# Flood of April 2007 in New Hampshire

By Robert H. Flynn

Prepared in cooperation with the Federal Emergency Management Agency

Scientific Investigations Report 2008–5120

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## Conversion Factors and Datum

| Multiply | By | To obtain |
|---|---|---|
| | Length | |
| inch (in.) | 2.54 | centimeter (cm) |
| inch (in.) | 25.4 | millimeter (mm) |
| foot (ft) | 0.3048 | meter (m) |
| mile (mi) | 1.609 | kilometer (km) |
| | Area | |
| square mile ($mi^2$) | 2.590 | square kilometer ($km^2$) |
| | Flow rate | |
| cubic foot per second ($ft^3/s$) | 0.02832 | cubic meter per second ($m^3/s$) |

Horizontal coordinate information is referenced to the North American Datum of 1927 (NAD 27).

Vertical coordinate information is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and North American Vertical Datum of 1988 (NAVD 88).

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## Abstract

During April 16–18, 2007, central and southeastern New Hampshire experienced severe flooding as a result of up to 7 inches of rainfall from a storm that stalled off the New England coast. As a result of the flooding, a Presidential Disaster Declaration was issued on April 27, 2007. On that day, disaster declarations were announced for Grafton, Hillsborough, Merrimack, Rockingham, and Strafford Counties. On May 10, 2007, Belknap County was added to the disaster declaration.

Following the flooding, the U.S. Geological Survey, in a cooperative investigation with the Federal Emergency Management Agency, determined the peak stages, peak discharges, and recurrence-interval estimates of the April 2007 flood at 57 streamgages and 4 ungaged sites in and adjacent to the counties named in the disaster declaration. Data from flood-insurance studies published by the Federal Emergency Management Agency also were compiled for each streamgage site for comparison purposes.

The peak discharges during the April 2007 flood were the highest ever recorded at five long-term (more than 10 years of record) streamgage sites on the New Hampshire-Salmon Falls River at Milton, Cocheco River near Rochester, Oyster River near Durham, Contoocook River at Peterborough, and South Branch Piscataquog River near Goffstown. In addition, peak discharges equaled or exceeded a 100-year recurrence interval at 10 streamgages and a 50-year recurrence interval at 16 streamgages. The most severe flooding occurred in Rockingham, Strafford, Merrimack, and Hillsborough Counties.

## Introduction

Major flooding in central and southern New Hampshire (fig. 1) from April 16 to 18, 2007, resulted in substantial damage to public and personal property. Homes and roads were damaged, and numerous residential areas were evacuated for several days. As a result of the widespread damage caused by the flooding, President George W. Bush issued a Presidential Disaster Declaration on April 27, 2007, for the counties of Grafton, Hillsborough, Merrimack, Rockingham, and Strafford in New Hampshire (fig. 1; Federal Emergency Management Agency, 2007). Belknap County in New Hampshire was added to the disaster declaration on May 10, 2007 (Federal Emergency Management Agency, 2007). In response to the disaster declaration, the U.S. Geological Survey (USGS), in cooperation with the Federal Emergency Management Agency (FEMA), measured or computed flood characteristics at 57 streamgages and 4 ungaged locations within and adjacent to the disaster areas.

The April 2007 flood is documented in this report through the presentation of flood data collected at 46 active and 11 discontinued streamgages and 4 ungaged locations in central and southern New Hampshire. The flood data include peak-stage data, peak-discharge data, flow-frequency curves, and estimates of flood-recurrence intervals at each streamgage. In addition, data were compiled from 20 town/city-wide and 3 county-wide FEMA flood-insurance studies for comparison purposes. The active streamgages include 37 operated by the USGS, 7 operated by the New Hampshire Department of Environmental Services (NHDES), and 2 operated by the U.S. Army Corps of Engineers (USACE). All 11 discontinued streamgages previously had been operated by the USGS. A description of each streamgage site included in this investigation is provided in table 1 (in back of report).

Although the April 16–18, 2007, storm produced less precipitation than either the October 1996 or May 2006 storm events, some streams in New Hampshire had higher discharges in the 2007 event. For example, on April 16, 2007, a peak discharge of 1,320 $ft^3/s$ occurred at the Oyster River streamgage near Durham, N.H. Prior to this peak, the peak discharge of record at that station was 1,160 $ft^3/s$ on October 21, 1996. The April 16–18, 2007, precipitation resulted in discharges that were the maximum for the period of record at 5 long-term (more than 10 years of record) streamgage sites in central and southern New Hampshire.

The primary difference between the flooding events of May 2006 and October 1996 was the antecedent ground conditions in May 2006 (National Oceanic and Atmospheric Administration, 2006b) that resulted in greater discharges during the May 2006 event at many streamgages. The primary difference between the April 2007 flooding event and the May 2006 and October 1996 events was the precipitation on top of snowpack that resulted in greater discharges during the April 2007 event at many streamgages.

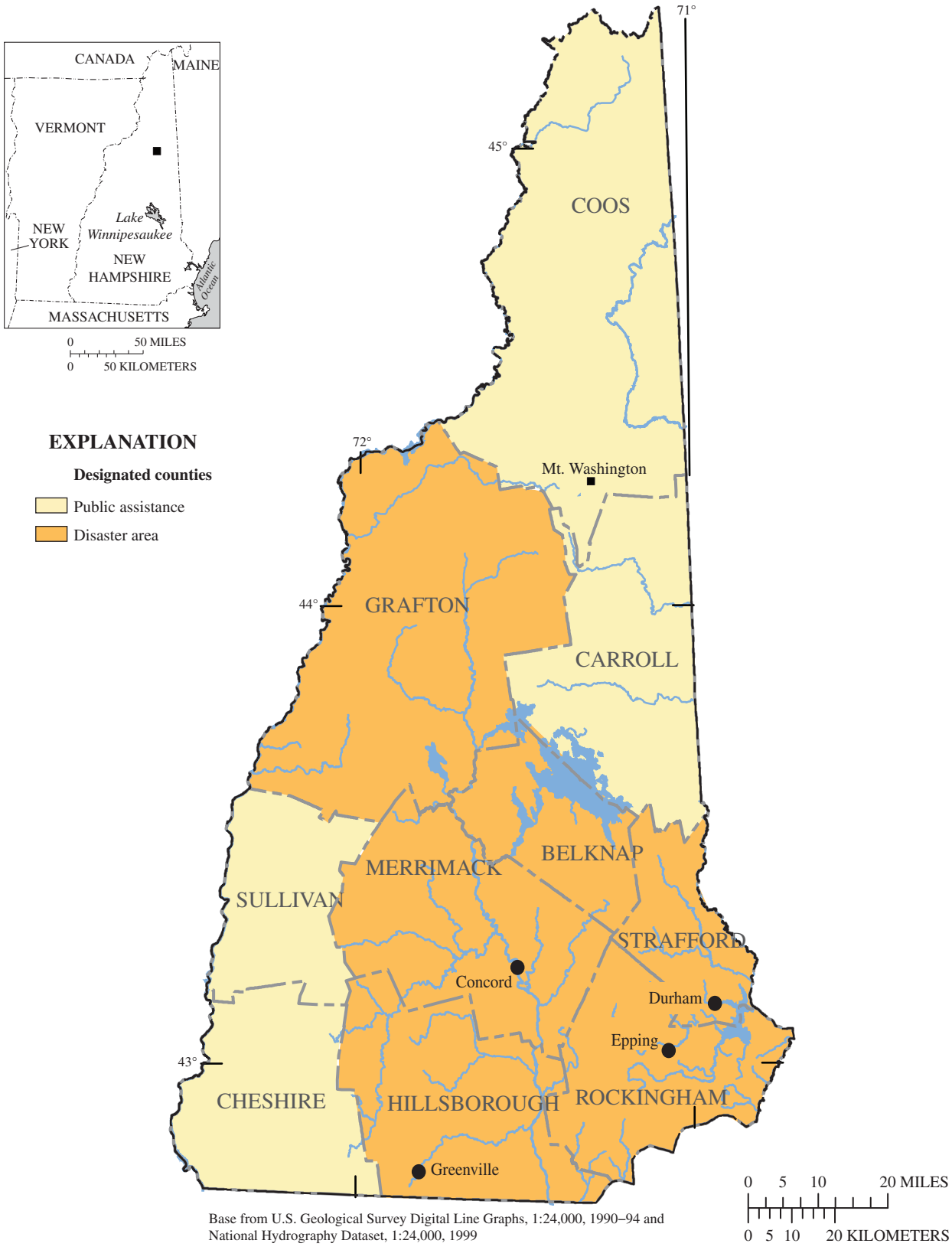


**Figure 1.** Counties included in the Presidential Disaster Declarations of April 27 and May 10, 2007. (FEMA-1695-DR, Federal Emergency Management Agency, 2007)

The higher than normal precipitation from the April 2007 storm, which included precipitation on top of snowpack at higher elevations, downed trees, and wood debris in some rivers all contributed to the high flows and flooding in southern and central New Hampshire. In addition, an abnormally high spring tide along with a storm surge of nearly 3 ft caused tidal flooding along portions of the seacoast (National Oceanic and Atmospheric Administration, 2007b), and the prolonged period of strong northeast winds caused a prolonged storm surge along the coastline (National Climate Data Center, 2007).

## Description of Study Area

The six New Hampshire counties included in the disaster declaration (fig. 1) compose a land area of 5,245 $mi^2$ in the northeastern United States. Land elevations range from zero feet above the North American Vertical Datum of 1988 (NAVD 88) at Mean Lower Low Water (MLLW) at the seacoast to greater than 4,000 ft above the NAVD 88 in the north-central part of New Hampshire. The climate of New Hampshire is humid. Precipitation is distributed fairly evenly across the state and averages about 43 in. per year except in regions that can receive additional precipitation due to elevation and snowfall. From 1971 to 2000, Mount Washington received an average of 101.9 in. of precipitation per year, while Concord received an average of 37.6 in. of precipitation (National Climate Data Center, 2008). The average (1971–2000) precipitation for April in Concord, N.H., was approximately 3.07 in. (National Climate Data Center, 2008).

## Storm Characteristics

The precipitation that occurred from April 15 to 19, 2007, produced 6.54 in. of rainfall in the southeastern New Hampshire towns of Durham and Epping and 7.25 in. of rainfall in Greenville, N.H.—a town in the south-central part of the state (National Oceanic and Atmospheric Administration, 2007a). Because April 16, 2007, was the Patriot's Day holiday, the storm has since been referred to as the Patriot's Day storm. The rainfall began on Sunday, April 15, 2007; snow accumulated in many areas and changed to rain, at first along the coast then eventually inland and northward. In Concord, snow accumulated to a total melted precipitation of 1.26 in. (National Oceanic and Atmospheric Administration, 2007b) on April 15. The rainfall became heavy on Sunday, April 15, during the afternoon and overnight. By the morning of Monday, April 16, 3 to 5 in. of rain had fallen over much of southeastern New Hampshire (fig. 2A; Northeast River Forecast Center, 2007a), and 1 to 3 in. had fallen across much of the remainder of the state. In the mountains of New Hampshire, 3 to 11 in. of snow had fallen. Although the heaviest precipitation fell from Sunday afternoon into Monday afternoon, precipitation persisted through Tuesday, April 17 (fig. 2B; Northeast River Forecast Center, 2007a) and into Wednesday, April 18 (fig. 2C; Northeast River Forecast Center, 2007a). The heaviest rain fell on Monday, April 16 with 5.46 in. of rain recorded in Durham (National Oceanic and Atmospheric Administration, 2007a). The heavy rain combined with snow melt caused small rivers and streams in much of New Hampshire to flood. As with the May 2006 flood in New Hampshire (Olson, 2007), the most severe flooding occurred in Rockingham, Strafford, Merrimack, and Hillsborough Counties, although the smaller rivers in Rockingham County were the most severely affected (National Climate Data Center, 2007).

In addition to the rainfall, downed trees exacerbated flooding conditions in many rivers and streams. A barometric-pressure gradient associated with the storm brought high winds to the region with a peak wind of 45 mph recorded in Concord on April 16, 2007 (National Oceanic and Atmospheric Administration, 2007b). The damage observed in the hardest-hit areas was typical for wind gusts of 60 to 80 mph (National Climate Data Center, 2007). Strong winds late on Sunday, April 15, and through most of Monday, April 16, were reported to have downed many trees, branches, and power lines. Damage from the wind was magnified because of the heavy rain that accompanied the wind and the soft, wet ground caused by the spring thaw. Due to high winds and antecedent wet-ground conditions, many trees were reported to have had their entire root systems lifted out of the ground (National Oceanic and Atmospheric Administration, 2007b).

As a result of the Patriot's Day storm of April 16–18, 2007, the month of April 2007 is the second wettest April (fig. 3) ever recorded in Concord, N.H. (National Oceanic and Atmospheric Administration, 2007b). A total of 7.22 in. of precipitation was recorded for Concord, which is just shy of the April record precipitation of 7.44 in. set in 1904. Snowfall also was abundant in April 2007 with 12 in. measured in Concord. This measurement tied the 1876 and 1879 levels as the 9th-snowiest April for Concord in the past 140 years of snowfall records (National Oceanic and Atmospheric Administration, 2007b). The largest snowfall in April 2007 for Concord totaled nearly 7.7 in. and fell during April 4–5 (National Oceanic and Atmospheric Administration, 2007b). All of the April snow for Concord fell over the first 15 days of the month (National Oceanic and Atmospheric Administration, 2007b). In March and April 2007, Concord received 29.2 in. of rainfall.

The total precipitation that occurred during April 15–19, 2007, in southeastern New Hampshire (6.54 in. in Durham) was approximately one-half of the 13 in. of precipitation that fell during October 20–22, 1996, across southeastern New Hampshire (National Oceanic and Atmospheric Administration, 1996). The total April 15–19, 2007, precipitation in southeastern New Hampshire was less than one-half of the up to 14 in. of precipitation that fell during May 11–15, 2006, across the coastal regions of New Hampshire (National Oceanic and Atmospheric Administration, 2006a) and approximately 60 percent of the up to 11 in. of precipitation that fell

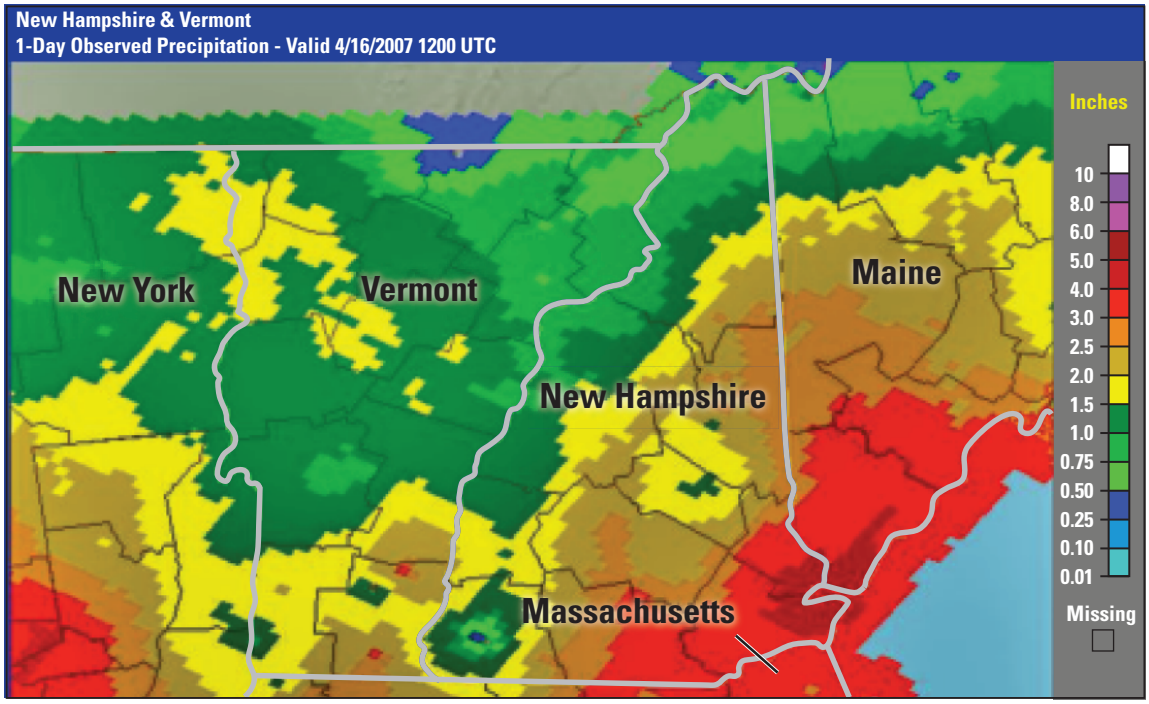


**Figure 2A.** The 1-day observed precipitation totals ending on April 16, 2007, New Hampshire and Vermont. (From Northeast River Forecast Center, 2007a)

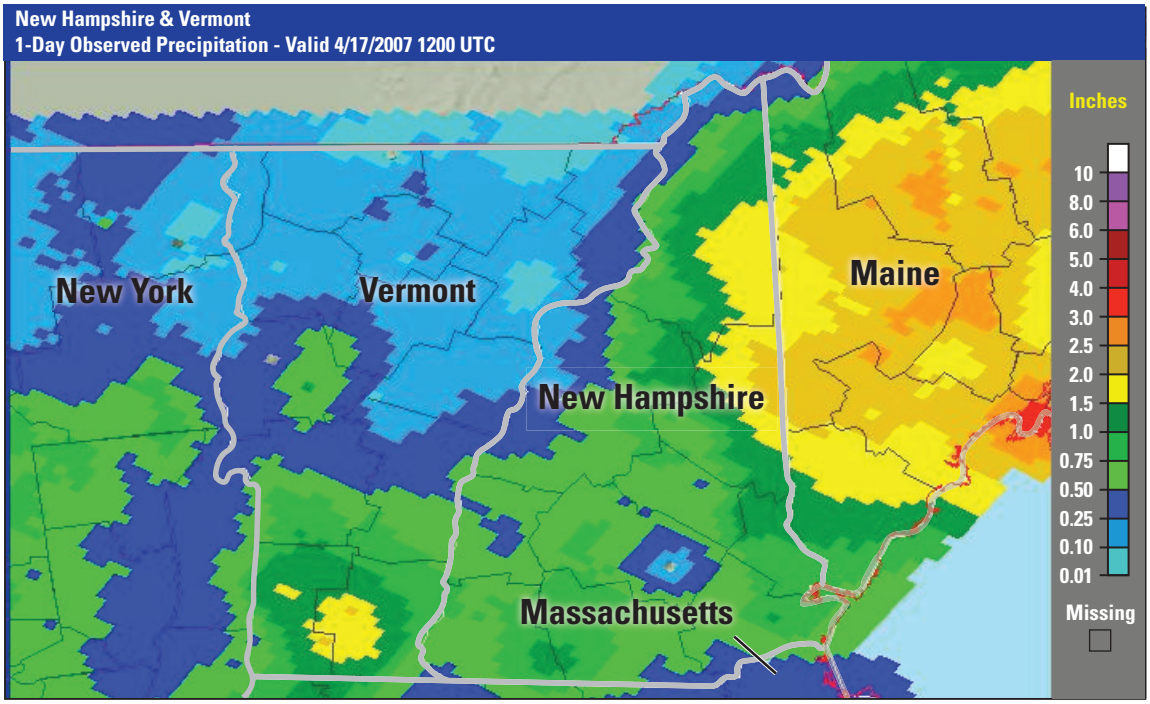


**Figure 2B.** The 1-day observed precipitation totals ending on April 17, 2007, New Hampshire and Vermont. (From Northeast River Forecast Center, 2007a)

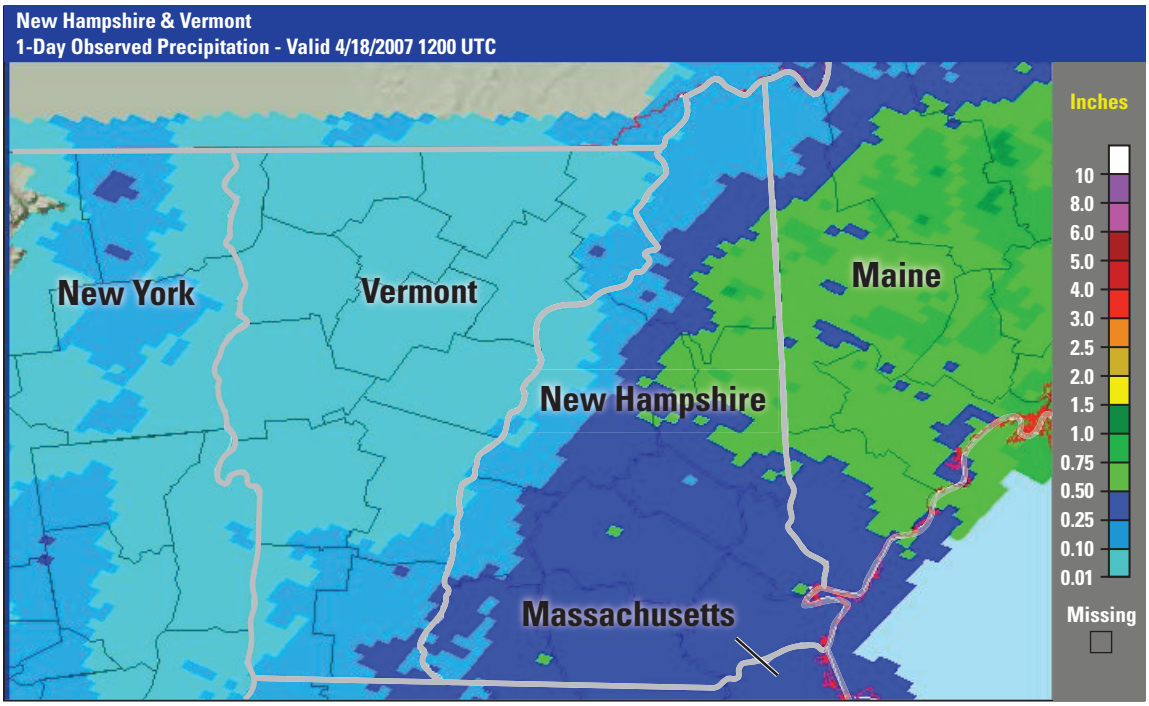


**Figure 2C.** The 1-day observed precipitation totals ending on April 18, 2007, New Hampshire and Vermont. (From Northeast River Forecast Center, 2007a)

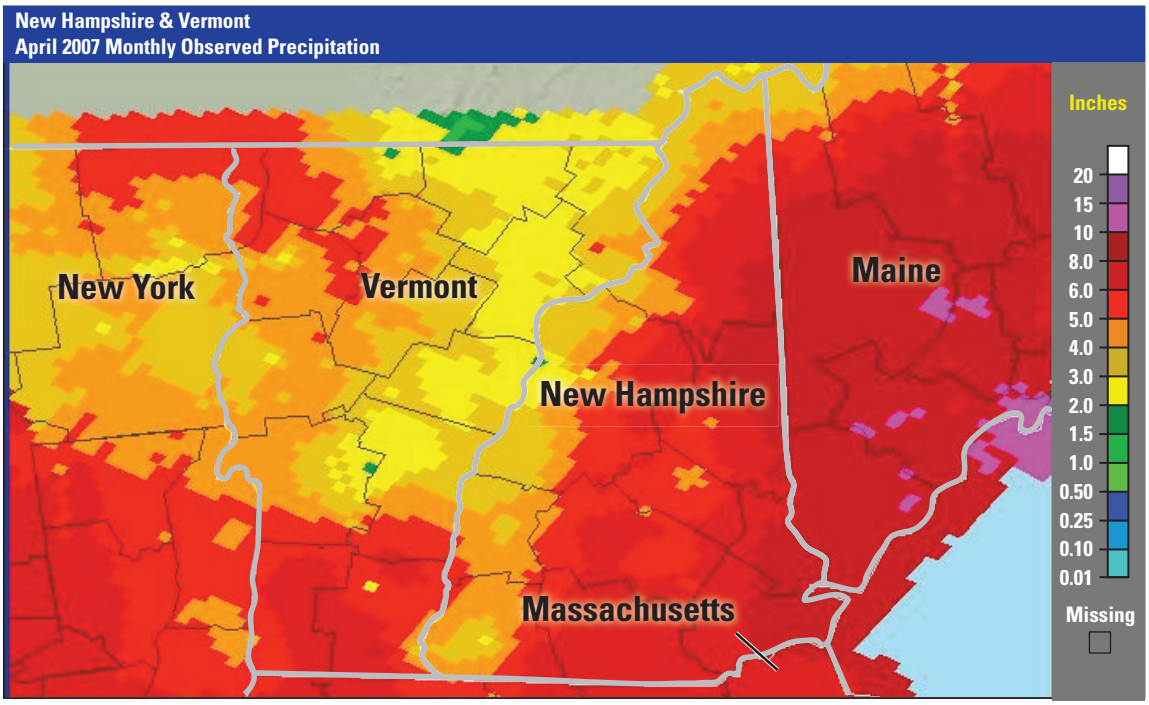


**Figure 3.** The April 2007 monthly observed precipitation, New Hampshire and Vermont. (From Northeast River Forecast Center, 2007b)

during May 11–15, 2006, in the south-central part of the state (National Oceanic and Atmospheric Administration, 2006b). The October 20–22, 1996, May 11–15, 2006, and April 15–19, 2007, precipitation events all resulted in streamflow discharges that were the maximum for the periods of record at several streamgages in southern and southeastern New Hampshire.

