Chapter 12
Floods and Droughts

NEW HAMPSHIRE
DEPARTMENT OF
Environmental
Services

Photo: Damage to infrastructure due to the Patriots Day Flood of April 2007, Epsom, N.H.
By: Eric Orff, Courtesy of New Hampshire Friends of Suncook River

Overview

Floods and droughts have caused, and continue to cause, serious economic and environmental losses. These events are the result of both natural disasters and human actions. Due to climate change and landscape change (see Chapter 1 – Introduction and Overview), there is an increasing need to emphasize prevention, preparedness, mitigation, and risk management to respond to these events in order to protect our safety, quality of life, economy and environment.

12.1 Description and Significance

Floods and droughts are the most frequent natural disasters that strike New Hampshire. They are both natural phenomena; however, landscape change and climate change can alter the intensity and frequency of these phenomena and lead to greater losses. Further development in floodplains and in areas with limited water supplies also increase losses. Flooding events in New Hampshire are generally confined to localized areas within the state. Drought conditions may exist concurrently over several states or be confined to a smaller region within New Hampshire.

12.1.1 Flood Background

New Hampshire has nearly 17,000 miles of rivers and streams, approximately 1,000 lakes, and 238 miles of ocean and estuarine coastline. The state's settlement pattern historically coincides with these natural features. Communities developed along waterways, which provided ports for trading, harbors for commerce, and power and transportation for mills. In addition to being easily accessible, river valleys are some of the easiest lands to develop. As a result of this development pattern, the floodplains and shorelands of the state were rapidly settled. The shift to industrialization during the mid-nineteenth century compounded the problem, with residents moving to the floodplains of cities and larger villages (Figure 12-1). Such encroachment has led to flooding problems, since floodplains are extensions of watercourses and have evolved to carry excessive runoffs naturally (New Hampshire Department of Safety [NHDOS], 2007).

Riverine flooding is the most common natural disaster in New Hampshire. Significant riverine flooding impacts some areas in the state at intervals of less than ten years. NHDOS, 2007).

Development tends to exacerbate flooding in several ways. First, as described in Chapter 10 – Stormwater, removing vegetation and soil, grading and paving the land surface, and constructing drainage networks increase runoff to streams from rainfall and snowmelt. As a result, the peak discharge, volume, and frequency of floods increase in nearby streams. Second, changes to stream channels during urban development (hardening stream channels, building in floodplains) can limit their capacity to convey floodwaters. Structures that encroach on the floodplain, such as bridges, can increase upstream flooding by narrowing the width of the

Figure 12-1. Flooding in 1936, Bridge Street, Concord. ***Photo from New Hampshire Historical Society.***

channel and increasing the channel's resistance to flow. As a result, the water is at a higher stage as it flows past the obstruction, creating a backwater that will inundate a larger upstream area (Konrad, 2003). Finally, many residential and commercial developments have relied on detention basins to manage stormwater for the last 30 years or so. While these basins may detain major storms temporarily, they are generally too large to hold back flows from smaller, more frequent storms and they can lead to downstream flooding problems because they do not reduce runoff volume (National Research Council, 2008).

Erosion and Inundation

Flood damage is caused by two processes: erosion and inundation. Erosion that changes the course of a river, the shoreland of a lake, or the beach of a coast can also damage waterfront buildings and infrastructure by washing away the ground they are built upon (Figure 12-2). Inundation, the rising of a body of water and its overflowing onto normally dry land, also causes damage to buildings and infrastructure.

A study completed in Vermont found that most flood damage in that state is caused by erosion from rivers, not by inundation (Dolan, 2007). Much of the flood damage is due to landscape change (from forested to impervious), including historic settlement and land use. Currently, homes and infrastructure are often in areas where attempts have been made to contain meandering rivers in concrete or otherwise hardened channels or with berms. The erosive power of floodwaters, no longer able to dissipate in a natural channel, threatens homes and infrastructure. The greatest damage tends to be to roadways, which are often adjacent to channelized rivers. Streams and rivers are not static systems, and treating them as such puts homes and infrastructure in harm's way.

Figure 12-2. Flood-related erosion along Warren Brook in Alstead. ***Photo by Chris Covel.***

Debris and Contaminants

Storm debris, such as trash, downed trees, or leaves, carried by floodwaters can clog bridges and culverts, narrow river channels, or interfere with the functioning of water diversion structures such as bypass pipes, spillways and gates. Blockage caused by debris may exacerbate a given flood event by obstructing stormwater flow at otherwise adequately sized bridges, dams, culverts or buffer zones. Chemical and other contaminants, particularly hazardous materials and sewage, carried by floodwaters can also contaminate land, surface waters, and wells, making them unsafe for humans and wildlife.

Ice Jams and Snow Melt

Ice formed in rivers and against structures such as bridges, roads, docks and buildings can damage these structures and erode abutments and riverbanks. Warm temperatures and heavy rains, usually during spring, can speed the melting of snow pack, leading to flash-flood incidents or inundation events. Rapid melting can also lead to the formation of ice jams, a collection of ice chunks that has a damming effect. This can create cold weather flood hazard conditions where none exist during warm weather. The more development in floodplains and alteration of river channels or shorelines, the greater the potential for flood damage associated with ice jams.

Lakes

Flooding associated with lakes in New Hampshire is not as common as in river systems; however, it does occur during extreme rainfall and snowmelt events. Dams are used to regulate the levels of many of the state's lakes. Even though flood control is not the primary purpose for the majority of these dams, their operation during potential flooding situations can affect flooding of adjacent shorelands. If water is released or withheld incorrectly, dams can cause flooding above or below dams on lakes and rivers.

Bridges and Dams

Bridges are designed using the flood of record or the 50-year storm event, whichever is greater. Neither future alterations of the landscape by development nor likely climate change-related increases to the frequency of intense storms are considered when designing bridges or culverts. Currently, of the 3,661 state and municipally owned bridges, 498 are in need of replacement (Pillsbury, 2008). As noted in Chapter 10 – Stormwater, a significant percentage of culverts are under-sized as a result of watershed development and changes in hydrology that are expected as a result of climate change.

New Hampshire's flood control dams, most operated by the U.S. Army Corps of Engineers, have prevented $4.3 billion in flood damages with construction costs of $482 million (Kennelly, 2008). Only 45 of the 3,070 dams in the state have available storage for flood control; therefore, aside from some isolated opportunities, the feasibility of significantly achieving a cost-effective reduction in flood damages through the construction of additional flood control impoundments is quite low (Comprehensive Flood Management Study Commission, 2008). More information on New Hampshire Dams is found in Chapter 11 – Dams.

