

KEENE, NEW HAMPSHIRE

Adapting to Climate Change: Planning a Climate Resilient Community

November 2007

Prepared by:



In association with:



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Executive Summary

Keene has a long, steadfast history of climate protection. In April, 2000, the City signed onto the Cities for Climate Protection Campaign® (CCP), administered by ICLEI—Local Governments for Sustainability (ICLEI). Since agreeing to participate in the CCP Campaign, the City of Keene has developed a Local Action Climate Plan to identify ways in which the greater Keene community can assist in lowering greenhouse gas emissions. The City, lead by its CCP Committee, has developed processes and implemented projects to ensure that they are on track to meet their greenhouse gas emissions reduction goal of 10% below 1995 levels by 2015. Keene reaffirmed this commitment in its Community Goals of 2003.

Despite the City's commitment to mitigation, the impacts associated with a changing climate are already being felt in Keene. From more frequent and severe flooding, to changes in annual snowfall amounts, to the infestation of non-native plant and animal species, to the increase in total number of high heat index days and more numerous poor air quality days, the City has come to recognize that these changes are ultimately impacting the community's built, natural, and social environments.

To address these changes, the City of Keene has committed to expanding their climate protection efforts to include climate adaptation. Keene is working with ICLEI to develop a Milestone process, similar to the CCP Program, specifically designed to assess the community's vulnerability to these climate impacts and establish a methodology to enhance its resiliency to them.

ICLEI's Climate Resilient Communities™ (CRC) Milestones process is designed to focus on three key community systems: the built, natural, and social networks that collectively provide the key services or activities within a community or region. Working within these three systems, there are five key milestones to creating a climate resilient community:

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

Keene has a long, steadfast history of climate protection.

Keene is the first community to complete Milestones One through Three as a pilot city for ICLEI's CRC Program¹. This document represents the Third Milestone in ICLEI's process. It begins with an overview of why planning for adaptation is important to communities; provides a brief synopsis of the CRC Program and how Keene came to be a pilot community; and highlights the Five Milestones and the process through which

ICLEI facilitated Keene's CRC Committee. Section II reviews climate change impacts and science, and highlights expected impacts in the Northeast and more specifically in New Hampshire. Section III reviews the identified community vulnerabilities in relation to climate change predictions for Keene. Section IV identifies goals and targets that the City government can pursue to create a more resilient community. Section V proposes how Keene can move forward in implementing this plan and its other climate change goals. This section identifies the need for appropriate staffing and organization, and combining mitigation and adaptation efforts, as well as further work to identify which

targets to pursue first and how to finance those efforts. Section VI focuses on lessons learned in this process in the hopes of providing additional guidance to other communities as they embark on climate change adaptation planning.

The purpose of this document is to:

- Aid Keene’s progress in enhancing its resiliency to the impacts associated with climate change, and in its overall planning protection efforts.
- Highlight ICLEI’s Climate Resilient Communities Program process.
- Offer an example to other communities to learn from as they embark on their adaptation planning efforts.



It is important to note that this document represents the first time that a community has attempted to undertake the development of an adaptation plan based upon ICLEI’s Five Milestones CRC Process. It is not an exhaustive planning exercise and should not be represented as such. Much of this document lays the foundation for Keene to move forward with a public process and further refinement of its climate change and overall sustainability goals.

Another important process Keene is preparing for is a comprehensive master plan update, wherein the City, community members, and other local and regional stakeholders will play a major role in setting the course for Keene’s future. This Adaptation Plan should be utilized in that process and incorporated accordingly into the comprehensive master plan in order to provide the climate lens necessary to coordinate policy, make land use decisions, identify capital improvement projects, and establish funding priorities.

Footnotes for Executive Summary

¹ Fall, 2007 marked the release of *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (the *Guidebook*) written by The Climate Impacts Group, King County, Washington, in association with ICLEI. This document is another excellent source for communities that are contemplating climate adaptation planning. Keene’s participation with ICLEI as a pilot community was simultaneous with the creation of the *Guidebook* and thus the CRC Committee was not able to refer to the *Guidebook* as the group navigated their way through this process. It is highly encouraged that the Milestones process and the *Guidebook* be utilized by communities as complementary documents throughout their climate adaptation planning work. Communities will need to formulate and tailor the adaptation planning process specifically to their needs, available staffing and resources, and other relevant factors.

Section I: Why Plan to Adapt to Climate Change?

Humans are altering the earth's atmosphere, causing changes in global climate that will affect our environment and communities for centuries to come. There are many indications that these changes are already underway: temperatures are rising, glaciers are retreating, snowpack is disappearing, spring is arriving earlier, the ranges of plants and animals are shifting, and seas are rising. Within a handful of decades, climate in many parts of the United States is expected to be significantly warmer than even the warmest years of the twentieth century, increasing the risk of drought, flooding, forest fires, disease, and other impacts across many regions.

We have a critical opportunity—and need—to start preparing today for the impacts of climate change, even as we collectively continue the important work of reducing current and future greenhouse gas emissions. If we wait until climate change impacts are clear to develop preparedness strategies, we risk being poorly equipped to manage the economic and ecological consequences, and to take advantage of the potential benefits.

Preparing for climate change is not a “one size fits all” process. Just as the impacts of climate change will vary from place to place, the combination of institutions and legal and political tools available to public decision-makers are unique from region to region. Preparedness strategies will need to be tailored to the circumstances of different communities. It is therefore necessary that local, regional, and state government decision-makers, like those in Keene, NH, take an active role in preparing for climate change, because it is in their jurisdictions that climate change impacts are felt and understood most clearly¹.

Increases in the variability of weather patterns and in the frequency of extreme weather events are already occurring across the country and in the Northeast. As changes in climate occur, it is expected there will be significant impacts to the various components that comprise the built, natural, and social environments within municipalities. This means that roadways, bridges, flood and stormwater control systems, forests, watersheds, public health systems, buildings, and other aspects of our communities will be affected in both positive and negative ways. In order to ensure that communities are able to effectively deal with the expected impacts from climate change, they must first understand how the climate will change in their particular locale, identify how the community could be impacted by those changes, and then identify the steps they can take to adapt to the anticipated impacts. Planning to adapt to the impacts of climate change can help communities save money, make better long-term decisions, and influence policies and incentives that foster climate mitigation and adaptation efforts. Ultimately, climate change adaptation planning can help protect people, property, and resources that are essential to community sustainability.

Addressing climate change on any level requires a balance between the actions necessary to reduce greenhouse gas emissions (mitigation) and the actions necessary to adapt, or become resilient (adaptation), to climate change impacts. Keene has already taken the first step by pledging to reduce its community-wide carbon footprint by 10% by the year 2015. Implementation of the Cities for Climate Protection Action Plan (CCP Action Plan) is already underway. By participating in the CRC Program, Keene is well positioned to take the next steps to increasing the community's overall ability to plan for, and respond to, climate change impacts.

Climate Resilient Communities Program

In July of 2006, ICLEI – Local Governments for Sustainability (ICLEI) approached the City of Keene to become the first municipality to participate in a climate adaptation initiative, the Climate Resilient Communities Program. Keene was chosen by ICLEI to pilot the new program due to the City’s proactive approach to addressing the issue of climate change, its hazard-mitigation and disaster preparedness efforts, and in response to Keene’s major flooding event in 2005.



ICLEI’s CRC Program recognizes that communities are beyond the point of addressing climate change solely through greenhouse gas reduction efforts. The CRC Program assists local governments in assessing community vulnerabilities associated with local climate change impacts, prioritizing those vulnerabilities, and then effectively identifying solutions to adapt. In Keene, such advance preparation will be very beneficial. The

adaptation focus of the CRC Program will enable Keene to include climate preparedness strategies into its comprehensive master planning efforts and capital improvement projects, ultimately providing a mechanism to reduce the impact of climate induced changes to the built, natural, and social environments.

