2022 Drought in New England

Scientific Investigations Report 2023–5016

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

Cover. Photograph of low streamflow at the Salmon River near East Hampton, Connecticut (01193500) U.S. Geological Survey streamgage on August 10, 2022; photograph by Tabatha Lewis, U.S. Geological Survey.

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By Dee-Ann E. McCarthy, James M. LeNoir, and Pamela J. Lombard

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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
inch (in.)	2.54	centimeter (cm)
foot (ft)	0.3048	meter (m)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)

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

$$°C = (°F - 32) / 1.8.$$

Datums

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.

Supplemental Information

A water year is the 12-month period beginning October 1 and ending September 30. It is designated by the calendar year in which it ends.

Normal, as used in this report, approximates the statistical average or norm.

Abbreviations

CRN	Climate Response Network
NWIS	National Water Information System
PET	potential evapotranspiration
USGS	U.S. Geological Survey

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Introduction

During April through September 2022, much of New England experienced a short but extreme hydrologic drought that was similar to the drought of 2020. By August 2022, Providence, Rhode Island, was declared a Federal disaster area, and New London and Windham counties in Connecticut were declared natural disaster areas. Mandatory water use restrictions were put in place in communities in Connecticut, Massachusetts, New Hampshire, and Rhode Island (Mecray and Borisoff, 2022). Precipitation in many areas of New England fell below normal levels in November 2021 and continued to decline until September 2022, contributing to low streamflows and groundwater levels in the region. U.S. Geological Survey (USGS) streamflow and groundwater conditions from April to September 2022 were used to characterize the hydrologic component of this short-duration drought. Several record low streamflows and groundwater levels were observed across New England, even falling below 2020 levels in parts of southern New England. The severity of this drought varied across New England, and regional and statewide perspectives are presented in this report.

Highlights

- May through August in 2022 ranked as the driest for those 4 months in 138 years of record at Boston, Massachusetts, with only 5.74 inches of rain (average of 13.26 inches).
- Water levels at 95 USGS groundwater monitoring wells across New England were below normal in August; 16 of these wells recorded their lowest August water level in 25 years.
- Flows at 54 USGS streamgages across New England were below normal in August, and 10 of those streamgages recorded their lowest August flows in 30 years.
- Two USGS streamgages in Massachusetts (stations 01105600 and 01171500 with 56 and 83 years of record, respectively) had record 7-day average low flows on August 21, 2022, and August 22, 2022, respectively.

Study Area

Data from 78 USGS streamgages and 126 USGS groundwater monitoring wells (fig. 1) were used to characterize the hydrologic component of the 2022 drought in New England. Elevations in New England range from 0 feet (ft) relative to the North American Vertical Datum of 1988 (NAVD 88) at the coastline to 6,288 ft NAVD 88 at Mount Washington in New Hampshire (U.S. Geological Survey, 2023). Geologically, in much of the region, the river valleys consist of sand and gravel deposits, and the upland areas, of till deposits (Soller and Reheis, 2004). Glacial deposits overlay carbonate-rock, sandstone, and crystalline rock. Climatologically, average annual precipitation ranged from 36 to 60 inches for the 30-year period from 1981 through 2010 (PRISM Climate Group, 2020; National Oceanic and Atmospheric Administration, 2022b). Although precipitation is generally evenly distributed throughout the year, the lowest streamflows and groundwater levels are generally in the late summer and early fall.

Photograph of a low streamflow measurement made using a Parshall flume at the Pendleton Hill Brook near Clarks Falls, Connecticut (01118300) U.S. Geological Survey streamgage on August 11, 2022; photograph from video by Nigel Pepin, U.S. Geological Survey.

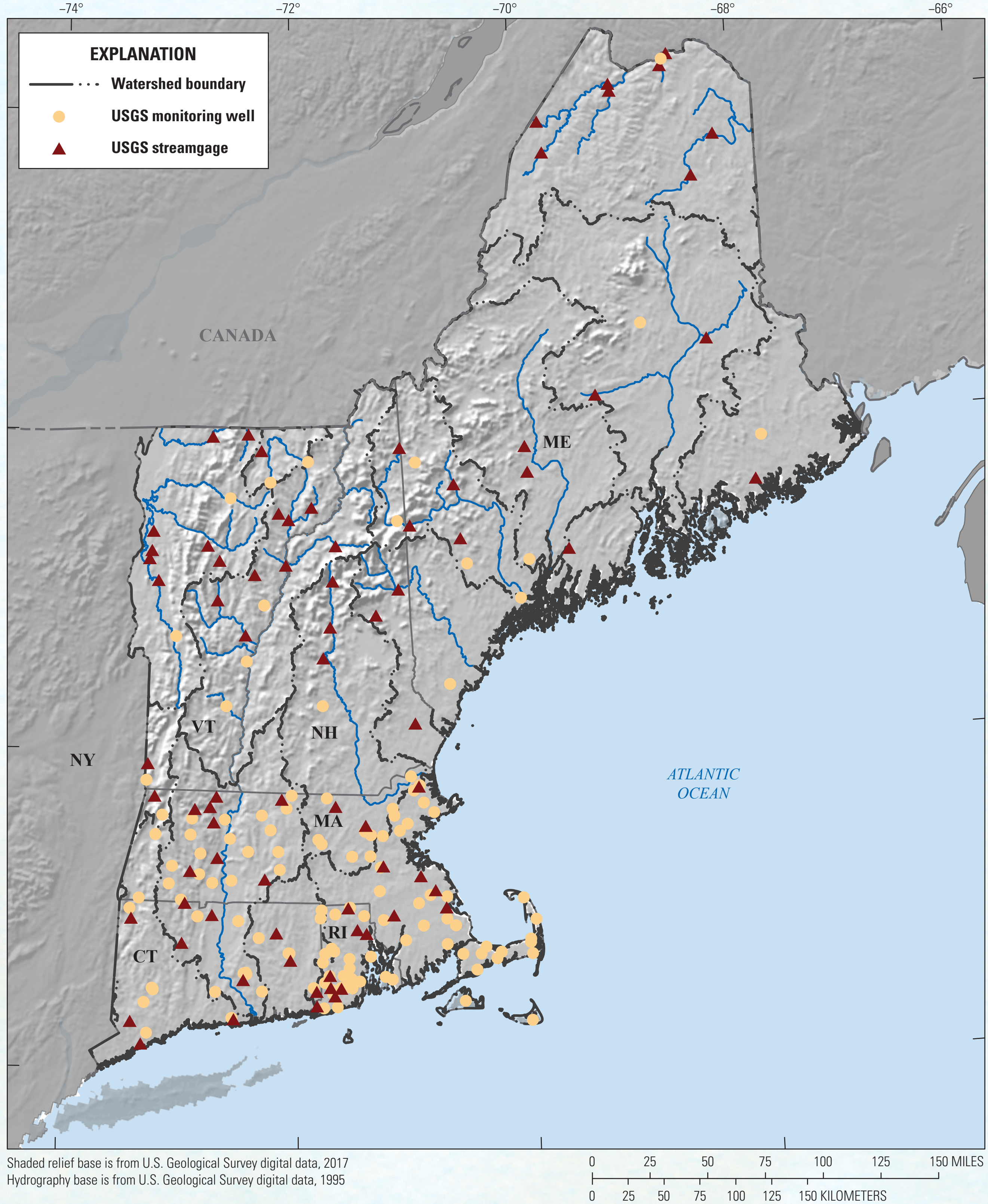


Figure 1. Map showing locations of U.S. Geological Survey (USGS) streamgages and groundwater monitoring wells in New England used for drought analyses for 2022 and boundaries of major watersheds. Watershed boundaries are based on the drainage basin six-digit hydrologic unit code boundaries from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019).

Drought Definition

Droughts are defined by their spatial extent, intensity, magnitude, and duration; the components of the hydrologic cycle they affect; and the systems they affect. For example, a meteorological drought is defined by below-average precipitation, whereas an agricultural drought is defined by below-average soil moisture at a time critical to crop development. Hydrologic droughts are characterized by below-average streamflow or groundwater levels and typically lag meteorological and agricultural droughts; a flash drought is typically defined by how quickly drought conditions intensify. Socioeconomic droughts occur when the demand for goods exceeds supply as a result of shortfalls in water supplies, and ecological droughts are prolonged and widespread deficits in water supplies that create stresses across multiple ecosystems (National Drought Mitigation Center, 2022c). Although the 2022 drought in New England included all the above listed types of drought at different times and to different geographic extents between April and September, this report highlights the hydrologic drought during this period.

Drought Severity

For the purposes of a drought declaration, each of the New England States defines drought levels differently (National Drought Mitigation Center, 2022b). The U.S. Drought Monitor (National Drought Mitigation Center, 2022a) characterizes drought similarly across the States using a combination of indicators including the standardized precipitation index, streamflows percentiles, soil moisture percentiles, and the Palmer drought severity index (based on precipitation and temperature). The U.S. Drought Monitor integrates these indicators into five categories: D0, abnormally dry; D1, moderate drought; D2, severe drought; D3, extreme drought; and D4, exceptional drought. Extreme drought includes widespread crop loss, modified recreation, extremely reduced streamflow to no flow, and increased well drilling and bulk water hauling. Extreme droughts would be expected to happen on average once every 20 to 50 years (Svoboda and others, 2002).

Based on the U.S. Drought Monitor (National Drought Mitigation Center, 2022a), northern parts of Maine, New Hampshire, and Vermont started water year 2022 with dry conditions carried over from summer 2021. Dry conditions started expanding into southern New England in mid-May and were widespread by mid-August, with parts of southeastern New-England reaching extreme drought. At the peak of drought severity in August, Rhode Island, Massachusetts, and Connecticut had 99, 39.5, and 13 percent of their respective areas, in D3–extreme drought conditions. Maine, New Hampshire, and Vermont did not experience as severe conditions, with only a very small part of southeastern New Hampshire along the Massachusetts border meeting the U.S. Drought Monitor's classification of D3–extreme drought classification during 2022.

Photograph of streambed with zero streamflow at the Segreganset River near North Dighton, Massachusetts (01109070) U.S. Geological Survey streamgage on August 21, 2022; photograph by Kyle Fronte, U.S. Geological Survey.

Photograph of a low flow measurement section used at the Byram River at Pemberwick, Connecticut (01212500) U.S. Geological Survey streamgage on August 17, 2022; photograph by Maria Skarzynski, U.S. Geological Survey.

Meteorological Drought

Snowpack

Historical data on the water content of snowpack in New England are limited. For much of the late winter and spring 2022, snow water content in coastal Maine was in the lowest 10 to 25 percent of the past 10 years. By April, most of the State except northern Maine had snow water content in the lowest 10 percent of the past 10 years (Maine Geological Survey, 2022). New Hampshire had above average snow water content from the end of January through mid-February in most basins, and then average to below average snow water content in March except in the Mascoma and Lake Francis areas where it remained above average (25 to 70 years of record; New Hampshire Department of Environmental Services, 2022).

Temperature and Potential Evapotranspiration

New England was characterized by above average temperatures and above average potential evapotranspiration for much of summer 2022 (June to August), which was ranked the second warmest in Massachusetts and Rhode Island, the third warmest in Connecticut, and the fourth warmest in New Hampshire based on 128 years (1895–2022) of records (National Oceanic and Atmospheric Administration, 2022c). The meteorological station in Portland, Maine, recorded the second warmest summer on record, with an average temperature of 69.1 degrees Fahrenheit (°F), ranking only lower than summer 2020, which was the warmest on record (National Oceanic and Atmospheric Administration, 2022a). Connecticut, Rhode Island, Massachusetts, and New Hampshire recorded the warmest August on record in 128 years. The average August temperature in Massachusetts was 4.4 °F above average, the furthest from average in all New England States (National Oceanic and Atmospheric Administration, 2022c).

In Boston, Massachusetts, cumulative potential evapotranspiration (PET) stayed above average from March through August 2022, with the most rapid increase between June and mid-August. By mid-August, PET in Boston reached more than 5 inches, more than 1.5 inches above average. Cumulative PET in Caribou in northern Maine was up to 0.3 inch above average between May and mid-June and from mid-July to the end of August (National Oceanic and Atmospheric Administration, 2022b; Northeast Regional Climate Center, 2022).

Rainfall

During July to September 2021, many southern New England States had received excess rainfall due to the remnants of tropical storms Henri, Elsa, and Ida, but by November 2021, precipitation had fallen below average in many areas. In water year 2022, much of New England recorded below average precipitation, ranging from 44 inches (greater than [>] 3 inches below average) in Portland, Maine, to 30.77 inches (>16 inches below average) in Westerly, R.I., based on averages from the 1981–2010 period of record (fig. 2; National Oceanic and Atmospheric Administration, 2022a). Precipitation in Westerly was nearly 10 inches below average for water year 2022 by May and continued to decline to >18 inches below the water year average in early September (fig. 2). Stations in Boston recorded the driest May through August ever from 1884 to 2022, with only 5.74 inches of rainfall (average is 13.28 inches; National Oceanic and Atmospheric Administration, 2022a). Many areas of New England received monthly precipitation in June 2022 that was 2 to 3 inches below the average. July 2022 was ranked as the second driest July on record (1893–2022) in Rhode Island, with Providence only receiving 0.46 inch of rainfall (average 3.03 inches; National Oceanic and Atmospheric Administration, 2022a, d).

During 2022, some locations in northern New England recorded above average precipitation, including Burlington, Vermont, which received 3.6 inches more precipitation than a typical April through September period (record from 1884 to 2022). Widespread rainfall in New England in late August and early September 2022 resulted in improvements to the precipitation deficits, with most areas receiving 1 to 5 inches above average rainfall for the month of September. However, parts of Cape Cod and northeastern Massachusetts did not receive notable rainfall in September (National Oceanic and Atmospheric Administration, 2022a).

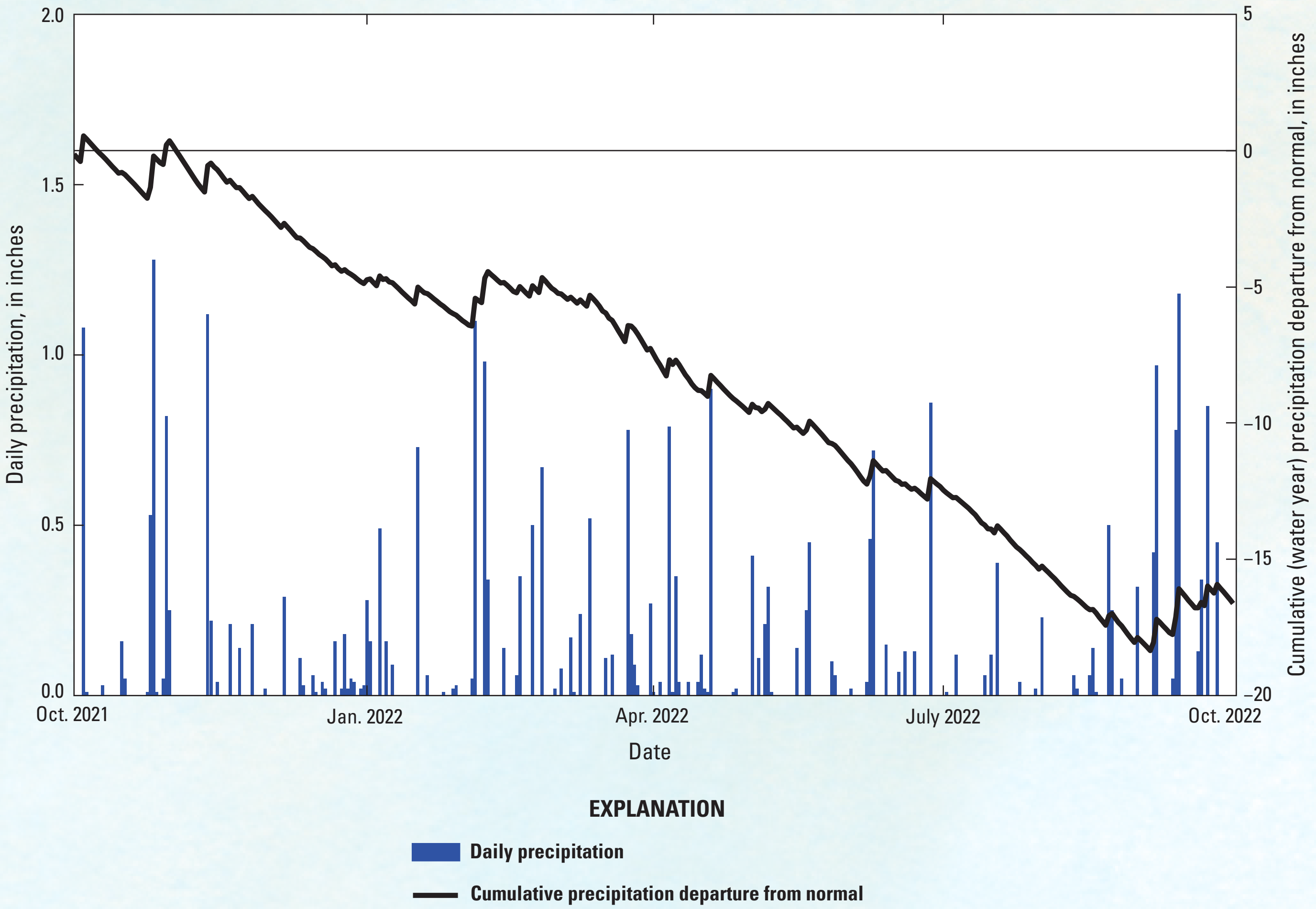


Figure 2. Graph showing total daily rainfall and cumulative precipitation departure from normal for October 1, 2021, through September 30, 2022, at the National Oceanic and Atmospheric Administration meteorological station at the Westerly State Airport (station USW00014794) in Rhode Island. Departure from normal is based on data from 1981 to 2010. Data are from National Oceanic and Atmospheric Administration (2022a).

