WD-14-02

Climate Change Resilience Plan

Resilience & Preparedness in State Government Project

New Hampshire Department of Environmental Services
Drinking Water & Groundwater Bureau

Thomas S. Burack, Commissioner
Vicki V. Quiram, Assistant Commissioner
Eugene Forbes, Division Director
Sarah Pillsbury, Bureau Administrator

Prepared by Bethann McCarthy

October 2014

Acknowledgements

This material is based upon work supported by the U.S. Department of Energy under Award Number(s) DE-EE0000228. This grant was received through the New Hampshire Office of Energy and Planning's State Energy Program, which was funded by the American Recovery and Reinvestment Act (ARRA) of 2009. The purpose of the grant was to support efforts by the New Hampshire Department of Environmental Services (NHDES) to develop data and tools that will help institutionalize resilience, mitigation and adaptation to severe weather and natural events across all department programs.

The Drinking Water and Groundwater Bureau would like to acknowledge the following NHDES staff who contributed to the development of this Plan:

Bethann McCarthy, who conducted the research and wrote the Plan on behalf of the Bureau;

Paul Susca, who provided guidance in developing the plan and performed final editing of the Plan;

Christine Bowman, Mary Clairmont, Dan Dudley, Brandon Kernen, Cindy Klevens, Chip Mackey, Selina Makofsky, Jennifer Mates, Johnna McKenna, Leah McKenna, Kevin Riel, Steve Roy, Rick Skarinka and Susan Willoughby, who assisted in developing, vetting, and prioritizing the list of action items and provided technical information;

Diana Morgan and Gail Dailey-St. Onge who reviewed and assisted in editing the Plan;

Sherry Godlewski, who provided information on resilience planning projects in New Hampshire communities;

Chris Skoglund, who obtained the grant to fund this project and provided background climate data and guidance in developing the Plan; and

Sarah Pillsbury for her leadership in recognizing the need to implement programmatic changes to evaluate and improve the resilience of the state's public water systems in light of climate challenges.

Commissioner Thomas Burack and Assistant Commissioner Vicki Quiram for their leadership in promoting a Department-wide assessment of climate change impacts and potential adaptation and mitigation strategies in the interest of environmental protection and public health and safety.

October 2014

Climate Change Resilience Plan

New Hampshire Department of Environmental Services
Drinking Water and Groundwater Bureau

1.0 Introduction **1**
1.1 Overview of the Project 1
1.2 Overview of the Drinking Water & Groundwater Bureau 1
2.0 Characterization of the Problem **2**
2.1 Climate Change Science 2
2.2 Changing Regional and State Weather Trends 2
2.3 Challenges for New Hampshire's Drinking Water Systems 2
2.4 Reducing Greenhouse Gas Emissions 3
3.0 Response to the Challenge **4**
3.1 Department of Environmental Services Response 4
3.2 DWGB Activities Related to Climate Change Resilience Leading up to this Plan 4
3.3 Strategies Water Systems Can Use to Become More Resilient 6
3.4 Actions NHDES Can Take to Promote Water System Resiliency 9
3.5 Implementation of the Plan 12

Resources **14**

Appendix A. Climate Change Planning Initiatives in New Hampshire Communities
Appendix B. Adaptation Planning by Other States
Appendix C. DWGB 2010 Flood Survey Report
Appendix D. 2013 Survey – CWSs and Extreme Weather Events

October 2014

1.0 Introduction

1.1 Overview of the Project

New Hampshire's climate is changing, and will continue to change in the future. Many aspects of this changing climate have stressed and will further stress the state's water systems. Climate trends that are expected to stress drinking water systems include: higher temperatures, more intense rainfall events, increased ice, wind and snow storms, earlier snow melt, and potentially more frequent and/or periods of short-term low stream flows and groundwater levels in the summer. The New Hampshire Department of Environmental Services' (NHDES) Drinking Water and Groundwater Bureau (DWGB) has developed this action plan[1] to guide the Bureau's activities to help community water systems (CWSs) become more resilient to the impacts associated with climate change.

What does *resilience* mean? The National Research Council defines resilience as "a capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment." (National Research Council, 2013)

With this plan, the DWGB identifies some of the most likely impacts of extreme weather events on New Hampshire's CWS and some examples of adaptation measures that CWSs could take to improve resilience. The plan also identifies priorities for changes to the Bureau's policies, operations, regulations and education/outreach and technical assistance activities as resources allow for these changes. Short-, medium- and long-term action items are listed in section 3.4.

A list of resources that can be accessed for climate change data and predictions and guidance on how to proceed on action items is included at the end of this Plan.

1.2 Overview of the Drinking Water & Groundwater Bureau

There are four key functions of the NHDES DWGB:

- Administering the federal Safe Drinking Water Act (SDWA) and state statutes to ensure that safe drinking water is reliably being provided at approximately 2,400 public drinking water systems throughout the state.
- Protecting groundwater by regulating large groundwater withdrawals and discharges to groundwater, working with municipalities and water systems to implement local groundwater protection programs, coordinating the efforts of other NHDES programs to protect drinking water sources, and implementing the state's Water Well Program.
- Promoting conservation and ensuring accurate water use reporting.
- Evaluating and accrediting laboratories that test water and wastewater.

[1] This Plan is in keeping with the NHDES 2010-2015 Strategic Plan, which states that: "*NHDES will consider and integrate climate change mitigation and adaptation across all existing NHDES program areas.*"

2.0 Characterization of the Problem

2.1 Climate Change Science

Climate is the normal range of temperature, humidity, wind, precipitation and other weather variables in a region over a long period. In contrast, weather is the condition of these variables over a short period. Earth's climate is influenced by numerous factors, including the so-called "greenhouse gases" (GHGs) that act as a "blanket" to retain heat from the Sun and protect Earth from the cold of space. Carbon dioxide (CO_2) makes up less than 0.05 percent of Earth's atmosphere, but is critical to life on Earth.

As a result of activities like driving, manufacturing, electricity generation and clearing of land, the concentration of CO_2 in the atmosphere has grown from 280 ppm (parts per million) before the industrial revolution to more than 395 ppm in 2013. Other GHGs, such as methane, have also risen significantly. As a result of these increases, the global average temperature has increased by more than 1.5°F over the last century (IPCC, 2013). This rapid rate of change has been attributed to human activities by an overwhelming majority of the scientific community (NASA, 2013). Depending on future emissions of GHGs and how Earth responds, average global temperatures are projected to increase by 2°F to 11.5°F by 2100. (NRC, 2010)

2.2 Changing Regional and State Weather Trends

As a result of the change in global temperature, the very character of the New Hampshire has changed over the past several decades.

- Since 1970, annual temperatures have risen by nearly 2°F while winter temperatures have risen by 4°F.
- The state has, in general, experienced more precipitation each year, with more falling as rain and less as snow. More of this precipitation has also fallen in extreme precipitation events.
- The most pronounced change has occurred in winter, with an increase in the rain-to-snow precipitation ratio and fewer days with snow on the ground, and with spring occurring earlier. There have also been earlier ice-out dates, earlier spring runoff, earlier spring bloom dates for lilacs and longer growing seasons.
- Sea-level rose about 5.3 inches during the 75 year period of 1926 to 2001.

2.3 Challenges for New Hampshire's Drinking Water Systems

The following principal challenges to water systems in the Northeast have been identified by the U.S. Environmental Protection Agengy ((EPA), 2013). Some systems will be affected more than others, based on parameters such as proximity to the seashore and Great Bay, location in relation to fresh water bodies, elevation of system components, size of contributing watershed to a surface water source, and geologic settings of groundwater sources. Responses to a survey that DWGB distributed in 2013 to CWSs (described in Section 3) indicate that many water systems have already experienced impacts over the past 5 to 10 years to a greater extent than they had in the past.

- **Damage to infrastructure.** More frequent extreme precipitation events will cause physical damages to water system infrastructure. Wellheads, pumps and pump houses could be flooded, flood waters could damage access roads and undermine and sever distribution pipes. Loss of electrical power will result from more intense storms. Downed trees can also damage infrastructure. Intense storms and rising sea level will be particularly troublesome along the coast, causing greater damage to coastal facilities and an increased risk of inundation.

- **Water quality concerns.** Water quality could be degraded by algal blooms associated with higher ambient water temperatures and altered lake stratification cycles; nutrients and contaminants becoming more concentrated with longer residence times at periods of low flow; increased loading of sediment and associated nutrients during storm and flooding events; groundwater being pumped from a longer distance, where there could be more potential for contaminants, at periods of low water levels.

- **Water availability concerns.** With reduced snowpack and higher temperatures, the amount and timing of spring runoff will be altered: peak runoff periods will occur earlier in the year. Higher temperatures and longer growing seasons will cause water demand to rise due to increased human and irrigation/agricultural needs. There will also be greater evapotranspiration from soil and plants and evaporation of surface waters. With more precipitation falling in extreme events, groundwater recharge may be decreased. Summer precipitation is expected to increase somewhat but not as much as during the winter and spring seasons and is not expected to keep pace with evapotranspiration and evaporation losses and increased uses. These combined factors will result in more frequent low summer groundwater and surface water levels and, and more frequent short-term (1 to 3 months) and medium-term (3 to 6 month) droughts.

Outdated floodplain mapping. In addition to the challenges posed by climate change described above, a particular problem arises from the use of standard methodologies and tools that use historic precipitation data to evaluate the risk to infrastructure. Many design professionals and regulators use floodplain mapping issued by the U.S. Federal Emergency Management Agency (FEMA) through the National Flood Insurance Program to determine design parameters for infrastructure, typically referencing the 100-year floodplain and the 100-year flood elevations. In most areas of New Hampshire, FEMA's reports and mapping represent results of analyses performed in the 1980s which were based on precipitation data collected prior to 1960.

In the last four to five decades, precipitation and flooding have become more severe in the northeast United States. Floods that were considered 100-year floods in the past are occurring more often. When 100-year flood calculations are performed using statistical analysis of current data, 100-year flood discharges are typically higher. Further, since the magnitude and frequency of extreme precipitation events are expected to increase due to climate change, designing for the future based on current hydrologic conditions, let alone 60 year-old data, does not adequately address future flooding threats.

2.4 Reducing Greenhouse Gas Emissions

Although this plan is focused on helping community water systems in New Hampshire become more resilient to the impacts of climate change, it is important to also work towards reducing greenhouse gas emissions. If we continue with business as usual, the impacts will be more severe and will happen more quickly than if we change course. If we act quickly to reduce our reliance on fossil fuels, Earth's climate will continue to change for many years in the future, but we can avoid the more severe impacts to water systems and other infrastructure, as well as to human and ecological health.

There is some risk in losing sight of this, when we talk about climate change as a "given" and something we need to adapt to. People may feel that since we are taking actions to adapt or become more resilient, there is no need to reduce greenhouse gas emissions. With this in mind, outreach to water systems on adaptation strategies should also include some focus on energy efficiency and renewable energy. Reducing energy use has the added benefit of reducing the cost of providing water and/or freeing up funds to invest in infrastructure improvements.

3.0 Response to the Challenge

3.1 Department of Environmental Services Response

NHDES' 2010-2015 Strategic Plan outlines goals and actions to achieve its mission of helping to "sustain a high quality of life for all citizens by protecting and restoring the environment and public health in New Hampshire." Goal Number 1 of the Strategic Plan is to "…address climate change through effective mitigation and adaptation strategies and efforts to foster the transition to a clean energy economy." "Mitigation" in the climate change context means actions that reduce net carbon emissions and limit long-term climate change.[2] Adaptation (resilience) actions pertinent to the DWGB Resilience Plan include:

- NHDES will continue to participate in regional and national initiatives to better prepare for the impacts of climate change.
- NHDES will collaborate with partners to provide information and technical assistance to communities and organizations that are seeking to incorporate adaptation measures into their projects and plans.

In recognition that climate change is real, serious and substantially man-made, and that New Hampshire's residents, economy and environment are already experiencing its impacts, NHDES has launched a two-year effort: the "Department Climate Initiative." Under this initiative, agency management and staff are engaged in a strategic review of all NHDES programs and activities to identify where and how programmatic changes could be made to improve resiliency around the state and also to reduce energy use by both the department and our customers. Changes to the department's outreach activities, grants and regulatory programs are currently being considered and this work has been incorporated into NHDES' 2010-2015 Strategic Plan.

3.2 DWGB Activities Related to Climate Change Resilience Leading up to this Plan

Some of the programs that have been implemented by DWGB related to emergency planning and vulnerability assessments can serve as a basis for expanding the bureau's activities to improve resilience to climate change impacts. Some steps taken to date are outlined below.

Emergency Planning and Vulnerability Assessments Prior to September 11, 2001, emergency plans were required for CWSs serving 500 people or more. In March of 2002 the Emergency Plan rules were revised to require Emergency Plans for all community systems, regardless of size. Systems are required to update their Plan at least annually and submit the Plan to NHDES every six years.

The 2002 Bioterrorism Act required community systems that serve 3,300 people or more to develop and submit vulnerability assessments directly to EPA. While the efforts following 9/11 were focused on terrorism, over the past twelve years water systems have been impacted by various natural hazards such as ice storms, floods, tornadoes and drought. DWGB has expanded its technical and financial assistance related to emergency preparedness to include an all-hazards approach.