Coastal Flooding

Flooding of low-lying areas on New Hampshire's coast is a natural phenomenon that has occurred for centuries. Coastal flooding in New Hampshire primarily occurs due to major rain storms and nor'easters. The flooding caused by these storms is compounded by full-moon tides, which intensify storm surge and wave effects. Human activities, particularly the disruption of natural protective coastal features, e.g. dunes or wetlands, or the lowering of land as a consequence of drainage, may also aggravate the coastal flooding hazard in some areas. A recent study by the National Oceanic and Atmospheric Administration (NOAA) identified 96 major inundation and storm surge events between 1914 and 2007, and 37 events between 1980 and 2007 for the coastal area of northern New England (Cannon, 2007). This study identified several important aspects of storm surges on New Hampshire's coast:

- Eighty-three percent of storms happen in the colder months of October through March.
- Tidal flooding, although relatively infrequent, tends to cluster with two or more events in a single year.
- While most flooding occurs with high tides (above 12 feet), many happen at lower tides due to wind, wave and tidal water "piling."
- Storm surge can be very difficult to predict due to the complexities of the shape of New Hampshire's coast and variability in meteorological data.

Figure 12-3. Coastal flooding damage in 1978 approximately 0.5 miles from the coast at High Street, Hampton, N.H. *Source: Seacoast SAD, 1978.*

Climate change will also aggravate existing coastal flooding hazards through rising sea levels and increasing frequency and intensity of coastal storms. Sea level has been rising at an average rate of 2 – 2.7 millimeters per year for the last millennium, which equates to about 8-10 inches per century. This rate of sea level rise will reduce the recurrence interval of today's 100-year storm surge to between two and 15 years (Kirshen et al., 2008). This means that, on average, a large flooding storm will happen every few years to a decade. As a point of reference, the Blizzard of 1978 storm is considered to be a 10- to 20-year storm surge (Figure 12-3).

12.1.2 Adverse Impacts of Floods

"*The devastation wrought by flood…The power of an irresistible mass of water was never more fully realized by our citizens than at this time, when the city's debt has been swelled over a hundred thousand dollars, some of our businessmen almost financially ruined by losses which no insurance covers, to say nothing of losses small in comparison that poor and even well off persons who live on the river's bank have suffered. At no time could the city and its inhabitants have stood such a calamity so poorly.*" (March, 1896 Dover Enquirer, New Hamsphire newspaper account of the flood that devastated the city. *Source: Dover Public Library*).

Buildings and Infrastructure

Structures within a floodplain can be extensively damaged by the force of moving water, the pressure of standing water, or the debris and sediment associated with flooding. Suspended sediments in floodwaters can settle, leaving a layer of mud on all flooded areas including building interiors. After floodwaters have receded, repairing damage caused by mold growth or contaminants can continue to increase costs associated with flood damage.

The federal, public, and individual assistance for damage resulting from New Hampshire's three flood events October 2005, April 2006 and May 2007 has totaled $60 million (NHDOS, 2007). The total amount the Federal Emergency Management Agency has paid for flood losses though the National Flood Insurance Program in New Hampshire is shown in Table 12-1.

Table 12-1. Total amount the Federal Emergency Management Agency has paid for flood losses though the National Flood Insurance Program in New Hampshire, 1978-2008. *Source: FEMA, 2008.*

County	NFIP Policies	Insurance In Force	Total Paid Losses	Total Paid Amount	Total Repetitive Loss Properties
Belknap	331	$62,819,300	91	$754,070	13
Carroll	542	$103,710,800	205	$917,674	11
Cheshire	552	$104,428,400	175	$4,418,672	0
Coos	196	$26,653,200	64	$358,739	4
Grafton	895	$136,516,500	192	$1,296,235	19
Hillsborough	1,317	$277,353,200	530	$9,120,271	64
Merrimack	610	$120,398,600	258	$5,128,165	49
Rockingham	3,790	$638,515,800	1,552	$15,002,917	132
Strafford	450	$92,592,800	111	$1,853,638	10
Sullivan	172	$31,745,700	33	$260,776	2
Total	**8,855**	**$1,594,734,300**	**3,211**	**$39,111,157**	**304**

"Repetitive Loss" means flood-related damage sustained by a structure on two separate occasions during a 10-year period for which the cost of repairs at the time of each such flood event, on the average, equals or exceeds 25 percent of the market value of the structure before the damage occurred.

Water Contamination

Flooding can cause water to become contaminated from oil, gasoline, and other chemicals, as well as with fecal matter from sewage systems and septic tanks. Most municipal water supplies are capable of ensuring safe drinking water during flood events; however, private drinking water wells can easily become contaminated by floodwaters. Heavy precipitation tends to mobilize bacteria, which can contaminate wells that are in poor condition. When flooding occurs, private well owners are urged to boil their drinking water and have their wells tested for contamination after the floodwaters have receded.

Habitat Destruction

The plants and animals that occupy floodplain areas have evolved to cope with floods, and many species in floodplains rely on changing water levels associated with flooding as part of their life cycles; however, they often fare poorly with frequent, intense flood events. Landscape change and climate change will increase flooding frequency and intensity, causing inundation and erosion that can alter habitat, destroy breeding grounds, or simply kill native plants and animals in flooded areas.

12.1.3 Drought Background

Droughts of varying duration and intensity are natural events that have occurred throughout history and they are part of the cyclical fluctuations of the climate. Droughts may last from several months to years. The occurrence of droughts can be characterized in terms of duration and magnitude of dryness. Research is being conducted that will likely lead to accurately predicting months ahead of time when a drought may occur. However, there currently is no reliable method to accurately predict a drought.

***Drought*: a sustained and regionally extensive occurrence of appreciably below-average natural water availability in the form of precipitation, streamflow or groundwater.**

Even in the northeastern U.S., where water is generally abundant, recent drought conditions accompanied by increasing human demands on freshwater resources require that we gain a better understanding of extremes in regional hydrologic variability. Drought is of particular concern because extended periods of low stream flows often result in significant ecological damage from high surface water temperatures, reduced levels of dissolved oxygen, higher concentrations of pollutants, the landward migration of salt-water estuaries, and resulting impacts on aquatic life. Impacts of drought on human activity promise to be more severe in the future because of a rapidly growing population (Bradbury et al., 2002).

