gorham, N.H.	1,361	2.06	1.09	[f]3.01	.95
25	01054200	Wild River at Gilead, Maine	69.6	7.60	5.68	—	−1.92
26	01054500	Androscoggin River at Rumford, Maine.	2,068	3.11	2.28	[f]3.67	.56
27	01055000	Swift River near Roxbury, Maine	96.9	2.89	5.69	—	2.80
28	01055500	Nezinscot River at Turner Center, Maine	169	4.79	3.59	—	−1.20

Table 14. Rainfall and runoff data for the storm of March 30 through April 2, 1987—Continued

Site number (see fig. 1)	Station number	Stream and place of determination	Drainage area (square miles)	Precipitation (inches)	Direct basin runoff		Direct runoff minus precipitation (inches)
					Unadjusted[a] (inches)	Adjusted for[b] storage (inches)	
		ANDROSCOGGIN RIVER BASIN—Continued					
29	01057000	Little Androscoggin River near South Paris, Maine.	73.5	5.64	5.06	—	−0.58
30	01059000	Androscoggin River near Auburn, Maine	3,263	3.68	2.91	[f]3.71	.03
		ROYAL RIVER BASIN					
31	01060000	Royal River at Yarmouth, Maine	141	3.53	3.21	—	−.32
		PRESUMPSCOT RIVER BASIN					
32	01064118	Presumpscot River at Westbrook, Maine	577	4.22	.79	[g]1.54	−2.68
		SACO RIVER BASIN					
33	01064500	Saco River near Conway, N.H.	385	6.20	5.34	—	−.86
34	01065500	Ossipee River at Cornish, Maine	452	4.51	2.81	—	−1.70
35	01066000	Saco River at Cornish, Maine	1,293	5.19	4.15	—	−1.04

[a]A dash indicates that daily discharge data are unavailable.
[b]A dash indicates either no significant upstream regulation or change of contents data unavailable.
[c]Adjusted for change in contents of the West Branch reservoir system upstream from Dolby Pond Dam and the East Branch reservoir systems upstream from Grand Lake Dam.
[d]Adjusted for change in contents of the reservoir systems upstream from Indian Pond Dam.
[e]Adjusted for change in contents of the reservoir systems upstream from Wyman Lake Dam.
[f]Adjusted for change in contents of the reservoir systems upstream from Errol Dam.
[g]Adjusted for change in contents of Sebago Lake.

Analyses of the ratios of direct to total runoff yielded several results. Runoff ratios for 10 of 11 sites where storage adjustments were made (table 14) ranged from 0.60 to 0.70 (Bingham, site 13, was 0.74). The mean runoff ratio for the 11 regulation-affected sites was 0.64. The remaining sites, or those not adjusted for storage, were subjectively subdivided into two groups: those where snow was a probable contributor to runoff during the storm and those where it was not. Runoff ratios for sites where snowmelt was a likely contributor averaged 0.76. Runoff ratios for sites where snowmelt was not a likely contributor were uniformly lower and averaged 0.56.

One reason for the variation in runoff ratios at the unregulated sites is that sites where snowmelt was virtually complete by March 31 were likely to have received greater ground-water recharge before the storm than sites where snowpack remained. As a result, base flow and antecedent runoff in these watersheds were elevated relative to sites where snowmelt was incomplete; thus, runoff ratios were reduced. Runoff on the day before the storm was 9.1, 9.0, and 19.1 percent of the peak-daily streamflows at sites on the Piscataquis River (site 4), Swift River (site 27), and Sheepscot River (site 11), respectively. Only in the Sheepscot basin was snowmelt virtually complete before the flood. Snowmelt contributed significantly to storm runoff in the Piscataquis and Swift River basins.

Runoff ratios at 11 unregulated sites, where auxiliary basin characteristics (such as main-channel slope) have been computed, were further analyzed. Statistical analyses indicated that runoff ratios were positively correlated to the logs of main-channel slope and the peak discharge, expressed in cubic feet per second per square mile. Correlation coefficients between the runoff ratios and slope and peak-discharge rates were 0.93 and 0.90.

Adjustment to direct runoff was made for selected sites in the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins (table 14). Magnitude of the storage adjustment was based on inches of runoff stored by the reservoir systems (table 13) and the ratio of drainage area of the reservoir system outlet (table 5) to the site of interest.

Table 15. Runoff-hydrograph-separation data for the storm of March 30 through April 2, 1987
[Dash indicates daily discharge data unavailable]

Site number (see fig. 1)	Station number	Stream and place of determination	Unadjusted basin runoff			Ratio of direct to total runoff
			Total (inches)	Direct (inches)	Baseflow (inches)	
		PENOBSCOT RIVER BASIN				
1	01029500	East Branch Penobscot River at Grindstone, Maine	—	—	—	—
2	01030000	Penobscot River near Mattawamkeag, Maine	3.21	1.91	1.30	0.60
3	01030500	Mattawamkeag River near Mattawamkeag, Maine	5.38	2.54	2.84	.47
4	01031500	Piscataquis River near Dover-Foxcroft, Maine	7.89	6.01	1.88	.76
5	01033000	Sebec River at Sebec, Maine	7.63	5.41	2.22	.71
6	01033500	Pleasant River near Milo, Maine	—	—	—	—
7	01034000	Piscataquis River at Medford, Maine	—	—	—	—
8	01034500	Penobscot River at West Enfield, Maine	5.02	2.96	2.06	.59
9	01036390	Penobscot River at Eddington, Maine	5.09	3.01	2.08	.59
10	01036500	Kenduskeag Stream near Kenduskeag, Maine	—	—	—	—
		SHEEPSCOT RIVER BASIN				
11	01038000	Sheepscot River at North Whitefield, Maine	6.48	4.12	2.36	.64
		KENNEBEC RIVER BASIN				
12	01042500	Kennebec River at The Forks, Maine	1.36	.91	.45	.67
13	01046500	Kennebec River at Bingham, Maine	2.18	1.61	.57	.74
14	01047000	Carrabassett River near North Anson, Maine	6.78	4.87	1.91	.72
15	01048000	Sandy River near Mercer, Maine	—	—	—	—
16	01049000	Sebasticook River near Pittsfield, Maine	7.63	4.18	3.45	.55
17	01049130	Johnson Brook at South Albion, Maine	6.60	3.21	3.39	.49
18	01049265	Kennebec River at North Sidney, Maine	4.35	2.85	1.50	.66
19	01049373	Mill Stream at Winthrop, Maine	8.24	5.07	3.17	.62
20	01049500	Cobbosseecontee Stream at Gardiner, Maine	4.31	1.83	2.48	.42
21	01049550	Togus Stream at Togus, Maine	4.99	2.83	2.16	.57
		ANDROSCOGGIN RIVER BASIN				
22	01052500	Diamond River near Wentworth Location, N.H.	3.54	2.68	.86	.76
23	01053500	Androscoggin River at Errol, N.H.	1.18	.83	.35	.70
24	01054000	Androscoggin River at Gorham, N.H.	1.83	1.09	.74	.60
25	01054200	Wild River at Gilead, Maine	6.72	5.68	1.04	.85
26	01054500	Androscoggin River at Rumford, Maine	3.43	2.28	1.15	.66
27	01055000	Swift River near Roxbury, Maine	6.65	5.69	.96	.86
28	01055500	Nezinscot River at Turner Center, Maine	5.34	3.59	1.75	.67
29	01057000	Little Androscoggin River near South Paris, Maine	6.70	5.06	1.64	.76
30	01059000	Androscoggin River near Auburn, Maine	4.67	2.91	1.76	.62
		ROYAL RIVER BASIN				
31	01060000	Royal River at Yarmouth, Maine	4.80	3.21	1.59	.67
		PRESUMPSCOT RIVER BASIN				
32	01064118	Presumpscot River at Westbrook, Maine	1.19	.79	.40	.66
		SACO RIVER BASIN				
33	01064500	Saco River near Conway, N.H.	7.32	5.34	1.98	.73
34	01065500	Ossipee River at Cornish, Maine	5.01	2.81	2.20	.56
35	01066000	Saco River at Cornish, Maine	6.89	4.15	2.74	.60

Runoff volume in storage represents direct runoff and base flow combined. Adjustment of direct runoff to account for storage should represent only stored direct runoff. Computed storage adjustments were reduced by the ratio of direct to total runoff at the site where adjustments were being made (table 15). Estimates of direct runoff without the effects of reservoir storage are shown in table 14.

The rainfall-runoff data for the storm of March 30 through April 2 show the effect of snowmelt. Snowpack data for the period immediately preceding are insufficient for direct determination of basin-wide snowmelt input to runoff. A few simplifying assumptions, however, can be used to estimate snowmelt input from rainfall-runoff data.

