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Elevation of the March–April 2010 Flood High Water in Selected River Reaches in Central and Eastern Massachusetts

Open-File Report 2010–1315

U.S. Department of the Interior
U.S. Geological Survey

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U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
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Conversion Factors

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	259.0	hectare (ha)
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)

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Elevation, as used in this report, refers to distance above the vertical datum.

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By Phillip J. Zarriello and Gardner C. Bent

Abstract

A series of widespread, large, low-pressure systems in southern New England in late February through late March 2010 resulted in record, or near record, rainfall and runoff. The total rainfall in the region during this period ranged from about 17 to 25 inches, which coupled with seasonal low evaporation, resulted in record or near record peak flows at 13 of 37 streamgages in central and eastern Massachusetts. The highest record peaks generally occurred in southeastern Massachusetts in late March–early April; at most other streamgages, the peak was in mid-March.

Determination of the flood-peak high-water elevation is a critical part of the recovery operations and post-flood analysis for improving future flood-hazard maps and flood-management practices. High-water marks (HWMs) were identified by the U.S. Geological Survey (USGS) from April 13 through May 10, 2010, and by a consultant for Massachusetts Department of Conservation and Recreation (MADCR) after peak flows in mid-March and again in late March–early April. HWMs were identified at 25 river reaches in 7 designated Massachusetts Executive Office of Energy and Environmental Affairs (EEA) basins by the USGS and at 8 river reaches in 2 designated EEA basins by MADCR. The USGS identified 293 HWMs at 152 sites. A site may have more than one HWM, typically upstream and downstream from a bridge. The MADCR identified 133 HWMs; of these, 98 are at unique locations, and 29 of the 133 HWMs were visited once following the mid-March peak and again following the late March peak. The HWMs identified by the USGS and MADCR covered about 300 river miles, determined from the upstream and downstream HWMs (about 230 and 70 river miles, respectively). Elevation of HWMs was later determined to a standard vertical datum (NAVD 88) using the Global Navigation Satellite System and survey grade Global Positioning System (GPS) receivers along with standard optical surveying equipment.

Introduction

Flood flows and water levels set, or nearly set, record highs in mid- and late March into early April 2010 following repeated storms. In the wake of the severe flooding, a state of emergency was declared in many communities in central and eastern Massachusetts, and a Presidential Disaster was declared on March 29, 2010. The President's action affected the emergency recovery operations in Bristol, Essex, Middlesex, Norfolk, Plymouth, Suffolk, and Worcester Counties. Federal assistance for storm-related damages from this disaster totaled more than $100 million on August 17, 2010 (FEMA, 2010). As part of the recovery operations, the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) required analysis of the flood to assess damages and to prepare for and minimize future flood damages.

Determination of the peak high-water elevation is a critical part of the recovery operations and post-flood analysis. This information also is extremely valuable when defining and understanding flood risks for flood management. FEMA entered into an agreement with the USGS on April 29, 2010, to identify high-water marks (HWMs) in selected river reaches in Massachusetts in the counties affected by the disaster declaration. A subsequent agreement between FEMA and the USGS was signed in June 2010 to survey and document the HWMs identified from the March–April 2010 floods to support future analysis for flood-mitigation efforts.

Purpose and Scope

The purpose of this report is to document the elevation of peak high water following the March–April 2010 floods in central and eastern Massachusetts. The report describes the conditions prior to the flood, recorded gage heights and flows at USGS streamgages, methods used to identify high-water marks, and the surveying methods used to obtain a vertical

datum of the high-water mark. The report summarizes the HWM data for selected river reaches and presents data in tables and figures.

Study Area

High-water elevations of the March–April 2010 floods were documented mostly for rivers in the eastern part of Massachusetts where flooding was the most severe (fig. 1); elevations are also documented for several basins in the central part of the State. The following Massachusetts Executive Office of Environmental and Energy Affairs (EEA) planning basins were included in this study: Taunton, Ten Mile, South Coastal, Boston Harbor, Charles, SuAsCo (Sudbury, Assabet, and Concord River Basins), Nashua, Millers, North Coastal, and Ipswich Basins.

Rainfall and Antecedent Conditions

A series of widespread, large, low-pressure systems passed through the New England region in late February and in mid- through late March 2010 resulted in record, or near record, amounts of rainfall. During March, the total rainfall at Logan International Airport in Boston was the second highest recorded (14.83 in.) since 1872; the highest total rainfall of record (18.81 in.) recorded at Blue Hill Observatory southeast of Boston since in 1885 (National Weather Service stations 190770 and 190736, respectively; fig. 2). The highest monthly total rainfall recorded in Boston (17.09 in.) was in August 1955 that resulted from tropical hurricanes Connie and Dianne (U.S. Department of Commerce, 1955).

During a period when evaporation losses are normally low, these low-pressure systems maintained wet soil moisture conditions and filled available surface storages that resulted in record, or near record, floods in southern New England. The Northeast Regional Climate Center (2010) March Climate Summary report described the following conditions: “The mid-March storm hit the region from March 13–15, dropping as much as 9 inches of rain in eastern Massachusetts. As floodwaters began to recede an additional 2 to 5 inches of rain fell on March 22nd and 23rd, followed by 5 to 9 inches of rain on the 29th and 30th.”

Rainfall hyetographs and cumulative rainfall (fig. 3A and 3B) for four selected National Weather Service (NWS) daily record stations (190840, 193890, 194760, and 195524; fig. 2) exemplify the pattern of excessive moisture in eastern Massachusetts. Prior to the March high water, a late February storm dropped nearly 5 inches of rain over the region, saturating soils, filling available storage, and elevating streamflows. Thus, conditions were primed for the first large runoff response following the 4 to 9 inches of rain that fell between March 13th and 15th. From late February through mid-March total precipitation ranged from about 9 to 15 inches in the study area, resulting in the maximum peak stages and flows at streamgages in the region that set new record peaks at some stations. As flood waters began to recede, rainfall on March 22–23 amounted to an additional 2 to 5 inches, which maintained wet conditions and elevated streamflows in the region. Wet conditions continued through late March with another large pulse of rain on the 29th and 30th. The new rains resulted in peak stream stages and flows that exceeded the mid-March stages and flows at 11 streamgages depending on the rainfall intensity and totals. Overall, the total rainfall at four NWS stations (fig. 3) ranged from about 17 to 22 inches since late February through March, which is unprecedented in the past 100-year weather history, especially during the cool season when moisture losses to evaporation are low. The total rainfall during February and March 2010 over eastern Massachusetts and surrounding states (fig. 2) indicates the highest amounts occurred from Narragansett Bay northward along the southern New England coast. The area of high rainfall in northeastern Massachusetts and northward was about equal to the total rainfall in southeastern Massachusetts and Rhode Island, but northeastern Massachusetts had less severe flooding than southeastern Massachusetts. Less severe flooding in northeastern Massachusetts resulted because a greater portion of the total rainfall in this region was in late February when water storage was more available.

Streamflows

Peak stages and flows recorded at USGS streamgages in central and eastern Massachusetts (table 1) indicate the magnitude of the March–April 2010 flood relative to the magnitude of past floods over the period of the streamgage record. The 2010 stage and flow data are provisional until the entire segment of streamflow record is analyzed and approved. Waiting for the approval of streamflow data would cause undue delays for this report. Approval of the data was not considered necessary for the primary objective of documenting the elevation of the flood high water. However, the data on peak stage and flow were reviewed and are considered to be in good condition for use in this report.

Of the 37 streamgages listed in table 1, new peak stage and flow records were set at 13 streamgages following the March–April 2010 floods. The average increase in peak flows from the previous peak of record at the 13 streamgages was about 10 percent; the maximum increase in peak flow was at Quniapoxet River at Canada Mills near Holden (01095375), which was 31 percent greater than the previous peak recorded in March 1998. Peak flows at three streamgages were within about 10 percent of the previous record peak. Peak flows at 24 streamgages during March–April 2010 did not exceed the previous peaks of record; the average March–April peak flows at these streamgages were about 28 percent less than the previous peaks of record. In general, the previous peaks of record were greater than the March–April 2010 peaks for streamgages in the western and central parts of the study area to the west, particularly for streamgages that included floods of 1936, 1938, and 1955.

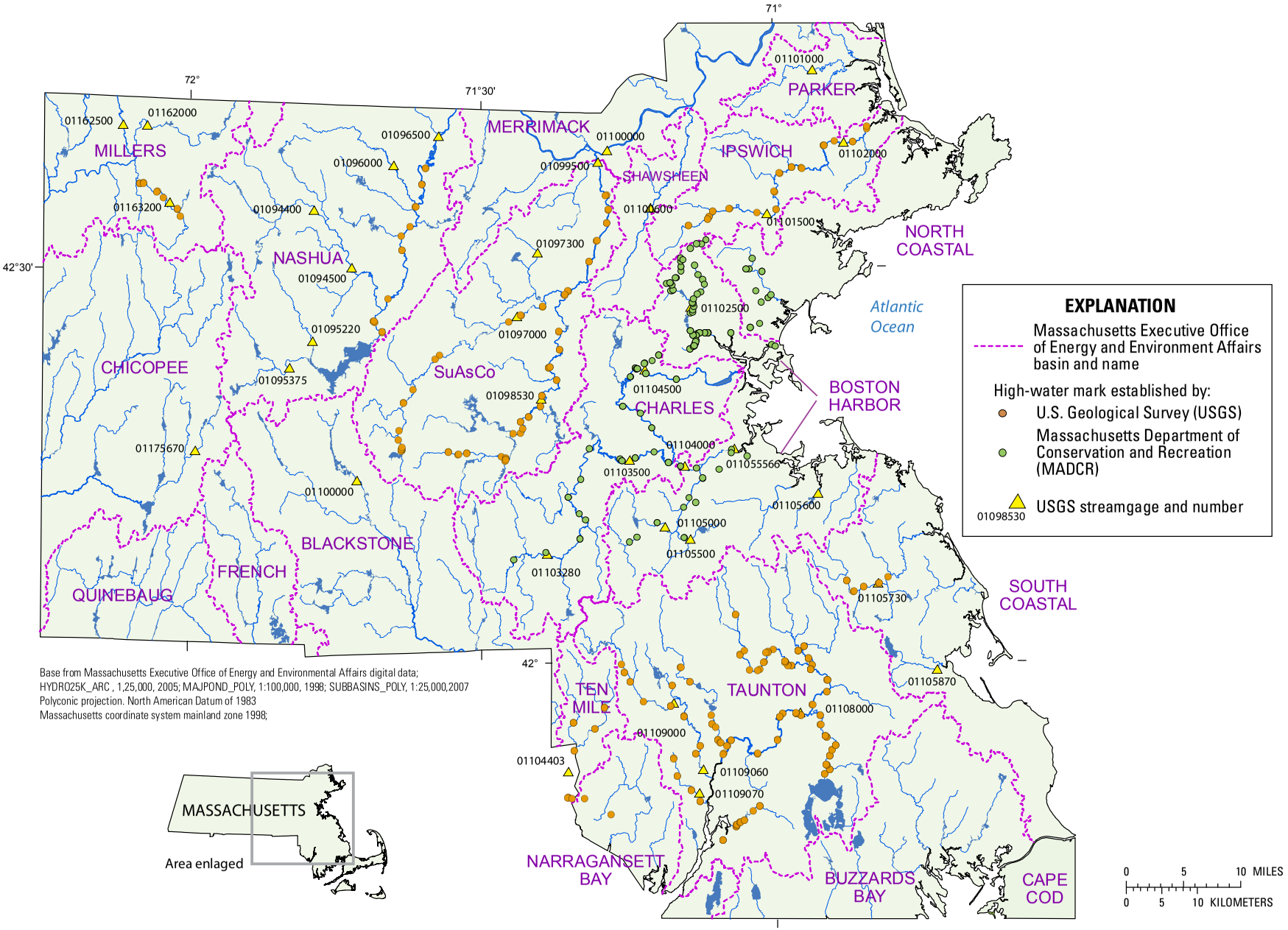


Figure 1. River basins where high-water elevations were determined following the March–April 2010 floods in central and eastern Massachusetts.

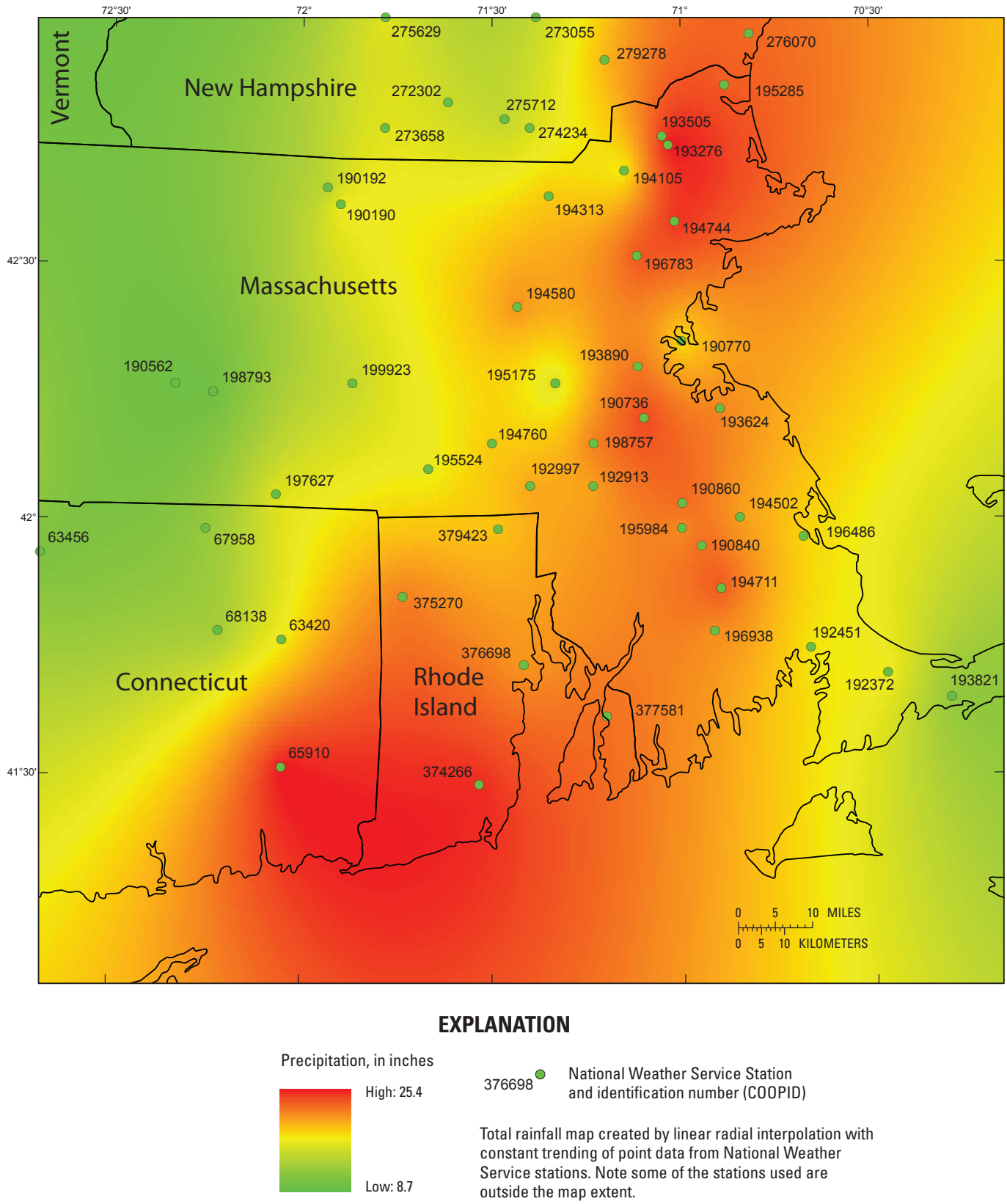


Figure 2. Total rainfall during February and March 2010 in southeastern New England.