## Peak-Stage Data

Peak-stage data at active streamgages operated by the USGS were retrieved directly from the stage data recorded at the streamgages, along with the precise date and time of the peak stage. At active streamgages not operated by the USGS, the peak stage with date and time was provided by the station operators. All peak-stage data from active streamgages were rated excellent, which means that measurements are considered to be within 0.05 ft of the actual water surface.

For discontinued streamgages, USGS personnel identified and flagged the April 2007 high-water marks near the streamgage. The high-water marks typically consisted of debris lines, wash lines, or mud lines left behind by the peak water elevation during the flood. The flagged high-water marks were rated for accuracy. This accuracy rating is subjective and is based on the type of high-water mark and the abundance of other confirming marks in the immediate vicinity (Benson and Dalrymple, 1967). The accuracies of the marks are defined as follows. A high-water mark with (1) an excellent rating is thought to be within 0.05 ft of the actual water surface; (2) a good rating, within 0.1 ft; (3) a fair rating, within 0.2 ft; and (4) a poor rating, greater than 0.2 ft from the true water surface.

The flagged high-water marks at the discontinued streamgages were referenced to the datum of the streamgage by using closed level-loop surveying techniques (elevations were determined at the high-water marks by differential leveling from a known elevation datum). The streamgage datum is the local base elevation that was used in developing the stage-discharge relationship when the streamgage was active. Because the high-water marks were referenced to the streamgage datum, the marks represented the peak stages of the flooding at the discontinued streamgage. The date of the peak stages at discontinued streamgages was estimated from peak-stage hydrographs for active streamgages in the same or adjacent watersheds.

At active streamgages as well as at discontinued streamgages where high-water marks had been flagged, the peak stage was referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29) and the NAVD 88 by using closed level-loop surveying techniques from either a known reference datum or from a reference datum established using Leica System 1200 Global Positioning System (GPS) with 3-mm (0.01-ft) horizontal accuracy and 10-mm (0.03-ft) vertical accuracy in static mode (Leica Geosystems, 2008). Referencing the peak stage to NGVD 29 and NAVD 88 allows the high-water mark to be compared to the existing FEMA Flood-Insurance Study data for the streamgage location.

The peak-stage data for all sites included in this investigation are shown in table 2. The location of each streamgage is shown, by county, in figures 4A–G. Although a disaster declaration was not made in Carroll County (fig. 4G), flows at four streamgages in that county were investigated because of their close proximity to Belknap and Grafton Counties, which were declared disaster areas (table 1, in back of report).

**Table 2.** Peak-stage data and peak-discharge data during the April 2007 flood at 57 streamgage sites in central and southern New Hampshire.

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route; ft, feet; NAVD 88, North American Vertical Datum of 1988; NGVD 29, National Geodetic Vertical Datum of 1929; $ft^3/s$, cubic feet per second; na, not available. Periods of record without an end date are active streamgages]

| USGS stream-gage number | Streamgage name | April 2007 flood | | | | | | | Period of record | Maximum previously recorded flood | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Peak stage, local datum (ft) | Peak stage, NGVD 29 (ft) | Peak stage, NAVD 88 (ft) | Quality ranking of stage | Peak dis-charge ($ft^3/s$) | Day | Time | | Peak discharge ($ft^3/s$) | Date |
| 01064500 | Saco River near Conway | 8.30 | 426.49 | 426.05 | Excellent | 9,750[n] | April 24 | 1:30 am | 1904–10, 1929– | 47,200 | 3-27-1953 |
| 01064801 | Bearcamp River at South Tamworth | 8.12 | 501.49 | 501.03 | Excellent | 3,720[n] | April 17 | 12:30 am | 1993– | 6,150 | 6-14-1998 |
| 01065000 | Ossipee River at Effingham Falls | 9.25[a] | na | na | Excellent | 5,370[a] | April 19 | na | 1942–90, 1998– | 11,700 | 3-28-1953 |
| 01072100 | Salmon Falls River at Milton | 7.32[a] | 404.46 | 403.90 | Excellent | 5,500[a,b,c] | April 17 | 9:30 am | 1968– | 5,450 | 5-14-2006 |
| 01072800 | Cocheco River near Rochester | 20.82 | 140.20 | 139.59 | Excellent | 7,240[c] | April 16 | 11:15 pm | 1995– | 5,550 | 5-14-2006 |
| 01072870 | Isinglass River at Rochester Neck Road, near Dover | 21.81 | na | na | Excellent | 6,160 | April 17 | 12:30 pm | 2003– | 4,370 | 5-14-2006 |
| 01073000 | Oyster River near Durham | 10.20 | 75.49 | 74.78 | Excellent | 1,320[c] | April 16 | 5:45 pm | 1934– | 1,160 | 10-21-1996 |
| 01073500 | Lamprey River near Newmarket | 17.49 | 55.77 | 55.04 | Excellent | 8,450 | April 18 | 2:00 pm | 1934– | 8,970 | 5-14-2006 |
| 01073587 | Exeter River at Haigh Road, near Brentwood | 11.19 | 71.46 | 70.71 | Excellent | 2,840 | April 17 | 5:30 am | 1996– | 3,520 | 5-15-2006 |
| 01073600 | Dudley Brook near Exeter | 8.35 | 94.40 | 93.65 | Fair | 470[b,o] | April 17 | na | 1962–85 | 660 | 5-14-2006 |
| 01073750 | Mill Brook near SR 108, at Stratham | 11.06 | 496.19 | 495.44 | Excellent | 325[b,o] | April 18 | na | 1973–79, 2003–04 | 390 | 4-2-1973 |
| 01073785 | Winnicut River at Greenland, near Portsmouth | 5.93 | 14.19 | 13.44 | Excellent | 1,030 | April 16 | 8:15 am | 2002– | 1,450 | 5-14-2006 |
| 01073810 | Berrys Brook at Sagamore Road, near Portsmouth | 4.95 | 22.07 | 21.30 | Excellent | 278[b,o] | April 17 | na | 2003–04 | 505 | 5-14-2006 |
| 01073838 | Taylor River at Old Stage Road near Hampton | 6.84 | 18.92 | 18.14 | Fair | 436[o] | April 17 | na | 2004 | na | na |
| 01074520 | East Branch Pemigewasset River at Lincoln | 8.86 | 829.89 | 829.58 | Excellent | 2,730[n] | April 24 | 9:45 am | 1993– | 16,900 | 4-14-2002 |
| 01075000 | Pemigewasset River at Woodstock | 6.83 | 623.27 | 622.93 | Excellent | 4,460[n] | April 23 | 10:30 pm | 1939–77, 2002– | 47,000 | 10-24-1959 |
| 01076000 | Baker River near Rumney | 5.65 | 502.99 | 502.59 | Excellent | 3,040[n] | April 16 | 7:00 pm | 1929–77, 2001– | 21,400 | 6-15-1942 |
| 01076500 | Pemigewasset River at Plymouth | 10.71 | 467.78 | 467.37 | Excellent | 13,900[n] | April 17 | 12:15 am | 1904– | 65,400 | 3-19-1936 |
| 01077000 | Squam River at Ashland | 12.06[a] | na | na | Excellent | 543[a] | April 18 | 5:15 pm | 1939– | 1,090 | 7-4-1973 |
| 01077510 | Newfound River below Newfound Lake near Bristol | 8.81[a] | na | na | Excellent | 1,690[a] | April 19 | 4:15 am | 1994– | 3,500 | 5-16-2006 |
| 01078000 | Smith River near Bristol | 8.65 | 458.45 | 458.07 | Excellent | 2,770 | April 17 | 10:00 pm | 1918– | 8,100 | 3-19-1936 |
| 01079602 | Poorfarm Brook near Gilford | 5.74[e] | 512.30[e] | 511.86[e] | Good | 505[o] | April 17 | na | 1998–2004 | 1,050 | 5-14-2006 |
| 01079900 | Shannon Brook near Moultonborough | 8.37 | na | na | Excellent | 570[b,o] | April 17 | na | 1999–2004 | 565 | 5-14-2006 |
| 01080000 | Lake Winnipesaukee at Weirs Beach | 5.00[a] | 505.00 | 504.57 | Excellent | na | April 22 | 11:00 pm | 1934– | 505.86 | 6-4-1984 |
| 01080500 | Lake Winnipesaukee Outlet at Lakeport | na | na | na | Excellent | 2,430[a] | April 25 | 8:00 am | 1933–83, 1988– | 2,890[r] | 3-31-1936 |

**Table 2.** Peak-stage data and peak-discharge data during the April 2007 flood at 57 streamgage sites in central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route; ft, feet; NAVD 88, North American Vertical Datum of 1988; NGVD 29, National Geodetic Vertical Datum of 1929; $ft^3/s$, cubic feet per second; na, not available. Periods of record without an end date are active streamgages]

| USGS stream-gage number | Streamgage name | April 2007 flood | | | | | | | Period of record | Maximum previously recorded flood | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Peak stage, local datum (ft) | Peak stage, NGVD 29 (ft) | Peak stage, NAVD 88 (ft) | Quality ranking of stage | Peak dis-charge ($ft^3/s$) | Day | Time | | Peak discharge ($ft^3/s$) | Date |
| 01081000 | Winnipesaukee River at Tilton | 7.61 | 449.48 | 449.01 | Excellent | 3,550 | April 17 | 1:30 am | 1937– | 4,580 | 3-31-1984 |
| 01081500 | Merrimack River at Franklin Junction | 13.62 | 264.70 | 264.20 | Excellent | 17,300 | April 17 | 5:15 am | 1905–78, 1983– | 83,000 | 3-19-1936 |
| 01082000 | Contoocook River at Peterborough | 7.21 | 739.18 | 738.46 | Excellent | 4,110[c] | April 16 | 1:00 pm | 1946– | 3210 | 4-2-2004 |
| 01083000 | Nubanusit Brook below MacDowell Dam near Peterborough | 5.71 | 936.74 | 936.07 | Excellent | 637[g] | April 24 | 4:00 pm | 1921–31, 1946– | 1,130 | 4-11-1931 |
| 01084500 | Beards Brook near Hillsborough | 8.69 | 602.33 | 601.72 | Good | 3,550[b,o] | April 17 | na | 1946–76 | 4,800[b,h] | 10-9-2005 |
| 01085000 | Contoocook River near Henniker | 14.49 | 484.81 | 484.19 | Excellent | 13,000 | April 17 | 6:00 pm | 1938, 1940–77, 1989– | 22,200 | 9-21-1938 |
| 01085500 | Contoocook River below Hopkinton Dam at West Hopkinton | 8.51 | 364.34 | 363.66 | Excellent | 5,370 | April 30 | 5:45 pm | 1964– | 7,530 | 4-8-1987 |
| 01086000 | Warner River at Davisville | 11.87[i] | 391.90 | 391.31 | Excellent | 7,730 | April 16 | 10:45 pm | 1940–78, 1999– | 8,640 | 5-15-2006 |
| 01087000 | Blackwater River near Webster | 6.87 | 438.60 | 438.04 | Excellent | 1,950 | April 25 | 12:30 pm | 1919–20, 1927– | 11,000[j] | 3-19-1936 |
| 01087850 | Contoocook River at River Hill, near Penacook | 15.90[g] | 347.87 | 347.27 | Excellent | 7,780[g,o] | April 17 | 4:15 am | na | na | na |
| 01088400 | Merrimack River at Concord | 14.35 | 231.52 | 230.91 | Excellent | 32,800[o] | April 21 | 2:00 pm | na | na | na |
| 01089000 | Soucook River near Concord | na | 305.79 | 305.21 | Excellent | 3,500[k,o] | April 17 | na | 1952–1987 | 4,790[k] | 5-14-2006 |
| 01089100 | Soucook River at Pembroke Road, near Concord | 13.37 | 269.26 | 268.66 | Excellent | 3,730 | April 17 | 4:15 pm | 1989– | 5,110[b] | 5-14-2006 |
| 01089500 | Suncook River at North Chichester | 15.97[a] | 345.32 | 344.75 | Excellent | 10,600[l] | April 17 | na | 1919–20, 1922–27, 1929–70, 2007– | 12,900 | 3-19-1936 |
| 01090800 | Piscataquog River below Everett Dam, near East Weare | 8.71 | 328.37 | 327.71 | Excellent | 1,600 | April 25 | 3:00 am | 1963– | 1,770 | 6-12-1984 |
| 01091000 | South Branch Piscataquog River near Goffstown | na | 322.97 | 322.28 | Good | 8,880[c,o,p] | April 16 | na | 1941–78 | 7,180 | 5-14-2006 |
| 01091500 | Piscataquog River near Goffstown | 13.05 | 187.70 | 187.03 | Excellent | 11,200 | April 16 | 5:00 pm | 1936, 1938, 1940–78, 1983– | 21,900 | 9-21-1938 |
| 01092000 | Merrimack River near Goffs Falls, below Manchester | 16.79 | 126.06 | 125.37 | Excellent | 59,700 | April 17 | 12:45 pm | 1936– | 150,000[j] | 3-20-1936 |
| 01093000 | Sucker Brook at Auburn | 4.12 | 256.84 | 256.14 | Excellent | na[d,o] | April 17 | na | 1938–70 | 602[m] | 9-12-1954 |
| 01094000 | Souhegan River at Merrimack | 12.71 | 173.29 | 172.59 | Excellent | 10,500 | April 17 | 5:45 am | 1910–76, 1980, 1982– | 16,900 | 3-19-1936 |
| 010965817 | Beaver Brook at Fordway Extension at Derry | 6.00 | na | na | Excellent | 1,100 | April 16 | 7:00 pm | 2006– | na | na |

**Table 2.** Peak-stage data and peak-discharge data during the April 2007 flood at 57 streamgage sites in central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route; ft, feet; NAVD 88, North American Vertical Datum of 1988; NGVD 29, National Geodetic Vertical Datum of 1929; $ft^3/s$, cubic feet per second; na, not available. Periods of record without an end date are active streamgages]

| USGS stream-gage number | Streamgage name | April 2007 flood | | | | | | | Period of record | Maximum previously recorded flood | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Peak stage, local datum (ft) | Peak stage, NGVD 29 (ft) | Peak stage, NAVD 88 (ft) | Quality ranking of stage | Peak dis-charge ($ft^3/s$) | Day | Time | | Peak discharge ($ft^3/s$) | Date |
| 010965844 | Beaver Brook at South Road, near Derry | 5.69 | 219.45 | 218.76 | Excellent | 1,470 | April 16 | 7:15 pm | 2006– | 2,230 | 5-15-2006 |
| 010965852 | Beaver Brook at North Pelham | 13.52 | 162.78 | 162.07 | Excellent | 1,900 | April 16 | 10:45 pm | 1987– | 2,940 | 5-15-2006 |
| 01096587 | Tributary to Cobbetts Pond at I-93 south exit ramp near Windham | 3.67 | na | na | Excellent | 59 | April 16 | 7:00 am | 2006– | 72 | 5-14-2006 |
| 01100505 | Spicket River at North Salem | 6.04 | na | na | Excellent | 434 | April 18 | 3:45 am | 2001– | 801 | 5-15-2006 |
| 01100549 | Policy Brook at Rockingham Park Boulevard at Salem | 3.17 | na | na | Excellent | 95 | April 16 | 6:45 pm | 2006– | na | na |
| 011005605 | Policy Brook at I-93 north rest stop entrance ramp, near Salem | 6.10 | 111.80 | 111.04 | Excellent | 338 | April 16 | 9:30 pm | 2006– | 515 | 5-15-2006 |
| 01100561 | Spicket River near Methuen, Mass. | 9.01 | 109.91 | 109.14 | Excellent | 1,130 | April 18 | 1:45 pm | 2001– | 2,480 | 5-15-2006 |
| 01137500 | Ammonoosuc River at Bethlehem Junction | 7.15 | 1,187.89 | 1,187.63 | Excellent | 3,370 | April 16 | 4:45 pm | 1940– | 11,300 | 11-12-1995 |
| 01138500 | Connecticut River at Wells River, Vt. | 9.25 | 409.00 | 408.62 | Excellent | 27,300 | April 24 | 5:00 pm | 1950– | 57,100 | 7-1-1973 |
| 01144500 | Connecticut River at West Lebanon | 16.41 | 337.93 | 337.52 | Excellent | 38,800 | April 24 | 11:30 am | 1912–76, 1979– | 136,000 | 11-4-1927 |
| 01150500 | Mascoma River at Mascoma | 8.33[a] | 749.01 | 748.71 | Excellent | 2,990[a] | April 18 | 7:00 am | 1924– | 5,090 | 3-19-1936 |

[a] Data provided by New Hampshire Department of Environmental Services.

[b] Discharge estimated by graphically extending stage-discharge relationship.

[c] Discharge is maximum for the period of record which is greater than 10 years.

[d] Backwater from downstream conditions invalidated the stage-discharge relationship.

[e] Peak stages determined at upstream and downstream control locations as control for the streamgage was moved during period of record. Reported elevations are at a point approximately 100 ft downstream from the streamgage house.

[f] Maximum daily mean discharge.

[g] Streamgage data obtained from the U.S. Army Corps of Engineer's Web site (U.S. Army Corps of Engineers, 2007).

[h] Discharge estimate from flagged high-water marks following the October 8 and 9, 2005, flood (Olson, 2007).

[i] Stage of September 1938 flood was 12.80 ft.

[j] Prior to construction of flood-control structures.

[k] Discharge estimated by adjusting the peak discharge determined at the downstream streamgage 01089100 by using the ratio of the drainage areas.

[l] Measurement of peak discharge at width contraction by indirect methods at locations upstream and downstream from the streamgage (Matthai, 1967; U.S. Army Corps of Engineers, 2005).

[m] Maximum stage on May 14, 2006, was 4.36 ft, and on September 12, 1954, it was 2.55 ft.

[n] Not the peak discharge for 2007 water year.

[o] Not known if listed value is peak for 2007 water year because gage is inactive.

[p] Discharge estimated by adjusting the peak discharge determined at the downstream streamgage 01091500 by using the ratio of the drainage areas. The drainage area of streamgage 01091500 was adjusted to 139 $mi^2$ to account for negligible flow (20–50 $ft^3/s$) below upstream gage 01090800 during the April 16, 2007, peak flow at downstream gage 01091500.

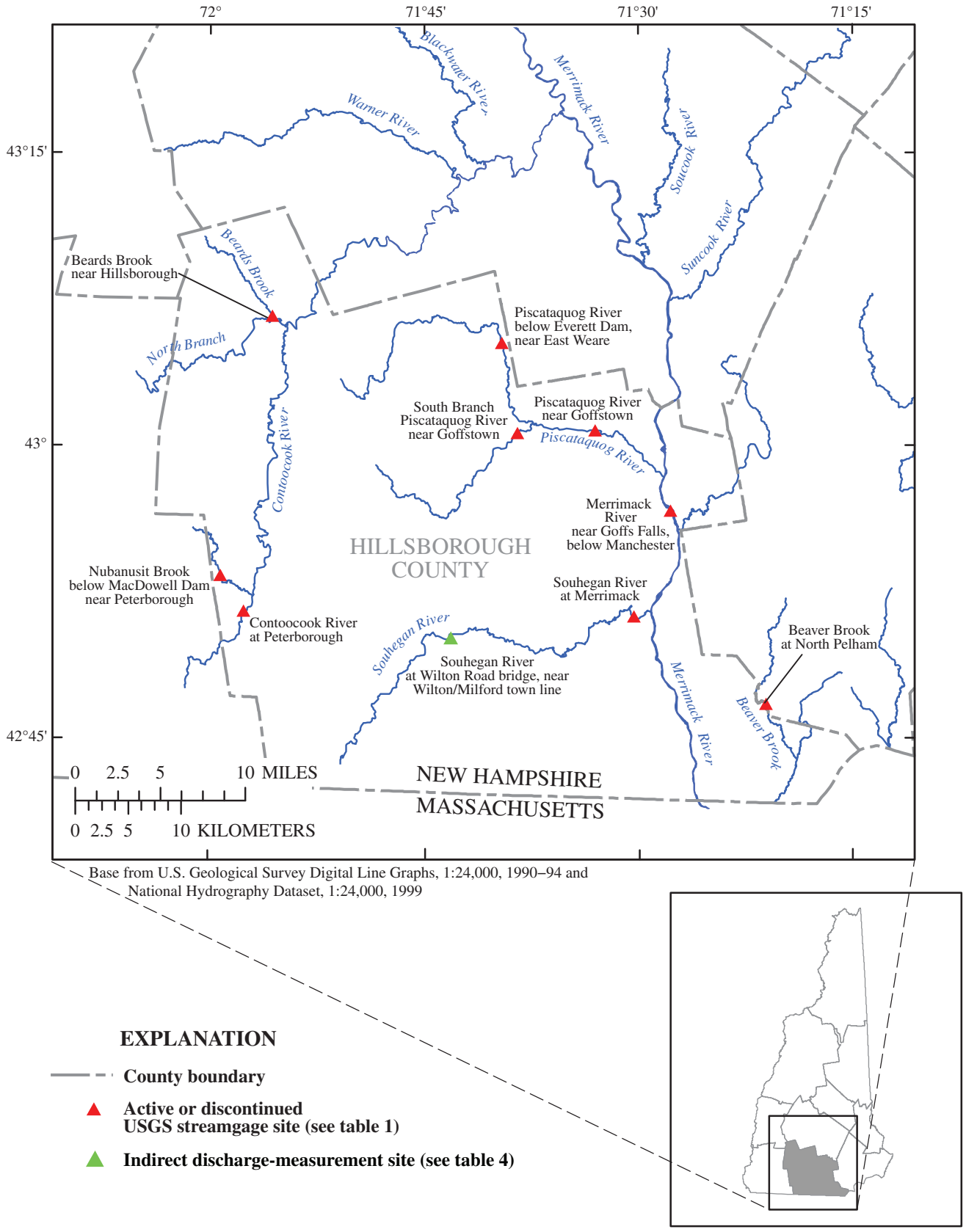


**Figure 4A.** Location of U.S. Geological Survey (USGS) streamgage sites and indirect discharge-measurement sites having peak stage and discharge data for the April 2007 flood in Hillsborough County, New Hampshire.