In the last column of table 14, precipitation was subtracted from direct runoff. Given that direct runoff should not exceed inputs to the baisn, all numbers in the last column should be negative. The magnitude of the negative number represents the amount of ground-water recharge, surface storage for which adjust-ments were not made, and other losses from the system (such as evapotranspiration). The difference between runoff and precipitation in table 14 is less than ±0.5 in. at 7 stations, greater than −0.5 in. at 9 stations, and greater than +0.5 in. at 14 stations. Where runoff is nearly equal to or greater than precipitation, several explanations are possible: streamflow or precipitation data could be in error, hydrograph separation techniques could be flawed, or another source of input to the system has not been accounted for. Snowmelt is another source of input to the system and is the most likely explanation for near-zero and positive differences.

Differences between direct runoff and precipitation should be viewed strictly in a comparative or relative manner. For example, at site 3 on the Mattawamkeag River, total precipitation was only 1.16 in. and direct runoff was 2.54 in. (a difference of 1.38 in.) Clearly, in this basin snowmelt had a substantial contribution, and input from snow was likely to be equal to or greater than precipitation. At site 4 on the Piscataquis River, precipitation was 5.61 in. and direct runoff was 6.01 in. (a difference of 0.40 in.) Again, a positive or near-zero value indicates that snowmelt is a likely contributor to runoff. Because the difference at site 4 was close to zero and less than that for site 3, snowmelt contribution was smaller, relative to incoming precipitation, on the Piscataquis River than it was on the Mattawamkeag. Finally, for site 35 on the Saco River, precipitation was 5.19 in. and direct runoff was 4.15 in. (a difference of −1.04 in.). At this site, the magnitude of the negative number relative to precipitation indicates that snowmelt was less significant as a runoff factor than at site 3 on the Mattawamkeag and site 4 on the Piscataquis Rivers.

RECORDS OF HISTORICAL FLOODS

Detailed analyses of historical floods (Thomson and others, 1964; and Grover, 1937) allow the comparison of 1987 and older floods. In Maine, extreme floods can be local (Federal Emergency Management Agency, 1991a), regional (Fontaine and Haskell, 1981; Fontaine, 1985), or statewide (Grover, 1937). Also of significance are coastal floods (Morrill and others, 1979; Gadoury, 1979). By most measures, the flood of April 1987 will be remembered as one of the worst regional floods in Maine history.

In the section on Flood Discharge and Frequency, historical peak-streamflow data were used to illustrate the significance of April 1987 flood crests. In this section, results of other analyses of historical data are presented. Analyses include the use of available data on the extent of flood damage, maximum flood levels, and seasonal characteristics of floods.

Accurate flood-damage information is difficult to obtain. In most cases, the total flood damage is never known; however, comparison of damage information from extreme floods can be useful. The U.S. Army Corps of Engineers (1978, table 24) compiled damage data (in 1977 dollars) from several floods. Data for historical floods have been updated to 1987 dollars and are compared to data for the 1987 flood (table 16). Included in table 16 are total damage figures and breakdowns by river basin. In terms of total statewide damage, the 1936 flood was the most severe of the six floods studied. Damages in the Kennebec and Penobscot River basins in 1987, however, were greater than those in 1936 or in any of the other floods.

In retrospect, flood-damage data can be used as a measure of the effectiveness of attempts to mitigate flood hazards. Damage data are also an indicator of problem areas or unusual floods where planning is inadequate. For example, during the 1936 flood (Grover, 1937) and more recently the 1991 flood in Allagash, Maine (Federal Emergency

Table 16. Historical flood-damage estimates for Maine
[In 1987 dollars; all figures rounded to nearest ten thousand dollars]

River Basin	Floods					
	March 1936[a]	March 1953[a]	December 1969[a]	April 1973[a]	December 1973[a]	April 1987[b]
Androscoggin	75,030,000	12,590,000	2,050,000	0	1,180,000	14,900,000
Kennebec	33,060,000	4,090,000	3,560,000	0	3,520,000	44,600,000
Penobscot	7,280,000	1,280,000	4,440,000	500,000	1,460,000	10,600,000
Presumpscot	0	0	540,000	0	0	200,000
Saco	27,760,000	5,070,000	390,000	0	130,000	1,600,000
Other rivers and general	0	290,000	1,720,000	2,850,000	920,000	2,600,000
Total	143,130,000	23,320,000	12,700,000	3,350,000	7,210,000	74,500,000

[a]Data from U.S. Army Corps of Engineers (1978, table 24).
[b]Data from Hasbrouck (1987, p. 10).

Management Agency, 1991a), major damage was caused by ice jams. During the 1991 flood, damage was substantial even though the peak flow had a low recurrence interval.

Although flow rates and volumes are critical, the ultimate variable of concern is often maximum elevations of flood waters. Data summarized in table 11 include peak stages of the 1987 flood and those for the previously known maximum floods at USGS streamflow-gaging stations. Flood-crest data along approximately 600 mi of rivers and streams in the flood-affected area are presented in table 12. Flood-stage data extending back as far as 1776 are available for selected locations (Thomson, 1964) and a comparison to 1987 flood levels follows.

According to Grover (1937, p. 44), the May 1923 flood was the largest of record in the Penobscot River basin. Grover (1937, p. 439) compared 1936 flood elevations at selected locations to those from 1923. During the 1987 flood, elevations were determined at two of the same locations. These data are listed below.

Location	Maximum elevation (in feet) 1923	1936	1987
East Branch Penobscot River at Grindstone	311.3	308.8	[a]308.7
Penobscot River above Milford Dam	110.2	107.1	[b]107.2

[a]See table 11.
[b]See table 12.

Thomson and others (1964, p. 75) noted that the 1936 flood was the greatest on the Sandy River at Farmington Falls since 1776, when the area was settled. Stages relative to the 1936 flood stage, given by Thomson and others include:

Date		*Relative stage (in feet)*
	1785	97
	1820	96
	1832	94
October	1855	99.0
December	1901	96.76
April	1923	94.36
March	1936	100.0

Although the exact location of the relative stages is unknown, an indirect comparison is still possible. According to Grover (1937, p. 381), the elevation of the 1936 flood at river mile 22.5 on the Sandy River at Farmington Falls was 339.8 ft. The elevation of the 1987 flood at this site was 2.8 ft higher at 342.6 ft.

Grover (1937, p. 441) tabulated elevations reached during various historical floods on the Kennebec River at a gristmill in Norridgewock, Maine, as follows:

Date		*Elevation (in feet)*
October	1855	168.6
November	1863	163.4
October	1869	169.1
May	1882	169.7
December	1901	170.0
June	1917	162.9
April	1923	168.0
March	1926	171.7
April	1987	177 (estimated)

A highwater elevation of 177.7 ft (table 12) was determined for the 1987 flood at a location approximately 0.4 mi upstream, at the U.S. Route 201A highway bridge. From these data and flood profiles published by the Federal Emergency Management Agency (1988c, panel 02P), the elevation at the gristmill site during the 1987 flood was estimated to be about 177 ft.

The elevations reached during historical floods on the Kennebec River have been marked on the corner of the building at 136 Water Street in Hallowell, Maine (Grover, 1937, p. 438). Elevations determined for these marks (Grover, 1937, p. 442) follow:

Date		*Elevation (in feet)*
March	1826	22.2
February	1870	24.1
March	1896	26.0
March	1936	29.6
April	1987	29.1

During the 1987 flood a maximum elevation of 29.1 feet was determined (table 12).

Long-term historical elevations of previous floods are available at only a few locations (Thomson and others, 1964). In addition, hydrologic conditions at the time of these historical floods are often poorly documented and may differ from those during the 1987 flood.

To this point, discussion of historical floods has focused on relative measures of severity. Equally important is a knowledge of when floods occur. For example, are peak floods seasonal or are they likely to occur at anytime in the year? Although a complete analysis of this topic is beyond the scope of this report, some simple temporal relations can be explored.

Two factors were examined for possible influence on the seasonality of floods in Maine: (1) the size of the basin and (2) seasonal variations in climate, temperature, precipitation, and snowmelt.

Three separate watersheds were selected for analysis: North Branch Tanning Brook near Manchester (not included in table 11), Piscataquis River near Dover-Foxcroft (site 4 in table 11), and Androscoggin River near Auburn (site 30 in table 11). Drainage areas of the Tanning Brook (Manchester), Piscataquis River (Dover), and Androscoggin River (Auburn) watersheds are 0.93, 298, and 3,263 mi^2, respectively. Annual peak discharge is plotted against day of occurrence in figure 14 and the monthly occurrence of annual peak discharges is plotted in figure 15.