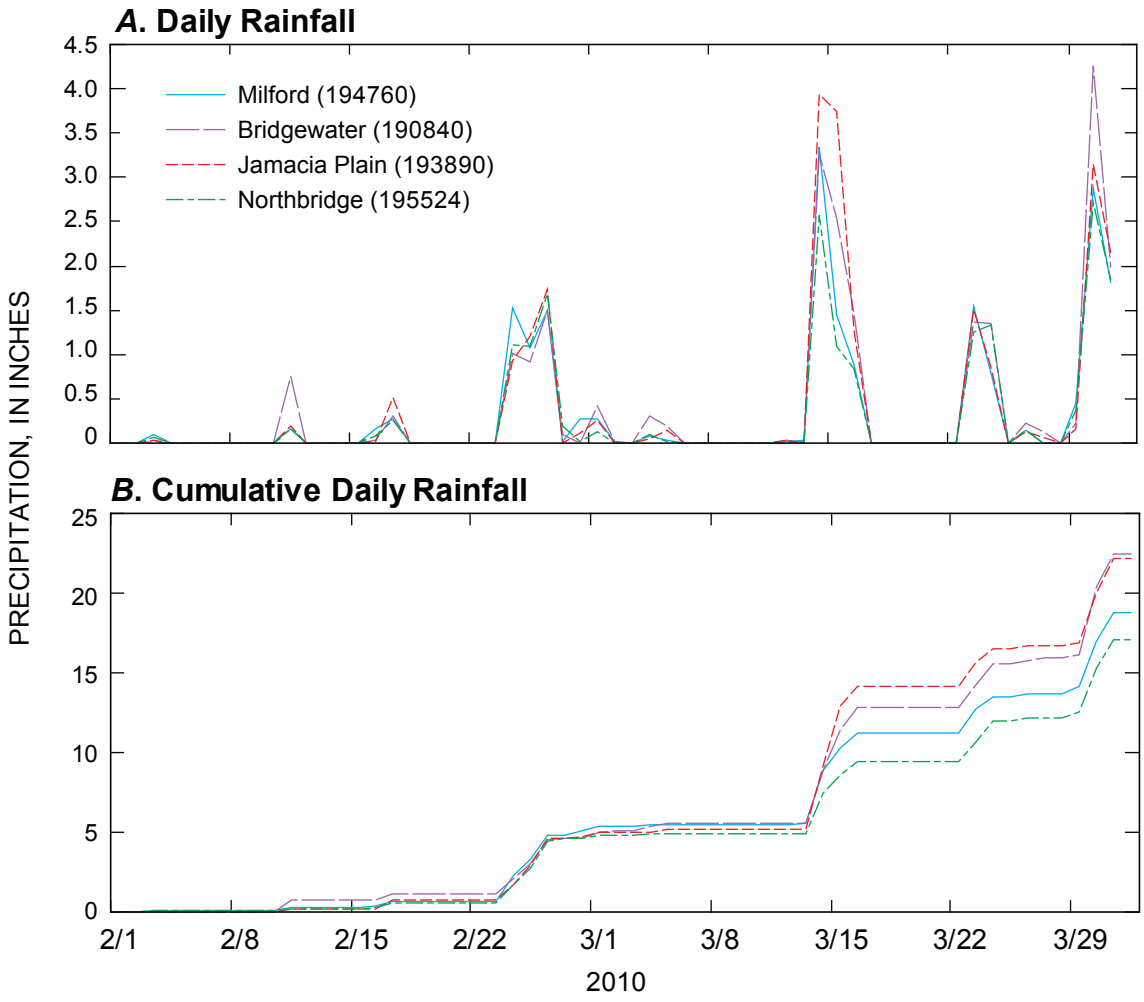


Figure 3. Daily rainfall (*A*) hyetographs and (*B*) cumulative totals during February and March 2010 at four National Weather Service (NWS) stations in central and eastern Massachusetts. Number in parenthesis is the NWS station shown in figure 2.

Table 1. Summary of March–April 2010 flood peak stage and flow data at selected U.S. Geological Survey streamgages in central and eastern Massachusetts.

[Locations shown on figure 1 . mi^2, square miles; ft feet;, ft^3/s, cubic feet per second; numbers in **bold** indicate new peak of record]

Station number	Station Name	Drainage area (mi^2)	Start of record	March–April 2010 peak[a]			Recorded peak prior to March–April 2010 flood			Secondary peak[a] March–April 2010		
				Date	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)
NASHUA RIVER BASIN												
01094400	North Nashua River at Fitchburg, MA	64.2	1973	03/15	7.99	3,260	04/16/2007	8.59	3,930	03/30	6.15	1,490
01094500	North Nashua River near Leominster, MA	110	1937	03/15	12.66	5,730	09/21/1938	14.57	10,300	03/31	11.96	4,890
01095220	Stillwater River near Sterling, MA	31.6	1995	03/14	9.01	1,590	04/16/2007	9.10	1,850	03/31	8.57	1,210
01095375	Quinapoxet River at Canada Mills Near Holden, MA	46.3	1997	03/14	**14.06**	**2,190**	03/10/1998	13.76	1,670	03/30	13.47	1,860
01096000	Squannacock River at West Groton, MA	63.7	1950	03/15	8.03	3,990	04/16/2007	8.50	4,820	03/31	7.56	3,240
01096500	Nashua River at East Pepperell, MA[b]	435	1936	03/16	15.75	11,100	03/20/1936	19.10	20,900	04/01	13.77	9,060
SUASCO BASIN												
01097000	Assabet River at Maynard, MA	114	1942	03/16	7.11	2,530	08/20/1955	8.94	4250	03/31	7.08	2,500
01097300	Nashoba River near Acton, MA	12.8	1964	03/15	7.88	498	01/26/1979	5.57	679	03/31	7.42	402
01098530	Sudbury River at Saxonville, MA[b]	106	1980	03/31	**13.99**	**2,590**	06/07/1982	13.47	2,420	03/15	12.90	2,000
01099500	Concord River below Meadow Brook at Lowell, MA[b]	400	1938	03/17	**9.74**	**5,660**	01/28/1979	9.60	5,410	04/02	9.59	5,580
MERRIMACK RIVER BASIN												
01100000	Merrimack River at Lowell, MA[b]	4,635	1924	04/01	54.64	63,400	03/20/1936	68.40	173,000	03/16	53.58	56,000
SHAWSHEEN RIVER BASIN												
01100600	Shawsheen River near Wilmington, MA	36.5	1964	03/15	**10.59**	**1,900**	10/22/1996	10.49	1,850	03/31	9.42	1,390
PARKER RIVER BASIN												
01101000	Parker River at Byfield, MA	21.3	1946	03/16	7.24	750	10/22/1996	7.82	883	03/31	6.28	575
IPSWICH RIVER BASIN												
01101500	Ipswich River at South Middleton, MA	44.5	1938	03/15	8.43	1,320	05/15/2006	8.46	1,330	03/31	7.65	1,070
01102000	Ipswich River at Ipswich, MA	125	1931	03/17	9.96	3,950	05/26/2006	10.53	4,600	04/01	8.52	2,760
NORTH COASTAL BASIN												
01102345	Saugus River at Saugus Ironworks at Saugus, MA	20.8	1994	03/15	6.49	899	05/14/2006	7.39	1,420	03/31	6.30	813
BOSTON HARBOR BASIN												
01102500	Aberjona River at Winchester, MA[b]	24.7	1940	03/15	16.49	1,450	03/22/2001	16.90	1,590	03/31	15.56	1,200
01105000	Neponset River at Norwood, MA	34.7	1940	03/30	11.16	1,180	11/05/1955	14.65	1490	03/15	11.00	1,130
01105500	East Branch Neponset River at Canton, MA	27.2	1953	03/30	6.00	1,200	08/19/1955	8.18	1790	03/15	5.63	1,050
011055566	Neponset River at Milton Village, MA[b]	101	1997	03/16	**6.91**[c]	**3,310**	06/18/1998	36.93	2,720	03/31	6.54	3,010
01105600	Old Swamp River near Weymouth, MA	4.50	1967	03/15	5.70	399	05/31/1984	5.92	590	03/30	5.46	340

Table 1. Summary of March–April 2010 flood peak stage and flow data at selected U.S. Geological Survey streamgages in central and eastern Massachusetts.—Continued

[Locations shown on figure 1 . mi^2, square miles; ft feet;, ft^3/s, cubic feet per second; numbers in **bold** indicate new peak of record]

Station number	Station Name	Drainage area (mi^2)	Start of record	March–April 2010 peak[a]			Recorded peak prior to March–April 2010 flood			Secondary peak[a] March–April 2010		
				Date	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)	Date	Gage height (ft)	Discharge (ft^3/s)
CHARLES RIVER BASIN												
01103280	Charles River at Medway, MA	65.7	1998	03/31	**7.21**	**1,780**	10/16/2005	7.02	1,710	03/15	6.55	1,550
01103500	Charles River at Dover, MA	183	1938	04/02	8.05	2,790	03/22/1968	8.72	3,220	03/18	7.76	2,640
01104500	Charles River at Waltham, MA[b]	251	1932	03/15	**7.56**	**4,160**	02/03/1976	6.54	4,150	03/31	6.46	3,150
SOUTH COASTAL RIVER BASIN												
01105730	Indian Head River at Hanover, MA	30.3	1967	03/15	**7.32**	**1,510**	03/18/1968	7.13	1,390	03/31	6.51	1120
01105870	Jones River at Kingston, MA[b]	19.8	1967	03/15	6.20	400	03/19/1968	4.60	575	03/31	6.16	395
BUZZARDS BAY BASIN												
01105933	Paskamanset River near South Dartmouth, MA	26.2	1996	03/31	14.15	695	10/16/2005	14.44	792	03/15	13.38	484
TAUNTON RIVER BASIN												
01108000	Taunton River near Bridgewater, MA	261	1930	04/01	**14.97**	**5,480**	03/20/1968	14.48	4,980	03/17	14.51	5,230
01109000	Wading River near Norton, MA	43.3	1926	03/30	**11.48**[d]	1,310	03/19/1968	11.47	1,460	03/15	9.93	786
01109060	Threemile River at North Dighton, MA	84.3	1967	03/31	**8.98**	**2,930**	06/16/1998	8.89	2,870	03/16	7.23	1,840
01109070	Segreganset River near Dighton, MA	10.6	1967	03/30	**8.66**	**1,010**	03/18/1968	7.69	867	03/15	5.70	426
BLACKSTONE RIVER BASIN												
01110000	Quinsigamond River at North Grafton, MA[b]	25.6	1940	03/31	4.22	581	08/20/1955	5.15	820	03/15	3.55	411
MILLERS RIVER BASIN												
01162000	Millers River near Winchendon, MA	81.8	1918	03/16	11.75	3640	09/22/1938	21.55	8,500	04/01	10.39	2,440
01162500	Priest Brook near Winchendon, MA	19.4	1917	03/15	4.12	452	09/21/1938	9.90	3,000	03/31	4.31	390
01163200	Otter River at Otter River, MA	34.2	1965	03/15	**4.96**[d]	**971**	03/07/1979	5.02	948	03/31	4.47	782
CHICOPEE RIVER BASIN												
01175670	Sevenmile River near Spencer, MA	8.81	1961	03/14	12.18	478	10/15/2005	12.95	900	03/30	11.50	255
TEN MILE RIVER BASIN												
01109403	Ten Mile River at East Providence, RI	53.1	1987	03/31	**10.79**	**2,250**	10/16/2005	10.00	1,900	03/15	7.36	975

[a] Gage height and discharge may change pending further analysis of entire water-year record.

[b] Streamflow affected by regulation.

[c] Gage height is lower than the historical peak gage height due to a change in the gage datum.

[d] Gage height is lower than the historical peak gage height due to a change in the stage-discharge relation.

Flow conditions in the region prior the March floods are illustrated by the daily mean flow for the 2010 water year in relation to the 10th-, 25th-, 50th-, 75th-, and 90th-percentile flows for a given day, calculated from the period-of-record daily mean flows at Charles River at Dover (01103500) and Taunton River near Bridgewater (01108000) (fig. 4A and 4B, respectively). Note that these streamgages were established in 1938 and 1930, respectively. Prior to the late February rainfall, flows were below the median (50th percentile) but quickly rose well above the 90th percentile following the late February rainfall. Flows that exceeded the 90th percentile occurred only 10 percent of the time at this time of year, which is the normal seasonal high-flow period. Flows receded to about the median range in early March, then rose sharply following the mid-March storm to set a new peak flow for water year 2010. Flows continued to stay above the 90th percentile into late March because of saturated conditions and additional rainfall. Another large rainfall event at the end of March caused a rise in streamflow that slightly exceeded the peak flow in mid-March at the Charles River at Dover (01103500) and Taunton River near Bridgewater (01108000) streamgages. Again, note that at 24 of the 37 streamgages in table 1, the mid-March peak flows exceeded the late March–early April peak flows.

Streamgages in southeastern Massachusetts indicate that the highest peak stages and flows during the 2010 floods generally occurred in late March–early April (table 1); these included streamgages in the Neponset River, except at Milton Village (011055566); in the Charles River, except at Waltham (01104500); and in Buzzards Bay, Taunton River, and Ten Mile River Basins. At the seven streamgages in these basins the median late March–early April peak flows were about 13 percent greater than the mid-March peak flows. The greatest differences in peak flows were in the lower Taunton and Ten Mile River Basins for Wading River (01109000), Threemile River (01109060), Segreganset River (01109070), and Ten Mile River (01109403), which had late March–early April peak flows that were about 40-, 37-, 58-, and 57-percent greater, respectively, than the mid-March peak flows. At most other streamgages reported in table 1, the primary 2010 peak occurred in mid-March. The mid-March peak flows were as little as 1 percent greater than the late March–early April peak flows in the Assabet and Concord River Basins, but the differences between the mid-March peaks and the late March–early April peaks generally increased to the west and north of southeastern Massachusetts. In rivers and streams where the mid-March peak stages were higher than the secondary peaks in late March–early April, the determination of the highest peak stage was less certain because evidence of the earlier peaks may have been destroyed.

Methods

HWMs are the evidence of the highest water levels during a flood (Benson and Dalrymple, 1967). There are many types of HWMs, but most are left by vegetative debris stranded at the highest water elevation. The best HWMs are small seeds or floating debris that adhere to smooth surfaces or lodge in tree bark that forms a distinct water line. Stain lines on buildings, fences, and other structures also provide excellent marks. HWMs are best identified immediately following the peak stage as time and weather (wind and rain) fade the evidence of the peak water line. Additionally, care was taken to identify HWMs farthest from the main channel as possible where velocities are generally small and pileup or drawdown's common in fast moving waters are best avoided. The general methods used to identify and document HWMs are described by Benson and Dalrymple (1967).

Setting High-Water Marks

USGS field crews consisted of at least one person experienced in identifying HWMs. Crews would identify HWMs and corroborating evidence of surrounding HWMs. The corroborating information became more important as the quality of the HWM decreased. After a satisfactory HWM was found, a more permanent identification mark was established, such as a disk, stake, chisel mark, or paint line (examples shown in fig. 5). Flagging, written descriptions, sketches, photos, and handheld Geographic Position System (GPS) horizontal position measurements were made so the marks could be found later and surveyed to a standard vertical datum or for other analysis, such as determination of the flood profile over the river reach.

Identification of HWMs by the USGS began on April 13 and continued through May 10, 2010. Four USGS field crews were mobilized to identify HWMs as soon as possible because of the significance of the flood and to minimize loss of time critical data. Note that high-water levels became more difficult and time consuming to identify, and the quality of the HWMs deteriorated with time. Field work was limited until an agreement was signed (April 29, 2010) and resources could be directed to this activity. As a result USGS field crews sometimes found two distinct high-water lines that likely resulted where the late March–early April peak was lower than the mid-March peak. The highest water-level evidence was used when establishing a HWM, but if the overall peak occurred in mid-March, evidence of that peak could have been erased by heavy rains that occurred later in the month.

The MADCR HWMs were identified by a consultant working under contract for MADCR. The MADCR HWMs were identified mostly at bridges and were marked by a wide paint line, which made the vertical position of the HWM uncertain when the marks were later surveyed to a standard vertical datum. Generally, the surveyor assumed the middle of the paint line was the vertical position of the HWM. In addition, most HWMs were located near the main channel, which also can cause uncertainty because of wave action, potential pileup of water against the upstream side of a bridge, and drawdown at the downstream of a bridge. The MADCR HWMs were identified shortly after peak flows in mid-March and in late-March to early-April.