[2] B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds). Climate Change 2007: Mitigation of Climate Change; Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. Accessed September 10, 2013 at http://www.ipcc.ch/publications_and_data/ar4/wg3/en/ch3s3-5.html.

DWGB's education and outreach efforts regarding all-hazards preparedness address:

- Assessment of vulnerability to various hazards, including flooding and droughts.
- Emergency planning.
- National Incident Management System (NIMS) and Incident Command System (ICS).
- Radiological events.
- Cyber security.
- Community-based tabletop exercises involving water system personnel and local officials.
- Emergency planning and security webpage.
- Partnerships with EPA, NH Homeland Security & Emergency Management (HSEM), NH Information and Analysis Center, and the NH Public Works Mutual Aid program.
- Grant programs that funded emergency interconnection studies and security measures such as fencing, alarms and generators.
- Hazard mitigation funding outreach.
- No trespassing signs.
- Flood risk mapping.
- Department of Homeland Security physical security and cyber assessments.
- Improved bulk water requirements.
- Distribution of security and storm related advisories.

In-house efforts to improve DWGB's all-hazards preparedness include having go-kits that contain important contact and system information at key off-site locations, developing an emergency event tracking system, and participating at the State Emergency Operations Center during drills and real events.

2010 Flood Survey In 2010, a survey pertaining to flood-related experiences was distributed to all community water systems in the state. The goal of the survey was to define the types, causes and costs of flood-related impacts to CWSs over the past five years. The intent was to use the results of the survey to help guide changes to existing programs and administrative rules to improve water system preparedness and response to a damaging flood, and identify additional resources available to flood-impacted drinking water systems. The recommended action items that were identified as a result of the survey were included among those considered for inclusion in this Plan. The report is included as Appendix E.

Preliminary Evaluation of Climate Change Adaptation Strategies A preliminary identification of actions that could be taken to address the effects of climate change through DWGB programs was prepared by the Hydrology & Conservation Section (2010). These action items were also included among those considered for inclusion in this Plan.

Climate Change Vulnerability during Sanitary Surveys DWGB developed a list of questions concerning climate change impacts to ask operators during the drinking water system sanitary surveys. The vulnerability questionnaire is an extension of the sanitary survey program to assist in evaluation of sustainable capacity and assessment of the impacts of natural hazards at CWS.

Participating in regional and national work groups DWGB staff participate in the New England Interstate Water Pollution Control Commission (NEIWPCC) Climate Change Work Group, the Groundwater/Source Water Protection Work Group, the Drinking Water Administrators Work Group, and the Climate Change Work Group on the regional level. On the national level, bureau staff participate in the Source Water Protection working group of the Association of State Drinking Water Administrators (ASDWA), as well as ASDWA's Water Availability, Variability, and Sustainability initiative, and serve as representatives on the ASDWA Security Committee and on the ASDWA Water Sector Government Coordinating Council.

Additional Data and Information Collection To develop this Plan, DWGB performed a literature review of climate change science topics, especially those studies specific to New Hampshire and/or the northeast U.S. Tools for planning and implementing climate change resilience strategies were also reviewed. A list of literature that was reviewed and utilized in preparation for this study is included in Section 4. Many of these documents can be used to further develop bureau policies and outreach material or when providing technical assistance.

In addition to the literature review, surveys of CWS contacts and of DWGB staff were performed as described below.

CWS Extreme Weather Event Survey In 2013, a survey was developed to obtain information from community water system representatives relative to climate change impacts. The objective of the survey was to elicit information on impacts that CWSs are experiencing and also to gauge the level of concern regarding current and future impacts. The survey was designed to collect the following information:

- Current experiences with extreme weather events (wind, snow and ice storms, flood, drought, water quality).
- Perceptions of the threats to drinking water systems due to climate change.
- Needs for education, outreach and technical assistance related to climate change impact.
- Names of system representatives that would be interested in assisting in outreach on climate change adaptation strategies.

The survey used both multiple choice and priority ranking questions, with the intent that qualitative data could be obtained through open-ended questions. Survey Monkey was used for survey development and distribution. The survey was sent to 614 representatives of small and large community water systems. The initial survey request was sent on August 2, 2013 and responses were collected through August 23, 2013. Two hundred (200) online questionnaires were completed, 19 of which were partially completed. Appendix F includes a summary of the responses.

DWGB Staff Survey A questionnaire was provided to key DWGB staff to guide conversations about the concerns of staff relative to climate change impacts and to prioritize the many potential action items that had been identified during previous efforts and in recent phases of the development of this Plan. The questionnaire was filled out by eight key staff, including four section supervisors. After evaluating the responses, a preliminary prioritized list of action items (Short-, Medium- and Long-Term) was developed for further review by key staff members and the Bureau Administrator.

Bureau Climate Change Coordinator A staff person has been assigned duties related to climate change resilience, including coordinating the bureau's activities related to climate resilience and being the contact person for climate change-related issues for public water systems, inter-department personnel and EPA. These responsibilities complement other responsibilities within an existing engineering position. She has been reaching out to CWSs through presentations, newspaper articles, etc. on the climate change impacts to CWSs and adaptation strategies that can be taken.

3.3 Strategies Water Systems Can Use to Become More Resilient

There are many ways that drinking water systems can improve their resilience to the impacts of climate change. The methods vary based on the threat (flood, drought, increased turbidity, etc), the type and degree of impact, and the system's design and treatment processes. Options include planning, operational and infrastructure improvements. Some examples of resilience measures are described below:

General

- Conduct training for personnel in climate change impacts and resilience, as well as in energy efficiency, to help staff understand the long-term impacts and resilience strategies.
- Educate customers, municipal officials and commissioners on the impacts of climate change and how the changes are expected to impact the water system. This may help in obtaining "buy-in" for required upgrades, water conservation and source water protection initiatives.
- Participate in community and regional planning related to climate change adaptation.
- Maintain an inventory of all assets, including photographs. Pre- and post-event documentation is important to document damages in support of insurance claims and in obtaining FEMA reimbursement, Hazard Mitigation Funding and other public assistance funding.
- Take advantage of forecasting tools to assist in reservoir operations.
- Investigate alternative management procedures (such as reservoir operations, reuse of gray water and water conservation) to ensure adequate supply, especially for the summer months.
- Have redundant sources in case one source becomes damaged, contaminated or does not have adequate storage.
- Expand resources by developing interconnectivity to an adjacent water system.
- Perform a vulnerability assessment to evaluate the impacts of climate change on a drinking water system and identify system weaknesses.
- Participate in mutual aid programs and agreements, such as those offered by the New Hampshire Public Works Mutual Aid Program.

Severe Storms (e.g. rain, wind, ice, snow)

- Large water systems should have back-up power for all critical infrastructure.
- Small water systems should install a transfer switch to readily accept a generator when necessary.
- Consider a rental agreement to obtain priority over customers with non-emergency needs.
- Identify reliable sources for obtaining generator fuel in an emergency.
- Monitor the health of trees near critical infrastructure and remove trees and/or limbs when they threaten system components and/or power lines.

Floods

- Raise wellheads to ensure flood water does not contaminate sources.
- Raise equipment and generators.
- Raise pumps and pump houses above flood levels.
- Strap fuel and water storage tanks to prevent flotation during floods.
- Raise access roads as wetlands permitting allows. Install or upgrade to adequately sized culverts to avoid road washouts.
- Armor stream banks susceptible to erosion, to prevent the banks from back-cutting and threatening damage to wells, pump houses, distribution pipes, etc. Use bio-engineering techniques which use natural materials to the extent possible.
- Build berms to protect critical infrastructure from flood waters.
- Install flood barriers (for example: door gates) to prevent flood waters from entering pump houses.
- Set aside land to support future flood-proofing needs (such as berms, dikes and retractable gates).
- Ensure that emergency response plans deal with flooding and include stakeholder engagement and communication.

Low Water Levels/Short- and Medium-Term Drought

- Encourage and implement water conservation techniques, including fixing and repairing leaks.
- Monitor well yield using data from pump run-time meters or level transducers in conjunction with flow meters.
- Incorporate monitoring of groundwater conditions and climate change projections into groundwater models.
- Support systems to recycle water, including use of grey water in homes and businesses.
- Practice demand management through communication to customers on water conservation actions.

Source Water Quality

- Team with community stakeholders to reduce sources of transported sediment and other non-point pollutants in watersheds, thereby minimizing the amount of treatment required.
- Encourage Low Impact Development and other stormwater infiltration practices in places where they are appropriate (green roofs, reduction in impervious land cover, use of pervious pavement, etc.) and incorporation of those practices into land use permitting in order to preserve hydrologic function of watershed lands while protecting groundwater quality.
- Treat raw water or increase storage of treated water prior to predicted high turbidity events to the extent feasible, if the treatment plant does not run continuously.
- Purchase or conserve critical tracts of land within the watershed and otherwise support the preservation of lands (e.g., riparian buffers) important to protecting water quality.
- Increase water quality monitoring at times of high turbidity.
- Develop a Source Water Protection Program that includes some combination of public education, management of potential contamination sources and land use restrictions.

There are many actions that can be taken to improve resilience of drinking water systems, and drainage/river systems in general. NHDES recognizes that communities have limited resources, so will need to prioritize efforts in implementing resilience strategies as resources allow.

3.4 Actions NHDES Can Take to Promote Water System Resiliency

Based on the results of the studies, research and surveys/interviews described above, the following action items were selected for implementation by DWGB, as resources allow, to help drinking water systems prepare for and respond to the threats of climate change. When implementing these recommendations, DWGB should coordinate with other bureaus and agencies, when applicable, to ensure that their actions and the actions of others do not lead to adverse unintended consequences.

Short-Term Action Items (1 month to 1 year)

DWGB hopes to implement the following action items within the next year. Action items that will be continued as on-going activities are marked with an asterisk (*).

1. Increase staff awareness and education. Encourage staff to obtain training in climate change in order to stay on top of the science, solutions and available resources related to DWGB and its role.
   Individual/Section(s) to Implement: Bureau Administrator or Designee
2. Continue to focus on ensuring adequate supply and system redundancy, as well as on identifying potential system vulnerabilities.*
   Section(s) to Implement: Hydrology & Conservation; Engineering & Survey
3. Continue to encourage system interconnections when appropriate and feasible.*
   Section(s) to Implement: Engineering & Survey
4. Stay abreast of updated flood and sea level rise mapping that may be developed by state or federal agencies or other organizations and use this data as appropriate to determine flood elevations and/or inundation limits for well siting and CWS design requirements.*
   Section(s) to Implement: Engineering & Survey; Hydrology & Conservation
5. Develop a short set of questions to ask during Sanitary Surveys to evaluate the threat of flooding, extended periods of low flow, and other impacts of extreme ice/wind/snow storms. Inquire as to whether there are any threats/damages to distribution pipes that cross rivers and view potentially damaged areas when feasible.
   Section(s) to Implement: Engineering & Survey
6. Enhance outreach on the following topics, in cooperation with Granite State Rural Water Association and NH Water Works Association (NHWWA), and/or in DWGB activities, publications and correspondence*:

   a. Best management practices for source water protection.
      Section(s) to Implement: Hydrology & Conservation; Planning, Protection & Assistance;

   b. Installing generators and/or automatic power switches.
      Section(s) to Implement: Engineering & Survey

   c. Developing back-up water sources and developing interconnections.
      Section(s) to Implement: Hydrology & Conservation; Engineering & Survey

   d. Tracking pump run times and water levels to evaluate supply adequacy.
      Section(s) to Implement: Engineering & Survey

   e. Maintaining an inventory of all assets and documenting condition of assets with photographs before and after extreme weather in support of hazard mitigation funding applications.

Section to Implement: Engineering & Survey

f. Encouraging community water systems to become members of the New Hampshire Public Works Mutual Aid program.
Section to Implement: Engineering & Survey.

g. Include articles in the Supply Lines with The Source newsletter on climate change impacts and resilience strategies.*
Section(s) to Implement: Planning, Protection & Assistance

Medium-Term Action Items (1-3 years)

DWGB plans to implement the following action items within the next 1-3 years. Action items that will be initiated and then continued as on-going activities are marked with an asterisk (*).

1. Develop and implement a climate change vulnerability assessment program for water systems. (See further explanation to right.)
Section(s) to Implement: Engineering & Survey
2. In any guidance that DWGB develops for asset management plans, incorporate consideration of climate change impacts into risk assessments.
Section(s) to Implement: Engineering & Survey
3. Work with Homeland Security and Emergency Management to ensure timely notification of public water systems when hazard mitigation and public assistance funding is available.*
Section(s) to Implement: Engineering & Survey
4. Improve the After Action Review process by developing a list of systems that are impacted during natural disasters. Follow up with the systems to inquire whether assistance is needed during recovery.
Section(s) to Implement: Engineering & Survey
5. Include climate change impacts and adaptation strategies in emergency planning workshops as appropriate given time constraints of workshops.*
Section(s) to Implement: Engineering & Survey
6. When scientifically acceptable methods have been used to develop updated flood mapping, use inundation areas and flood levels from these maps/analyses for required system component elevations, if the information is more current than FEMA mapping.*
Section(s) to Implement: Engineering & Survey; Hydrology & Conservation
7. Encourage collection of raw water quality data (e.g. bacteria, disinfection by-product pre-cursors) by CWSs to use in evaluation of short- and long-term trends for surface water and groundwater sources, as applicable.*
Section(s) to Implement: Engineering & Survey
8. Recruit water systems with surface water sources to participate in a voluntary monitoring and reporting network for algae blooms, to allow DWGB to assess trends in algal outbreaks.*

Vulnerability Assessments

DWGB will develop a program to evaluate the usefulness of climate change vulnerability assessments for water systems. Based on knowledge of potential vulnerabilities from results of past CWS surveys, known flooding problems, discussions with system staff, etc., DWGB will recruit systems to participate in a pilot program.