The data in figures 14 and 15 show distinct seasonal patterns in the distribution of annual peaks for all three watersheds. Annual peaks are in two groups (spring and fall). In the period of record at Manchester, Dover, and Auburn, 60, 58, and 68 percent of the annual peaks occurred during March, April and May. During October, November, and December, 20, 27, and 13 percent of the annual peaks occurred at Manchester, Dover, and Auburn, respectively. These spring and fall months combined to account for an average of 82 percent of the annual peaks at the three sites. Of the 166 annual peaks, only 1 peak occurred during July and August.

Distribution of precipitation alone cannot account for the seasonality of annul peak discharges. Fontaine and Cowing (1986, p. 259) noted that precipitation in Maine does not exhibit a strong seasonal pattern. In spring and fall, evapotranspiration is small, and during most spring peaks and several of the later fall peaks, snowmelt was a factor. The evapotranspiration and snowmelt variables may be the greatest contributors to the spring and fall seasonality of annual peaks. Because most peaks occur in spring, snowmelt is likely the more significant variable.

No significant difference in the seasonality of annual peaks as a function of the drainage area of the three sites was noted, although the short period of record at Manchester (20 years) may have masked any differences. (Manchester was selected as the site in Maine with the longest period of record among sites whose drainage area is less than 5.0 mi^2.)

The data used to generate the scatterplots in figure 14 were reviewed to determine the relations, if any, between magnitude of annual peaks and seasons. At Manchester, all but one of the highest flood peaks occurred in the winter-spring season when snow was melting. The one peak not associated with snowmelt was the peak of record in December 1973 (no data are available at Manchester in 1987). At Dover-Foxcroft, of the 10 largest floods, the second, eighth and ninth highest peaks occurred in the fall and the remainder occurred in the spring snowmelt season. At Auburn, the nine highest peaks occurred in the winter-spring season when snowmelt was likely. Snowmelt peaks were dominant among the highest peaks at each of the three sites. Only at the Manchester and Dover sites, however, were recurrence intervals of annual peaks greater than 10 years when snowmelt was not a probable factor.

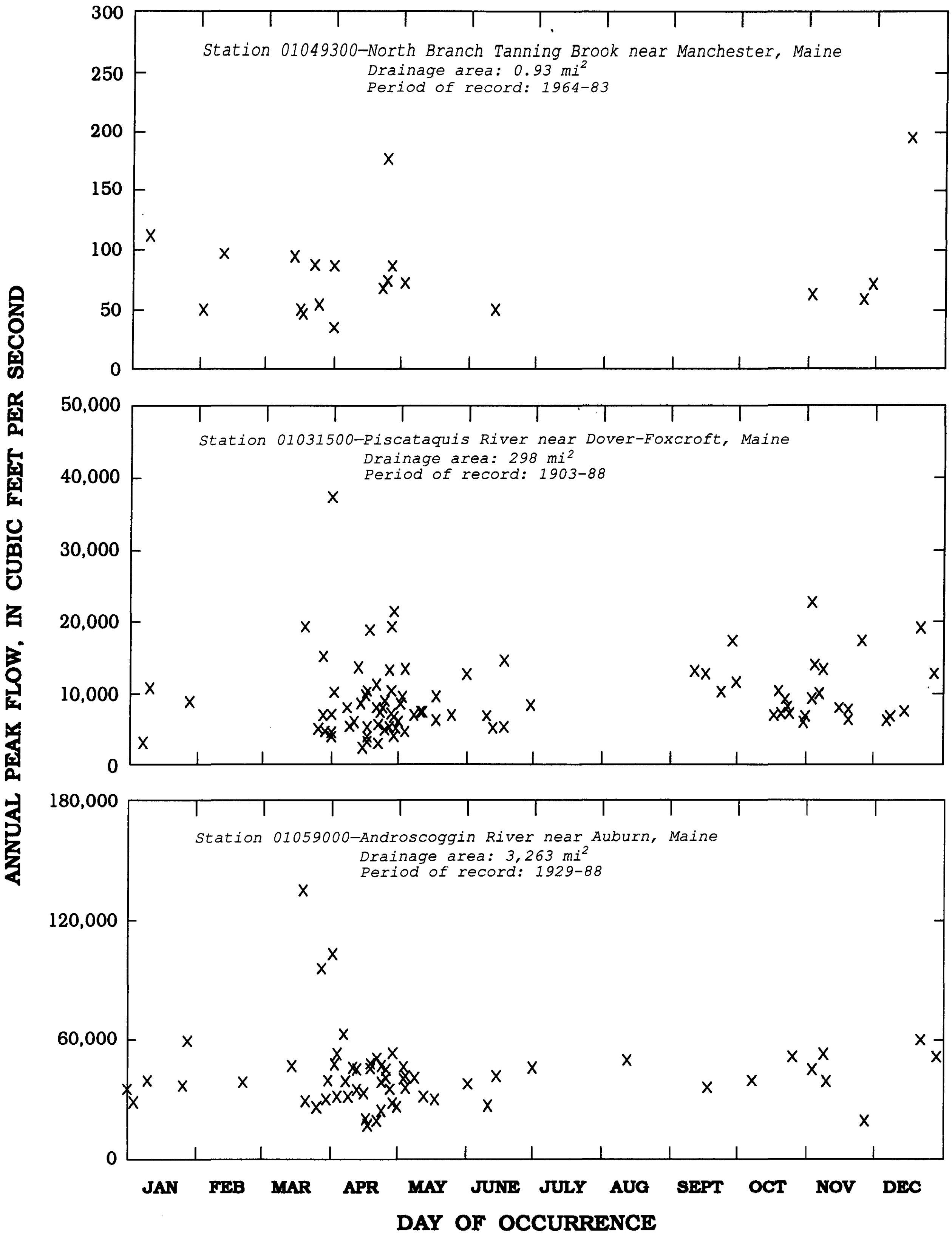

Figure 14. Scatterplots of annual peak discharges and day of occurrence for the period of record, Tanning Brook near Manchester, Piscataquis River near Dover-Foxcroft, and Androscoggin River near Auburn.

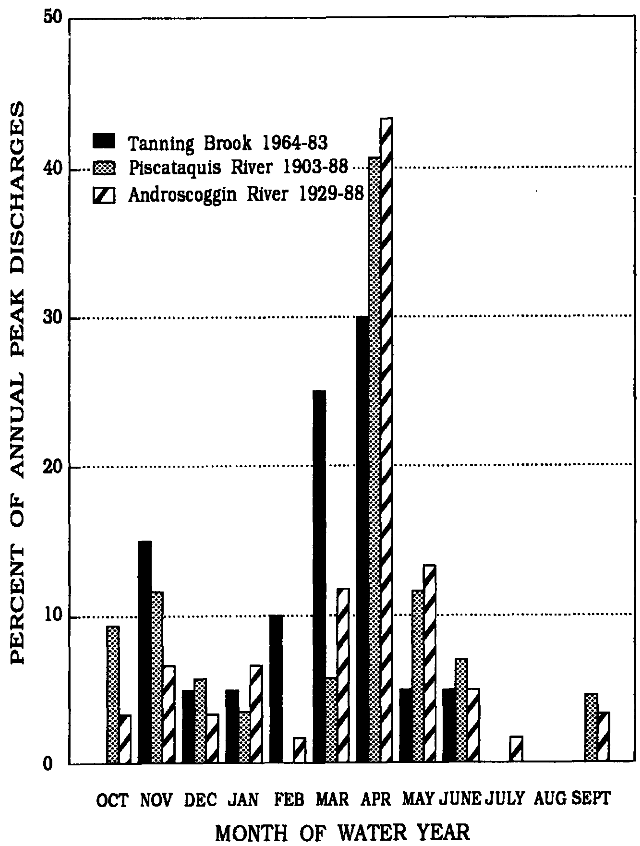

Figure 15. Monthly occurrence of annual peak discharges for the period of record, Tanning Brook near Manchester, Piscataquis River near Dover-Foxcroft, and Androscoggin River near Auburn.

SUMMARY AND CONCLUSIONS

Hydrometeorologic conditions before the April 1987 flood gave no clear indication of the severity of the flooding that was to come. From December 1986 through March 1987, precipitation was below normal. In early March, the snowpack was below normal in northern Maine, normal in southern interior sections, and above normal in coastal areas. During March, air temperatures were above normal statewide after two consecutive months of temperatures well below normal. Above freezing temperatures in March depleted the snowpack and, as a result, runoff was above normal in upland areas of western Maine and normal over most of the remainder of the State. Storage was below long-term averages in all the major storage-reservoir systems.

From March 30 through April 2, an area of low pressure moved slowly northeast toward Maine. The slow speed of the low-pressure center caused an extended period of southeast winds that blew almost perpendicular to the axis of the mountains of western Maine.