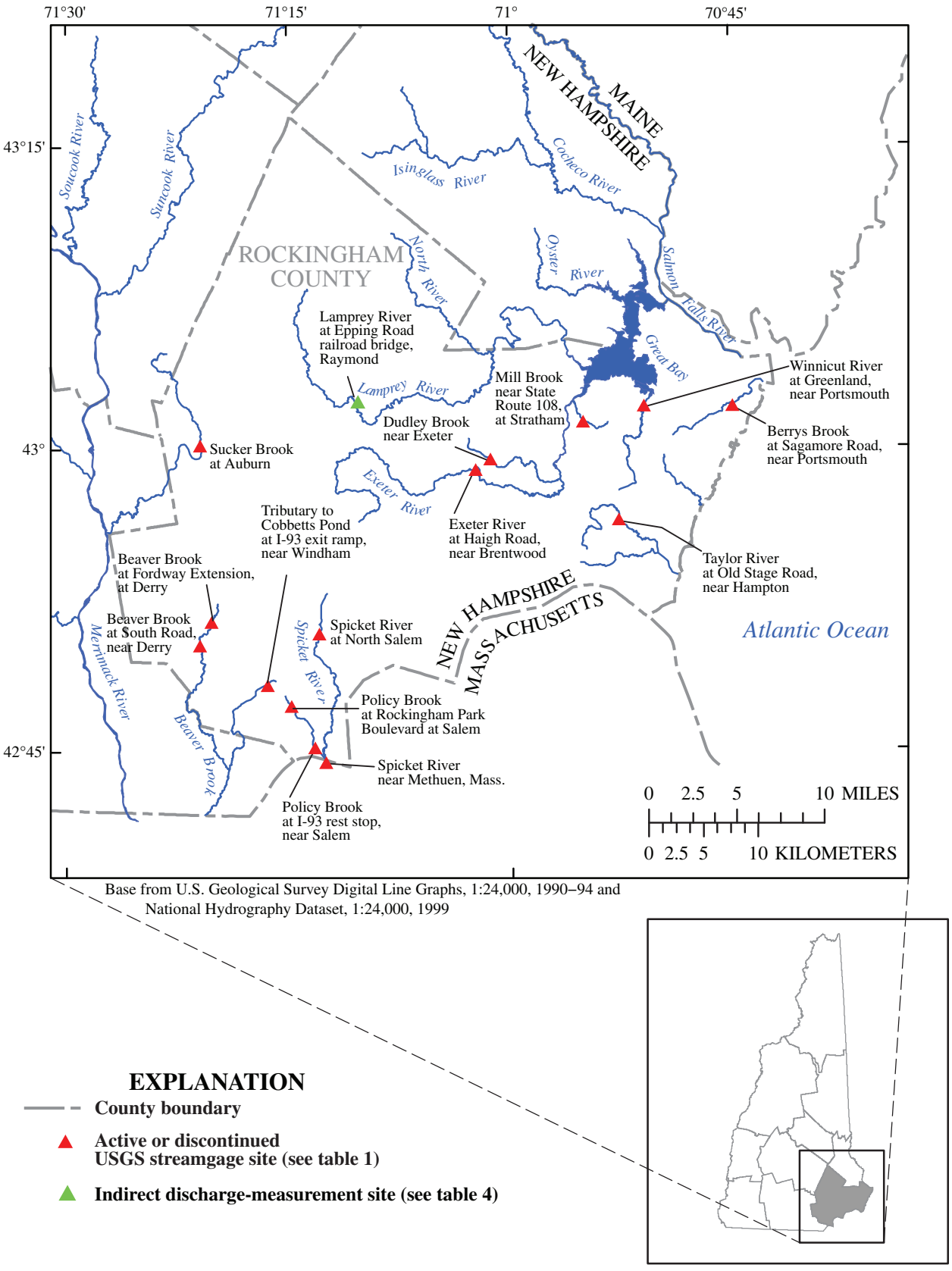


**Figure 4B.** Location of U.S. Geological Survey (USGS) streamgage sites and indirect discharge-measurement sites having peak stage and discharge data for the April 2007 flood in Rockingham County, New Hampshire.

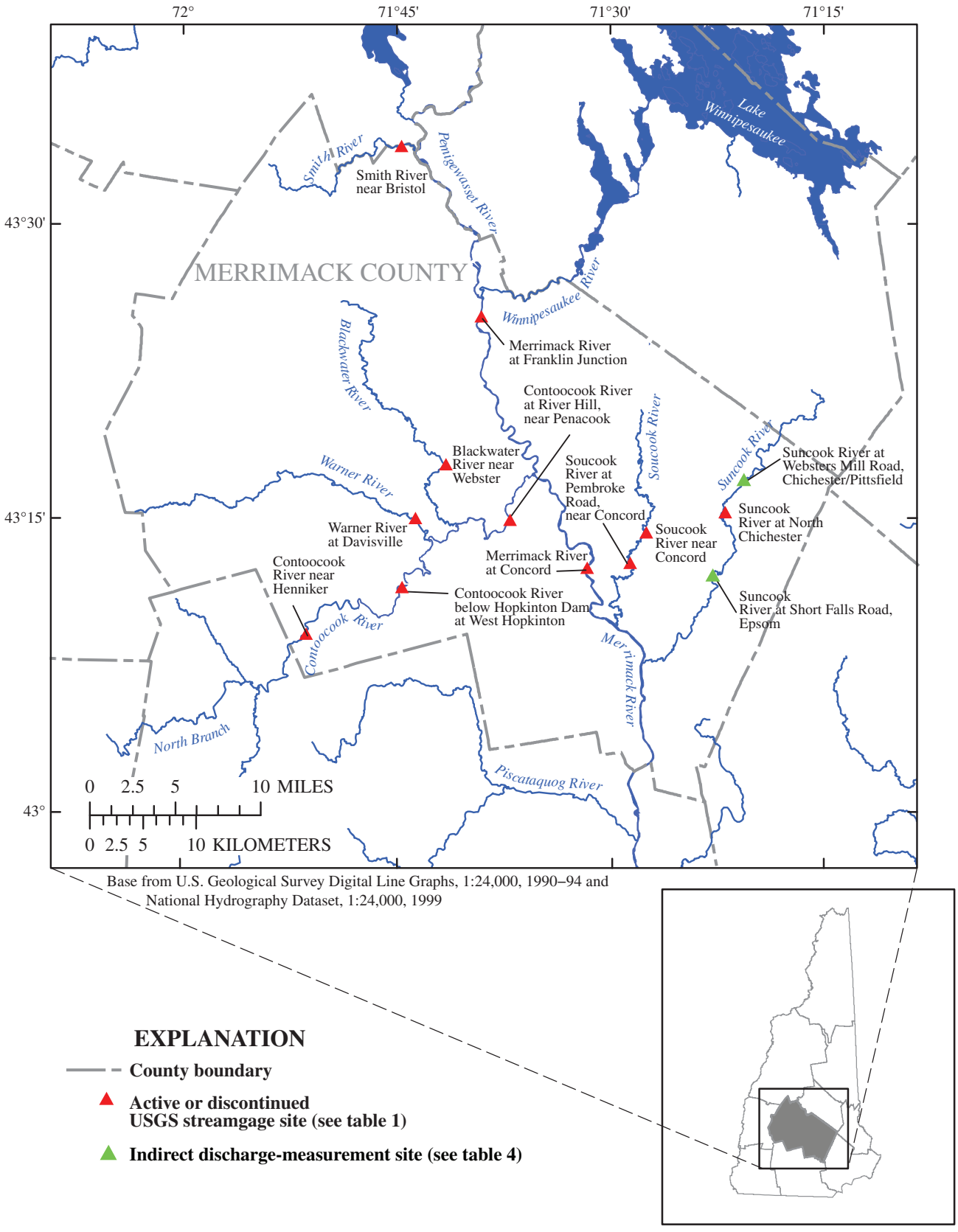


**Figure 4C.** Location of U.S. Geological Survey (USGS) streamgage sites and indirect discharge-measurement sites having peak stage and discharge data for the April 2007 flood in Merrimack County, New Hampshire.

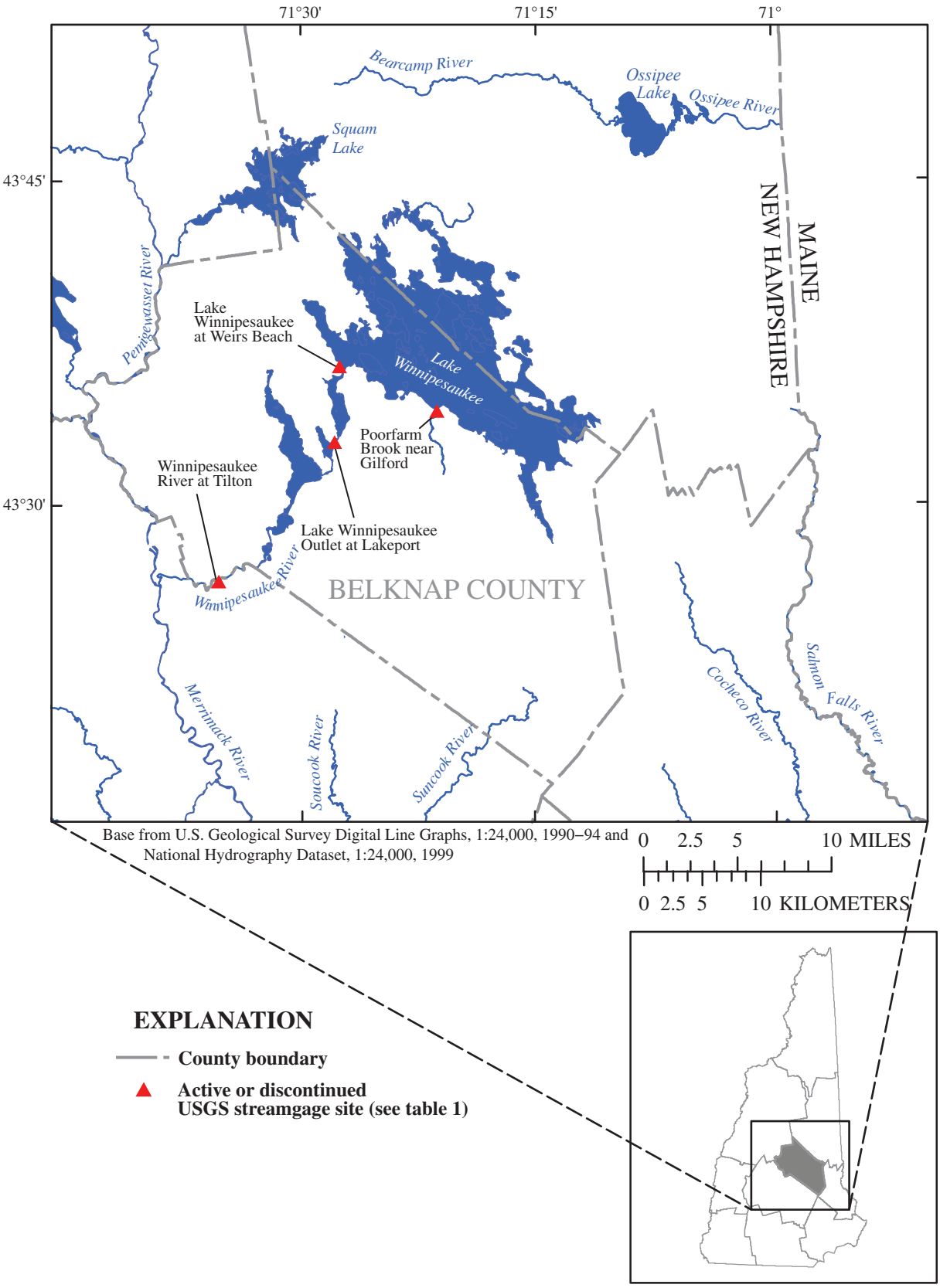


**Figure 4D.** Location of U.S. Geological Survey (USGS) streamgage sites having peak stage and discharge data for the April 2007 flood in Belknap County, New Hampshire.

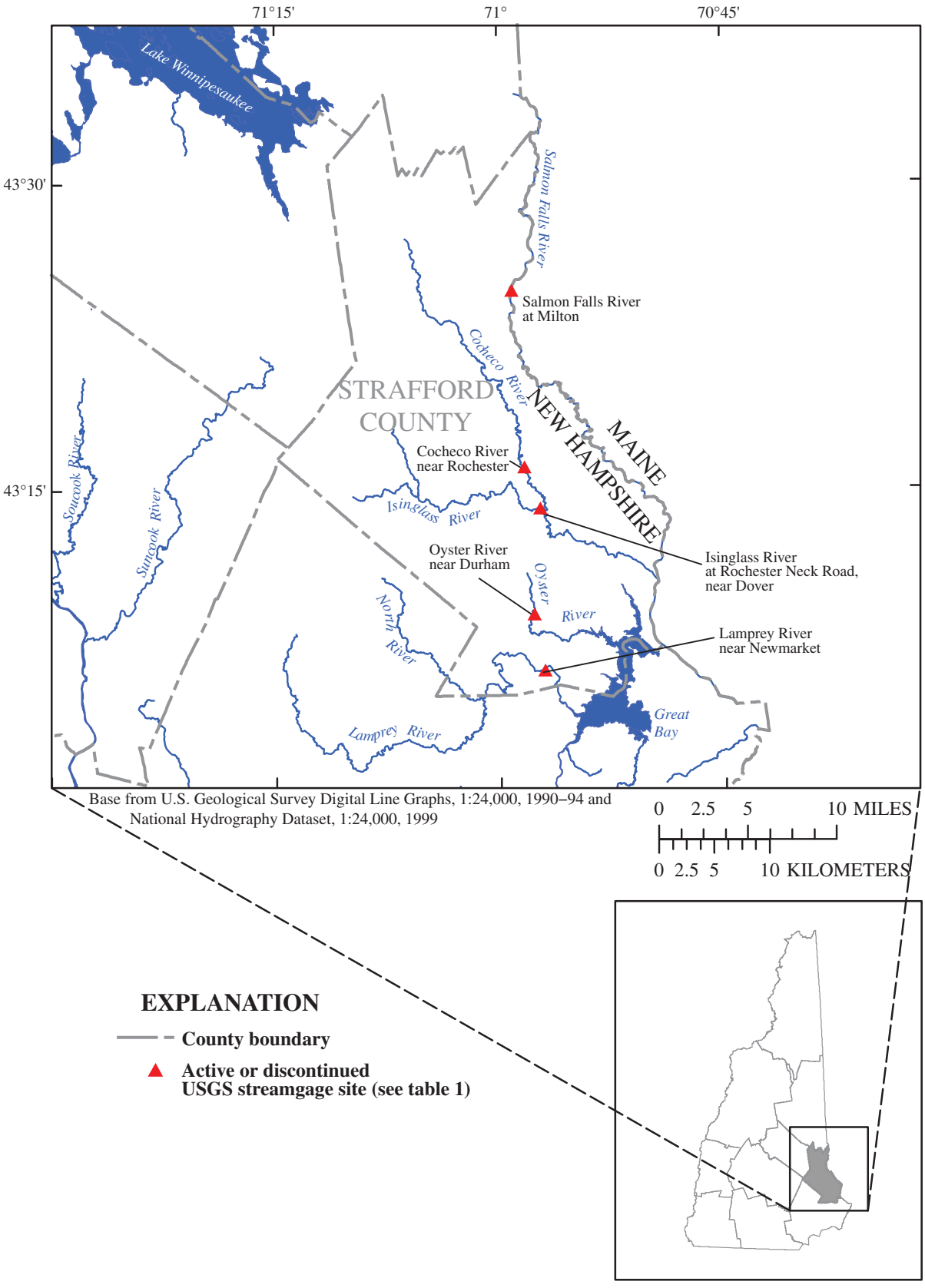


**Figure 4E.** Location of U.S. Geological Survey (USGS) streamgage sites having peak stage and discharge data for the April 2007 flood in Strafford County, New Hampshire.

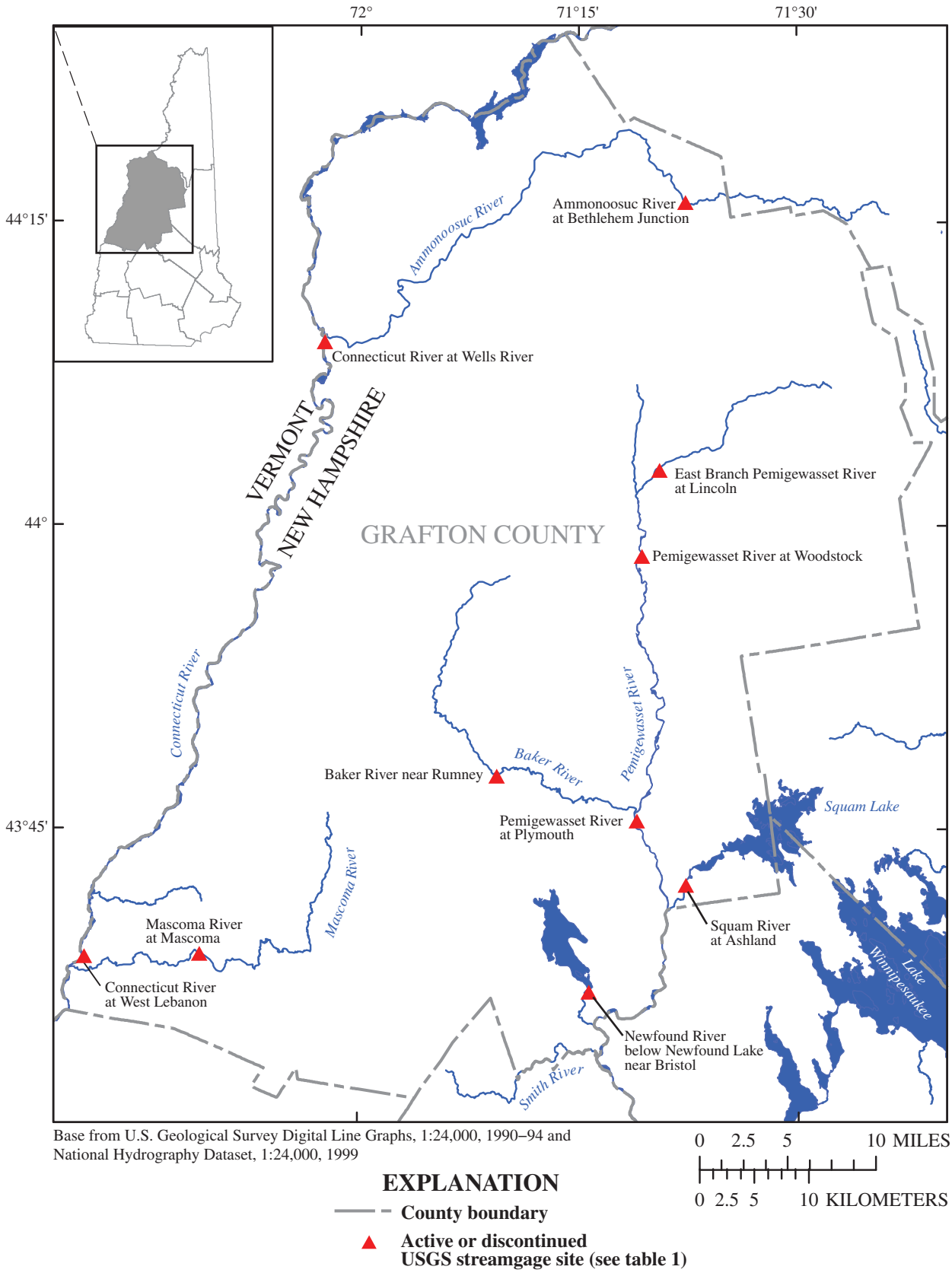


**Figure 4F.** Location of U.S. Geological Survey (USGS) streamgage sites having peak stage and discharge data for the April 2007 flood in Grafton County, New Hampshire.

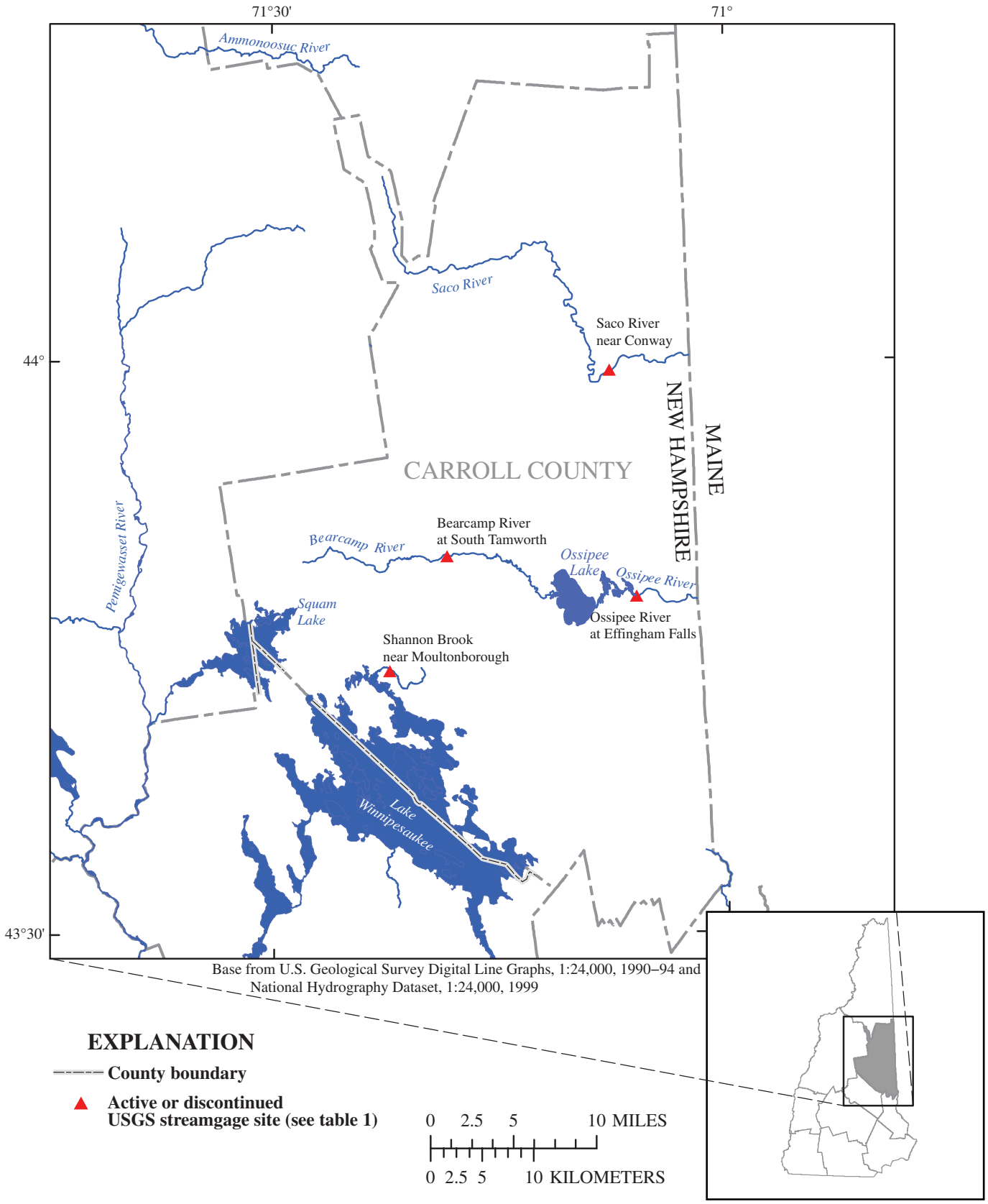


**Figure 4G.** Location of U.S. Geological Survey (USGS) streamgage sites having peak stage and discharge data for the April 2007 flood in Carroll County, New Hampshire.

## Peak-Discharge Data

Peak discharges for most streamgages were determined by applying the peak stage to the most current stage-discharge relation developed for that streamgage (table 2). At discontinued streamgages, there is the possibility that the stage-discharge relation has changed during the years that the site has been inactive. Each of the discontinued streamgages, however, is at a site having a stable channel or control, and the most recent stage-discharge relationship available for the site provides reasonable results.

There were four exceptions to using the stage-discharge relation for determining the peak-discharge of the April 2007 flood:

1. At six streamgages (01072100, 01073600, 01073750, 01073810, 01079900, and 01084500; table 2, footnote b), the current stage-discharge relation was undeveloped for the unusually large peak stage. In such cases, the stage-discharge relation was graphically extended to the peak stage by using the trend of the upper end of the stage-discharge relation. The error introduced to the peak-discharge value is unknown when the stage-discharge relation is extended without manually measured discharges.

2. At discontinued streamgage 01093000, Sucker Brook at Auburn (fig. 4B; table 2, footnote d), Rockingham County, backwater resulting from hydraulic conditions in the channel downstream from the streamgage prevented the use of the stage-discharge relation to determine the peak discharge from the peak stage. The peak discharge at this streamgage is therefore unknown.

3. At discontinued streamgage 01091000 (drainage area of 104 $mi^2$), South Branch Piscataquog River near Goffstown, N.H. (fig. 4A; table 2, footnote p), Hillsborough County, the USGS streamgage house was removed and datum reference marks were destroyed during the construction of a new bridge in 2003. Because the reference marks were destroyed, it was not possible to tie the surveyed high-water marks at this site to the streamgage datum. Without this information, the stage-discharge relation for the streamgage could not be used. Although enough high-water marks were available upstream and downstream from the bridge to allow a discharge estimate to be made at the bridge by using indirect techniques (Matthai, 1967), the area upstream from the bridge experienced backwater effects during the April 2007 flood. This invalidated the use of indirect techniques to determine the April 2007 flood discharge at this location.