U.S. Geological Survey Streamflow and Groundwater Level Monitoring Networks in New England

The 2022 hydrologic drought conditions were evaluated using 78 USGS streamgages and 126 USGS groundwater monitoring wells in New England. The 78 streamgages are relatively unaffected by water withdrawals, wastewater discharges, diversions, or dams and have continuous data for at least the past 30 years (April 1993 through September 2022; fig. 1; table 7.1). At USGS streamgages, the stage (stream height) of the river is typically measured at 5- to 15-minute intervals and is then transmitted by telemetry to the USGS for display on the web interface of the USGS National Water Information System (NWIS; U.S. Geological Survey, 2022). Continuous streamflow is computed based on the graphical relation between streamflow and concurrent stage measurements at each streamgage, referred to as a stage-discharge rating curve (Rantz and others, 1982). This rating curve allows for near real-time estimates of streamflow from the transmitted stage values. The rating curve for each streamgage is continually verified and updated with periodic direct measurements, following USGS procedures described in Rantz and others (1982), Sauer and Turnipseed (2010), and Turnipseed and Sauer (2010).

Photograph of a groundwater level measurement taken at the MA–HHW 1R Hardwick, Mass. (422058072085101) U.S. Geological Survey real-time monitoring well in Hardwick, Massachusetts, on October 17, 2022; photograph by Samuel Banas, U.S. Geological Survey.

The 126 USGS groundwater monitoring wells used to assess the 2022 hydrologic drought in New England are included in the USGS Climate Response Network (CRN) and have at least 25 years of record (April 1998 through September 2022; fig. 1; table 7.2). Wells in the CRN network are minimally affected by pumping and other anthropogenic stresses (Cunningham and others, 2007). Although a minimum of 30 years of record is typically used for long-term averages, there are a limited number of wells with 30 years of record in New England. The monitoring wells evaluated for this report were completed in glacial sand and gravel or till deposits and are generally shallow-depth wells (9.6 to 110 feet); wells finished in bedrock were excluded from the study.

Of the 126 wells used in the analysis, 61 were physically measured periodically, generally once per month from the 20th day to the end of the month, based on USGS procedures described in Cunningham and Schalk (2011). The remaining 65 wells were monitored in real time, and the water level was recorded hourly or more frequently and transmitted by telemetry. The water level data at real-time monitored wells are verified and updated, as needed, with physical measurements every 2 to 3 months, based on USGS procedures described in Cunningham and Schalk (2011). Water level data for both the monthly measured and real time monitoring wells are available through NWIS (U.S. Geological Survey, 2022). For consistency between well types (monthly and real time), only one daily mean groundwater level was used to represent the month for a real-time monitored site. At the real-time monitored wells, the daily mean groundwater level on the median day the well had been measured before the well was made real time was used. This typically would be 1 day from the 20th day to the end of the month.

Data Analysis

Data analysis methods used in this study are similar to those used in Lombard and others (2020). Hydrologic drought conditions are characterized for streamflows by daily-streamflow percentiles computed from 7-day average streamflows, and for groundwater, as monthly groundwater-level percentiles. For this study, the 7-day average streamflow refers to the average streamflow during the past 7 days at a streamgage, and the average 7-day streamflow refers to the average of the 7-day average streamflows across multiple streamgages in a drainage basin or across New England. Percentiles for streamflows were calculated using 30 years of record (water years 1993 to 2022), and for groundwater levels, using 25 years of record (water years 1998 to 2022). The 25th to 75th percentiles indicate normal conditions, the 76th and greater percentiles are above normal, and the 24th and lower percentiles are below normal. The 10th or lower percentiles are much below normal. Percentiles were also averaged across drainage basins to highlight drought conditions spatially across New England (fig. 3).

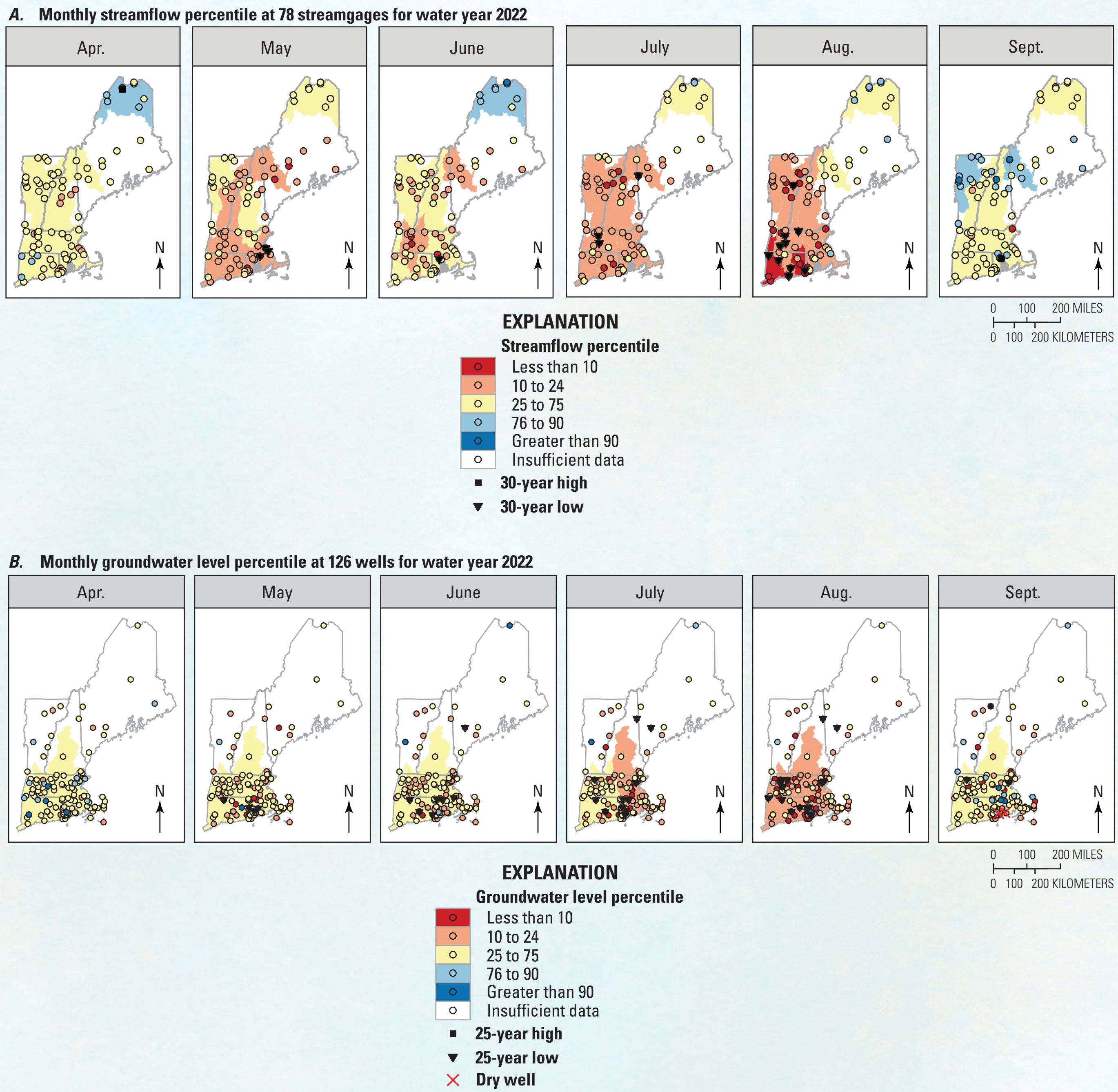


Figure 3. Maps showing percentiles of *A*, mean monthly streamflow at 78 U.S. Geological Survey streamgages and *B*, monthly groundwater levels at 126 U.S. Geological Survey observation wells in New England for April through September 2022 compared with the 30-year (1993–2022) and 25-year (1998–2022) conditions, respectively. Watersheds are based on the drainage basin six-digit hydrologic unit code boundaries from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019); watersheds with four or more sites are shaded according to the mean percentile across those sites.

Hydrologic Drought of 2022

Streamflow Conditions

The New England-wide average 7-day flows at 78 streamgages fluctuated in the normal range (25th to 75th percentile) during winter 2021–22 and spring 2022, with a very brief period of below normal flows (less than 25th percentile) around the beginning of February and prolonged normal to above normal flows (>75th percentile) from the middle of February to the end of April. The average 7-day streamflows began to decline in late April and dropped below normal conditions from May 12 to 16, June 6 to 7, July 11 to 18, and August 1 to 20 (fig. 4). The lowest New England-wide average 7-day streamflow percentile for 2022 was on August 8 (18th percentile). Other notable low average 7-day streamflow percentiles were on May 14 (20th percentile) and July 14 (18th percentile). The last date of below normal average 7-day streamflows across New England was on August 20, after which streamflows continued to increase through the remainder of August and September (fig. 4).

The onset of the 2022 drought was earlier (mid-May) than the drought in 2020 (early June); however, New England-wide average 7-day streamflows did not reach the same level of dry conditions as experienced in the 2020 drought when the lowest New England-wide average 7-day streamflow was in the 6th percentile from September 23 through 28, 2020 (fig. 4; Lombard and others, 2020). Additionally, the 2020 drought had longer periods of below normal average 7-day streamflows compared with the 2022 drought. A potential reason that 2022 streamflows did not reach the lower and longer period of percentile levels as seen in 2020 (Lombard and others, 2020) is the spatial variability in the severity of the 2022 drought; sustained normal and above normal streamflows in northern Maine increased New England-wide averaged streamflow throughout the 2022 drought. September rainfalls resulted in most of New England recovering to normal to above normal streamflows (fig. 3*A*).

The drought in New England varied in severity over three general regions: southern New England (Connecticut, Massachusetts, and Rhode Island), central New England (southern and central Maine, New Hampshire, and Vermont), and northern Maine. Southern New England experienced widespread below normal flow conditions beginning in May, that continued into regionwide below normal flows in July and August when 9 of the 28 streamgages in Connecticut and Massachusetts recorded mean July or August 30-year record lows, with 2 of those 9 streamgages recording mean monthly lows in both July and August (fig. 3*A*). The 7-day average streamflow at Mill River at Northampton, Mass. (01171500) USGS streamgage reached its lowest values (4.0 ft^3/s) on August 22, which is the lowest 7-day average value observed for any month during the past 30 years, including the 2020 drought (fig. 5*A*). In central New England, below normal conditions were most widespread in July and August when 2 of the 34 streamgages (Wild River at Gilead, Maine [01054200] USGS streamgage in July and East Orange Branch at East Orange, Vt. [01139800] USGS streamgage in August) experienced mean monthly record lows. In northern Maine, normal or above normal streamflow conditions were maintained throughout the study period. All streamgages across New England, except two streamgages in Massachusetts and one streamgage in Vermont, returned to normal or above normal streamflow conditions in September (fig. 3*A*). State-specific streamflow conditions are discussed briefly in appendixes 1 to 6.

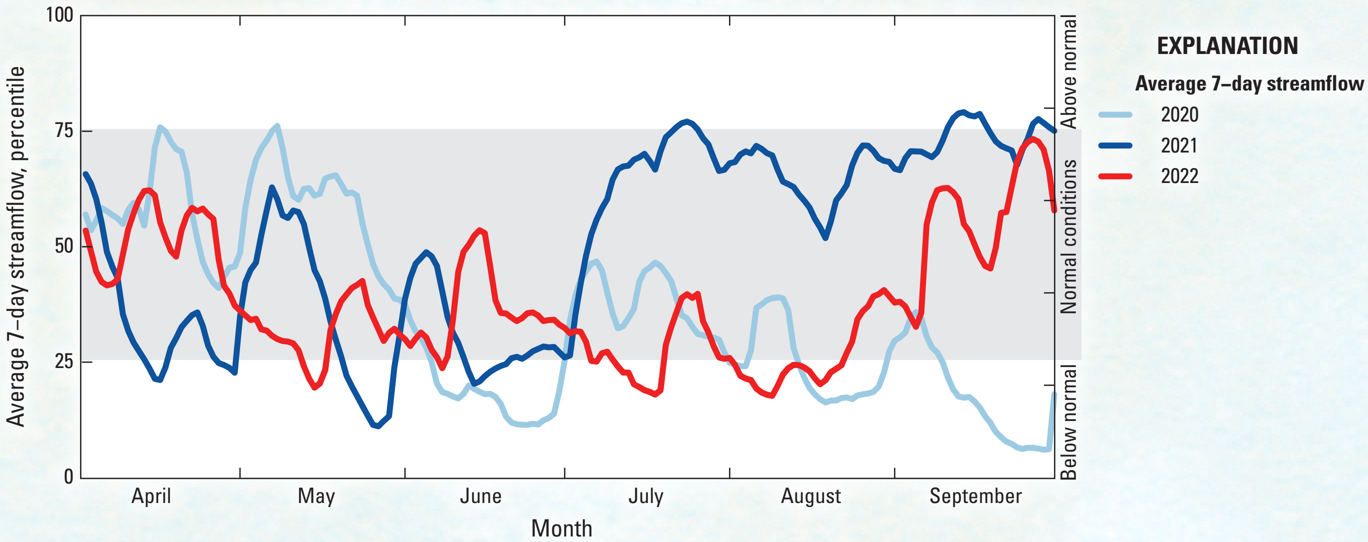


Figure 4. Graph showing the average 7-day streamflow percentile for 78 streamgages in New England from April 1 through September 30 in 2020 (drought conditions), 2021 (above normal conditions), and 2022 (drought conditions) compared with normal conditions (25th to 75th percentile) from water years 1993 to 2022 (area shaded in gray). The minimum average 7-day streamflow in 2022 was in the 18th percentile on August 8, and the maximum average 7-day streamflow in 2022 was in the 73rd percentile on September 26.