Distinct centers of extreme precipitation were observed at Pinkham Notch (8.36 in.) and Blanchard (7.33 in.). Runoff from this storm was augmented by as much as 4 in. of snowmelt. Recurrence intervals of resultant peak discharges exceeded 100 years at eight streamflow-gaging stations. Record peaks occurred at 13 gaging stations with periods of record as long as 85 years. An additional 3–5 in. of rain fell from April 4 through 8, primarily in southern Maine. Flooding caused by the second storm was less severe than that of the first storm. Total flood damage for both storms exceeded $74 million; however, no lives were lost.

Flood-crest data were obtained at 378 locations along 600 mi of rivers and streams to aid in the evaluation of the April 1987 flood. The floodmarks were obtained at hydraulic structures such as bridges and dams and at locations where information on historical floods was available.

Storage data indicate that substantial volumes of water were captured in headwater reservoirs in the Penobscot, Kennebec, Androscoggin, and Presumpscot River basins (as much as 5 in. in the West Branch of the Penobscot River). Rainfall-runoff analyses indicate that snowmelt was a significant contributor to the flood peaks from the storm of March 30 through April 2.

Records of past floods indicate that the April 1987 flood was one of the most significant in Maine's history. At selected sites, the 1987 flood was the worst since the area was settled more than 200 years ago. Flood damage in the Penobscot and Kennebec River basins in 1987 was the greatest for any flood (including March 1936) for which data are available. The April 1987 flood was distinctive in the virtual absence of ice jams. Damage would have been substantially greater if large ice jams had formed. Past floods in Maine indicate distinct seasonal trends. At three index sites, annual flood peaks occur 58–68 percent of the time in March, April, and May.

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Table 12. Flood-crest stages for April 1987 flood in Maine

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
PENOBSCOT RIVER BASIN		
Penobscot River:		
Medway, Maine, Rockabema Dam, headwater	105.4	[b,c]262.1
tailwater	105.4	[c]246.2
Mattawamkeag, Maine, 0.3 mile downstream from Mattaseunk Dam, U.S. Geological Survey gage 01030000, left bank.	97.9	204.6
Howland, Maine, Howland or Stanford Dam, headwater	67.6	[c,d]157.7
tailwater	67.5	[c]150.0
Howland, Maine, mouth of Piscataquis River, right bank, 1000 feet upstream from Route 155 bridge	66.9	149.6
West Enfield, Maine, left bank, 30 feet downstream from Route 155 bridge, U.S. Geological Survey gage 01034500.	66.7	149.5
West Enfield, Maine, 0.1 mile downstream from Route 155 bridge, average of left and right bank elevations.	66.6	148.7
Old Town, Maine, right bank, 0.1 mile upstream from Indian Island Bridge	43.5	107.6
Milford, Maine, Milford Dam, headwater	43.3	[c,e]107.2
tailwater	43.3	[c]98.2
Old Town, Maine, upstream side Route 2 bridge, average of left and right bank elevations	43.0	97.9
Old Town, Maine, downstream side Route 2 bridge, average of left and right bank elevations	42.9	97.0
Old Town, Maine, downstream side Maine Central Railroad bridge, right bank	42.8	95.1
Orono, Maine, mouth of the Stillwater River, right bank	38.0	55.1
Veazie, Maine, Veazie Dam, headwater	34.4	[c,f]39.5
Eddington, Maine, U.S. Geological Survey gage 01036390, 0.4 mile downstream from Veazie Dam, left bank.	34.0	30.7
Bangor, Maine, 300 feet downstream from Bangor Dam, right bank	31.0	23.1
Bangor, Maine, upstream side Route 9 bridge, average of left and right bank elevations	29.8	14.8
Bangor, Maine, mouth of Kenduskeag Stream, right bank	29.6	14.3
Hampden, Maine at Hampden Marina, right bank	27.4	11.8
Frankfort, Maine, near mouth of Marsh Stream, right bank	13.4	9.9
Piscataquis River:		
Upper Abbot Village, Maine, upstream side Routes 6 and 15 bridge, left bank	54.1	413.3
Upper Abbot Village, Maine, downstream side Routes 6 and 15 bridge, left bank	54.1	411.0
Abbot, Maine, 1.2 miles upstream from Routes 6 and 15 bridge in Guilford, Maine, right bank	50.0	403.8
Guilford, Maine, 0.2 mile upstream from Routes 6 and 15 bridge in Guilford, Maine, right bank	49.0	[g]401.8
Guilford, Maine, 0.3 mile downstream from Routes 6 and 15 bridge in Guilford, Maine, left bank	48.5	394.6
Sangerville, Maine, downstream side Route 23 bridge, average of left and right bank elevations	47.4	389.8
Guilford, Maine, 0.5 mile downstream from Route 23 bridge, right bank	46.9	[g]388.1
Guilford, Maine, upstream side Lowes Bridge, left bank	44.9	382.8
Guilford, Maine, downstream side Lowes Bridge, U.S. Geological Survey station 01031500, left bank	44.9	381.1
Dover-Foxcroft, Maine, upstream side of dam upstream from Route 15 bridge, right bank	40.3	[h]356.5
Dover-Foxcroft, Maine, 600 feet upstream from Brown Dam, left bank	39.9	[g]339.7
Dover-Foxcroft, Maine, 700 feet downstream from Brown Dam, left bank	39.7	[g]318.9
Dover-Foxcroft, Maine, 0.9 mile upstream from East Dover bridge, left bank	37.6	[g]311.9
South Sebec, Maine, upstream side of Stage Coach Road bridge, right bank	30.2	295.0
Milo, Maine, 0.2 mile upstream from railroad bridge, right bank	22.4	[g]288.6
Milo, Maine, 100 feet upstream from Route 16 Highway bridge, right bank	21.9	[g]286.4
Medford, Maine, U.S. Geological Survey station 01034000, left bank	16.0	267.3
Howland, Maine, upstream side of Route 116 bridge, left bank	0.2	154.6
Howland, Maine, mouth of Piscataquis River, right bank	0	149.6

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
KENNEBEC RIVER BASIN		
Kennebec River:		
Bingham, Maine, downstream from Route 16 bridge, left bank	117.6	346.0
Bingham, Maine, U.S. Geological Survey station 01046500, 200 feet downstream from Route 16 bridge, right bank.	117.6	345.7
Solon, Maine, upstream side of railroad bridge at Williams Station and Caratunk Falls Dam, right bank	110.6	321.9
Solon, Maine, downstream side of Williams Station and Caratunk Falls Dam, right bank	110.5	290.9
Solon, Maine, upstream side of Route 201A bridge, average of left and right bank elevations	109.0	285.4
Solon, Maine, downstream side of Route 201A bridge, average of left and right bank elevations	109.0	284.3
Madison, Maine, upstream side of railroad bridge, average of left and right bank elevations	95.7	262.0
Anson, Maine, upstream side of Route 201A bridge, right bank	95.6	260.4
Anson, Maine, downstream side of Route 201A bridge, right bank	95.6	258.2
Starks, Maine, mouth of Sandy River, right bank	92.9	192.8
Norridgewock, Maine, upstream side of railroad bridge, right bank	86.8	178.6
Norridgewock, Maine, upstream side of Route 201A bridge, average of left and right bank elevations	86.7	178.2
Norridgewock, Maine, downstream side of Route 201A bridge, average of left and right bank elevations	86.7	177.7
Skowhegan, Maine, upstream of Weston Dam and the divergence of the Kennebec River around an island, left bank.	82.0	173.2
Skowhegan, Maine, north channel, downstream side of Weston Dam and upstream side of highway bridge, average of left and right bank elevations.	81.7	170.1
Skowhegan, Maine, south channel and upstream side of highway bridge, average of left and right bank elevations.	81.6	169.6
Skowhegan, Maine, outside bank of Great Eddy in area of pileup and on left bank of river	80.7	145.2
Skowhegan, Maine, at the outlet of Great Eddy and head of island on left bank	80.6	139.8
Fairfield, Maine, Hinckley Highway bridge, upstream side, average of left and right elevations	73.2	125.9
Fairfield, Maine, Hinckley Highway bridge, downstream side, average of left and right elevations	73.2	125.3
Fairfield, Maine, Shawmut Dam, upstream side, right bank	68.4	[j]120.4
Fairfield, Maine, Shawmut Dam, downstream side, right bank	68.4	109.9
Fairfield, Maine, upstream side of Interstate 95 highway bridge, right bank	66.1	106.8
Fairfield, Maine, downstream side of Interstate 95 highway bridge, right bank	66.1	104.7
Fairfield, Maine, upstream side of railroad bridge, right bank	65.4	101.1
Fairfield, Maine, downstream side of railroad bridge, right bank	65.4	100.6
Fairfield, Maine, upstream side of highway bridge, right bank	65.0	100.1
Fairfield, Maine, downstream side of highway bridge, right bank	65.0	99.3
Winslow, Maine, Scott Paper Co. dam, upstream side, left bank	62.6	[k]92.5
Waterville, Maine, Scott Paper Co. dam, 300 feet downstream, right bank	62.5	83.6
Winslow, Maine, 250 feet downstream from Two Penny Bridge, left bank	61.7	72.6
Winslow, Maine, mouth of the Sebasticook River, left bank	60.8	64.2
North Sidney, Maine, U.S. Geological Survey gage 01049265, 11.5 miles upstream from Cushnoc Dam, right bank.	55.2	54.3
Augusta, Maine, U.S. Geological Survey gage 01049295, 2,500 feet upstream from Cushnoc Dam, left bank.	44.2	39.1
Augusta, Maine, 200 feet upstream from Cushnoc Dam, right bank	43.7	[l]38.8
Augusta, Maine, 0.2 mile downstream from Cushnoc Dam, right bank	43.5	37.0
Augusta, Maine, 400 feet upstream from Father Curran Bridge, left bank	43.1	35.4
Augusta, Maine, Old Post Office building on Water Street, right bank	42.9	33.3
Augusta, Maine, downstream side of Memorial Bridge, left bank	42.7	33.0
Hallowell, Maine, building at 136 Water Street, right bank	40.9	29.1