   High-water-mark elevation data were collected upstream and downstream from discontinued streamgage 01091000 at the Route 13 (Mount Vernon Road) bridge (drainage area of 54 $mi^2$) over the South Branch Piscataquog River in New Boston. These data were collected to determine the peak flow for the April 2007 flood at the Route 13 bridge as well as at discontinued streamgage 01091000 by using the ratio of the drainage areas between the Route 13 bridge and the discontinued streamgage. Although the bridge provides sufficient river constriction to allow a discharge estimate to be made by using indirect methods (Matthai, 1967), subsequent information provided by two residents living near the Route 13 bridge indicated that the main channel of the South Branch Piscataquog River overtopped the banks upstream from the Route 13 bridge, and water flowed down a road 500 ft south of the bridge, along the downstream side of Route 13, and back into the South Branch Piscataquog River downstream from the Route 13 bridge. This road overflow invalidated a discharge determination made by indirect methods at the Route 13 bridge in New Boston.

   Peak discharge at discontinued streamgage 01091000, South Branch Piscataquog River near Goffstown, N.H., could not be determined by indirect methods due to backwater effects, nor could it be determined at the Route 13 bridge over the South Branch Piscataquog River in New Boston due to flow on the upstream right overbank. It was decided, however, that the April 2007 peak discharge at streamgage 01091000, could be determined by using the ratio of the drainage area for this streamgage to the area for streamgage 01091500 (drainage area of 202 $mi^2$), Piscataquog River near Goffstown (fig. 4A), downstream from discontinued streamgage 01091000. The South Branch Piscataquog River flows into the Piscataquog River downstream from streamgage 01090800 (drainage area of 63 $mi^2$) at Piscataquog River below Everett Dam, near East Weare and upstream from streamgage 01091500 at Piscataquog River near Goffstown. Determination of the April 2007 peak discharge by ratio of drainage areas between the South Branch Piscataquog River near Goffstown and Piscataquog River near Goffstown streamgages was deemed acceptable because there was negligible contribution to flow downstream from the Hopkinton-Everett Lake Dam (as recorded at streamgage 01090800, Piscataquog River below Everett Dam, near East Weare) to the peak flood flow at the Piscataquog River near Goffstown, N.H. streamgage. The 202-$mi^2$ drainage area of the Piscataquog River near Goffstown, N.H. streamgage was adjusted to 139 $mi^2$ to reflect the negligible contribution of 20–50 $ft^3/s$ (U.S. Army Corps of Engineers, 2007) for April 16–17, 2007, below the Hopkinton-Everett Lake Dam in Contoocook as measured at the Piscataquog River below Everett Dam, near East Weare. The peak discharge at streamgage 01091000, South Branch Piscataquog River near Goffstown, was 11,200 $ft^3/s$ on April 16 at 5 pm. The flood-peak discharge for the April 2007 flood at the discontinued South Branch Piscataquog River near Goffstown streamgage was estimated to be 8,880 $ft^3/s$ by adjusting the peak

discharge (using equation 1—explained in the section "Determination of the April 2007 Flood Discharge by Indirect Methods at Ungaged Sites") determined for the downstream Piscataquog River near Goffstown streamgage by the ratio of the drainage areas for streamgages at South Branch Piscataquog River near Goffstown and Piscataquog River near Goffstown.

4. USGS streamgage 01089500 (drainage area of 155 $mi^2$), Suncook River at Depot Road in North Chichester (fig. 4C; table 2, footnote l), Merrimack County, was active during 1919 to 1920, 1922 to 1927, and 1929 to 1970. In November of 2007, it was again activated. After the April 16–18, 2007, flood, high-water mark information was collected at the former streamgage site. By using the streamgage rating (stage/discharge relation) established for the period of record prior to 1970, a peak discharge of 15,000 $ft^3/s$ was determined for the former location of the Suncook River at Depot Road in North Chichester streamgage for the April 16–18, 2007, flood. Subsequently, indirect discharge determinations were made at locations upstream and downstream from the discontinued streamgage. These locations are at the Websters Mill Road bridge in Chichester/Pittsfield and Short Falls Road bridge in Epsom, with drainage areas of 137 and 210 $mi^2$, respectively. The high-water marks upstream and downstream from each bridge, the bridge-opening geometry, and channel and floodplain cross sections upstream and downstream from the bridge were surveyed and the values were input to the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) program (2005). Discharges were selected iteratively and input to the HEC-RAS program so that the resulting water-surface-elevation output from the program matched the high-water marks surveyed upstream from the bridge. A flood-peak discharge of 10,600 $ft^3/s$ was determined for the former Suncook River at Depot Road in North Chichester streamgage site on the basis of the discharge/drainage-area relation between the two indirectly determined (Matthai, 1967; U.S. Army Corps of Engineers, 2005) April 2007 flood-peak discharges at the Short Falls and Websters Mill Road bridges on the Suncook River. The upper end of the rating (stage/discharge relation) at the former streamgage has shifted since it was determined from the March 19, 1936, flood data, when a discharge of 12,900 $ft^3/s$ at a gage height of 15.27 ft was ascertained by slope-area and contracted-opening methods. The shift in the upper end of the rating likely is due to a greater amount of vegetation on the right overbank in 2007 than in 1936 (as seen in USGS photographs on file at the New Hampshire-Vermont Water Science Center) and the construction of a weir control along with the removal of a channel island below the streamgage in the summer of 1937. For this reason, the discharge of 10,600 $ft^3/s$ was determined to be the peak discharge for the April 16–18, 2007, flood at the former streamgage.

The peak-discharge data for all of the sites included in this investigation are shown in table 2. At five long-term (more than 10 years of record) streamgages, the peak discharge from the April 2007 flood was the maximum discharge for the period of record. The discharges for these five streamgages are listed in table 2 in footnote c. Four of these streamgages have very long periods of record: streamgage 01091000, South Branch Piscataquog River near Goffstown, 1941–78; streamgage 01082000, Contoocook River at Peterborough, 1946–present (2007); streamgage 01073000, Oyster River near Durham, 1934–present (2007); and streamgage 01072100, Salmon Falls River at Milton, 1968–present (2007).

## Flow-Frequency Analyses of the April 2007 Flooding

Flow-frequency curves were determined for all 57 streamgages included in this investigation. For 39 of the 57 streamgages, the guidelines in Bulletin 17B (U.S. Interagency Advisory Committee on Water Data, 1982) were used to determine flow-frequency curves. Bulletin 17B recommends the use of a log-Pearson Type III distribution for estimating flow frequency and provides procedures for weighting station skews, determining historical peaks, and detecting and treating outliers and trends. Bulletin 17B also recommends at least 10 years of streamgage record for a flow-frequency analysis. Software developed by the USGS to analyze peak-flow frequency (PeakFQ) was used for these computations (U.S. Geological Survey, 2007a). The peak-flow data used as input to the PeakFQ program were retrieved from the National Water Information System (NWIS) (U.S. Geological Survey, 2007b). When the flow-frequency curves were computed, if peak discharges at a streamgage were affected by regulation, the station skew—without weighting from the generalized skew as described in Bulletin 17B—was used for computing the frequency curve. If the April 2007 peak discharge was the annual peak for the 2007 water year, it was added to the peak-flow data prior to computing the frequency curves.

For 11 of the 57 streamgages, flood-control structures operated by the USACE are in the basin. Flow-frequency data for 3 of these 11 streamgages were obtained from frequency curves developed by the USACE and published in FEMA Flood-Insurance Studies (table 3, footnote a). At 8 of the 11 streamgages, the flow-frequency curve published in the FEMA Flood-Insurance Study was not developed by the USACE and was recomputed for this study by following the Bulletin 17B guidelines and incorporating peak-flow data collected since the flood-control structures were built.

At 10 of the 57 streamgages in this investigation, a record length of 10 or fewer years was considered insufficient for a

**Table 3.** Flow-frequency data and recurrence-interval estimates for 57 streamgages during the April 2007 flood in central and southern New Hampshire.

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; $ft^3/s$, cubic feet per second; yr, year; <, less than; >, greater than; na, not available. Frequency curve determination method: LeBlanc, frequency curve estimated with regression equation (LeBlanc, 1978); LP3, log-Pearson type-3 frequency analysis; FIS, flow-frequency curve from Federal Emergency Management Agency flood-insurance study; Ratio, frequency curve based on a downstream streamgage with frequency curve adjusted by the ratio of drainage areas of the streamgages]

| USGS stream-gage number | Streamgage name | Peak discharge of April (16–18) 2007 flood ($ft^3/s$) | Estimated discharges for selected recurrence intervals ($ft^3/s$) | | | | | | | Frequency curve determination method | Recurrence interval of April 2007 flood (yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | | |
| 01064500 | Saco River near Conway | 9,750 | 17,000 | 26,200 | 32,700 | 41,200 | 47,700 | 54,400 | 70,700 | LP3 | <2 |
| 01064801 | Bearcamp River at South Tamworth | 3,720 | 3,640 | 5,070 | 6,000 | 7,140 | 7,970 | 8,790 | 10,650 | LP3 | 2–5 |
| 01065000 | Ossipee River at Effingham Falls | 5,370 | 3,550 | 4,970 | 5,930 | 7,190 | 8,160 | 9,140 | 11,500 | LP3 | 5–10 |
| 01072100 | Salmon Falls River at Milton | 5,500 | 1,440 | 2,380 | 3,190 | 4,450 | 5,590 | 6,920 | 10,900 | LP3 | 25–50 |
| 01072800 | Cocheco River near Rochester | 7,240 | 2,140 | 3,850 | 5,350 | 7,740 | 9,920 | 12,500 | 20,300 | LP3 | 10–25 |
| 01072800 | Cocheco River near Rochester—record extension with Lamprey River streamgage 01073500 | 7,240 | 1,640 | 2,650 | 3,460 | 4,660 | 5,680 | 6,820 | 10,000 | LP3[c] | 100–500 |
| 01072870 | Isinglass River at Rochester Neck Road, near Dover | 6,160 | 1,560 | 2,380 | 2,920 | 3,940 | 4,680 | 5,620 | 8,230 | LeBlanc[b] | 100–500 |
| 01073000 | Oyster River near Durham | 1,320 | 304 | 488 | 633 | 843 | 1,020 | 1,220 | 1,750 | LP3 | 100–500 |
| 01073500 | Lamprey River near Newmarket | 8,450 | 2,190 | 3,550 | 4,660 | 6,320 | 7,760 | 9,400 | 14,100 | LP3 | 50–100 |
| 01073587 | Exeter River at Haigh Road, near Brentwood | 2,840 | 1,250 | 2,410 | 3,450 | 5,140 | 6,690 | 8,530 | 14,100 | LP3 | 5–10 |
| 01073587 | Exeter River at Haigh Road, near Brentwood—record extension with Lamprey River streamgage 01073500 | 2,840 | 882 | 1,420 | 1,840 | 2,450 | 2,960 | 3,530 | 5,060 | LP3[c] | 25–50 |
| 01073600 | Dudley Brook near Exeter | 470 | 164 | 242 | 300 | 378 | 440 | 506 | 675 | LP3 | 50–100 |
| 01073750 | Mill Brook near NH108, at Stratham | 325 | 157 | 312 | 450 | 667 | 863 | 1,089 | 1,755 | LP3 | 5–10 |
| 01073785 | Winnicut River at Greenland, near Portsmouth | 1,030 | 227 | 334 | 406 | 542 | 637 | 758 | 1,100 | LeBlanc[b] | 100–500 |
| 01073810 | Berrys Brook at Sagamore Road, near Portsmouth | 278 | 77.4 | 112 | 136 | 182 | 213 | 253 | 368 | LeBlanc[b] | 100–500 |
| 01073838 | Taylor River at Old Stage Road near Hampton | 436 | 102 | 143 | 172 | 222 | 257 | 302 | 424 | LeBlanc[b] | >500 |
| 01074520 | East Branch Pemigewasset River at Lincoln | 2,730 | 10,700 | 14,300 | 16,600 | 19,400 | 21,400 | 23,400 | 27,900 | LP3 | <2 |
| 01075000 | Pemigewasset River at Woodstock | 4,460 | 11,800 | 19,000 | 24,600 | 32,300 | 38,700 | 45,500 | 63,600 | LP3 | <2 |
| 01076000 | Baker River near Rumney | 3,040 | 5,130 | 8,620 | 11,600 | 16,300 | 20,500 | 25,500 | 40,500 | LP3 | <2 |
| 01076500 | Pemigewasset River at Plymouth | 13,900 | 21,200 | 30,100 | 36,400 | 44,700 | 51,200 | 58,000 | 74,900 | LP3 | <2 |
| 01077000 | Squam River at Ashland | 543 | 244 | 445 | 616 | 877 | 1,110 | 1,370 | 2,130 | LP3 | 5–10 |
| 01077510 | Newfound River below Newfound Lake near Bristol | 1,690 | 1,590 | 2,300 | 2,720 | 3,190 | 3,500 | 3,780 | 4,350 | LP3 | 2–5 |

**Table 3.** Flow-frequency data and recurrence-interval estimates for 57 streamgages during the April 2007 flood in central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; $ft^3/s$, cubic feet per second; yr, year; <, less than; >, greater than; na, not available. Frequency curve determination method: LeBlanc, frequency curve estimated with regression equation (LeBlanc, 1978); LP3, log-Pearson type-3 frequency analysis; FIS, flow-frequency curve from Federal Emergency Management Agency flood-insurance study; Ratio, frequency curve based on a downstream streamgage with frequency curve adjusted by the ratio of drainage areas of the streamgages]

| USGS stream-gage number | Streamgage name | Peak discharge of April (16–18) 2007 flood ($ft^3/s$) | Estimated discharges for selected recurrence intervals ($ft^3/s$) | | | | | | | Frequency curve determination method | Recurrence interval of April 2007 flood (yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | | |
| 01078000 | Smith River near Bristol | 2,770 | 1,750 | 2,610 | 3,270 | 4,220 | 5,020 | 5,900 | 8,300 | LP3 | 5–10 |
| 01079602 | Poorfarm Brook near Gilford | 505 | 220 | 374 | 472 | 722 | 882 | 1,090 | 1,780 | LeBlanc[b] | 10–25 |
| 01079900 | Shannon Brook near Moultonborough | 570 | 325 | 592 | 770 | 1,240 | 1,560 | 1,970 | 3,420 | LeBlanc[b] | 2–5 |
| 01080000 | Lake Winnipesaukee at Weirs Beach | na | na | na | 505.4 ft | na | 505.9 ft | 506.2 ft | 506.7 ft | FIS | <10 |
| 01080500 | Lake Winnipesaukee Outlet at Lakeport | 2,430 | 1,650 | 2,140 | 2,350 | 2,520 | 2,610 | 2,670 | 2,750 | LP3 | 10–25 |
| 01081000 | Winnipesaukee River at Tilton | 3,550 | 2,260 | 3,000 | 3,440 | 3,940 | 4,290 | 4,610 | 5,280 | LP3 | 10–25 |
| 01081500 | Merrimack River at Franklin Junction | 17,300 | 17,700 | 20,000 | 20,900 | 21,600 | 21,900 | 22,100 | 22,300 | LP3 | <2 |
| 01082000 | Contoocook River at Peterborough | 4,110 | 1,310 | 1,920 | 2,370 | 2,990 | 3,480 | 3,990 | 5,330 | LP3 | 100–500 |
| 01083000 | Nubanusit Brook below MacDowell Dam near Peterborough | 637 | na | na | 650 | na | 700 | 800 | 900 | FIS[a] | <10 |
| 01084500 | Beards Brook near Hillsborough | 3,550 | 1,200 | 1,640 | 1,930 | 2,300 | 2,580 | 2,850 | 3,510 | LP3 | >500 |
| 01085000 | Contoocook River near Henniker | 13,000 | 4,960 | 7,360 | 9,240 | 12,000 | 14,300 | 16,800 | 23,900 | LP3 | 25–50 |
| 01085500 | Contoocook River below Hopkinton Dam at West Hopkinton | 5,370 | 4,580 | 5,570 | 6,070 | 6,570 | 6,880 | 7,150 | 7,630 | LP3 | 2–5 |
| 01086000 | Warner River at Davisville | 7,730 | 2,200 | 3,390 | 4,310 | 5,630 | 6,730 | 7,930 | 11,200 | LP3 | 50–100 |
| 01087000 | Blackwater River near Webster | 1,950 | 1,790 | 2,100 | 2,200 | 2,270 | 2,300 | 2,320 | 2,340 | LP3 | 2–5 |
| 01087850 | Contoocook River at River Hill, near Penacook | 7,780 | na | na | 8,000 | na | 15,000 | 23,300 | 33,000 | FIS[a] | <10 |
| 01088400 | Merrimack River at Concord | 32,800 | na | na | 19,300 | na | 33,750 | 44,000 | 86,250 | FIS[a] | 10–50 |
| 01089000 | Soucook River near Concord | 3,500 | 1,270 | 2,000 | 2,560 | 3,370 | 4,030 | 4,760 | 6,750 | Ratio | 25–50 |
| 01089100 | Soucook River at Pembroke Road, near Concord | 3,730 | 1,360 | 2,130 | 2,730 | 3,590 | 4,300 | 5,080 | 7,200 | LP3 | 25–50 |
| 01089500 | Suncook River at North Chichester | 10,600 | 2,230 | 3,550 | 4,680 | 6,430 | 7,990 | 9,820 | 15,300 | LP3 | 100–500 |
| 01090800 | Piscataquog River below Everett Dam, near East Weare | 1,600 | 1,030 | 1,380 | 1,580 | 1,780 | 1,910 | 2,010 | 2,220 | LP3 | 10–25 |
| 01091000 | South Branch Piscataquog River near Goffstown | 8,880 | 2,040 | 3,000 | 3,650 | 4,460 | 5,070 | 5,680 | 7,110 | LP3 | >500 |
| 01091500 | Piscataquog River near Goffstown | 11,200 | 3,200 | 5,100 | 6,500 | 8,420 | 9,950 | 11,600 | 15,700 | LP3 | 50–100 |
| 01092000 | Merrimack River near Goffs Falls, below Manchester | 59,700 | 30,200 | 39,200 | 45,000 | 52,400 | 57,800 | 63,200 | 75,900 | LP3 | 50–100 |

**Table 3.** Flow-frequency data and recurrence-interval estimates for 57 streamgages during the April 2007 flood in central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; $ft^3/s$, cubic feet per second; yr, year; <, less than; >, greater than; na, not available. Frequency curve determination method: LeBlanc, frequency curve estimated with regression equation (LeBlanc, 1978); LP3, log-Pearson type-3 frequency analysis; FIS, flow-frequency curve from Federal Emergency Management Agency flood-insurance study; Ratio, frequency curve based on a downstream streamgage with frequency curve adjusted by the ratio of drainage areas of the streamgages]

| USGS stream-gage number | Streamgage name | Peak discharge of April (16–18) 2007 flood ($ft^3/s$) | Estimated discharges for selected recurrence intervals ($ft^3/s$) | | | | | | | Frequency curve determination method | Recurrence interval of April 2007 flood (yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | | |
| 01093000 | Sucker Brook at Auburn | na | 256 | 379 | 459 | 556 | 626 | 693 | 843 | LP3 | na |
| 01094000 | Souhegan River at Merrimack | 10,500 | 3,170 | 4,930 | 6,370 | 8,530 | 10,400 | 12,600 | 18,800 | LP3 | 50–100 |
| 010965817 | Beaver Brook at Fordway Extension at Derry | 1,100 | 463 | 811 | 1,110 | 1,590 | 2,020 | 2,520 | 4,060 | Ratio | 5–10 |
| 010965844 | Beaver Brook at South Road, near Derry | 1,470 | 618 | 1,080 | 1,490 | 2,120 | 2,700 | 3,370 | 5,430 | Ratio | 5–10 |
| 010965852 | Beaver Brook at North Pelham | 1,900 | 799 | 1,400 | 1,920 | 2,740 | 3,490 | 4,360 | 7,020 | LP3 | 5–10 |
| 01096587 | Tributary to Cobbetts Pond at I-93 south exit ramp near Windham | 59 | 20.8 | 37.5 | 48.3 | 79.3 | 98.7 | 124 | 218 | LeBlanc[b] | 10–25 |
| 01100505 | Spicket River at North Salem | 434 | 338 | 519 | 639 | 884 | 1,050 | 1,270 | 1,900 | LeBlanc[b] | 2–5 |
| 01100549 | Policy Brook at Rockingham Park Boulevard at Salem | 95 | 57.3 | 88.3 | 109 | 151 | 180 | 217 | 326 | Ratio | 5–10 |
| 011005605 | Policy Brook at I-93 north rest stop entrance ramp, near Salem | 338 | 204 | 314 | 387 | 538 | 640 | 772 | 1,160 | LeBlanc[b] | 5–10 |
| 01100561 | Spicket River near Methuen, Mass. | 1,130 | 854 | 1,200 | 1,440 | 1,820 | 2,110 | 2,470 | 3,410 | LeBlanc[b] | 2–5 |
| 01137500 | Ammonoosuc River at Bethlehem Junction | 3,370 | 4,360 | 6,290 | 7,700 | 9,620 | 11,100 | 12,800 | 16,930 | LP3 | <2 |
| 01138500 | Connecticut River at Wells River, Vt. | 27,300 | 32,700 | 41,100 | 46,000 | 51,500 | 55,100 | 58,500 | 65,600 | LP3 | <2 |
| 01144500 | Connecticut River at West Lebanon | 38,800 | 47,100 | 62,800 | 73,900 | 88,900 | 101,000 | 113,000 | 145,000 | LP3 | <2 |
| 01150500 | Mascoma River at Mascoma | 2,990 | 2,020 | 2,980 | 3,580 | 4,290 | 4,780 | 5,250 | 6,230 | LP3 | 5–10 |

[a] Computed by the U.S. Army Corps of Engineers for the flood-insurance study.

[b] Results from the LeBlanc (1978) regression equations may be unreliable in basins with urbanization or regulation.

[c] Bulletin 17B "two-station comparison" technique applied to extend the streamgage record by using long-term streamgage 01073500, Lamprey River near Newmarket.

flow-frequency analysis. At these sites, the flow-frequency curves were computed by Olson (2007) by using the regression equations for estimating flow frequency developed by LeBlanc (1978). The resulting frequency curves were not adjusted for urbanization or regulation.

At two streamgages, the flow record was sufficient for flow-frequency analysis; however, both of these sites have a short period of record, and within that short record period, these streamgage sites have experienced severe flooding. The streamgage Cocheco River near Rochester (01072800) (fig. 4E) has 13 years of record, and the streamgage Exeter River at Haigh Road near Brentwood (01073587) (fig. 4B) has 12 years of record. A log-Pearson Type III analysis was performed on the flow record at the streamgages and resulted in a recurrence interval for the April 2007 flood peak of 10 to 25 years for the Cocheco River near the Rochester streamgage and 5–10 years for the Exeter River at Haigh Road near Brentwood streamgage. The two-station-comparison technique in Bulletin 17B was applied to extend the records of these streamgages (S.A. Olson, U.S. Geological Survey, written commun., 2008) by using the long-term streamgage Lamprey River near Newmarket (01073500) (fig. 4E), which has 73 years of record. The records of the streamgages Cocheco River near Rochester and Exeter River at Haigh Road near Brentwood have correlation coefficients with the record of the streamgage at Lamprey River near Newmarket of 0.84 and 0.97, respectively. The two-station comparison record-extension technique resulted in a recurrence interval for the April 2007 flood peak of 100 to 500 years for the streamgage Cocheco River near Rochester and 25 to 50 years for the streamgage Exeter River at Haigh Road near Brentwood. These data are listed in table 3 and shown in figure 5.

For the streamgage Lake Winnipesaukee at Weirs Beach (01080000), only stage data are available. The frequency data for this site were obtained from the Flood-Insurance Study for the city of Laconia (Federal Emergency Management Agency, 1980a).