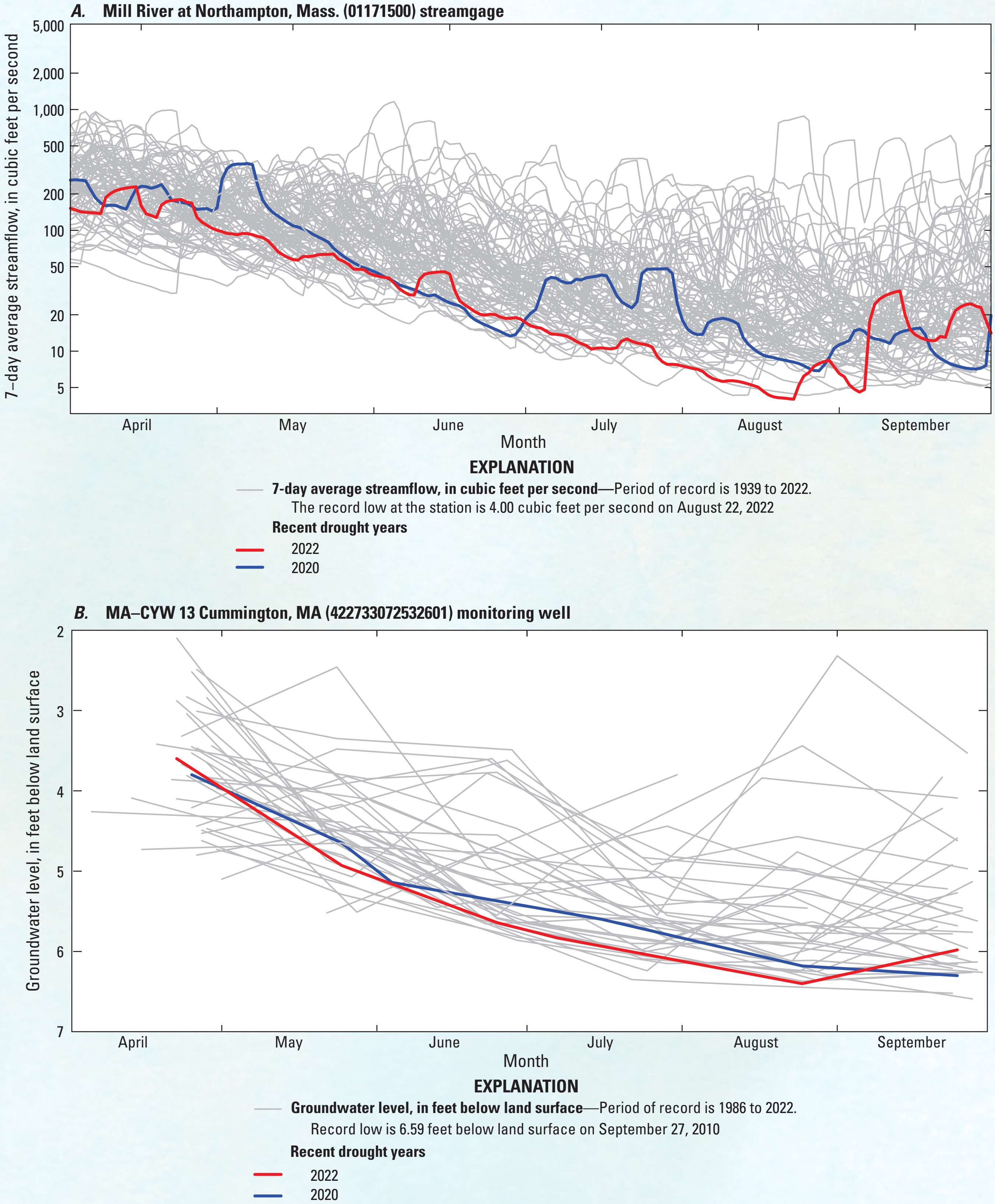


Figure 5. Graphs showing the *A*, moving average 7-day flows at the Mill River at Northampton, Mass. (01171500) U.S. Geological Survey (USGS) streamgage and *B*, monthly groundwater levels at the MA–CYW 13 Cummington, MA (422733072532601) USGS monitoring well for each April through September for their period of record.

Despite below normal flows observed at streamgages throughout parts of New England in 2022, only 3 of the 78 streamgages (with 30 to 120 years of record extending through September 2022) included in this study recorded the lowest 7-day average flows during the streamgage's period of record. The Old Swamp River near South Weymouth, Mass. (01105600; period of record 1966 to 2022) USGS streamgage experienced a record 7-day average low flow on August 21; and the Mill River at Northampton, Mass. (01171500; period of record 1939 to 2022; fig. 5*A*) and Parker River at Byfield, Mass. (01101000; period of record 1946 to 2022) USGS streamgages experienced record 7-day average low flows on August 22. In contrast, 10 of the 78 streamgages experienced record 7-day average low flows in 2020, including two streamgages in Maine that have a period of record beginning in 1903 (USGS streamgages 01031500 and 01013500). The relative lack of streamgages that experienced record 7-day average low flows in 2022, in comparison to the 2020 drought, could be attributed to the timing of the two droughts. The drought in 2020 peaked in September, which is the month that typically experiences the lowest flows during the year (Lombard and others, 2020). The drought in 2022 peaked in August and generally returned to normal conditions in September across New England (figs. 4 and 5*A*).

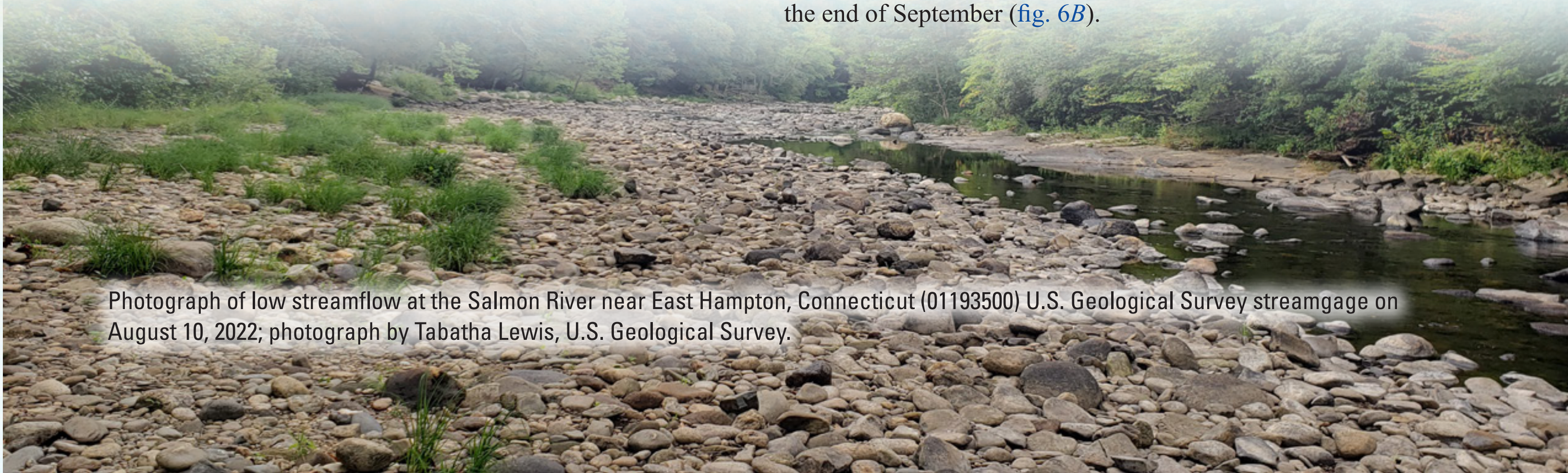
Groundwater Conditions

Parts of northern New England, including Maine and Vermont, experienced below normal groundwater levels in the beginning of water year 2022. Most of southern New England, however, experienced normal to above normal groundwater levels at the beginning of the water year into spring 2022. Groundwater levels in 2022, especially in southern New England, had an earlier onset of widespread below normal conditions (July) than in 2020 (August; fig. 3*B*; apps. 1 to 6; Lombard and others, 2020). In August, groundwater levels were most severely affected by drought conditions, with more than 75 percent of the monitoring wells (95 of 126) in New England indicating below normal conditions; 16 of these represented a 25-year low for August (fig. 3*B*). Unlike in 2020 when water levels continued to decline further below normal past the 2020 water year, water levels in 2022 showed substantial recovery in September, with 76 of 126 wells indicating normal or above normal conditions (fig. 3*B*).

Similar to streamflows, the severity of drought effects on groundwater levels in 2022 varied across New England. Water levels were more severely affected by below normal conditions in southern New England, in many cases declining below 2020 water levels in July and August (apps. 1 to 6). For example, the monthly water level at the MA–CYW 13 Cummington, MA (422733072532601) USGS monitoring well shows similar conditions in April and May in both 2020 and 2022, but the water level in 2022 declined below 2020 levels from June through August before recovering slightly in September (fig. 5*B*). In August 2022, the water level at 86 of 108 groundwater monitoring wells was below normal in the three States making up southern New England, with the water level at 14 of these wells representing the 25-year low for August (fig. 3*B*). In central and northern New England, groundwater levels were only marginally affected, with water levels generally not declining below 2020 conditions (apps. 1 to 6). Of the 18 monitoring wells in central New England and northern Maine, the groundwater level in August was below normal at 9 wells and represented the monthly 25-year low for August at 2 wells.

Paired Streamflow and Groundwater Responses to Precipitation Deficits

Streamflows and groundwater levels at nearby sites are presented to compare their response to precipitation deficits (figs. 6 and 7). Notable water year precipitation deficits in the Hartford, Conn., area began as early as December 2021, and by August 2022, the Hartford area was nearly 10 inches below average (1981–2010) for the water year (fig. 6*A*; National Oceanic and Atmospheric Administration, 2022a). In April, streamflows at the Salmon River near East Hampton, Conn. (01193500) USGS streamgage and groundwater levels at the CT–MB 32 Marlborough, CT (413535072253701) USGS monitoring well indicated normal to above normal conditions, but by mid-August streamflows and water levels dropped well below normal conditions (fig. 6*B*). The Marlborough monitoring well recorded monthly 25-year low groundwater levels in June, July, and August. Flows at the Salmon River streamgage began to recover at the end of August because of increased precipitation. The water level at the monitoring well had a delayed response to the precipitation and only had started recovering slightly in September, remaining below normal at the end of September (fig. 6*B*).



Photograph of low streamflow at the Salmon River near East Hampton, Connecticut (01193500) U.S. Geological Survey streamgage on August 10, 2022; photograph by Tabatha Lewis, U.S. Geological Survey.

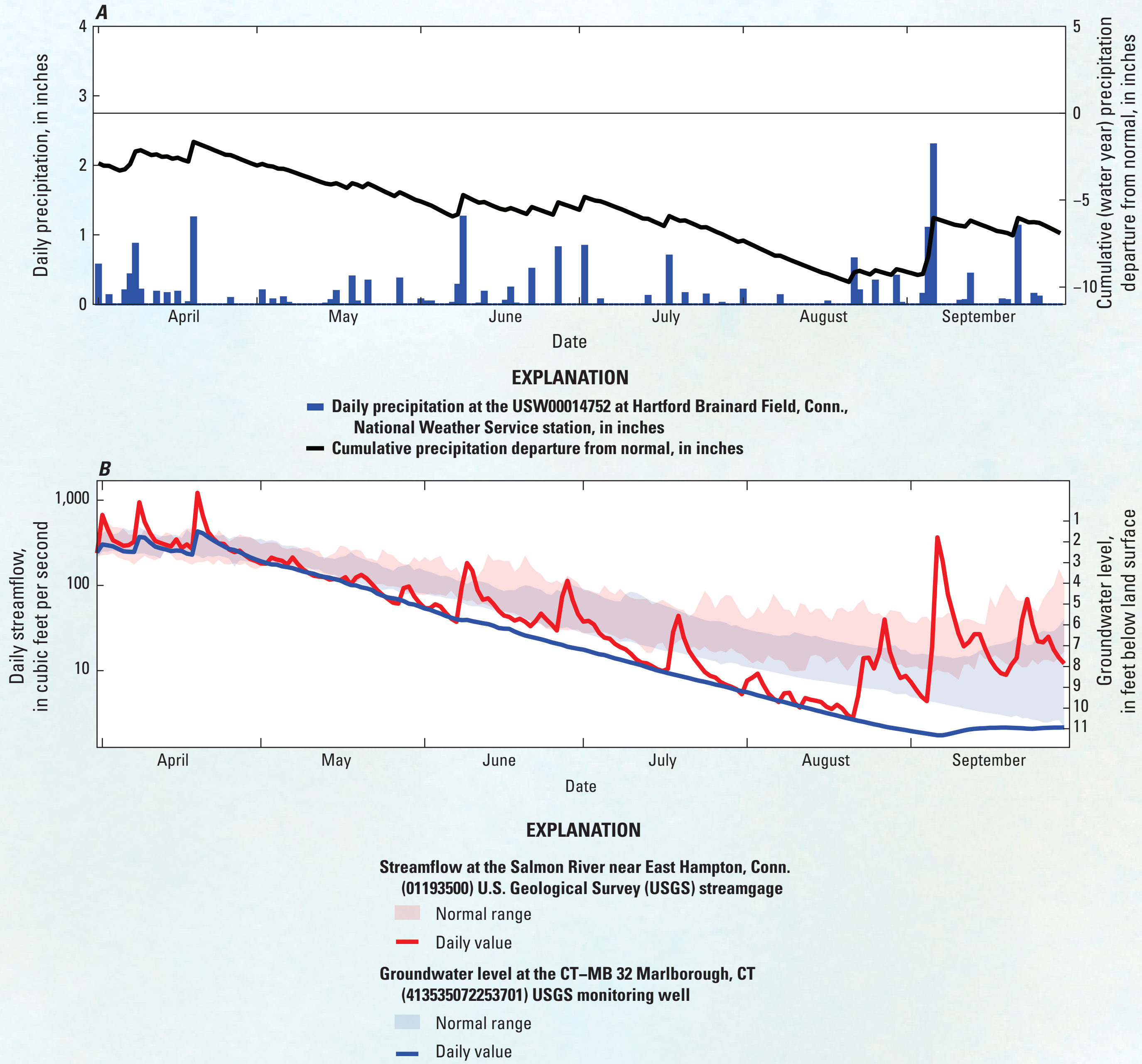


Figure 6. Graphs showing climatic and hydrologic conditions in central Connecticut from April through September 2022. *A*, Daily total precipitation at the USW00014752 at Hartford Brainard Field, Conn., National Weather Service station. *B*, Daily mean flow at the Salmon River near East Hampton, Conn. (01193500) U.S. Geological Survey (USGS) streamgage and daily mean groundwater level at the CT–MB 32 Marlborough, CT (413535072253701) USGS monitoring well. Shaded areas for streamflow and groundwater levels represent normal conditions, which are between the 25th and 75th percentiles, based on 30 years of data for streamflow (1993–2022) and 25 years for data for groundwater levels (1998–2022). Precipitation normal is based on averages of 30 years of data (1981–2010).

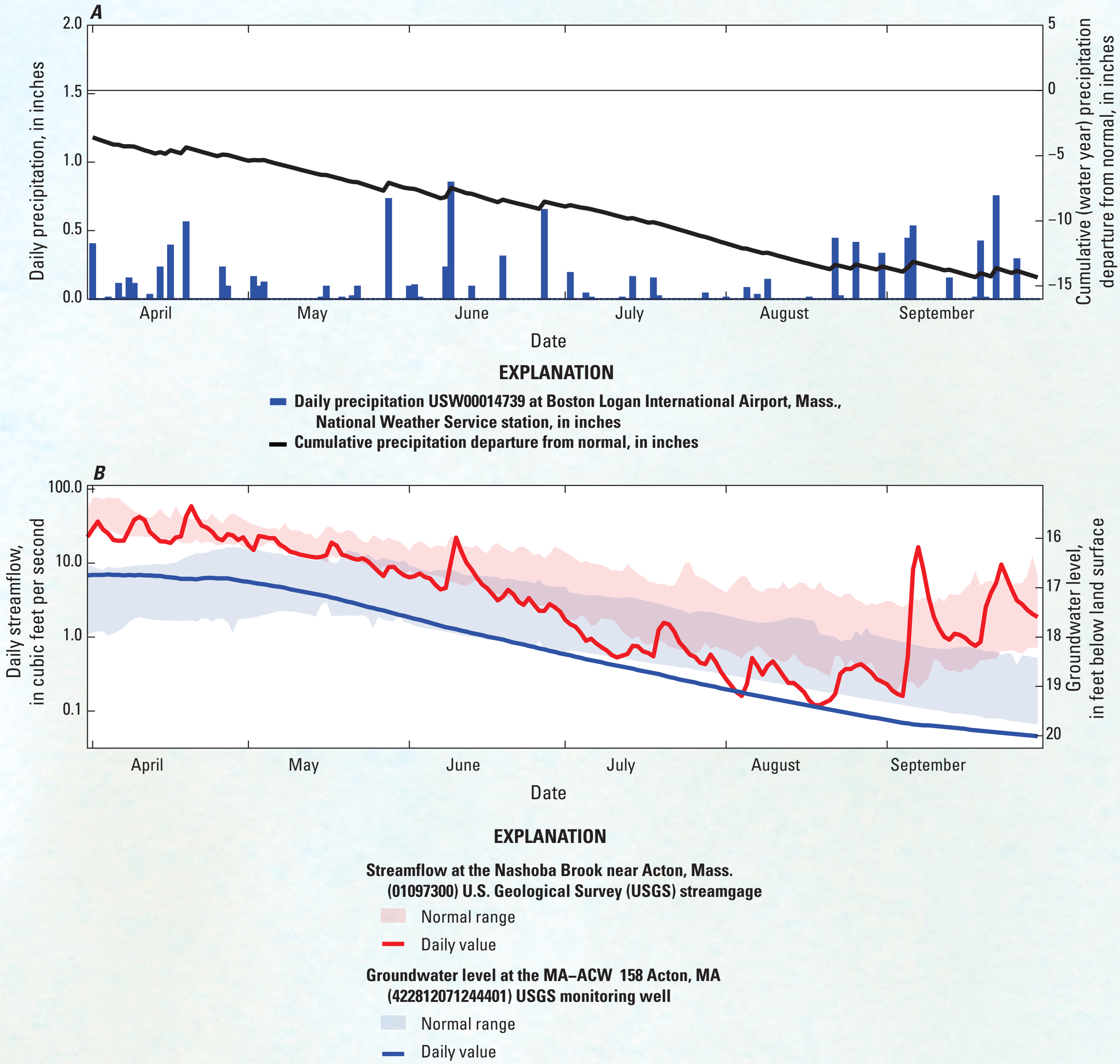


Figure 7. Graphs showing climatic and hydrologic conditions in the Acton, Massachusetts, area from April through September 2022, for *A*, daily total precipitation at the USW00014739 at Boston Logan International Airport, Mass., National Weather Service station and *B*, daily mean flow at the Nashoba Brook near Acton, Mass. (01097300) U.S. Geological Survey (USGS) streamgage and daily mean groundwater levels at the MA–ACW 158 Acton, MA (422812071244401) USGS monitoring well. Shaded areas for streamflow and groundwater levels represent normal conditions, which are between the 25th and 75th percentiles, based on 30 years of data for streamflow (1993–2022) and 25 years for data for groundwater levels (1998–2022). Precipitation normal is based on averages of 30 years of data (1981–2010).