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
KENNEBEC RIVER BASIN—Continued		
Kennebec River—Continued:		
Farmingdale, Maine, at site of power lines crossing the river, right bank	38.2	27.0
Farmingdale, Maine, Central Maine Power substation, right bank	37.6	26.0
Randolph, Maine, 100 feet upstream from Belmont Street, left bank	37.3	25.1
Farmingdale, Maine, 700 feet upstream from new Gardiner-Randolph highway bridge, right bank	37.2	24.7
Gardiner, Maine, old railroad station, right bank	36.9	24.7
Pittston, Maine, south end of bridge over Togus Stream, left bank	36.3	23.4
South Gardiner, Maine, near old railroad station, right bank	32.3	19.3
Richmond, Maine, railroad bridge over Wilmot Brook, right bank	30.6	18.9
Dresden, Maine, 600 feet upstream from intersection of Route 128 and Everson Road, left bank	29.1	17.4
Dresden, Maine, upstream side of Richmond-Dresden highway bridge, left bank	26.4	14.5
Richmond, Maine, Water Works pump house, right bank	26.0	13.7
Woolwich, Maine, at site of power lines crossing the river just downstream from Abagadasset Point, left bank.	19.0	10.3
Bath, Maine, downstream side of Route 1 highway bridge, right bank	12.0	7.7
Carrabassett River:		
Carrabassett Valley, Maine, South Branch, 50 feet upstream from Routes 16 and 27 bridge, average of left and right bank elevations.	37.8	1289.0
Carrabassett Valley, Maine, South Branch, 50 feet downstream of Routes 16 and 27 bridge, average of left and right bank elevations.	37.8	1287.6
Carrabassett Valley, Maine, South Branch, across from Carrabassett Valley Academy and behind Somerset Telephone Company building, right bank.	37.4	1271.0
Carrabassett Valley, Maine, South Branch, 300 feet downstream from Lumberjack Lodge, right bank	37.3	1261.4
Carrabassett Valley, Maine, South Branch, 30 feet downstream from mouth of unnamed stream, right bank.	35.5	1196.1
Carrabassett Valley, Maine, South Branch, 100 feet downstream from mouth of Redington Pond outlet stream, right bank.	34.1	1126.9
Carrabassett Valley, Maine, at confluence with Huston Brook, right bank	32.4	881.8
Carrabassett Valley, Maine, 100 feet downstream from mouth of unnamed stream, right bank	31.3	855.8
Carrabassett Valley, Maine, at fire station, left bank	31.2	849.5
Carrabassett Valley, Maine, 50 feet upstream from Red Stallion Bridge, left bank	31.1	842.6
Carrabassett Valley, Maine, 50 feet downstream from Red Stallion Bridge, left bank	31.1	836.9
Carrabassett Valley, Maine, at the Ledges and upstream from private bridge, average of left and right bank elevations.	30.0	794.6
Carrabassett Valley, Maine, at the Ledges and 250 feet downstream from private bridge, right bank	29.9	786.0
Carrabassett Valley, Maine, 0.5 mile downstream from the Ledges, right bank	29.4	764.7
Kingfield, Maine, streamward from the intersection of Tufts Pond Road and Routes 16 and 27, right bank.	22.8	596.8
Kingfield, Maine, 100 feet downstream from the confluence of the West Branch, left bank	21.5	566.8
Kingfield, Maine, 100 feet upstream from Route 16 bridge, average of left and right bank elevations	21.3	565.9
Kingfield, Maine, downstream side Route 16 bridge, left bank	21.3	562.7
Kingfield, Maine, downstream from confluence of Stanley Stream, left bank	21.2	560.1
Kingfield, Maine, 200 feet downstream from Kingfield Dam, right bank	21.1	555.9
Kingfield, Maine, 700 feet downstream from Kingfield Dam, left bank	21.0	553.6
Kingfield, Maine, 1.2 miles downstream from Kingfield Dam, left bank	19.9	537.8
New Portland, Maine, 100 feet upstream from wire bridge, right bank	14.5	473.5
New Portland, Maine, 100 feet downstream from wire bridge, right bank	14.5	471.6

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
KENNEBEC RIVER BASIN—Continued		
Carrabassett River—Continued:		
New Portland, Maine, upstream side Route 146 bridge, right bank	12.5	437.9
North Anson, Maine, U.S. Geological Survey station 01047000, 3.4 miles upstream from mouth of Mill Stream, left bank.	4.6	330.0
North Anson, Maine, 2.0 miles upstream from mouth of Mill Stream, left bank	3.2	323.8
North Anson, Maine, 150 feet upstream from railroad bridge, left bank	1.3	309.5
North Anson, Miane, 150 feet downstream from railroad bridge, left bank	1.3	305.8
North Anson, Maine, 50 feet upstream from mouth of Mill Stream, left bank	1.2	300.4
North Anson, Maine, downstream side mouth of Mill Stream, left bank	1.2	299.0
North Anson, Maine, 100 feet upstream from Route 201A bridge, right bank	1.0	281.6
North Anson, Maine, 500 feet downstream from Route 201A bridge, right bank	.9	273.9
Sandy River:		
Phillips, Maine, 100 feet upstream from Route 142 bridge, left bank	51.5	607.2
Phillips, Maine, 20 feet downstream from Route 142 bridge, right bank	51.5	597.2
Phillips, Maine, 1,000 feet upstream from Route 149 bridge, right bank	50.1	569.2
Avon, Maine, upstream from mouth of Bean Brook, left bank	44.3	487.2
Strong, Maine, 100 feet upstream from Route 145 bridge, right bank	41.5	443.4
Strong, Maine, 100 feet downstream from Route 145 bridge, right bank	41.5	441.4
Strong, Maine, 4.1 miles downstream from Route 145 bridge, right bank	37.4	399.1
Farmington, Maine, 175 feet upstream from Route 4 bridge, right bank	33.0	373.9
Farmington, Maine, 500 feet downstream from Route 4 bridge, right bank	32.9	370.8
Farmington, Maine, upstream side of railroad bridge, left bank	29.9	360.1
Farmington, Maine, 150 feet downstream of railroad bridge, left bank	29.9	358.9
Farmington, Maine, 500 feet upstream from Route 2 bridge, right bank	29.6	359.2
Farmington, Maine, 100 feet downstream from Route 2 bridge, right bank	29.6	357.9
Farmington, Maine, mouth of Temple Stream, right bank	29.0	356.1
Farmington, Maine, across Route 2 from State picnic area, right bank	26.3	351.2
Farmington, Maine, 500 feet upstream from Route 41 bridge, left bank	22.7	345.7
Farmington, Maine, 100 feet downstream from Route 41 bridge, left bank	22.6	342.6
New Sharon, Maine, 0.5 mile upstream from mouth of Muddy Brook, left bank	17.9	338.6
New Sharon, Maine, mouth of Muddy Brook, left bank	17.4	332.5
New Sharon, Maine, 60 feet upstream from Route 2 bridge, left bank	16.3	324.0
New Sharon, Maine, 60 feet downstream from Route 2 bridge, left bank	16.3	323.3
Mercer, Maine, U.S. Geological Survey station 01048000, 0.9 mile upstream from mouth of Bog Stream, right bank.	8.7	216.4
Norridgewock, Maine, Madison Electric Company dam, headwater	3.9	[m]197.0
tailwater	3.9	195.5
Starks, Maine, confluence with the Kennebec River	0.0	192.8
Temple Stream:		
Farmington, Maine, 50 feet upstream from Russells Mill Bridge, left bank	4.3	449.8
Farmington, Maine, 50 feet downstream from Russells Mill Bridge, left bank	4.3	445.0
Farmington, Maine, 150 feet upstream from Temple Road bridge, right bank	3.0	382.2
Farmington, Maine, 75 feet downstream from Temple Road bridge, right bank	3.0	379.2
Farmington, Maine, Temple Stream Dam, left bank, headwater	1.5	[n]370.9
tailwater	1.5	[n]360.0
Farmington, Maine, upstream from Morrison Hill Road bridge, right bank	1.4	355.9