Results of the flow-frequency analyses are shown in table 3. The recurrence interval of the April 2007 peak flow at each streamgage was determined by using the results of frequency analysis. Peak discharge equaled or exceeded a 50-year flood at 16 streamgages. Peak discharge equaled or exceeded a 100-year flood at the 10 streamgages listed below:

1. Cocheco River near Rochester (01072800—with streamgage-record extension);
2. Isinglass River at Rochester Neck Road, near Dover (01072870);
3. Oyster River near Durham (01073000);
4. Winnicut River at Greenland, near Portsmouth (01073785);
5. Berrys Brook at Sagamore Road, near Portsmouth (01073810);
6. Taylor River at Old Stage Road, near Hampton (01073838);
7. Contoocook River at Peterborough (01082000);
8. Beards Brook near Hillsborough (01084500);
9. Suncook River at North Chichester (01089500); and
10. South Branch Piscataquog River near Goffstown (01091000).

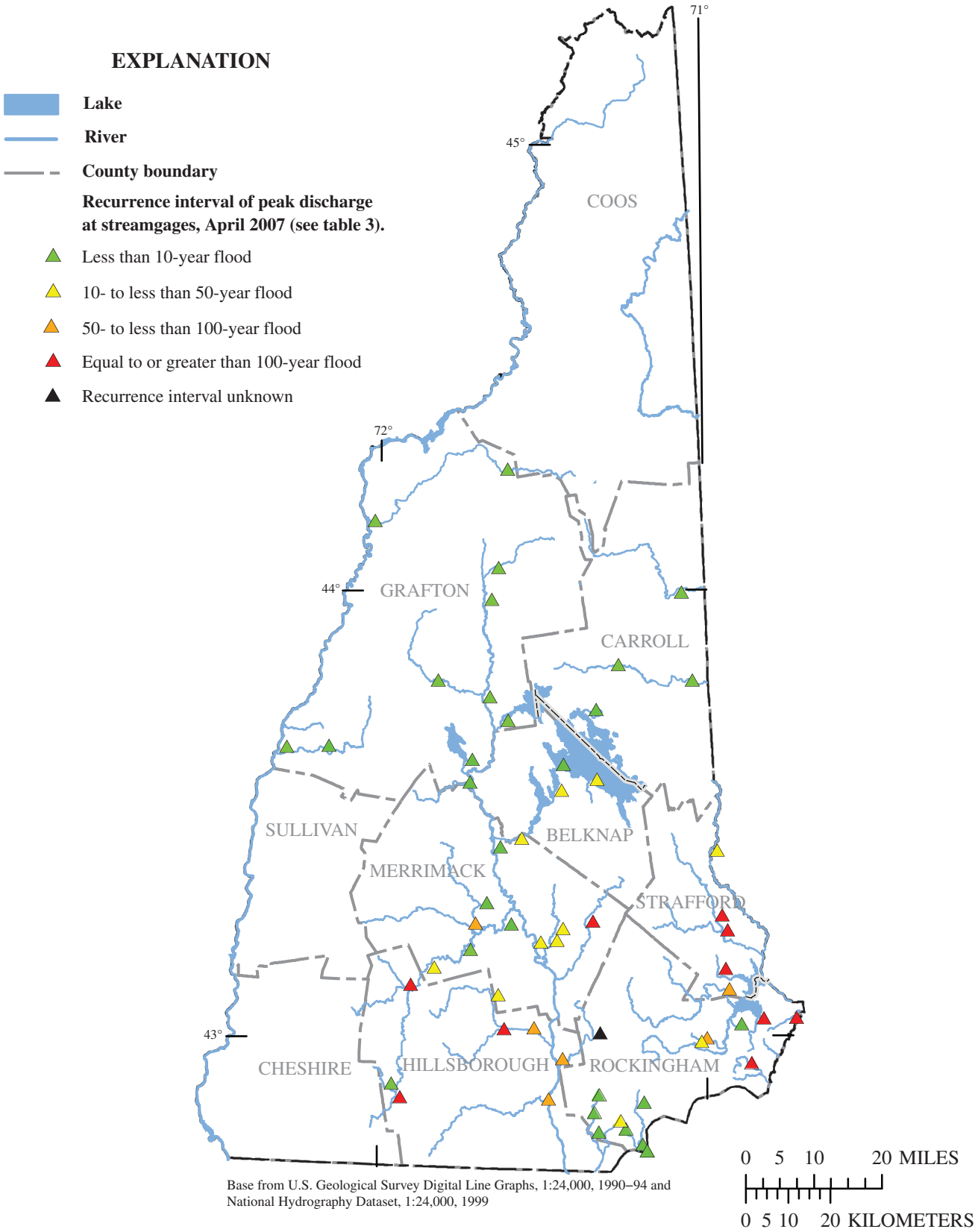


**Figure 5.** Recurrence intervals for the April 2007 flood at streamgages in Hillsborough, Rockingham, Merrimack, Belknap, Strafford, Grafton, and Carroll Counties in New Hampshire.

# Determination of the April 2007 Flood Discharge by Indirect Methods at Ungaged Sites

Four bridge sites were chosen for the determination of the April 2007 peak discharge by indirect methods (Matthai, 1967; table 4):

1. Lamprey River at Epping Road railroad bridge in Raymond, N.H. (drainage area of 70 $mi^2$);
2. Souhegan River at Wilton Road (Elm Street) bridge in Milford, N.H., approximately 2,000 ft east of the Wilton/Milford, N.H. town line (drainage area of 102 $mi^2$);
3. Suncook River at Short Falls Road bridge in Epsom, N.H. (drainage area of 210 $mi^2$); and
4. Suncook River at Websters Mill Road bridge at the Chichester/Pittsfield, N.H. town line (drainage area of 137 $mi^2$).

The four locations chosen for the indirect determination of the April 2007 peak-flood discharge have never been streamgage sites. High-water-mark information (table 6), the bridge-opening geometry, and channel and floodplain cross sections upstream and downstream from the bridge were surveyed at each of these sites and input into the USACE HEC-RAS program (2005). The discharges were iteratively selected and input into the HEC-RAS program to match the surface-elevation output and surveyed high-water marks (appendix 1, tables 1–1 to 1–4).

All four of these sites are located on rivers that have streamgage records. On the basis of the indirectly determined April 2007 flood-peak discharge at the ungaged location (by using high-water-mark data and the USACE HEC-RAS program) and the April 2007 flood-peak discharge determined for the streamgage site, a flow-frequency curve was generated for each of the four ungaged sites (table 4). To determine the flow-frequency curve at the ungaged site, the relation between the April 2007 peaks and drainage areas at the gaged and ungaged sites was determined. After this relation was determined, it was applied to the log-Pearson Type III flow-frequency curve determined at the streamgage site to ascertain the flow-frequency curve at the ungaged site. For comparison purposes, flow-frequency curves at all four sites also were computed by using the regression equations for estimating flow frequency developed by LeBlanc (1978) (table 4).

The coefficient $n$ in the equation below was determined through a drainage-area relation between the April 2007 flood peak discharge at the streamgage site and the indirectly determined April 2007 peak discharge at the ungaged site on each of the rivers of interest by using the drainage-area relation:

$$Q/Q_g = \left(A/A_g\right)^n, \quad (1)$$

where

$Q$ is the discharge at the ungaged site,
$Q_g$ is the discharge at the USGS streamgage site,
$A$ is the drainage area at the ungaged site,
$A_g$ is the drainage area at the USGS streamgage site, and
$n$ is the drainage-area adjustment value.

The drainage areas are shown in table 1 (in back of report) for the streamgages and in table 4 for the indirect discharge-measurement sites. April 2007 peak flood discharges are shown in table 2 for the streamgage sites and in table 4 for the indirect discharge-measurement sites. The calculated-coefficient $n$ values for each indirect discharge-measurement location and related streamgage are shown below:

1. Lamprey River between Epping Road railroad bridge in Raymond, N.H., and streamgage 01073500 near Newmarket ($n$ = 0.79);
2. Souhegan River between Wilton Road bridge near the Wilton/Milford, N.H. town line and streamgage 01094000 at Merrimack ($n$ = 0.80);
3. Suncook River between Short Falls Road bridge in Epsom, N.H., and streamgage 01089500 at North Chichester ($n$ = 0.94); and
4. Suncook River between Websters Mill Road bridge in Chichester/Pittsfield, N.H., and streamgage 01089500 at North Chichester ($n$ = 0.94).

**Table 4.** Flow-frequency data and recurrence-interval estimates by indirect methods for four ungaged sites during the April 2007 flood in central and southern New Hampshire.

[Location of indirect discharge-determination sites in figures 4A–C. $ft^3/s$, cubic feet per second; yr, year; >, greater than. Frequency curve determination method: LeBlanc, frequency curve estimated with regression equation (LeBlanc, 1978); LP3, log-Pearson type-3 frequency analysis; Ratio, frequency curve based on a downstream streamgage with frequency curve adjusted by the ratio of drainage areas of the streamgages]

| Indirect discharge-determination location | Indirect peak discharge of April (16–18) 2007 flood ($ft^3/s$) | Estimated discharges for selected recurrence intervals ($ft^3/s$) | | | | | | | Frequency-curve determination method | Recurrence interval of April 2007 flood (yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-yr | 5-yr | 10-yr | 25-yr | 50-yr | 100-yr | 500-yr | | |
| 1a) Lamprey River at Epping Road railroad bridge in Raymond, N.H. (drainage area = 70 $mi^2$) | 3,990 | 891 | 1,230 | 1,470 | 1,830 | 2,110 | 2,470 | 3,350 | LeBlanc[a] | >500 |
| 1b) Lamprey River at Epping Road railroad bridge in Raymond, N.H. (drainage area = 70 $mi^2$) | 3,990 | 1,030 | 1,660 | 2,180 | 2,960 | 3,630 | 4,400 | 6,600 | Ratio with LP3 at streamgage 01073500 | 50–100 |
| 2a) Souhegan River at Wilton Road bridge near the Wilton/Milford, N.H. town line (drainage area = 102 $mi^2$) | 6,950 | 1,910 | 2,830 | 3,450 | 4,540 | 5,340 | 6,370 | 9,090 | LeBlanc[a] | 100–500 |
| 2b) Souhegan River at Wilton Road bridge near the Wilton/Milford, N.H. town line (drainage area = 102 $mi^2$) | 6,950 | 2,100 | 3,260 | 4,210 | 5,640 | 6,880 | 8,330 | 12,400 | Ratio with LP3 at streamgage 01094000 | 50–100 |
| 3a) Suncook River at Short Falls Road in Epsom, N.H. (drainage area = 210 $mi^2$) | 14,100 | 2,140 | 2,790 | 3,280 | 3,850 | 4,380 | 5,040 | 6,480 | LeBlanc[a] | >500 |
| 3b) Suncook River at Short Falls Road in Epsom, N.H. (drainage area = 210 $mi^2$) | 14,100 | 2,980 | 4,740 | 6,250 | 8,590 | 10,700 | 13,100 | 20,400 | Ratio with LP3 at streamgage 01089500 | 100–500 |
| 4a) Suncook River at Websters Mill Road in Chichester/Pittsfield, N.H. (drainage area = 137 $mi^2$) | 9,400 | 3,260 | 5,030 | 6,200 | 8,430 | 10,100 | 12,100 | 17,900 | LeBlanc[a] | 25–50 |
| 4b) Suncook River at Websters Mill Road in Chichester/Pittsfield, N.H. (drainage area = 137 $mi^2$) | 9,400 | 1,990 | 3,160 | 4,170 | 5,730 | 7,120 | 8,750 | 13,600 | Ratio with LP3 at streamgage 01089500 | 100–500 |

[a] Results from the LeBlanc (1978) regression equations may be unreliable in basins with urbanization or regulation.

## Comparison of the April 2007 Flood Data to Flood-Insurance Studies

FEMA Flood-Insurance Studies provide communities with information on the severity of flood hazards. This information includes estimated discharges and water-surface-elevation profiles for the 10-, 50-, 100-, and 500-year floods for selected potential surface-water bodies around which development has occurred or is expected to occur. The 10-, 50-, 100-, and 500-year floods have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded in any given year. These data are used for planning purposes and for setting flood-insurance rates for structures within communities participating in the National Flood-Insurance Program.

For the streamgage and indirect-discharge sites in this study that were included in a Flood-Insurance Study, discharges and peak water-surface elevations (stage) were compiled from the appropriate study and are given in table 5. Flood-Insurance Study recurrence-interval discharges were obtained from the "Summary of Discharges" table for the reach that incorporated the streamgage site, and the peak water-surface elevations were extracted from the water-surface-elevation profiles. In cases where the streamgage site was not identified on the water-surface-elevation profiles, interpretation of the streamgage location was required to obtain the water-surface-elevation for the corresponding recurrence interval.

The compiled Flood-Insurance Study data are shown in table 5 along with the peak-stage and peak-discharge data for the April 2007 flood. The flow-frequency data obtained from the Flood-Insurance Studies (table 5) often differ from the flow-frequency data determined for this investigation (table 3) because the methods used for determining the frequency curves may be different, and (or) more data are currently available for the development of the frequency curves.

The data contained in this report may aid in the updating of future Flood-Insurance Study water-surface-elevation profiles for some communities through FEMA's Map Modernization program. For instance, at the Piscataquog River near Goffstown streamgage (01091500), the peak discharge in April 2007 was 11,200 $ft^3/s$. The recurrence interval for this discharge, as reported in the Goffstown Flood-Insurance Study (Federal Emergency Management Agency, 1978b), is 50 to 100 years. It would be expected that the peak stage in April 2007 also would fall between the 50- and 100-year water-surface-elevation profiles at this location. However, the peak stage for the April 2007 flood was 187.70 ft (NGVD 29), which is greater than the 100-year water-surface elevation reported in the Goffstown Flood-Insurance Study. There are 16 streamgage sites and 1 indirect discharge site for which the observed peak discharge of the April 2007 flood is bracketed by a recurrence interval different than the Flood-Insurance Study recurrence interval that brackets the observed peak April 2007 flood stage or water-surface elevation (table 5). The reasons for these discrepancies are beyond the scope of this study.

**Table 5.** Flood-insurance study data for selected streamgage sites in central and southern New Hampshire.

[Location of streamgages in figure 4. na, not available; $ft^3/s$, cubic feet per second; yr, year; NAVD 88, North American Datum of 1988; NGVD 29, National Geodetic Vertical Datum of 1929]

| USGS stream-gage number | Streamgage name and ungaged site location | Peak discharge of April 2007 flood ($ft^3/s$) | Magnitude of discharge for X-yr recurrence interval at streamgage location from flood-insurance study ($ft^3/s$) | | | | Peak stage of April 2007 flood, NGVD 29 (ft) | Water-surface elevation for X-yr recurrence interval at streamgage location from flood-insurance study, NGVD 29 (ft) | | | | Value to subtract from NGVD 29 elevation to obtain NAVD 88 (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10-yr | 50-yr | 100-yr | 500-yr | | 10-yr | 50-yr | 100-yr | 500-yr | |
| 01064500 | Saco River near Conway | 9,750 | 29,750 | 45,840 | 53,640 | 72,180 | 426.49 | 431.9 | 435.4 | 437.1 | 440.5 | 0.44 |
| 01064801 | Bearcamp River at South Tamworth | 3,720 | na | na | 14,900 | na | 501.49 | na | na | 510 | na | 0.46 |
| 01072100 | Salmon Falls River at Milton[a] | 5,500 | 2,930 | 4,500 | 5,290 | 7,490 | 404.46 | 408.1 | 409.2 | 409.8 | 411.0 | 0.56 |
| 01072800 | Cocheco River near Rochester[a] | 7,240 | 3,160 | 5,100 | 6,120 | 9,580 | 140.20 | 135.0 | 136.6 | 137.5 | 139.8 | 0.61 |
| 01073500 | Lamprey River near Newmarket | 8,450 | 4,120 | 6,270 | 7,300 | 10,000 | 55.77 | 48.1 | 52.0 | 53.5 | 58.0 | 0.73 |
| 01073587 | Exeter River at Haigh Road, near Brentwood[a] | 2,840 | 1,810 | 2,640 | 3,010 | 3,900 | 71.46 | 69.0 | 70.1 | 70.4 | 71.2 | 0.75 |
| 01073600 | Dudley Brook near Exeter[a] | 470 | na | na | 506 | na | 94.40 | na | na | 94.1 | na | 0.75 |
| 01074520 | East Branch Pemigewasset River at Lincoln | 2,730 | 13,000 | 24,000 | 30,300 | 50,000 | 829.89 | 834.0 | 836.5 | 838.0 | 842.0 | 0.31 |
| 01075000 | Pemigewasset River at Woodstock | 4,460 | na | na | 47,700 | na | 623.27 | na | na | 632.0 | na | 0.34 |
| 01076000 | Baker River near Rumney | 3,040 | 8,200 | 12,800 | 14,400 | 19,000 | 502.99 | 506.4 | 509.1 | 509.7 | 511.4 | 0.40 |
| 01076500 | Pemigewasset River at Plymouth | 13,900 | 35,000 | 53,500 | 62,000 | 82,700 | 467.78 | 482.0 | 482.5 | 483.4 | 494.0 | 0.41 |
| 01080000 | Lake Winnipesaukee at Weirs Beach | na | na | na | na | na | 505.00 | 505.4 | 505.9 | 506.2 | 506.7 | 0.43 |
| 01080500 | Lake Winnipesaukee Outlet at Lakeport | 2,430 | 2,600 | 2,600 | 3,500 | 4,300 | na | 504.0 | 504.3 | 504.3 | 504.3 | 0.44 |
| 01081000 | Winnipesaukee River at Tilton[a] | 3,550 | 3,465 | 4,965 | 5,715 | 7,670 | 449.48 | 449.8 | 451.4 | 452.2 | 454.1 | 0.47 |
| 01081500 | Merrimack River at Franklin Junction | 17,300 | 14,800 | 25,000 | 30,000 | 62,000 | 264.70 | 263.1 | 268.4 | 270.4 | 281.1 | 0.50 |
| 01082000 | Contoocook River at Peterborough | 4,110 | 2,300 | 4,310 | 5,700 | 9,890 | 739.18 | 736.7 | 739.4 | 740.5 | 742.6 | 0.72 |
| 01083000 | Nubanusit Brook below MacDowell Dam near Peterborough | 637 | 650 | 700 | 800 | 900 | 936.74 | na | na | na | na | 0.67 |
| 01084500 | Beards Brook near Hillsborough[a] | 3,550 | 2,300 | 3,900 | 4,800 | 7,100 | 602.33 | 598.4 | 601.8 | 603.7 | 610.0 | 0.61 |
| 01085000 | Contoocook River near Henniker | 13,000 | 9,100 | 17,000 | 21,600 | 34,000 | 484.81 | 484.4 | 489.2 | 491.6 | 496.0 | 0.62 |
| 01085500 | Contoocook River below Hopkinton Dam at West Hopkinton | 5,370 | 7,200 | 7,300 | 9,500 | 13,000 | 364.34 | 365.7 | 365.8 | 367.5 | 370.0 | 0.68 |
| 01086000 | Warner River at Davisville[a] | 7,730 | 4,600 | 7,800 | 9,500 | 14,550 | 391.90 | 386.0 | 388.0 | 389.0 | 391.5 | 0.59 |
| 01087000 | Blackwater River near Webster | 1,950 | na | na | 2,600 | na | 438.60 | na | na | 440.0 | na | 0.56 |
| 01087850 | Contoocook River at River Hill, near Penacook | 7,780 | 8,000 | 15,000 | 23,300 | 33,000 | 347.87 | 348.2 | 352.3 | 356.1 | 359.5 | 0.60 |
| 01088400 | Merrimack River at Concord[a] | 32,800 | 19,300 | 33,750 | 44,000 | 86,250 | 231.52 | 226.4 | 230.1 | 232.4 | 238.8 | 0.61 |
| 01089000 | Soucook River near Concord[a] | 3,500 | 2,410 | 4,100 | 5,045 | 7,605 | 305.79 | 301.4 | 304.0 | 305.2 | 307.0 | 0.58 |

**Table 5.** Flood-insurance study data for selected streamgage sites in central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. na, not available; ft³/s, cubic feet per second; yr, year; NAVD 88, North American Datum of 1988; NGVD 29, National Geodetic Vertical Datum of 1929]

| USGS stream-gage number | Streamgage name and ungaged site location | Peak discharge of April 2007 flood (ft³/s) | Magnitude of discharge for X-yr recurrence interval at streamgage location from flood-insurance study (ft³/s) | | | | Peak stage of April 2007 flood, NGVD 29 (ft) | Water-surface elevation for X-yr recurrence interval at streamgage location from flood-insurance study, NGVD 29 (ft) | | | | Value to subtract from NGVD 29 elevation to obtain NAVD 88 (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 10-yr | 50-yr | 100-yr | 500-yr | | 10-yr | 50-yr | 100-yr | 500-yr | |
| 01089100 | Soucook River at Pembroke Road, near Concord[a] | 3,730 | 2,620 | 4,450 | 5,475 | 8,255 | 296.26 | 268.0 | 271.2 | 272.0 | 274.0 | 0.60 |
| 01089500 | Suncook River at North Chichester | 10,600 | 4,775 | 8,335 | 10,330 | 15,970 | 345.32 | 341.3 | 344.0 | 345.2 | 347.9 | 0.57 |
| Ungaged location | Suncook River at Short Falls Road bridge in Epsom | 14,100 | 6,040 | 10,540 | 13,065 | 20,195 | 308.57 | 302.5 | 306.8 | 308.2 | 312.0 | 0.59 |
| Ungaged location | Suncook River at Websters Mill Road bridge in Chichester/Pittsfield | 9,400 | 4,510 | 7,870 | 9,750 | 15,070 | 393.21 | 391.0 | 392.5 | 393.5 | 395.0 | 0.56 |
| 01090800 | Piscataquog River below Everett Dam, near East Weare | 1,600 | na | na | 2,200 | na | 328.37 | na | na | 329.6 | na | 0.66 |
| 01091000 | South Branch Piscataquog River near Goffstown | 8,880 | 3,690 | 5,910 | 6,990 | 10,220 | 322.97 | 317.8 | 320.0 | 321.0 | 323.8 | 0.67 |
| 01091500 | Piscataquog River near Goffstown[a] | 11,200 | 5,300 | 9,700 | 12,500 | 21,000 | 187.70 | 182.9 | 185.8 | 186.9 | 189.4 | 0.67 |
| 01092000 | Merrimack River near Goffs Falls, below Manchester[a] | 59,700 | 44,000 | 56,000 | 69,000 | 127,000 | 126.06 | 122.1 | 126.0 | 128.0 | 140.0 | 0.69 |
| 01094000 | Souhegan River at Merrimack | 10,500 | 6,920 | 11,900 | 12,500 | 22,000 | 173.29 | 171.1 | 174.2 | 174.7 | 179.0 | 0.70 |
| Ungaged location | Souhegan River at Wilton Road bridge in Milford[a] | 6,950 | 3,740 | 6,360 | 7,550 | 11,000 | 297.88 | 297.2 | 299.5 | 300.2 | 302.8 | 0.68 |
| 010965817 | Beaver Brook at Fordway Extension at Derry | 1,100 | 750 | 1,520 | 1,860 | 3,300 | na | 239.5 | 240.6 | 241.0 | 242.6 | 0.69 |
| 010965844 | Beaver Brook at South Road, near Derry[a] | 1,470 | 860 | 1,760 | 2,160 | 3,600 | 219.45 | 217.5 | 218.8 | 219.2 | 220.4 | 0.69 |
| 010965852 | Beaver Brook at North Pelham[a] | 1,900 | 1,450 | 2,470 | 3,070 | 4,750 | 162.78 | 161.3 | 162.9 | 163.5 | 165.3 | 0.71 |
| 01100561 | Spicket River near Methuen, Mass. | 1,130 | 900 | 1,600 | 1,900 | 2,900 | 109.91 | 109.0 | 111.3 | 111.6 | 114.3 | 0.77 |
| 01138500 | Connecticut River at Wells River, Vt. | 27,300 | na | na | 80,300 | na | 409.00 | na | na | 420.0 | na | 0.38 |
| 01144500 | Connecticut River at West Lebanon | 38,800 | 72,000 | 108,000 | 125,000 | 157,000 | 337.93 | 345.4 | 351.0 | 353.9 | 358.0 | 0.41 |
| 01150500 | Mascoma River at Mascoma[a] | 2,990 | 3,500 | 5,750 | 7,000 | 10,000 | 749.01 | 748.8 | 750.8 | 752.8 | 754.0 | 0.30 |

[a] The FIS recurrence interval that brackets the observed peak discharge of the April 2007 flood differs from the FIS recurrence interval that brackets the observed peak April 2007 flood stage or water-surface elevation.