It is important to note that the City embarked upon this project prior to the finalization of ICLEI’s

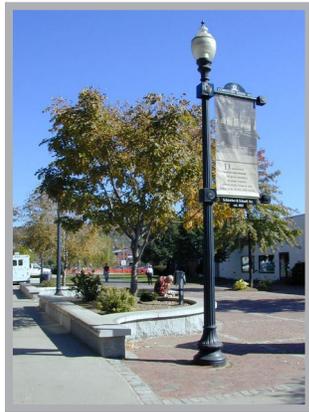
Milestones process, and before the issuance of King County, Washington’s climate change preparation guidebook. It is recommended that municipalities refer to this document as an early example of adaptation planning to learn how Keene maneuvered through the process, as well as to improve upon it and adjust it to specific community needs.

We have a critical opportunity—and need—to start preparing today for the impacts of climate change, even as we collectively continue the important work of reducing current and future greenhouse gas emissions.

The Climate Resilient Communities Adaptation Planning Process

Similar to the CCP Campaign, ICLEI developed a Five Milestones process to guide local governments through assessing vulnerabilities and identifying strategic opportunities to increase resiliency. Keene's participation was geared towards testing the CRC Program process to refine it for further use by other communities. Piloting the process also allowed Keene to begin a dialogue with City staff and the community about local climate change impacts and how to respond by creating a more resilient community.

The first step was to convene a CRC Committee. The Committee would identify climate change impacts, identify community vulnerabilities and opportunities to those impacts, and establish goals and targets to achieve resiliency. Keene's CRC Committee



consisted of the Mayor, City Manager, department heads, City Council members, and representatives from the college community, CCP Committee, Southwest Region Planning Commission, and stakeholders from the public health field. This group was supported by ICLEI and the National Oceanic and Atmospheric Administration (NOAA) Regional Integrated Sciences and Assessment (RISA) staff.

Once formed, the CRC Committee began the process of identifying Keene's vulnerabilities to climate change, which is Milestone 1. During the pilot program with ICLEI, the CRC Committee worked primarily on Milestones 1 and 2. This document is the beginning of Milestone 3, but more work is needed to fully complete the process, which is identified as an action in the implementation section of this document. With dedicated staff and resources, the City's adaptation planning efforts will continue to evolve over time and will be revisited to ensure continued progress.

ICLEI's CRC Five Milestones² are:

1. Conduct a Climate Resiliency Study
2. Prioritize Areas for Action and Set Goals
3. Develop an Adaptation Action Plan
4. Implement the Action Plan
5. Monitor, Evaluate, and Update the Plan

The following is an overview of each milestone and the CRC Committee's process through each step.

MILESTONE 1: CONDUCT A CLIMATE RESILIENCY STUDY

Through the CRC Program, ICLEI worked with Keene to gather region-specific climate impact data and reports for use in developing climate preparedness strategies. Sources of information on climate impacts included NOAA RISA offices, the Union of Concerned Scientists (UCS), University of New Hampshire staff, and other regional climate groups. In addition, the CRC Committee reviewed internal City planning and policy documents. ICLEI facilitated several meetings of the Committee to satisfy this first Milestone.

Meeting 1: Climate Science Education

To accomplish Milestone 1, Committee members reviewed *Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts* prepared by the UCS (October, 2006). The CRC Committee also reviewed the projected climate impacts for Keene prepared by ICLEI and NOAA staff based on EPA data. The list of local climate impacts was later used to guide discussions and assist the CRC Committee in identifying specific actions, goals, and targets the City could implement to adapt to climate change.

ICLEI staff also prepared and presented to the CRC Committee other national climate change studies and information to help educate and ensure a consistent understanding of the topic amongst the group. By taking the time up front to discuss the issues of climate change, the CRC Committee was able to understand the language used and to effectively communicate about climate change and the adaptation effort with which they were tasked.

Meeting 2: The Climate Lens: Identification of Keene's Vulnerabilities

The CRC Committee members evaluated their roles and responsibilities within City government and/or the community. Then each member revisited that evaluation through a "climate change lens." By assessing their roles against the identified climate impacts they learned about in Meeting #1, combined with local knowledge of existing climate vulnerabilities, the group was able to identify ways in which Keene might be vulnerable to climate change.

The Committee determined that the community's vulnerabilities could be grouped into three main categories, or sectors: the Built Environment, the Natural Environment, and the Social Environment. The Built Environment consists of man-made infrastructure within the City, such as buildings, and transportation and stormwater

Table 1: Keene's Identified Vulnerable Sectors and Subsectors

Built Environment

- Buildings & Development
- Transportation Infrastructure
- Stormwater Infrastructure
- Energy Systems

Natural Environment

- Wetlands
- Groundwater
- Agriculture

Social Environment

- Economy
- Public Health
- Emergency Services

infrastructure. The Natural Environment are those naturally occurring resources within the City consisting of wetlands, flora, and fauna. The Social Environment focuses on the areas that impact human life, such as the economy and public health. These sectors were then further categorized into sub-sectors.

Within each sub-sector, specific vulnerabilities were identified and are listed in Table 1. In doing this exercise, it became clear that many sub-sectors shared similar vulnerabilities.

Meetings 3 and 4: Identifying Goals and Targets

In two subsequent meetings, Committee members identified goals and targets that Keene could pursue to increase “adaptive capacity”—the community’s ability to adjust to the impacts of climate change.

The Committee struggled to identify specific actions for some of the identified vulnerabilities. This was a pivotal point to reach in the process. The group had to become comfortable with the facts that they didn’t have all the answers and that they may not be able to identify actions for some of the vulnerabilities or opportunities. Additionally, the group found it difficult to separate goals and targets focused strictly on building adaptive capacity from those that are mitigation focused. Given Keene’s strong commitment to mitigation, it was not surprising that the best approach for them to build adaptive capacity includes a strong mitigation component. As the City moves forward, goals and actions will have to be revisited as more information becomes available.

MILESTONE 2: PRIORITIZE AREAS FOR ACTIONS AND SET GOALS

Following the completion of Milestone 1, ICLEI facilitated a goal-setting and prioritization workshop. Areas for action were identified and listed as a result of the baseline assessment completed in Milestone 1. A simple template was generated based on this list to organize goals, targets, and recommended actions. A schedule for prioritization was applied to short-, mid-, and long-term timelines.

Keene’s CRC Committee met during an all-day workshop to identify goals and targets for each identified climate vulnerability. The group assigned targets and a timeframe to achieve each identified goal.

*Climate Resilient Communities
Committee members returned
repeatedly to one question:
“How is the identified subsector
vulnerable to climate change?”*

The workshop began with a review of climate science and what changes could be expected locally. CRC Committee members then ranked the opportunities formulated during the first Milestone. The purpose of the ranking was to help Committee members prioritize where efforts should be focused and to identify appropriate goals and targets for each priority area. However, in the end, all

the vulnerabilities identified by the group were included in this document. To the best of their ability, the Committee assigned dates of completion to targets. The group used the following criteria to rank each opportunity:

Impacts to:

- Local Business
- Environment
- Community

Influence:

- Visibility
- Supporting existing initiatives

Investment:

- Available funding
- Easy to implement
- Time sensitive
- Cost effectiveness

Ranking Scale	
0	No impact, opportunity, or contribution to the community
1	Minor impact, opportunity, or contribution to the community
2	Great impact, opportunity, or contribution to the community

Milestones 3, 4, and 5: Creating, Implementing, and Updating the Plan

Milestone 3 involves creating a plan that describes the actions and policies that will be carried out, including information about timing, financing, and responsible parties. This plan is Keene’s initial step toward achieving Milestone 3 goals.

All of the initial work the Committee completed was summarized by ICLEI and Keene’s Planning Department staff, and is incorporated into this document. This plan will evolve based on the City’s upcoming comprehensive master planning process, which will further define City and community sustainability goals by allowing for public input.

Milestone 4 is the actual implementation of the plan and Milestone 5 reviews accomplishments, identifies results, and then evaluates what is left to accomplish and identifies new goals and actions.

Footnotes for Section I

¹ *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments*; The Climate Impacts Group, University of Washington and King County, Washington; 2007.

² ICLEI was working with this version of the Milestones at the time of the project. The Milestones have since been updated. The updated version of the Milestones can be found elsewhere in this report.

Section II: Climate Change Impacts

Planning for climate impacts based upon scientific data is essential for future community health and safety. Linking climate science and community planning tools is crucial to creating a meaningful—and workable—strategy to improve community climate resiliency. In order to achieve this, a review of climate impacts is presented in this section.