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
KENNEBEC RIVER BASIN—Continued		
Temple Stream—Continued:		
Farmington, Maine, downstream from Morrison Hill Road bridge, right bank	1.4	355.8
Farmington, Maine, 250 feet upstream from Route 2 bridge, left bank	.6	356.1
Farmington, Maine, 250 feet downstream from Route 2 bridge, left bank	.5	356.1
Wilson Stream:		
Wilton, Maine, upstream from Canal Street bridge, left bank	16.4	575.6
Wilton, Maine, downstream from Canal Street bridge, left bank	16.4	575.2
Wilton, Maine, 400 feet upstream from Library Bridge, left bank	16.3	556.1
Wilton, Maine, 100 feet downstream from Library Bridge, right bank	16.2	549.2
Wilton, Maine, upstream side gas station, left bank	16.0	531.2
Wilton, Maine, 20 feet upstream from intersection of Davis Street and Stickney Court, left bank	15.2	476.6
Wilton, Maine, upstream from mouth of Coubers Brook, left bank	15.1	471.0
Wilton, Maine, downstream from Backus Garage, left bank	13.2	424.1
Wilton, Maine, U.S. Geological Survey gage 01047730, 0.1 mile upstream from railroad bridge, left bank.	12.7	416.9
Wilton, Maine, downstream side East Wilton Bridge, right bank	12.6	407.0
Wilton, Maine, 40 feet upstream from railroad bridge, right bank	12.6	397.4
Wilton, Maine, 40 feet downstream from railroad bridge, right bank	12.6	395.4
Wilton, Maine, 100 feet upstream from Route 2 bridge, right bank	12.0	389.7
Wilton, Maine, 100 feet downstream from Route 2 bridge, right bank	12.0	386.5
Wilton, Maine, 0.2 mile downstream from Route 2 bridge, right bank	11.8	386.3
Wilton, Maine, upstream side, Butterfield Road bridge, left bank	10.6	383.2
Wilton, Maine, downstream side, Butterfield Road bridge, right bank	10.6	381.5
Farmington, Maine, upstream side Route 133 bridge, left bank	9.6	368.7
Farmington, Maine, downstream side Route 133 bridge, right bank	9.6	366.8
Farmington, Maine, 100 feet upstream from Webster Road bridge, right bank	7.5	359.4
Farmington, Maine, 100 feet downstream from Webster Road bridge, right bank	7.5	358.7
North Chesterville, Maine, 140 feet upstream from Knowltons Corner Road bridge, average of left and right bank elevations.	3.8	351.4
North Chesterville, Maine, downstream side Knowltons Corner Road bridge, right bank	3.8	350.2
Chesterville, Maine, upstream side Route 156 bridge, right bank	.4	347.5
Chesterville, Maine, 300 feet downstream from Route 156 bridge, right bank	.4	345.5
Chesterville, Maine, confluence with Sandy River, right bank	0	345.4
Sebasticook River:		
Hartland, Maine, 150 feet upstream from dam at outlet of Great Moose Lake, right bank	40.6	[c]249.6
Hartland, Maine, 40 feet upstream from bridge located just downstream from Great Moose Lake Dam, left bank.	40.6	244.3
Hartland, Maine, 125 feet downstream from bridge located just downstream from Great Moose Lake Dam, average left and right bank elevations.	40.5	241.8
Hartland, Maine, 250 feet upstream from Route 43 bridge, left bank	40.3	240.3
Hartland, Maine, 250 feet upstream from Route 43 bridge, right bank	40.3	239.7
Hartland, Maine, 100 feet downstream from Route 43 bridge, right bank	40.3	239.0
Palmyra, Maine, upstream side Route 2 bridge, left bank	35.9	223.9
Palmyra, Maine, downstream side Route 2 bridge, left bank	35.9	223.9
Pittsfield, Maine, 75 feet upstream from Waverly Street bridge, right bank	33.1	220.7
Pittsfield, Maine, 30 feet downstream from Waverly Street bridge, right bank	33.1	220.4

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
KENNEBEC RIVER BASIN—Continued		
Sebasticook River—Continued:		
Pittsfield, Maine, 150 feet downstream from Water Works dam, right bank	33.0	212.2
Pittsfield, Maine, upstream side Routes 100 and 11 bridge, left bank	32.2	211.6
Pittsfield, Maine, 100 feet upstream from American Woolen Co. dam, left bank	32.2	208.7
Pittsfield, Maine, 300 feet downstream from American Woolen Co. dam, left bank	32.1	202.7
Pittsfield, Maine, 800 feet upstream from Route 69 bridge, left bank	32.1	201.8
Pittsfield, Maine, 200 feet upstream from Route 69 bridge, left bank	31.9	197.8
Pittsfield, Maine, 60 feet downstream from Route 69 bridge, right bank	31.9	196.0
Pittsfield, Maine, downstream side railroad bridge, average of left and right bank elevations	31.8	193.7
Pittsfield, Maine, 150 feet upstream from Eelwier Bridge, right bank	24.8	174.1
Pittsfield, Maine, 150 feet downstream from Eelwier Bridge, right bank	24.8	172.9
Pittsfield, Maine, 100 feet upstream from Burnham Dam, right bank	22.2	[p]169.1
Pittsfield, Maine, Burnham Dam, tailwater, right bank	22.1	[p]150.5
Pittsfield, Maine, U.S. Geological Survey station 01049000, 1.7 miles upstream from mouth of Twenty-five Mile Stream, right bank.	21.7	149.5
Burnham, Maine, 30 feet upstream from Johnson Flat Bridge, right bank	19.9	145.4
Burnham, Maine, 100 feet downstream from Johnson Flat Bridge, right bank	19.9	144.2
Burnham, Maine, 100 feet upstream from railroad bridge, left bank	19.8	144.2
Burnham, Maine, downstream side of railroad bridge, left bank	19.8	142.9
Clinton, Maine, 0.9 mile south along Route 100 from Clinton-Burnham Townline, right bank	16.9	139.2
Clinton, Maine, 0.3 mile upstream from Pleasant Street bridge, right bank	11.2	120.2
Clinton, Maine, 200 feet upstream from Pleasant Street bridge, average of left and right bank elevations	10.9	118.5
Clinton, Maine, 100 feet downstream from Pleasant Street bridge, average of left and right bank elevations.	10.9	116.3
Benton, Maine, 300 feet upstream from Route 139 bridge, right bank	6.3	82.0
Benton, Maine, 200 feet downstream from Route 139 bridge, right bank	6.3	77.8
Winslow, Maine, Fort Halifax Dam, headwater	.4	[q]64.8
tailwater	.4	[q]64.7
Winslow, Maine, upstream side, Routes 100 and 201 bridge, average of left and right bank elevations	.2	64.7
Winslow, Maine, downstream side, Routes 100 and 201 bridge, average of left and right bank elevations.	.2	64.3
Winslow, Maine, at confluence with Kennebec River, left bank	0	64.2
East Branch Sebasticook River:		
Newport, Maine, 75 feet upstream from dam at outlet of Sebasticook Lake, right bank	8.6	201.9
Newport, Maine, 15 feet downstream from bridge at outlet of Sebasticook Lake, right bank	8.6	198.4
Newport, Maine, 100 feet upstream from Center Street bridge, right bank	8.4	197.8
Newport, Maine, 50 feet downstream from Center Street bridge, right bank	8.4	197.5
Newport, Maine, 200 feet upstream from railroad bridge, right bank	8.1	190.2
Newport, Maine, 160 feet downstream from railroad bridge, left bank	8.1	189.0
Newport, Maine, 40 feet upstream from Interstate 95 bridge, right bank	7.2	186.9
Newport, Maine, 40 feet downstream from Interstate 95 bridge, right bank	7.2	186.7
Detroit, Maine, 125 feet upstream from Routes 69 and 220 bridge, right bank	3.2	181.6
Detroit, Maine, 200 feet downstream from Routes 69 and 220 bridge, left bank	3.2	177.8