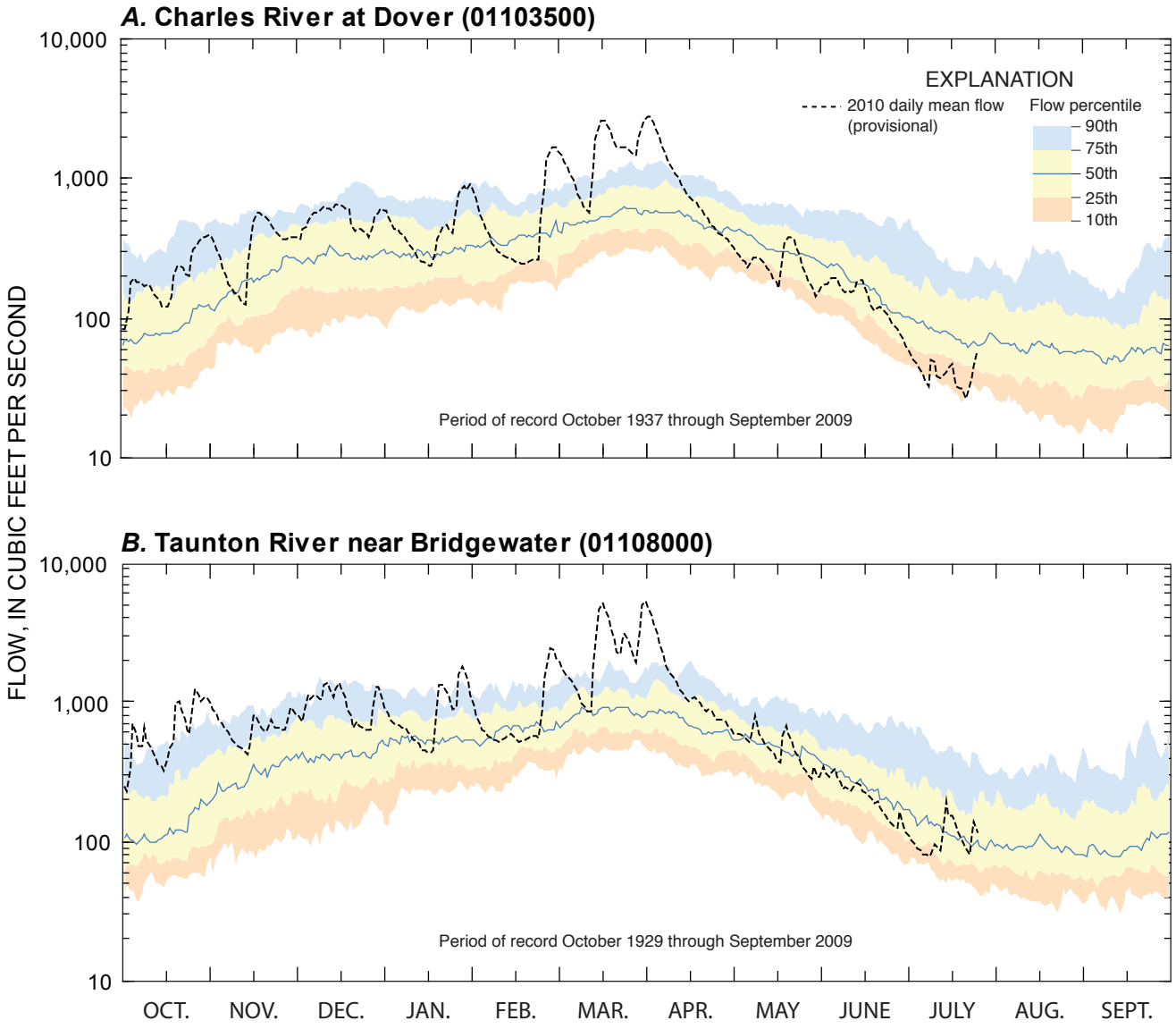


Figure 4. Period-of-record daily mean flow percentiles and 2010 daily mean flow at (*A*) Charles River at Dover (01103500) and (*B*) Taunton River near Bridgewater (01108000), Massachusetts. Location shown in figure 1.

Ipswich River (IpsSR)

Indian Head River (IHRKS)

Nashua River (A80000)

Assabet River (A700005)

Figure 5. Examples of high-water mark debris lines on trees and structures found following the March–April 2010 floods in central and eastern Massachusetts. Value in parentheses refers to the Site_ID in Appendix I, table 1-1.

Elevation of High-Water Marks

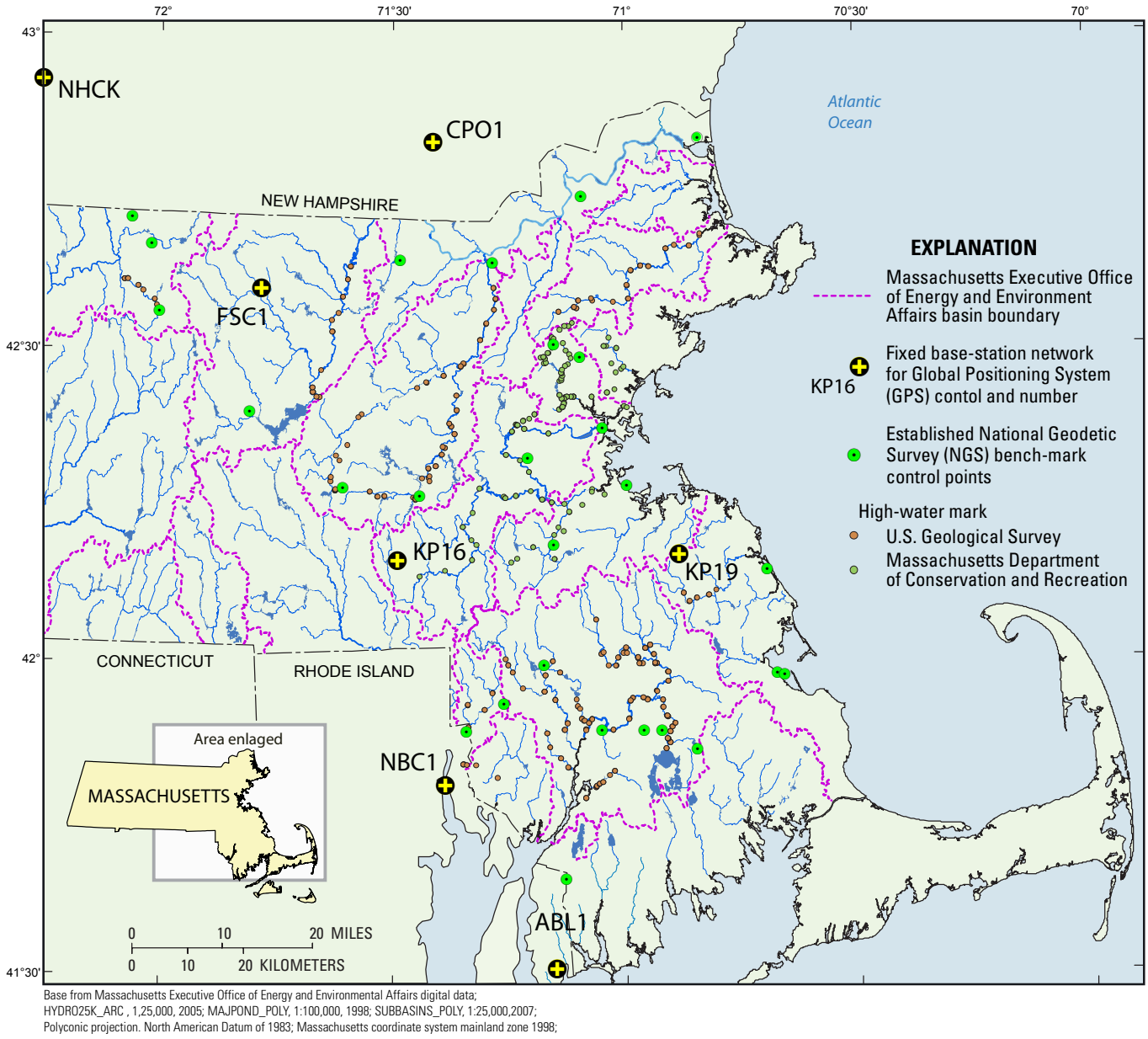
Elevation of HWMs were later surveyed to a standard vertical datum (NAVD 88) using the Global Navigation Satellite System (GNSS) and survey grade GPS receivers along with standard optical surveying equipment. The GPS surveys were conducted using Trimble R8 receivers that support the L1 and L2 signals; two of the four receivers used also support GLONASS L2C and L5 signals. At each HWM site a temporary survey point (PK) was established in an open area to provide the best possible satellite reception. For each PK, the GPS receiver was initialized away from, and then leveled over the PK. This procedure was repeated by reinitializing the GPS unit (the receiver was flipped upside down for several seconds to lose the GPS signals) to obtain an independent reading. If the vertical elevation of the PK differed by more than about 0.10 ft, the procedure was repeated until an acceptable agreement was reached. Elevation of repeated PK measurements generally agreed to within 0.05 ft. Standard optical surveying equipment was used to tie the HWM to the PK elevation using a closed loop survey. Ninety-seven percent of the 339 loop surveys closed to within 0.01 ft or less, 2 percent closed to within 0.02 ft, and two closed within 0.05 ft and 0.11 ft.

Continuous real-time differential corrections to the GPS horizontal and vertical positions were made using a proprietary fixed-base station GPS network operated by KeyNetGPS, Inc. The network and associated software determine corrections for satellite signals received by the field GPS for ionosphere and other atmospheric disturbances recorded at three or more of the closest fixed-base stations relative to the position of the field GPS receiver. The fixed-base stations receivers continuously stream data to a central server that calculates corrections at the location of the field GPS receiver in real time. The field GPS controllers require at least version 12 GPS controller software to utilize the fixed network. The fixed-station network in the eastern Massachusetts region, nearest the HWMs, consists of seven stations near Keene (NHCK) and Derry (CPO1), NH; Boston (KP19), Fall River (ABL1), Fitchburg (FSC1), and Framingham (KP16), MA; and Providence (NBC1), RI. Quality-assurance GPS measurements were made at 27 National Geodetic Survey (NGS) bench marks (BMs) with vertical datum's throughout the study area (fig. 6). The elevation of the GPS measured BMs yielded a vertical root mean square error (RMSE) of 0.15 ft (table 2) for 26 of the 27 BMs; one BM was not used because it appeared to have been reset (new construction), which is collaborated by the vertical difference of 0.78 ft. between the published and the GPS-determined elevation. The accuracy of the HWM survey meets the standards specified by FEMA (2003) in Guidelines and specifications for flood hazards mapping partners, Appendix A: Guidance for aerial mapping and surveying.

Summary of High-Water Marks Identified

High-water marks were identified following the March–April 2010 flood along 25 river reaches in 7 EEA designated basins by the USGS and in 8 river reaches in 2 EEA designated basins by MADCR (table 3). The USGS identified 293 HWMs at 152 sites (a site may have more than one HWM, typically a bridge crossing with HWMs identified on the upstream and downstream side of the bridge), which are listed in Appendix I, table 1-1. At seven of the sites listed in table 1-1, no HWM was set; note, the dataset does not consistently report all sites visited where no HWM was set. During the later GPS surveys, three of the USGS HWMs were destroyed, and two others could not be found. The MADCR identified 133 HWMs, which are listed in Appendix I, table 1-2. Of these, 98 are at unique locations; 29 of these were visited twice following the mid-March peak flows and again after the late-March peak flows. One HWM was identified in the GPS survey in the same general location where a HWM was previously identified. Multiple HWMs sighted by MADCR were not typically identified at the same location, such as upstream and downstream from a bridge, but multiple HWMs were identified separately following the mid- and late-March peak flows. During the later GPS survey, 11 of the MADCR HWMs could not be found. Six HWMs were found to have an elevation (NAVD88) below sea level and were found below the water surface at the time of the GPS survey; five of these were in the Mystic Basin.

The HWMs identified by the USGS and MADCR covered about 300 river miles, as determined from the upstream and downstream HWMs along river reaches; about 230 and 70 river miles were covered by USGS and MADCR, respectively. The density of HWMs per mile of river reach for USGS HWMs ranges from a lower quartile of about 1.0 to an upper quartile of about 1.6, with a median of 1.5 HWMs per mile. The elevation of HWMs upstream from bridges were, on average, about 1.2 ft higher than the downstream HWMs near the same bridge; in 27 out of 106 HWMs at a bridge, the upstream elevation was lower than the downstream elevation (these sites were not included in the average elevation difference between upstream and downstream HWMs). HWMs that are higher downstream than upstream may be the result of a poor quality mark, which is often reflected in the rating of the HWM, but also could be attributed to different high-water peaks from mid- and late March, as previously noted. The density of HWMs identified by MADCR varied by storm; about 35 percent more HWMs were identified following the mid-March peak flows than the late March peak flows. The density of MADCR HWMs following the mid-March peak flows ranged from a lower quartile of about 1.0 to an upper quartile of about 2.2, with a median of 1.1 HWMs per mile.



Base from Massachusetts Executive Office of Energy and Environmental Affairs digital data;
HYDRO25K_ARC , 1,25,000, 2005; MAJPOND_POLY, 1:100,000, 1998; SUBBASINS_POLY, 1:25,000,2007;
Polyconic projection. North American Datum of 1983; Massachusetts coordinate system mainland zone 1998;

Figure 6. Fixed-based station Global Positioning System receiver network and National Geodetic Survey bench-mark control points used in the determination of the elevation of the March–April 2010 flood high water in central and eastern Massachusetts.

Table 2. Summary of Global Positioning System (GPS) measurements made to National Geodetic Survey (NGS) bench marks.

[PID, NGS identification; TYPE– V, vertical position only, 3D, horizontal and vertical position; EAST and NORTH, horizontal position referenced to North American Datum of 1983 (NAD 83), in feet; Elev(88), vertical reference to North American Datum of 1988 (NAVD 88), in feet; Offset, GPS point offset from bench mark to obtain the best quality signal; Deltas, difference between published and surveyed values, in feet; –, not determined; RMSE, Root Mean Square Error]

NGS bench mark		Published by NGS			Surveyed by GPS			Offset (feet)	Deltas		
PID	Type	East	North	Elev(88)	East	North	Elev(88)		East	North	Elev(88)
MZ0040	V	–	–	979.44	–	–	981.141	-1.4	–	–	0.30
MZ0045	V	–	–	1063.34	–	–	1066.888	-3.34	–	–	0.21
MY0856	V	–	–	1028.69	–	–	1038.980	-10.15	–	–	0.14
MY0715	V	–	–	414.46	–	–	411.890	2.75	–	–	0.18
MY2204	3D	658449.849	3050077.993	418.30	658449.822	3050078.007	418.285	0.00	-0.03	0.01	-0.02
MY0312	3D	709262.521	3048562.559	141.50	–	–	141.493	0.30	–	–	0.29
MY0361	3D	758226.176	3085541.184	158.85	758226.189	3085541.125	158.866	0.00	0.01	-0.06	0.02
MY0150	3D	822696.094	3117987.648	31.36	822696.110	3117987.699	31.340	0.00	0.02	0.05	-0.02
MY0617	3D	743045.912	3003502.772	256.89	743046.220	3003502.629	256.891	0.00	0.31	-0.14	0.00
MY0734	V	–	–	296.82	–	–	296.637	-0.10	–	–	-0.28
MY2101	V	–	–	180.56	–	–	180.508	0.00	–	–	-0.05
MY2088	V	–	–	78.41	–	–	75.914	2.48	–	–	-0.02
MY0580	V	–	–	11.00	–	–	9.664	1.46	–	–	0.12
MY0495	V	–	–	70.74	–	–	67.030	3.69	–	–	-0.02
MY2181	V	–	–	28.71	–	–	25.259	3.39	–	–	-0.06
LW5230	3D	694828.853	2789387.645	100.63	694828.910	2789387.564	100.489	0.00	0.06	-0.08	-0.14
LW1475	V	–	–	131.49	–	–	126.547	4.78	–	–	-0.16
MY0465	3D	737911.462	2826017.161	122.40	737911.436	2826017.296	122.415	0.00	-0.03	0.14	0.01
LW1487	V	–	–	14.50	–	–	15.285	0.00	–	–	0.78[a]
LW1494	3D	803318.804	2790147.691	51.27	803318.838	2790147.912	51.441	0.00	0.03	0.22	0.17
LW1492	V	–	–	24.15	–	–	23.427	0.80	–	–	0.07
LW1498	V	–	–	94.71	–	–	94.765	-0.27	–	–	-0.22
MY2151	V	–	–	115.34	–	–	115.344	0.00	–	–	0.00
LW1549	V	–	–	13.53	–	–	12.677	0.73	–	–	-0.12
LW1550	V	–	–	14.56	–	–	13.640	1.02	–	–	0.10
LW0526	V	–	–	238.07	–	–	238.061	0.00	–	–	-0.01
MY0607	V	–	–	28.32	–	–	29.366	-1.22	–	–	-0.17
								RMSE	**0.12**	**0.12**	**0.15**

[a] Could not verify mark stamping, may have been reset; not included in RMSE.

Table 3. Summary of high-water marks (HWMs) established by the U.S. Geological Survey (USGS) and the Massachusetts Department of Conservation and Recreation (MADCR) following the March–April 2010 floods in central and eastern Massachusetts.

[EEA, Massachusetts Executive Office of Environmental Affairs; HWM, high-water mark; Location, number of unique locations where HWMs were identified such as upstream and downstream from a bridge; Length, approximant reach length between the most upstream and downstream HWMs; Bk, brook; HWMs and EEA basins shown in figure 1]

By USGS					By MADCR				
EEA basin	River	Number of		Length (miles)	EEA basin	River	Number of		Length (miles)
		HWMs	Locations				HWMs	Locations	
Ipswich	Ipswich	28	18	32	Charles	Charles	35	23	22
	Martins Bk	2	1	0		Beaver Bk	5	3	2.6
	Subtotal	30	19	32		Subtotal	40	26	25
Millers	Otter	11	6	14	Boston Harbor	Mystic	60	47	17
						Neponset	15	11	18
Nashua	Nashua	17	11	24		Saugus	10	8	5.6
						Sales Creek	2	2	0.3
South Coastal	Indian Head[1]	10	5	6.2		Town Line Bk	3	2	1.0
						Mother Bk	3	2	1.8
SuAsCo[2]	Assabet	17	11	28		Subtotal	93	72	44
	Sudbury	34	18	25					
	Concord	14	7	15		**Total**	**133**	**98**	**68**
	Subtotal	65	36	68					
Taunton	Assonet	10	5	3.4					
	Canoe	4	2	3.3					
	Cedar Swamp	3	1	0					
	Dorchester Bk	2	1	0					
	Fall Brook	3	1	0.5					
	Hockomock	4	3	2.1					
	Matfield	7	2	1.9					
	Mill	10	6	4.2					
	Nemasket	23	10	8.8					
	Rattlesnake Bk	3	1	0					
	Satucket	3	1	1.2					
	Segreganset	8	4	6.8					
	Taunton	29	12	23					
	Threemile	8	4	3.4					
	Town	19	11	6.5					
	Wading	10	5	9.9					
	Subtotal	146	69	75					
Ten Mile	Ten Mile	14	6	9.9					
	Total	**293**	**152**	**229**					

[1] Includes one HWM at North River, which is the name of the Indian Head River near its mouth.