12.1.4 The Occurrence of Water in the Environment and New Hampshire's Susceptibility to Drought

New Hampshire, on average, receives roughly the same amount of precipitation each month of the year. Based on records from 1895 to present for all weather observation stations in the state, the average annual precipitation for the state is 43 inches per year. Figure 12-4 summarizes rainfall variation from the average for each year from 1895 to present (National Oceanic and Atmospheric Administration [NOAA], 2008b).

Approximately half of all precipitation evaporates, is taken up by vegetation, or immediately runs off the land to surface water. Just less than half of all precipitation is recharged to groundwater. Recharge occurs primarily in the spring when snow pack melts and the growing season for vegetation has not yet begun. The second highest seasonal occurrence of recharge is during the late fall and winter when much vegetation is again dormant. Although consistent rainfall takes place, on average, during the summer, there is minimal groundwater recharge because precipitation evaporates from the land surface and vegetation, or is captured in the shallow subsurface and transpired by vegetation. This means the groundwater table and instream flows generally decline between June and October and recover from November through May of each year. Figure 12-5

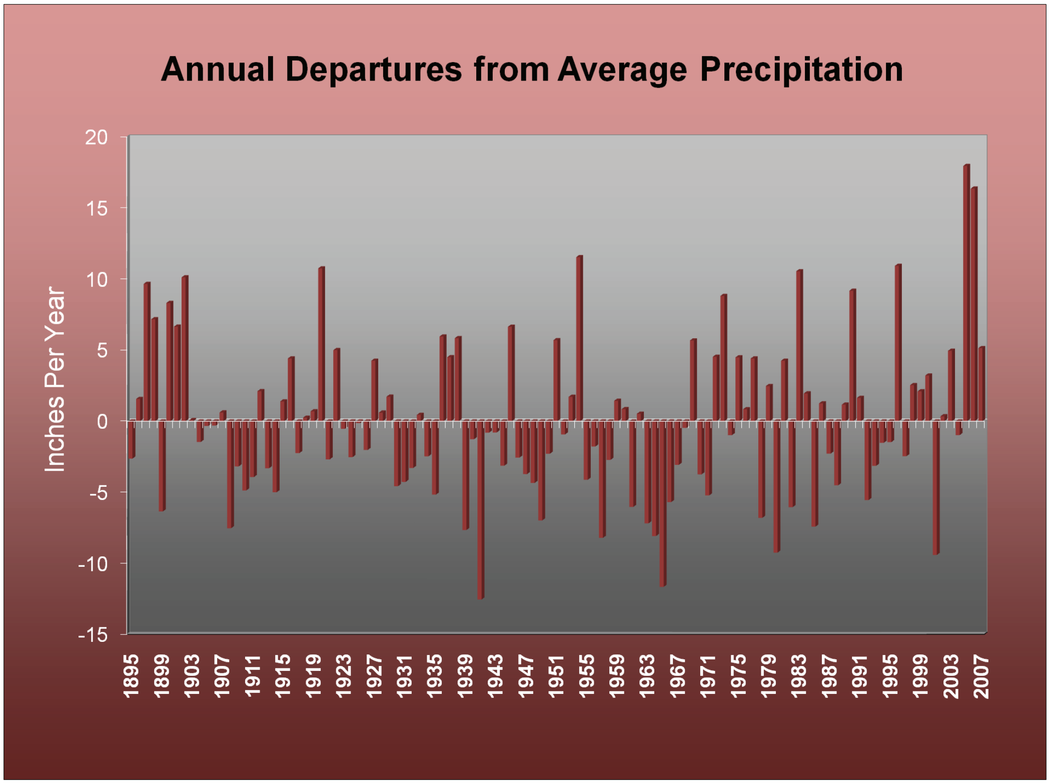

Figure 12-4. Annual departures from average precipitation. ***Data Source: NOAA, 2008b.***

summarizes average precipitation and recharge data for each month of the year based on an analysis of seasonal ground recharge completed by the U.S. Geological Survey (USGS) in 2004 (Flynn & Tasker, 2004).

New Hampshire is perhaps more susceptible than many other states to droughts. This is because New Hampshire's watersheds are not able to store large volumes of water due to their geology and general lack of storage capacity in lakes and impoundments. For instance, aquifers in many other parts of the country have coarse unconsolidated deposits that store groundwater thousands of feet underground. Surface water supply reservoirs in other areas of the country can store the volume of water needed by major cities for many years. In contrast, only 14 percent of New Hampshire's land surface sits over coarse unconsolidated deposits (Medalie and Moore, 1995) and where present, these materials are usually less than 100 feet thick. Storage of water in bedrock aquifers is limited, and water-bearing fractures are found less frequently at depths of 800-1000 feet. Surface water impoundments in the state generally have been designed to support flood control or recreational rather than water supply needs.

Due to the relative lack of water storage in New Hampshire, even short-term deficits in precipitation can cause adverse impacts. In years when New Hampshire has received 30-35 inches of rainfall (approximately 70 percent of average), severe drought conditions have developed, wells have become dewatered, and record low flows in rivers have occurred. Recent drought conditions in 2001-2003 caused many water systems to institute bans on outdoor lawn watering. So many private wells became dewatered during the 2001-2003 drought that water well contractors had up to a three-month waiting list of customers requiring services to address wells impaired by drought.