The bureau then hopes to engage a contractor to prepare vulnerability assessments for a small number of interested systems. These assessments could include hydrologic modeling and stress tests on sources. The goal of the assessments would be to assess the risk of impacts, as well as associated costs, and to prepare CWSs to develop climate change adaptation plans.

Section(s) to Implement: Planning, Protection & Assistance

9. Provide outreach to regional planning commissions to encourage them to involve public water systems in climate change planning projects and in hazard mitigation planning.*
   Section(s) to Implement: Planning, Protection & Assistance

10. Include education on climate planning and mitigation measures in Certified Operator training.*
    Section(s) to Implement: Engineering & Survey

11. Develop climate change impact and resilience fact sheets, as well as climate change mitigation (water and energy efficiency initiatives) fact sheets.
    Section(s) to Implement: Engineering & Survey

12. Incorporate climate change impacts and examples of adaptation strategies into emergency plan templates as "optional" concerns to be addressed, until rules are amended in 2015. Also include a sample water purchase agreement in the template for Emergency Plans.
    Section(s) to Implement: Engineering & Survey

13. For large CWSs, require that wellheads be three feet above the 100-year flood level or the highest known flood elevation, whichever is greater. This will replace DWGB's current practice of requiring the wellhead to be two feet above the 100-year flood level, which has been the policy in response to the Ten State Standards language, "or as reviewing authority dictates."
    Section(s) to Implement: Engineering & Survey

14. Adopt the following amendments to administrative rules relative to design standards for new and modified structures:
    Section(s) to Implement: Engineering & Survey

    a. For large and small CWSs, require that pump run time meters be installed (Env-Ws 372 and 374). Requiring pump run time meters is recommended as they are useful tools to enable system operators to evaluate the capacity of their wells, which usually changes over time. Detecting degradation of capacity in early stages is one strategy that will help ensure long-term viability of a source, especially given the potential for longer periods of drought.

    b. For small CWSs, require a minimum five ft depth for distribution pipes crossing water bodies 15 ft or wider (Env-Ws 372). Ten State Standards require this of large CWSs.

    c. For small CWSs, require isolation devices at each side of distribution pipes crossing a water body greater than 15' in width (Env-Ws 372). Ten State Standards require this of large CWSs.

    d. For small CWSs, increase the required elevation for the wellhead to three feet above 100-year flood or three feet above highest known flood elevation, whichever is greater (Env-Ws 372). Recognizing that existing flood mapping and analyses are outdated with respect to current climate conditions, and the fact that the 100-year flood does not take into account future

Existing Elevation Requirements for CWSs

Requirements for *large* systems are included in Env-Ws 374, which references *Recommended Standards for Water Works* (Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, 2012), commonly called the "Ten State Standards."

Requirements for *small* CWSs are in Env-Ws 372, but the rules only have required elevations for wells and pump houses. The rules require these components to be above the 100-year flood elevation. (DWGB may decide to extend the freeboard above 3 feet in the future as conditions warrant.)

increases in flood magnitudes, three feet represents a safety factor for wellheads and pump houses. This matches the criteria included in the Ten State Standards.

e. For small CWSs, increase the required elevation of pump houses to three feet above 100-year flood or three ft above highest known flood elevation, whichever is greater (Env-Ws 372).

f. Require an automatic power transfer switch for generators at new small CWSs (Env-Ws 372).

15. For large and small systems, recommend that isolation valves be spaced at not more than 500 feet in flood plains or in areas with high erosion potential.

16. Provide outreach on energy efficiency activities at large and small systems, such as pumping efficiency, energy efficient treatment techniques and the relationship between water conservation and energy efficiency.

17. Work with NHWWA and the Public Utilities Commission to expand energy efficiency incentives administered by electrical and gas utilities.

Long-Term Action Items (More than 3 years)

DWGB plans to implement the following action items within the next eight years.

1. Perform a detailed review of this Plan every five years and revise as necessary.
   Section(s) to Implement: Administrator's designee

2. Review siting and design standards on a routine basis (every five to eight years) to assess the need to integrate new knowledge on predicted climate change impacts during rule re-adoptions (which typically occur every ten years). If a rule amendment appears to be key to ensuring resilience based on observed climate change impacts, consider amending the rule prior to its expiration or recommending that CWSs comply with a higher standard.
   Section(s) to Implement: Engineering & Survey

3. Amend Env-Ws 360.15 to require that emergency plans include consideration of climate change impacts and how systems will respond to increased frequency of flooding, drought and other climate impacts. At the latest, this should be accomplished when the rules are readopted in 2023. However, DWGB will consider amending the rule in time for the submission of updated Emergency Plans, in 2021.
   Section(s) to Implement: Engineering & Survey

3.5 Implementation of the Plan

This plan is very ambitious and includes many action items to be integrated into the overall work of the bureau. Implementing this plan will require vigilance and, in some cases, finding some additional resources. The tasks and responsibilities outlined in this plan complement other important on-going programs as needed to help ensure resilience of water systems against the impacts of climate change.

An important factor to ensure implementation of the Plan is that the Bureau Administrator delivers a consistent message: climate change adaptation is necessary to ensure safe and reliable drinking water. As stated in short-term action item No. 2, the Bureau Administrator will assign a staff person to coordinate implementation of this Plan. In fact, this duty has been included in a job description for a position in the engineering and survey section that will be filled in the next few months. This "Plan Coordinator" will check in with section supervisors every few months to see that sections are on track with meeting the goals to implement specific activities and that the activities are integrated in the annual initiative report for the section. As staff resources and other work priorities present challenges to full implementation, the

Plan Coordinator will work with the Administrator and staff to develop strategies to find alternative approaches that may require different resources or additional time. To ensure forward progress in the face of challenge, the Plan Coordinator will perform a formal review of the plan every five years and update it as necessary.

It is important to note that some of the recommended action items will potentially require additional expenditures by water systems. DWGB works closely with the water industry and intends to vet the initiatives in this plan through them for their input and recommendations on how to best achieve resilience goals. Further, the bureau, as a matter of routine, convenes stakeholder groups for any rule changes and will do so for rules and policy changes envisioned in this plan.

Resources

Climate Science

1. IPCC, 2007: *Climate Change 2007: Synthesis Report, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.*
   This is a comprehensive report on the science of climate change.

2. IPCC, 2014: *Climate Change 2014: Mitigation of Climate Change, IPCC Working Group III Contribution to AR5*and *Summary for Policy Makers*
   The Working Group III's website states that this report responds to the request of the world's governments for a comprehensive, objective and policy neutral assessment of the current scientific knowledge on mitigating climate change.
   http://ipcc.ch/report/ar5/wg3/

3. National Aeronautic and Space Administration (NASA), 2013: *Consensus: 97% of Climate Scientists Agree Global Change.*
   http://climate.nasa.gov/scientific-consensus
   This statement by NASA summarizes the scientific understanding of 97 percent of climate scientists worldwide that global climate change is worldwide. The website lists 18 organizations worldwide that have issued statements supporting this understanding, with links to their reports.

4. National Resource Council (NRC), 2010: *Advancing the Science of Climate Change.*
   http://www.nap.edu/catalog.php?record_id=12782
   This report is part of a congressionally request suite of studies known as *America's Climate Choices*. The report shows that hypotheses about climate change are supported by multiple lines of evidence, and have stood firm in the face of serious debate and careful evaluation of alternative explanations. (Taken from the website)

5. Frumhoff, P. C., J. J. McCarthy, et al. Union of Concerned Scientists, 2006: *Climate Change in the U.S. Northeast. A Report of the Northeast Climate Impacts Assessment.*
   http://www.climatechoices.org/assets/documents/climatechoices/NECIA_climate_report_final.pdf
   This report includes outlines of the current trends being observed in New Hampshire's climate and describes how these the state's climate is expected to change based on two different emissions scenarios. Impacts to forests, winter recreation, human health and agriculture are identified. This is the full report that serves as the background for the 6-page synopsis listed as reference 6.

6. Frumhoff, P. C., J. J. McCarthy, et al., Union of Concerned Scientists, 2007: *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions*. Synthesis report of the Northeast Climate Impacts Assessment (NECIA)
   http://www.climatechoices.org/assets/documents/climatechoices/new-hampshire_necia.pdf
   This report includes outlines of the current trends being observed in New Hampshire's climate and describes how the state's climate is expected to change based on two different emissions scenarios. Impacts to forests, winter recreation, human health and agriculture are identified. This brief report is a synopsis of the report listed as reference 5.

7. Kunkel, K.E., L.E. Stevens et al., 2013: Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. Part 1. Climate of the Northeast U.S., NOAA Technical Report NESDIS
   http://scenarios.globalchange.gov/regions/northeast

This document provides a brief overview of the observed changes in the climate of the Northeast United States as well as possible future climate conditions as simulated by climate models, based on two scenarios of future greenhouse gas emissions.

8. Wake,C.P, E. Burakowski, P. Wilkinson et al, Climate Solutions New England, 2014: Climate Change in Southern New Hampshire, Past, Present, and Future,
This report describes how the climate of southern New Hampshire has changed over the past century and how the future climate of the region will be affected by a warmer planet due to human activities.
http://climatesolutionsne.org/sites/climatesolutionsne.org/files/2014_northernnh_climate_assessment_unhsi_csne_gsf.pdf

9. Wake,C.P, E. Burakowski, P. Wilkinson et al, Climate Solutions New England, 2014: Climate Change in Northern New Hampshire, Past, Present, and Future,
This report describes how the climate of northern New Hampshire has changed over the past century and how the future climate of the region will be affected by a warmer planet due to human activities.
http://climatesolutionsne.org/sites/climatesolutionsne.org/files/2014_southernnh_climate_assessment_unhsi_csne_gsf.pdf

Adaptation/Planning Tools and Guidance

10. U.S. Environmental Protection Agency, 2014: *Flood Resilience, A Basic Guide for Water and Wastewater Utilities.*
http://water.epa.gov/infrastructure/watersecurity/emerplan/upload/epa817b14006.pdf
Using this guide, the utility would examine the threat of flooding, determine impacts to utility assets and identify cost-effective mitigation options. This approach was successfully tested during a pilot project at a small drinking water system, the Berwick Water Department (BWD), in Berwick, Maine.

11. American Rivers and Natural Resources Defense Council, 2013: *Getting Climate Smart, A Water Preparedness Guide for State Action.*
http://www.nrdc.org/water/climate-smart/
This is an online, interactive guide to assist water managers and state governments in readying themselves for the impacts of climate change. The guide includes practical guidance, planning tools, case studies and a toolbox of strategies covering many sectors, including drinking water.

12. U.S. Environmental Protection Agency, 2010: *Climate Change Vulnerability Assessments: A Review of Water Utility Practices.*
http://water.epa.gov/scitech/climatechange/upload/Climate-Change-Vulnerability-Assessments-Sept-2010.pdf
This study examines and documents the steps taken by eight large drinking water utilities across the U.S. and identifies the emerging practices taken to evaluate water utility climate change vulnerability assessments.

13. U.S. Environmental Protection Agency, 2011: *Climate Ready Water Utilities toolbox.* http://www.epa.gov/safewater/watersecurity/climate/toolbox.html
The CRWU toolbox provides online access to climate change resources, including reports, models, training opportunities, mitigation strategies and adaptation strategies. Resources are from EPA, NOAA, USGS, utility associations, states, and many other organizations/agencies.

14. U.S. Environmental Protection Agency, 2012: *Preparing for Extreme Weather Events: Workshop Planner for the Water Sector.* *http://water.epa.gov/infrastructure/watersecurity/climate/*
The Planner provides materials for planning, facilitating and conducting an adaptation planning workshop, including Powerpoint presentations, sample workshop agendas, etc.

15. U.S. Environmental Protection Agency, 2012a: *Climate Resilience Evaluation and Awareness Tool (CREAT 2.0).* http://water.epa.gov/infrastructure/watersecurity/climate/creat.cfm
This is a software tool to assist drinking water and wastewater utility owners and operators in understanding potential climate change threats and in assessing the related risks at their utilities.

16. U.S. Environmental Protection Agency, 2013: *Adaptation Strategies Guide for Water Utilities*. http://water.epa.gov/infrastructure/watersecurity/climate/upload/epa817k13001.pdf
This guide provides drinking water and wastewater utilities with a basic understanding of climate change impacts to utility operations and missions, and examples of different adaptation actions utilities can take. The guide includes a basic vulnerability questionnaire.

17. Awwa Research Foundation, 2006: *Climate Change and Water Resources: A Primer for Municipal Water Providers.* http://waterinstitute.ufl.edu/WorkingGroups/downloads/WRF%20Climate%20Change%20DocumentsSHARE/Project%202973%20-%20Climate%20Change%20and%20Water%20Resources.pdf
This primer includes an introduction to the science of climate change, discussion of expected impacts to water resources, and guidance on planning and adaptation strategies. This document may be especially useful to the larger water system owners and operators.