**Table 6.** High-water-mark data used in the determination of April 2007 flood discharge by indirect methods for four ungaged sites in central and southern New Hampshire.

[ft, feet; NAVD 88, North American Vertical Datum of 1988; NGVD 29, National Geodetic Vertical Datum of 1929]

| High-water-mark name | Elevation NAVD 88 (ft) | Elevation NGVD 29 (ft) | Latitude (decimal degree) | Longitude (decimal degree) | River name | Location/road | Town | Mark rating | Mark type | Mark description |
|---|---|---|---|---|---|---|---|---|---|---|
| Ray10 | 187.9 | 188.625 | 43.03811 | -71.17194 | Lamprey | Abandoned railroad bridge behind I.C. Reed and Son's (Epping Street) | Raymond | Good | Seed line | Nail in 1.5-ft-diameter pine tree |
| Ray11 | 187.79 | 188.515 | 43.03801 | -71.17255 | Lamprey | Upstream from abandoned railroad bridge behind I.C. Reed and Son's (Epping Street) | Raymond | Good | Seed line | Nail in 1.0-ft-diameter hardwood |
| Ray12 | 187.685 | 188.41 | 43.03798 | -71.17266 | Lamprey | 30 ft upstream from Ray11 behind I.C. Reed and Son's (Epping Street) | Raymond | Good | Seed line | Nail in 2.0-ft-diameter dead pine tree |
| Ray13 | 186.675 | 187.4 | 43.03761 | -71.17160 | Lamprey | Downstream from abandoned railroad bridge behind I.C. Reed and Son's (Epping Street) | Raymond | Good | Seed line | Nail in 2.0-ft-diameter pine tree |
| Ray14 | 186.67 | 187.395 | 43.03738 | -71.17309 | Lamprey | 55 ft downstream from monitoring well behind I.C. Reed and Son's (Epping Street) | Raymond | Good | Seed line | Nail in 0.5-ft-diameter pine tree |
| Sunhwm33 | 308.055 | 308.645 | 43.20207 | -71.38300 | Suncook | 100 ft downstream and 80 ft bankward at Short Falls Road bridge | Epsom | Good | Seed line | Nail in base of pine tree |
| Sunhwm34 | 308.905 | 309.495 | 43.20224 | -71.38233 | Suncook | Top downstream corner of old abutment at Short Falls Road bridge | Epsom | Fair | Wash line | Stake with line |
| Sunhwm35 | 309.225 | 309.815 | 43.20235 | -71.38183 | Suncook | Top of left bank at Short Falls Road bridge | Epsom | Good | Weed line | Nail in pine tree |
| Souh8 | 294.76 | 295.44 | 42.84212 | -71.71996 | Souhegan River | 200 ft downstream of Wilton Road bridge | Milford | Fair | Wash line | Nail in tree |
| Souh9 | 298.77 | 299.45 | 42.84086 | -71.72031 | Souhegan River | 100 ft upstream of Wilton Road bridge | Milford | Good | Wash line | Nail in tree |
| Souh10 | 296.075 | 296.755 | 42.84185 | -71.72022 | Souhegan River | 20 ft downstream from mill and 150 ft downstream from Wilton Road bridge | Milford | Fair | Sash line | Nail in tree |
| SuncookWMB1 | 394.445 | 395.005 | 43.27838 | -71.34515 | Suncook | 100 ft upstream from Websters Mill bridge on left bank | Pittsfield | Poor | Sash line | Stake with mark |
| SuncookWMB2 | 389.045 | 389.605 | 43.27888 | -71.34735 | Suncook | 300 ft downstream from bridge on right bank and 15 ft streamward from mailbox #186 | Pittsfield | Poor | Sash line | Stake with mark |
| SuncookWMB3 | 395.295 | 395.855 | 43.27916 | -71.34491 | Suncook | 300 ft upstream from last house on upstream right bank and 400 ft upstream from bridge on right bank | Pittsfield | Poor | Sash line | Stake with mark |
| SuncookWMB4 | 395.49 | 396.05 | 43.27890 | -71.34451 | Suncook | 600 ft upstream from bridge on right bank | Pittsfield | Fair | Debris line | Nail in base of 1.0-ft-diameter maple tree |
| SuncookWMB6 | 383.365 | 383.925 | 43.27773 | -71.34895 | Suncook | Left edge of water at Websters Mill | Pittsfield | Fair | Seed line | Nail in base of spruce tree |

## Summary

During April 16–18, 2007, central and southern New Hampshire experienced severe flooding caused by as much as 7 in. of rainfall in the region. A Presidential Disaster Declaration was issued on April 27, 2007, for five counties (Grafton, Hillsborough, Merrimack, Rockingham, and Strafford) in New Hampshire. On May 10, 2007, a sixth county (Belknap) was added to the disaster declaration. The U.S. Geological Survey, in a cooperative investigation with the Federal Emergency Management Agency (FEMA), measured or computed flood data at 57 streamgages and 4 ungaged sites in and adjacent to the counties declared disaster areas. These data include peak stages, peak discharges, and recurrence-interval estimates for the April 2007 flooding, and data compiled from FEMA Flood-Insurance Studies for comparison purposes.

The total precipitation that occurred during April 15–19, 2007, in southeastern New Hampshire (6.54 in. in Durham) is approximately one-half of the 13 in. of precipitation that fell during October 20–22, 1996, in the same area (National Oceanic and Atmospheric Administration, 1996). The total April 15–19, 2007, precipitation in southeastern New Hampshire is less than one-half of the up to 14 in. of precipitation that fell during May 11–15, 2006, across the coastal regions of New Hampshire (National Oceanic and Atmospheric Administration, 2006a) and approximately 60 percent of the up to 11 in. of precipitation that fell during May 11–15, 2006, in the south-central part of the state (National Oceanic and Atmospheric Administration, 2006b). Although the April 2007 storm produced less precipitation than either the October 1996 or May 2006 storm events, some streams in New Hampshire had higher discharges in the 2007 event. The higher than normal precipitation from the April 2007 storm, including precipitation on top of snowpack at higher elevations, downed trees, and wood debris in some rivers contributed to the high flows and flooding in southern and central New Hampshire. In addition, an abnormally high spring tide along with a storm surge of nearly 3 ft caused tidal flooding along portions of the seacoast (National Oceanic and Atmospheric Administration, 2007b), and the prolonged period of strong northeast winds caused a prolonged storm surge along the coastline (National Climate Data Center, 2007).

At 5 long-term (more than 10 years of record) streamgage sites, the peak discharge in April 2007 was the maximum discharge for the period of record. These streamgages include South Branch Piscataquog River near Goffstown (1941–78), Contoocook River at Peterborough, 1946–present (2008); Oyster River near Durham, 1934–present (2008); Cocheco River near Rochester, 1995–present (2008); and Salmon Falls River at Milton, 1968–present (2008).

Peak discharges equaled or exceeded a 100-year recurrence interval at 10 streamgages and equaled or exceeded a 50-year recurrence interval at 16 streamgages. The most severe flooding was in Rockingham, Strafford, Merrimack, and Hillsborough Counties.

Peak-flood discharge and stage data from the April 2007 flood event at streamgage and indirect-discharge sites were compared to recurrence-interval discharges and peak water-surface elevations (stage) determined by Flood-Insurance Studies, where available. Flood-Insurance Study recurrence-interval discharges were obtained from the "Summary of Discharges" table for the reach that incorporated the streamgage site, and the peak water-surface elevations were extracted from the water-surface-elevation profiles. In cases where the streamgage site was not identified on the water-surface-elevation profiles, interpretation of the streamgage location was required to obtain the water-surface-elevation for the corresponding recurrence interval.

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**Table 1.** Description of streamgages used in the April 2007 flood investigation, central and southern New Hampshire.

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route, mi$^2$, square miles; lat, latitude; long, longitude; NHDES, New Hampshire Department of Environmental Services; ft, feet; USACE, U.S. Army Corps of Engineers]

| USGS stream-gage number | Streamgage name | Status | Operator | Drainage area (mi$^2$) | Streamgage location |
|---|---|---|---|---|---|
| 01064500 | Saco River near Conway | Active | USGS | 385 | Lat 43°59'27", long 71°05'29", Carroll County, on left bank, at Odell Falls, 0.4 mi upstream from US 302, 1.5 mi northeast of the intersection of SR 16 and 113 in Conway, and 1.8 mi downstream from mouth of Swift River. |
| 01064801 | Bearcamp River at South Tamworth | Active | USGS | 67.6 | Lat 43°49'48", long 71°17'18", Carroll County, on right bank, at downstream side of abandoned stone abutments, 0.7 mi upstream from Sanger Brook, 0.8 mi east of Bemis Mountain Road and SR 25 intersection at South Tamworth, 1.0 mi downstream from Cold Brook, and 1.1 mi west of SR 25 and SR 113 intersection at Whittier. |
| 01065000 | Ossipee River at Effingham Falls | Active | NHDES[a] | 330 | Lat 43°47'42", long 71°03'35", Carroll County, on left bank, 850 ft upstream from SR 153 bridge, 1,400 ft downstream from dam at outlet of Ossipee Lake, and 0.2 mi west of the intersection of SR 153 and 25 at Effingham Falls. |
| 01072100 | Salmon Falls River at Milton | Active | NHDES[a] | 108 | Lat 43°24'48", long 70°59'15", Strafford County, on right bank, just downstream from Milton Pond Dam and 300 ft southeast of SR 125 and Prospect Hill Road intersection in Milton. |
| 01072800 | Cocheco River near Rochester | Active | USGS | 85.7 | Lat 43°16'06", long 70°58'27", Strafford County, on right bank, directly behind Rochester Country Club, 2,200 ft upstream from treatment lagoons, and 0.5 mi southeast of Main Street and Church Street intersection in Gonic. |
| 01072870 | Isinglass River at Rochester Neck Road, near Dover | Active | USGS | 73.6 | Lat 43°14'05", long 70°57'25", Strafford County, 600 ft upstream from Rochester Neck Road bridge, and 0.7 mi upstream from mouth on Cocheco River. |
| 01073000 | Oyster River near Durham | Active | USGS | 12.1 | Lat 43°08'55", long 70°57'56", Strafford County, on left bank, 50 ft upstream from Old Concord Road bridge, and 0.6 mi east of US 4 and SR 155 intersection. |
| 01073500 | Lamprey River near Newmarket | Active | USGS | 183 | Lat 43°06'09", long 70°57'11", Strafford County, on right bank, 200 ft upstream from Packers Falls and Packers Falls Road bridge. |
| 01073587 | Exeter River at Haigh Road, near Brentwood | Active | USGS | 63.5 | Lat 42°59'04", long 71°02'20", Rockingham County, on right bank, 10 ft downstream from Haigh Road bridge. |
| 01073600 | Dudley Brook near Exeter | Discon-tinued | USGS | 4.97 | Lat 42°59'35", long 71°01'20", Rockingham County, on right bank, upstream side of breached dam, 100 ft upstream from SR 111A culvert, and 180 ft west of SR 111A and Deer Hill Road intersection. |
| 01073750 | Mill Brook near SR 108, at Stratham | Discon-tinued | USGS | 2.3 | Lat 43°01'24", long 70°55'04", Rockingham County, on right bank, at most downstream culvert of the Stratham traffic circle at the intersection of SR 108 and 33 in Stratham. |
| 01073785 | Winnicut River at Green-land, near Portsmouth | Active | USGS | 14.1 | Lat 43°02'12", long 70°50'55", Rockingham County, on left bank, 20 ft upstream from State Fish and Game Department Dam, 150 ft downstream from SR 33 bridge, and 1.1 mi west of the intersection of SR 33 and 151 in Greenland. |
| 01073810 | Berrys Brook at Sagamore Road, near Portsmouth | Discon-tinued | USGS | 5.38 | Lat 43°02'10", long 70°44'59", Rockingham County, on right bank, at upstream side of Sagamore Road, and 0.7 mi south of SR 1A and Sagamore Road intersection at Foyers Corner in Rye. |
| 01073838 | Taylor River at Old Stage Road near Hampton | Discon-tinued | USGS | 8.41 | Lat 42°56'33", long 70°52'40", Rockingham County, on left bank, at upstream side of dam, 100 ft upstream from Old Stage Road bridge, and 650 ft southwest of Old Stage Road and Timber Swamp Road intersection at Coffins Mill in Hampton. |

**Table 1.** Description of streamgages used in the April 2007 flood investigation, central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route, mi$^2$, square miles; lat, latitude; long, longitude; NHDES, New Hampshire Department of Environmental Services; ft, feet; USACE, U.S. Army Corps of Engineers]

| USGS stream-gage number | Streamgage name | Status | Operator | Drainage area (mi$^2$) | Streamgage location |
|---|---|---|---|---|---|
| 01074520 | East Branch Pemigewasset River at Lincoln | Active | USGS | 115 | Lat 44°02'51", long 71°39'37", Grafton County, on right bank, at upstream side of Old Crib Dam, locally known as "the old hole," 800 ft upstream from Cooper Memorial Drive bridge, 1,900 ft downstream from Pollard Brook, 1.8 mi above mouth, and 0.8 mi east of Connector Road and SR 112 intersection in Lincoln. |
| 01075000 | Pemigewasset River at Woodstock | Active | USGS | 193 | Lat 43°58'34", long 71°40'48", Grafton County, on right bank at downstream side of abandoned bridge abutments, immediately east of Woodstock Fire Station, 300 ft upstream from southernmost SR 175 bridge, and 300 ft east of North Station Road and SR 175 intersection in Woodstock. |
| 01076000 | Baker River near Rumney | Active | USGS | 143 | Lat 43°47'44", long 71°50'45", Grafton County, on right bank, 200 ft upstream from small right bank tributary, 1,900 ft upstream from mouth of Halls Brook, 1,400 ft west of Halls Brook Road and SR 25 intersection, and 1.7 mi southeast of Sand Hill Road and SR 25 intersection in West Rumney. |
| 01076500 | Pemigewasset River at Plymouth | Active | USGS | 622 | Lat 43°45'33", long 71°41'10", Grafton County, on right bank, 150 ft downstream from Holderness Road bridge in Plymouth, 1,700 ft downstream from Baker River, and 0.8 mi south of SR 3A and US 3 intersection. |
| 01077000 | Squam River at Ashland | Active | NHDES[a] | 57.6 | Lat 43°42'19", long 71°37'49", Grafton County, on right bank, 250 ft downstream from the Little Squam Lake Dam, 300 ft upstream from River Street bridge, and 300 ft north of River Street and US 3 intersection. |
| 01077510 | Newfound River below Newfound Lake near Bristol | Active | NHDES | 98 | Lat 43°37'02", long 71°44'28", Grafton County, at outlet of Newfound Lake, 75 ft downstream from Newfound Lake Dam, 500 ft downstream from West Shore Road, and 800 ft west of West Shore Road and SR 3A intersection in Bristol. |
| 01078000 | Smith River near Bristol | Active | USGS | 85.8 | Lat 43°33'59", long 71°44'54", Merrimack County, on right bank, 2,200 ft north of Borough Road and Axtell Road intersection, and 4,700 ft upstream from Borough Road bridge in Bristol. |
| 01079602 | Poorfarm Brook near Gilford | Discon-tinued | USGS | 6.38 | Lat 43°34'22", long 71°21'20", Belknap County, on right bank, at downstream side of Scenic Drive bridge, 250 ft downstream from SR 11, 500 ft west of Scenic Drive and SR 11 intersection, 950 ft upstream from mouth on Lake Winnipesaukee. |
| 01079900 | Shannon Brook near Moultonborough | Discon-tinued | USGS | 6.99 | Lat 43°43'49", long 71°21'28", Carroll County, on left bank, immediately upstream from SR 109 bridge (gage house is 20 ft downstream from bridge), 3,800 ft south of the intersection of SR 109 and 171 in Moultonborough, and 1.4 mi upstream from mouth on Lake Winnipesaukee. |
| 01080000 | Lake Winnipesaukee at Weirs Beach | Active | NHDES[a] | 363 | Lat 43°36'27", long 71°27'34", Belknap County, 600 ft east of Weirs Beach Post Office, and 0.3 mi northwest of US 3 bridge across Paugus Bay at Weirs Beach. |
| 01080500 | Lake Winnipesaukee Outlet at Lakeport | Active | NHDES[a] | 363 | Lat 43°32'57", long 71°27'54", Belknap County, 100 ft upstream from Elm Street bridge across Paugus Bay, 150 ft upstream from dam across Paugus Bay, and 0.2 mi northwest of Elm Street and Union Avenue intersection in Lakeport. |
| 01081000 | Winnipesaukee River at Tilton | Active | USGS | 471 | Lat 43°26'30", long 71°35'17", Belknap County, on right bank, 150 ft upstream from Bridge/School Street bridge, 300 ft south of Town Hall in Tilton, and 0.3 mi southeast of US 3 and SR 132 intersection in Tilton. |

**Table 1.** Description of streamgages used in the April 2007 flood investigation, central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route, mi$^2$, square miles; lat, latitude; long, longitude; NHDES, New Hampshire Department of Environmental Services; ft, feet; USACE, U.S. Army Corps of Engineers]

| USGS stream-gage number | Streamgage name | Status | Operator | Drainage area (mi$^2$) | Streamgage location |
|---|---|---|---|---|---|
| 01081500 | Merrimack River at Franklin Junction | Active | USGS | 1,507 | Lat 43°25'22", long 71°39'12", Merrimack County, on right bank, at Franklin Junction, 4,000 ft south of SR 127 and US 3 intersection, 5,300 ft downstream from confluence of Pemigewasset and Winnipesaukee Rivers, and 1.5 mi south of US 3 and Church Street intersection in Franklin. |
| 01082000 | Contoocook River at Peterborough | Active | USGS | 68.1 | Lat 42°51'45", long 71°57'35", Hillsborough County, on left bank, 750 ft upstream from Morrison Road bridge, 1,300 ft downstream from mill dam in Noone, and 0.6 mi southwest of US 202 and SR 101 intersection in Peterborough. |
| 01083000 | Nubanusit Brook below MacDowell Dam near Peterborough | Active | USGS | 44 | Lat 42°53'34", long 71°59'14", Hillsborough County, on left bank, 300 ft downstream from Edward MacDowell Dam, 600 ft upstream from abandoned mill dam, and 0.4 mi north of Wilder Street and Union Street in West Peterborough. |
| 01084500 | Beards Brook near Hillsborough | Discontinued | USGS | 55.4 | Lat 43°06'51", long 71°55'36", Hillsborough County, on right bank, 300 ft upstream from West Main Street bridge, 560 ft upstream from mouth on North Branch, and 1,800 ft west of US 202 and West Main Street intersection in Hillsborough. |
| 01085000 | Contoocook River near Henniker | Active | USGS | 368 | Lat 43°09'07", long 71°51'28", Merrimack County, on right bank, 900 ft west of Western Avenue and Cote Hill Road intersection, 1.6 mi downstream from Sand Brook, and 1.7 mi upstream from Western Avenue bridge in Henniker. |
| 01085500 | Contoocook River below Hopkinton Dam at West Hopkinton | Active | USGS | 427 | Lat 43°11'33", long 71°44'43", Merrimack County, on right bank 750 ft downstream from covered bridge at West Hopkinton, 2,200 ft downstream from Hopkinton Dam, and 1.2 mi north of the intersection of SR 127 and 9 in Hopkinton. |
| 01086000 | Warner River at Davisville | Active | USGS | 146 | Lat 43°15'03", long 71°43'58", Merrimack County, on left bank, 60 ft downstream from SR 127 bridge at Davisville, and 0.9 mi east of I-89 and SR 103 interchange in Warner. |
| 01087000 | Blackwater River near Webster | Active | USGS | 129 | Lat 43°17'49", long 71°41'42", Merrimack County, on left bank, 1,200 ft west of Clothespin Bridge Road and Pleasant Street intersection at Dingit Corner, 2,300 ft downstream from Clothespin Bridge Road bridge, and 2.4 mi downstream from Blackwater Dam. |
| 01087850 | Contoocook River at River Hill, near Penacook | Active | USACE | 760 | Lat 43°14'59", long 71°37'12", Merrimack County, at Horse Hill Road bridge, 200 ft west of River Road, Horse Hill Road, and Bog Road intersection at River Hill, and 2.4 mi southwest of US 3 and Washington Street intersection in Penacook. |
| 01088400 | Merrimack River at Concord | Active | USACE | 2,300 | Lat 43°12'32", long 71°31'51", Merrimack County, at downstream side of Bridge Street (SR 9) bridge over the Merrimack River, and 1,600 ft east of Bridge Street (SR 9) and Main Street (US 3) intersection in Concord. |
| 01089000 | Soucook River near Concord | Discontinued | USGS | 76.8 | Lat 43°14'19", long 71°27'45", Merrimack County, on left bank, 500 ft upstream from SR 9 bridge, 4,300 ft upstream from Cemetery Brook, and 0.4 mi northeast of the intersection of SR 106 and 9. |
| 01089100 | Soucook River at Pembroke Road, near Concord | Active | USGS | 81.9 | Lat 43°12'49", long 71°28'51", Merrimack County, on left bank, 100 ft upstream from Pembroke Road bridge, 550 ft upstream from Frenchs Brook, and 770 ft east of SR 106 and Pembroke Road intersection in Concord. |
| 01089500 | Suncook River at North Chichester | Discontinued[b] | USGS | 155 | Lat 43°15'24", long 71°22'12", Merrimack County, on left bank, 100 ft downstream from Depot Road, 800 ft east of Depot Road and SR 28 intersection, and 2,000 ft upstream from Sanders Brook. |

**Table 1.** Description of streamgages used in the April 2007 flood investigation, central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route, mi$^2$, square miles; lat, latitude; long, longitude; NHDES, New Hampshire Department of Environmental Services; ft, feet; USACE, U.S. Army Corps of Engineers]

| USGS stream-gage number | Streamgage name | Status | Operator | Drainage area (mi$^2$) | Streamgage location |
|---|---|---|---|---|---|
| 01090800 | Piscataquog River below Everett Dam, near East Weare | Active | USGS | 63.1 | Lat 43°05'29", long 71°39'36", Hillsborough County, on right bank, 500 ft downstream from Everett Dam, 2,700 ft upstream from Clough Park Road bridge, and 1.7 mi north of Clough Park Road and River Road intersection in Weare. |
| 01091000 | South Branch Piscataquog River near Goffstown | Discon-tinued | USGS | 103 | Lat 43°00'53", long 71°38'31", Hillsborough County, on right bank, 20 ft upstream from Breed Brook Road bridge, 50 ft northwest of Breed Brook Road and SR 13 intersection, 2.3 mi west of the intersection of SR 13 and 114 and Mountain Road in Goffstown. |
| 01091500 | Piscataquog River near Goffstown | Active | USGS | 202 | Lat 43°01'00", long 71°33'04", Hillsborough County, on left bank, 300 ft upstream from Henry Bridge Road bridge, 1,400 ft upstream from Harry Brook, and 0.6 mi northwest of Henry Bridge Road and SR 114 intersection in Goffstown. |
| 01092000 | Merrimack River near Goffs Falls, below Manchester | Active | USGS | 3,092 | Lat 42°56'53", long 71°27'50", Hillsborough County, on right bank, 600 ft upstream from I-293 bridge, and 3,300 ft downstream from Bowman Brook in Manchester. |
| 01093000 | Sucker Brook at Auburn | Discon-tinued | USGS | 27.8 | Lat 43°00'21", long 71°20'57", Rockingham County, on left bank, 600 ft upstream from SR 121, and 600 ft north of SR 121 and Hooksett Road intersection in Auburn. |
| 01094000 | Souhegan River at Merrimack | Active | USGS | 171 | Lat 42°51'27", long 71°30'24", Hillsborough County, on left bank, at head of Wildcat Falls, 2,850 ft upstream from southbound bridge on Everett Turnpike, 0.9 mi southwest of Baboosic Lake Road and US 3 intersection in Merrimack. |
| 010965817 | Beaver Brook at Fordway Extension at Derry | Active | USGS | 23.9 | Lat 42°52'21", long 71°19'47", Rockingham County, on left bank, 30 ft upstream from culverts on Fordway Extension, 75 ft east of Fordway Street, Fordway Extension and Bridge Street intersection, 0.4 mi south of Fordway Street and West Broadway (SR 102) intersection, 0.6 mi east of I-93 and Nashua Road (SR 102) interchange, and 0.7 mi southwest of West Broadway (SR 102), Birch Street (SR 28), Storer Street (SR 102), and Crystal Avenue (SR 28) intersection. |
| 010965844 | Beaver Brook at South Road, near Derry | Active | USGS | 30.3 | Lat 42°50'22", long 71°21'00", Rockingham County, on left bank, upstream side of South Road, at Kendall Pond outlet, 100 ft east of Kendall Pond Road and South Road intersection, 0.8 mi southeast of the intersection of SR 128 and 102 in Londonderry. |
| 010965852 | Beaver Brook at North Pelham | Active | USGS | 47.8 | Lat 42°46'58", long 71°21'15", Hillsborough County, on right bank, 10 ft downstream from SR 128 bridge at the Windham-Pelham town line, 0.7 mi north of SR 128 and Castle Hill Road intersection in North Pelham, and 1.4 mi south of the intersection of SR 111 and 128. |
| 01096587 | Tributary to Cobbetts Pond at I-93 south exit ramp near Windham | Active | USGS | 0.54 | Lat 42°48'24", long 71°16'27", Rockingham County, on right bank, upstream from I-93 south exit ramp, 675 ft upstream from mouth at Cobbetts Pond, 675 ft south of SR 111 and I-93 south exit ramp intersection, and 1.7 mi east of Lowell Road and SR 111 intersection at Windham. |
| 01100505 | Spicket River at North Salem | Active | USGS | 16.5 | Lat 42°50'57", long 71°12'56", Rockingham County, on right bank, 70 ft downstream from Haverhill Road bridge, 100 ft southeast of North Main Street, Haverhill Road, and Island Pond Road intersection in Cowbell Corners, and 1,200 ft south of Island Pond Road and SR 111 intersection in Derry. |