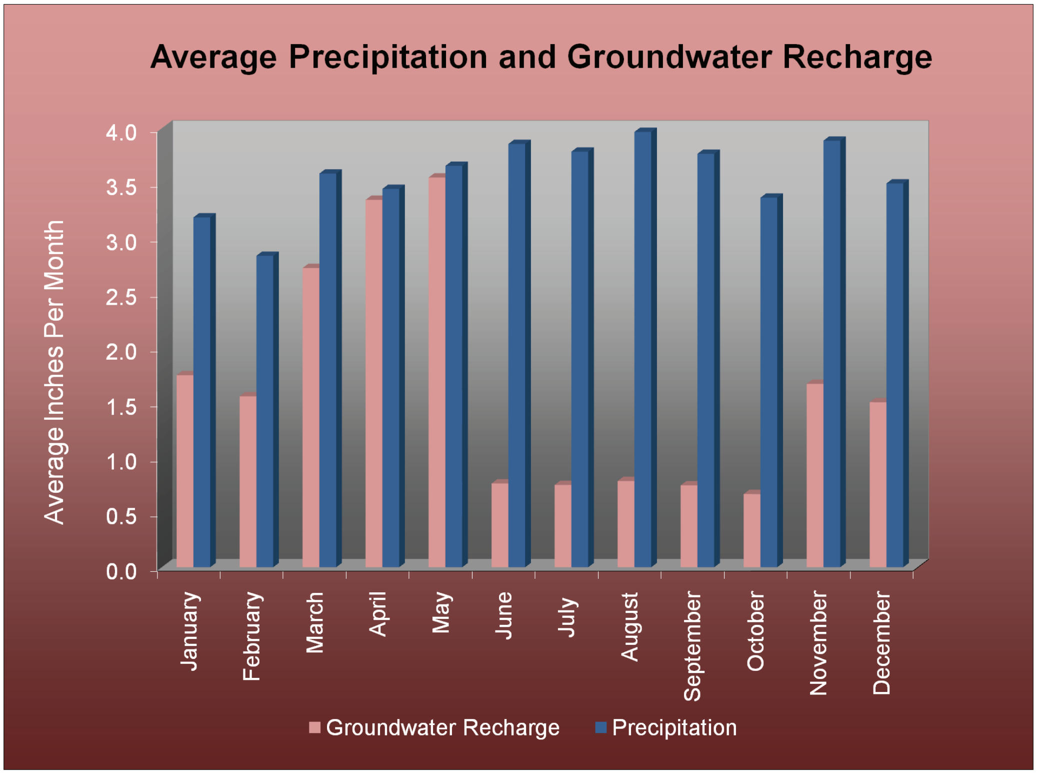

Figure 12-5. Average precipitation and groundwater recharge conditions in New Hampshire. *Data Source: Flynn & Tasker, 2004.*

Mild drought conditions are far more common in New Hampshire than many realize. Based on data collected and averaged from weather observations throughout the state over the last 113 years, New Hampshire has been in a mild drought condition that has extended for a period of at least three months approximately 25 percent of the time (Figure 12-6). These drought conditions occurred on average every 27 months with a median recurrence period of 17 months (NOAA, 2008a).

12.1.5 Adverse Impacts Associated with Drought

No studies have been conducted that quantify the social or economic costs of past droughts in New Hampshire. It is apparent, however, that drought can affect many economic sectors. Drought may impact farm production if sufficient rainfall or irrigation water is not present to support the growth of crops or maintenance of livestock. When combined with lightning strikes and human actions, drought may facilitate the occurrence of wildfires. Reduced lake, reservoir and river levels hamper boating, swimming, angling, wildlife watching and other activities. A snowless winter reduces skiing opportunity. A shortage of water caused by drought can also affect a number of industries. For example, drought may significantly reduce the generation of electricity from hydropower, biomass, or fossil fuel facilities. Drought also affects the availability of aquatic habitat, drinking water, and food for wildlife. Drought may cause sources of water for community water systems or private residential wells to be diminished or fail. During droughts that occurred in 1999 and 2001-2003, a number of community water systems and private residents had to replace wells that failed. Some community water systems had to make emergency connections to other nearby water systems to maintain their water supply.

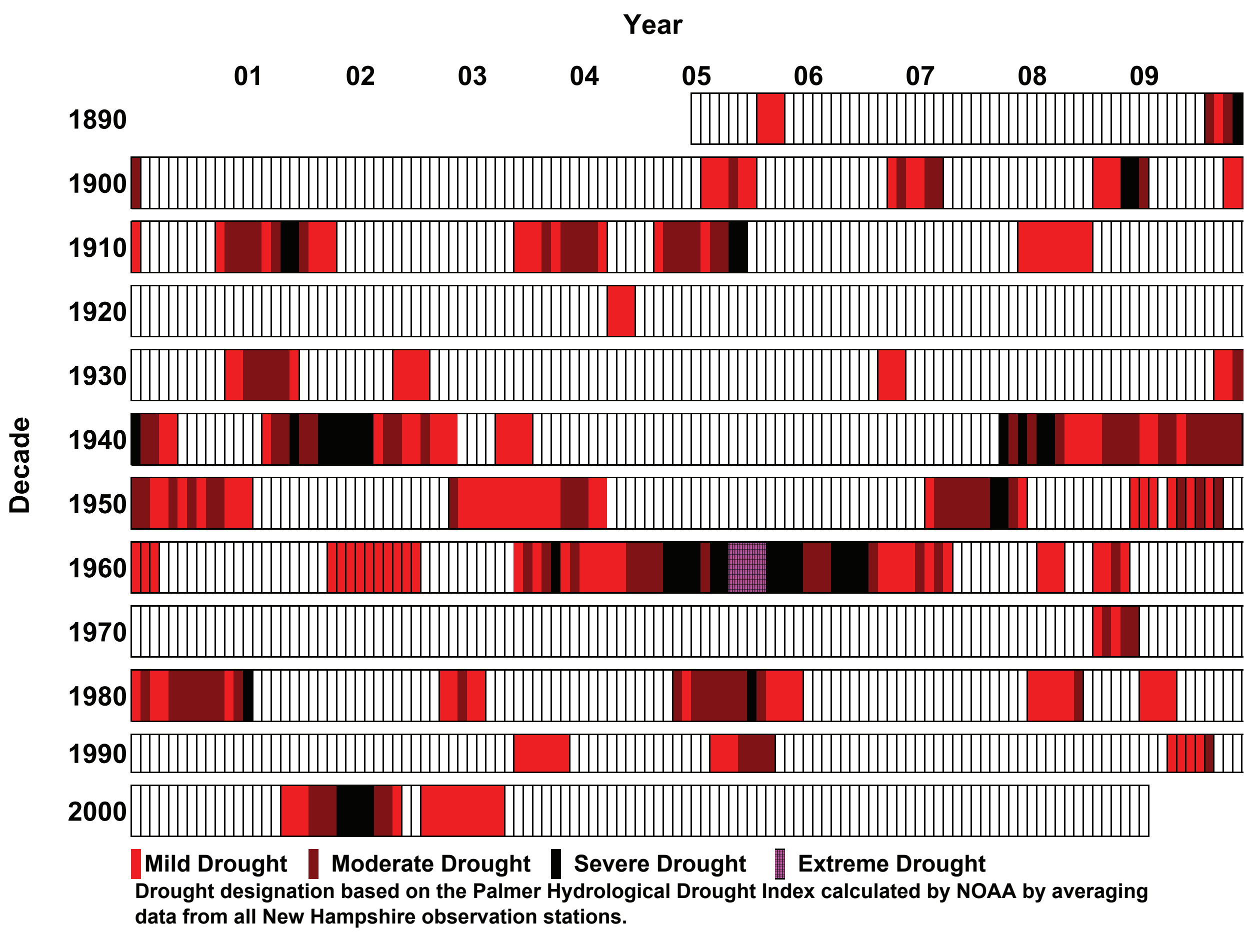

Figure 12-6. Occurrences of drought conditions for three or more months in New Hampshire, 1895 - 2008. ***Data Source: NOAA, 2008a.***