[2] Acronym for Sudbury, Assabet, and Concord River Basins.

Potential Use of High-Water Data

HWMs provide critical information on inundation following a flood. Mapping flood inundation is greatly enhanced by the availability of LIDAR (LIght Detection and Ranging) elevation data, which provides a high level of precision and accuracy (Gesch, 2009). The Massachusetts Office of Geographic Information (MassGIS) has twice acquired LIDAR data, once for the Boston Metro area in 2002 and again in 2004 as part of an orthoimagery and LIDAR pilot project in an area adjacent to the City of Brockton, south of Boston (fig. 7). The existing LIDAR resolution is 0.75 m (meter) to 1.5 m with a vertical accuracy of 15 cm (centimeter). As part of the American Recovery and Reinvestment Act of 2009, a comprehensive LIDAR mapping program was begun in the summer of 2010 to map the coastal northeast (fig. 7) at 2-m resolution and a vertical accuracy of 15 cm (Smith and other, 2010). The LIDAR data generated by this program is not expected to be completed until September 2011. When the LIDAR data become available, the HWM elevations determined in this study can be used to define the extent and depth of flooding in the selected reaches. The new LIDAR data are expected to provide complete coverage of the Taunton, Ten Mile, South Coastal, and North Coastal Basins. The lower Ipswich Basin probably will be covered by the new LIDAR data, but other areas where HWMs exist, such as the SuAsCo, Nashua, Millers, and upper Charles Basins, will still lack LIDAR data.

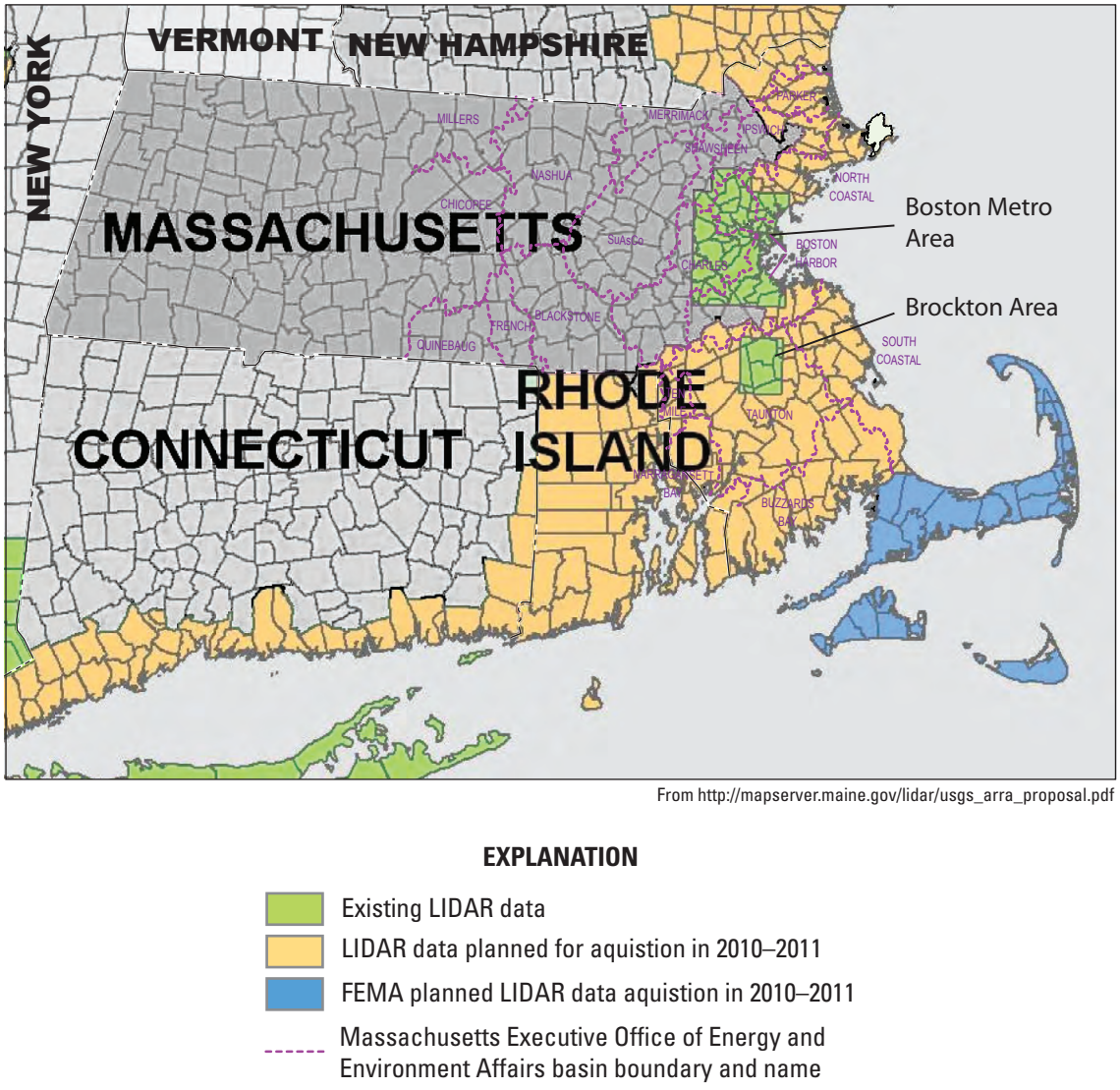


Figure 7. Areas of availability of LIght Detection and Ranging (LIDAR) data and projected 2011 LIDAR data in Massachusetts and adjacent states.

Summary

A series of widespread, large, low-pressure systems in southern New England in late February and in mid- through late March resulted in record, or near record, amounts of rainfall. The late February storm dropped nearly 5 inches of rain over the region that primed conditions for triggering the first large flood that followed the 4 to 9 inches of rain that fell between March 13 and 15, 2010. As flood waters began to recede, 2 to 5 inches of rain fell on March 22–23, maintaining wet conditions and elevating streamflows over the region. This was followed by another storm on March 29–30. The total rainfall in central and eastern Massachusetts from late February to the end of March 2010 ranged from about 17 to 25 inches, which is unprecedented in the past 100-year weather history, especially during the cool season when moisture losses to evaporation are low.

Record total rains during late February and March resulted in peak stream stages and flows that set, or nearly set, period-of-record peaks at streamgages in central and eastern Massachusetts. Streamgages in southeastern Massachusetts indicated the highest peak stages and flows generally occurred in late March–early April; at most other streamgages in central and eastern Massachusetts, the primary peaks were in mid-March. The mid-March peak flows were as little as 1 percent greater than the late March–early April peaks in the Assabet and Concord Rivers, but the differences between the mid-March peak flows and the late March–early April peak flows generally increased to the west and north of southeastern Massachusetts. In rivers and streams where the mid-March peak stages were higher than the secondary peak stages in late March–early April, the determination of the HWM was less certain because evidence of the earlier peaks may have been destroyed.

Identification of HWMs by the USGS began on April 13 and continued through May 10, 2010. Because identification of HWMs by the USGS did not begin until mid-April, field crews sometimes found two distinct high-water lines that likely resulted when the late March–early April peak was lower than the mid-March peak. The topmost evidence of high water was used when establishing a HWM, but if the overall peak occurred in mid-March, evidence of that peak could have been erased by heavy rains in late March. The MADCR marks were made shortly after peak flows in mid-March and again in March–early April by a consultant for MADCR.

The elevation of HWMs were later determined to a standard vertical datum (NAVD 88) using the Global Navigation Satellite System and survey grade Global Positioning System (GPS) receivers along with standard optical surveying equipment. Continuous real-time differential corrections to the GPS positions were made using a proprietary fixed-base station network. Quality-assurance GPS measurements made at 26 established National Geodetic Survey bench marks (BMs) with vertical datum throughout the study area (fig. 1) yielded a vertical root mean square error of 0.15 ft.

HWMs following the March 2010 floods were obtained for 25 river reaches in 7 designated EEA basins by the USGS and for 8 river reaches in 2 designated EEA basins by MADCR. The USGS identified 293 HWMs at 152 sites. A site may have more than one HWM, typically a bridge crossing with HWMs identified on the upstream and downstream sides of the bridge. The MADCR identified 133 HWMs; of these, 98 are at unique locations, and 29 were visited twice following the mid-March peaks and again after the late March peaks. The HWMs identified by the USGS and MADCR covered about 300 river miles (about 230 and 70 river miles, respectively), as determined from the upstream and downstream HWMs along a reach.

Acknowledgments

Identification of HWMs was made by USGS personnel from Water Science Centers in Massachusetts–Rhode Island (Robert Breault, Gene Parker, Mark Nimiroski, and Andy Waite), Connecticut (Elizabeth Ahearn, Karen Beaulieu, Jonathon Morrison, and Jason Pollander,) and Maine (Pamela Lombard, Nicholas Stasulis, and Greg Stewart). HWMs made for MADCR were supplied by Richard Zingarelli. Survey of HWMs was made by personnel from USGS Water Science Centers in Massachusetts–Rhode Island (Paul Friesz, Gene Parker, Andy Massey, and Andy Waite) and Ohio (Carrie Huitger, Jonathon Lageman, Chad Ostheimer, and Matthew Whitehead).

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Appendix

Appendix 1. High-water marks identified by the U.S. Geological Survey and the Massachusetts Department of Conservation and Recreation

Note, most of the information contained in the tables can be obtained electronically in a geographical information system format (shape file) at *http://pubs.usgs.gov/ofr/2010/1315*/.

- Table 1-1. High-water marks identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.
- Table 1-2. High-water marks identified by the Massachusetts Department of Conservation and Recreation following the March-April 2010 floods in eastern Massachusetts.

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS1	a600000	US1	RFB,AMW	41.99762	-70.93807	04/13/2010	Town River	Hayward St Bridge US	G	Disk	R	30.44
GS2	a600000	DS1	RFB,AMW	41.99768	-70.93703	04/13/2010	Town River	Hayward St Bridge DS	G	Disk	R	30.13
GS3	a600001	US1	RFB,AMW	41.99715	-70.97242	04/13/2010	Town River	Broad St (Rt 18) Bridge US	G	Nail	R	32.85
GS4	a600001	DS1	RFB,AMW	41.99697	-70.97183	04/13/2010	Town River	Broad St (Rt 18) Bridge US	G	Disk	L	32.51
GS5	a600002	DS1	RFB,AMW	41.99757	-70.97768	04/13/2010	Town River	Oak St Bridge DS	E	Disk	L	33.68
GS6	a600002	US1	RFB,AMW	41.99690	-70.97812	04/13/2010	Town River	Oak St Bridge US	G	Disk	R	33.90
GS7	a600003	US1	RFB,AMW	42.00188	-70.98222	04/13/2010	Town River	Lazell-Parkins Iron Works footbridge	P	Disk	R	35.09
GS8	a600003	DS1	RFB,AMW	42.00077	-70.98232	04/13/2010	Town River	Lazell-Parkins Iron Works footbridge	E	Pen	R	34.75
GS9	a600004	US1	RFB,AMW	42.00260	-70.98270	04/13/2010	Town River	High St Bridge	G	Disk	R	44.59
GS10	a600004	US2	RFB,AMW	42.00317	-70.98205	04/13/2010	Town River	High St Bridge	P	Disk	L	44.62
GS11	a600004	DS1	RFB,AMW	42.00260	-70.98270	04/13/2010	Town River	High St Bridge	P	Disk	R	43.44
GS12	a600005	DS1	RFB,AMW	42.01783	-71.00325	04/13/2010	Town River	South Main St Bridge (Rt 28)	E	Disk	L	46.94
GS13	a600005	US1	RFB,AMW	42.01735	-71.00322	04/13/2010	Town River	South Main St Bridge (Rt 28)	G	Disk	R	45.91
GS14	a600006	DS1	RFB,AMW	42.01512	-71.01173	04/13/2010	Town River	South St Bridge	G	Disk	R	55.87
GS15	a600006	US1	RFB,AMW	42.01363	-71.01242	04/13/2010	Town River	South St Bridge	F	Disk	L	57.69
GS16	Cano1	USN1	GJS,EAA	41.99539	-71.15966	04/13/2010	Canoe River	Newland St Bridge US	F	Disk	R	85.85
GS17	Cano1	DSN1	GJS,EAA	41.99514	-71.15854	04/13/2010	Canoe River	Newland St Bridge DS	G	Disk	L	85.99
GS18	Cano2	USPL1	GJS,EAA	41.97732	-71.14375	04/13/2010	Canoe River	Plain St Bridge US	F	Disk	L	71.08
GS19	Cano2	DSPL1	GJS,EAA	41.97700	-71.14401	04/13/2010	Canoe River	Plain St Bridge DS	G	Disk	R	69.33
GS20	Mill1	DSPL1	GJS,EAA	41.93417	-71.10838	04/13/2010	Mill River	Bay St Bridge US	G	Disk	R	63.66
GS21	Mill2	DSWH1	GJS,EAA	41.92316	-71.10602	04/13/2010	Mill River	Whittenton St Bridge DS	G	u	L	51.77
GS22	Mill2	USWH1	GJS,EAA	41.92355	-71.10604	04/13/2010	Mill River	Whittenton St Bridge US	F	Chisel	R	51.80
GS23	Mill3	USWB1	GJS,EAA	41.91928	-71.10147	04/13/2010	Mill River	W. Britannia St Bridge US	F	Chisel	L	49.84
GS24	Mill4	US	GJS,EAA	41.90376	-71.09766	04/13/2010	Mill River	Washington St Bridge US	F	Pen	L	25.49
GS25	Mill4	DS140	GJS,EAA	41.90322	-71.09754	04/13/2010	Mill River	Washington St Bridge DS	G	Disk	L	25.68
GS26	Mill5	US	GJS,EAA	41.89996	-71.09304	04/13/2010	Mill River	Hill St Bridge US	F	Pen	R	14.76
GS27	Mill5	DSM1	GJS,EAA	41.90014	-71.09152	04/13/2010	Mill River	Hill St Bridge DS	G	Disk	L	13.78
GS28	Mill6	DSIN1	GJS,EAA	41.89608	-71.08184	04/13/2010	Mill River	Ingell St Bridge DS	F	Disk	L	9.64
GS29	Mill6	USIN1	GJS,EAA	41.89604	-71.08237	04/13/2010	Mill River	Ingell St Bridge US	u	Disk	R	9.97
GS30	Segre1	USSEG1	GJS,EAA	41.84027	-71.14272	04/13/2010	Segreganset River	Center Rd Bridge US	G	Disk	L	40.11
GS31	Segre1	DS1	GJS,EAA	41.83989	-71.14288	04/13/2010	Segreganset River	Center Rd Bridge DS	F	Stake	R	36.96