Intergovernmental Panel on Climate Change Report

In a highly acclaimed, and much awaited, scientific report, The Intergovernmental Panel on Climate Change (IPCC) released their findings focused on climate adaptation on April 6, 2007. The IPCC is an international body of more than two thousand scientists from 154 countries, charged in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP) with assessing the “risk of human-induced climate change.” The report, *Impacts, Adaptation and Vulnerability* (April, 2007), addresses the current and predicted impacts of global warming and ways in which the world will adapt to those changes. It underscores the serious threat global warming poses to our communities as well as the need for immediate action.

IPCC scientists assert that certain areas of the United States will be particularly susceptible to flooding, drought, or erratic weather patterns and intense storms. The report summarizes conclusions by category of certainty, and then by sector within each category. In the category of “virtually certain” (greater than 99% probability of occurrence), warmer and fewer cold days and nights, and warmer and more frequent hot days and nights are expected, resulting in:

- An increase in agriculture, forestry, and other ecosystem yields in colder environments; a decrease in yields in warmer environments; and an increase in insect outbreaks
- Effects on water resources reliant on snowmelt
- Reduced energy demand for heating; increased demand for cooling; and declining air quality in cities

In the category of “very likely” (90 to 99% probability), warm spells and heat waves, and heavy and more frequent precipitation events are expected, resulting in:

- Reduced agriculture, forestry, and other ecosystem yields; increased wild fire danger; damage to crops; soil erosion; and the inability to cultivate land due to water logging of soils
- An increase in water demands; water quality problems (e.g., algal blooms from heat); and adverse effects on surface and groundwater quality from increased precipitation

- Reduced quality of life for people in warm areas, including increased risk of heat-related mortality, especially for those without appropriate housing, the elderly, very young and poor; and increased pressures on urban and rural infrastructures, and loss of property

The IPCC report encourages communities to integrate climate preparedness strategies into existing all-hazard mitigation plans to reduce the costs associated with disaster relief, and prioritize vulnerabilities such as infrastructure, land use and zoning, and water capacity.

Dr. Cameron Wake, UNH Professor

Summary of Testimony by Dr. Cameron Wake of the University of New Hampshire Climate Change Research Center: House and Senate Energy and Environment Committees, January 29, 2007.

Even more specific to New Hampshire, Dr. Cameron Wake, professor with the University of New Hampshire Climate Change Research Center, provided insight into the climate change impacts most likely to affect Keene. Dr. Wake indicated that 2007 has been a perfect example of how warming temperatures are affecting New Hampshire seasons, specifically the winter economy. He says that winter temperatures have gone up much more rapidly than previously predicted and New Hampshire has seen an overall increase since 1970 of 4.3° Fahrenheit. Dr. Wake also estimates that New Hampshire has also already seen fewer days with snow on the ground. A report on winter recreation shows that during warm winters there are 310,000 fewer alpine skiers, 43,000 fewer Nordic skiers, and 11,000 fewer snow mobile licenses sold. Wake says that's an economic impact of more than \$13.2 million.

“That’s just the ticket sales, as that cascades down through the economy and the people who fix your skis or sell you snowmobiles, or serve you a meal, you can imagine that impact is two to three to four or six times that large—a significant economic impact in the north country.”

He predicts that if the world remains on a pathway of using fossil fuels as it does now, New Hampshire will be a very different place, with sixty summer days over 90°, and 50% less snowfall. Wake says New Hampshire weather will be like a very dry North Carolina. Using another model, the study showed that if there's a shift this decade to clean and renewable energy, only thirty days would be over 90° by the middle of the century and there would be 25% less snowfall.

Northeast Climate Impacts

At a more regional level for the City of Keene, a recent study published by the Union of Concerned Scientists, *Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts* (October, 2006), focused on the climate impacts on the Northeastern United States. Northeast predictions of climate change impacts were presented for both low and high emissions scenarios. The high emissions scenario is based on business as usual, while the low emissions scenario assumes humans take fairly significant actions to achieve emissions reductions. The UCS report indicates that there are vastly different outcomes in relation to the severity of climate impacts dependent upon the emissions scenario the Northeast follows. For example, rather than the Northeast experiencing an increase in average annual temperature over the next century of up to 7° F based upon the low emissions scenario, the high emissions scenario predicts an increase of up to 14° F (UCS, 2006). The extent, severity, and frequency to which the Northeast experiences these impacts are entirely dependent upon actions taken locally and globally to reduce greenhouse gas emissions as well as to adapt to climate changes already underway (UCS, 2006).

In particular, the UCS estimates that the Northeast, in general, will experience the following impacts:

Summer:

- Increase in the number and frequency of extremely hot (over 90° F) days
- Increase in the number and frequency of days over 100° F
- Amplification of the heat index due to rising humidity
- Expansion of the summer season into traditional seasonal timeframes for spring and fall

Figure 1: The Changing Face of Winter in the Northeast



Photo courtesy of the Union of Concerned Scientists

Fall:

- Delay in the arrival of the fall season
- Lengthening of the low-flow period for water resources
- Increasing periods of drought
- Increased flooding events

Winter:

- Decreased natural snowfall cover
- Increase in winter precipitation in the form of rain or mixed precipitation
- Decrease in the length of the winter season

Spring:

- Earlier arrival and ending of spring
- River and lake ice break up earlier
- Increased flooding events

Overall, the UCS report concludes that the impacts associated with global warming will vary in degree depending upon a low or high greenhouse gas emissions scenario and efforts should focus not only on mitigation, but also on adapting to the impacts already underway as a result of a changing climate.

New Hampshire Climate Impacts

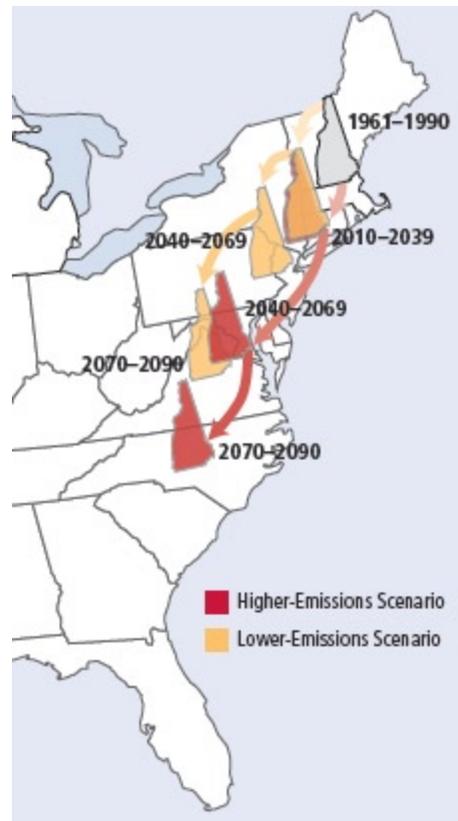
In July, 2007, UCS followed up its Northeast Climate Impact Assessment Report with state-specific reports on projected climate impacts. *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions* included a six-page summary of specific climate impacts for New Hampshire. Many of the impacts are similar to those identified for the entire Northeast region. The UCS indicates that as global warming continues, New Hampshire will see:

- Increases in the number of days over 90° F from ten per year between 1961 and 1990 to between thirty and seventy days per year by late century
- Increases in the number of days over 100° F from one per year between 1961 and 1990 to between six and twenty-three days per year by late century
- Increases in winter precipitation of about 20 to 30%, featuring less snow and more rain or mixed precipitation
- Decreases in winter snow season of 16 to 50%
- Earlier river and lake-ice breakup
- Earlier blooming dates for lilacs and other plants
- Increases in major flooding events

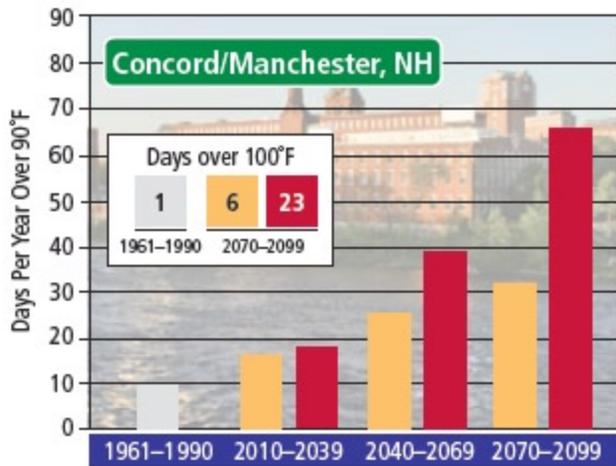
- Increased frequency of short-term (one to three months) drought, with annual droughts under the higher emissions scenario and droughts every two to three years under lower emissions scenarios
- Increased length of the growing season
- Increased frequency of about 400% of poor air quality days in larger cities

These impacts have the ability to affect the economy and tourist industry in the state, quality of life, and overall regional character. The following combines information excerpted from the CCP Action Plan and UCS Confronting Climate Change in the U.S. Northeast New Hampshire fact sheet and explores in more detail how the state may be impacted by a change in climate. The information below can also be found on the New Hampshire Department of Environmental Services website (<http://www.des.state.nh.us/ard/climatechange/impacts.htm>), which is the source of the information used in the CCP Action Plan.