12.2 Issues

12.2.1 Floods and Droughts are Likely to Become More Frequent and More Severe

A preponderance of data and analyses indicate that flooding, and in particular coastal flooding, will become more frequent and destructive due to climate change and landscape change (see Chapter 1 – Introduction and Overview). It does not appear that measures are in place to ensure that new developments and infrastructure are protected from the impacts of all types of floods. Droughts are also expected to become more frequent as a consequence of climate change (Frumhoff et al., 2007; Field et al., 2007).

12.2.2 Inadequate Mapping of Floodplains

Floodplain maps in New Hampshire are based on historical data that may or may not be accurate given current and future changes to the landscape. Without accurate floodplain mapping and information, it is impossible to identify areas that may have an increased risk of flooding due to these changes. Current Flood Insurance Rate Maps (FIRMs) are being digitized by the Federal Emergency Management Agency as part of its Map Modernization program (Figure 12-7). These maps utilize aerial photography for their base layer; for New Hampshire this means aerial photos from 1998. The flood elevation and topographic data are usually older, from the 1970s and early 1980s.

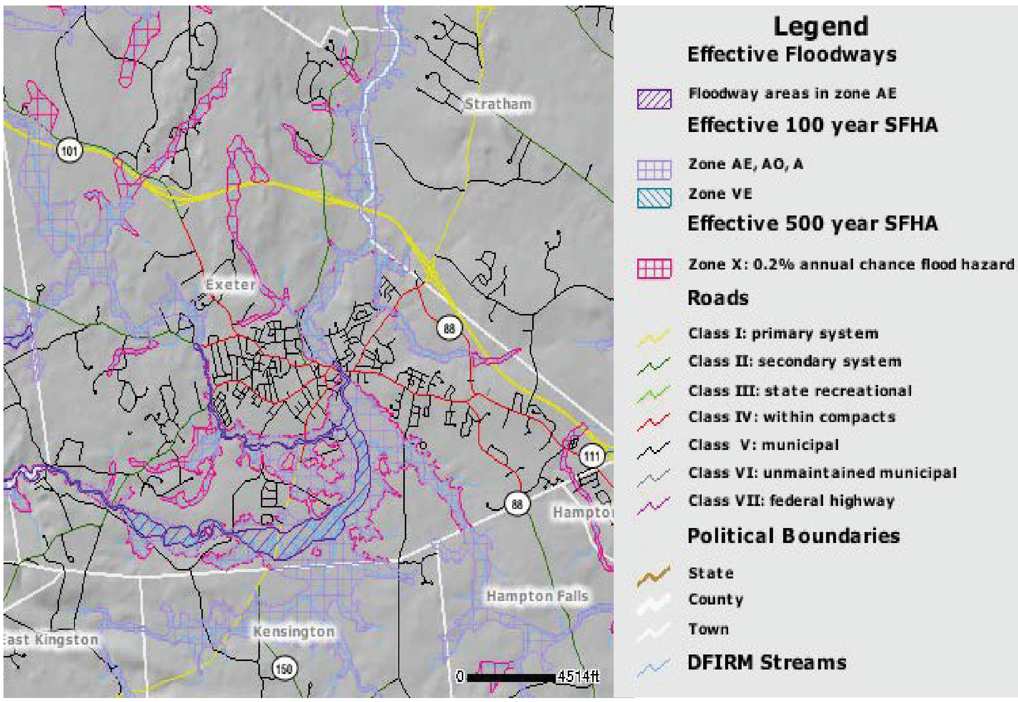

Figure 12-7 Example of a digital Flood Insurance Rate Map. Special Flood Hazard Areas (SFHA) for the 100- and 500-year frequency flood are shown. The 100-year frequency zones are further categorized as A (no detailed hydraulic analysis has been performed), AE (hydraulic analysis has been performed), AO (hydraulic analysis has been performed and average depths are 1 to 3 feet during a flood), and VE (additional hazards due to storm-induced velocity wave action). Floodway areas in zone AE (dark purple) depict the water course or portion of the floodplain which must be reserved in order to carry or discharge the regulatory flood without cumulatively increasing the flood elevation of the floodplain more than a foot at any point. Data Source: NH GRANIT, 2008.

These digital Flood Insurance Rate Maps (DFIRMs) have already been produced for Rockingham, Strafford, Cheshire, Sullivan and Grafton counties. Merrimack and Hillsborough will be the next two counties to have their maps digitized (Comprehensive Flood Management Study Commission, 2008). The updated maps are intended to provide local officials with better references when regulating floodplain development.

The majority of the flood hazard data used for these new DFIRMs is not being updated and sufficient funding is not available to complete new flood studies. The best data available include five-foot land elevation contours in the seacoast area, but those contour data do not continue inland or around Great Bay's 144 miles of shoreline. According to a study by the National Academy's Committee on Floodplain Mapping Technologies, detailed studies cost approximately $20,000 per stream mile and this does not include new elevation data (National Academy of Sciences, 2007).

12.2.3 The Drought Management Plan Is Outdated

The state's Drought Management Plan, last updated in 1990, does not reflect the current structure of government agencies, nor does it include any assessment of groundwater levels in bedrock for assessing drought conditions (NHDES, 1990). The plan and state law generally do not provide any entity with authority to proactively manage water resources in a drought condition unless the governor declares a state of emergency.