Other Reports and Planning Documents

18. Carbon Solutions New England, 2010: *Assessing Flood Risk in the Lamprey River Watershed*. http://100yearfloods.org/
This report summarizes a hydrologic and hydraulic model performed to update the 100-year flood mapping for the watershed. The 100-year flood was updated using 2005 conditions and updated and projected (2100) precipitation data. The mapping and analysis results could be used to evaluate water system vulnerabilities and also to obtain system siting and design elevation data for new and/or modified systems. This mapping has not been accepted by FEMA. FEMA is in the process of updating the 100-year flood in this watershed.

19. City of Portsmouth, New Hampshire, 2013: *Coastal Resilience Initiative, Climate Change Vulnerability Assessment and Adaptation Plan.* http://www.planportsmouth.com/cri/CRI-Report.pdf
The mapping of sea level rise maps included in this plan will be useful to evaluate the risk to the City's drinking water infrastructure due to sea level rise. More information on this plan is included in Appendix B.

20. National Science Foundation, 2009: *Press Release 09-110: Sea-level Rise May Pose Greatest Risk to Northeast U.S., Canada.*
http://www.nsf.gov/news/news_summ.jsp?cntn_id=114871
This press release describes the expected locally higher sea level rise on north Atlantic seaboard of the U.S., as compared to global sea level rise.

21. Rhode Island Department of Health, Office of Drinking Water Quality, 2012: *Safe Water Rhode Island, Ensuring Safe Water for Rhode Island's Future.*
http://www.health.ri.gov/materialbyothers/SafeWaterRIReport.pdf
This report describes the vulnerability assessment and adaptation strategies developed for Rhode Island drinking water systems. The study included evaluation of the cost of expected damages for the systems' existing conditions and the cost of adaptation strategies. This report can be used by the DWGB or by larger utilities as a reference in developing vulnerability assessment programs.

22. Wake, C.P., E. Burakowski et al., Carbon Solutions New England and the University of New Hampshire, 2011: *Climate Change in the Piscataqua/Great Bay Region: Past, Present and Future*.
http://carbonsolutionsne.org/resources/reports/pdf/greatbayreport_online.pdf
This document reports the results of studies on current climate trends, as well as projected trends for temperature, precipitation and sea level rise in the Piscataqua River/Great Bay region.

Online Database Compendiums

23. *Climate Wizard*, The Nature Conservancy.
http://www.climatewizard.org/
Climate Wizard is a web-based program that enables technical and non-technical users to access climate change information and visualize the impacts anywhere on Earth. The program allows the user to choose a state or country and to assess how climate has changed over time and to project what future changes are predicted to occur in a given area. Historic and projected temperature and precipitation data is viewed in GIS format. Projections are available for the years 2050 and 2080, under different emissions scenarios and climate models.

24. *NEClimateUS.org.* A collaborative effort of NOAA, NALCC, NWSF and EPA.
http://neclimateus.org
This is a searchable online database that provides links to a variety of climate information, plans and reports for the Eastern US, including: available data, products, services, planned and on-going vulnerability and adaptation projects and maps. As of this date, NeclimateUS.org is in its early stages of development.

25. *U.S. Global Change Research Program.*
www.globalchange.gov
The online database of the U.S. Global Change Research Program (USGCRP) provides access to information on climate change research, adaptation/mitigation strategies and technologies, and global change-related educational resources on behalf of the various U.S. Federal Agencies that are involved in the USGCRP.

Appendix A. Climate Change Planning Initiatives in New Hampshire Communities

Town of Exeter

As described in the main body of this report, a Flood Planning Workshop was conducted in Exeter, NH on November 10, 2011. The workshop was funded by EPA, and was developed using EPA's *Preparing for Extreme Weather Events - Workshop Planner for the Water Sector*. A major objective of this workshop was to provide information and facilitate an interactive discussion where utility staff and other stakeholders could share information, obtain new perspectives, and discuss adaptation actions/measures that the Exeter water and wastewater utility may pursue as they look to manage the consequences of more frequent and more severe flooding events.

Exeter is currently developing a Climate Change Adaptation Plan through a $683,472 grant from the National Oceanic and Atmospheric Association.

City of Keene

Keene has been one of the more proactive municipalities in New Hampshire in addressing climate change mitigation and adaptation strategies. In November 2007, a report titled *Adapting to Climate Change: Planning a Climate Resistent Community* was released. (http://www.ci.keene.nh.us/sites/default/files/Keene%20Report_ICLEI_FINAL_v2_1.pdf)

The City of Keene has developed a Climate Resilient Communities Committee. The Committee, along with the City Planner, is working with ICLEI – Local Governments for Sustainability, and developed this plan as part of ICLEI's[3] Climate Resilient Communities™ (CRC) Milestones process. The process is designed to focus on three key community systems: the built, natural, and social networks that provide the key services or activities within a community. The process identifies five key milestones to creating a climate resilient community:

1. Initiate a Climate Resilience Effort.
2. Conduct a Climate Resilience Study.
3. Develop a Climate Resilient Action Plan.
4. Implement a Climate Resilient Action Plan.
5. Monitor, Motivate, and Re-evaluate.

Although the report listed the likelihood of an increase in water demands and water quality problems resulting from heat and from increased precipitation, vulnerabilities of drinking water systems was not called out specifically in the report. The vulnerable sectors which were addressed in detail in the report were: buildings, transportation, stormwater and wastewater, energy systems, communication systems, park and open space resources, emergency services, agriculture and forestry.

The report did identify some adaptation strategies related to wetlands and sub-surface waters protection and management, as listed below:

Opportunity: Wetlands and Sub-surface Waters Protection and Management

[3] International Council for Local Environmental Initiatives

Goal A: Increase the protection of existing and future wetlands to maintain the ability of these systems to naturally recharge aquifers and decrease stormwater run-off.

Target A: Develop a wetlands management strategy by 2010 that includes the identification of and recommendation to preserve key wetland areas in the City that will reduce the impact of a flooding event.
Target B: Develop a City-wide hydrologic study identifying the hydrologic areas, particularly those most susceptible to changes in climate and develop management plans by 2010.
Target C: Incorporate wetland and sub-surface waters protection into the comprehensive master plan.
Target D: Update all relevant City standards to consistently support the protection of wetlands and sub-surface waters, whether during plan review, construction, or during operations.

Goal B: Educate the public about wetland protection as a climate adaptation strategy.

Target A: Develop a guide for homeowners, developers, architects, etc., by 2009, to educate them about the significance of wetlands and their role in adapting to climate change.
Target B: Devise a public outreach campaign/presentation.
Target C: Incorporate wetland education into Earth Week and Community Planning Month activities.

Goal C: Increase Keene's water storage capabilities in the face of drought conditions.

Target A: Create a watershed management plan.
Target B: Protect aquifer recharge areas.
Target C: Devise grey water storage features.

The following targets related to Stormwater/Buildings and Development are also of interest as they relate to planning for larger storm events:

- Identify a 200-year floodplain and prevent future development in these areas.
- Incorporate sustainable stormwater design and management techniques to lessen the ecological footprint of new development, and take into account the potential for greater storm loads by 2012.

City of Portsmouth

The City of Portsmouth has been very active in addressing climate change mitigation and adaptation. The City worked with the Rockingham Planning Commission, University of New Hampshire professors and Chris Watson, a GIS consultant, to develop the *Climate Resilience Initiative, Climate Change Vulnerability Assessment and Adaptation Plan* on March 29, 2013.

A vulnerability assessment was performed based on mapping for 1.0 ft., 1.7 ft., 2.5 ft. and 6.3 ft. sea level rise scenarios. This mapping was used to identify at-risk areas and structures. Some of the mapped conditions consider the 100-year flood. Since damages to many roads and neighborhoods were identified, it is very likely that water distribution piping would be at risk.

Adaptation strategies were developed for several areas of the city under different sea level rise scenarios. Strategies for systems related to drinking water include: pumping of fresh and stormwater, elevating infrastructure and considering whether more stringent design standards are necessary for protecting citizens, property and infrastructure.

Maps included in the plan can be used to evaluate the potential for flooding of the wellhead protection area and distribution systems.

Town of Seabrook

In July 2009, the Town of Seabrook published the *Adaptation Strategies to Protect Areas of Increased Risk from Coastal Flooding Due to Climate Change (Adaptation Strategies Plan)*. The plan was developed for the Town by the Rockingham Planning Commission. The plan identified strategies to address the risk of sea level rise, storm surge and increased flood levels that could be experienced as a result of climate change. Sections of the 2009 plan related to drinking water vulnerability and adaptation.

One of the non-regulatory recommendations included in the plan is to evaluate the impacts of salt water intrusion into all aquifers that support the local and regional population. Aquifers located underneath Collins Street and South Main Street, near the marsh, were identified as being of significant importance given their proximity to sea level and high potential of inundation.

According to the plan, the Seabrook Hazard Mitigation Plan (HMP) was compiled in 2007 to assist the Town in reducing and mitigating future losses from natural hazard events. One of the recommendations in the 2009 Adaptation Strategies Plan is that the Town should consider revisiting certain sections of the HMP to mitigate future damage from sea level rise and storm events. Another recommendation is to identify structures within the "Extended Coastal Flood Hazard Zone"[4], including water and wastewater facilities. The report recommends that critical infrastucture be built 5 feet above the Base Flood Elevation (BFE) shown on 2005 FEMA Flood Insurance Rate Maps. Accessory structures would be required to be built 1 foot above the BFE. (These latter recommendations on infrastructure requirements have not been implemented to date.)

City of Somersworth

The Somersworth Water Treatment Plant, which is located on the bank of the Salmon Falls River, was significantly damaged by floods in May 2006 and April 2007. Both floods exceeded the 500-year flood. During the May 2006 flood, the system was down and the Town was able to interconnect with the City of Dover. The plant was reopened within four days. The April 2007 flood resulted in even higher floodwaters at the plant. At this time, the plant was undergoing construction in response to the 2006 flood. There were open construction pits, the garage door had been removed, and there was debris and materials on site and throughout the entire facility. Pumps, blowers, a programmable logic controller, a generator and the HVAC equipment were lost.

The Town was forced to undertake major repairs to the plant. As part of the project, major steps were taken to reduce the impacts of future flooding, including:

- Elevated and sealed equipment.

[4] The Extended Coastal Flood Hazard Zone comprises the areas that would be inundated under a 5 foot sea level rise scenario. Although not yet adopted, a sample ordinance with design standards, including design elevations, within the overlay district was developed by RPC.

- Switched to liquid petroleum gas for building heat (eliminated need for larger oil tank).
- Installed a new, self-contained generator. The generator was elevated approximately 5 feet. The fuel storage tank was raised.
- Protection for storm windows & doors to prevent water flow into building.
- Relocated or sealed HVAC systems, louvers, and pipework.
- Strapped propane tanks to a concrete pad to resist buoyancy.

The cost to implement this project was approximately $7,000,000, including upgrades planned prior to flood damages. Funding sources were: FEMA mitigation grants, insurance pay-outs and Town budget for upgrades. There have been no flood damages since these upgrades were made. (Note that floods experienced since 2007 have not been as severe.)

Somersworth lists its "lessons learned" as:

- Review Emergency Response Plan yearly or after any process changes.
- Develop protocols for notification, defense & when to abandon.
- Maintain customer confidence.
- Foster and cultivate cooperation with neighbors & vendors.
- Simple solutions can solve big problems.

Rockingham Planning Commission

The Rockingham Planning Commission (RPC) worked with Portsmouth to develop the Climate Resilience Initiative plan described above. The RPC is currently working under a grant from HSEM to develop similar vulnerability assessments and adaptation plans for the six other communities on the seacoast (New Castle, Rye, North Hampton, Hampton Falls, Hampton and Seabrook).

Appendix B. Adaptation Planning by Other States

While developing this Plan, DWGB discussed climate change initiatives being undertaken by other Northeastern U.S. states with staff of drinking water programs and NEIWPCC. The state initiatives are listed roughly in order of effort currently being undertaken in the drinking water sector, starting with the most comprehensive initiative.

Rhode Island

SafeWater RI - Ensuring Safe Water for Rhode Island's Future

Project Background

In January 2012 the Rhode Island Department of Health (HEALTH), Office of Drinking Water Quality, launched *SafeWater RI: Ensuring Safe Water for Rhode Island's Future.* The project studied the impacts of climate change on drinking water utilities in the state and provided specific information for water utility managers to evaluate and plan for the future. The objective of the project was to assess how temperature, rainfall, and other changes might impact Rhode Island, and to develop strategies to address these changing conditions.

The project was funded through the 15 percent Local Assistance Set Aside. The total project budget is $245,735.00. The project was awarded to Tetra Tech, Inc.

The SafeWater RI project included the following phases.

Phase 1 - conducted a survey of drinking water utilities and met with many utility representatives to compile data and information for the project.

Phase 2 – performed vulnerability assessments to evaluate the impacts of changing environmental conditions on drinking water utilities.

Phase 3 - identified appropriate management strategies that could help make those impacts less severe.

Phase 4 - identified specific recommendations for utilities, as well as state and local governments, to help them develop and implement outreach activities to reach audiences that will be affected by the management strategies identified in Phase 3.