Summer Climate Migration



New Hampshire's summer climate will be somewhere between that of the current climate in northern Virginia and North Carolina by the end of the century. Source: UCS New Hampshire fact sheet based on *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions* (July, 2007)



The number of days over 90° F (graph) and over 100° F (insert) is projected to increase dramatically. Source: UCS New Hampshire fact sheet based on *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions* (July, 2007)

NEW HAMPSHIRE BUILT ENVIRONMENT IMPACTS

Flooding

New Hampshire was one of the hardest-hit states from the Fall 2005 storm that resulted in floods across the Northeast region. The storm dropped nearly eighteen inches of rain, including nearly three feet of snow on the summit of Mount Washington¹. More than one thousand people were forced to evacuate their homes in the region. Seven deaths were confirmed in the state. Roads and bridges were also damaged by the floods. Damage totaled an estimated \$16 million, primarily in Cheshire County. Other floods in 2006 and 2007 have caused deaths, destroyed homes, and cost millions of dollars of damage. The UCS predicts the frequency and severity of such flooding events will continue to rise.

NEW HAMPSHIRE NATURAL ENVIRONMENT IMPACTS

Cold Water Fishing

Habitat Loss: An Environmental Protection Agency (EPA) study for New England indicated that some states could potentially lose all habitats important for cold-water fish. Estimates as high as a 50% loss was predicted for northern New Hampshire.

Lower Fish Stocks: The temperatures of streams in New Hampshire may increase to levels exceeding tolerances for most cold-water fish such as brook, brown, and rainbow trout. Warm water fish may have difficulty moving into vacated cold-water fish habitats because they are unable to tolerate fast stream rates. Temperature is critical to reproduction in many cold-water fish species. Thus, even though some adult fish may tolerate higher stream temperatures, they will not reproduce.

Lost Revenue: Fishing in New England is big business. Hotels, restaurants, retail, and other tourism-supported businesses also profit from a strong cold-water fishing sector. Two million fishermen in 1991 spent \$1.3 billion in New Hampshire and 35% of those traveled to New England from out of state. Revenue loss, in both direct and indirect spending, from depleted cold-water fishing resources would be significant.

Forests

Tree Loss: Disturbances to tree health and growth, such as pest and pathogen outbreaks, flooding, and wind damage are expected to increase, potentially resulting in the death of a large number of trees and forests. Extreme events such as periods of winter thaw followed by intense cold, spring and summer drought, and summer heat stress, have been associated with die-backs and declines in several northern hardwood species (e.g., Sugar Maple, White Ash, Yellow Birch) in New England. The expected rise in the frequency of these weather events also threatens the health of New Hampshire's forests. UCS reports that a higher emissions scenario could create a climate completely unsuitable for existing spruce/fir forests and cause a significant decline in maple, beech, and birch forests. Areas suitable for New Hampshire's hemlock trees could shrink by 20 to 40% by late century.

Sugar maple trees, for which the Northeast is known, are extremely susceptible to mid-winter thaws and summer droughts—impacts associated with climate change.

Forest Migration: In general, ecological models predict that warmer temperatures and extreme weather events associated with climate change would move optimal conditions for the growth of northern hardwood forest species northwards by at least 100 to 300 miles.

Lost Revenue: The forest product industry is the fourth largest employer in New Hampshire and third in terms of revenue. Gross revenues may be affected. Sugar maple, ash, and yellow birch, all northern hardwoods, are sensitive to

warming temperatures and extreme weather events. As such, forests may migrate, decline, or even collapse, resulting in the breakdown of the forest product industry. In particular, sugar maple trees, for which the Northeast is known, are extremely susceptible to mid-winter thaws and summer droughts. The maple syrup industry, an annual \$3 billion economic generator, may collapse. In addition, the lumber, pulp, and paper industries use harvesting practices that rely on frozen soil conditions. An increase in the mud season will negatively impact the industry and increase the environmental damage from the harvesting process.

Lost Tourism: Revenue from New Hampshire foliage visitors (or "leaf-peepers") is approximately \$292 million annually. On average, foliage visitors spend 16% more than non-foliage visitors. Sugar maples, a source of brilliant fall leaf colors, may sicken, decline, and disappear, or their geographic distribution may migrate north, impacting tourism and tourism generated revenue.

NEW HAMPSHIRE SOCIAL ENVIRONMENT IMPACTS

Ski Industry

Snow Conditions: Potential mid-season rain and significantly more freeze-thaw cycles could result in icier, more granular snow conditions. Snow conditions in general may deteriorate.

Snowmaking: Warmer winter nights will impact winter sport resort snowmaking capabilities. UCS estimates that many New Hampshire ski resorts will no longer be viable and those that remain open will need to increase snowmaking capacity by 30% over the next several decades and as much as 70% by mid-century.

Revenue Changes: The New Hampshire ski and snowboard industry represents 8.6% of total direct visitor spending, approximately \$190 million annually. Total ski and snowboard spending, including indirect spending such as meals, overnight accommodations, etc., totals \$420.7 million annually. Without consistent snow conditions, the economic generation capability of the industry could deteriorate.

Job Loss: Approximately seventeen thousand New Hampshire residents are employed directly by the New Hampshire ski industry. This number is already representative of the impacts of global warming on the ski industry in New Hampshire. Since 1970, over half of New Hampshire's ski and snowboard resorts have closed. Only eighteen remain in the state today.

Agriculture

Drought and Heat: The increased frequency of short-term drought would have a detrimental effect on the small but vibrant agriculture sector in New Hampshire. Increasing summer temperatures and heat stress could reduce crop yields and quality.

Migration of Pests and Weeds: Northward expansion of certain varieties of weeds and agricultural pests puts additional pressure on farmers to use pesticides and herbicides or places the burden of additional labor on organic farms that choose not to.



Revenue: New Hampshire fruit and vegetable crops bring in about \$18 million annually. Changing conditions could reduce yields of economically critical crops like cabbage, potatoes, and apples. Under the lower emissions scenarios, these impacts are expected to be relatively small.

Insurance

Many insurance companies have stated that future insurance risks due to a changing climate will raise premiums or will lead to a denial of coverage in many areas for flood, home, and perhaps even life insurance. Climate change will likely magnify losses in the years ahead, whether in homeowner losses due to floods, or crop losses due to drought. A 2005 report, *Availability and Affordability of Insurance Under Climate Change: A Growing Challenge for the U.S.*, by Dr. Evan Mills, indicates that over the past thirty years, insured losses from catastrophic weather events with damages amounting to over \$1 billion have increased fifteen-fold. The report indicates that these losses have far out-stripped premium increases, inflation, and population growth over the same time period.