12.2.4 Prevention and Mitigation Strategies for Water Supplies Adversely Affected by Drought Are Lacking

Approximately 40 percent of the state's residents rely on a private water supply (U.S. Census Bureau, 1990). During the drought of 2001-2003, so many private wells went dry that homeowners had to wait up to three months to have wells replaced or deepened. Many homeowners were not able to afford the thousands of dollars required to retrofit or replace their private wells.

The distribution networks of community water systems in many areas are in close enough proximity to one another that interconnections can be established to provide back-up emergency water supplies, although this is not a viable option for the majority of small water systems. The state provides grants to encourage such interconnection of water systems for emergency preparedness. Many water systems have already entered into mutual aid agreements to provide water supply in the event of man-made or natural disasters, but many systems do not yet have such measures in place.

12.3 Current Management and Protection

12.3.1 Floods

Disaster Response

The New Hampshire Department of Safety, Bureau of Emergency Management, is responsible for coordinating responses with all state, federal, and local agencies when flooding or other natural disasters occur. DES has authority to regulate the operation of dams and can order impoundments to store or release water when needed to protect public safety. The state and federal government also operate a series of flood control impoundments throughout the state.

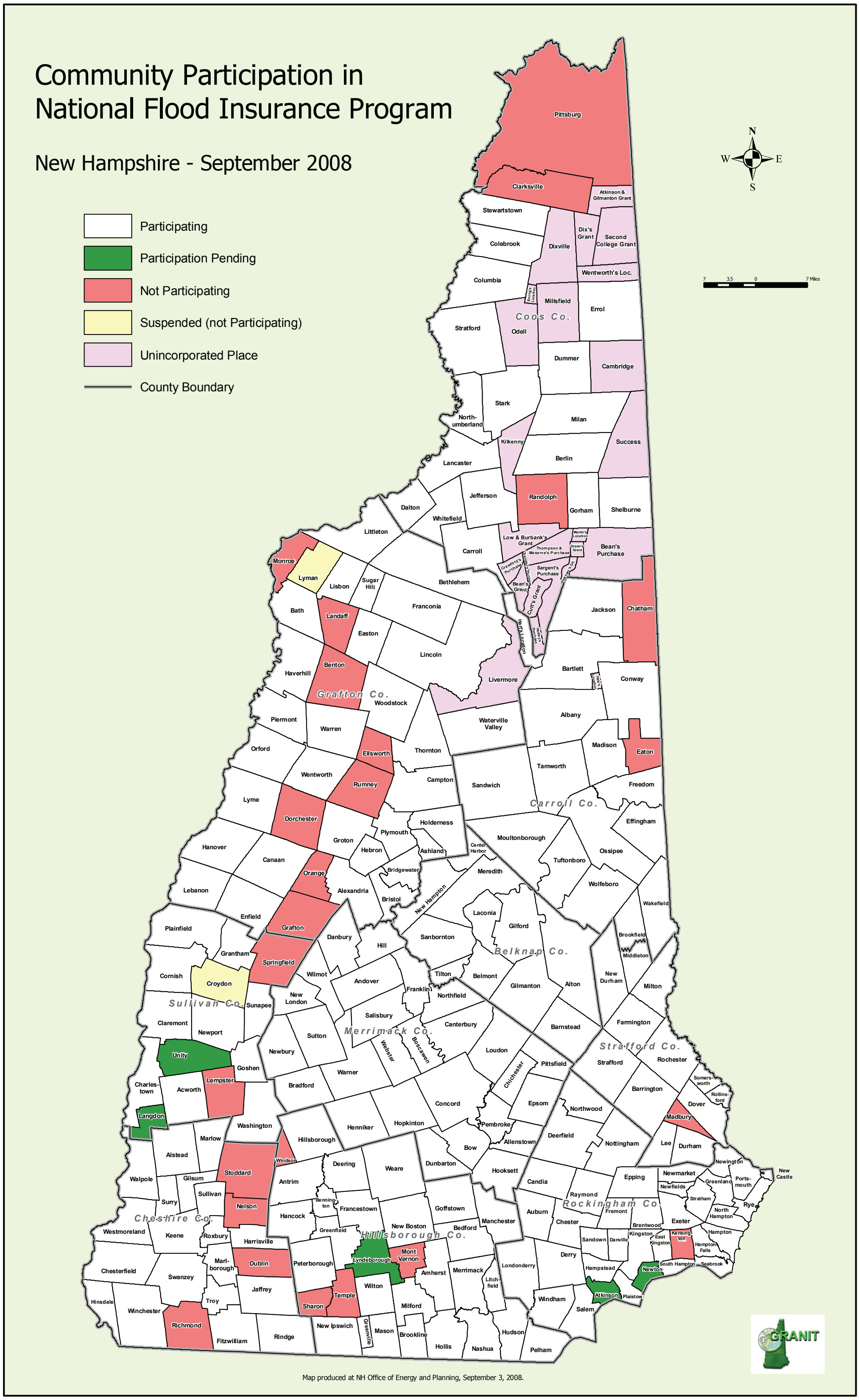

Figure 12-8. New Hampshire communities that are participating in the NFIP. *Source: New Hampshire Office of Energy and Planning, 2008.*

National Flood Insurance Program – An Incentive for Local Regulation

The development of land in and near flood prone areas is regulated by municipal governments. Municipal governments are encouraged to amend their subdivision and site plan review regulations to ensure that projects are not prone to losses associated with flooding. The New Hampshire Office of Energy and Planning (OEP) provides communities with assistance to develop these regulations. OEP also administers the National Flood Insurance Program (NFIP) in New Hampshire and receives a grant from FEMA for this work. OEP conducts community assistance visits to ensure that communities participating in the NFIP are meeting program goals. As an incentive for communities to participate in the NFIP, residents in participating communities can purchase feder-