Twenty-four scenarios were evaluated to assess potential climate change impacts on RI Water Utilities including assessments of drought, sea level rise, coastal flooding, riverine flooding, and hurricanes. The project uncovered the fact that all water utilities would be affected by one or more scenarios. Forty-two systems were represented through participation in Phase 1 activities, fifteen of which served populations of 10,000 or fewer. The climate scenario impacts were assessed, system vulnerabilities were uncovered and a set of adaptation goals and strategies for achieving each goal were developed including a list of next steps, training, outreach and a set of tools to be shared with the systems and other state agencies.

Phases 1 through 3 have been completed (as of July, 2013). Using the results of Phase 3, the State developed system-specific fact sheets about the project which will be used directly by the systems for educating their consumers. Phase 4 is nearing completion. The State is in the process of brainstorming the

next steps which will include developing and implementing Capacity Development tools for outreach and training to system owners, operators, boards and city planners.

The Phase 2 impacts assessment used FEMA's Hazus-MH software to evaluate climate change hazards posed to water utilities' infrastructure from riverine and coastal flooding, sea level rise and hurricanes. HAZUS-MH is an established public-domain simulation model. A major component of the training goals is to enable water utility representatives to learn how to use FEMA's free HAZUS-MH software, at no-cost to the utility (except for staff time to attend the training). Training is to be performed by FEMA, Tetra Tech and the University of Rhode Island. Under this strategy, water utility representatives would participate in the training to enable continued analysis by the water utilities as new data become available and to run updated scenarios for new infrastructure siting. Alternatively, water utility managers could evaluate the GIS data developed in the SafeWater RI project to determine whether proposed infrastructure would be at risk.

Other educational and outreach tools under consideration include:

- Encouraging collaboration between water and wastewater utilities to uncover opportunities for water reuse.
- Workshops and templates for development of Emergency Water Agreements.
- Guidance documents and a superintendent symposium around the topic of enhancing operations and systems management for improving system efficiencies to free up resources for adaptation projects.
- We are also working with other state agencies to develop outreach and education strategies for local governments such as: integrating climate change into water utility planning, requiring climate change adaptation be included in water supply management plans and clean water infrastructure replacement plans, coordinating efforts with community and municipal plans.

Contact information:

Steven Boudreau
State of Rhode Island Department of Health
3 Capitol Hill Room 209, Providence, RI 02908
401.222.7781
Steven.Boudreau@health.ri.gov
www.health.ri.gov

Connecticut

The CT DPH Drinking Water Section (DWS) is approaching climate change resilience for public water systems on two fronts. The DWS Compliance and Statewide Planning Units are working together to ensure supply adequacy at large community systems and encouraging regional interconnections for redundancy purposes which are particularly critical for the state's coastal communities. In addition, the DWS Source Water Protection (SWP) unit has requested that surface water systems voluntarily submit information on HABs to incorporate the data into the Department of Public Health GIS system to assist in assessing changing trends in algal outbreaks due to increased ambient water temperature. The SWP Unit is also developing two fact sheets on harmful algae blooms: one for utility assessment, management, treatment and testing and one for the general public from a public health perspective. The SWP Unit is also working with utilities on forest management best management practices to minimize the impact that storms may have on watersheds and water quality.

Massachusetts

Worcester Polytechnic Institute (WPI) students developed a screening tool to measure vulnerabilities of drinking water and wastewater plants. As of August 2013, the tool was not actively being applied to target any outreach, funding, etc. The tool uses parameters, such as location relative to 100-year flood plain and/or hurricane zones, history of past flooding, onsite power and discharge source (groundwater versus surface water) to assign points (0 to 100) to each water system. The score can be used by the system to gauge their overall vulnerability and identify weaknesses.

EPA Region 1 funded some vulnerability screening using GIS locations of water systems and 100-year and 500-year flood mapping. New England Water Works Association (NEWWA) will be overlaying GIS locations of water systems with the flood mapping and 3 ft. sea level rise to identify systems that are subject to flooding (on Cape Cod, hurricane mapping is being used). The most vulnerable systems will be targeted for training of climate change adaptation strategies. It is planned that training will be focused on small systems.

NEWWA will be conducting the climate change impact and adaptation trainings. NEWWA will review the WPI tool. The Drinking Water Program is not currently using the tool as it requires very site-specific information that the Program does not have. It is likely that NEWWA will walk through how to use the tool during the training and the systems can then plug in their site-specific information.

Future Projects include:

- Having discussions with system operators during sanitary surveys to help systems start thinking about what strategies they may need to implement to be prepared for climate change impacts.
- Incorporating climate change concepts and recommended adaptation strategies as checklists in Emergency Plans.

Maine

Currently, Maine is not officially studying or performing outreach on climate change impact or adaptation strategies. The state's previous administration, under Governor John Baldacci, had supported a law, which was passed, directing the Maine Department of Environmental Protection to create a climate change report. The report was completed in 2010 and had 60 recommendations for the state relating to climate change effects. The implementation of the plan has stalled under the current administration.

A bill was put forward in the most recent legislative session, L.D. 825, titled "Resolve, To Study Climate Change and Implement the Recommendations of the Department of Environmental Protection on Climate Change." The bill passed but was vetoed by Governor LePage. The legislature did not override the Governor's veto.

"Maine's Climate Future, An Initial Assessment" was completed in 2010 can be found at http://climatechange.umaine.edu/research/publications/climate-future.

Appendix C. DWGB 2010 Flood Survey Report

2010 Flood Impact Survey for Community Water Systems in New Hampshire

Prepared by:
New Hampshire Department of Environmental Services
Drinking Water and Groundwater Bureau
5/28/13-Final

Table of Contents

1. Introduction 1
2. Study Approach 1
3. Universe of Flood Related Impacts 1
   General Risk Issue Category 2
   Groundwater Well Related Questions 3
   Infrastructure Impact Related Questions 5
   Impact Related Expenditure Questions 6
   Survey Overview 7
4. Issues Identified 7
5. Recommendations 9
6. Bureau Activities 12

Figures:

Figure 1. Flood Risk Rating Map
Figure 2. Flood Risk Focus Map – South Central NH
Figure 3. Flood Impacted Water Supply Well Map

Note: the following Attachments are not included in this abbreviated copy of the report:

Attachment A Survey Monkey® Summary Table
Attachment B CWS Expenditure Related Response Table

1. Introduction

Over the last ten years, substantial flooding and rainfall events have resulted in 11 federally declared disasters for numerous counties across the state and impacted both private and public property. During these events, much of the focus on disaster related damage centers on property losses, road damage, travel limitations or prolonged electrical power outages. Community water systems however, are uniquely vulnerable to a flood because water system facilities are routinely located near surface water features that experience flooding. Impact to these facilities could impair the availability of safe drinking water for hundreds to thousands of consumers, even though many of those consumers may not be located within a flood impacted area.

The possible hazards that a flood poses to a water system vary widely and can be generally categorized as direct and indirect impacts. Direct impacts include flood water inundation of water system components that damages equipment, water supplies, pumphouses, booster stations, etc. Indirect impacts are associated with events that may disrupt water supply service, but do not damage the water system itself. Indirect impacts include prolonged power outages, exposure of distribution system piping at washed out roads and stream banks, or cutting off of access to critical components of the water system until flood waters recede. In reference to current climate trends, projections imply an increase in the frequency of high-intensity rainfall events; as such, flooding related threats to critical water supply infrastructure and water system consumers would, in turn, also increase.

2. Study Approach

A survey pertaining to flood related experiences was distributed to all community water systems in the state. The intent of the survey was to define the relative type, cause and cost to water systems that encountered flood-related impacts. The results of the survey will help guide changes to existing programs and administrative rules to improve water system preparedness and response to a damaging flood, and identify additional resources available to flood impacted water systems.

The survey conducted was a digital survey (Survey Monkey®) that was sent via email to owners and primary operators of all active community water systems in the state. The questions on the survey focused on flood impact experiences covering three general topic areas: groundwater well related issues; water system infrastructure related issues; and issues related to expenditures from historic flood impacts. The survey was developed by staff members of the Drinking Water and Groundwater Bureau at NHDES.

3. Universe of Flood Related Impacts

A total of 220 water systems responded to the flood survey, representing approximately 30 percent of the active community water systems in the state. Based on the detailed survey responses, it is clear that the results of the survey are limited by the varying

interpretation of the questions by respondents, lack of responses to some of the questions asked, and, occasionally, multiple respondents for a single water system with inconsistent responses. A bar plot summary of all the responses to all questions on a percent/count basis is provided as Attachment A.

General Risk Issue Category

Overall, 24 percent of respondents identified their system as being at either a high risk (10 systems) or moderate risk (44 systems) of having components of their water system susceptible to impacts from a flood. Descriptive responses from the ten systems that self-identified as *High* risk to flooding impacts stated their basis for the rating as having experienced routine or recurring flooding of their system sources or infrastructure (pump stations, treatment plants, etc.) during prior events. Most of the high risk respondents referenced the reason for the recurring flooded infrastructure being its close proximity to a river, stream or creek. Of the ten high risk systems, eight have water supply sources or facilities within the limits of a designated flood zone. Additionally, the majority of high risk systems were located in the southeastern portion of the state, consistent with the general statewide trend for the distribution of community water systems. Figure 1 depicts the extent of the respondent water systems and their self-identified risk rating. Figure 2 depicts a summary of responses from the south central portion of the state that highlights the relative risk rating and the proximity of facilities or sources within designated flood zones.

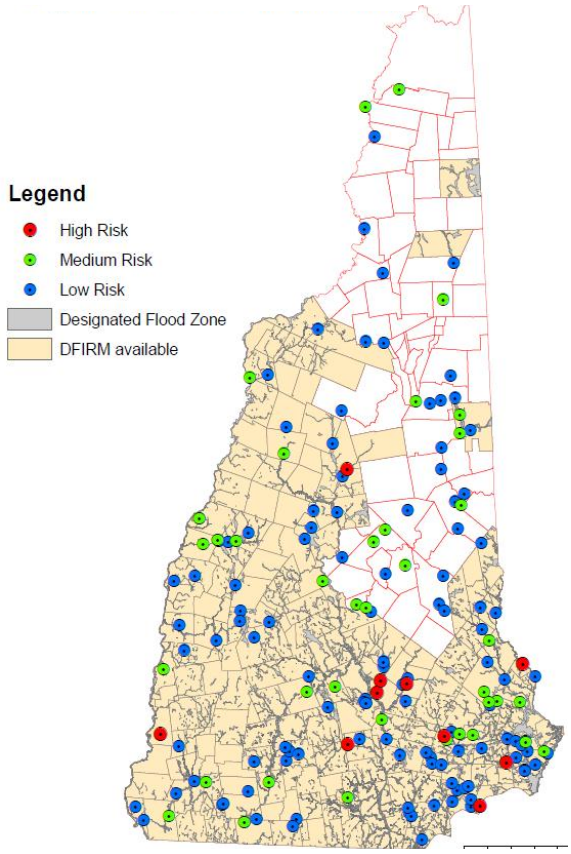


Figure 1. Statewide response to flood-related impact survey and self-identified risk rating.

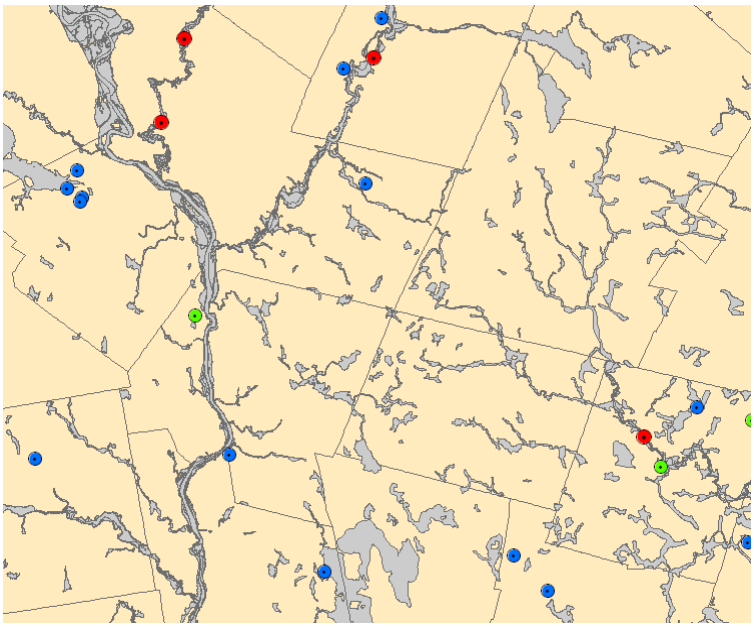


Figure 2. South Central NH. CWS risk rating
(blue is low, green is medium, red is high), gray denotes designated flood zone.

Groundwater Well Related Questions

Eighteen (18) systems (8 percent of respondents) having a total of approximately 50 active groundwater supply wells stated that one or more of their wellheads were either submerged, inundated or isolated by floodwaters during a prior flooding event (Figure 3). Thirteen water systems with 39 active groundwater supply wells are located in parts of the state where FEMA's Flood Insurance Rate Map (FIRM) coverage is available. Twenty-two of the 39 wells (approximately 56 percent) are present within the mapped limits of the 100- or 500-year flood zones and 17 are not. For comparison, of the total of 1,023 active groundwater wells for community water systems within FIRM coverage areas in the state, approximately 165 [16 percent] are located within the mapped limits of the designated 100- or 500-year flood zone.