Human Health

According to UCS, a recent study explored global warming and its impact on air quality. The study indicated that summer-storm clearing activity from Canada would decrease, resulting in air stagnation over much of New England. According to the study, if emissions remain at the levels they are at today, air stagnation will result in hazardous smog episodes that will increase in both severity and duration by mid-century. Additionally, UCS projects that the number of days with poor air quality and ground-level ozone levels in excess of EPA limits will double or quadruple in larger cities like Concord and Manchester. Increases in poor air quality days will increase respiratory ailments and will also impact New Hampshire residents who suffer from asthma and cardiovascular disease. Poor air quality in New Hampshire currently results in the death of more than 100 residents each year, costing the state \$1 billion annually². The UCS report also states that if the frequency and severity of poor air quality days increase, then air pollution-related health problems will likely increase, compromising the health of many New Hampshire citizens and increasing the state's public health care expenses. Coupled with the poor air quality, the increased number of high heat index days and extreme cold days can adversely affect human health, especially children, seniors, and those challenged with respiratory-related illnesses. The migrating heat index for the State of New Hampshire indicates that vector-borne illnesses, such as West Nile Virus, will become more prevalent, further exacerbating the health impacts associated with climate change.

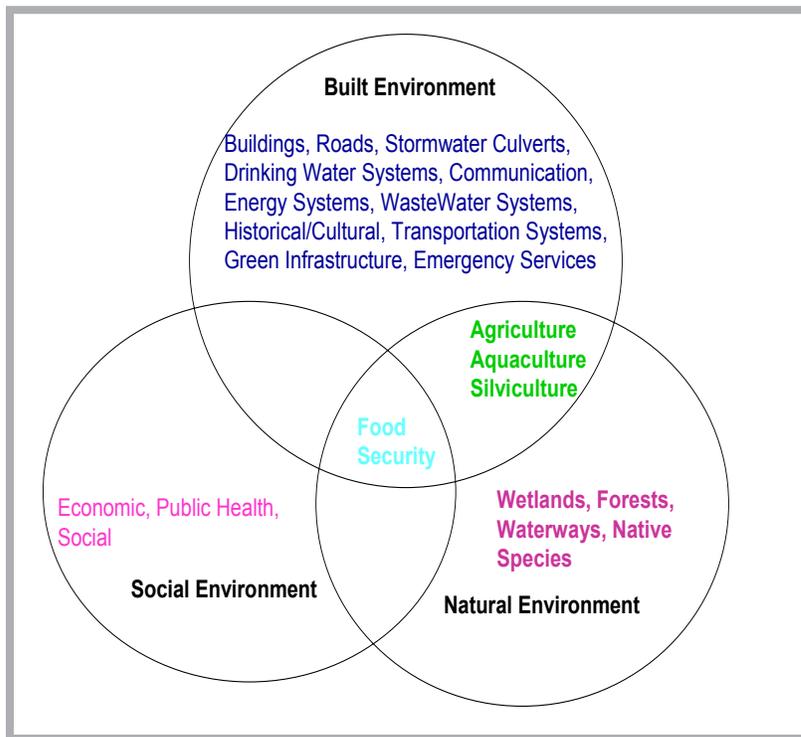
Footnotes for Section II

¹ As recorded by the Mount Washington Observatory.

² *Northeast Climate Impact Assessment Report*; Union of Concerned Scientists; 2006.

Section III: Assessing Community Climate Vulnerability

At the first two meetings, the CRC Committee members considered the specific ways in which Keene is vulnerable to climate change. In thinking about the sectors in relation to climate change, the group was directed to identify a community resource and then identify how that resource may be impacted by the predicted changes for the region. As the group brainstormed community resources, it became easier for the Committee to identify additional sub-sectors and then describe how that particular resource was vulnerable to climate change. The following is an example of how the group mentally worked through the identification of climate vulnerabilities:



Early on, the Committee realized that the three sectors they had devised were not mutually exclusive. In particular, agricultural areas and park areas seemed to be part of both Keene’s built environment and Keene’s natural environment (i.e., these areas are man-made constructs that also contain natural elements). Thus the Committee created an additional “overlay” sector termed the “anthropogenic natural environment.” However, as the process moved forward, this overlay was abandoned as sub-sectors identified for the overlay sector absorbed in the natural and built environment sectors.

The Committee began to view the crossover between sectors as a benefit because it is representative of the world we live in and would guide the prioritization of actions later in the process (i.e., actions that could address vulnerabilities in multiple sectors might be ranked higher).

Example

Sector: Built Environment

Subsector: Roofs

Overarching question: How will, or how can, a change in climate affect the built environment in Keene?

Answer: Climate change will impact the built environment by affecting buildings themselves. Roofs, basements, use of land, HVAC systems, and building materials will all be impacted by climate change.

Specifically, how will buildings be impacted? Roofs will be affected by increased roof-top loads from heavier, denser snow or by more frequent ice storms. Roofs will also be affected by, and influence, stormwater run-off and drainage.

Identified Vulnerabilities

The main vulnerabilities the group identified are summarized as follows:

SECTOR 1: THE BUILT ENVIRONMENT

Buildings

Having experienced a severe flood in 2005, Keene is aware of the devastating effects extreme precipitation events can have on the community. As stated earlier, an increased frequency and intensity of severe storms is expected in the Northeast as a direct result of climate change. These severe storms could result in flooding and an increase in the number and extent of flooding events. Given this and the committee's knowledge of Keene's existing vulnerabilities, they identified flooding, groundwater intrusion, and mold as some of the vulnerabilities that could ultimately affect Keene's built environment.

Concern was also expressed regarding the City's land use policies as they relate to building within the floodplain. Keene's current flood maps are representative of a 100-year flood event meaning that land within this area has a 1% chance of flooding in any given year. The City's *Floodplain Master Plan* (July, 1990) and *Flood Hazard Mitigation Plan* (April, 2000) specifically state, as a policy, that development should be placed at, or above, the 100-year floodplain, inclusive of roads, to ensure that they are not negatively affected in severe flooding events, or that development in the floodplain should be avoided altogether. These plans also outline the history of flooding events in Keene as far back as the flood of 1738. Major flooding events have consistently occurred in every century since that time.

While most flooding in Keene has traditionally occurred in the spring as a result of snowmelt and spring precipitation, Keene is seeing an increase in severe flooding events in the fall that are entirely due to heavy rainstorms. The amount of flooding that

occurred in Fall 2005 was a result of a 500-year storm event. If flooding events become increasingly more frequent and intense, Keene's floodplain may have to be redefined to take this level of storms into account.

An increase in a variety of extreme weather and precipitation were also seen as a threat to Keene's buildings. With more winter precipitation predicted to fall as wet snow or sleet/ice (which is considerably heavier than dry snow), the Committee determined that the roofs of Keene's buildings may be vulnerable to collapse.

Transportation Infrastructure

As severe storm events become more frequent, the Committee identified that Keene's transportation system is also vulnerable. Flooding, large amounts of snowfall, and ice-storms all have the ability to affect roadways and bridges. Ice is more difficult to remove from roads and requires more man-power, materials, and equipment, as opposed to snow removal. Roads covered in ice are more difficult to navigate safely and may hamper emergency services.

The Committee discussed how roadways could be vulnerable. In particular, culvert capacity was identified as a known issue. Due to the capacity, or lack thereof, of current culverts to handle increased precipitation and stormwater run-off, Keene roadways are increasingly vulnerable to flooding and damage.

In a 2005 culvert capacity study conducted in the White Brook Watershed by Antioch New England Graduate School, it was estimated that "43% of culverts in the study site are likely to be undersized as a result of climate change and population growth."

—Stack L.J., M.H. Simpson, T.W. Crosslin, W.S. Spearing, E.P.M. Hague,
A point process model of drainage system capacity under climate change,
June 2006

In addition to the weather becoming more extreme, it is predicted that global climate change will result in more erratic weather patterns accompanied by dramatic temperature fluctuations. Erratic freeze-thaw patterns, for example, could increase the buckling of roadways, causing unsafe surfaces for motorists and increasing roadway repair costs. Roads that cross streams may be more vulnerable to bridge failure and flooding, rendering a roadway impassible until repairs can be made or water levels subside.

Ultimately, weather events, combined with New Hampshire's topography, affects overall accessibility of people, goods, and emergency services. If roadways, airports, railroad tracks, bicycle routes, and even footpaths are flooded with no alternative routes available, citizens in Keene may find themselves stranded in an extreme weather-related emergency situation.



Stormwater and Wastewater Infrastructure

As previously mentioned, the City's stormwater infrastructure, which encompasses the City's culverts, retention and detention ponds, inlets, catch basins, and stormwater pipes are all vulnerable to increases in flow that they are not designed to handle. When these systems fail, other systems, such as the transportation system and buildings, can be negatively impacted.