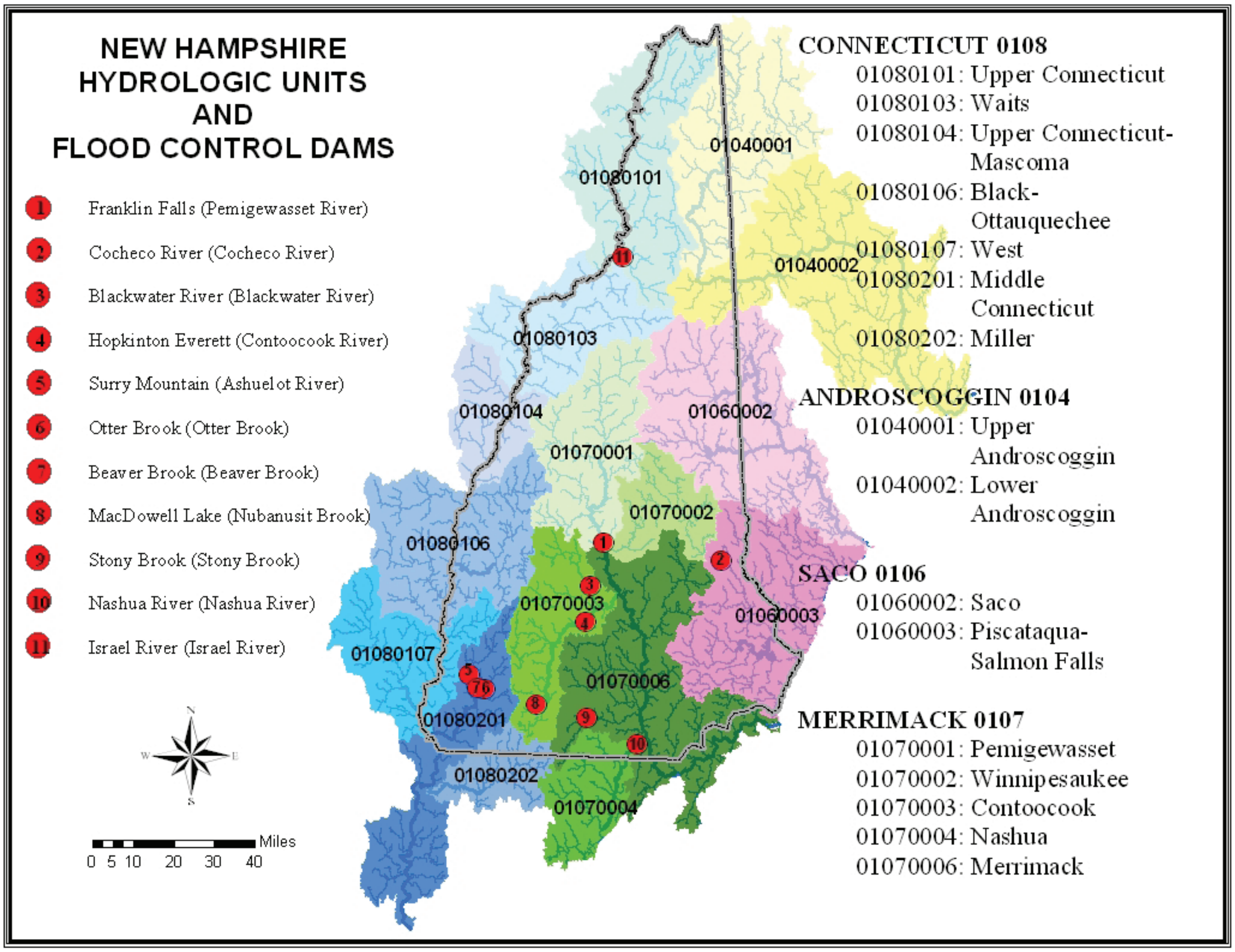

Figure 12-9. Federal flood control projects. ***Data Source: NHDES GIS Database.***

ally subsidized flood insurance. Anyone who applies for a federally-funded mortgage or refinancing on an existing home in a flood-prone area is required to carry flood insurance for the life of the mortgage. Flood insurance is necessary because homeowner's insurance does not cover flood losses. For residents in non-participating communities, private insurance for such at-risk structures can be very expensive and difficult to obtain. In order to participate in the NFIP, communities must implement subdivision and site plan review regulations that prevent the development of projects in areas subject to flooding. Figure 12-8 (on page 12-13) shows the communities that are participating in the NFIP.

Federal Flood Control Projects

The U.S. Army Corps of Engineers has developed a series of flood control dams in New Hampshire. These structures have been designed to capture peak flow to reduce downstream flooding impacts during periods of rapid snow melt or significant precipitation. Figure 12-9 shows the locations of these structures. As noted in section 12.1.1, New Hampshire's dams have prevented nine dollars in flood damages for every dollar of construction costs (Kennelly, 2008).

Flood Management Commission

Flooding events in 2005, 2006 and 2007 prompted the state Legislature to create a Flood Management Commission to develop a comprehensive flood management plan for the state. The commission's September 2008 report looks at New Hampshire's historical and predicted floods, current and expected dam inventory, the trends and regulation of development, as well as the current state and needs for both short- and long-term weather forecasts. It presents current thinking on actual and future risks to guide the wise investment of taxpayer funds to efficiently reach a more reasonable level of protection. The report contains 50 recommendations, which are listed in Appendix B (Comprehensive Flood Management Study Commission, 2008).

12.3.2 Drought

Drought Management Plan

An interagency task force prepared a Drought Management Plan in 1990 (NHDES, 1990). The plan was developed because during the 1980s the southeastern United States experienced an extensive drought and concerns were raised that the same could occur in New Hampshire. The Drought Management Plan establishes methods to describe drought conditions and suggested response actions for different classifications of drought (Table 12-2). The plan relies on a Drought Management Team to disseminate information to the public regarding drought conditions and appropriate water conservation measures that should be implemented by water users. The responsibility for implementing water conservation measures rests with the water users.

Drought Management Team

- **Governor's Office**
- **Office of Energy and Planning (formerly Office of State Planning)**
- **Department of Safety - Bureau of Emergency Management (formerly of the Office of Emergency Management in the Governor's office)**
- **Department of Environmental Services**
- **Department of Agriculture, Markets and Food**
- **Department of Health and Human Services**
- **Department of Resources and Economic Development**
- **New Hampshire Municipal Association**
- **New Hampshire Water Works Association**
- **New Hampshire Business and Industry Association**
- **New Hampshire State Climatologist**
- **United States Geological Survey**