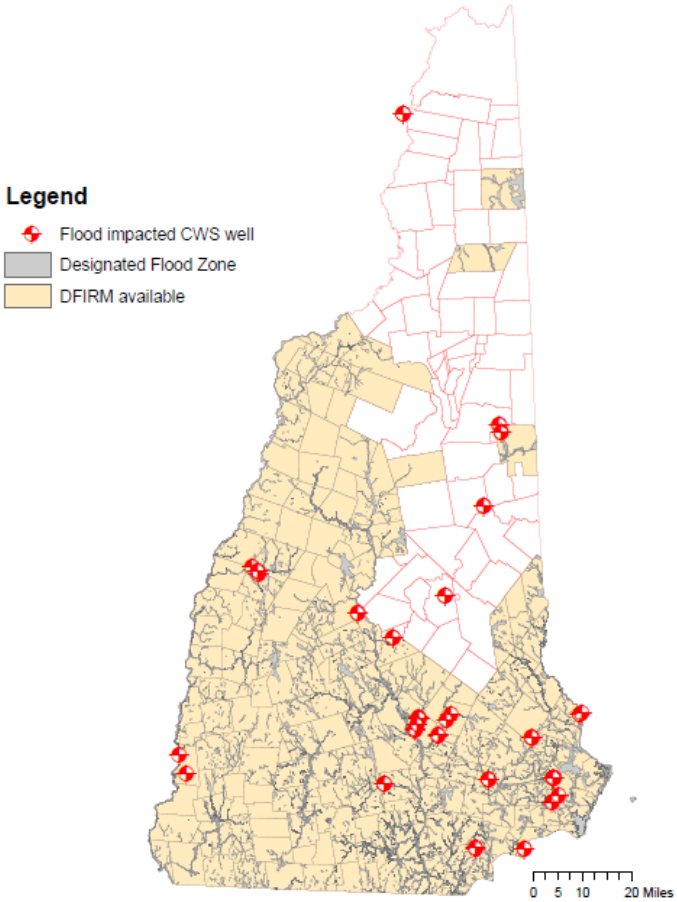
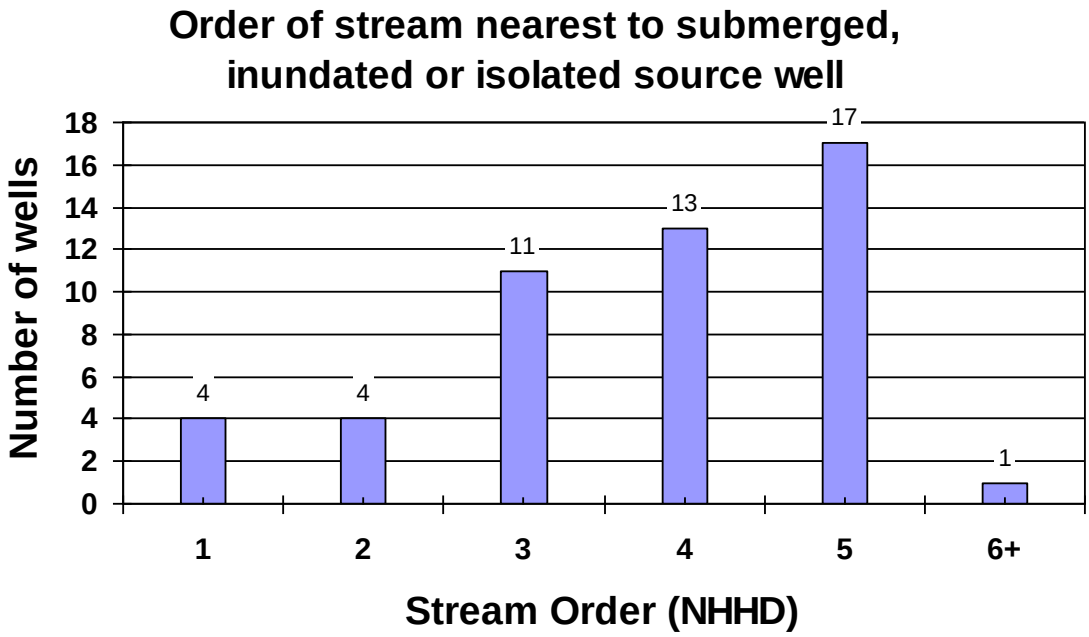


Figure 3. Locations of reported submerged, inundated or isolated water supply wells.

The most common cause of submergence, inundation or isolation of active wells was identified by respondents as being 'natural' over-bank flooding of a nearby surface water feature due to an extreme or continuous rain event, as opposed to flooding due to a nearby manmade constriction to surface water flow. Given that close proximity to a surface water feature was the more predominant cause identified for flooded source wells, the locations for each of the 50 identified groundwater well locations were reviewed relative to the nearest surface water feature using available GIS data. In general, the most prevalent surface water feature near these wells appeared to be a river or stream, usually at a distance less than 1,000 feet from the well[1]. The following graph presents a review of the stream order for the river/stream features nearest these 50 well sites (per the NH hydrography data layer).

[1] In general, hydrography data layers that contain location information on rivers, stream and lakes are completed at a larger, more detailed, mapping scale than national wetland coverage information.



Order of stream reach that was closest to a source well impacted by flood water.

As shown on the graph above, about 40 percent of the well sites appear to be closer to streams of 3rd order or less (and generally without mapped flood zones), indicating that flooding of source wells may not solely be attributable to 'big' river flooding and that the proximity to smaller tributaries of big rivers may play more than a minimal role in flood-related impacts. Of the 18 systems that had flood impacted wells, nine (50 percent) incurred expenditures related to those impacts (see below).

Infrastructure Impact Related Questions

Approximately 11 percent (24 systems) of the respondents stated that larger components of their system, other than sources, have been impacted by flooding. For those systems, flood damage to pump houses was the most commonly impacted component, although damage to distribution system piping was also noted (see below). Causes of impacts to pump houses most frequently were related to entry of floodwater into the pump house (or vault) due to natural over-bank flooding caused by higher than normal rainfall events. Individual comments from some respondents noted pump house damage due to a persistent power outage that prohibited sump pumps from operating in the facility, or backfilling of water into the pump house from a floor drain outlet located below the level of flood water. Of the 24 systems with the impacted facilities, 17 were in areas with FIRM coverage, and 9 of those 17 appeared to have facilities located within the mapped limits of the 100- or 500-year flood zone. Note that a detailed evaluation of the proximity of water system facilities to surface water features or flood zones is limited by the availability and locational accuracy of some of the GIS data layers for these facilities (see recommendation section).

Flood related impacts to distribution system piping was specifically identified by seven respondents. Six of the respondents were large municipally owned community water systems. The respondents stated that riverbank/roadbed washout or damage to waterlines exposed at river and stream crossings was the cause for impact. Of those municipally-owned community water systems that had impacted piping, all had experienced piping damage within the flood zone of and near larger, high-order rivers.

Impact Related Expenditure Questions

Twenty-three respondents stated that they have made expenditures over the last five years to rectify damage to their system due to flooding. Associated costs incurred by the systems reportedly ranged from $200 to $200,000 with a median expenditure of $10,000, and an average of $24,000. Review of the detail descriptions of impacts suffered by the systems identified that most impacts fell into three primary areas, as follows in order of most frequent to least:

- Repair and regrading of road bed and/or stream banks to protect water system piping exposed or un-bedded during a flood event. This work was done as a result of washout of roads or stream banks that reside within the limits of the distribution system, or river bed scour exposing and damaging a water line at a river crossing. Generally, moneys were expended on excavation, regrading, resurfacing and soil stabilization with the goal to cover exposed piping.
- Repair and reconstruction of wellhead [well casing], well piping or recovery of the area around the well. Soil erosion/washout caused by submergence of land around the wellhead by floodwater exposed both the casing and well water supply line and compromised the sanitary seal at the wellhead. Work to address this issue entailed performing associated regrading and slope stabilization work and, in some instances, elevating of wellhead casing and water supply piping.
- Repair and replacement of floodwater damaged equipment. The types of equipment identified as being damaged included: pump controls and drives, sump pumps, pumphouse heating and dehumidification systems, and treatment units. Note that not all respondents indicated direct impacts from flood water, rather, prolonged electrical power loss to facilities and concomitant inoperable sump pumps were sometimes noted as the cause for water damage.

Of the 23 respondents, 16 systems happen to be in areas with FIRM coverage and at least seven of these systems either have a source or facility within the mapped limits of the 100- or 500-year flood zone, although most of the respondents likely have piping within these zones also. It should be noted again that this evaluation is limited by the availability and locational accuracy of water system components and piping maps at the time this survey was completed. See Attachment B for individual responses to expenditure related issues.

Survey Overview

The general results from the survey indicate that the majority of water systems in the state have not experienced a flood-related impact over the last five years; however, about one quarter of the systems in this survey identified themselves as having more than a minimal risk of being impacted by a flood. Prior impacts are from over-bank flooding from a nearby stream or river appear to be the driver for the higher risk rating at some systems, and some of the reported impacts imply that some components of water systems may not be well positioned to be resilient to a flood event.

Proximity or presence of a designated flood zone near water system sources or infrastructure appears to be a good relative indicator of the potential for flood related impacts as over half of the impacts reported are located in designated flood zones; however, using prior experience in conjunction with flood zone mapping would be the better predictor of impact risk. Water supply wells were subject to flood waters from a broad size range of rivers/streams and incurred damage due to their flooding in about half of the cases reported. Flood impact related expenditures were most commonly made to fix damaged or exposed distribution system piping as compared to other components of the water system.

The table below summarizes the survey results for the three general topic areas addressed by the 220 respondent water systems:

Self-Identified Flood Risk		
High	Medium	Low
10 (4%)	43 (19%)	176 (77%)
Number of Systems that experienced:		
Submerged, Inundated or Isolated Source Wells	Inundated or isolated pumphouses or treatment facilities	Damaged distribution system piping
18	23	7
Relative Cost to Water System to Address Impact to:		
Sources	Pumphouses/Facilities	Distribution System
$	$$$	$$*

* Impacts to distribution piping were the most frequently reported flood impact that resulted in expenditure.

4. Issues Identified

Based on the survey results, discussions with flood impacted water systems, and discussions with both NH Homeland Security Emergency Management [HSEM] and DWGB staff, major issues identified by NHDES are:

- While DWGB (NHDES) and HSEM work together during emergency events, drills and exercises routine meetings are not held between the agencies to review cross-program issues that are not in the context of a crisis or natural disaster.

- Geographic Information System (GIS) data layers for public water system (PWS) infrastructure (e.g. sources, piping, facilities, etc.) contains data that is of low accuracy or is partial, outdated and/or not updated on a fixed schedule, or may not exist for some water system components. In 2010, DWGB staff completed a review of water system related GIS data and concluded that significant inaccuracies exist for the locations of over 1,200 water system sources, specifically identifying the likely derivation of low-accuracy locational data in the GIS system. This review developed a program to improve the accuracy of poorly located water system sources that included an implementation strategy using existing staff.

- Water systems in the state have not completed vulnerability assessments specific to flood impacts (this is equally true for potential sea level rise impacts in the case of some coastal communities). Town-specific hazard mitigation plans [HMPs] that are necessary for participation in the federal Flood Insurance Rate program [FIRM] are generally done by regionally-focused entities (e.g. planning commissions). These plans do not always include system-specific flood impact hazard assessments for water system infrastructure (or impacts of sea level rise in the case of coastal communities);. Additionally, current emergency plan requirements for water systems are intended to be respondent in nature and do not serve as potential impact assessment tools.

- Some provisions of the current water system design rules need revision to better establish design criteria that minimizes or prevents impacts to a water system from a flood. Generally, existing design criteria for small community water systems are substantially less stringent than the large water system design standards that pertain to minimizing impacts from floods. As an example, small community water supply systems and systems that serve as designated emergency shelters are not required to establish backup power service for the water supply system.

- Some water system design criteria that pertain to ‘hardening’ water system infrastructure to better withstand damage from flooding may not be consistently enforced by NHDES staff. Exposed water system piping at river crossings, reports of supply wells submerged by flood water, and use of sump pumps in pumphouses are examples of recorded or reported items that do not comply with current water system design requirements, yet persist at some systems.

- No formal protocol is followed or post-event review process is conducted by NHDES staff for those systems that were impacted during a flood to assess the nature and cause of the flood’s impact on the system. Similarly, HSEM disaster area declaration notices get sent directly to state agencies and local emergency management directors and not directly to public water systems and NHDES has no fixed protocol in place following a disaster declaration to directly inform water systems in the declaration area that federal resources may be available to assist with recovery of disaster-related impacts.

5. Recommendations

The following recommendations were developed based on the results of the survey, discussion with NH Homeland Security Emergency Management (HSEM) staff, discussions with impacted water systems, input from DWGB staff, and review of administrative rules.

Recommendation 1: *DWGB and HSEM staff should coordinate a meeting on a recurring annual or semiannual basis to discuss experiences with flood impacts and responses, and review any programmatic or procedural changes to the federal or state flood relief programs* or participate in after action meetings Each agency could benefit from more direct interaction regarding communications on flood impacts to 'close the gap' of knowledge about water system issues and agency programs/objectives that are in place to assist impacted systems.