The Committee noted that the capacity of existing culverts, the design of current stormwater infrastructure, increases in impervious surfaces, and a lack of an effective regional stormwater policy and planning effort are factors that contribute to the system's vulnerability to climate change.

The wastewater treatment plant may also be compromised during flood events due to stormwater inflow and intrusion into the system. Not only is the system vulnerable to infrastructure damage as a result of flooding, but a breach of the system would then impact public health, possibly leading to the spread of disease.

Energy Systems

Keene is also susceptible to power outages that result from severe storm events, or by exceeding the existing capacity of the New England power grid; thus, power outages could occur irrespective of the season. Heavy snow or ice accumulation and higher winds could cause power lines to come down, interrupting the distribution of power. It is also expected that the state of New Hampshire will experience an increase in the number of days over 90° and 100°. Extreme heat waves would result in an increase in demand for energy as people cool their homes. Too much demand for electricity could exceed the current transmission or supply capacity, causing increased outages for longer periods of time.

Communication Infrastructure

The Committee raised a concern that communication systems in general are vulnerable to lapses in power, which could be expected with increased frequency and severity of storms. Computers, phones, radio, and all other forms of communication technology could be useless in the event of a widespread power outage.

In particular, the Committee identified the lack of land line telephone use as a vulnerability to the communication system, especially as it relates to emergency services. Many people rely on cellular phones as their primary phone service and do not have land line telephone service in their homes. There is also the increasing trend of the removal of public pay-phones by telephone service providers due to the increased use and availability of cellular telephone service. In the event of a severe storm that knocks out power supplies, cellular phone infrastructure can also be impacted by lack of power, or overload of the system, thus interrupting communications. This very scenario actually took place during the events of September 11, 2001, and subsequently during the blackout experienced in the United States in the summer of 2003. The other concern was the inability to notify community members of impending disaster through the Reverse 911 system.

Even Keene community members who retain their land lines could be vulnerable if they have portable phones that rely upon electricity to power and charge the handset. These phones could also fail in the face of an extreme weather event.

Parks and Open Space Resources

Keene's open spaces provide many benefits to community members: places to relax or engage in outdoor recreation activities; animal and plant habitat; and, a natural infrastructure to recharge aquifers, protect drinking water, and control flooding. Thus, Keene's parks, recreation, and natural areas are a valuable community resource. These places tend to be located in low-lying areas or in the surrounding hillsides. As a result, they are vulnerable to flooding, wind damage (see flora for additional information), erosion, and quick fluctuations in temperature. All of these climate impacts could result in the degradation of habitat, which in turn impacts wildlife as well as the function of natural ecosystems.

As an example of how the three sectors interconnect at times, a reduction in open space in Keene can impact the habitat of native flora and fauna. This loss of open space also translates to a loss of natural areas for hiking, fishing, and other outdoor recreation activities (natural environment). The loss of natural flood control areas or aquifer recharge areas could affect the built environment by making it more susceptible to flooding. Public health could also be affected if the community's aquifers are depleted, forcing the community to find other sources of potable water (social environment).

SECTOR 2: THE NATURAL ENVIRONMENT

Wetlands

Climate change is predicted to result not only in an increased frequency and intensity of severe storm events, but also in longer, more frequent drought periods in the late summer and early fall. Wetland areas would be vulnerable to both types of weather extremes. In the event of severe storms, wetland areas are likely to be hit with flash floods. This could cause erosion and damage to fragile areas of wetlands, such as stream banks or water inlets to lakes and ponds.

Flash floods would also bring a great deal of silt and sediment into the wetlands, increasing their turbidity and decreasing their functionality. An increase in the amount of water entering wetlands may also cause them to reach their water-holding capacity, breaching their boundaries and exacerbating flood problems further downstream.

Conversely, wetlands are also in danger of decreasing in number and size. With an increase in droughts and a decrease in the amount of water recharging the wetland areas during the summer and fall months, some of them may become severely degraded or simply dry up.

Since wetlands assist in stormwater filtration and flood control, the impact development has upon existing wetlands should also be considered. In general, the loss of natural

*Computers, phones, radio,
and all other forms of
communication technology
could be useless in the event
of a widespread power
outage.*



wetlands tends to be a result of development that removes wetland areas and increases impervious surfaces. As changes in climate occur, the severity of the degradation of wetlands is expected to increase as a result of previous human activity.

Flora

The natural plant communities currently found in and around Keene are greatly threatened by the effects of climate change. Some plant species, such as the sugar maple, are already dying off and shifting northward because they cannot adapt to a warmer climate zone. If the climate in Keene becomes warmer, which is a predicted result of climate change, northern plant species are threatened with death in the southern portion of their natural growing climate ranges.

Keene's plant communities are also vulnerable to the introduction of new pests—pests that were once controlled (at least to some extent) by cold winters. Thus, invasive exotic plants (e.g., purple loosestrife, Japanese knotweed) already present in New Hampshire may be able to invade more vigorously. Similarly, insects, such as the hemlock wooly adelgid, may be able to travel northward and survive. Pests such as this bug have been known to change an entire forest ecosystem by killing the trees they live on.

Keene's natural communities are also vulnerable to extreme weather events due to the damage, or even mortality, they cause to trees and plants. Ice storms can cause tree limbs and the crowns of trees to break, which can result in the death of a tree. Similarly, erratic freeze-thaw patterns leave Keene's plants vulnerable to leaf mortality or a reduction in reproduction success because their buds and flowers could be damaged by cold temperatures and therefore fail. An early spring thaw followed by a snow storm, for example, could kill buds that had "mistakenly" begun to open.

Fauna

Animal species depend directly on the habitats in which they live. With so many changes likely to occur to Keene's plant communities, the animals that are dependent on them are also vulnerable. Species dependent on wetland areas, hemlock stands, etc., will be vulnerable to a loss of habitat.

Similarly, animals will be vulnerable to a loss of food sources, not only because of the disappearance of some plant species but also because of a difference in food availability patterns. For example, some short lived plants that provide animals with the food they need to survive in the spring after a long, cold winter may begin to bloom and die before the animals are ready to forage on them. Animals migrating to and through Keene may miss bugs that appear during the spring thaw because their migration timing is dependent on the availability of light rather than the increase in spring temperatures.

An increase in erratic weather may also result in higher mortality rates of animals as a direct result of quick changes in temperature or severe storm events. This is especially true of young animals. For example, an increase in the frequency and intensity of storms

may result in spring weather that is too wet and cold for young bird species to live through. Some animals will likely be affected by these impacts more than others and this will only serve to further disrupt the natural, ecological balance.

Food Supply

Regional and local food supplies are vulnerable to climate change due to the impacts that temperature and precipitation changes have upon the conditions that influence agriculture, such as water availability, temperature, and length of growing season. Although climate change may increase the growing season in Keene, the community may be unable to reap the benefits of this due to a possible simultaneous increase in the number and severity of droughts. This, in essence, could lead to community or regional food insecurity.

In addition, food travels on average fifteen hundred miles from farm to plate. Should other sources of the food supply, whether in the United States or elsewhere, be impacted by climate change or any other variable, communities will need to become self-reliant in food production within their own regions.

SECTOR 3: THE SOCIAL ENVIRONMENT

Economy

Many people who live in Keene not only enjoy the area for its seasons and natural attributes, but also depend on the natural environment for their livelihood. “Sugaring” or maple syrup production, fall foliage viewing, and winter recreational sports have long been part of New England’s economic engine. With an increase in winter temperatures, less precipitation will fall as snow. Similarly, an increase in seasonal temperatures could dampen fall foliage (the process of leaves changing color and the overall brilliance of those colors is dependent on cold weather). A decrease in the number of tourists coming to New England, and thus to Keene, to view the fall foliage, or to ski or snowboard could negatively impact many businesses that are in, or related to, the hospitality and winter recreation industries.

Sugaring and snow-plowing are also part of the traditional New England economy and way of life. Warmer temperatures threaten the traditional, natural sugaring cycle, possibly shortening it, or even eradicating the sugar maple tree entirely from the region. These changes in climate would not only result in a change of New England’s traditional way of life, but also in the kinds of jobs available in New Hampshire and in Keene.