The precipitation deficit was even more substantial in the Boston area for water year 2022, with deficits during the study period exceeding 4 inches in April and declining to more than 14 inches below normal (1981–2010) by the end of September (fig. 7*A*; National Oceanic and Atmospheric Administration, 2022a). Streamflow at the Nashoba Brook near Acton, Mass. (01097300) USGS streamgage indicated normal or below normal conditions from April through June, with streamflow generally declining to well below normal conditions in July and August; fig. 7*B*). Water levels at the MA–ACW 158 Acton, MA (422812071244401) USGS monitoring well, however, started April in the upper range of normal conditions likely due to recharge from rainfall in the summer and early fall 2021. The groundwater level at the well in Acton dropped below normal levels in early July and stayed below normal levels through the end of September, whereas the streamflow at Nashoba Brook showed some improvement from rainfall in late August through September (fig. 7*B*).

Comparison of Streamflow Statistics to Previous Droughts

Because of the differences in lengths, spatial extents, and types of droughts, it is challenging to put droughts into historical context. A streamgage recording a period of record low with 10 years of record has different implications than a streamgage recording a period of record low with 80 years of record. In an effort to compare droughts across the region during the past 30 years, the analysis computed for this study (table 1) indicated the months and years for which the annual 7-day average streamflow was a 30-year low (between 1993 and 2022) for at least 2 months at more than 10 percent of the 78 streamgages in New England. In 2021, all the 30-year lows happened in the three northern New England States, whereas in 2016, all the 30-year lows happened in the three southern New England States.

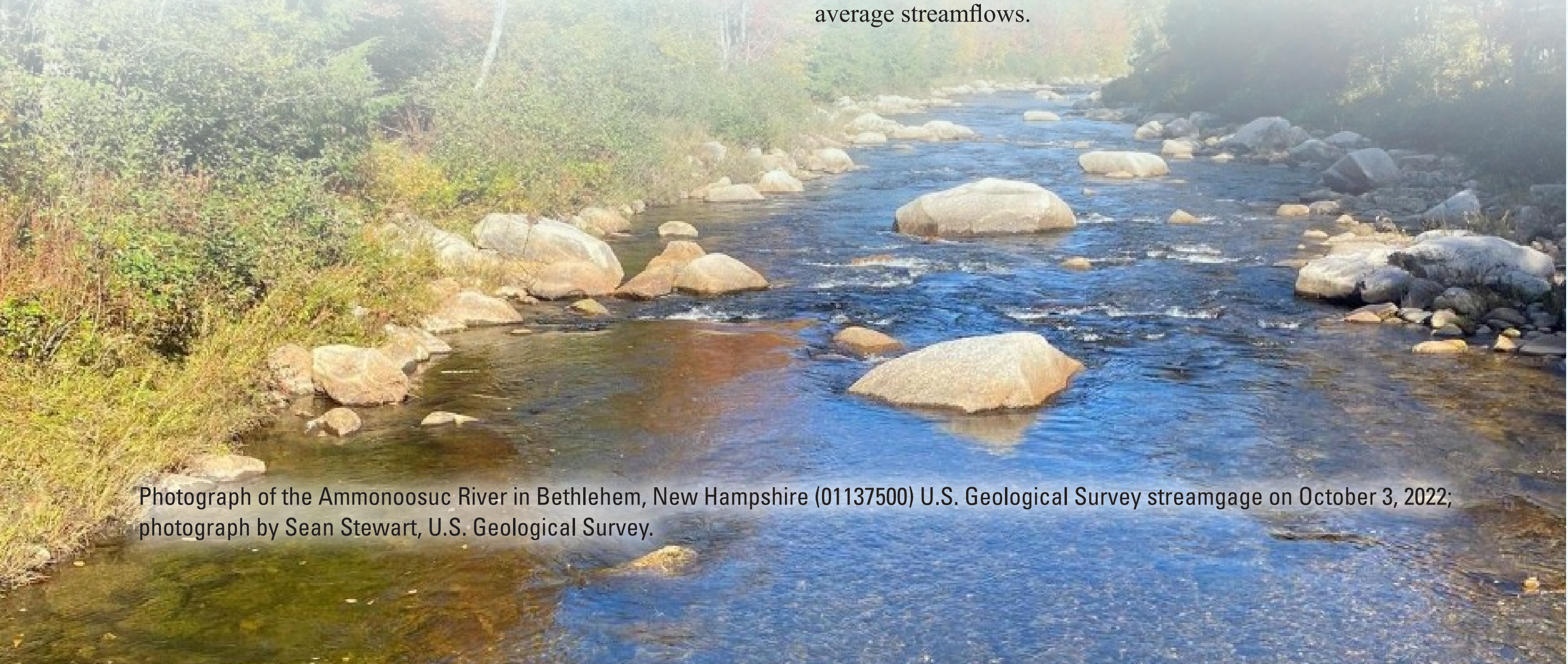
Table 1. Drought periods in New England from 1993 to 2022 compiled from 7-day average streamflows that were 30-year lows for at least 2 months at more than 10 percent of the streamgages in New England.

[Data are aggregated from the National Water Information System (U.S. Geological Survey, 2022)]

Year	Month	States severely affected
1995	June to September	All
1999	June to August	All
2001	August to September	All
2002	August to September	All
2016	June to September	Massachusetts, Rhode Island, Connecticut
2020	June and September	All
2021	May and June	Maine, New Hampshire, Vermont

For 2016, more than 10 percent of the streamgages had 30-year lows from June to September (table 1); however, more than 20 percent of the streamgages had 30-year lows in July 2016 (all in southern New England). In 1995, 30-year lows were recorded in more than 10 percent of the 78 total streamgages in all States from June through September (table 1), and 30-year lows were recorded in more than 20 percent of the total 78 streamgages in June and July.

The data for 2022 are not included in table 1 because 30-year lows were not recorded at more than 10 percent of the 78 streamgages for the year for a 2-month period; however. more than 10 percent of the 78 streamgages recorded 30-year lows during the month of August in 2022, with these lows recorded in Connecticut, Massachusetts, and Vermont. This type of analysis does not include droughts such as the severe 1960s regional drought because it took place more than 30 years ago, nor does it quantify the compounded effects of multiyear droughts, such as for 1961–69 and 1998–2002 because this analysis is based only on annual 7-day average streamflows.



Photograph of the Ammonoosuc River in Bethlehem, New Hampshire (01137500) U.S. Geological Survey streamgage on October 3, 2022; photograph by Sean Stewart, U.S. Geological Survey.

Provisional Nature of the Data

Many of the data presented in this report are provisional and subject to revision following formal quality assurance review by the USGS, as indicated in NWIS (U.S. Geological Survey, 2022).

Summary

From April through September 2022, parts of New England experienced a hydrologic drought (below normal streamflow or groundwater levels); however, the drought was generally confined to May through August and was most prevalent in southern New England. Precipitation was below average for much of New England in April 2022 and continued to rapidly decline throughout the growing season. This resulted in below normal to much below normal streamflows and groundwater levels in southern New England, including Connecticut, Massachusetts, and Rhode Island. Parts of southern Maine, New Hampshire, and Vermont were moderately affected by below normal hydrologic conditions. The hydrologic drought was most severe in August, the month that recorded the greatest number of 30-year low streamflows and 25-year low groundwater levels. Many streamgages and groundwater monitoring wells returned to normal levels in September. The drought in 2022 recorded fewer period of record lows at streamgages than the drought in 2020, in part because of the timing of the drought; period of record lows often happen in September when many of the streamgages had already started to recover in 2022.

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Appendix 1. Drought in Connecticut in 2022

Flows were at or above normal in April but began decreasing in May 2022 when 7 of the 11 U.S. Geological Survey (USGS) streamgages experienced below normal conditions. Flow at most streamgages increased slightly in June but returned to below normal to much below normal conditions through July and August (fig. 3*A*). The 2022 low streamflow conditions are comparable with, and in many cases, dropped below conditions recorded in the 2020 drought, for example, at the Little River near Hanover, Conn. (01123000) USGS streamgage (fig. 1.1). Streamflows across the State reached their lowest values at the end of August or beginning of September, when streamflows quickly increased and fluctuated around normal to above normal conditions through September.

Most groundwater monitoring wells indicated normal to above normal water levels in April but steadily declined to below 25-year normal levels during the summer months (fig. 3*B*). In April, water levels in 17 of 19 wells were normal or above normal for the month, but by August, 15 of the 19 wells had water levels that were below normal (for example, at the CT–SC 22 Scotland [414240072033201] USGS monitoring well in Scotland, Conn.; fig. 1.2), and 4 wells had groundwater levels that were a 25-year low for August (fig. 3*B*). In September, water levels in some wells in Connecticut recovered, with only 9 of the 16 wells indicating below normal conditions.

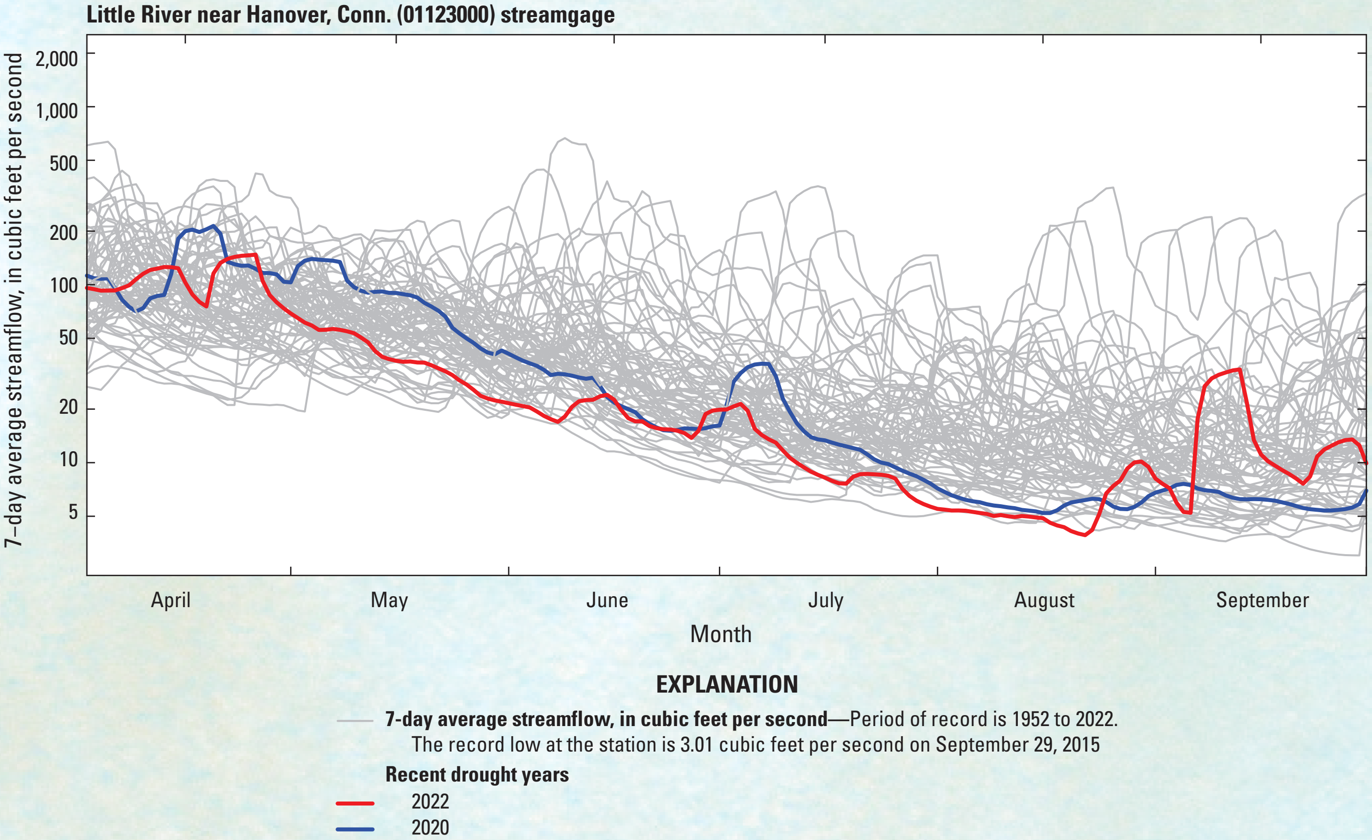


Figure 1.1. Graph showing the moving average 7-day flows at the Little River near Hanover, Conn. (01123000) U.S. Geological streamgage for April through September for the streamgage period of record.

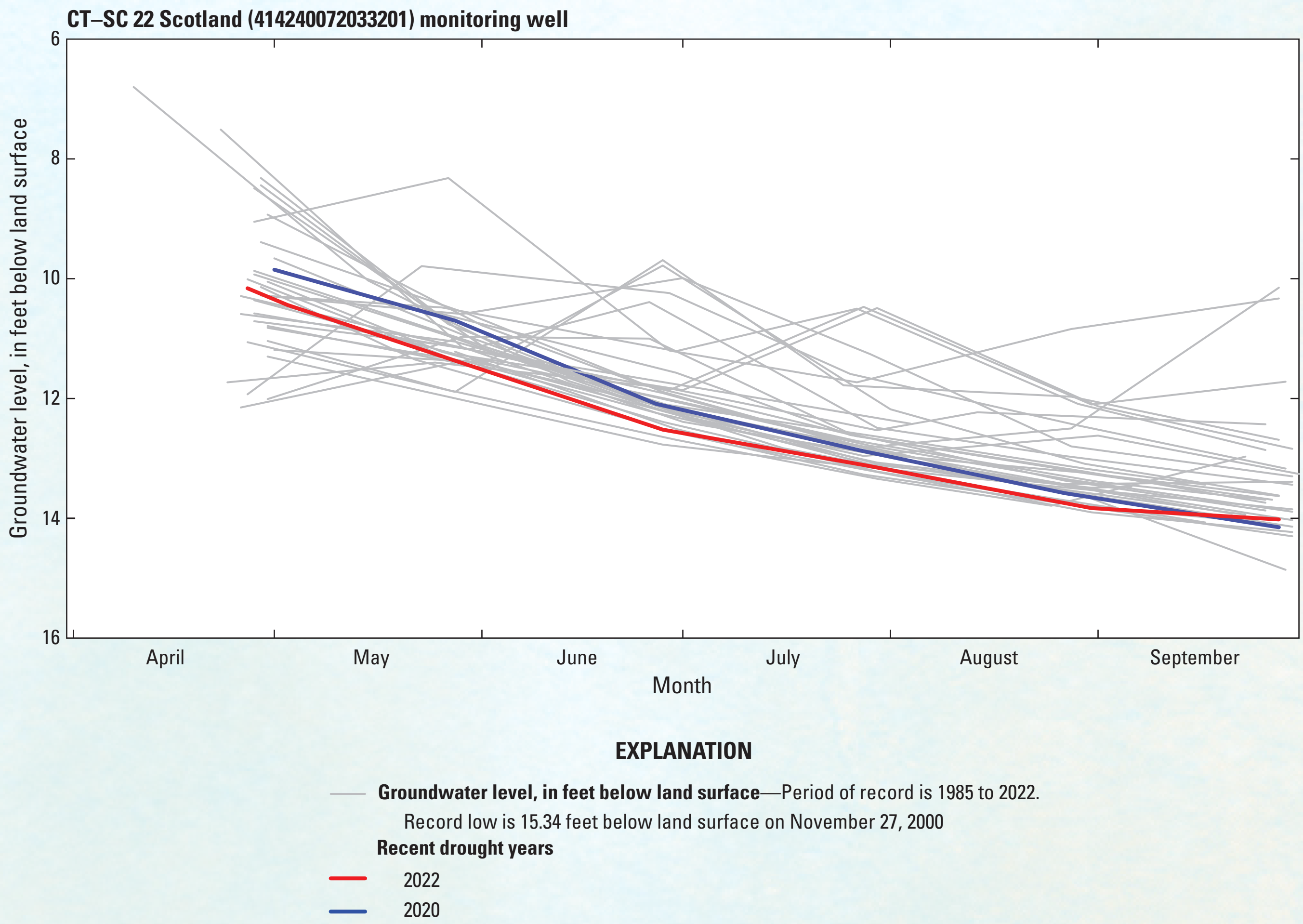


Figure 1.2. Graph showing monthly groundwater levels at the CT–SC 22 Scotland (414240072033201) monitoring well in Scotland, Conn., for April through September for the well's period of record.