**Table 1.** Description of streamgages used in the April 2007 flood investigation, central and southern New Hampshire.—Continued

[Location of streamgages in figure 4. USGS, U.S. Geological Survey; SR, State Route, mi$^2$, square miles; lat, latitude; long, longitude; NHDES, New Hampshire Department of Environmental Services; ft, feet; USACE, U.S. Army Corps of Engineers]

| USGS stream-gage number | Streamgage name | Status | Operator | Drainage area (mi$^2$) | Streamgage location |
|---|---|---|---|---|---|
| 01100549 | Policy Brook at Rocking-ham Park Boulevard at Salem | Active | USGS | 5.1 | Lat 42°46'04", long 71°13'23", Rockingham County, on left bank, 300 ft downstream from Rocking-ham Park Boulevard, 0.2 mi southwest of Rockingham Park Boulevard and South Broadway (SR 28) intersection, 0.2 mi upstream from mouth of Porcupine Brook, 1.0 mi south of Broadway (SR 28) and Main Street (SR 97) intersection in Salem Depot, and 1.8 mi southwest of Main Street (SR 97), Bridge Street, and School Street intersection in Salem. |
| 011005605 | Policy Brook at I-93 north rest stop entrance ramp, near Salem | Active | USGS | 10.2 | Lat 42°45'13", long 71°13'15", Rockingham County, on left bank, upstream from I-93 northbound rest-stop entrance ramp, and 2,100 ft southeast of the Cross Street bridge over I-93 in Salem. |
| 01100561 | Spicket River near Methuen, Mass. | Active | USGS | 62.1 | Lat 42°44'35", long 71°12'32", Rockingham County, on left bank, at upstream side of Hampshire Road bridge at the New Hampshire-Massachusetts border, 800 ft downstream from mouth of Policy Brook, and 0.5 mi west of SR 28 and Lawrence Road intersection. |
| 01137500 | Ammonoosuc River at Bethlehem Junction | Active | USGS | 87.6 | Lat 44°16'07", long 71°37'51", Grafton County, on left bank, 1,200 ft upstream from US 302 bridge at Pierce Bridge, 1,300 ft south of US 302 and Muchmore Road intersection and 3.0 mi east of US 302 and SR 142 intersection in Bethlehem. |
| 01138500 | Connecticut River at Wells River, Vt. | Active | USGS | 2,644 | Lat 44°09'12", long 72°02'32", Orange County, on right bank, at village of Wells River, 200 ft down-stream from US 302 bridge, 400 ft upstream from Wells River, 1,200 ft downstream from Ammo-noosuc River, and 0.2 mi west of US 302 and SR 135 in Woodsville, N.H. |
| 01144500 | Connecticut River at West Lebanon | Active | USGS | 4,092 | Lat 43°38'46", long 72°18'46", Grafton County, on left bank, 50 ft downstream from Boston & Maine railroad bridge, 500 ft downstream from White River, and 1,100 ft northwest of US 4 and SR 12A intersection in West Lebanon. |
| 01150500 | Mascoma River at Mascoma | Active | NHDES[a] | 153 | Lat 43°38'56", long 72°10'57", Grafton County, on left bank, 100 ft upstream from Payne Road bridge, 100 ft downstream from Mascoma Lake Dam, and 0.2 mi south of US 4 and Payne Road intersection in Mascoma. |

[a] Streamgage formerly operated by the U.S. Geological Survey.

[b] Streamgage 01089500 active as of November 14, 2007.

# Appendix 1. HEC-RAS Model Calibrations to Estimate the April 2007 Flood-Peak Discharge from High-Water-Mark Data Collected for the Lamprey, Souhegan, and Suncook Rivers

## Tables

**Table 1-1.** HEC-RAS model calibration to estimate the April 2007 Lamprey River flood-peak discharge from high-water-mark data collected at the railroad bridge upstream of Epping Road in Raymond, New Hampshire.

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 4 | 4,000 | 169.90 | 187.79 | 0.00011 | 2,728.74 | 233.30 | 0.08 |
| 4 | 3,990 | 169.90 | 187.79 | 0.00011 | 2,727.37 | 233.27 | 0.08 |
| 4 | 3,980 | 169.90 | 187.78 | 0.00011 | 2,726.00 | 233.25 | 0.08 |
| 4 | 3,970 | 169.90 | 187.77 | 0.00011 | 2,724.63 | 233.22 | 0.08 |
| 4 | 3,960 | 169.90 | 187.77 | 0.00010 | 2,723.26 | 233.20 | 0.08 |
| 4 | 3,950 | 169.90 | 187.76 | 0.00010 | 2,721.90 | 233.17 | 0.08 |
| 4 | 3,940 | 169.90 | 187.76 | 0.00010 | 2,720.54 | 233.15 | 0.08 |
| 4 | 3,930 | 169.90 | 187.75 | 0.00010 | 2,719.19 | 233.12 | 0.08 |
| 4 | 3,920 | 169.90 | 187.74 | 0.00010 | 2,717.84 | 233.10 | 0.08 |
| 4 | 3,910 | 169.90 | 187.74 | 0.00010 | 2,716.49 | 233.08 | 0.08 |
| 4 | 3,900 | 169.90 | 187.73 | 0.00010 | 2,715.16 | 233.05 | 0.08 |
| | | | | | | | |
| 3 | 4,000 | 168.91 | 187.58 | 0.00061 | 1,148.02 | 134.55 | 0.18 |
| 3 | 3,990 | 168.91 | 187.58 | 0.00061 | 1,147.33 | 134.53 | 0.18 |
| 3 | 3,980 | 168.91 | 187.57 | 0.00061 | 1,146.66 | 134.52 | 0.18 |
| 3 | 3,970 | 168.91 | 187.57 | 0.00061 | 1,145.98 | 134.50 | 0.18 |
| 3 | 3,960 | 168.91 | 187.56 | 0.00060 | 1,145.30 | 134.48 | 0.18 |
| 3 | 3,950 | 168.91 | 187.56 | 0.00060 | 1,144.63 | 134.47 | 0.18 |
| 3 | 3,940 | 168.91 | 187.55 | 0.00060 | 1,143.96 | 134.45 | 0.18 |
| 3 | 3,930 | 168.91 | 187.55 | 0.00060 | 1,143.29 | 134.44 | 0.18 |
| 3 | 3,920 | 168.91 | 187.54 | 0.00059 | 1,142.63 | 134.42 | 0.18 |
| 3 | 3,910 | 168.91 | 187.54 | 0.00059 | 1,141.96 | 134.41 | 0.18 |
| 3 | 3,900 | 168.91 | 187.53 | 0.00059 | 1,141.30 | 134.39 | 0.18 |
| | | | | | | | |
| 2.7 | 4,000 | 169.20 | 186.80 | 0.00186 | 571.85 | 38.79 | 0.32 |
| 2.7 | 3,990 | 169.20 | 186.80 | 0.00185 | 571.80 | 38.79 | 0.32 |
| 2.7 | 3,980 | 169.20 | 186.80 | 0.00184 | 571.76 | 38.79 | 0.32 |
| 2.7 | 3,970 | 169.20 | 186.80 | 0.00183 | 571.72 | 38.79 | 0.32 |
| 2.7 | 3,960 | 169.20 | 186.80 | 0.00183 | 571.68 | 38.79 | 0.32 |
| 2.7 | 3,950 | 169.20 | 186.80 | 0.00182 | 571.63 | 38.79 | 0.32 |
| 2.7 | 3,940 | 169.20 | 186.79 | 0.00181 | 571.59 | 38.79 | 0.32 |
| 2.7 | 3,930 | 169.20 | 186.79 | 0.00180 | 571.55 | 38.79 | 0.32 |
| 2.7 | 3,920 | 169.20 | 186.79 | 0.00179 | 571.51 | 38.79 | 0.31 |
| 2.7 | 3,910 | 169.20 | 186.79 | 0.00178 | 571.47 | 38.79 | 0.31 |
| 2.7 | 3,900 | 169.20 | 186.79 | 0.00177 | 571.43 | 38.79 | 0.31 |
| | | | | | | | |
| 2.5 | Bridge | | | | | | |
| | | | | | | | |
| 2.3 | 4,000 | 169.78 | 186.22 | 0.00270 | 502.80 | 37.90 | 0.38 |
| 2.3 | 3,990 | 169.78 | 186.23 | 0.00268 | 502.89 | 37.90 | 0.38 |
| 2.3 | 3,980 | 169.78 | 186.23 | 0.00267 | 502.98 | 37.90 | 0.38 |
| 2.3 | 3,970 | 169.78 | 186.23 | 0.00266 | 503.07 | 37.90 | 0.38 |
| 2.3 | 3,960 | 169.78 | 186.23 | 0.00264 | 503.16 | 37.90 | 0.38 |
| 2.3 | 3,950 | 169.78 | 186.24 | 0.00263 | 503.24 | 37.90 | 0.38 |
| 2.3 | 3,940 | 169.78 | 186.24 | 0.00261 | 503.33 | 37.90 | 0.38 |
| 2.3 | 3,930 | 169.78 | 186.24 | 0.00260 | 503.42 | 37.90 | 0.38 |
| 2.3 | 3,920 | 169.78 | 186.24 | 0.00258 | 503.50 | 37.91 | 0.38 |
| 2.3 | 3,910 | 169.78 | 186.25 | 0.00257 | 503.59 | 37.91 | 0.38 |
| 2.3 | 3,900 | 169.78 | 186.25 | 0.00255 | 503.68 | 37.91 | 0.37 |

**Table 1-1.** HEC-RAS model calibration to estimate the April 2007 Lamprey River flood-peak discharge from high-water-mark data collected at the railroad bridge upstream of Epping Road in Raymond, New Hampshire.—Continued

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 2 | 4,000 | 165.71 | 186.67 | 0.00006 | 3,064.42 | 280.06 | 0.08 |
| 2 | 3,990 | 165.71 | 186.67 | 0.00006 | 3,064.41 | 280.06 | 0.08 |
| 2 | 3,980 | 165.71 | 186.67 | 0.00006 | 3,064.40 | 280.06 | 0.08 |
| 2 | 3,970 | 165.71 | 186.67 | 0.00006 | 3,064.39 | 280.06 | 0.08 |
| 2 | 3,960 | 165.71 | 186.67 | 0.00006 | 3,064.38 | 280.06 | 0.08 |
| 2 | 3,950 | 165.71 | 186.67 | 0.00006 | 3,064.37 | 280.06 | 0.08 |
| 2 | 3,940 | 165.71 | 186.67 | 0.00006 | 3,064.36 | 280.06 | 0.08 |
| 2 | 3,930 | 165.71 | 186.67 | 0.00006 | 3,064.35 | 280.06 | 0.08 |
| 2 | 3,920 | 165.71 | 186.67 | 0.00006 | 3,064.34 | 280.05 | 0.08 |
| 2 | 3,910 | 165.71 | 186.67 | 0.00006 | 3,064.33 | 280.05 | 0.08 |
| 2 | 3,900 | 165.71 | 186.67 | 0.00006 | 3,064.32 | 280.05 | 0.07 |
| | | | | | | | |
| 1 | 4,000 | 171.11 | 186.66 | 0.00029 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,990 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,980 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,970 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,960 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,950 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,940 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,930 | 171.11 | 186.66 | 0.00028 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,920 | 171.11 | 186.66 | 0.00027 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,910 | 171.11 | 186.66 | 0.00027 | 3,115.09 | 362.46 | 0.10 |
| 1 | 3,900 | 171.11 | 186.66 | 0.00027 | 3,115.09 | 362.46 | 0.10 |

**Table 1-2.** HEC-RAS model calibration to estimate the April 2007 Souhegan River flood-peak discharge from high-water-mark data collected at the Wilton Road (Elm Street) bridge in Milford, New Hampshire.

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 6 | 7,000 | 288.52 | 299.45 | 0.00463 | 1,093.40 | 135.79 | 0.42 |
| 6 | 6,990 | 288.52 | 299.44 | 0.00463 | 1,092.31 | 135.77 | 0.42 |
| 6 | 6,980 | 288.52 | 299.43 | 0.00462 | 1,091.41 | 135.75 | 0.42 |
| 6 | 6,970 | 288.52 | 299.42 | 0.00462 | 1,090.33 | 135.72 | 0.42 |
| 6 | 6,960 | 288.52 | 299.42 | 0.00462 | 1,089.42 | 135.70 | 0.42 |
| 6 | 6,950 | 288.52 | 299.41 | 0.00462 | 1,088.33 | 135.68 | 0.42 |
| 6 | 6,940 | 288.52 | 299.40 | 0.00462 | 1,087.24 | 135.66 | 0.42 |
| 6 | 6,930 | 288.52 | 299.40 | 0.00462 | 1,086.35 | 135.64 | 0.42 |
| 6 | 6,920 | 288.52 | 299.39 | 0.00462 | 1,085.26 | 135.61 | 0.42 |
| 6 | 6,910 | 288.52 | 299.38 | 0.00462 | 1,084.36 | 135.59 | 0.42 |
| 6 | 6,900 | 288.52 | 299.37 | 0.00462 | 1,083.28 | 135.57 | 0.42 |
| 5 | 7,000 | 288.28 | 298.81 | 0.00839 | 1,119.23 | 136.23 | 0.38 |
| 5 | 6,990 | 288.28 | 298.81 | 0.00839 | 1,118.11 | 136.21 | 0.38 |
| 5 | 6,980 | 288.28 | 298.80 | 0.00838 | 1,117.22 | 136.20 | 0.38 |
| 5 | 6,970 | 288.28 | 298.79 | 0.00838 | 1,116.10 | 136.18 | 0.38 |
| 5 | 6,960 | 288.28 | 298.78 | 0.00838 | 1,115.22 | 136.16 | 0.38 |
| 5 | 6,950 | 288.28 | 298.78 | 0.00838 | 1,114.10 | 136.14 | 0.38 |
| 5 | 6,940 | 288.28 | 298.77 | 0.00838 | 1,112.98 | 136.12 | 0.38 |
| 5 | 6,930 | 288.28 | 298.76 | 0.00838 | 1,112.10 | 136.11 | 0.38 |
| 5 | 6,920 | 288.28 | 298.75 | 0.00838 | 1,110.98 | 136.09 | 0.38 |
| 5 | 6,910 | 288.28 | 298.75 | 0.00837 | 1,110.10 | 136.07 | 0.38 |
| 5 | 6,900 | 288.28 | 298.74 | 0.00837 | 1,108.98 | 136.05 | 0.38 |
| 4.7 | 7,000 | 284.76 | 297.21 | 0.00564 | 968.32 | 104.05 | 0.42 |
| 4.7 | 6,990 | 284.76 | 297.20 | 0.00563 | 967.54 | 104.03 | 0.42 |
| 4.7 | 6,980 | 284.76 | 297.19 | 0.00563 | 967.09 | 104.02 | 0.42 |
| 4.7 | 6,970 | 284.76 | 297.19 | 0.00562 | 966.31 | 104.00 | 0.42 |
| 4.7 | 6,960 | 284.76 | 297.18 | 0.00562 | 965.87 | 103.99 | 0.42 |
| 4.7 | 6,950 | 284.76 | 297.17 | 0.00561 | 965.09 | 103.98 | 0.42 |
| 4.7 | 6,940 | 284.76 | 297.17 | 0.00561 | 964.31 | 103.96 | 0.42 |
| 4.7 | 6,930 | 284.76 | 297.16 | 0.00560 | 963.88 | 103.95 | 0.42 |
| 4.7 | 6,920 | 284.76 | 297.16 | 0.00560 | 963.10 | 103.93 | 0.42 |
| 4.7 | 6,910 | 284.76 | 297.15 | 0.00559 | 962.67 | 103.92 | 0.42 |
| 4.7 | 6,900 | 284.76 | 297.14 | 0.00559 | 961.90 | 103.91 | 0.42 |
| 4.5 | Bridge | | | | | | |
| 4.3 | 7,000 | 283.70 | 297.03 | 0.00484 | 1,025.16 | 119.93 | 0.41 |
| 4.3 | 6,990 | 283.70 | 297.02 | 0.00484 | 1,024.29 | 119.92 | 0.41 |
| 4.3 | 6,980 | 283.70 | 297.02 | 0.00483 | 1,023.81 | 119.91 | 0.41 |
| 4.3 | 6,970 | 283.70 | 297.01 | 0.00483 | 1,022.94 | 119.89 | 0.41 |
| 4.3 | 6,960 | 283.70 | 297.01 | 0.00482 | 1,022.48 | 119.88 | 0.41 |
| 4.3 | 6,950 | 283.70 | 297.00 | 0.00482 | 1,021.60 | 119.86 | 0.41 |
| 4.3 | 6,940 | 283.70 | 296.99 | 0.00482 | 1,020.72 | 119.84 | 0.41 |
| 4.3 | 6,930 | 283.70 | 296.99 | 0.00481 | 1,020.26 | 119.84 | 0.41 |
| 4.3 | 6,920 | 283.70 | 296.98 | 0.00481 | 1,019.39 | 119.82 | 0.41 |
| 4.3 | 6,910 | 283.70 | 296.98 | 0.00481 | 1,018.94 | 119.81 | 0.41 |
| 4.3 | 6,900 | 283.70 | 296.97 | 0.00480 | 1,018.07 | 119.79 | 0.41 |

**Table 1-2.** HEC-RAS model calibration to estimate the April 2007 Souhegan River flood-peak discharge from high-water-mark data collected at the Wilton Road (Elm Street) bridge in Milford, New Hampshire.—Continued

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 4 | 7,000 | 282.64 | 296.09 | 0.00642 | 950.43 | 94.97 | 0.41 |
| 4 | 6,990 | 282.64 | 296.09 | 0.00641 | 949.86 | 94.96 | 0.41 |
| 4 | 6,980 | 282.64 | 296.09 | 0.00640 | 949.71 | 94.95 | 0.41 |
| 4 | 6,970 | 282.64 | 296.08 | 0.00639 | 949.14 | 94.93 | 0.41 |
| 4 | 6,960 | 282.64 | 296.08 | 0.00637 | 948.99 | 94.93 | 0.41 |
| 4 | 6,950 | 282.64 | 296.07 | 0.00636 | 948.42 | 94.91 | 0.41 |
| 4 | 6,940 | 282.64 | 296.07 | 0.00635 | 947.85 | 94.89 | 0.41 |
| 4 | 6,930 | 282.64 | 296.06 | 0.00634 | 947.71 | 94.89 | 0.41 |
| 4 | 6,920 | 282.64 | 296.06 | 0.00633 | 947.14 | 94.87 | 0.41 |
| 4 | 6,910 | 282.64 | 296.06 | 0.00631 | 947.01 | 94.86 | 0.41 |
| 4 | 6,900 | 282.64 | 296.05 | 0.00630 | 946.45 | 94.84 | 0.41 |
| 3 | 7,000 | 282.21 | 294.36 | 0.01649 | 673.14 | 74.79 | 0.61 |
| 3 | 6,980 | 282.21 | 294.37 | 0.01641 | 673.66 | 74.81 | 0.61 |
| 3 | 6,970 | 282.21 | 294.37 | 0.01637 | 673.55 | 74.80 | 0.61 |
| 3 | 6,960 | 282.21 | 294.37 | 0.01629 | 674.07 | 74.82 | 0.61 |
| 3 | 6,950 | 282.21 | 294.37 | 0.01625 | 673.97 | 74.82 | 0.61 |
| 3 | 6,940 | 282.21 | 294.37 | 0.01621 | 673.86 | 74.81 | 0.60 |
| 3 | 6,930 | 282.21 | 294.38 | 0.01613 | 674.38 | 74.83 | 0.60 |
| 3 | 6,920 | 282.21 | 294.38 | 0.01609 | 674.28 | 74.83 | 0.60 |
| 3 | 6,910 | 282.21 | 294.38 | 0.01601 | 674.80 | 74.84 | 0.60 |
| 3 | 6,900 | 282.21 | 294.38 | 0.01597 | 674.70 | 74.84 | 0.60 |
| 2 | 7,000 | 278.67 | 294.76 | 0.00400 | 1,043.55 | 103.02 | 0.36 |
| 2 | 6,990 | 278.67 | 294.76 | 0.00400 | 1,043.29 | 103.01 | 0.36 |
| 2 | 6,980 | 278.67 | 294.76 | 0.00398 | 1,043.79 | 103.03 | 0.36 |
| 2 | 6,970 | 278.67 | 294.76 | 0.00397 | 1,043.53 | 103.02 | 0.36 |
| 2 | 6,960 | 278.67 | 294.76 | 0.00395 | 1,044.04 | 103.04 | 0.36 |
| 2 | 6,950 | 278.67 | 294.76 | 0.00395 | 1,043.78 | 103.03 | 0.36 |
| 2 | 6,940 | 278.67 | 294.76 | 0.00394 | 1,043.51 | 103.02 | 0.36 |
| 2 | 6,930 | 278.67 | 294.76 | 0.00392 | 1,044.02 | 103.04 | 0.36 |
| 2 | 6,920 | 278.67 | 294.76 | 0.00391 | 1,043.77 | 103.03 | 0.36 |
| 2 | 6,910 | 278.67 | 294.76 | 0.00390 | 1,044.28 | 103.05 | 0.36 |
| 2 | 6,900 | 278.67 | 294.76 | 0.00389 | 1,044.02 | 103.04 | 0.36 |
| 1 | 7,000 | 280.46 | 293.83 | 0.00442 | 1,104.17 | 113.64 | 0.36 |
| 1 | 6,990 | 280.46 | 293.83 | 0.00441 | 1,104.17 | 113.64 | 0.36 |
| 1 | 6,980 | 280.46 | 293.84 | 0.00438 | 1,105.31 | 113.65 | 0.36 |
| 1 | 6,970 | 280.46 | 293.84 | 0.00437 | 1,105.31 | 113.65 | 0.36 |
| 1 | 6,960 | 280.46 | 293.85 | 0.00434 | 1,106.45 | 113.66 | 0.36 |
| 1 | 6,950 | 280.46 | 293.85 | 0.00433 | 1,106.45 | 113.66 | 0.35 |
| 1 | 6,940 | 280.46 | 293.85 | 0.00432 | 1,106.45 | 113.66 | 0.35 |
| 1 | 6,930 | 280.46 | 293.86 | 0.00429 | 1,107.58 | 113.68 | 0.35 |
| 1 | 6,920 | 280.46 | 293.86 | 0.00428 | 1,107.58 | 113.68 | 0.35 |
| 1 | 6,910 | 280.46 | 293.87 | 0.00426 | 1,108.72 | 113.69 | 0.35 |
| 1 | 6,900 | 280.46 | 293.87 | 0.00424 | 1,108.72 | 113.69 | 0.35 |

**Table 1-3.** HEC-RAS model calibration to estimate the April 2007 Suncook River flood-peak discharge from high-water-mark data collected at the Short Falls Road bridge in Epsom, New Hampshire.