The aspects of New England that attract tourists to Keene also attract students to some of the local colleges, such as Keene State College and Antioch University New England Graduate School. If the “natural science laboratory” disappears, or if students that want to compete in winter sports are not able to train due to a lack of snow, they may decide to go elsewhere

A decrease in the number of tourists coming to New England, and thus to Keene, to view the fall foliage, or to ski or snowboard could negatively impact many businesses that are in, or related to, the hospitality and winter recreation industries.

for their education. This puts Keene's college admissions at risk, which in turn affects the colleges' ability to contribute to the local economy. Similarly, colleges in Keene may have to increase their tuition to help pay for increases in flood insurance, revamping infrastructure, etc., in order to adapt to changes in climate.

Public Health

The community's health may become vulnerable to a change in climate. The predicted increase in the frequency and severity of poor air quality days will lead to an increase in air pollution-related health problems, compromising the health of many New Hampshire citizens and increasing the state's public health care expenses.

An increase in temperature is likely to increase the number of insects that can live in and around the region. Some of these insects are known transmitters of disease, such as West Nile Virus and Lyme disease. Thus, the community is vulnerable to an increase in the vectors that carry disease that in turn increases the community's vulnerability to disease outbreaks.

The general public may also become vulnerable to the impacts from severe storm events upon the built environment. In a flood situation, for example, potable water may become contaminated via sewage infiltration into public or private water systems. Water left standing after a flood could also contain harmful chemical runoff from lawns, dead plants, and animals, and would be prone to the growth of bacteria in general. This would further the possibility of human exposure to elements that could make them sick.

Keene's citizens are vulnerable to more direct effects of climate change—especially the young, elder, and homeless populations. For example, additional days that exceed 100° could increase heat stress and associated medical problems, such as heart attacks, which could be triggered by warmer temperatures. Similarly, people would also be vulnerable to increased respiratory problems that would result from higher heat and humidity, and an overall reduction in air quality.

Warm weather, such as the extreme heat predicted as a result of climate change, can also trigger emotional responses that precipitate violent acts or emotional distress. For example, in the case of a severe flood, many people could lose property and some might even lose loved ones. The stress associated with such loss can be mentally incapacitating. In addition, extreme heat days have been linked to an escalation in domestic violence. An increase in the number and frequency of such days may also lead to a rise in domestic violence rates.

Emergency Services

While emergency services are the responders to many of the extreme events that could occur due to changes in climate, they may also be affected negatively by climate change. Police, fire, and ambulance services may experience a spike in demand for their services. Emergency services personnel may also be impacted directly by severe weather events: routes may be blocked, a high volume of calls may overwhelm available staff, and the communication system may be impacted by preventing or degrading communication capabilities between responders.

Section IV: Climate Adaptation Priority Goals and Targets

After identifying and categorizing the sectors and subsectors that will be most impacted by climate change, Committee members were tasked with prioritizing the opportunities to strengthen Keene's ability to adapt. The Committee found that there was significant overlap between what actions they believed were important to address from an adaptation perspective and those typically associated with climate mitigation. The Committee worked diligently to frame most efforts through the adaptation lens, but strongly believe that their mitigation efforts are key to their adaptive success, and therefore included some measures that may also be construed as mitigation efforts.

After the top priorities were determined from the ranking system, Committee members divided into three teams (one team per sector) and each team developed goals and targets for each priority opportunity. Goals were defined as broad, general statements about the expectations of a program, project, or activity. Goals, in general, are immeasurable; they provide direction for a program, project or activity. Targets (or objectives) were defined as being more specific statements that provide a standard of measurement. Targets evaluate progress toward achieving the stated goal, and can provide a performance measure, an estimated time for completion, or a specific scope.

Given that many parts of the world are already beginning to feel the impacts associated with a changing climate and that growing and existing concentrations of greenhouse gases in the atmosphere will continue to warm our planet, addressing both adaptation and mitigation in climate protection activities is increasingly necessary.

It is important to keep in mind that the following opportunities, goals, and targets were identified as ways in which City government could begin efforts to adapt to climate change vulnerabilities. Some of these efforts impact City government only, while others are inclusive of the community at large. The Committee felt strongly that a priority should be reducing greenhouse gas emissions associated with climate change. Given that many parts of the world are already beginning to feel the impacts associated with a changing climate and that growing and existing concentrations of greenhouse gases in the atmosphere will continue to warm our planet, addressing both adaptation and mitigation in climate protection activities is increasingly necessary. Keene has therefore identified certain mitigation strategies in this plan that will ideally lessen the need for long-term adaptation efforts.

Keene's Climate Adaptation Opportunities, Goals, and Targets

SECTOR 1: THE BUILT ENVIRONMENT

Opportunity: Building and Development

Goal A: Reduce the likelihood of structural damage resulting from predicted increases in severe weather events.

Target A: Encourage more pitched roofs and incorporate design standards that consider snow stacking (zones and increase in roof loads) and ice falling zones.

Target B: Identify a 200-year floodplain and prevent future development in these areas.

Target C: Investigate design standards for buildings that currently handle weather conditions similar to the climate forecast New England can expect in the future (e.g., buildings constructed in the southern states).

Target D: Continue to research and allow City staff to participate in educational opportunities to learn about advances in green building design and practice.

Goal B: Create, adopt, and implement a City building and energy code that incorporates sustainability, green building materials, and energy conservation principles by 2012.

Target A: Research and review existing information and how similar codes have been developed and implemented in other communities.

Target B: Improve existing energy conservation standards by a minimum of 25% through implementation of the code in both commercial and residential development.

Target C: Garner input from the development community and other stakeholders to ensure the development of a code that is easy to understand and easy to implement, while simultaneously achieving the City's sustainable development and energy conservation goals.

Target D: Explore the use of traditional and alternative building materials for added strength and durability of construction to improve the longevity of buildings and then incorporate these materials into building code requirements.

Goal C: Make all new development in Keene “green” (i.e., sustainable).

Target A: Build a green building (City-owned or private) in Keene that can serve as an example for the community that incorporates sustainable design and materials and is 50 to 70% more energy efficient than a conventionally designed building, within five to seven years.

Target B: 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.

Target C: Explore, craft, and implement design standards that will support development that creates a smaller ecological footprint for municipal and public buildings (e.g., LEED certification for municipal buildings) while enhancing their resiliency to severe weather events.

Goal D: Lower the ecological footprint of existing buildings.

Target A: Update City code to include green building standards for all major renovations, in a fashion consistent with Goal A outlined above, by 2012.

Target B: Include options and incentives in the building and energy code for developers and homeowners: alternative building materials, alternative energy sources, HVAC system designs that achieve, at a minimum, 50% greater energy efficiency, by 2012.

Target C: Update the City’s Infrastructure Standards to ensure public safety in the event of major flooding or severe storm events.

Goal E: Reduce sprawl and promote infill development/redevelopment.

Target A: Identify areas within the City that have infill or redevelopment potential and are outside an area of potential significant impact to flooding. Aim to have 50% of these areas developed by 2027.

Target B: Adopt smart growth principles in the comprehensive master plan to support this goal, which provide for growth boundaries to avoid new or continued development in areas that are deemed high risk through a vulnerability assessment.

Target C: Revise conservation subdivision regulations to create incentive for the developer to provide greater densities and community services in this type of development, while achieving open space conservation.

Target D: Devise incentives to foster infill development in areas within the City that have been identified as being at low risk for flooding.

Opportunity: Transportation Infrastructure

Goal A: Create alternative route options for movement of goods and people.

Target A: Identify alternate routes and modes for goods transport and evacuation efforts during emergency situations.

Target B: Incorporate requirements into site plan, subdivision, or zoning regulations that require a grid system for future street layout patterns.

Goal B: Design and reconstruct roadways to handle changes in temperature and precipitation as a result of a change in climate.

Target A: Change design requirements for new or refurbished roadways to include different pitches combined with stormwater design and/or use of more permeable surfaces to effectively remove water from the roadway.

Target B: Explore roadway materials that may be utilized in road construction that are more tolerant to quick changes in hot or cold weather in order to decrease repair costs, enhance safety, and increase longevity of road surfaces.