Appendix 2. Drought in Maine in 2022

The effects of the 2022 drought varied within Maine. In northern Maine, all streamgages experienced normal to above normal flows from April to September (fig. 3*A*) and did not drop below the low flow conditions experienced in summer 2020, as indicated at the St. John River below Fish River near Fort Kent, Maine (01014000) U.S. Geological Survey (USGS) streamgage (fig. 2.1*A*). In central and southern Maine, all nine streamgages experienced below normal flows in May, with two of those streamgages experiencing flows much below normal (fig. 3*A*). Some streamgages, such as the Little Androscoggin River near South Paris, Maine (01057000) experienced lower than normal flows in May, June, and July, and in some instances dropped below flows observed in 2020 (fig. 2.1*B*). Flow at all streamgages in Maine returned to normal or above normal conditions in August and September (fig. 3*A*).

Groundwater levels also varied across Maine in 2022, with many indicating less severe drought conditions than in 2020. The lowest water levels were in July and August, with three and four wells, respectively, of eight, indicating below normal conditions, and almost all were in the southwestern part of the State (fig. 3*B*). The ME–OW1214 Oxford, Maine (440823070291501) USGS monitoring well recorded a 25-year low in June, July, and August (fig. 2.2*A*). There are a limited number of USGS groundwater monitoring wells in much of central Maine. In northern Maine, the ME–ARW890 Fort Kent, Maine (471457068353001) USGS monitoring well had normal to above normal water levels throughout the period studied in 2022, exceeding water levels from April through September for many of the years in the period of record (fig. 2.2*B*).

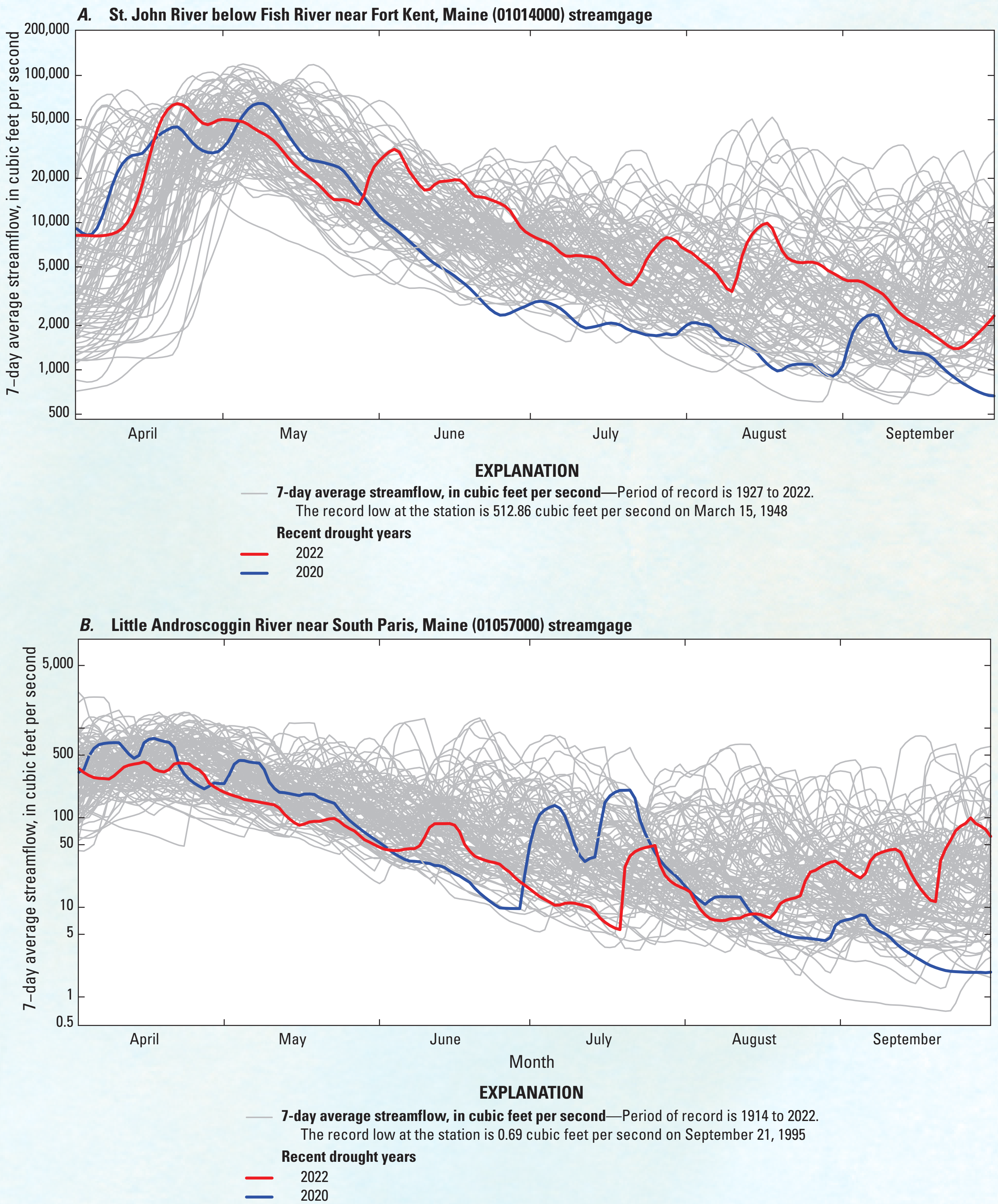
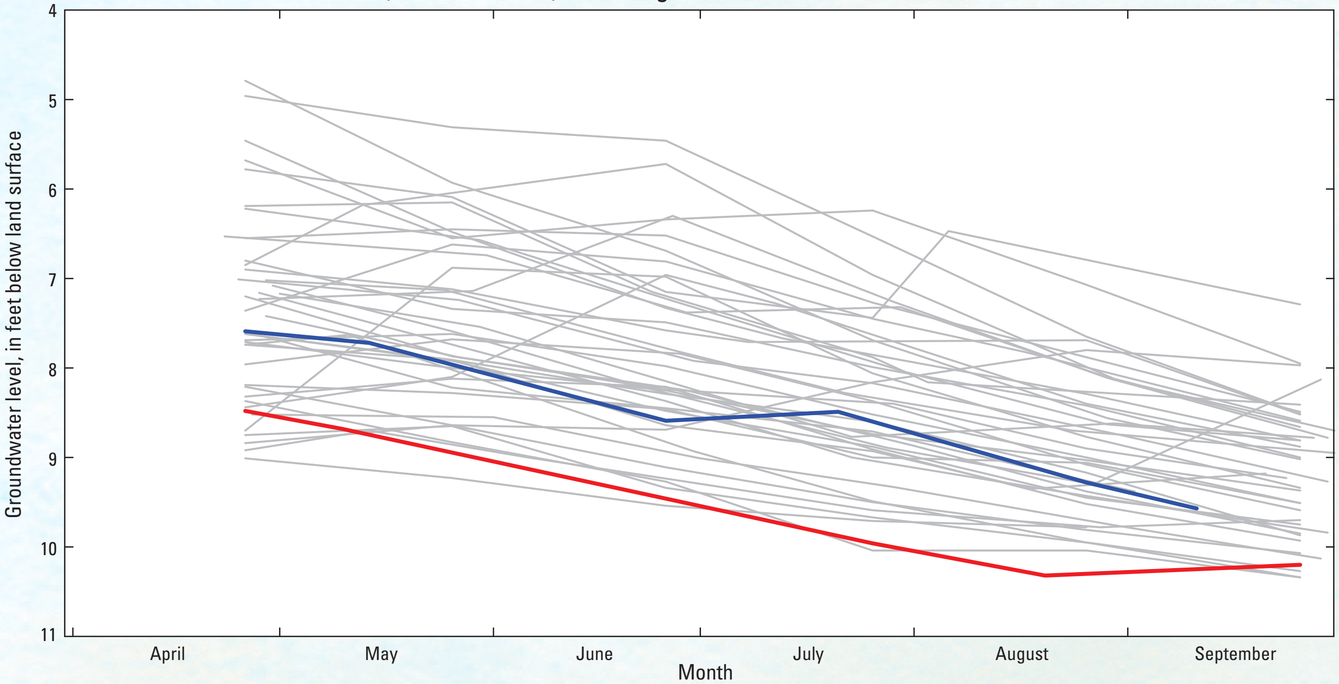


Figure 2.1. Graphs showing the moving average 7-day flows at the *A*, St. John River below Fish River near Fort Kent, Maine (01014000) and *B*, Little Androscoggin River near South Paris, Maine (01057000) U.S. Geological Survey streamgages for April through September for their periods of record.



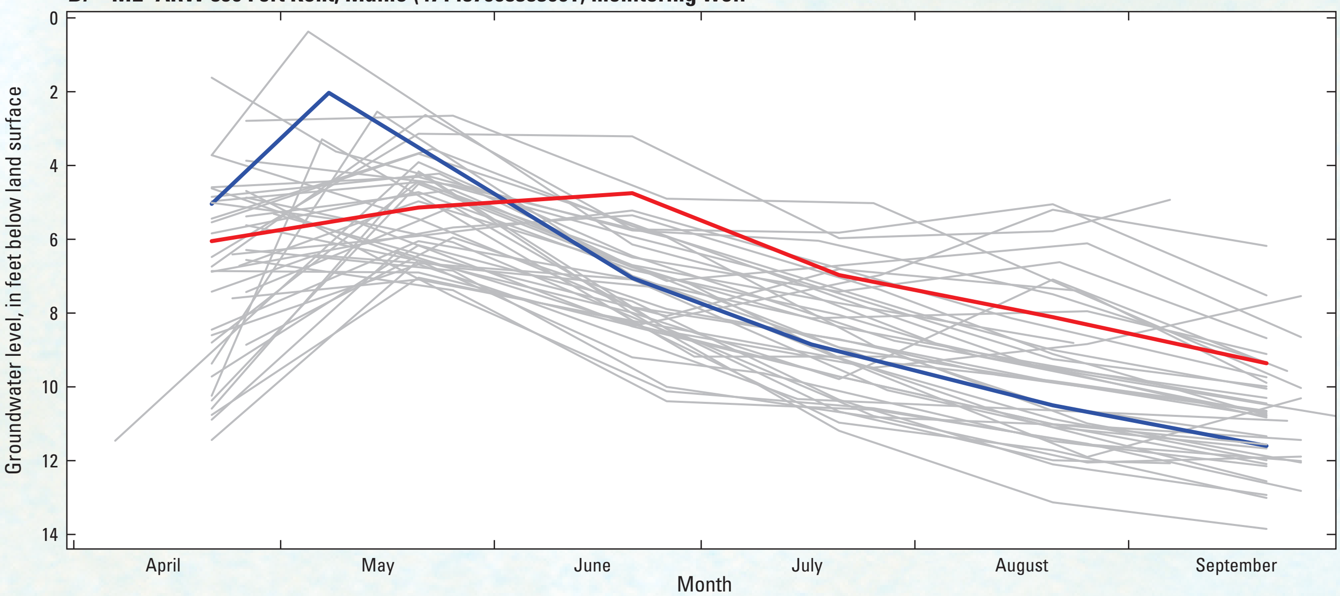


Figure 2.2. Graphs showing monthly groundwater levels at the *A*, ME–OW 1214 Oxford, Maine (440823070291501) and *B*, ME–ARW 890 Fort Kent, Maine (471457068353001) monitoring wells for April through September for their periods of record.

Appendix 3. Drought in Massachusetts in 2022

Drought conditions first became widespread in Massachusetts in May, when flows at 11 of 17 streamgages experienced below normal conditions, 3 streamgages experienced well below normal conditions, and only 3 streamgages had normal conditions (fig. 3*A*). Flows remained below normal in June when only 4 of 17 streamgages experienced normal conditions. In July and most noticeably August, streamflow conditions for most the State were below or well below normal. In August, four streamgages recorded 30-year mean monthly record flows, and only two streamgages recorded normal or above normal conditions. Mean monthly record low flows were recorded at three streamgages in southeastern Massachusetts during May; however, the most severely affected streamgages were in western Massachusetts (fig. 5*A*) where four streamgages recorded 30-year mean monthly record low flows in August (fig. 3*A*). Two streamgages, Old Swamp River near South Weymouth, Mass. (01105600) in eastern Massachusetts and Mill River at Northampton, Mass. (01171500) in western Massachusetts (fig. 5*A*), recorded 7-day average record low flows for their entire period of record on August 21 and 22, respectively. Additionally, the Parker River at Byfield, Mass. (01101000) streamgage in northeastern Massachusetts recorded a 7-day average zero-flow from August 22 to September 4 (zero flow ties the period of record low for the gage). At the end of August to the beginning of September, streamflows began increasing in a fluctuating pattern (long-term increasing trend with shorter periods of increasing and decreasing flows), for example, at the Quaboag River at West Brimfield, Mass. (01176000) U.S. Geological Survey (USGS) streamgage (fig. 3.1).

Massachusetts has an extensive groundwater monitoring network, with a total of 62 wells evaluated. Statewide, in April, 54 of the 60 monitoring wells with measurements had groundwater levels within the normal or above normal range. From May to August, the number of wells with below normal monthly water levels steadily increased each month, with 46 of the 62 wells recording water levels below normal by August, including the MA–HLW 23 Haverhill, MA (424841071004101) USGS monitoring well (fig. 3.2). For 6 of the 62 wells, the monthly water level was a 25-year low in August (figs. 3*B* and 5*B*). Drought severity differed across the State during the summer months. In July, a total of 37 wells recorded water level measurements below normal, with 22 of these wells in eastern Massachusetts (Massachusetts-Rhode Island coastal watershed). In August, water levels in western Massachusetts (Lower Connecticut River watershed) declined substantially as an additional 6 wells recorded water levels below normal, whereas only one additional well in eastern Massachusetts indicated below normal conditions. Water levels in many wells recovered to at least normal conditions in September (39 of 62 wells). Many of the wells with groundwater levels that remained below normal in September were in northeastern Massachusetts and Cape Cod.

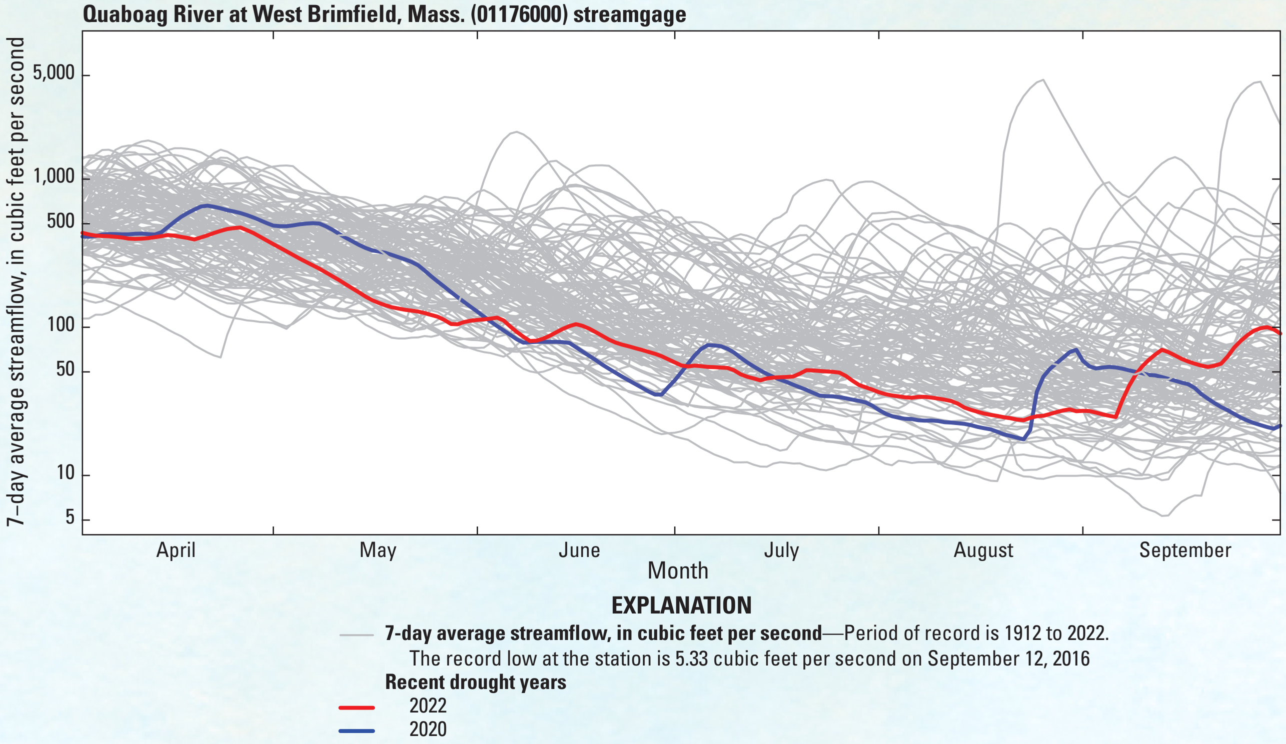


Figure 3.1. Graph showing the moving average 7-day flows at the Quaboag River at West Brimfield, Mass. (01176000) U.S. Geological Survey streamgage for April through September for the streamgage period of record.