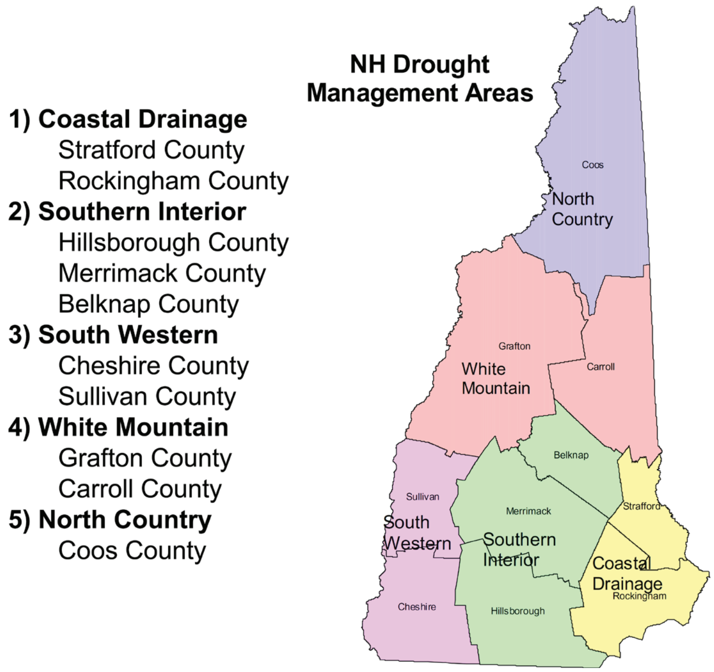

Figure 12-10. New Hampshire drought management areas. ***Source: NHDOS, 2007.***

The Drought Management Plan divides New Hampshire into five drought management areas (Figure 12-10). The management areas largely coincide with watershed and county political boundaries which are reasonably proximal to each other. Table 12-2 lists the suggested response actions for each drought classification as specified in the plan.

The Drought Management Plan classifies drought based on measurements of precipitation, soil moisture, stream flow, groundwater in sand and gravel, forest moisture, and reservoir levels. The plan does not contain criteria for drought classification for groundwater levels in bedrock.

Table 12-2. Suggested response actions for different classifications of drought for the Drought Management Plan. ***Source: NHDOS, 2007.***

Drought Classification	Suggested Response Action
Level 1 - Alert	Assess conditions
Level 2 - Warning	Initiate voluntary water conservation Investigate potential source augmentation Evaluate need for mandatory action
Level 3 - Emergency	Implement mandatory conservation measures
Level 4 - Disaster	Impose water use restrictions with significant economic implications Exercise emergency powers of Governor

The Drought Management Plan was developed outside of any statutory mandate and therefore water conservation measures recommended by the Drought Management Team cannot be mandated unless the governor declares a state of emergency and mandates these conservation measures be implemented.

In response to the large number of private wells becoming dewatered during the drought of 2001-2003, the Legislature adopted RSA 41:11-d in 2007 to provide municipalities with the authority to restrict residential lawn watering if the state or federal government declares a condition of drought. Additionally, new groundwater withdrawals exceeding 57,600 gallons over a 24-hour period and new surface water withdrawals permitted by DES are required to reduce or terminate water use when drought is reducing the amount of water in the environment. There is limited statutory authority to require other water users to implement conservation in response to a drought condition.

Bureau of Emergency Management

The Drought Management Plan predates the establishment of the Bureau of Emergency Management within the Department of Safety which was established pursuant to RSA 21-P:36 in 2002. In accordance with RSA 21-P-35:5, the Bureau of Emergency Management is responsible for preparing and carrying out all emergency prevention and response functions for any natural or man-made disasters, including drought.

12.4 Stakeholder Recommendations

This section contains key recommendations that have been developed through collaboration with a group of volunteer stakeholders who have reviewed and contributed to this chapter.

12.4.1 Develop Improved Mapping Programs for Floods

Action needs to be taken to prepare for floods and to prevent or reduce the damage to property and human life that could result from floods. An initial step towards achieving this goal is to characterize where and how much water will be moving across a landscape. Because flooding is influenced by the topography of the land, accurate elevation data is needed. Current flood maps in the state are not based on high resolution data; consequently, we do not know with a high degree of certainty where floods will impact humans or the potential severity of flooding. Light Detection and Ranging (LIDAR) should be used to help update and develop new flood maps. High resolution imagery maps need to be collected on a cyclical basis to overlay with the flood maps generated by LIDAR.

Other states along the east coast are implementing LIDAR and imagery data collection programs after witnessing millions of dollars in costs and loss of life associated with flood disasters. New Hampshire should not wait for similar disasters to occur within the state before initiating this effort. This information will also be critical for developing adaptive strategies to address climate change.

12.4.2 Increase the Number of Stream Gages to Better Predict Flooding

When floods occur, stream gages are indispensable tools for flood forecasting and warning along rivers and streams. Relying on historical data is not adequate, since the severity and duration of precipitation events in New Hampshire may increase due to climate change, and summer flows may decline causing more low-flow periods. After the installation of 15 new gages from the 2007 capital budget request and an Emergency Management Performance Grant, the state will have a total of 54 continuous USGS gage stations. This will exceed the number of gages that were present in 1962. However, the state will lose 15 gages in October 2009 if state funding is not developed, bringing the number of gages in the state below the number operating in the 1930s. Funding for operating and maintaining one gage in 2009 is $14,450 annually (NHDES, 2008). This amount does not include the installation cost of new gages or contributions from the USGS, which helps to share the cost of many gages in the state.

12.4.3 Develop and Implement Disaster Prevention for Floods

Floods in New Hampshire historically have been the most costly and most frequently recurring natural disasters. More intense storms and rising sea levels associated with climate change will make floods an even more significant problem in the future. New Hampshire needs to take action to prevent loss of property or human life as a result of flooding. New or upgraded infrastructure (culverts, bridges, stormwater management systems) should be developed to prevent flooding from causing loss of life or property. Existing developments should be retrofitted, relocated or insured to mitigate losses that may occur due to flooding. New developments should be located in areas not prone to flooding or flood-related erosion as determined by state-of-the-art land elevation and erosion hazard mapping.

12.4.4 Revise the Drought Management Plan

The Drought Management Plan needs to be updated to reflect the current structure of state government. The plan also needs to include criteria for assessing bedrock groundwater levels because approximately 60 percent of the state's population relies on this resource for drinking water. The Drought Management Team should assess whether the state or other levels of government need to have authority to manage water resources when extensive drought conditions persist.

12.4.5 Establish Prevention and Mitigation Strategies for Water Supplies Adversely Affected by Drought

Government agencies and all water users, including water systems, businesses, agriculture, and residents with private water supply wells, need to understand that droughts do occur in New Hampshire. Drought contingency plans, insurance, financial resources, and mutual aid agreements need to be established to effectively cope with the effects of drought.

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