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS32	Three1	DSCH1	GJS,EAA	41.88594	-71.13449	04/13/2010	Threemile River	Cohannet St Bridge DS	u	Disk	R	34.13
GS33	Three1	USCO1	GJS,EAA	41.88597	-71.13388	04/13/2010	Threemile River	Cohannet St Bridge US	G	Disk	R	36.31
GS34	Three2	USFI1	GJS,EAA	41.89649	-71.12807	04/13/2010	Threemile River	Fisher St Bridge US	F	Disk	R	41.13
GS35	Three2	DSFI1	GJS,EAA	41.89610	-71.12773	04/13/2010	Threemile River	Fisher St Bridge DS	F	Disk	R	40.53
GS36	Three4	USHA1	GJS,EAA	41.93395	-71.15393	04/13/2010	Threemile River	Harvey St Bridge US	F	Disk	L	56.61
GS37	Three4	DSHA1	GJS,EAA	41.93330	-71.15384	04/13/2010	Threemile River	Harvey St Bridge DS	G	Disk	L	55.37
GS38	Three5	US123	GJS,EAA	41.93330	-71.15385	04/13/2010	Threemile River	Rt 123 Bridge US	F	Disk	L	72.08
GS39	Three5	DS123	GJS,EAA	41.97270	-71.17489	04/13/2010	Threemile River	Rt 123 Bridge DS	u	Disk	R	71.48
GS40	NemR1	NRVUS1	JM,NWS	41.85975	-70.91705	04/13/2010	Nemasket River	Vaughm St Bridge US	G	Disk	L	55.83
GS41	NemR1	NRVDS1	JM,NWS	41.85963	-70.91690	04/13/2010	Nemasket River	Vaughm St Bridge DS	G	u	L	55.58
GS42	a01107400	FBWSUS1	JM,NWS	41.86528	-70.90806	04/13/2010	Fall Brook	Wood St Bridge US	F	Disk	R	54.31
GS43	a01107400	FBWSUS2	JM,NWS	41.86528	-70.90806	04/13/2010	Fall Brook	Wood St Bridge US2	F	Disk	R	54.43
GS44	a01107400	FBWSDS1	JM,NWS	41.86556	-70.90806	04/13/2010	Fall Brook	Wood St Bridge DS	F	Disk	R	54.51
GS45	NemR2	NRBUS1	JM,NWS	41.87083	-70.91306	04/13/2010	Nemasket River	Bridge St Bridge US	G	Disk	R	54.28
GS46	NemR2	NRBDS1	JM,NWS	41.87083	-70.91306	04/13/2010	Nemasket River	Bridge St Bridge DS	G	Disk	R	54.96
GS47	NemR3	NROUS1	JM,NWS	41.87167	-70.91417	04/13/2010	Nemasket River	Old Bridge St Bridge US	G	Disk	R	54.79
GS48	NemR3	NRODS1	JM,NWS	41.87167	-70.91417	04/13/2010	Nemasket River	Old Bridge St Bridge DS	G	Disk	R	54.60
GS49	NemR4	NRGDS1	JM,NWS	41.88278	-70.90833	04/13/2010	Nemasket River	East Grove St Bridge DS	u	Disk	R	53.18
GS50	NemR4	NRGUS1	JM,NWS	41.88278	-70.90833	04/13/2010	Nemasket River	East Grove St Bridge US	u	Disk	L	53.30
GS51	NemR4	NRGUS2	JM,NWS	41.88278	-70.90833	04/13/2010	Nemasket River	East Grove St Bridge US2	u	Pen	R	53.29
GS52	NemR5	NRCUS1	JM,NWS	41.89028	-70.90444	04/13/2010	Nemasket River	Center St Bridge US1	G	Paint	R	52.11
GS53	NemR5	NRCUS2	JM,NWS	41.89000	-70.90389	04/13/2010	Nemasket River	Center St Bridge US2	F	Paint	L	51.70
GS54	NemR6	NRMUS1	JM,NWS	41.89611	-70.89750	04/13/2010	Nemasket River	East Main St Bridge US1	G	Paint	R	32.88
GS55	NemR6	NRMUS2	JM,NWS	41.89611	-70.89750	04/13/2010	Nemasket River	East Main St Bridge US2	u	Disk	L	32.69
GS56	NemR6	NRMDS1	JM,NWS	41.89611	-70.89722	04/13/2010	Nemasket River	East Main St Bridge DS	G	Disk	R	32.18
GS57	NemR7	NRNUS1	JM,NWS	41.90639	-70.91306	04/13/2010	Nemasket River	Nemasket Rd Bridge US	F	Stake	L	28.10
GS58	NemR7	NRNDS1	JM,NWS	41.90611	-70.91306	04/13/2010	Nemasket River	Nemasket Rd Bridge DS	F	Pen	L	26.71
GS59	NemR8	NR44DS1	JM,NWS	41.90750	-70.91528	04/13/2010	Nemasket River	Rt 44 Bridge DS1	G	Disk	L	26.30
GS60	NemR8	NR44DS2	JM,NWS	41.90750	-70.91500	04/13/2010	Nemasket River	Rt 44 Bridge DS2	G	Pen	L	26.42
GS61	NemR8	NR44US1	JM,NWS	41.90750	-70.91472	04/13/2010	Nemasket River	Rt 44 Bridge US1	G	Stake	R	26.39
GS62	NemR9	NRPUS1	JM,NWS	41.92167	-70.92333	04/13/2010	Nemasket River	Plymouth St Bridge US (closed)	G	Disk	L	25.78

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS63	NemR9	NRPDS1	JM,NWS	41.92167	-70.92278	04/13/2010	Nemasket River	Plymouth St Bridge DS (closed)	G	Disk	R	25.36
GS64	NemR10	NRMDS1	JM,NWS	41.93361	-70.92333	04/13/2010	Nemasket River	Murdock St Bridge DS	u	Disk	L	24.79
GS65	NemR10	NRMUS1	JM,NWS	41.93361	-70.92306	04/13/2010	Nemasket River	Murdock St Bridge US	G	Disk	L	23.05
GS66	TAU10	TR104US1	JM,NWS	41.99222	-70.94000	04/13/2010	Taunton River	Rt 104 Bridge US1	G	Disk	R	30.00
GS67	TAU10	TR104DS1	JM,NWS	41.99167	-70.94000	04/13/2010	Taunton River	Rt 104 Bridge DS1	F	Disk	u	27.61
GS68	TAU10	TR104DS2	JM,NWS	41.99167	-70.94000	04/13/2010	Taunton River	Rt 104 Bridge DS2	P	Paint	u	29.84
GS69	TAU10	TR104DS3	JM,NWS	41.99222	-70.93972	04/13/2010	Taunton River	Rt 104 Bridge DS2	G	Paint	u	29.72
GS70	TAU11	TRCUS1	JM,NWS	41.97833	-70.91194	04/13/2010	Taunton River	Cherry St Bridge US1	G	Disk	R	27.52
GS71	TAU11	TRCUS2	JM,NWS	41.97833	-70.91194	04/13/2010	Taunton River	Cherry St Bridge US2	F	Paint	R	27.40
GS72	TAU11	TRCUS3	JM,NWS	41.97833	-70.91222	04/13/2010	Taunton River	Cherry St Bridge US3	G	Paint	u	27.50
GS73	TAU11	TRCDS1	JM,NWS	41.97833	-70.91194	04/13/2010	Taunton River	Cherry St Bridge DS1	u	Disk	R	27.25
GS74	TAU12	TRAUS1	JM,NWS	41.96333	-70.91222	04/13/2010	Taunton River	Auburn St Bridge US (closed)	u	Disk	R	26.30
GS75	TAU12	TRADS1	JM,NWS	41.96333	-70.91222	04/13/2010	Taunton River	Auburn St Bridge dS (closed)	F	Nail	R	26.15
GS76	Wad1	DSW140	GJS,EAA	41.97270	-71.17489	04/14/2010	Wading River	Rt 140 Bridge DS	F	Disk	R	66.27
GS77	Wad1	USW140	GJS,EAA	41.94687	-71.17690	04/14/2010	Wading River	Rt 140 Bridge US	G	Disk	R	66.46
GS78	Wad1	USW140B	GJS,EAA	41.94668	-71.17695	04/14/2010	Wading River	Rt 140 Bridge US2	F	Disk	R	67.19
GS79	Wad2	USW123	GJS,EAA	41.94671	-71.17695	04/14/2010	Wading River	Rt 123 Bridge US	F	Disk	L	94.88
GS80	Wad2	DSW123	GJS,EAA	41.95209	-71.22352	04/14/2010	Wading River	Rt 123 Bridge DS	G	Disk	R	93.89
GS81	Wad3	USWRI1	GJS,EAA	41.97758	-71.24489	04/14/2010	Wading River	Richardson Rd (Rt 123) Bridge US	G	Disk	R	107.95
GS82	Wad3	DSWRI1	GJS,EAA	41.97738	-71.24488	04/14/2010	Wading River	Richardson Rd (Rt 123) Bridge DS	u	Chisel	R	106.97
GS83	Wad4	USWAD1	GJS,EAA	41.98953	-71.25461	04/14/2010	Wading River	Otis St Bridge US	G	Disk	L	122.78
GS84	Wad4	DSWAD1	GJS,EAA	41.98919	-71.25460	04/14/2010	Wading River	Otis St Bridge DS	F	Hub	R	117.51
GS85	Wad5	DSBA	GJS,EAA	41.99910	-71.26011	04/14/2010	Wading River	Balcom St Bridge DS	G	Disk	R	127.38
GS86	Ten1	DSTENRI1	GJS,EAA	41.94491	-71.28796	04/14/2010	Tenmile River	Riverbank Rd Bridge DS	G	Disk	R	113.33
GS87	Ten1	USTENRI1	GJS,EAA	41.94470	-71.28852	04/14/2010	Tenmile River	Riverbank Rd Bridge US	G	Disk	R	113.60
GS88	Ten2	USTIF	GJS,EAA	41.91787	-71.30565	04/14/2010	Tenmile River	Tiffany St Bridge US	G	Pen	L	90.81
GS89	Ten2	DSTIF	GJS,EAA	41.91774	-71.30580	04/14/2010	Tenmile River	Tiffany St Bridge DS	G	Pen	L	90.03
GS90	Sev1	DS7MR1	GJS,EAA	41.92563	-71.34155	04/14/2010	Tenmile River	Read St Bridge DS	G	Disk	L	86.61
GS91	Sev1	US7MR1	GJS,EAA	41.92580	-71.34142	04/14/2010	Tenmile River	Read St Bridge US	G	Disk	L	89.15
GS92	Sev1	US7MR2	GJS,EAA	41.92590	-71.34150	04/14/2010	Tenmile River	Read St Bridge US2	F	Disk	R	89.66
GS93	Ten4	USTENMR1	GJS,EAA	41.83109	-71.35068	04/14/2010	Tenmile River	Rt 1 Bridge US	G	Disk	R	19.64

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS94	Ten4	USTENMR2	GJS,EAA	41.83043	-71.35117	04/14/2010	Tenmile River	Rt 1 Bridge US2	G	Disk	L	18.07
GS95	Ten4	DSTENMR1	GJS,EAA	41.83085	-71.35144	04/14/2010	Tenmile River	Rt 1 Bridge DS	G	Disk	R	19.81
GS96	Ten5	DSTEN114	GJS,EAA	41.82956	-71.32389	04/14/2010	Tenmile River	Rt 114 Bridge DS	G	Disk	L	40.75
GS97	Ten5	USTEN114	GJS,EAA	41.82985	-71.34373	04/14/2010	Tenmile River	Rt 114 Bridge US	G	Disk	L	39.89
GS98	Ten6	USTENC	GJS,EAA	41.89036	-71.33978	04/14/2010	Tenmile River	Central Ave Bridge US	F	Disk	L	66.74
GS99	Ten6	DSTENC	GJS,EAA	41.88998	-71.34022	04/14/2010	Tenmile River	Central Ave Bridge DS	G	Disk	L	64.11
GS100	TAU1	TRSSUS1	JM,NWS	41.94750	-70.93694	04/14/2010	Taunton River	Sumer St/ Woodward Bridge US	u	Disk	R	25.58
GS101	TAU1	TRSSDS1	JM,NWS	41.94694	-70.93583	04/14/2010	Taunton River	Sumer St/ Woodward Bridge DS	G	Disk	L	25.18
GS102	TAU2	TRTSUS1	JM,NWS	41.93444	-70.95750	04/14/2010	Taunton River	Titocus St Bridge US (gage 01108000)	F	Disk	R	23.28
GS103	TAU2	TRTSDS1	JM,NWS	41.93417	-70.95611	04/14/2010	Taunton River	Titocus St Bridge DS (gage 01108000)	G	Disk	R	23.41
GS104	TAU2	TRTSUS2	JM,NWS	41.93389	-70.95639	04/14/2010	Taunton River	Titocus St Bridge US2 (gage 01108000)	G	Stake	R	23.70
GS105	TAU3	TR18US1	JM,NWS	41.93667	-70.96556	04/14/2010	Taunton River	Rt 18 Bridge US	G	Disk	R	23.15
GS106	TAU3	TR18DS1	JM,NWS	41.93722	-70.96556	04/14/2010	Taunton River	Rt 18 Bridge DS	G	Disk	R	22.91
GS107	TAU4	TRPSUS1	JM,NWS	41.93611	-70.98750	04/14/2010	Taunton River	Plymouth St Bridge US	G	Disk	R	21.17
GS108	TAU4	TRPSDS1	JM,NWS	41.93611	-70.98750	04/14/2010	Taunton River	Plymouth St Bridge DS	G	Disk	R	21.25
GS109	TAU5	TRVSDS1	JM,NWS	41.93194	-70.99306	04/14/2010	Taunton River	Vernon St Bridge DS	G	Disk	L	20.33
GS110	TAU5	TRVSUS1	JM,NWS	41.93250	-70.99306	04/14/2010	Taunton River	Vernon St Bridge DS	G	Disk	R	20.47
GS111	TAU6	TR44US1	JM,NWS	41.90361	-70.99583	04/14/2010	Taunton River	Rt 44 Bridge US	u	Disk	R	17.98
GS112	TAU6	TR44DS1	JM,NWS	41.90278	-70.99639	04/14/2010	Taunton River	Rt 44 Bridge DS	G	Disk	R	17.89
GS113	TAU7	TROSUS1	JM,NWS	41.88556	-71.02972	04/14/2010	Taunton River	Old Colony St Bridge US	G	Disk	L	15.01
GS114	TAU7	TROSDS1	JM,NWS	41.88611	-71.03000	04/14/2010	Taunton River	Old Colony St Bridge DS	G	Disk	R	14.38
GS115	TAU8	TRLRDS1	JM,NWS	41.90306	-71.07556	04/14/2010	Taunton River	Long Meadow Rd Bridge DS	F	Disk	L	11.36
GS116	TAU8	TRLRUS1	JM,NWS	41.90278	-71.07528	04/14/2010	Taunton River	Long Meadow Rd Bridge US	G	Disk	L	11.50
GS117	TAU9	TRPSUS1	JM,NWS	41.88639	-71.08833	04/14/2010	Taunton River	Plain St Bridge US	G	Disk	L	8.04
GS118	TAU9	TRPSDS1	JM,NWS	41.88528	-71.08861	04/14/2010	Taunton River	Plain St Bridge DS	G	Disk	L	8.24
GS119	AssoR1	AR79US1	GJS,NWS	41.79381	-71.06712	04/14/2010	Assonet River	Rt 79 Bridge US	G	Disk	C	5.78
GS120	AssoR1	AR79DS1	GJS,NWS	41.79374	-71.06775	04/14/2010	Assonet River	Rt 79 Bridge DS	G	Disk	L	5.33
GS121	AssoR2	AREDS1	GJS,NWS	41.79539	-71.06581	04/14/2010	Assonet River	Elm St Bridge & dam DS	G	Chisel	L	6.67
GS122	AssoR2	AREUS1	GJS,NWS	41.79575	-71.06592	04/14/2010	Assonet River	Elm St Bridge & dam US	F	Hub	L	7.78
GS123	AssoR2	AREUS2	GJS,NWS	41.79602	-71.06582	04/14/2010	Assonet River	Elm St Bridge & dam US2	G	Chisel	L	13.90
GS124	AssoR3	ARLSDS1	GJS,NWS	41.79907	-71.06038	04/14/2010	Assonet River	Locust St Bridge DS	F	Disk	L	22.09

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

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GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS125	AssoR3	ARLSUS1	GJS,NWS	41.79935	-71.05995	04/14/2010	Assonet River	Locust St Bridge US	F	Disk	L	Destroyed
GS126	AssoR3	ARLSUS2	GJS,NWS	41.79950	-71.05938	04/14/2010	Assonet River	Locust St Bridge US2 above low head dam	G	Disk	L	32.75
GS127	a600007	TRFDS1	RFB,AMW	42.01347	-72.68183	04/14/2010	Town River	Forest St Bridge DS	G	Disk	L	57.70
GS128	a600008	TRFUS1	RFB,AMW	42.00142	-71.01820	04/14/2010	Town River	Forest St Bridge US	G	Disk	R	59.94
GS129	FEMA1	Clinton	FEMA	42.00083	-71.01944	–	Town River?	60 Clinton Rd W.Bridgewater	–	–	–	No HWM
GS130	a600009	TRSUS1	RFB,AMW	41.99213	-71.02613	04/14/2010	Town River	Scotland Rd Bridge US1	F	Disk	L	59.90
GS131	a600010	TR24US1	RFB,AMW	41.99068	-71.02898	04/14/2010	Town River	Rt 24 south Bridge US	G	Disk	L	60.51
GS132	a600100	HRMUS1	RFB,AMW	41.99188	-71.04323	04/14/2010	Hockomock River	Maple St culvert US	F	Disk	R	63.08
GS133	a600011	HR106US1	RFB,AMW	42.01122	-71.05860	04/14/2010	Hockomock River	Rt 106 (w. Center St) Bridge US1	G	Disk	R	68.84
GS134	a600011	HR106DS1	RFB,AMW	42.01085	-71.05837	04/14/2010	Hockomock River	Rt 106 (w. Center St) Bridge DS1	P	Disk	R	67.53
GS135	a600012	HRMSDS1	RFB,AMW	42.01587	-71.05068	04/14/2010	Hockomock River	Manley St Bridge DS	F	Disk	L	70.04
GS136	a700000	ARMDS1	RFB,AMW	42.26982	-71.63263	04/15/2010	Assabet River	Mill St Bridge DS	F	Stake	L	Destroyed
GS137	a700000	ARMUS1	RFB,AMW	42.26927	-71.63327	04/15/2010	Assabet River	Mill St Bridge US	F	Stake	R	295.16
GS138	a700001	ARFDS1	RFB,AMW	42.27112	-71.63240	04/15/2010	Assabet River	Fisher St Bridge DS	P	Disk	R	285.65
GS139	a700001	ARFUS1	RFB,AMW	42.27113	-71.63277	04/15/2010	Assabet River	Fisher St Bridge US	F	Disk	R	287.72
GS140	a700002	ARMSUS1	RFB,AMW	42.27397	-71.63240	04/15/2010	Assabet River	Maynard St Bridge US	P	Disk	R	279.10
GS141	a700003	AR9US1	RFB,AMW	42.28343	-71.63862	04/15/2010	Assabet River	Rt 9 east St Bridge US	F	Disk	R	272.61
GS142	a700004	AR135DS1	RFB,AMW	42.29477	-71.63743	04/15/2010	Assabet River	Rt 135 St Bridge US	F	Disk	L	273.64
GS143	a700005	ARADS1	RFB,AMW	42.33000	-73.29700	04/15/2010	Assabet River	Allen St Bridge DS	F	Disk	R	239.72
GS144	a700005	ARAUS1	RFB,AMW	42.32948	-71.63002	04/15/2010	Assabet River	Allen St Bridge US	E	Pen	L	248.59
GS145	a700006	ARRDS1	RFB,AMW	42.34652	-73.28117	04/15/2010	Assabet River	Robin St Bridge DS	G	Disk	R	217.45
GS146	SUD1	SRFUS1	PJL,GWP	42.26833	-71.55272	04/15/2010	Sudbury River	Fruit St Bridge US	G	Disk	R	273.30
GS147	SUD1	SRFDS1	PJL,GWP	42.26725	-71.55243	04/15/2010	Sudbury River	Fruit St Bridge DS	u	Disk	R	272.85
GS148	SUD2	SRFCUS1	PJL,GWP	42.26468	-71.53662	04/15/2010	Sudbury River	Fay Court Bridge US	P	Disk	L	254.25
GS149	SUD2	SRFCDS1	PJL,GWP	42.26490	-71.53607	04/15/2010	Sudbury River	Fay Court Bridge DS	P	Disk	L	253.95
GS150	SUD3	SRRSUS1	PJL,GWP	42.26652	-71.52257	04/15/2010	Sudbury River	River St Bridge US	P	Stake	L	233.39
GS151	SUD3	SRRSDS1	PJL,GWP	42.26632	-71.52225	04/15/2010	Sudbury River	River St Bridge DS	G	Pen	R	233.20
GS152	SUD4	SRCSUS1	PJL,GWP	42.26225	-71.46342	04/15/2010	Sudbury River	Concord St Bridge DS	P	Pen	L	176.31
GS153	01097480	SRGDS1	PJL,GWP	42.26020	-71.45605	04/15/2010	Sudbury River	228 Front St Bridge (discont gage) DS	F	Disk	L	175.72
GS154	01097480	SRGUS1	PJL,GWP	42.25652	-71.45652	04/15/2010	Sudbury River	228 Front St Bridge (discont gage) US	P	Disk	R	173.52
GS155	SUD5	SRUUS1	PJL,GWP	42.25877	-71.45515	04/15/2010	Sudbury River	Union St Bridge US	F	Disk	L	174.40