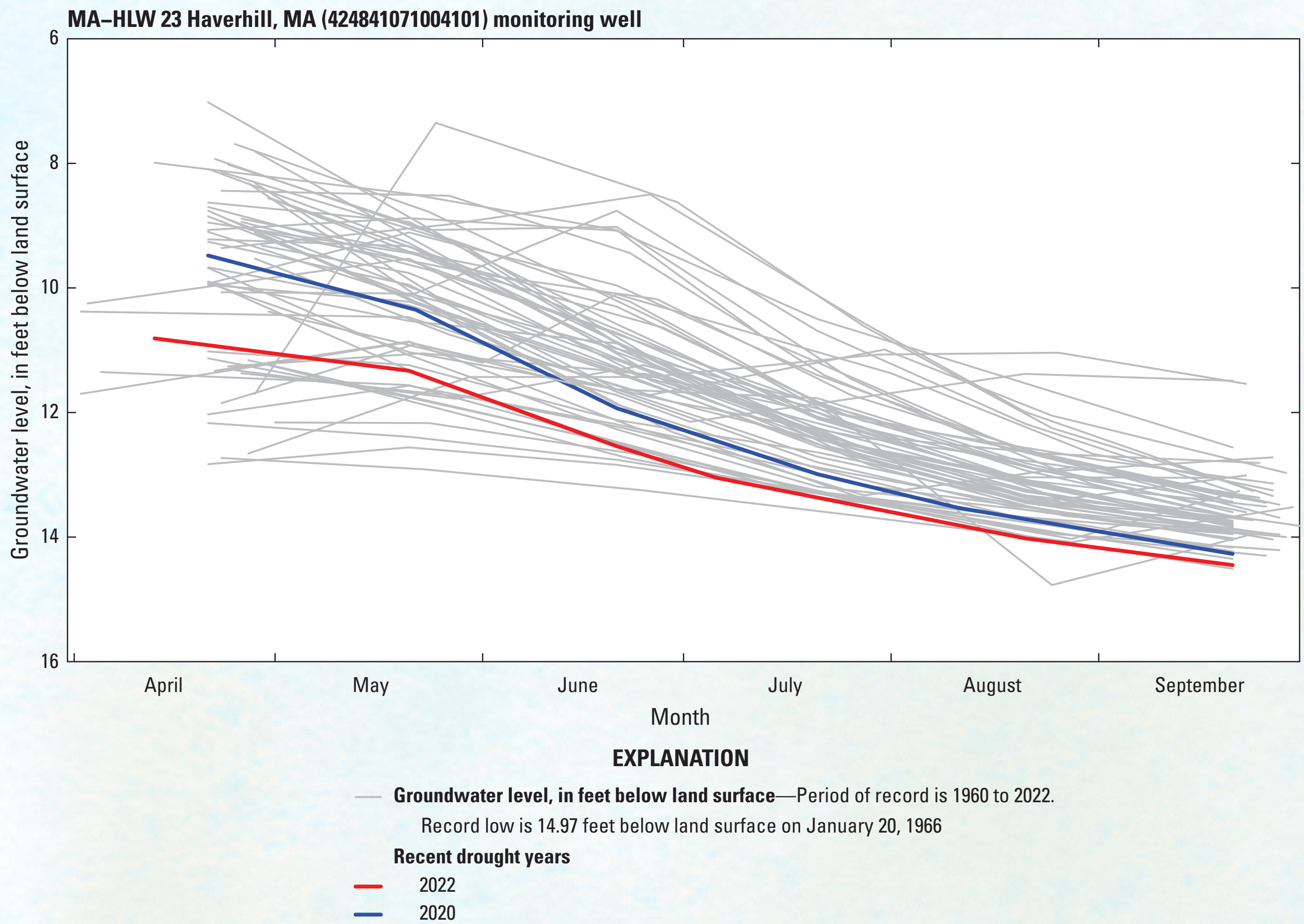


Figure 3.2. Graph showing monthly groundwater levels at the MA–HLW 23 Haverhill, MA (424841071004101) U.S. Geological Survey monitoring well for April through September for the well's period of record.

Appendix 4. Drought in New Hampshire in 2022

Streamflows in New Hampshire were relatively low from April through August but did not reach the much below normal levels seen in southern New England. In April and May, four of the eight New Hampshire streamgages experienced below normal flows (fig. 3*A*), however, flows did not decline below 2020 conditions. By August, the number of streamgages with below normal flows increased to six of the eight in New Hampshire, and in September, all streamgages had flow increase to normal or above normal conditions, for example, at the Pemigewasset River at Plymouth, N.H. (01076500) U.S. Geological Survey streamgage (fig. 4.1).

The water levels at only two monitoring wells in New Hampshire were evaluated in this report (fig. 3*B*). Water levels at the NH–SJW 2 (442450071052301) monitoring well in northern New Hampshire were below normal before the study period and continued to have below normal water levels during May and June and 25-year lows in July and August. Water levels at the NH–WCW 1 Warner, NH (431540071452801) monitoring well in south-central New Hampshire remained within the normal range for most of the study period, until falling below normal in September (fig. 4.2).

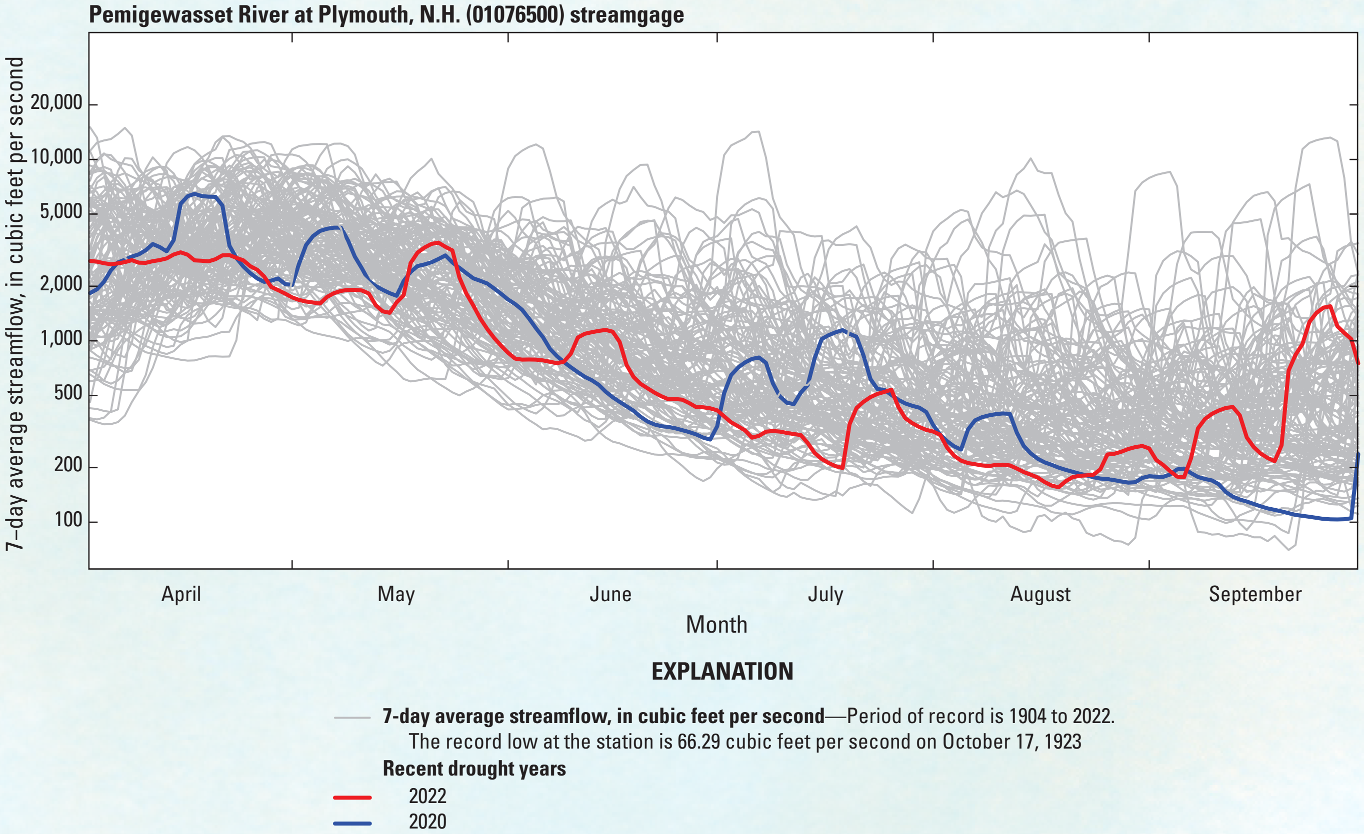
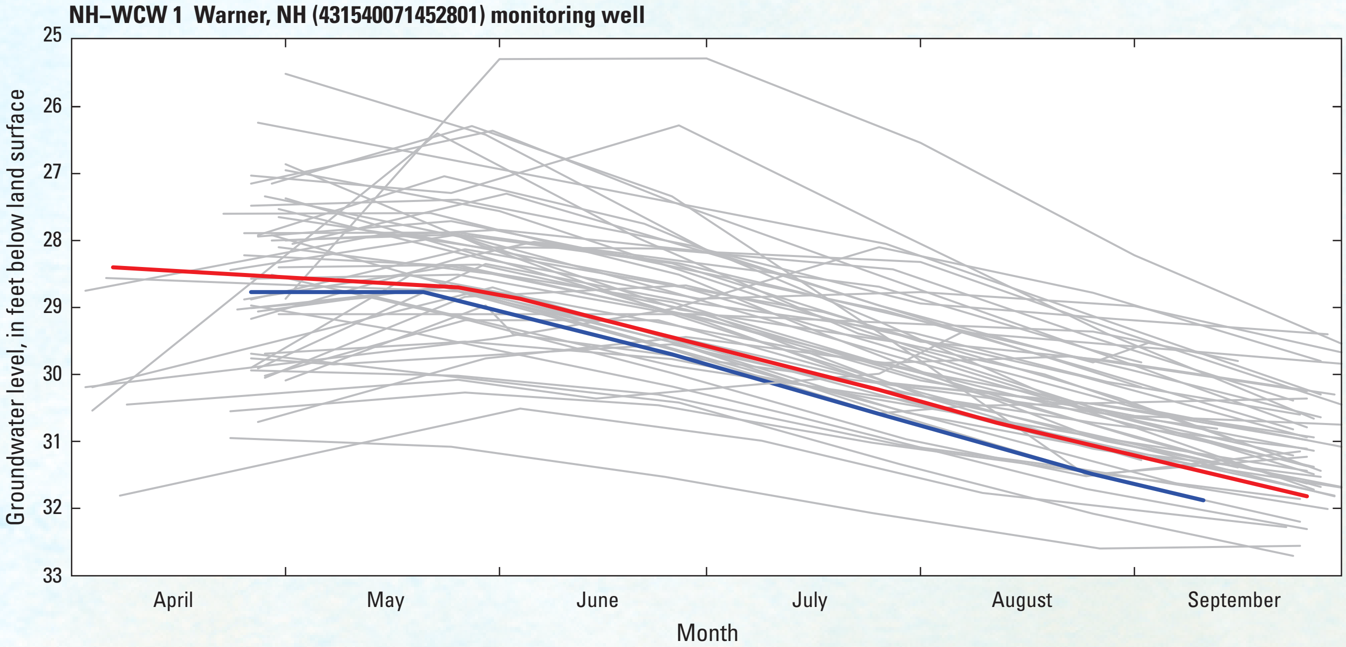


Figure 4.1. Graph showing the moving average 7-day flows at the Pemigewasset River at Plymouth, N.H. (01076500) U.S. Geological Survey streamgage for April through September for the streamgage period of record.



EXPLANATION

Groundwater level, in feet below land surface—Period of record is 1965 to 2022. Record low is 33.82 feet below land surface on December 17, 1965

Recent drought years

2022

2020

Figure 4.2. Graph showing monthly groundwater levels at the NH–WCW 1 Warner, NH (431540071452801) U.S. Geological Survey monitoring well for April through September for the well's period of record.

Appendix 5. Drought in Rhode Island in 2022

Flows in Rhode Island were normal or above normal in April but began to decrease in May when 6 of 8 streamgages experienced below normal conditions and 1 experienced well below normal conditions (fig. 3*A*). Flows at most streamgages increased slightly in June but returned to below normal to well below normal conditions through July and August. Flow conditions were comparable to conditions in 2020, with a few streamgages having flows below 2020 conditions during some months; for example, streamflow at the Pawcatuck River at Wood River Junction, Rhode Island (01117500) U.S. Geological Survey (USGS) streamgage dropped below 2020 conditions in May, July, and August 2022 (fig. 5.1). Streamflows across the State reached their lowest values at the end of August or beginning of September, when streamflows quickly increased and fluctuated around normal to above normal conditions through September.

Groundwater levels at wells in Rhode Island were highly affected by drought conditions in the summer (fig. 3*B*), many showing comparable or worse conditions than those of the 2020 drought. Nearly all monitoring wells had water levels within the normal range in April (26 of 27 wells). However, water levels declined rapidly, with many wells experiencing below normal conditions in May through August, for example, at the RI–EXW 475 Exeter, RI (413358071433801) USGS monitoring well (fig. 5.2). Of the 27 wells in Rhode Island, 25 had water levels that were below normal in August, and 5 wells recorded a water level representing a 25-year low in July (fig. 3*B*). In September, water levels improved throughout much of the State, especially in northern Rhode Island, with only 10 wells statewide recording below normal monthly water levels. Two of the 10 wells (RI–EXW 278 413135071314201 and RI–POW 551 413325071152401) were observed to be dry in September; both are completed in till, which can respond slower to precipitation events.

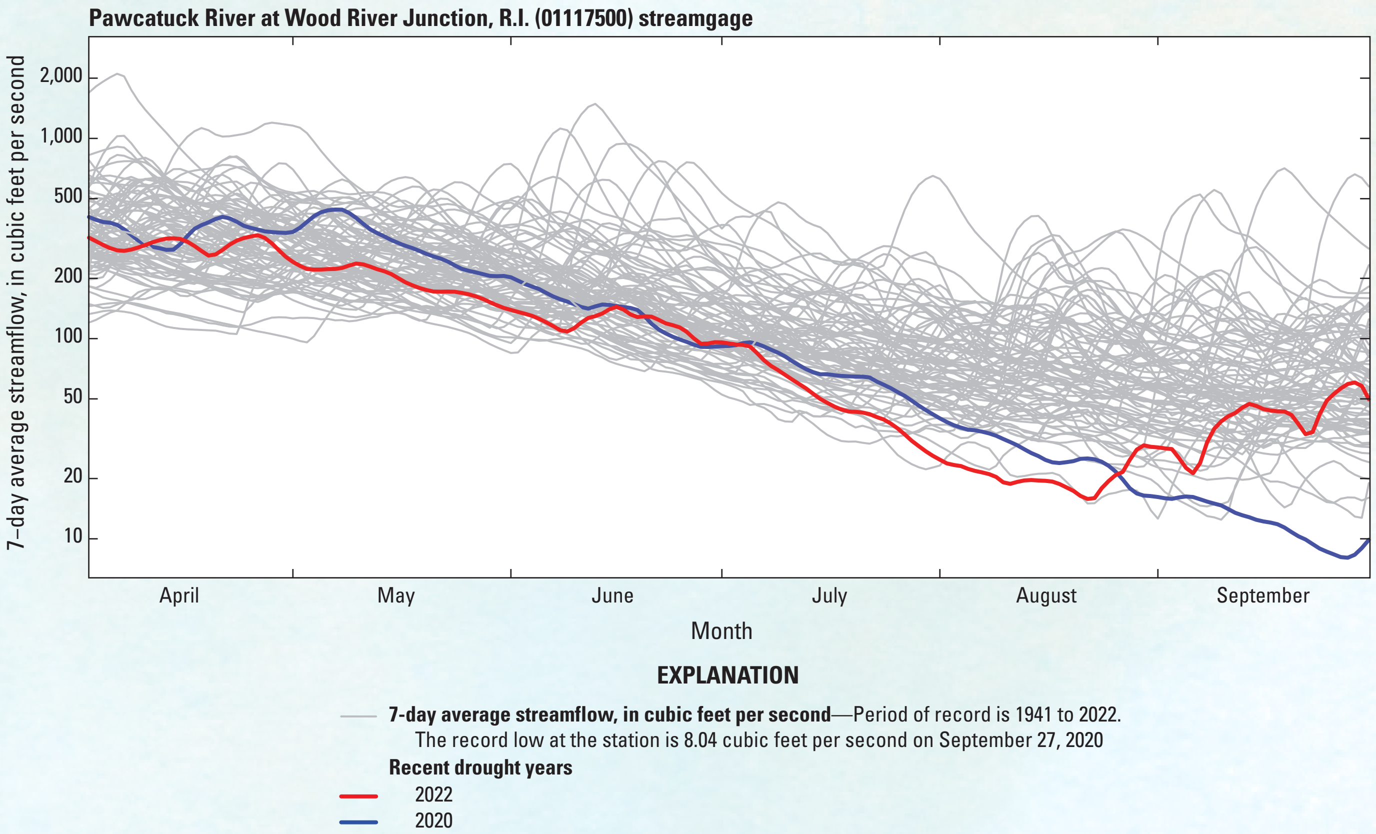


Figure 5.1. Graph showing the moving average 7-day flows at the Pawcatuck River at Wood River Junction, R.I. (01117500) U.S. Geological Survey streamgage for April through September for the streamgage period of record.