Recommendation 2: *Increase the completeness, accuracy and maintenance schedule of the GIS data layer for water system sources and facilities; and develop new GIS data layers for water system components not yet present in any layer*. The proximity of water system components (sources, pumphouse, piping, etc.) relative to a designated flood zone is a reasonably good indicator of flood impact risk. As such, a tool in assessing potential flood impact risk is an easily referable, up-to-date and accurate digital GIS data layer that depicts the location of water system components and allows for comparison against digital flood zone maps. DWGB has previously developed a mechanism to improve the locational accuracy of water system sources; this program should be expanded to include all water system components.

- Staff/program responsible to implement recommendation: SWP/Engineering & Survey/IT
- Completion timeframe: Three years (2015)

Recommendation 3:
1. Using GIS spatial data, conduct an assessment to identify where water system sources or infrastructure overlap with designated flood zones and identify systems potentially at risk of flood impacts.

2. Develop a Vulnerability Self Assessment Survey specific to flood impacts and distribute to the identified 'at risk' water systems. For those systems that do not complete the vulnerability assessment survey, DWGB should complete it in coordination with the system personnel during a scheduled system survey or as part of a separate effort.

Digital flood zone maps and water system layers provide for a method to readily identify water systems with sources or any other major system component within the limits of the designated 100- or 500-year flood zones. A vulnerability assessment survey for these 'at risk' systems is a way to highlight a system's relative degree of exposure to impacts from a flood event. Examples of the type of information included in the vulnerability assessment would be a review historic flood impacts, a system design deficiency

inventory, a piping system isolation device inventory, a description of backup power capabilities and redundant fixed assets, an equipment inventory, and other related items.

- Staff/program responsible to implement recommendation: SWP/ Emergency Planning
- Completion timeframe: One to three years

Recommendation 4: *Conduct a 'focus area' assessment for flood impact risks to water systems in coastal communities.* Current trends in rising sea level imply that more land area in coastal towns will be inundated with sea water during future tidal surges. Additionally, sea level rise would raise the elevation of the shallow groundwater table in coastal areas and, when coupled with high intensity rainfall events, expand coastal flood plain areas along coastal river systems. Water system infrastructure in coastal towns could therefore be more susceptible to flood-related impacts.

- Staff/program responsible to implement recommendation: SWP/ Emergency Planning
- Completion timeframe: One year

Recommendation 5: *Conduct an assessment for flood impact risks to water systems in the Lamprey River Basin with recently updated flood mapping tools.* Updated Light Detection and Ranging (LiDAR) data and recent precipitation data were used to revise base flood zones within the Lamprey River basin. Improved GIS layer data for water system components should be overlain with updated flood zone maps from FEMA (once issued) to assess flood risk in the basin and inform water systems of their potential for impacts.

- Staff/program responsible to implement recommendation: SWP/ Emergency Planning
- Completion timeframe: One year

Recommendation 6: *Amend existing large and small community water system design standards to incorporate criteria focused on hardening infrastructure to minimize and avoid impacts from a flooding event.* Standards related to elevating the grade of system components above the base flood elevation, maximum isolation device spacing distance criteria, minimum depth criteria for waterlines at river crossing, and provisions for minimum backup power capacity greatly reduce the degree of impact a water system might experience during a flooding event and minimizes the threat such impacts pose to the public health.

- Staff/program responsible to implement recommendation: Engineering & Survey
- Completion timeframe: One to two years

Recommendation 7: *Initiate additional outreach efforts to promote expansion of backup power capacity at water systems.* In addition to ensuring water service to consumers, having backup power available at a water system could protect vital water system components and equipment that may otherwise be vulnerable to inundation by flood water. At many mid-size to small water systems, the cost to equip a system's facility

building or sources with backup power are relatively low when compared to the cost of potential equipment damages/losses.

- Staff/program responsible to implement recommendation: Emergency Planning
- Completion timeframe: One year

Recommendation 8: *Modify the water system survey to include review of flood impact readiness for those systems with infrastructure within designated flood zones*. The water system survey conducted every three years by DWGB staff presents an opportunity to evaluate a system's preparedness for flooding and gauge its degree of compliance with appropriate design standards. The survey can review flood impacts at the system over the three year period, observe current conditions of infrastructure within the flood zone, and confirm backup power system capacity.

- Staff/program responsible to implement recommendation: Engineering & Survey
- Completion timeframe: Immediate

Recommendation 9: *Develop a formal process to be followed by DWGB staff following report of a flood impact at a water system. The process should include a detailed evaluation of the cause, nature and extent of the flood impact, a review of temporary measures to address the impact and an assessment of the system infrastructure that failed or was otherwise vulnerable to impacts to flood waters.* A post-impact assessment process will enable DWGB staff to provide the water system with state HSEM office contact information, and ensure the system is notified of federal disaster relief recovery resources if made available. The post impact review will also aid staff in ensuring that compliance with water system design standards are being met upon reconstruction of impacted facilities or infrastructure.

- Staff/program responsible to implement recommendation: Engineering & Survey
- Completion timeframe: Immediate

Recommendations 10: *Perform a co-occurrence evaluation for water system infrastructure in areas mapped as high soil erosion potential.* The results of a current project being completed by NH Geological Survey to map high, very high and extreme soil erosion potential in the state can be overlaid with water system GIS data layers to assess for potential risk of impact at water systems. DWGB staff can then use this information to target outreach efforts to water systems with assets in these areas to complete a vulnerability assessment and provide guidance to assist in long-range planning efforts to reduce risk.

- Staff/program responsible to implement recommendation: Engineering & Survey
- Completion timeframe: Ongoing

Recommendation 11*: Provide Hazard Mitigation Plan [HMP] development guidance to appropriate planning authority*. In accordance with HSEM/FEMA requirements, a town must have an HMP in order to be eligible for available disaster relief funding; in general,

regional planning commissions complete the HMPs on behalf of their member towns. DWGB should implement an outreach program in coordination with HSEM to regional planning commission staff/towns to ensure adequate consideration of water system vulnerabilities and needs within HMPs.

- Staff/program responsible to implement recommendation: SWP
- Completion timeframe: Two years

6. Bureau Activities

In light of the recommendations above, the following list summarizes DWGB program efforts that were either in-place, expanded or initiated as a result of the flood survey:

- DWGB's emergency response contact distributes notification letters directly to water systems in federally declared disaster areas. The notifications informs the systems of the disaster declaration, provides general guidance and contacts for the bureau and FEMA, and identifies FEMA related disaster relief grant information and deadlines that are linked to the declaration. Notifications regarding other hazard mitigation funding opportunities are also distributed as they become available.
- Technical survey staff have expanded a program initially started to improve the location accuracy for approved water system sources and update related GIS layers to include obtaining locations for pumping facilities, treatment facilities and water storage facilities.
- A three-year grant program (completed in 2009) either put-in-place or expanded backup power supply capacity at over 30 water systems. As a follow up, DWGB funded a generator needs assessment study in 2011 that developed design specifications and system plans to install backup power generators for 78 water systems.
- Notification letters were sent to seven water systems that have piping, sources or facilities within areas mapped by NHGS as having high, very high or extreme soil erosion potential. The letters suggested that the systems take action to abate and reduce impact potential in erosion prone areas and included pertinent contact information for programs and resources available to water systems. Further notifications are planned as more Fluvial Erosion Hazard maps become available.

Appendix D. 2013 Survey – CWSs and Extreme Weather Events

Survey Results
Community Water Systems and Extreme Weather Events
NHDES Drinking Water & Groundwater Bureau 2013 Survey

A survey was developed to obtain information from community water system representatives. The objective of the survey was to elicit information on impacts that CWS are experiencing and also to gauge the level of concern towards current and future impacts. The survey was designed to collect the following information:

- Current experiences with extreme flood events (wind, snow and ice storms, flood, drought, water quality).
- Perceptions of the threats to drinking water systems due to climate change.
- Needs for education, outreach and technical assistance related to climate change impacts.
- Names of system representatives interested in assisting in outreach on climate change adaptation strategies.

The survey used both multiple choice and priority ranking questions, with the intent that qualitative data could be obtained through open-ended questions. Survey Monkey was used for survey development and distribution. The survey was sent to 614 representatives of small and large community water systems. Consequently, there may be more than one response for some systems. The initial survey request was sent on August 2, 2013 and responses were collected through August 23, 2013. Two hundred (200) surveys were completed, 19 of which were partially completed. Graphical presentations of some of the questions are included in the pages immediately following this summary.

Eighty-three percent of respondents used groundwater as their source, 17 percent used surface water. According to the survey results, severe weather is impacting many community water systems in New Hampshire. Seventy eight (78) respondents (43 percent) notice increased impacts to CWS from storms. This was the most significant weather event cited for impacts to drinking water systems (groundwater and surface water). Almost all of the 61 comments that were made in response to this question indicated that power outages have been occurring during storm events.

Twenty seven (27) respondents (15 percent) noticed increased impacts from flooding of access roads (33 percent of surface water respondents). Twenty nine (29) noticed other flood related impacts affecting their systems or operation of their systems, including: road washouts, pump house flooding, exposed water mains or impacts to intakes. Additional survey results are tabulated in the following pages.

Roughly half of survey respondents indicated that they would appreciate assistance from the DWGB on information about expected trends in extreme weather events and how they would impact water systems, examples of projects undertaken in New Hampshire to reduce the impacts of climate change, assistance in evaluating the vulnerability of their systems to extreme weather events, and assistance in developing a plan to reduce vulnerabilities of their systems to extreme weather events.

By reviewing the responses of each individual, the DWGB can begin to identify some of the concerns, threats and needs for technical assistance for individual water systems.

SURVEY OF COMMUNITY WATER SYSTEM CONTACTS
AUGUST 2013

HIGHLIGHTS (8/23/13 draft)

614 invited to participate
200 responded (171 groundwater only + 24 surface water only + 5 GW and SW)

Severe weather is affecting many NH community water systems.

78 respondents (43 percent) notice increased impacts to CWS from storms (59 percent for surface water)

- Trees (15)
- Power outages, generator (10)
- Blocked (9)
- Ice storm (5)

13 (48 percent) surface water systems notice increased water quality impacts (algae, pathogens, turbidity)

27 (15 percent) notice increased impacts from flooding of access roads (33 percent for surface water)
29 (16 percent) notice other flooding impacts (41 percent for surface water)

- Road washouts (5)
- Pump house flooding (4)
- Exposed water main (3)
- Intake, surface water treatment (3)

25 (14 percent) notice increased impacts from extended dry periods (19 percent for surface water)

19 (10 percent) notice substantial increases in water use due to higher temps, less rainfall (7 percent surface water)

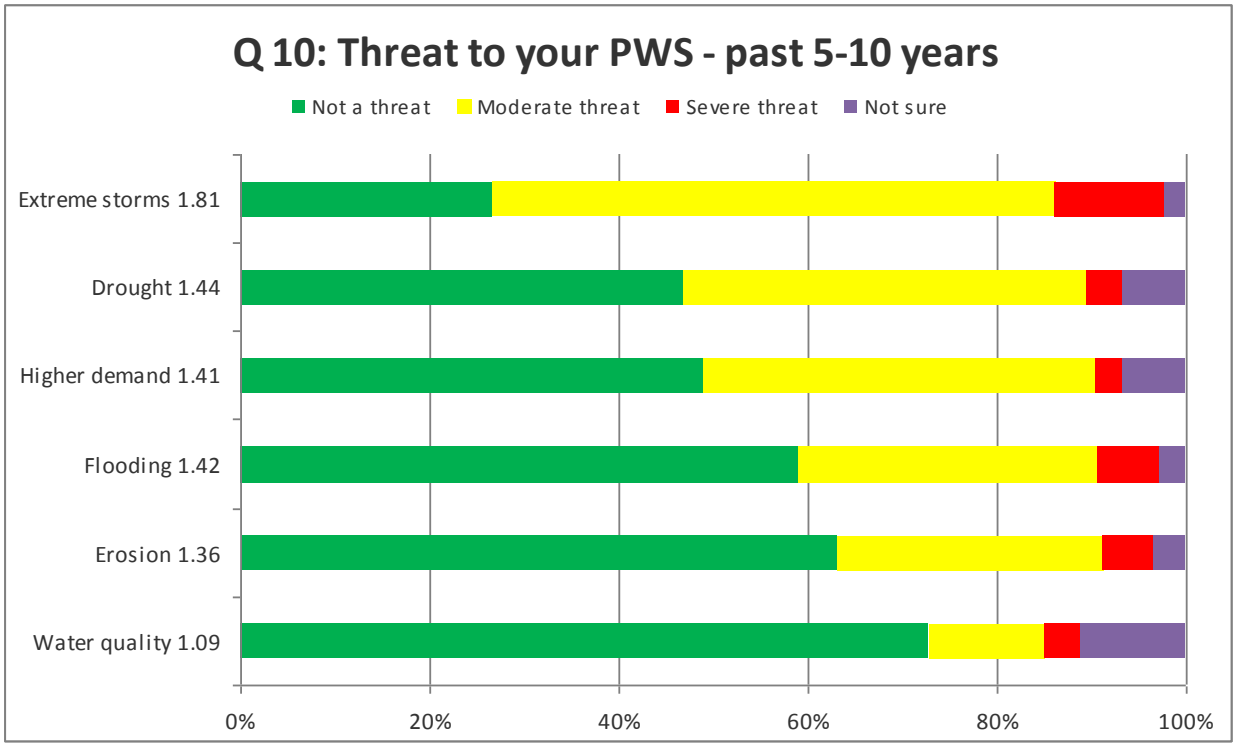
52 (29 percent) have made changes or equipment purchases as a result of actual or anticipated increase in extreme weather (48 percent for surface water)