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
ANDROSCOGGIN RIVER BASIN		
Androscoggin River:		
Bethel, Maine, 75 feet upstream from Route 2 bridge, right bank	109.0	648.5
Bethel, Maine, 125 feet downstream from Route 2 bridge, right bank	109.0	647.8
Newry, Maine, mouth of Bear River, left bank	103.6	637.7
Rumford Point, Maine, upstream side Route 232 bridge, right bank	97.4	627.9
Rumford Point, Maine, downstream side Route 232 bridge, right bank	97.4	627.5
Rumford Center, Maine, at Town Meeting House, left bank	92.8	623.2
Rumford, Maine, 100 feet upstream from South Rumford Road bridge, left bank	87.5	618.2
Rumford, Maine, 100 feet downstream from South Rumford Road bridge, right bank	87.5	609.1
Rumford, Maine, Upper dam, headwater	87.4	[r,s]607.8
tailwater	87.4	[s]509.1
Rumford, Maine, Middle dam, headwater	87.2	[s,t]509.1
Rumford, Maine, 50 feet upstream from Morse Bridge, left bank	87.1	502.7
Rumford, Maine, 75 feet downstream from Morse Bridge, left bank	87.1	501.4
Rumford, Maine, U.S. Geological Survey station 01054500, 1,000 feet upstream from mouth of Swift River, right bank.	86.5	443.2
Mexico, Maine, 100 feet downstream from mouth of Swift River, left bank	86.3	441.9
Mexico, Maine, 30 feet upstream from footbridge, left bank	85.8	437.5
Mexico, Maine, 30 feet downstream from footbridge, left bank	85.8	436.3
Mexico, Maine, 75 feet upstream from Ridlonville Bridge, left bank	85.6	435.8
Mexico, Maine, 75 feet downstream from Ridlonville Bridge, left bank	85.6	435.4
Dixfield, Maine, downstream side highway bridge, left bank	82.0	415.1
Canton, Maine, 1.7 miles upstream from Route 140 bridge, left bank	73.4	396.9
Canton, Maine, 0.4 mile northwest along Canton Point Road from Bradbury Chapel, left bank	72.8	395.2
Canton, Maine, 75 feet upstream from Route 140 bridge, right bank	71.7	395.0
Canton, Maine, 50 feet downstream from Route 140 bridge, right bank	71.7	395.0
Canton, Maine, 1.6 miles downstream from Route 140 bridge, left bank	70.1	392.7
Canton, Maine, near upstream end of Stevens Island, left bank	69.5	392.6
Jay, Maine, Riley Dam, headwater	66.6	[u,v]381.8
tailwater	66.6	[u]371.8
Jay, Maine, mouth of Sevenmile Stream, left bank	65.8	370.7
Jay, Maine, 0.7 mile downstream from mouth of Sevenmile Stream, left bank	65.1	370.4
Jay, Maine, 0.5 mile upstream from Jay Dam, left bank	64.3	366.4
Jay, Maine, Jay Dam, headwater	63.8	[u,w]360.3
tailwater	63.8	[u]356.6
Jay, Maine, upstream side Androscoggin Mill Road bridge, left bank	63.6	356.6
Jay, Maine, downstream side Androscoggin Mill Road bridge, left bank	63.6	355.8
Jay, Maine, Otis Dam, headwater	61.8	[u,x]349.5
tailwater	61.8	[u]330.0
Livermore Falls, Maine, Livermore Falls Dam, headwater	61.0	[y]321.4
tailwater	60.9	302.8
Livermore Falls, Maine, 0.1 mile upstream from mouth of Scott Brook at "Strickland Ferry"	52.9	290.1
Livermore, Maine, 800 feet downstream from mouth of Keith Brook, right bank	50.7	287.7
Turner, Maine, 100 feet upstream from Twin Bridges, right bank	49.0	281.7
Turner, Maine, 75 feet downstream from Twin Bridges, right bank	49.0	279.5
Greene, Maine, 75 feet upstream from Turner Bridge, left bank	42.6	266.2
Greene, Maine, 75 feet downstream from Turner Bridge, left bank	42.6	264.8

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
ANDROSCOGGIN RIVER BASIN—Continued		
Androscoggin River—Continued:		
Lewiston, Maine, Gulf Island Dam, headwater	34.4	[z,aa]264.2
tailwater	34.4	[z]213.2
Lewiston, Maine, Deer Rips Dam, headwater	33.6	[z,ab]211.5
Auburn, Maine, 90 feet upstream from Memorial Bridge, right bank	32.1	178.9
Auburn, Maine, 50 feet downstream from Memorial Bridge, right bank	32.1	178.7
Auburn, Maine, 175 feet upstream from railroad bridge and Union Water Power Company dam, right bank.	30.9	175.6
Auburn, Maine, 100 feet downstream from railroad bridge and Union Water Power Company dam, right bank.	30.9	170.2
Lewiston, Maine, Union Water Power Company dam, left bank headwater	30.8	[ac,ad]174.2
Lewiston, Maine, 50 feet upstream from North Bridge, left bank	30.6	140.5
Lewiston, Maine, 125 feet downstream from North Bridge, left bank	30.6	137.8
Lewiston, Maine, 75 feet upstream from South Bridge, left bank	30.1	135.4
Lewiston, Maine, 45 feet downstream from South Bridge, left bank	30.1	135.3
Auburn, Maine, U.S. Geological Survey station 01059000, 1.5 miles downstream from mouth of Little Androscoggin River, right bank.	28.4	132.9
Lisbon Falls, Maine, Worumbo Dam, headwater	16.1	[ae]104.1
Lisbon Falls, Maine, 100 feet upstream from Route 9 bridge, left bank	15.8	90.2
Durham, Maine, 225 feet downstream from Route 9 bridge, right bank	15.8	88.8
Topsham, Maine, Pejepscot Dam, headwater	12.5	[af,ag]79.2
tailwater	12.5	[af]67.4
Brunswick, Maine, Brunswick Dam headwater	8.2	[z,ah]51.0
Topsham, Maine, upstream side Route 201 bridge, left bank	8.1	31.0
Topsham, Maine, downstream side Route 201 bridge, left bank	8.1	30.9
Whitney Brook:		
Canton, Maine, 100 feet upstream from Route 108 bridge, right bank	2.3	397.0
Canton, Maine, downstream side Route 140 bridge, average of left and right bank elevations	2.3	395.3
Canton, Maine, upstream side Bixby Road, left bank	1.5	395.2
Canton, Maine, upstream side Route 140 and Pinewood Road bridge, left bank	.5	395.1
Canton, Maine, downstream side Route 140 and Pinewood Road bridge, average of left and right bank elevations.	.5	394.9
Little Androscoggin River:		
Greenwood, Maine, upstream side Route 219 bridge, right bank	71.5	502.2
Greenwood, Maine, downstream side Route 219 bridge, left bank	71.5	499.6
West Paris, Maine, upstream side Penley Avenue bridge, left bank	69.8	484.5
West Paris, Maine, downstream side Penley Avenue bridge, average of left and right elevations	69.8	483.6
West Paris, Maine, upstream side Route 219 bridge, left bank	69.6	481.5
West Paris, Maine, downstream side Route 219 bridge and dam, average of left right bank elevations	69.6	478.8
West Paris, Maine, 30 feet upstream from railroad bridge, average of left and right bank elevations	69.6	479.0
West Paris, Maine, downstream side of railroad bridge, left bank	69.6	478.0
West Paris, Maine, upstream side Hadley Pit Road, left bank	68.6	469.1
West Paris, Maine, downstream side Hadley Pit Road, left bank	68.6	464.7
West Paris, Maine, U.S. Geological Survey station 01057000, head of island 50 feet upstream from Snow Falls, right bank.	66.9	459.2
West Paris, Maine, 30 feet upstream from Bisco Falls Dam at former site of U.S. Geological Survey station 01057000.	65.6	407.5