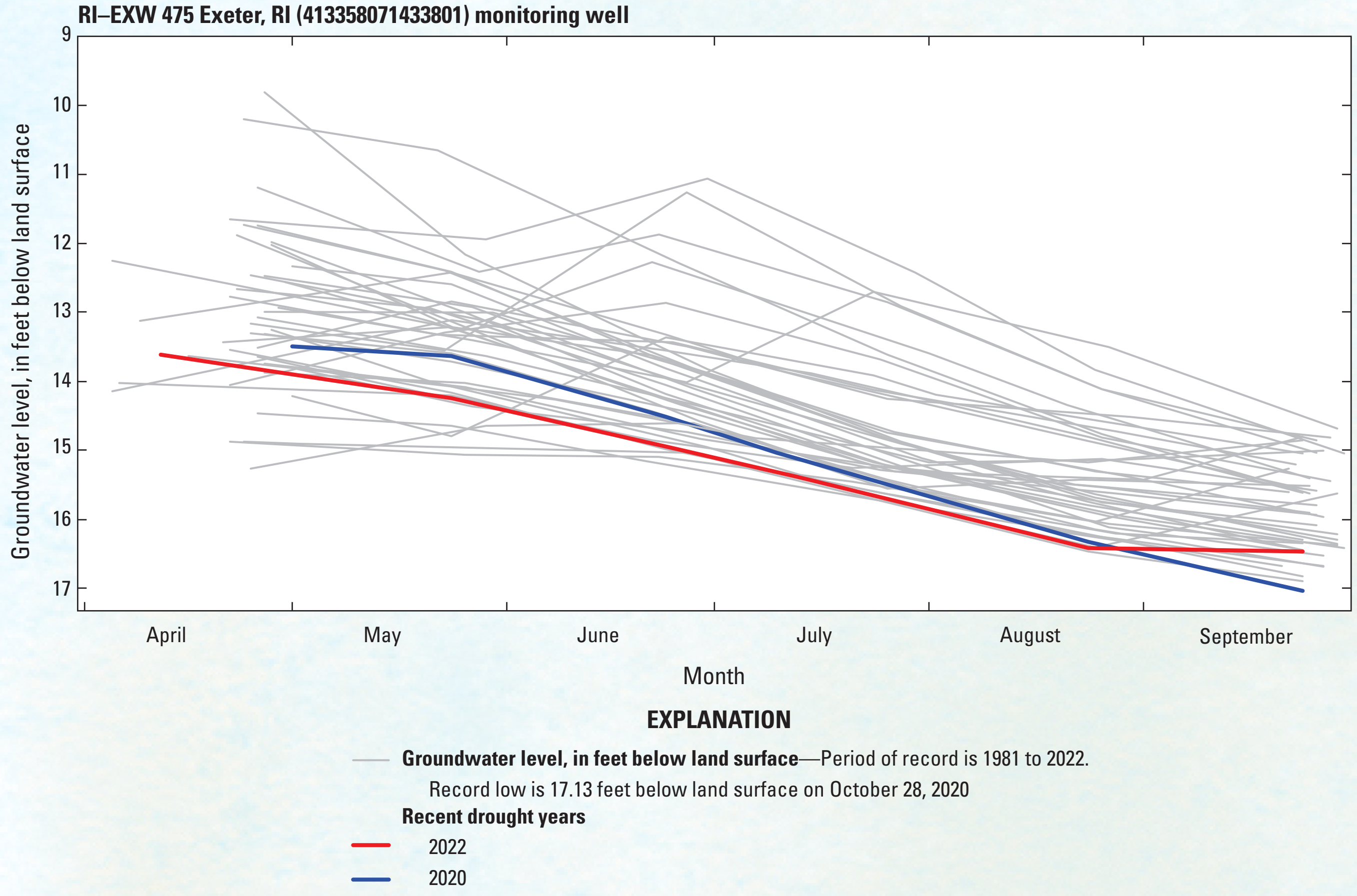


Figure 5.2. Graph showing monthly groundwater levels at the RI–EXW 475 Exeter, RI (413358071433801) U.S. Geological Survey monitoring well for April through September for the well's period of record.

Appendix 6. Drought in Vermont in 2022

Flows at all streamgages in April were within normal conditions but began to decline statewide month-by-month until flows from all 17 Vermont streamgages were below normal in August (fig. 3*A*). In July, 3 of the 17 streamgages had flows that were much below normal, and in August, 7 streamgages had flows much below normal, and 1 streamgage experienced a monthly mean 30-year record low. At the White River at West Hartford, Vt. (01144000) U.S. Geological Survey (USGS) streamgage, flows closely resembled those in 2020 until September when streamflows increased, unlike in 2020 (fig. 6.1). By September, only 1 of the 17 streamgages experienced below normal flows, and 9 of the 17 streamgages experienced above normal flows.

Groundwater levels were moderately affected by drought conditions. In April, only one of the eight monitoring wells recorded a below normal water level. Water levels in additional monitoring wells declined to below normal levels in the following months, with four wells recording below normal conditions in June, July, and August similar to the water level at the VT–WOW 1 (435343072151801) USGS monitoring well in West Fairlee, Vt. (figs. 3*B* and 6.2). No 25-year record low groundwater levels were observed from April to September. Although groundwater levels in three wells remained below normal in September, there was recovery from increased precipitation since four wells recorded water levels that were above normal.

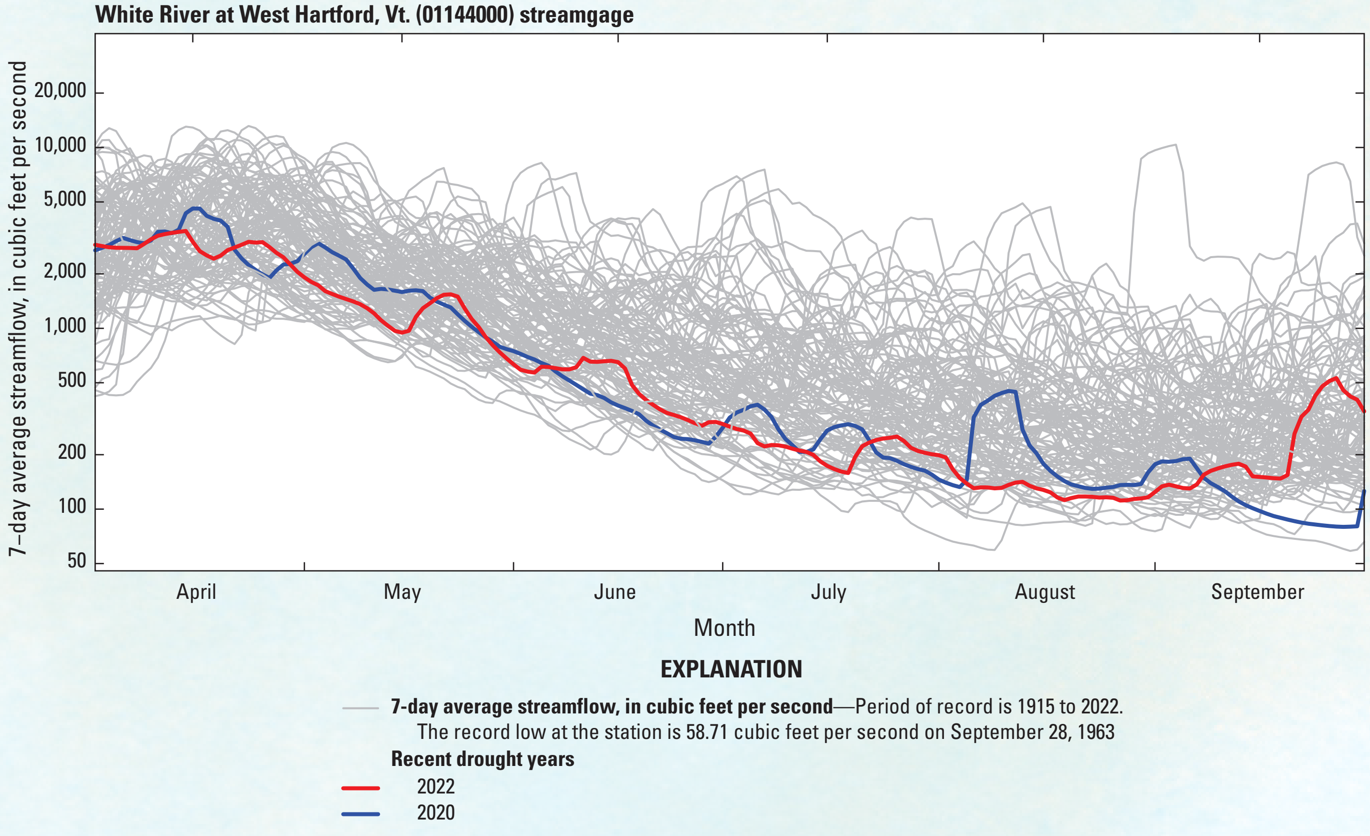
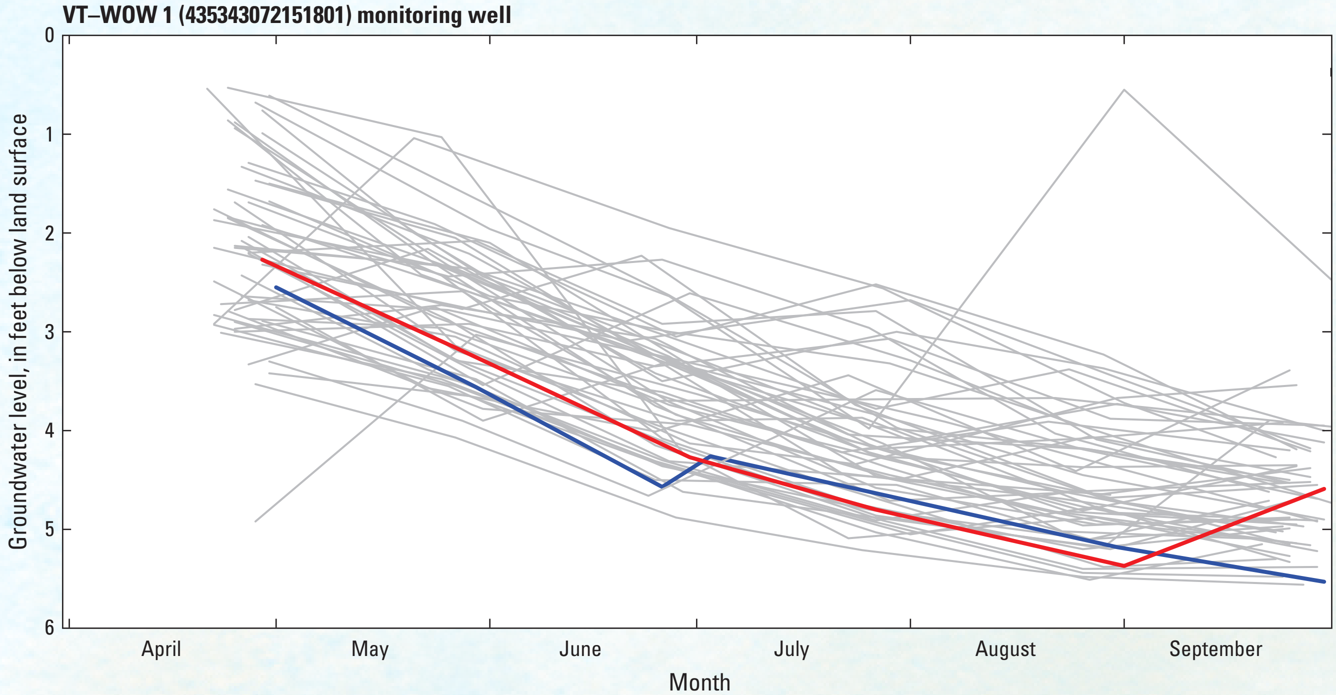


Figure 6.1. Graph showing the moving average 7-day flows at the White River at West Hartford, Vt. (01144000) U.S. Geological Survey streamgage for April through September for the streamgage period of record.



EXPLANATION

Groundwater level, in feet below land surface—Period of record is 1967 to 2022. Record low is 5.56 feet below land surface on September 26, 1995

Recent drought years

2022

2020

Figure 6.2. Graph showing monthly groundwater levels at the VT–WOW 1 (435343072151801) U.S. Geological Survey monitoring well in West Fairlee, Vermont, for April through September for the well's period of record.

Appendix 7. Streamgages and Groundwater Monitoring Stations in New England

Table 7.1. Streamgages used in a drought analysis for New England in 2022.