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS156	SUD5	SRUDS1	PJL,GWP	42.25822	-71.45548	04/15/2010	Sudbury River	Union St Bridge DS	F	Disk	R	173.89
GS157	SUD6	SRResUS1	PJL,GWP	42.29078	-71.44292	04/15/2010	Sudbury River	nr Reservoir 1 dam US	F	Disk	R	163.34
GS158	SUD7	SRFSDS1	PJL,GWP	42.29208	-71.43022	04/15/2010	Sudbury River	Franklin St Bridge DS	F	Disk	L	155.99
GS159	SUD8	SRMSUS1	PJL,GWP	42.29697	-71.42745	04/15/2010	Sudbury River	Main St Bridge US	F	Disk	L	150.36
GS160	SUD8	SRMSDS1	PJL,GWP	42.29717	-71.42738	04/15/2010	Sudbury River	Main St Bridge DS	G	Disk	L	154.56
GS161	SUD9	SRCSUS1	PJL,GWP	42.30585	-71.43082	04/15/2010	Sudbury River	Center St Bridge US	P	Disk	R	152.22
GS162	SUD9	SRCSDS1	PJL,GWP	42.30618	-71.43122	04/15/2010	Sudbury River	Center St Bridge DS	G	Disk	R	151.97
GS163	SUD10	SRFRUS1	PJL,GWP	42.31255	-71.41658	04/15/2010	Sudbury River	Fenwick Rd Bridge US (closed)	G	Disk	R	149.44
GS164	SUD10	SRFRMRB	PJL,GWP	42.31255	-71.41658	04/15/2010	Sudbury River	Fenwick Rd Bridge mid R US (closed)	F	Pen	R	148.65
GS165	SUD10	SRFRDS1	PJL,GWP	42.31255	-71.41658	04/15/2010	Sudbury River	Fenwick Rd Bridge DS (closed)	G	Disk	L	148.62
GS166	SUD11	SRPRUS1	PJL,GWP	42.33880	-71.39378	04/15/2010	Sudbury River	Potter Rd Bridge US	F	Disk	R	120.70
GS167	SUD11	SRPRDS1	PJL,GWP	42.33880	-71.39378	04/15/2010	Sudbury River	Potter Rd Bridge DS	F	Disk	R	121.39
GS168	SUD12	SROSRUS1	PJL,GWP	42.37397	-71.38195	04/15/2010	Sudbury River	Old Sudbury Rd Bridge US	G	Disk	L	120.08
GS169	SUD12	SROSRDS1	PJL,GWP	42.37397	-71.38195	04/15/2010	Sudbury River	Old Sudbury Rd Bridge DS	F	Disk	L	119.49
GS170	AssaR4	USPIN	EAA,KMB	42.45167	-71.39278	04/22/2010	Assabet River	Pine St Bridge. US	F	Nail	L	122.48
GS171	AssaR4	DSPIN	EAA,KMB	42.45194	-71.39278	04/22/2010	Assabet River	Pine St Bridge. DS	F	Nail	L	122.81
GS172	AssaR5	DSPWD	EAA,KMB	42.44056	-71.42861	04/22/2010	Assabet River	Rt62-Powder Mill Rd Bridge DS	G	Nail	R	131.93
GS173	AssaR5	DSPWD	EAA,KMB	42.44139	-71.42972	04/22/2010	Assabet River	Rt62-Powder Mill Rd Bridge US	F	Nail	R	132.70
GS174	AssaR6	USWAL	EAA,KMB	42.43222	-71.44972	04/22/2010	Assabet River	Waltham Rd Bdrg. US	F	Nail	R	148.16
GS175	AR7-gage	DSRT85	EAA,KMB	42.39028	-71.56889	04/22/2010	Assabet River	At USGS gage 01096840	G	Nail	L	202.79
GS176	AssaR8	DSPRT	EAA,KMB	42.38556	-71.57639	04/22/2010	Assabet River	Arch Foot Bridge off Port St US	F	Paint	L	208.79
GS177	a800000	NR1US1	AMW,RFB	42.41882	-71.66623	04/22/2010	Nashua River	Water St Bridge. US	F	Disk	L	253.92
GS178	a800000	NR1DS1	AMW,RFB	42.42013	-71.66680	04/22/2010	Nashua River	Water St Bridge. DS	F	Pen	L	255.77
GS179	a800001	WWTP1	AMW,RFB	42.43177	-71.67885	04/22/2010	Nashua River	Clinton WWTP	u	Nail	L	241.33
GS180	a800002	NR110DS1	AMW,RFB	42.43297	-71.68158	04/22/2010	Nashua River	Rt 110 Bridge DS1	G	Disk	R	242.64
GS181	a800002	NR110US1	AMW,RFB	42.43297	-71.68028	04/22/2010	Nashua River	Rt 110 Bridge US1	G	Disk	R	243.31
GS182	a800003	NR2US1	AMW,RFB	42.43817	-71.68155	04/22/2010	Nashua River	Mill St Bridge US1	G	Nail	L	239.29
GS182A	a800003	NR2US2	AMW,RFB	42.43817	-71.68155	04/22/2010	Nashua River	Mill St Bridge US2 (debris line 210 Mill St)	G	Nail	L	238.92
GS183	CRMon	DSMON	EAA,DMB	42.47083	-71.34944	04/23/2010	Concord River	Monument St Bridge DS	G	Nail	R	118.44
GS184	CRMon	USMON	EAA,DMB	42.47139	-71.35000	04/23/2010	Concord River	Monument St Bridge US	G	Paint	R	118.50
GS185	CRLR	USLOW	EAA,DMB	42.46611	-71.35556	04/23/2010	Concord River	Lowell Rd Bridge US	G	Nail	R	119.27

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS186	CRLR	DSLOW	EAA,DMB	42.46722	-71.35556	04/23/2010	Concord River	Lowell Rd Bridge DS	G	Nail	L	118.94
GS187	SUDSGR	DSSGR	EAA,DMB	42.42000	-71.36528	04/23/2010	Sudbury River	South Great Rd Bridge DS	G	Nail	R	120.23
GS188	SUDSGR	USSGR	EAA,DMB	42.42028	-71.36500	04/23/2010	Sudbury River	South Great Rd Bridge US	G	Nail	R	120.09
GS189	SUDSR	USSHM	EAA,DMB	42.39667	-71.36444	04/23/2010	Sudbury River	Sherman Rd Bridge US	G	Nail	L	118.98
GS190	SUDSR	DSSHM	EAA,DMB	42.39667	-71.36417	04/23/2010	Sudbury River	Sherman Rd Bridge DS	G	Nail	L	119.98
GS191	SUDRR	USRR	EAA,DMB	42.37528	-71.38000	04/23/2010	Sudbury River	River Rd Bridge (abondoned) US	G	Nail	L	120.26
GS192	SUDRR	DSRR	EAA,DMB	42.37528	-71.38000	04/23/2010	Sudbury River	River Rd Bridge (abondoned) DS	G	Nail	L	120.24
GS193	SUDPEL	DSPEL	EAA,DMB	42.35889	-71.36889	04/23/2010	Sudbury River	Pelham Inland Rd Bridge DS	P	Nail	L	121.10
GS194	SUDPEL	USPEL	EAA,DMB	42.35861	-71.36944	04/23/2010	Sudbury River	Pelham Inland Rd Bridge US	P	Nail	L	120.61
GS195	SUDSTB	USSTB	EAA,DMB	42.33861	-71.39444	04/23/2010	Sudbury River	Stonebridge Rd Bridge US	F	Nail	R	121.47
GS196	SUDDR	DSKNG	EAA,DMB	42.32583	-71.39694	04/23/2010	Sudbury River	Danforth Rd Bridge DS (01098530)	P	Nail	R	123.54
GS197	SUDDR	USKNG	EAA,DMB	42.32583	-71.39694	04/23/2010	Sudbury River	Danforth Rd Bridge US (01098530) staff Hgt	–	–	–	NF
GS198	CRRt225	DSC225	EAA,DMB	42.50889	-71.31333	04/28/2010	Concord River	Rt 225 Bridge DS	G	Nail	R	117.99
GS199	CRRt225	USC225	EAA,DMB	42.50861	-71.31361	04/28/2010	Concord River	Rt 225 Bridge US	u	Nail	R	118.10
GS200	CRRt4	USC4	EAA,DMB	42.53472	-71.30028	04/28/2010	Concord River	Rt 4 Bridge US	G	Nail	L	117.68
GS201	CRRt4	DSC4	EAA,DMB	42.53556	-71.29972	04/28/2010	Concord River	Rt 4 Bridge DS	G	Nail	L	117.75
GS202	CRRS	USCRS	EAA,DMB	42.55694	-71.28306	04/28/2010	Concord River	River St Bridge US	G	Nail	L	117.21
GS203	CRRS	DSCRS	EAA,DMB	42.55722	-71.28306	04/28/2010	Concord River	River St Bridge DS	u	Nail	L	117.33
GS204	CRRt3A	USCRS	EAA,DMB	42.57389	-71.28000	04/28/2010	Concord River	Rt 3A Bridge US	G	Nail	R	117.22
GS205	CRRt3A	DSCRS	EAA,DMB	42.57444	-71.27972	04/28/2010	Concord River	Rt 3A Bridge DS	G	Nail	R	116.13
GS206	CRFS	USCFM	EAA,DMB	42.59222	-71.28361	04/28/2010	Concord River	Faulkner St Bridge US	G	Nail	R	113.80
GS207	CRFS	DSCFM	EAA,DMB	42.59194	-71.28472	04/28/2010	Concord River	Faulkner St Bridge DS	F	Nail	R	106.68
GS208	NRRt119	USN119	EAA,DMB	42.62639	-71.59278	04/29/2010	Nashua River	Rt 119 Bridge becomes Rt 111 US	F	Paint	R	207.28
GS209	NRRt119	DSN119	EAA,DMB	42.62667	-71.59278	04/29/2010	Nashua River	Rt 119 Bridge becomes Rt 111 DS	F	Nail	R	206.22
GS210	NRRt225	USN225	EAA,DMB	42.60583	-71.59889	04/29/2010	Nashua River	Rt 225 Bridge US	F	Nail	R	210.22
GS211	NRRt225	DSN225	EAA,DMB	42.60583	-71.59889	04/29/2010	Nashua River	Rt 225 Bridge DS	G	Nail	R	209.46
GS212	NRRt2A	USN2A	EAA,DMB	42.57806	-71.61000	04/29/2010	Nashua River	Rt 2A (Great Rd) Bridge US	G	Paint	L	214.99
GS213	NRRt2A	DSN2A	EAA,DMB	42.57806	-71.60917	04/29/2010	Nashua River	Rt 2A (Great Rd) Bridge DS	P	Nail	R	214.25
GS214	NRWMD	DSN2A	EAA,DMB	42.55250	-71.61917	04/29/2010	Nashua River	West Main St DS above low head dam	u	Nail	L	222.13
GS215	NRHS	–	EAA,DMB	42.54111	-71.63389	04/29/2010	Nashua River	Hospital Rd Bridge (no mark obs)	–	–	–	No HWM
GS216	NRJR	USNJR	EAA,DMB	42.52278	-71.63250	04/29/2010	Nashua River	Jackson Rd Bridge US	G	Nail	R	223.78

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

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GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS217	NRJR	USNJR	EAA,DMB	42.52278	-71.63278	04/29/2010	Nashua River	Jackson Rd Bridge DS	G	Nail	R	223.68
GS218	NRRt117	USN117	EAA,DMB	42.46111	-71.65667	04/29/2010	Nashua River	Rt 117 Bridge US	u	Nail	L	229.52
GS219	400001	IpsWSDS	RFB,GWP	42.55361	-71.14361	05/05/2010	Ipswich River	Woburn St Bridge DS	P	Disk	R	77.27
GS220	400001	IpsWSUS	RFB,GWP	42.55389	-71.14389	05/05/2010	Ipswich River	Woburn St Bridge US	G	Disk	R	76.40
GS221	400002	IpsMSUS	RFB,GWP	42.56470	-71.10802	05/05/2010	Ipswich River	Main St Bridge US	P	Disk	L	70.52
GS222	400002	IpsMSDS	RFB,GWP	42.56470	-71.10802	05/05/2010	Ipswich River	Main St Bridge DS	P	Disk	R	70.07
GS223	400003	IpsPSUS	RFB,GWP	42.57457	-71.07298	05/06/2010	Ipswich River	Park St Bridge US	P	Disk	R	68.08
GS224	400003	IpsPSDS	RFB,GWP	42.57472	-71.07333	05/06/2010	Ipswich River	Park St Bridge DS	P	Disk	L	64.79
GS225	4004	IpsMSUS	GWP,GCB	42.56111	-71.11083	05/06/2010	Ipswich River	Mill St Bridge US	F	Disk	R	72.51
GS226	4004	IpsMSDS	GWP,GCB	42.56139	-71.11056	05/06/2010	Ipswich River	Mill St Bridge US	F	Disk	R	71.74
GS227	4005	MBPSUS	GWP,GCB	42.57167	-71.10139	05/06/2010	Martins Brook	Park St Bridge US	F	Disk	L	68.62
GS228	4005	MBPSDS	GWP,GCB	42.57167	-71.10111	05/06/2010	Martins Brook	Park St Bridge DS	P	Disk	L	66.87
GS229	4006	IpsGDS	GWP,GCB	42.56944	-71.02611	05/06/2010	Ipswich River	at gage 01101500	F	u	R	52.59
GS230	4007	IpsRt114US	GWP,GCB	42.57389	-70.99361	05/06/2010	Ipswich River	Rt 114 Bridge US	P	Disk	R	48.32
GS231	4007	IpsRt114DS	GWP,GCB	42.57389	-70.99333	05/06/2010	Ipswich River	Rt 114 Bridge DS	G	Disk	R	49.13
GS232	6001	SRBSDS	GCB, JMP	41.82556	-71.12667	05/07/2010	Segreganset River	Brook St Bridge DS	F	Disk	L	8.12
GS233	6001	SRBSUS	GCB, JMP	41.82583	-71.12694	05/07/2010	Segreganset River	Brook St Bridge US	P	Disk	L	6.38
GS234	6002	SRMSDS	GCB, JMP	41.85750	-71.16528	05/07/2010	Segreganset River	Maple St Bridge DS	G	None	L	74.80
GS235	6002	SRMSDS	GCB, JMP	41.85778	-71.16556	05/07/2010	Segreganset River	Maple St Bridge DS	P	Disk	L	72.66
GS236	6003	SRGSDS	GCB, JMP	41.88028	-71.17194	05/07/2010	Segreganset River	Gulliver St Bridge US	P	Disk	L	88.57
GS237	6003	SRGSDS	GCB, JMP	41.88000	-71.17167	05/07/2010	Segreganset River	Gulliver St Bridge US	G	Disk	L	85.79
GS238	6004	MRBSUS	GCB, JMP	42.00583	-70.94306	05/07/2010	Matfield River	Bridge St Bridge US	F	Disk	R	33.89
GS239	6004	MRBSDS	GCB, JMP	42.00556	-70.94250	05/07/2010	Matfield River	Bridge St Bridge DS 1	G	None	R	33.29
GS240	6004	MRBSDS2	GCB, JMP	42.00611	-70.94250	05/07/2010	Matfield River	Bridge St Bridge DS 2	P	Disk	R	32.69
GS241	300000	ORRt2ADS	GCB, RFB	42.56472	-72.01167	05/09/2010	Otter River	Rt 2A Bridge US	P	Disk	L	919.11
GS242	300001	ORRt101US	GCB, RFB	42.57361	-72.01639	05/09/2010	Otter River	Rt 101 Bridge US	G	Disk	L	916.71
GS243	300001	ORRt101DS	GCB, RFB	42.57417	-72.01639	05/09/2010	Otter River	Rt 101 Bridge DS	G	Disk	L	916.43
GS244	1163200	ORGDS	GCB, RFB	42.58833	-72.04139	05/09/2010	Otter River	at gage 01153200 CSG	u	u	u	897.84
GS245	300002	ORMSUS	GCB, RFB	42.59583	-72.05194	05/09/2010	Otter River	Main St Bridge US	G	Disk	L	877.55
GS246	300002	ORMSDS	GCB, RFB	42.59556	-72.05250	05/09/2010	Otter River	Main St Bridge DS	P	Stake	L	876.27
GS247	300003	ORMAUS	GCB, RFB	42.60639	-72.08167	05/09/2010	Otter River	Maple St Bridge US	G	Disk	L	836.02