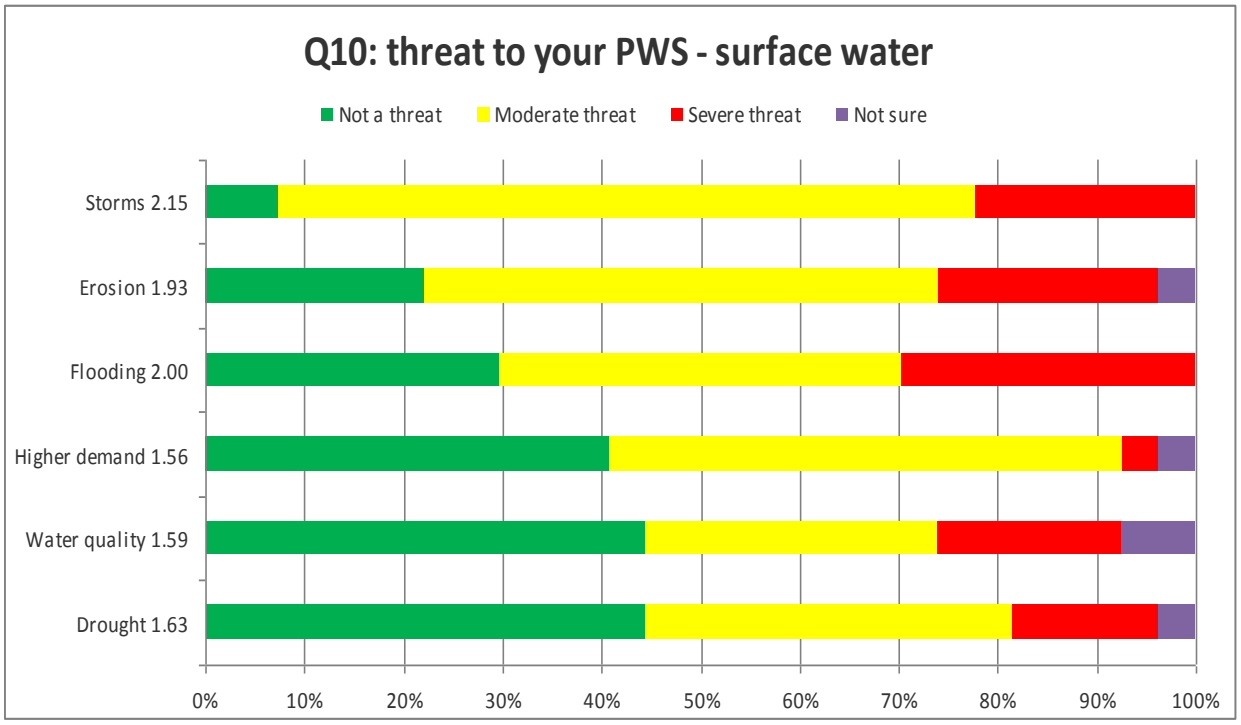
- 27 (14 percent) generator and/or other power supply
- 13 (7 percent) changes to intake and/or treatment
- 8 (4 percent) flood proofing, stormwater mgmt.
- 4 (2 percent) new or deepened source

8 (5 percent) of GW-only systems notice increased water quality impacts

<u>Majority of respondents see severe weather as moderate or severe threat (mostly moderate) to their systems.</u>

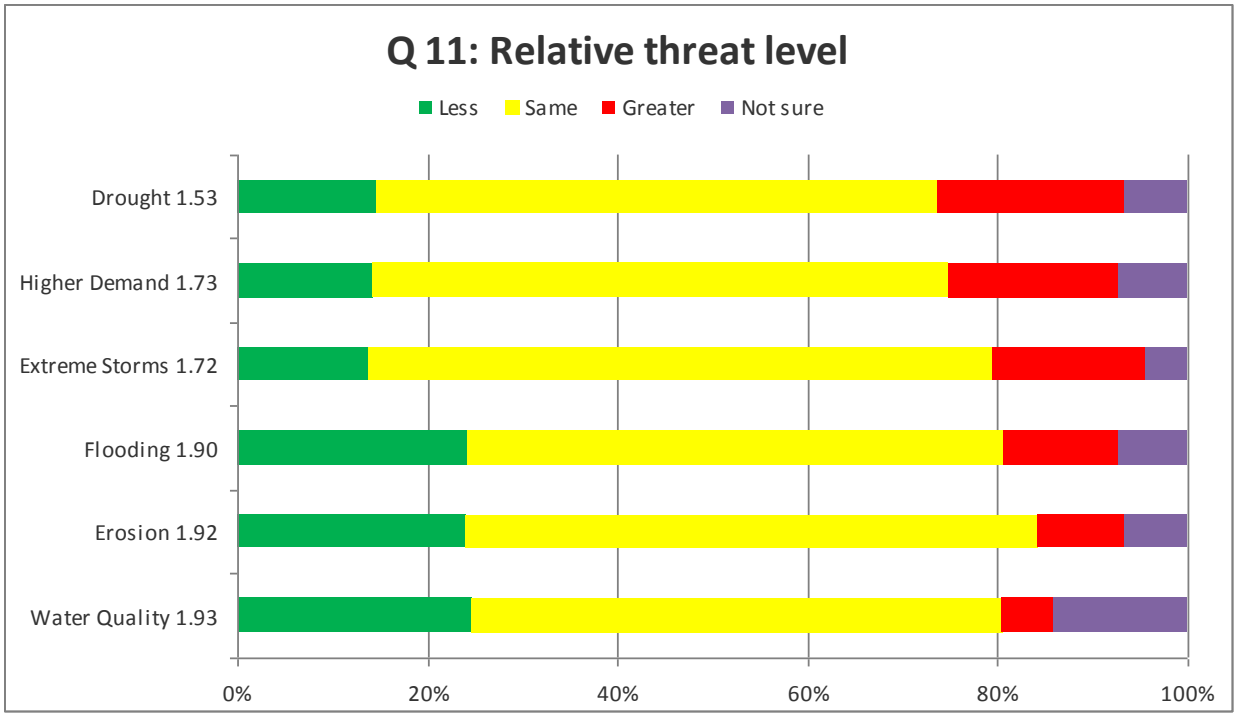
RECENT PAST Weather Patterns - - How would you rate the threat to your public water system(s) posed by extreme weather events experienced over the past 5 to 10 years +/-?

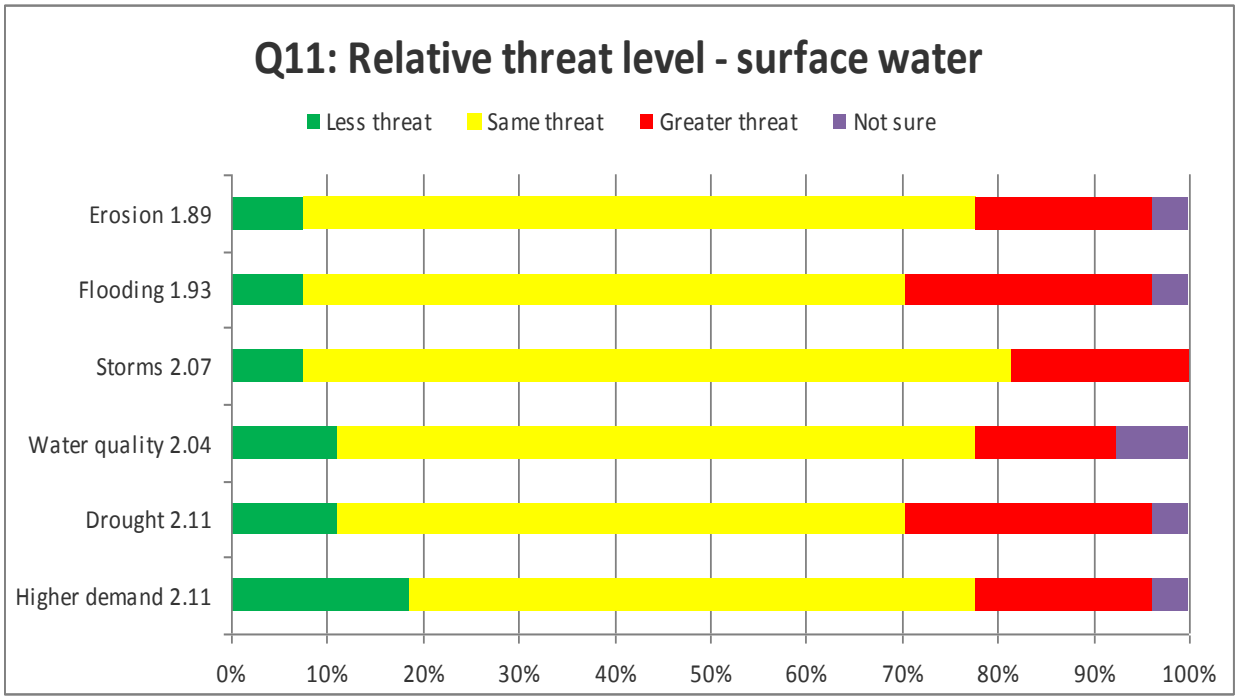
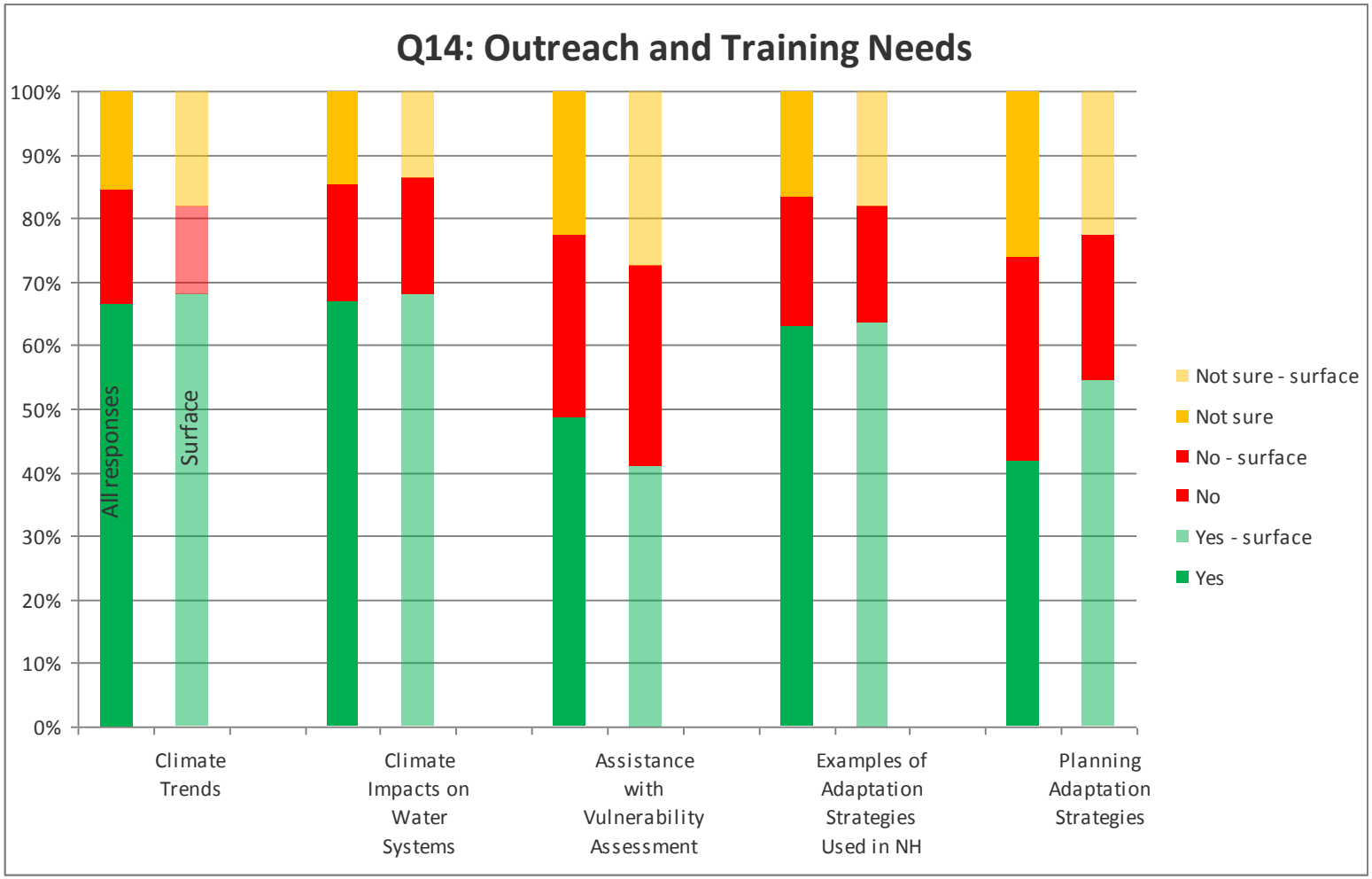




<u>Many see the threat increasing, but most see it as similar to what it has been recently.</u>

FUTURE Weather Patterns - Relatively to recent conditions, how would you rate the threat to your public water system(s) posed by extreme weather events that are expected to occur in the future due to a changing climate?





Outreach and training opportunities