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
ANDROSCOGGIN RIVER BASIN—Continued		
Little Androscoggin River—Continued:		
Paris, Maine, upstream side Route 26 bridge, average of left and right bank elevations	60.8	353.5
Paris, Maine, downstream side Route 26 bridge, right bank	60.8	352.8
Paris, Maine, upstream side Park Street bridge, average of left and right bank elevations	60.5	351.5
Paris, Maine, downstream side Park Street bridge, average of left and right bank elevations	60.5	350.7
Paris, Maine, Billings Dam, headwater, average of left and right bank elevations	60.2	[ai]350.0
Paris, Maine, 50 feet downstream from Route 117 bridge, left bank	60.2	344.6
Paris, Maine, upstream side railroad bridge, right bank	59.3	334.5
Paris, Maine, downstream side railroad bridge, average of left and right bank elevations	59.3	333.6
Oxford, Maine, upstream side Route 26 bridge, right bank	56.9	325.4
Oxford, Maine, downstream side Route 26 bridge, average of left and right bank elevations	56.9	325.1
Oxford, Maine, upstream side Route 121 bridge, average of left and right bank elevations	52.0	311.8
Oxford, Maine, downstream side Route 121 bridge, average of left and right bank elevations	52.0	311.7
Oxford, Maine, upstream side Route 26 bridge near Welchville, average of left and right bank elevations.	49.6	307.9
Oxford, Maine, Welchville Dam, right bank headwater	49.6	[aj]306.3
tailwater	49.6	304.8
Mechanic Falls, Maine, upstream side Memorial Bridge, average of left and right bank elevations	45.4	287.0
Mechanic Falls, Maine, downstream side Memorial Bridge, average of left and right bank elevations	45.4	286.6
Mechanic Falls, Maine, upstream side Route 11 bridge, average of left and right bank elevations	43.9	282.3
Mechanic Falls, Maine, downstream side Route 11 bridge, left bank	43.9	282.2
Mechanic Falls, Maine, upstream side of Route 121 bridge, average of left and right bank elevations	43.3	280.1
Mechanic Falls, Maine, 80 feet downstream from Mechanic Falls Dam, left bank	43.3	[ak]264.1
Minot, Maine, upstream side Routes 11 and 121 bridge, average of left and right bank elevations	39.0	243.6
Minot, Maine, downstream side Routes 11 and 121 bridge, average of left and right bank elevations	39.0	241.7
Minot, Maine, 60 feet downstream from Hacket Mills Dam, left bank	38.9	[al]234.8
Minot, Maine, upstream side Empire Road, average of left and right bank elevations	38.2	232.0
Minot, Maine, downstream side Empire Road, average of left and right bank elevations	38.2	230.6
Auburn, Maine, upstream side of Old Hotel Road, at site of former U.S. Geological Survey station 01058500, average of left and right bank elevations.	34.6	223.0
Auburn, Maine, upstream side of railroad bridge, left bank	34.6	221.2
Auburn, Maine, downstream side of railroad bridge, average of left and right bank elevations	34.6	221.2
Auburn, Maine, Central Maine Power Company Upper Dam, partially breached previous to flood headwater.	34.0	214.7
tailwater.	34.0	209.0
Auburn, Maine, upstream side of southbound Route 202 bridge, average of left and right bank elevations.	33.3	205.1
Auburn, Maine, downstream side of southbound Route 202 bridge, average of left and right bank elevations.	33.3	204.8
Auburn, Maine, upstream side of northbound Route 202 bridge, average of left and right bank elevations.	33.2	204.7
Auburn, Maine, downstream side of northbound Route 202 bridge, average of left and right bank elevations.	33.2	204.2
Auburn, Maine, upstream side of railroad bridge, average of left and right bank elevations	31.7	201.0
Auburn, Maine, downstream side of railroad bridge, average of left and right bank elevations	31.7	200.5
Auburn, Maine, upper Barker Mills Dam, left bank headwater	30.8	[am]189.8
Auburn, Maine, 200 feet downstream from Upper Barker Mills Dam, left bank	30.8	179.6

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

Stream and location	Miles upstream[a] from mouth	Elevation (in feet)
ANDROSCOGGIN RIVER BASIN—Continued		
Little Androscoggin River—Continued:		
Auburn, Maine, Barker Mills Dam, right bank headwater	30.6	[an]170.7
Auburn, Maine, 300 feet downstream from Barker Mills Dam, at upstream edge of Barker Mill, right bank.	30.6	138.9
Auburn, Maine, upstream side of Main Street bridge, average of left and right bank elevations	30.3	136.5
Auburn, Maine, downstream side of Main Street bridge, left bank	30.3	136.0
Stony Brook:		
Paris, Maine, upstream side Brett Hill Road bridge	1.0	412.0
Paris, Maine, downstream side Brett Hill Road bridge, average of left and right bank elevations	1.0	410.5
Paris, Maine, upstream side Hebron Road bridge, average of left and right bank elevations	.3	376.4
Paris, Maine, downstream side Hebron Road bridge, average of left and right bank elevations	.3	373.8
Paris, Maine, upstream side Route 117 bridge, average of left and right bank elevations	.2	350.7
Paris, Maine, downstream side Route 117 bridge, average of left and right bank elevations	.2	350.4
Bog Brook:		
Minot, Maine, upstream side Route 124 bridge, average of left and right bank elevations	7.3	307.4
Minot, Maine, downstream side Route 124 bridge, average of left and right bank elevations	7.3	306.0
Minot, Maine, upstream side Route 119 bridge, average of left and right bank elevations	7.0	301.9
Minot, Maine, downstream side Route 119 bridge, average of left and right bank elevations	7.0	300.0
Minot, Maine, upstream side Bucknam Road bridge, average of left and right bank elevations	4.8	249.7
Minot, Maine, downstream side Bucknam Road bridge, average of left and right bank elevations	4.8	249.4
Minot Maine, upstream side abandoned railroad bridge, average of left and right bank elevations	1.6	249.8
Minot Maine, downstream side Route 124 bridge, average of left and right bank elevations	1.6	249.7
Minot Maine, upstream side Marshall Street bridge, average of left and right bank elevations	.6	249.4
Minot Maine, downstream side Marshall Street bridge, average of left and right bank elevations	.6	249.4

[a]From Grover (1937, table 15).
[b]Elevation of dam crest, 259.0 feet (Federal Emergency Management Agency, 1987b).
[c]Furnished by Bangor Hydro.
[d]Elevation of dam crest, 148.8 feet (Bangor Hydro, oral commun., 1991).
[e]Elevation of dam crest, 98.2 feet (Federal Insurance Administration, 1977a).
[f]Elevation of dam crest, 28.2 feet (Federal Insurance Administration, 1977b).
[g]Furnished by U.S. Soil Conservation Service, Orono, Maine.
[h]Elevation of dam crest, 340.3 feet (Federal Insurance Administration, 1979a).
[j]Elevation of dam crest, 108.0 feet (Federal Emergency Management Agency, 1988a).
[k]Elevation of dam crest, 77.0 feet (Federal Emergency Management Agency, 1988b).
[l]Elevation of dam crest, 19.3 feet (Edwards Manufacturing Co., 1991, written commun.).
[m]Elevation of dam crest, 177.7 feet (Federal Emergency Management Agency, 1988c).
[n]Elevation of dam crest, 366.0 feet (Federal Emergency Management Agency, 1980a).
[o]Great Moose Lake Dam breached during flood.
[p]Elevation of dam crest, 162.0 feet (Federal Emergency Management Agency, 1991b).
[q]Elevation of dam crest, 50.7 feet (Federal Emergency Management Agency, 1987c).
[r]Elevation of dam crest, 598.7 feet (Federal Emergency Management Agency, 1980b).
[s]Furnished by Rumford Falls Power Company.
[t]Elevation of dam crest, 501.9 feet (Federal Emergency Management Agency, 1980b).
[u]Furnished by International Paper Company.
[v]Elevation of dam crest, 370.9 feet (Federal Emergency Management Agency, 1989).
[w]Elevation of dam crest, 351.2 feet (Federal Emergency Management Agency, 1989).
[x]Elevation of dam crest, 337.6 feet (Federal Emergency Management Agency, 1990a).
[y]Elevation of dam crest, 310.3 feet (Federal Emergency Management Agency, 1990a).

Table 12. Flood-crest stages for April 1987 flood in Maine—Continued

[z]Furnished by Central Maine Power Company.
[aa]Elevation of dam crest, 255.0 feet (Federal Insurance Administration, 1979b).
[ab]Elevation of dam crest, 201.6 feet (Federal Insurance Administration, 1979b).
[ac]Furnished by Union Water Power Company.
[ad]Elevation of dam crest, 164.3 feet (Federal Insurance Administration, 1979b).
[ae]Furnished by Miller Industries, dam under construction at time of flood and temporary dam failed.
[af]Furnished by Acres Engineering.
[ag]Elevation of dam crest, 61.2 feet (Federal Emergency Management Agency, 1987d).
[ah]Elevation of dam crest, 39.8 feet.
[ai]Elevation of dam crest, 342.7 feet (Federal Emergency Management Agency, 1991c).
[aj]Elevation of dam crest, 299.0 feet (Federal Emergency Management Agency, 1991d).
[ak]Elevation of dam crest, 271.3 feet (Federal Emergency Management Agency, 1990b).
[al]Elevation of dam crest, 235.0 feet (Federal Emergency Management Agency, 1990b).
[am]Dam under construction during flood.
[an]Elevation of dam crest, 164.4 feet (Federal Emergency Management Agency, 1980c).

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