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 6 | 14,500 | 289.88 | 309.33 | 0.00163 | 2,016.51 | 158.58 | 0.35 |
| 6 | 14,400 | 289.88 | 309.30 | 0.00161 | 2,012.63 | 158.37 | 0.35 |
| 6 | 14,300 | 289.88 | 309.28 | 0.00160 | 2,008.81 | 158.17 | 0.35 |
| 6 | 14,200 | 289.88 | 309.25 | 0.00159 | 2,005.08 | 157.97 | 0.35 |
| 6 | 14,100 | 289.88 | 309.23 | 0.00157 | 2,001.38 | 157.77 | 0.35 |
| 6 | 14,000 | 289.88 | 309.21 | 0.00156 | 1,997.76 | 157.58 | 0.35 |
| 6 | 13,900 | 289.88 | 309.19 | 0.00154 | 1,994.20 | 157.39 | 0.34 |
| 6 | 13,800 | 289.88 | 309.16 | 0.00153 | 1,990.69 | 157.20 | 0.34 |
| 6 | 13,700 | 289.88 | 309.14 | 0.00152 | 1,987.22 | 157.02 | 0.34 |
| 6 | 13,600 | 289.88 | 309.12 | 0.00150 | 1,983.84 | 156.84 | 0.34 |
| 6 | 13,500 | 289.88 | 309.10 | 0.00149 | 1,980.50 | 156.66 | 0.34 |
| 5.5 | 14,500 | 288.33 | 309.11 | 0.00295 | 1,906.97 | 145.14 | 0.37 |
| 5.5 | 14,400 | 288.33 | 309.09 | 0.00292 | 1,903.78 | 145.04 | 0.37 |
| 5.5 | 14,300 | 288.33 | 309.07 | 0.00290 | 1,900.64 | 144.94 | 0.37 |
| 5.5 | 14,200 | 288.33 | 309.05 | 0.00287 | 1,897.57 | 144.84 | 0.36 |
| 5.5 | 14,100 | 288.33 | 309.03 | 0.00284 | 1,894.53 | 144.74 | 0.36 |
| 5.5 | 14,000 | 288.33 | 309.01 | 0.00281 | 1,891.57 | 144.64 | 0.36 |
| 5.5 | 13,900 | 288.33 | 308.99 | 0.00278 | 1,888.65 | 144.55 | 0.36 |
| 5.5 | 13,800 | 288.33 | 308.97 | 0.00275 | 1,885.79 | 144.46 | 0.36 |
| 5.5 | 13,700 | 288.33 | 308.95 | 0.00272 | 1,882.96 | 144.36 | 0.36 |
| 5.5 | 13,600 | 288.33 | 308.93 | 0.00269 | 1,880.21 | 144.27 | 0.35 |
| 5.5 | 13,500 | 288.33 | 308.91 | 0.00266 | 1,877.49 | 144.19 | 0.35 |
| 5 | 14,500 | 288.33 | 308.43 | 0.00252 | 1,505.33 | 111.13 | 0.43 |
| 5 | 14,400 | 288.33 | 308.42 | 0.00249 | 1,504.00 | 110.93 | 0.43 |
| 5 | 14,300 | 288.33 | 308.41 | 0.00246 | 1,502.71 | 110.74 | 0.42 |
| 5 | 14,200 | 288.33 | 308.40 | 0.00243 | 1,501.45 | 110.56 | 0.42 |
| 5 | 14,100 | 288.33 | 308.39 | 0.00241 | 1,500.23 | 110.38 | 0.42 |
| 5 | 14,000 | 288.33 | 308.38 | 0.00238 | 1,499.04 | 110.20 | 0.42 |
| 5 | 13,900 | 288.33 | 308.36 | 0.00235 | 1,497.89 | 110.03 | 0.41 |
| 5 | 13,800 | 288.33 | 308.35 | 0.00232 | 1,496.77 | 109.87 | 0.41 |
| 5 | 13,700 | 288.33 | 308.34 | 0.00229 | 1,495.67 | 109.70 | 0.41 |
| 5 | 13,600 | 288.33 | 308.33 | 0.00226 | 1,494.61 | 109.55 | 0.41 |
| 5 | 13,500 | 288.33 | 308.33 | 0.00223 | 1,493.58 | 109.39 | 0.40 |
| 4.7 | 14,500 | 287.48 | 308.49 | 0.00172 | 1,725.49 | 124.84 | 0.40 |
| 4.7 | 14,400 | 287.48 | 308.48 | 0.00170 | 1,723.86 | 124.79 | 0.40 |
| 4.7 | 14,300 | 287.48 | 308.47 | 0.00168 | 1,722.27 | 124.75 | 0.39 |
| 4.7 | 14,200 | 287.48 | 308.45 | 0.00166 | 1,720.73 | 124.71 | 0.39 |
| 4.7 | 14,100 | 287.48 | 308.44 | 0.00165 | 1,719.23 | 124.67 | 0.39 |
| 4.7 | 14,000 | 287.48 | 308.43 | 0.00163 | 1,717.77 | 124.63 | 0.39 |
| 4.7 | 13,900 | 287.48 | 308.42 | 0.00161 | 1,716.34 | 124.59 | 0.38 |
| 4.7 | 13,800 | 287.48 | 308.41 | 0.00159 | 1,714.95 | 124.56 | 0.38 |
| 4.7 | 13,700 | 287.48 | 308.40 | 0.00157 | 1,713.59 | 124.52 | 0.38 |
| 4.7 | 13,600 | 287.48 | 308.39 | 0.00155 | 1,712.27 | 124.48 | 0.38 |
| 4.7 | 13,500 | 287.48 | 308.37 | 0.00153 | 1,710.98 | 124.45 | 0.38 |
| 4.5 | Bridge | | | | | | |

**Table 1-3.** HEC-RAS model calibration to estimate the April 2007 Suncook River flood-peak discharge from high-water-mark data collected at the Short Falls Road bridge in Epsom, New Hampshire.—Continued

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 4.3 | 14,500 | 287.48 | 307.48 | 0.00210 | 1,601.24 | 120.77 | 0.44 |
| 4.3 | 14,400 | 287.48 | 307.49 | 0.00207 | 1,602.19 | 120.82 | 0.43 |
| 4.3 | 14,300 | 287.48 | 307.50 | 0.00204 | 1,603.12 | 120.86 | 0.43 |
| 4.3 | 14,200 | 287.48 | 307.50 | 0.00201 | 1,604.05 | 120.91 | 0.43 |
| 4.3 | 14,100 | 287.48 | 307.51 | 0.00198 | 1,604.97 | 120.96 | 0.43 |
| 4.3 | 14,000 | 287.48 | 307.52 | 0.00195 | 1,605.89 | 121.00 | 0.42 |
| 4.3 | 13,900 | 287.48 | 307.53 | 0.00192 | 1,606.79 | 121.05 | 0.42 |
| 4.3 | 13,800 | 287.48 | 307.53 | 0.00189 | 1,607.69 | 121.09 | 0.42 |
| 4.3 | 13,700 | 287.48 | 307.54 | 0.00186 | 1,608.57 | 121.14 | 0.41 |
| 4.3 | 13,600 | 287.48 | 307.55 | 0.00183 | 1,609.45 | 121.18 | 0.41 |
| 4.3 | 13,500 | 287.48 | 307.56 | 0.00180 | 1,610.32 | 121.22 | 0.41 |
| 4 | 14,500 | 286.73 | 307.99 | 0.00032 | 4,897.13 | 385.23 | 0.16 |
| 4 | 14,400 | 286.73 | 307.99 | 0.00031 | 4,897.21 | 385.23 | 0.16 |
| 4 | 14,300 | 286.73 | 307.99 | 0.00031 | 4,897.29 | 385.23 | 0.16 |
| 4 | 14,200 | 286.73 | 307.99 | 0.00031 | 4,897.37 | 385.24 | 0.16 |
| 4 | 14,100 | 286.73 | 307.99 | 0.00030 | 4,897.45 | 385.24 | 0.15 |
| 4 | 14,000 | 286.73 | 307.99 | 0.00030 | 4,897.53 | 385.24 | 0.15 |
| 4 | 13,900 | 286.73 | 307.99 | 0.00029 | 4,897.60 | 385.24 | 0.15 |
| 4 | 13,800 | 286.73 | 307.99 | 0.00029 | 4,897.69 | 385.25 | 0.15 |
| 4 | 13,700 | 286.73 | 307.99 | 0.00028 | 4,897.76 | 385.25 | 0.15 |
| 4 | 13,600 | 286.73 | 307.99 | 0.00028 | 4,897.84 | 385.25 | 0.15 |
| 4 | 13,500 | 286.73 | 307.99 | 0.00028 | 4,897.91 | 385.26 | 0.15 |
| 3 | 14,500 | 276.83 | 308.05 | 0.000063 | 9,822.06 | 631.09 | 0.09 |
| 3 | 14,400 | 276.83 | 308.05 | 0.000063 | 9,821.64 | 631.08 | 0.09 |
| 3 | 14,300 | 276.83 | 308.05 | 0.000062 | 9,821.20 | 631.06 | 0.09 |
| 3 | 14,200 | 276.83 | 308.05 | 0.000061 | 9,820.77 | 631.05 | 0.09 |
| 3 | 14,100 | 276.83 | 308.05 | 0.000060 | 9,820.37 | 631.04 | 0.09 |
| 3 | 14,000 | 276.83 | 308.05 | 0.000059 | 9,819.94 | 631.03 | 0.09 |
| 3 | 13,900 | 276.83 | 308.05 | 0.000058 | 9,819.52 | 631.02 | 0.09 |
| 3 | 13,800 | 276.83 | 308.04 | 0.000057 | 9,819.11 | 631.01 | 0.09 |
| 3 | 13,700 | 276.83 | 308.04 | 0.000057 | 9,818.71 | 631.00 | 0.08 |
| 3 | 13,600 | 276.83 | 308.04 | 0.000057 | 9,818.31 | 630.99 | 0.08 |
| 3 | 13,500 | 276.83 | 308.04 | 0.000057 | 9,817.90 | 630.97 | 0.08 |
| 2 | 14,500 | 270.77 | 308.08 | 0.00002 | 15,316.79 | 937.35 | 0.05 |
| 2 | 14,400 | 270.77 | 308.08 | 0.00002 | 15,315.73 | 937.34 | 0.05 |
| 2 | 14,300 | 270.77 | 308.08 | 0.00002 | 15,314.65 | 937.33 | 0.05 |
| 2 | 14,200 | 270.77 | 308.08 | 0.00002 | 15,313.59 | 937.32 | 0.05 |
| 2 | 14,100 | 270.77 | 308.08 | 0.00002 | 15,312.56 | 937.31 | 0.05 |
| 2 | 14,000 | 270.77 | 308.08 | 0.00002 | 15,311.50 | 937.31 | 0.05 |
| 2 | 13,900 | 270.77 | 308.08 | 0.00002 | 15,310.47 | 937.30 | 0.05 |
| 2 | 13,800 | 270.77 | 308.08 | 0.00002 | 15,309.44 | 937.29 | 0.05 |
| 2 | 13,700 | 270.77 | 308.07 | 0.00002 | 15,308.44 | 937.28 | 0.05 |
| 2 | 13,600 | 270.77 | 308.07 | 0.00002 | 15,307.41 | 937.27 | 0.05 |
| 2 | 13,500 | 270.77 | 308.07 | 0.00002 | 15,306.41 | 937.26 | 0.05 |

**Table 1-3.** HEC-RAS model calibration to estimate the April 2007 Suncook River flood-peak discharge from high-water-mark data collected at the Short Falls Road bridge in Epsom, New Hampshire.—Continued

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 1 | 14,500 | 286.21 | 308.00 | 0.00014 | 9,571.49 | 943.03 | 0.12 |
| 1 | 14,400 | 286.21 | 308.00 | 0.00014 | 9,571.49 | 943.03 | 0.12 |
| 1 | 14,300 | 286.21 | 308.00 | 0.00014 | 9,571.49 | 943.03 | 0.12 |
| 1 | 14,200 | 286.21 | 308.00 | 0.00013 | 9,571.49 | 943.03 | 0.12 |
| 1 | 14,100 | 286.21 | 308.00 | 0.00013 | 9,571.49 | 943.03 | 0.12 |
| 1 | 14,000 | 286.21 | 308.00 | 0.00013 | 9,571.49 | 943.03 | 0.12 |
| 1 | 13,900 | 286.21 | 308.00 | 0.00013 | 9,571.49 | 943.03 | 0.12 |
| 1 | 13,800 | 286.21 | 308.00 | 0.00013 | 9,571.49 | 943.03 | 0.12 |
| 1 | 13,700 | 286.21 | 308.00 | 0.00012 | 9,571.49 | 943.03 | 0.12 |
| 1 | 13,600 | 286.21 | 308.00 | 0.00012 | 9,571.49 | 943.03 | 0.12 |
| 1 | 13,500 | 286.21 | 308.00 | 0.00012 | 9,571.49 | 943.03 | 0.11 |

**Table 1-4.** HEC-RAS model calibration to estimate the April 2007 Suncook River flood-peak discharge from high-water-mark data collected at the Websters Mill Road bridge in Chichester/Pittsfield, New Hampshire.

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 6 | 9,500 | 387.95 | 395.76 | 0.00631 | 988.50 | 224.12 | 0.94 |
| 6 | 9,400 | 387.95 | 395.72 | 0.00632 | 980.41 | 223.67 | 0.94 |
| 6 | 9,300 | 387.95 | 395.68 | 0.00632 | 972.32 | 223.22 | 0.94 |
| 6 | 9,200 | 387.95 | 395.64 | 0.00633 | 964.23 | 222.78 | 0.94 |
| 6 | 9,100 | 387.95 | 395.61 | 0.00633 | 956.06 | 222.33 | 0.94 |
| 6 | 9,000 | 387.95 | 395.58 | 0.00628 | 951.44 | 222.07 | 0.94 |
| 6 | 8,900 | 387.95 | 395.55 | 0.00627 | 944.01 | 221.66 | 0.94 |
| 6 | 8,800 | 387.95 | 395.51 | 0.00626 | 936.47 | 221.25 | 0.93 |
| 6 | 8,700 | 387.95 | 395.48 | 0.00625 | 928.87 | 220.83 | 0.93 |
| 6 | 8,600 | 387.95 | 395.44 | 0.00625 | 921.21 | 220.40 | 0.93 |
| 6 | 8,500 | 387.95 | 395.40 | 0.00624 | 913.45 | 219.97 | 0.93 |
| 5 | 9,500 | 387.63 | 395.39 | 0.00496 | 1,133.44 | 246.66 | 0.84 |
| 5 | 9,400 | 387.63 | 395.34 | 0.00501 | 1,119.73 | 246.29 | 0.85 |
| 5 | 9,300 | 387.63 | 395.28 | 0.00506 | 1,105.85 | 245.91 | 0.85 |
| 5 | 9,200 | 387.63 | 395.23 | 0.00511 | 1,091.88 | 245.52 | 0.85 |
| 5 | 9,100 | 387.63 | 395.17 | 0.00517 | 1,077.81 | 245.14 | 0.86 |
| 5 | 9,000 | 387.63 | 395.12 | 0.00518 | 1,066.95 | 244.84 | 0.86 |
| 5 | 8,900 | 387.63 | 395.06 | 0.00526 | 1,051.18 | 244.41 | 0.86 |
| 5 | 8,800 | 387.63 | 394.95 | 0.00548 | 1,025.07 | 243.69 | 0.88 |
| 5 | 8,700 | 387.63 | 394.88 | 0.00559 | 1,007.50 | 243.20 | 0.89 |
| 5 | 8,600 | 387.63 | 394.80 | 0.00574 | 987.66 | 242.65 | 0.90 |
| 5 | 8,500 | 387.63 | 394.73 | 0.00583 | 971.71 | 242.21 | 0.90 |
| 4 | 9,500 | 385.45 | 394.46 | 0.00739 | 942.93 | 184.20 | 1.01 |
| 4 | 9,400 | 385.45 | 394.42 | 0.00740 | 935.53 | 184.01 | 1.01 |
| 4 | 9,300 | 385.45 | 394.38 | 0.00742 | 928.15 | 183.83 | 1.01 |
| 4 | 9,200 | 385.45 | 394.34 | 0.00743 | 920.77 | 183.64 | 1.01 |
| 4 | 9,100 | 385.45 | 394.30 | 0.00745 | 913.34 | 183.46 | 1.01 |
| 4 | 9,000 | 385.45 | 394.25 | 0.00752 | 903.55 | 183.21 | 1.01 |
| 4 | 8,900 | 385.45 | 394.21 | 0.00751 | 897.17 | 183.05 | 1.01 |
| 4 | 8,800 | 385.45 | 394.17 | 0.00752 | 889.61 | 182.86 | 1.01 |
| 4 | 8,700 | 385.45 | 394.13 | 0.00753 | 882.58 | 182.69 | 1.01 |
| 4 | 8,600 | 385.45 | 394.10 | 0.00751 | 876.09 | 182.52 | 1.01 |
| 4 | 8,500 | 385.45 | 394.05 | 0.00755 | 867.84 | 182.32 | 1.01 |
| 3.7 | 9,500 | 384.07 | 393.47 | 0.00264 | 964.61 | 137.62 | 0.62 |
| 3.7 | 9,400 | 384.07 | 393.42 | 0.00265 | 957.86 | 136.96 | 0.62 |
| 3.7 | 9,300 | 384.07 | 393.36 | 0.00265 | 951.29 | 136.33 | 0.62 |
| 3.7 | 9,200 | 384.07 | 393.31 | 0.00266 | 944.49 | 135.67 | 0.62 |
| 3.7 | 9,100 | 384.07 | 393.25 | 0.00267 | 937.62 | 135.01 | 0.62 |
| 3.7 | 9,000 | 384.07 | 393.20 | 0.00267 | 930.79 | 134.35 | 0.62 |
| 3.7 | 8,900 | 384.07 | 393.14 | 0.00268 | 923.96 | 133.69 | 0.62 |
| 3.7 | 8,800 | 384.07 | 393.09 | 0.00268 | 917.05 | 133.02 | 0.62 |
| 3.7 | 8,700 | 384.07 | 393.03 | 0.00269 | 910.18 | 132.35 | 0.62 |
| 3.7 | 8,600 | 384.07 | 392.98 | 0.00270 | 903.20 | 131.68 | 0.62 |
| 3.7 | 8,500 | 384.07 | 392.92 | 0.00270 | 896.23 | 131.00 | 0.62 |

**Table 1-4.** HEC-RAS model calibration to estimate the April 2007 Suncook River flood-peak discharge from high-water-mark data collected at the Websters Mill Road bridge in Chichester/Pittsfield, New Hampshire.—Continued

[River station locations are indicated by an arbitrary cross-section numbering system and are not shown on any figure. ft, feet; $ft^3/s$, cubic feet per second]

| River station | Q, total discharge ($ft^3/s$) | Minimum channel elevation (ft) | Water-surface elevation (ft) | Energy grade slope (ft/ft) | Flow area ($ft^2$) | Top width (ft) | Channel Froude number |
|---|---|---|---|---|---|---|---|
| 3.5 | Bridge | | | | | | |
| 3.2 | 9,500 | 384.07 | 391.82 | 0.00558 | 767.08 | 127.89 | 0.87 |
| 3.2 | 9,400 | 384.07 | 391.78 | 0.00559 | 761.65 | 127.79 | 0.87 |
| 3.2 | 9,300 | 384.07 | 391.73 | 0.00562 | 755.17 | 127.66 | 0.88 |
| 3.2 | 9,200 | 384.07 | 391.67 | 0.00565 | 748.92 | 127.53 | 0.88 |
| 3.2 | 9,100 | 384.07 | 391.63 | 0.00567 | 743.12 | 127.41 | 0.88 |
| 3.2 | 9,000 | 384.07 | 391.58 | 0.00570 | 736.80 | 127.29 | 0.88 |
| 3.2 | 8,900 | 384.07 | 391.56 | 0.00562 | 734.79 | 127.25 | 0.87 |
| 3.2 | 8,800 | 384.07 | 391.51 | 0.00566 | 728.28 | 127.12 | 0.87 |
| 3.2 | 8,700 | 384.07 | 391.45 | 0.00570 | 721.64 | 126.98 | 0.88 |
| 3.2 | 8,600 | 384.07 | 391.40 | 0.00573 | 715.00 | 126.85 | 0.88 |
| 3.2 | 8,500 | 384.07 | 391.35 | 0.00576 | 708.66 | 126.72 | 0.88 |
| 3 | 9,400 | 381.86 | 391.91 | 0.00210 | 1,112.27 | 151.73 | 0.55 |
| 3 | 9,300 | 381.86 | 391.86 | 0.00211 | 1,103.75 | 151.49 | 0.55 |
| 3 | 9,200 | 381.86 | 391.80 | 0.00211 | 1,095.52 | 151.26 | 0.55 |
| 3 | 9,100 | 381.86 | 391.75 | 0.00211 | 1,087.83 | 151.05 | 0.55 |
| 3 | 9,000 | 381.86 | 391.70 | 0.00211 | 1,079.53 | 150.82 | 0.55 |
| 3 | 8,900 | 381.86 | 391.68 | 0.00208 | 1,076.52 | 150.74 | 0.55 |
| 3 | 8,800 | 381.86 | 391.62 | 0.00208 | 1,067.98 | 150.50 | 0.55 |
| 3 | 8,700 | 381.86 | 391.56 | 0.00209 | 1,059.29 | 150.26 | 0.55 |
| 3 | 8,600 | 381.86 | 391.50 | 0.00209 | 1,050.62 | 150.02 | 0.55 |
| 3 | 8,500 | 381.86 | 391.45 | 0.00209 | 1,042.31 | 149.79 | 0.54 |
| 2 | 9,500 | 381.20 | 389.07 | 0.01078 | 858.68 | 220.06 | 0.93 |
| 2 | 9,400 | 381.20 | 389.01 | 0.01088 | 849.29 | 219.86 | 0.94 |
| 2 | 9,300 | 381.20 | 388.98 | 0.01082 | 844.65 | 219.76 | 0.93 |
| 2 | 9,200 | 381.20 | 388.94 | 0.01079 | 838.84 | 219.64 | 0.93 |
| 2 | 9,100 | 381.20 | 388.89 | 0.01084 | 830.78 | 219.46 | 0.93 |
| 2 | 9,000 | 381.20 | 388.86 | 0.01081 | 825.01 | 219.34 | 0.93 |
| 2 | 8,900 | 381.20 | 388.67 | 0.01165 | 795.84 | 215.51 | 0.96 |
| 2 | 8,800 | 381.20 | 388.63 | 0.01167 | 788.71 | 214.23 | 0.96 |
| 2 | 8,700 | 381.20 | 388.58 | 0.01167 | 782.00 | 213.02 | 0.96 |
| 2 | 8,600 | 381.20 | 388.54 | 0.01168 | 775.15 | 211.77 | 0.96 |
| 2 | 8,500 | 381.20 | 388.49 | 0.01175 | 766.75 | 210.25 | 0.96 |
| 1 | 9,500 | 376.99 | 383.37 | 0.00598 | 1,089.92 | 241.65 | 0.67 |
| 1 | 9,400 | 376.99 | 383.37 | 0.00585 | 1,089.92 | 241.65 | 0.66 |
| 1 | 9,300 | 376.99 | 383.37 | 0.00573 | 1,089.92 | 241.65 | 0.65 |
| 1 | 9,200 | 376.99 | 383.37 | 0.00561 | 1,089.92 | 241.65 | 0.65 |
| 1 | 9,100 | 376.99 | 383.37 | 0.00549 | 1,089.92 | 241.65 | 0.64 |
| 1 | 9,000 | 376.99 | 383.37 | 0.00537 | 1,089.92 | 241.65 | 0.63 |
| 1 | 8,900 | 376.99 | 383.37 | 0.00525 | 1,089.92 | 241.65 | 0.63 |
| 1 | 8,800 | 376.99 | 383.37 | 0.00513 | 1,089.92 | 241.65 | 0.62 |
| 1 | 8,700 | 376.99 | 383.37 | 0.00501 | 1,089.92 | 241.65 | 0.61 |
| 1 | 8,600 | 376.99 | 383.37 | 0.00490 | 1,089.92 | 241.65 | 0.60 |
| 1 | 8,500 | 376.99 | 383.37 | 0.00479 | 1,089.92 | 241.65 | 0.60 |