[Data are from the National Water Information System (U.S. Geological Survey, 2022), unless otherwise indicated. USGS, U.S. Geological Survey; HUC6, drainage basin six-digit hydrologic code from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019)]

USGS site number	Station name and location	Latitude, in decimal degrees	Longitude, in decimal degrees	HUC6
01118300	Pendleton Hill Brook near Clarks Falls, CT	41.474822	−71.834236	010900
01121000	Mount Hope River near Warrenville, CT	41.843709	−72.168966	011000
01123000	Little River near Hanover, CT	41.671765	−72.052298	011000
01184100	Stony Brook near West Suffield, CT	41.960839	−72.710486	010802
01187300	Hubbard River near West Hartland, CT	42.037500	−72.939328	010802
01188000	Bunnell Brook near Burlington, CT	41.786209	−72.964826	010802
01193500	Salmon River near East Hampton, CT	41.552321	−72.449253	010802
01195100	Indian River near Clinton, CT	41.306172	−72.531033	011000
01199050	Salmon Creek at Lime Rock, Ct	41.942315	−73.390953	011000
01208950	Sasco Brook near Southport, CT	41.152874	−73.305950	011000
01208990	Saugatuck River near Redding, CT	41.294540	−73.395120	011000
01010000	St. John River at Ninemile Bridge, Maine	46.700556	−69.715556	010100
01010070	Big Black River near Depot Mtn, Maine	46.893889	−69.751667	010100
01010500	St. John River at Dickey, Maine	47.113056	−69.088056	010100
01011000	Allagash River near Allagash, Maine	47.069722	−69.079444	010100
01013500	Fish River near Fort Kent, Maine	47.237500	−68.582778	010100
01014000	St. John River below Fish R, nr Fort Kent, Maine	47.283333	−68.585278	010100
01015800	Aroostook River near Masardis, Maine	46.523056	−68.371667	010100
01017000	Aroostook River at Washburn, Maine	46.777222	−68.157222	010100
01022500	Narraguagus River at Cherryfield, Maine	44.608056	−67.935278	010500
01030500	Mattawamkeag River near Mattawamkeag, Maine	45.501111	−68.305833	010200
01031500	Piscataquis River near Dover-Foxcroft, Maine	45.175000	−69.314722	010200
01038000	Sheepscot River at North Whitefield, Maine	44.222778	−69.593889	010500
01047000	Carrabassett River near North Anson, Maine	44.869167	−69.955000	010300
01048000	Sandy River near Mercer, Maine	44.708056	−69.937500	010300
01054200	Wild River at Gilead, Maine	44.390556	−70.979722	010400
01055000	Swift River near Roxbury, Maine	44.642778	−70.588889	010400
01057000	Little Androscoggin River near South Paris, Maine	44.303889	−70.539722	010400
01096000	Squannacook River near West Groton, MA	42.634256	−71.657848	010700
01097300	Nashoba Brook near Acton, MA	42.512593	−71.404228	010700
01101000	Parker River at Byfield, MA	42.752869	−70.945610	010900
01103500	Charles River at Dover, MA	42.256209	−71.260056	010900
01105600	Old Swamp River near South Weymouth, MA	42.190378	−70.944768	010900
01105730	Indian Head River at Hanover, MA	42.100657	−70.822542	010900
01105870	Jones River at Kingston, MA	41.990936	−70.733649	010900
01109000	Wading River near Norton, MA	41.947600	−71.176716	010900
01162500	Priest Brook near Winchendon, MA	42.682586	−72.115081	010802
01168500	Deerfield River at Charlemont, MA	42.626000	−72.854194	010802

Table 7.1. Streamgages used in a drought analysis for New England in 2022.—Continued

[Data are from the National Water Information System (U.S. Geological Survey, 2022), unless otherwise indicated. USGS, U.S. Geological Survey; HUC6, drainage basin six-digit hydrologic code from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019)]

USGS site number	Station name and location	Latitude, in decimal degrees	Longitude, in decimal degrees	HUC6
01169000	North River at Shattuckville, MA	42.638418	−72.725092	010802
01169900	South River near Conway, MA	42.542030	−72.693702	010802
01170100	Green River near Colrain, MA	42.703417	−72.670647	010802
01171500	Mill River at Northampton, MA	42.318978	−72.665091	010802
01176000	Quaboag River at West Brimfield, MA	42.182316	−72.263691	010802
01181000	West Branch Westfield River at Huntington, MA	42.237312	−72.895654	010802
01333000	Green River at Williamstown, MA	42.708970	−73.196773	020200
01052500	Diamond River near Wentworth Location, NH	44.877500	−71.057500	010400
01064500	Saco River near Conway, NH	43.990833	−71.090556	010600
01064801	Bearcamp River at South Tamworth, NH	43.830074	−71.287849	010600
01073000	Oyster River near Durham, NH	43.148696	−70.965060	010600
01074520	East Branch Pemigewasset River at Lincoln, NH	44.047567	−71.659803	010700
01076500	Pemigewasset River at Plymouth, NH	43.759239	−71.685634	010700
01078000	Smith River Near Bristol, NH	43.566463	−71.747857	010700
01137500	Ammonoosuc River at Bethlehem Junction, NH	44.268674	−71.630362	010801
01111500	Branch River at Forestdale, RI	41.996487	−71.562008	010900
01114000	Moshassuck River at Providence, RI	41.833989	−71.410612	010900
01114500	Woonasquatucket River at Centerdale, RI	41.858988	−71.487282	010900
01117468	Beaver River near Usquepaug, RI	41.492600	−71.628119	010900
01117500	Pawcatuck River at Wood River Junction, RI	41.445100	−71.680898	010900
01117800	Wood River near Arcadia, RI	41.573988	−71.720623	010900
01118000	Wood River at Hope Valley, RI	41.498155	−71.716456	010900
01118500	Pawcatuck River at Westerly, RI	41.383711	−71.833125	010900
01134500	Moose River at Victory, VT	44.511723	−71.837314	010801
01135150	Pope Brook (Site W–3) near North Danville, VT	44.476167	−72.124543	010801
01135300	Sleepers River (Site W–5) near St. Johnsbury, VT	44.435335	−72.038429	010801
01139000	Wells River at Wells River, VT	44.150341	−72.065092	010801
01139800	East Orange Branch at East Orange, VT	44.092842	−72.335653	010801
01142500	Ayers Brook at Randolph, VT	43.934510	−72.657882	010801
01144000	White River at West Hartford, VT	43.714236	−72.418149	010801
01334000	Walloomsac River Near North Bennington, VT	42.912856	−73.256498	020200
04282525	New Haven River at Brooksville, nr Middlebury, VT	44.061725	−73.170674	041504
04282650	Little Otter Creek at Ferrisburg, Vt.	44.198110	−73.249012	041504
04282780	Lewis Creek at North Ferrisburg, Vt.	44.249220	−73.228457	041504
04282795	Laplatte River at Shelburne Falls, Vt.	44.370051	−73.216237	041504
04287000	Dog River at Northfield Falls, VT	44.182561	−72.640666	041504
04288000	Mad River near Moretown, VT	44.277280	−72.742616	041504
04293000	Missisquoi River near North Troy, VT	44.972823	−72.385386	041504
04293500	Missisquoi River near East Berkshire, VT	44.960046	−72.696521	041504
04296000	Black River at Coventry, VT	44.868936	−72.270104	041505

Table 7.2. Groundwater monitoring stations used in a drought analysis for New England in 2022.

[Data are from the National Water Information System (U.S. Geological Survey, 2022), unless otherwise indicated. USGS, U.S. Geological Survey; HUC6, drainage basin six-digit hydrologic code from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019)]

USGS site number	Station name	Latitude, in decimal degrees	Longitude, in decimal degrees	HUC6
411256073153101	CT–FF 23	41.215652	−73.258171	011000
411832072325501	CT–CL 223 Clinton, CT	41.308906	−72.548069	011000
412429073165101	CT–NT 15 Newtown, CT	41.408206	−73.280550	011000
412824072173301	CT–SM 7	41.473578	−72.291614	010802
412825072410501	CT–D 117 Durham, CT	41.472706	−72.683908	010802
412916073121701	CT–SB 42 Southbury, CT	41.487874	−73.204280	011000
412931071514201	CT–NSN 77	41.492100	−71.859853	010900
412935073122701	CT–SB 41	41.492906	−73.207006	011000
412954073125201	CT–SB 30	41.498247	−73.213836	011000
413457072252201	CT–CO 335	41.582883	−72.422086	010802
413518072264501	CT–MB 36	41.588432	−72.445364	010802
413535072253701	CT–MB 32 Marlborough, CT	41.593133	−72.426422	010802
414240072033201	CT–SC 22 Scotland	41.711017	−72.059167	011000
414243072040501	CT–SC 19	41.712153	−72.067508	011000
414833072190301	CT–CV 51	41.809265	−72.317025	011000
415458072291901	CT–EL 82	41.916264	−72.488542	010802
415647072495901	CT–GR 329	41.946497	−72.833161	010802
415649072494801	CT–GR 328	41.947097	−72.830017	010802
415956073241501	CT–SY 24 Salisbury, CT	41.999042	−73.403864	011000
432310070393301	ME–YW807 Sanford, Maine	43.386195	−70.658666	010600
435453070013601	ME–CW26 Brunswick, Maine	43.914802	−70.026162	010600
440823070291501	ME–OW1214 Oxford, Maine	44.139793	−70.487003	010400
440918069564001	ME–KW766 Litchfield, Maine	44.155073	−69.943939	010300
443647070552303	ME–OW 400B Middle Dam, Maine	44.778794	−70.921219	010400
445227067520101	ME–WW797 Township T24MD BPP (Hadley Lakes)	44.874240	−67.866392	010500
453629068531801	ME–PEW 594 Millinocket, Maine	45.608104	−68.887819	010200
471457068353001	ME–ARW890 Fort Kent, Maine	47.249206	−68.591158	010100
411555070021901	MA–NBW 228 Nantucket, MA	41.265401	−70.038071	010900
412346070353403	MA–ENW 52 Edgartown, MA	41.396226	−70.592250	010900
413525070291904	MA–MIW 29 Mashpee, MA	41.590388	−70.488083	010900
413930070190901	MA–A1W 306 Barnstable, MA	41.658444	−70.318633	010900
414101070011001	MA–CGW 138R Chatham, MA	41.683611	−70.019444	010900
414125070265901	MA–SDW 253R Sandwich, MA	41.690278	−70.449722	010900
414129070361401	MA–BHW 198 Bourne, MA	41.691495	−70.603364	010900
414154070165002	MA–A1W 247R Barnstable, MA	41.698333	−70.280556	010900
414400070242901	MA–SDW 252R Sandwich, MA	41.733333	−70.408056	010900
414518070015801	MA–BMW 21R Brewster, MA	41.755000	−70.032778	010900
414518070435701	MA–WFW 51 Wareham, MA	41.755156	−70.732017	010900
414632070014901	MA–BMW 22R Brewster, MA	41.775556	−70.030278	010900
414706071045001	MA–F3W 23R Freetown, MA	41.785000	−71.080556	010900
415217070393102	MA–PWW 494 Plymouth, MA	41.871493	−70.658090	010900
415228070554601	MA–LKW 14 Lakeville, MA	41.874546	−70.928930	010900

Table 7.2. Groundwater monitoring stations used in a drought analysis for New England in 2022.—Continued

[Data are from the National Water Information System (U.S. Geological Survey, 2022), unless otherwise indicated. USGS, U.S. Geological Survey; HUC6, drainage basin six-digit hydrologic code from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019)]

USGS site number	Station name	Latitude, in decimal degrees	Longitude, in decimal degrees	HUC6
415354069585201	MA–WNW 17R Wellfleet, MA	41.898333	−69.981111	010900
415449071155201	MA–ATW 83R Attleboro, MA	41.913611	−71.264444	010900
415453070434901	MA–PWW 22 Plymouth, MA	41.914925	−70.729767	010900
420056070575701	MA–EBW 30 East Bridgewater, MA	42.015656	−70.965321	010900
420206070045901	MA–TSW 89 Truro, MA	42.035228	−70.082572	010900
420305072581401	MA–GLW 6R Granville, MA	42.051403	−72.970678	010802
420316070433501	MA–D4W 79R Duxbury, MA	42.054444	−70.726389	010900
420350073193601	MA–SJW 58R Sheffield, MA	42.063889	−73.326667	011000
420355070520201	MA–HGW 76R Hanson, MA	42.065278	−70.867222	010900
420544071173701	MA–NNW 27R Norfolk, MA	42.095556	−71.293611	010900
420912072042801	MA–OTW 7R Otis, MA	42.153333	−73.074444	010802
420924072422602	MA–WVW 152 Westfield, MA	42.156759	−72.706759	010802
421012072324301	MA–CMW 95R Chicopee, MA	42.170000	−72.545278	010802
421240072490201	MA–M7W 19 Montgomery, MA	42.211267	−72.816997	010802
421410072081101	MA–WUW 2R West Brookfield, MA	42.236111	−72.136389	010802
421438071165601	MA–DVW 10R Dover, MA	42.243889	−71.282222	010900
421550073025101	MA–A3W 12 Becket, MA	42.264111	−73.046847	010802
421851071312601	MA–SSW 12 Southborough, MA	42.314261	−71.523398	010700
421853071220501	MA–WKW 2R Wayland, MA	42.314722	−71.368056	010700
421923072451001	MA–WXW 20 Westhampton, MA	42.341199	−72.806206	010802
422058072085101	MA–HHW 1R Hardwick, MA	42.349444	−72.147500	010802
422103072241103	MA–PDW 24 Pelham, MA	42.350924	−72.402585	010802
422341071464901	MA–WSW 26 West Boylston, MA	42.394783	−71.779853	010700
422520071483001	MA–SYW 177 Sterling, MA	42.422314	−71.807850	010700
422559072332402	MA–S6W 68 Sunderland, MA	42.433144	−72.556199	010802
422627071154002	MA–LTW 104 Lexington, MA	42.440928	−71.260612	010900
422650071213801	MA–CTW 167R Concord, MA	42.447222	−71.360556	010700
422733072532601	MA–CYW 13 Cummington, MA	42.459461	−72.890281	010802
422745073112001	MA–PTW 51 Pittsfield, MA	42.462585	−73.188437	011000
422812071244401	MA–ACW 158 Acton, MA	42.470114	−71.411881	010700
422819071065701	MA–XOW 14 Winchester, MA	42.472040	−71.115331	010900
422906072124301	MA–PHW 16 Petersham, MA	42.485075	−72.211436	010802
423058071025401	MA–WAW 38R Wakefield, MA	42.516111	−71.048333	010900
423311072355801	MA–DFW 44R Deerfield, MA	42.553142	−72.598978	010802
423339072524101	MA–HMW 8 Hawley, MA	42.560918	−72.877596	010802
423401071093801	MA–XMW 78 Wilmington, MA	42.566897	−71.159967	010900
423441072170701	MA–ORW 63 Orange, MA	42.578143	−72.284806	010802
423503073075401	MA–CJW 2 Cheshire, MA	42.584381	−73.131333	020200
423506070491401	MA–WPW 76R Wenham, MA	42.585000	−70.820556	010900
423641071102501	MA–AJW 462 Andover, MA	42.611482	−71.173112	010700
423715072042801	MA–TMW 3R Templeton, MA	42.620833	−72.074444	010802
423845070542501	MA–TQW 1 Topsfield, MA	42.646289	−70.906739	010900

Table 7.2. Groundwater monitoring stations used in a drought analysis for New England in 2022.—Continued

[Data are from the National Water Information System (U.S. Geological Survey, 2022), unless otherwise indicated. USGS, U.S. Geological Survey; HUC6, drainage basin six-digit hydrologic code from the National Hydrology Dataset Plus High Resolution (Moore and others, 2019)]

USGS site number	Station name	Latitude, in decimal degrees	Longitude, in decimal degrees	HUC6
424055071435302	MA–TRW 13R Townsend, MA	42.681944	−71.731389	010700
424204072015201	MA–XNW 13 Winchendon, MA	42.701019	−72.030836	010802
424322070592201	MA–GCW 168R Georgetown, MA	42.722778	−70.989444	010900
424520070562401	MA–NIW 27 Newbury, MA	42.755372	−70.939489	010900
424841071004101	MA–HLW 23 Haverhill, MA	42.811606	−71.011622	010700
431540071452801	NH–WCW 1 Warner, NH	43.261189	−71.757300	010700
442450071052301	NH–SJW 2	44.413950	−71.089242	010400
412154071462901	RI–WEW 522 Westerly, RI	41.365100	−71.774234	010900
412214071394001	RI–CHW 18	41.370656	−71.660618	010900
412718071415201	RI–RIW 785	41.455100	−71.697288	010900
412844071422802	RI–RIW 600 Richmond, RI	41.478989	−71.707289	010900
412918071321001	RI–SNW 6 South Kingstown, RI	41.488434	−71.535616	010900
412932071374302	RI–RIW 417 Richmond, RI	41.492323	−71.628119	010900
412935071355701	RI–SNW 1198	41.493156	−71.598674	010900
413126071455501	RI–HOW 67	41.523988	−71.764791	010900
413135071314201	RI–EXW 278	41.526490	−71.527838	010900
413148071281601	RI–NKW 255	41.530101	−71.470614	010900
413220071115501	RI–LTW 142	41.538992	−71.198102	010900
413252071323601	RI–EXW 554 Exeter, RI	41.547879	−71.542839	010900
413325071152401	RI–POW 551	41.557047	−71.256159	010900
413358071433801	RI–EXW 475 Exeter, RI	41.566211	−71.726734	010900
413400071363101	RI–EXW 238	41.566767	−71.608119	010900
413645071332901	RI–WGW 206	41.612601	−71.557562	010900
413907071465001	RI–WGW 181	41.652044	−71.780070	010900
414022071332801	RI–COW 411	41.672878	−71.557284	010900
414106071223901	RI–WCW 59	41.685101	−71.376999	010900
414223071453701	RI–COW 342	41.706488	−71.759792	011000
414315071410701	RI–COW 466	41.720933	−71.684789	010900
414420071422301	RI–FOW 40	41.738988	−71.705901	010900
415546071474701	RI–BUW 395 Burrillville, RI	41.929543	−71.795904	011000
415626071254601	RI–CUW 265	41.940655	−71.428947	010900
415710071402201	RI–BUW 187	41.952876	−71.672289	010900
415847071471401	RI–BUW 396	41.979820	−71.786737	011000
415948071325001	RI–NSW 21	41.994821	−71.547007	010900
424810073160401	VT–PQW 1	42.802857	−73.267331	020200
431551072350601	VT–CKW 1	43.264722	−72.584444	010801
433240072242901	VT–HLW 54	43.544515	−72.407592	010801
434217073010601	VT–PFW 8	43.704789	−73.017887	041504
435343072151801	VT–WOW 1	43.895278	−72.255417	010801
443405072323501	VT–MPW 1	44.568139	−72.544028	041504
443952072114001	VT–GLW 1	44.665000	−72.193889	041505
444731071514701	VT–BIW 1	44.792222	−71.863056	041505

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