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GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS247A	300003	ORMAUS2	GCB, RFB	42.60639	-72.08167	05/09/2010	Otter River	Maple St Bridge US2	G	Disk	L	836.85
GS248	300003	ORMADS	GCB, RFB	42.60639	-72.08167	05/09/2010	Otter River	Maple St Bridge DS	G	Disk	L	NF
GS249	300004	ORRt68DS	GCB, RFB	42.60667	-72.07556	05/09/2010	Otter River	Rt 68 St Bridge DS	P	Disk	R	845.81
GS250	300004	ORRt68US	GCB, RFB	42.60639	-72.07472	05/09/2010	Otter River	Rt 68 St Bridge US	P	Disk	L	846.35
GS251	IpsCem	IpsCMUS1	GWP,GCB	42.67472	-70.83806	05/10/2010	Ipswich River	Foobridge behind cemetary US1	P	Disk	R	13.52
GS252	IpsCem	IpsCMUS2	GWP,GCB	42.67778	-70.83806	05/10/2010	Ipswich River	Foobridge behind cemetary US2	F	Pen	L	20.77
GS253	8002	IpsMRDS	GWP,GCB	42.65833	-70.86111	05/10/2010	Ipswich River	Mill Rd Bridge DS	G	Disk	L	21.12
GS254	8002	IpsMRUS	GWP,GCB	42.65833	-70.86167	05/10/2010	Ipswich River	Mill Rd Bridge US	G	Disk	L	21.88
GS255	1102000	IpsGUS	GWP,GCB	42.65972	-70.89361	05/10/2010	Ipswich River	at gage 01102000	G	Disk	L	29.76
GS256	IpsAS	IpsASUS	GWP,GCB	42.65389	-70.91222	05/10/2010	Ipswich River	Asbury St Bridge US	G	Disk	L	34.50
GS257	IpsAS	IpsASDS1	GWP,GCB	42.65389	-70.91167	05/10/2010	Ipswich River	Asbury St Bridge DS1	F	Disk	L	32.27
GS258	IpsAS	IpsASDS2	GWP,GCB	42.65389	-70.91194	05/10/2010	Ipswich River	Asbury St Bridge DS2	P	Pen	L	31.90
GS259	IpsSR	IpsSRUS	GWP,GCB	42.62583	-70.95000	05/10/2010	Ipswich River	Salem Rd Bridge US	F	Disk	R	40.07
GS260	IpsSR	IpsSRDS	GWP,GCB	42.62556	-70.94944	05/10/2010	Ipswich River	Salem Rd Bridge DS	G	Disk	R	40.36
GS261	IpsRBR	IpsRBRUS1	GWP,GCB	42.62694	-70.96694	05/10/2010	Ipswich River	Rowley Bridge Rd Bridge US1	P	Disk	R	38.98
GS262	IpsRBR	IpsRBRUS2	GWP,GCB	42.62667	-70.96722	05/10/2010	Ipswich River	Rowley Bridge Rd Bridge US2	P	Disk	R	39.28
GS263	IpsRBR	IpsRBRDS	GWP,GCB	42.62694	-70.96667	05/10/2010	Ipswich River	Rowley Bridge Rd Bridge DS	G	Disk	R	41.24
GS264	IpsES	IpsESDS	GWP,GCB	42.61944	-70.98750	05/10/2010	Ipswich River	Elm St Bridge DS	P	Disk	R	40.98
GS265	IpsES	IpsESUS	GWP,GCB	42.61972	-70.98833	05/10/2010	Ipswich River	Elm St Bridge US	F	Disk	L	37.23
GS266	IpsRt62	IpsRt62US	GWP,GCB	42.59528	-70.99639	05/10/2010	Ipswich River	Rt 62 Bridge US	P	Disk	R	46.57
GS267	IpsRt62	IpsRt62DS	GWP,GCB	42.59611	-70.99667	05/10/2010	Ipswich River	Rt 62 Bridge DS	F	Disk	L	46.36
GS268	NROWS	NROWSUS	GWP,GCB	42.10861	-70.80722	05/11/2010	North River	Old Washington Rd Bridge US (tidal)	F	Disk	L	Destroyed
GS269	1105730	IHRGUS	GWP,GCB	42.10000	-70.82417	05/11/2010	Indian Head River	at gage 01105730 Elm St Bridge US	u	Pen	R	16.67
GS270	1105730	IHRGDS1	GWP,GCB	42.10056	-70.82306	05/11/2010	Indian Head River	at gage 01105730 Elm St Bridge DS1 (CSG)	–	–	R	Not done
GS271	1105730	IHRGDS2	GWP,GCB	42.10056	-70.82306	05/11/2010	Indian Head River	at gage 01105730 Elm St Bridge DS2	P	Disk	R	9.97
GS272	IHRCS	IHRCSUS	GWP,GCB	42.09583	-70.84917	05/11/2010	Indian Head River	Cross St Bridge US	P	Disk	L	38.02
GS273	IHRCS	IHRCSDS	GWP,GCB	42.09611	-70.84861	05/11/2010	Indian Head River	Cross St Bridge DS	F	Disk	L	34.84
GS274	IHRBW	IHRBWUS	GWP,GCB	42.09000	-70.86583	05/11/2010	Indian Head River	Broadway St Bridge US	F	Disk	R	44.15
GS275	IHRBW	IHRBWDS	GWP,GCB	42.09056	-70.86528	05/11/2010	Indian Head River	Broadway St Bridge DS	P	Disk	R	43.44
GS276	IHRKS	IHRKSDS1	GWP,GCB	42.10389	-70.87750	05/11/2010	Indian Head River	King St Bridge DS1	P	None	L	68.00
GS277	IHRKS	IHRKSDS2	GWP,GCB	42.10417	-70.87750	05/11/2010	Indian Head River	King St Bridge DS2	P	None	L	68.00

Table 1-1. High-water marks (HWMs) identified by the U.S. Geological Survey following the March–April 2010 floods in central and eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position survery (GPS), Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– E, excellent; G, good; F, fair; P, poor; u, undetermined; Mark– type of mark; u, unspecified; Bank– R, right; L, left; u, undetermined; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, Not Found; –, not applicable or unknown]

GPS_ID	Site_ID	HWM_ID	Party	Lat_DD	Long_DD	Date	River	Location	Rated	Mark	Bank	Elevation (ft)
GS278	IHRKS	IHRKSDS3	GWP,GCB	42.10389	-70.87750	05/11/2010	Indian Head River	King St Bridge DS3	P	Chisel	L	68.05
GS279	AssoR4	ARFRDS1	NWS	41.80194	-71.05222	04/15/2010	Assonet River	Forge Rd Bridge DS	G	Disk	L	34.70
GS280	AssoR4	ARFRDS2	NWS	41.80194	-71.05222	04/15/2010	Assonet River	Forge Rd Bridge DS	F	Paint	L	33.87
GS281	AssoR5	–	NWS	41.81306	-71.03806	04/15/2010	Assonet River	Rt 79 (Richmond Rd)	–	–	–	No HWM
GS282	AssoR6	CRMSDS1	NWS	41.81972	-71.02694	04/15/2010	Cedar Swamp River	Malbone St Bridge DS	F	Disk	L	49.29
GS283	AssoR6	CRMSUS1	NWS	41.81972	-71.02694	04/15/2010	Cedar Swamp River	Malbone St Bridge US1	F	Disk	R	49.68
GS284	AssoR6	CRMSUS2	NWS	41.81972	-71.02694	04/15/2010	Cedar Swamp River	Malbone St Bridge US2	G	Disk	R	50.30
GS285	Ratt1	RB79US1	NWS,MTN	41.77667	-71.08917	04/15/2010	Rattlesnake Bk	Rt 79 Bridge US (disc. gage)	G	Disk	L	26.06
GS286	Ratt1	RB79DS1	NWS,MTN	41.77667	-71.08917	04/15/2010	Rattlesnake Bk	Rt 79 Bridge DS (disc. gage)	F	Disk	R	24.76
GS287	Ratt1	RB79OG	NWS,MTN	41.77667	-71.08917	04/15/2010	Rattlesnake Bk	Rt 79 Bridge DS (disc. gage) O.G.	G	Pen	L	24.68
GS288	Matf1	MR18US1	NWS,MTN	42.01583	-70.96083	04/15/2010	Matfield River	Rt 18 Bridge (gage) US1	F	Disk	L	37.37
GS289	Matf1	MR18DS1	NWS,MTN	42.01583	-70.96083	04/15/2010	Matfield River	Rt 18 Bridge (gage) DS1	G	Paint	R	36.30
GS290	Matf1	MR18DS2	NWS,MTN	42.01583	-70.96083	04/15/2010	Matfield River	Rt 18 Bridge (gage) DS2	F	Disk	R	35.99
GS291	Matf1	MR18US2	NWS,MTN	42.01583	-70.96083	04/15/2010	Matfield River	Rt 18 Bridge (gage) US2	F	Disk	R	36.90
GS292	Satu1	SR106DS1	NWS,MTN	42.02139	-70.95028	04/15/2010	Satucket River	Rt 106 Bridge DS	G	Disk	L	38.84
GS293	Satu1	SR106US1	NWS,MTN	42.02139	-70.95028	04/15/2010	Satucket River	Rt 106 Bridge US	G	Chisel	L	38.35
GS294	Satu1	SR106US2	NWS,MTN	42.02139	-70.95028	04/15/2010	Satucket River	Rt 106 Bridge US	G	Chisel	L	39.11
GS295	DorBk1	DBPSUS1	NWS,MTN	42.06167	-71.06583	04/15/2010	Dorchester Bk	Pearl St Bridge US	u	Disk	R	101.80
GS296	DorBk1	DBPSDS1	NWS,MTN	42.06167	-71.06583	04/15/2010	Dorchester Bk	Pearl St Bridge DS	u	Disk	R	101.00
GS297	SalPR1	–	NWS,MTN	–	–	04/15/2010	Salisbury Plain River	DS Brockton WWTP	–	–	–	Not done
GS298	PalR1	Prgage	NWS,MTN	41.80917	-71.27806	04/15/2010	Palmer River	disc. 01109220, Reed St, Rehoboth, MA	–	–	–	Not done
GS299	AdamBk1	AdBk	NWS,MTN	41.55889	-71.12944	04/15/2010	Adamsville Bk	disc. 01106000 Adamsville, RI (1941-78)	–	–	–	Not done

Table 1-2. High-water marks (HWMs) identified by the Massachusetts Department of Conservation and Recreation following the March–April 2010 floods in eastern Massachusetts.

[GPS_ID, unique identification number used for global position system (GPS) survey, Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of a HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– G, good; F, fair; BG, best guess; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, not found; –, not reported]

GPS_ID	HWM_ID	Lat_DD	Long_DD	River	Date	Location	Rated	Notes	Storm	Elevation (ft)
DCR-3	3	42.13991	-71.38967	Charles	03/26/2010	Populatic Rd Brdg (USGS gage)	BG	Based on staining	March 16	135.54
DCR-4	4	42.15755	-71.33133	Charles	03/26/2010	Forest Rd Brdg	BG	Based on staining	March 16	120.46
DCR-5	5	42.18134	-71.32252	Charles	03/26/2010	Main St Brdg (trail to R from pump house)	F	Debris line on path	Both	119.31
DCR-6	6	42.18907	-71.33276	Charles	03/26/2010	West St Brdg	BG	Measured offset from center Bridge support	Both	119.62
DCR-7	7	42.20985	-71.35156	Charles	03/26/2010	South Main St Brdg	BG	Offset from downstream stain, upstream/right	March 16	117.86
DCR-8	8	42.23267	-71.33047	Charles	03/26/2010	Farm Rd/Brdg St	G	Staining & interview with local fisherman	March 16	116.82
DCR-9	9	42.27180	-71.31573	Charles	03/26/2010	Pleasant St Brdg	F	Erosion line & interview with local shop owner	March 16	109.81
DCR-10	10	42.25853	-71.26344	Charles	03/26/2010	South St Brdg	BG	Staining, right bank wall above dam	March 16	103.25
DCR-11	11	42.25617	-71.25993	Charles	03/26/2010	USGS gage (Dover)-Mill St	G	Staining & debris line	March 16	95.82
DCR-12	12	42.25996	-71.23728	Charles	03/26/2010	Chestnut St Brdg (west side) manhole structure	BG	Staining & debris line, on manhole structure	March 16	94.78
DCR-13	13	42.26697	-71.20511	Charles	03/26/2010	Greendale Ave Brdg	F	Debris line, flagged sappling-elevation at base	Both	91.17
DCR-14	14	42.25383	-71.18097	Charles	03/26/2010	Brdg St. Brdg (west side base of tree)	G	Based on interview, flags & marked curb	March 16	89.32
DCR-15	15	42.24904	-71.15991	Mother Bk	–	Maverick St	G	Mother Bk, upstream/right wall	Both	81.72
DCR-16	16	42.24657	-71.13330	Mother Bk	–	Neponset & Turtle Pond Pkwy	F	Debris line, side wall of dam	March 16	45.63
DCR-17	17	42.29795	-71.20873	Charles	03/26/2010	Nahanton Park off Kendrick St (HWM on dock)	BG	Debris line, cement dock support, Nahanton Park	March 16	87.74
DCR-18	18	42.31641	-71.22827	Charles	03/26/2010	USGS gage (Wellesley) (Quinobequin Rd)	G	Staining, on USGS gage block, same mark both storm	Both	73.02
DCR-19	19	42.32510	-71.25869	Charles	03/26/2010	Washington St Brdg (fish ladder)	G	Staining, on fish ladder	March 16	45.21
DCR-20	20	42.15943	-71.23478	Neponset	–	Plimpton St	G	March 30 storm 8 inches lower, couldn't mark	March 30	118.24
DCR-21	22	42.15323	-71.24720	Neponset	–	Main St & North St	G	–	March 30	123.29
DCR-22	23	42.17750	-71.20033	Neponset	–	Pleasant St & Riverside Court	G	–	Both	52.57

Table 1-2. High-water marks (HWMs) identified by the Massachusetts Department of Conservation and Recreation following the March–April 2010 floods in eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position system (GPS) survey, Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of a HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– G, good; F, fair; BG, best guess; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, not found; –, not reported]

GPS_ID	HWM_ID	Lat_DD	Long_DD	River	Date	Location	Rated	Notes	Storm	Elevation (ft)
DCR-23	24	42.17749	-71.20035	Neponset	–	Pleasant St & Riverside Court	G	–	Both	NF
DCR-24	25	42.19702	-71.15501	Neponset	–	Canton St & Dedham St	G	–	Both	46.79
DCR-25	26	42.20912	-71.14581	Neponset	–	Green Lodge St & Blue Hill Dr	G	–	March 30	45.79
DCR-26	27	42.15847	-71.15417	Neponset	–	Neponset St & Walpole St	G	On bridge	March 30	55.25
DCR-27	28	42.15864	-71.15472	Neponset	–	Neponset St & Walpole St	G	–	March 30	NF
DCR-28	29	42.20324	-71.13495	Neponset	–	Green Lodge St & Elm St	G	–	March 30	48.42
DCR-29	30	42.23370	-71.12224	Neponset	–	Neponset Valley Pkwy & Brush Hill Rd	G	Tributary	March 30	42.42
DCR-30	31	42.23435	-71.12246	Neponset	–	Neponset Valley Pkwy & Brush Hill Rd	G	Mark on rock	March 30	42.39
DCR-31	32	42.27015	-71.07302	Neponset	–	Central Ave & Elliot St	G	–	March 30	18.28
DCR-32	33	42.26177	-71.04690	Neponset	–	Squantum St & Christopher Dr	G	Tributary	March 30	5.99
DCR-33	34	42.26592	-71.07363	Neponset	–	School St & Hendrick Dr	G	–	March 30	21.47
DCR-34	35	42.24516	-71.09451	Neponset	–	Canton Ave & Sumner St	G	Mark on stone	March 30	NF
DCR-35	36	42.40266	-71.00358	Sales Creek	–	Route 1A near RailRd St	BG	–	March 30	NF
DCR-36	37	42.40075	-70.99754	Sales Creek	–	Revere Beach Pkwy & Northshore Rd	F	–	March 30	-2.12
DCR-37	38	42.42448	-71.03995	Town Line Bk	–	Lynn St	F	–	Both	2.23
DCR-38	39	42.42447	-71.03995	Town Line Bk	–	Lynn St	F	–	Both	3.10
DCR-39	40	42.42953	-71.02404	Town Line Bk	–	Brookdale St	G	Maybe tidal influence	March 16	1.68
DCR-40	41	42.46206	-71.00910	Saugus	–	Centennial Ave & Central St	G	–	Both	5.03
DCR-41	42	42.46207	-71.00912	Saugus	–	Centennial Ave & Central St	G	–	Both	4.23
DCR-42	43	42.45684	-71.02082	Saugus	–	Essex St & Vine St	BG	–	March 16	NF
DCR-43	44	42.46568	-71.00445	Saugus	–	Hamilton St & River Bank Rd	F	–	March 16	5.91
DCR-44	45	42.47066	-71.03022	Saugus	–	Oaklandvale Ave at Forest St	G	Debris & interview. Same mark for both storms	Both	48.27
DCR-45	46	42.37364	-71.23692	Charles	04/05/2010	Moody St (US retaining wall north bank)	G	–	March 30	36.31
DCR-46	47	42.37365	-71.23692	Charles	04/05/2010	Moody St	BG	Marking on wall,upper mark older storm	March 16	37.31
DCR-47	48	42.37244	-71.23502	Charles	04/05/2010	Downstream of Moody St Dam (under foot brdg)	G	Debris line	March 16	26.78
DCR-48	49	42.37244	-71.23502	Charles	04/05/2010	Downstream of Moody St Dam	G	Water level	March 30	26.01
DCR-49	50	42.37248	-71.23368	Charles	04/05/2010	Downstream of Moody St Dam near USGS gage	G	–	March 30	26.66

Table 1-2. High-water marks (HWMs) identified by the Massachusetts Department of Conservation and Recreation following the March–April 2010 floods in eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position system (GPS) survey, Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of a HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– G, good; F, fair; BG, best guess; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, not found; –, not reported]

GPS_ID	HWM_ID	Lat_DD	Long_DD	River	Date	Location	Rated	Notes	Storm	Elevation (ft)
DCR-50	51	42.37248	-71.23364	Charles	04/05/2010	Downstream of Moody St Dam on USGS gage	F	On USGS gage house	March 16	26.68
DCR-51	52	42.36240	-71.24474	Charles	04/05/2010	Woerd Ave	F	Top of curb	March 16	38.05
DCR-52	53	42.36257	-71.24498	Charles	04/05/2010	Woerd Ave	G	Pavement	March 30	36.30
DCR-53	54	42.36691	-71.21874	Charles	04/05/2010	Farwell St Brdg	G	Debris line	March 16	21.96
DCR-54	55	42.36703	-71.21873	Charles	04/05/2010	Farwell St Brdg	G	Debris line	March 30	NF
DCR-55	56	42.37981	-71.22122	Beaver Bk	–	Linden St	G	Water level, interview	March 30	35.89
DCR-56	57	42.37970	-71.22137	Beaver Bk	–	Linden St	BG	Interview, debris line, top of curb	March 16	36.99
DCR-57	58	42.38307	-71.20746	Beaver Bk	–	Beaver St (retaining wall south bank)	G	–	March 30	46.86
DCR-58	59	42.39020	-71.19687	Beaver Bk	–	Trapelo Rd at Mill St	G	Footbridge	March 30	73.22
DCR-59	60	42.39023	-71.19688	Beaver Bk	–	Trapelo Rd at Mill St	G	Debris line	March 16	74.47
DCR-60	61	42.35949	-71.16634	Charles	04/05/2010	Nonantum Rd, Community Rowing	G	Debris line, ramp surface	March 30	3.01
DCR-61	62	42.35948	-71.16635	Charles	04/05/2010	Nonantum Rd, Community Rowing	G	Debris line, boat ramp surface	March 16	2.29
DCR-62	63	42.41808	-71.07311	Mystic	–	Medford St	BG	Rip rap	March 16	-0.98
DCR-63	64	42.41811	-71.07311	Mystic	–	Medford St	G	Rip rap	March 30	-1.67
DCR-64	65	42.49553	-71.01938	Mystic	–	Mystic Valley Pkwy nr High St	G	Staining on bridge	March 16	1.00
DCR-65A	65A	42.49553	-71.01938	Mystic	–	Mystic Valley Pkwy nr High St		Paint line on culvert under footbridge (gps survey)	–	-0.25
DCR-65	66	42.41816	-71.11165	Mystic	–	Mystic Valley Pkwy nr High St	BG	Staining on wall	March 30	0.28
DCR-66	67	42.41816	-71.11164	Mystic	–	Mystic Valley Pkwy nr High St	G	Wrack line on wall	March 30	-0.25
DCR-67	68	42.41817	-71.11267	Mystic	–	Mystic Valley Pkwy & Forest St	F	Wrack line on wall	March 16	0.63
DCR-68	69	42.41817	-71.11268	Mystic	–	Mystic Valley Pkwy & Winthrop St	G	Wrack line on wall	March 16	0.22
DCR-69	70	42.41789	-71.11781	Mystic	–	Mystic Valley Pkwy & Winthrop St	BG	Wrack line on wall	March 30	-0.29
DCR-70	71	42.41790	-71.11781	Mystic	–	Mystic Valley Pkwy & Boston Ave	F	Wrack line on wall, strong gas smell	March 30	2.78
DCR-71	72	42.41722	-71.13050	Mystic	–	Mystic Valley Pkwy & Boston Ave	F	Wrack line on wall, strong gas smell	March 16	2.09
DCR-72	73	42.41720	-71.13052	Mystic	–	Mystic Valley Pkwy & Auburn St	F	Wrack line on wall	Both	1.70
DCR-73	74	42.41799	-71.12659	Mystic	–	Mystic Valley Pkwy & Auburn St	F	Wrack line on wall	Both	1.18
DCR-74	75	42.41800	-71.12659	Mystic	–	Alewife Bk, behind T station; West Rdway	F	Alewife Bk, staining on wall	March 30	3.73

Table 1-2. High-water marks (HWMs) identified by the Massachusetts Department of Conservation and Recreation following the March–April 2010 floods in eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position system (GPS) survey, Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of a HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– G, good; F, fair; BG, best guess; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, not found; –, not reported]

GPS_ID	HWM_ID	Lat_DD	Long_DD	River	Date	Location	Rated	Notes	Storm	Elevation (ft)
DCR-75	76	42.39756	-71.14340	Mystic	–	Alewife Bk, behind T station; West Rdway	F	Alewife Bk wrack line on wall	March 16	3.07
DCR-76	77	42.39755	-71.14341	Mystic	–	Alewife Bk Pkwy & Cross/Henderson St (DS)	BG	Henderson St Bridge, on concrete channel	March 16	3.26
DCR-77	78	42.40453	-71.13452	Mystic	–	Alewife Bk Pkwy & Cross/Henderson St (DS)	BG	Mark on concrete channel	March 30	3.02
DCR-78	79	42.40453	-71.13454	Mystic	–	MVP & Decatur St	F	Wrack line on bridge	Both	3.02
DCR-79	80	42.41473	-71.13253	Mystic	–	MVP & Decatur St	F	Wrack line on bridge	Both	2.00
DCR-80	81	42.41474	-71.13253	Mystic	–	Harvard Ave & MVP	F	Wrack line on bridge	Both	3.02
DCR-81	82	42.41539	-71.13836	Mystic	–	Harvard Ave & MVP	F	Wrack line on bridge	Both	2.47
DCR-82	83	42.41538	-71.13835	Mystic	–	FootBrdg near route 38 (Medford St) over river	BG	On side of bridge	March 30	3.30
DCR-83	84	42.42071	-71.14274	Mystic	–	Mystic Valley Pkwy & High St	BG	Wrack line on wall of bridge	March 16	2.65
DCR-84	85	42.42072	-71.14275	Mystic	–	Mystic Valley Pkwy & Lakeview Terrace	F	Debris line & wrack on wall	March 16	11.03
DCR-85	86	42.44284	-71.14283	Mystic	–	Mystic Valley Pkwy & Bacon St	G	Leaf line & wrack line top of spray	March 16	13.43
DCR-86	87	42.44443	-71.13863	Mystic	–	Mystic Valley Pkwy & Mystic Ave	G	Wrack line & staining	March 16	14.75
DCR-87	88	42.44732	-71.13861	Mystic	–	Mystic Valley Pkwy & Main St	G	Staining & wrack	March 16	17.96
DCR-88	89	42.45100	-71.13666	Mystic	–	Main St & Lake St	G	Wrack line on side wall	March 16	20.26
DCR-89	90	42.45574	-71.13803	Mystic	–	Horn Pond Bk Rd & Lake St	F	Wrack line & debris line on ground	March 16	20.76
DCR-90	91	42.45679	-71.13904	Mystic	–	Totman Drive	F	Wrack line on side wall of stream	March 16	47.87
DCR-91	92	42.47145	-71.17393	Mystic	–	Lexington St west of Totman Drive	F	Debris line mark on rock	March 16	50.20
DCR-92	93	42.47148	-71.17583	Mystic	–	Totman Drive & Lexington St	BG	Faint debris line, washed out bridge downstream	March 16	49.34
DCR-93	94	42.47203	-71.17182	Mystic	–	Willow St & Locust St	F	Followed wrack line along grass to rocks	March 16	62.17
DCR-94	95	42.47837	-71.17397	Mystic	–	Bedford Rd & CamBrdg St	G	Defined leaf line	March 16	93.66
DCR-95	96	42.48072	-71.18317	Mystic	–	Morrow Drive & Bedford Rd	BG	Wrack line upper	March 16	70.70
DCR-96	97	42.48158	-71.17666	Mystic	–	Morrow Drive & Bedford Rd	G	Wrack line lower	March 30	69.10
DCR-97	98	42.48151	-71.17699	Mystic	–	Winn St & Quimby Ave	G	Leaf line	March 16	NF
DCR-98	99	42.48768	-71.16664	Mystic	–	Winn St & Quimby Ave	G	Leaf debris line	March 16	96.10

Table 1-2. High-water marks (HWMs) identified by the Massachusetts Department of Conservation and Recreation following the March–April 2010 floods in eastern Massachusetts.—Continued

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GPS_ID	HWM_ID	Lat_DD	Long_DD	River	Date	Location	Rated	Notes	Storm	Elevation (ft)
DCR-99	100	42.48768	-71.16760	Mystic	–	Main St & Middlesex Canal Rd	BG	Followed debris line to mark wall	March 16	96.59
DCR-100	101	42.49643	-71.15765	Mystic	–	Main St at Alfred St	G	Wrack line on wall by street	March 16	97.13
DCR-101	102	42.50159	-71.15792	Mystic	–	Main St at Alfred St	F	Wrack line & staining on wall	March 30	94.93
DCR-102	103	42.50160	-71.15791	Mystic	–	School St & Merrimac St	G	Wrack line on wall, marked on corner	March 16	97.03
DCR-103	104	42.50873	-71.15841	Mystic	–	Dexter ave & Milan Ave	G	Debris line & water stain on wall	March 16	93.26
DCR-104	105	42.51295	-71.15847	Mystic	–	Merrimac St at Dartmouth St	F	Wrack line on wall	March 16	NF
DCR-105	106	42.51044	-71.15490	Mystic	–	Mishawum Rd (HWM on tree)	G	USGS HWM, stake in ground 1.6 gauge, we marked tree	March 16	50.76
DCR-106	107	42.50358	-71.13518	Mystic	–	Birch Meadow Drive off Intervale Terrace	G	Leaf line on bank	March 16	89.57
DCR-107	108	42.53560	-71.11489	Mystic	–	Willow St off Lowell St	BG	Leaf line & staining	March 16	82.84
DCR-108	109	42.53017	-71.12274	Mystic	–	West St & Catherine Ave	G	Leaf line & soil line	March 16	79.18
DCR-109	110	42.53084	-71.13172	Mystic	–	Woburn St & Presidential Way	F	Slight leaf line/debris line	March 16	83.40
DCR-110	111	42.52510	-71.14235	Mystic	–	Salem St & Aberjona Drive	G	USGS stake at HWM; gauge 1.70	March 16	44.38
DCR-111	112	42.49149	-71.12881	Mystic	–	Washington St & Washington Circle	F	Debris line, sticks	March 16	40.44
DCR-112	113	42.48582	-71.12094	Mystic	–	Montvale Ave & Mack Rd (McDonalds parking lot)	BG	Debris line at top of wall	March 16	37.18
DCR-113	114	42.47953	-71.11789	Mystic	–	Washington St & Sunset Rd	G	Wrack line on wall	March 16	26.74
DCR-114	115	42.46940	-71.12490	Mystic	–	Cross St & Forest St	F	Wrack line on bidge side wall	March 16	25.89
DCR-115	116	42.46724	-71.13060	Mystic	–	Swanton St & Chapin Court	G	Distinct leaf line, 154 down-stream of bridge marking	March 16	23.35
DCR-116	117	42.46106	-71.13696	Mystic	–	Broadway & Sunnyside Ave	F	Mark on chain link fence open-ing	March 30	NF
DCR-117	118	42.40838	-71.13300	Mystic	–	Alewife Bk Pkwy at Broadway	G	Other HWM, pink stake on either side of bridge	March 16	3.05
DCR-118	119	42.40710	-71.13377	Mystic	–	Alewife Bk Pkwy at Mass. Ave	BG	Small wrack line on side of bridge	March 16	5.14

Table 1-2. High-water marks (HWMs) identified by the Massachusetts Department of Conservation and Recreation following the March–April 2010 floods in eastern Massachusetts.—Continued

[GPS_ID, unique identification number used for global position system (GPS) survey, Site_ID, unique identifiation of a location, HWM_ID, unique identifiation of a HWM at a location, Lat_DD, Latitude in decimal degrees (North American Datum of 1983 (NAD83), Long_DD, Longitude in decimal degrees (NAD83); Rated– G, good; F, fair; BG, best guess; Elevation, in feet above North American Vertical Datum of 1988 (NAVD88); NF, not found; –, not reported]

GPS_ID	HWM_ID	Lat_DD	Long_DD	River	Date	Location	Rated	Notes	Storm	Elevation (ft)
DCR-119	120	42.40097	-71.13637	Mystic	–	Massachusetts Ave & Blvd. Rd	F	Wrack line on rock on west bank	March 16	NF
DCR-120	121	42.40070	-71.13722	Mystic	–	Alewife Bk Pkwy at Mass. Ave	G	Wrack line interview with local on walking path	March 16	3.74
DCR-121	122	42.40159	-71.13595	Saugus	–	Spring St at Walnut St	F	–	March 16	45.46
DCR-122	123	42.49843	-71.04195	Saugus	–	Water St	G	–	March 16	53.54
DCR-123	124	42.49834	-71.04664	Saugus	–	Water St at Wiley St	G	Staining on wall & interview	Both	53.30
DCR-124	125	42.49835	-71.04663	Saugus	–	Water St at Wiley St	G	Interview and local stain on wall, 30th HWM	Both	53.95
DCR-125	126	42.51186	-71.03666	Saugus	–	Kimball Lane at Salem St	F	Leaf line & sediment line	March 30	66.42
DCR-126	127	42.32511	-71.25870	Charles	04/08/2010	Washington St Brdg	F	Lower mark	March 30	45.00
DCR-127	128	42.29797	-71.20874	Charles	04/08/2010	Nahanton Park off Kendrick St	G	Lower mark March 30	March 30	87.51
DCR-128	129	42.24901	-71.15987	Mother Bk	–	Maverick St	G	Lower line on side of wall	Both	NF
DCR-129	130	42.25380	-71.18066	Charles	04/08/2010	Brdg St. Brdg	G	Interview, HWM, top of curb water dept parking lot	March 30	89.33
DCR-130	131	42.25999	-71.23727	Charles	04/08/2010	Chestnut St Brdg	G	Wrack line HWM on structure	March 30	93.61
DCR-131	132	42.25618	-71.25992	Charles	04/08/2010	Mill St	G	Higher mark on USGS gauge	March 30	97.17
DCR-132	133	42.20987	-71.35155	Charles	04/08/2010	South Main St Brdg	G	Wrack line, higher mark	March 30	118.81
DCR-133	134	42.15750	-71.33136	Charles	04/08/2010	Forest Rd Brdg	G	Wrack line, higher mark on wall	March 30	121.26
DCR-134	135	42.13095	-71.44455	Charles	04/08/2010	Pearl St	G	Upstream from bridge, west bank edge of field across from factory	March 30	187.84

For additional information, write to:
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http://ma.water.usgs.gov/

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