Goal C: Provide sustainable transportation mode choices (locally and regionally).

Target A: Identify and implement Transportation Demand Management (TDM) techniques.

Target B: Increase multi-modal trail infrastructure throughout the City to connect people from where they live to services and work through walking, bicycling, etc. Changes in site plan, subdivision, and land use policies may support the development of a more comprehensive system.

Target C: Identify and obtain funds (local, state, federal) for the development of a local public transportation system that connects with the regional transportation system.

Target D: Lobby policy makers to make changes in transportation policy to support the development of state-wide multi-modal transportation infrastructure in areas less susceptible to significant climate impacts.

Opportunity: Stormwater Systems

Goal A: Safely and efficiently remove stormwater from the built environment.

Target A: Work with the Regional Planning Commission to create a regional management plan for future stormwater runoff levels. Aim to develop and have all municipalities endorse or adopt the plan by 2015.

Target B: Research, create, and begin the implementation of a green streets and a sustainable infrastructure program in Keene, similar to those developed by the City of Portland, Oregon and the City of Seattle, Washington by 2012.

Target C: Adequately assess the need for new culvert capacity in the City; identify where capacity and infrastructure upgrades are needed; and begin a replacement program.

Target D: Include the reassessment of stormwater infrastructure into the City's Comprehensive Master Plan and Capital Improvement Program to replace failing or antiquated infrastructure (inclusive of Three Mile Reservoir, Ashuelot River, Surry Mountain, and Otter Brook dams).

Target E: Approach Army Corps of Engineers for reassessment, using climate change scenarios, of the capacity of existing dams and recommend changes to ensure the ability of these systems to withstand increases in precipitation by 2009.

Target F: Devise and implement a process for coordination of stormwater, utility, and streetscape improvements to occur in sync with the City's capital improvement schedule for road repairs by 2009.

Target G: Identify stormwater treatment and management standards to minimize discharge from private property and from public improvement projects.

Goal B: Decrease stormwater runoff and flash flooding.

Target A: Foster innovative storm water design requirements (on and off site) and include these in site plan requirements.

Target B: Adopt a Net Zero Runoff site plan requirement.

Target C: Identify areas where increased infrastructure capacity is needed to hold/divert water and include replacement or upgrade in Capital Improvement Program.

Opportunity: Energy Systems

Goal A: Decrease the ways in which energy supplies could be interrupted.

Target A: Identify low-risk areas that would allow for the safe burial of existing power lines (coordinate with road improvement projects and upgrades in the Capital Improvement Program) to avoid interruptions due to increased precipitation events.

Target B: Establish the requirement that new construction builders bury utilities during the construction phase.

Goal B: Increase the resiliency of emergency energy systems.

Target A: Connect emergency centers with onsite renewable energy sources to reduce susceptibility to lapses in the conventional energy supply.

Goal C: Increase municipal and community energy security, use of renewable resources, and overall energy efficiency.

Target A: Provide 50% of municipal and community energy needs locally through local renewable energy resource development (such as small scale wind, micro hydro, solar, geothermal, and other renewable resources) by 2027.

Target B: Take steps to decrease municipal and community energy consumption by 25% and decrease greenhouse gas emissions caused by the production of energy by 75% through energy conservation measures and the development of renewable energy resources by 2027.

Target C: Create a wind assessment specific to Keene that identifies sites for wind generation facility development, if feasible, including the City's recycling center, by 2010.

Target D: If Target C above results in adequate wind availability for a wind generation facility to be installed at the recycling center, the City should install such a facility and seek grants, other funds, or partnerships to leverage local dollars to cover the cost of purchase and installation of a wind generation facility by 2011.

Target E: Incorporate solar hot water heating into 20% of households by 2020.

Target F: Incorporate passive solar, micro hydro, geothermal, and micro wind into residential and commercial development and zoning codes by 2012.

Target G: Provide training for developers and designers to include these technologies (e.g., wind generation, solar, geothermal) into development design.

Target H: Expand City's green fleets program.

Target I: Develop alternative energy supply demonstration projects including micro hydro, wind, alternative fuels, etc.

Goal D: Engage energy providers to enhance local renewable generation opportunities.

Target A: Encourage the state to increase amount of renewable energy produced in the state and to keep that energy in the state.

Target B: Work with local energy providers to provide incentives for the development of renewable energy resources for residents and local businesses.

SECTOR 2: THE NATURAL ENVIRONMENT

Opportunity: Wetlands and Sub-surface Waters Protection and Management

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 greywater storage and reuse systems to recycle and utilize water resources more efficiently.

Opportunity: Fauna and Flora

Goal A: Integrate into recently published state wildlife action plan.

Target A: Align City policies to support goals of New Hampshire wildlife action plan by 2010.

Goal B: Protect habitats and migration routes.

Target A: Identify existing and future potential animal migration routes and techniques for crossing protection, and coordinate installation of crossing route protection infrastructure, by 2012.

Target B: Develop a habitat protection program and finance options by 2010.

Target C: Establish conservation-related standards for rural development to protect migration routes. Utilize these regulations to ensure habitat connections, or corridors, to allow animal movement.

Goal C: Devise land use regulations to preserve forests.

Target A: Require sustainable forest management plans for all commercial logging conducted in the City.

Target B: Create a ban on clear-cutting existing forested areas for building lots in the City and create standards for preparing a forested site for development.

Opportunity: Agriculture

Goal A: Increase Keene's food security.

Target A: Develop a food security plan for Keene by 2010.

Target B: Incorporate the food security policy and actions into planning efforts by 2012.

Target C: Create a local food security baseline and increase local food production by 20% within five years. The baseline should be completed by 2010, as part of the food security planning process.

Target D: Identify and protect prime agricultural soils through ordinance, conservation measures, or other protection measures.

Goal B: Research and identify what crops will be productive in our region with a warmer climate and changing soil composition.

Target A: Identify research currently underway.

Target B: Develop a "Farmer's Guide" and a residential growers guide that will identify appropriate crops by 2010.

Goal C: Encourage value added economic activities for agricultural products.

Target A: Develop a micro/incubator business program focused on agriculture and value-added agricultural products.

Target B: Create wood processing opportunities locally.

Target C: Create co-generation opportunities locally.

Target D: Develop a downtown food co-op by 2012.

Target E: Link local farmers with food-related businesses within the community and devise a public education campaign to link the public with establishments that support local farms.

SECTOR 3: THE SOCIAL ENVIRONMENT

Opportunity: Economy

Goal A: Create support services for people who lose their jobs (e.g., snowplowing, sugaring) as a result of climate change.

Target A: Establish retraining programs.

Target B: Establish scholarship programs.

Target C: Establish loan programs for citizens who need to revamp their businesses.

Target D: Prepare for possible in-migration of affected coastal populations as a result of rising sea level. All areas of social support will be impacted, including housing, jobs, social services, and food supply.

Opportunity: Public Health

Goal A: Increase public awareness about the public health implications of climate change, including risks and the need for emergency preparedness.

Target A: Provide public education on mosquito and tick protection and disease prevention.

Target B: Provide public education on emergency preparedness (e.g., creating an emergency food supply, community evacuation procedures, etc.). In developing a public education program, consider the methods available to effectively communicate the issue to a general audience.

Target C: Provide public education on how to handle flood emergency situations (e.g., toxic substances in basement, electrical lines, etc.).

Target D: Develop a program that identifies various vector control methods and policies to apply those methods.

Target E: Anticipate the arrival of new vectors and associated diseases and identify alternative methods to control or eradicate those vectors (develop early detection and warning systems, review the use of spraying and consider the health implications of those actions, etc.).

Goal B: Train and Educate Emergency/Human Services/Public Health officials and workers.

Target A: Establish training programs for public health workers to deal with the emotional aspects associated with loss of life and property caused by extreme weather events.

Target B: Establish a support system to identify and manage emergency worker burnout.

Opportunity: Emergency Services

Goal A: Improve the reliability of emergency communications during severe weather events.

Target A: Inventory the telephone land-line availability in local businesses and private residences by 2009.

Target B: Devise a plan to effectively identify community communications vulnerabilities and options by 2010.

Goal B: Increase community communication for emergency events.

Target A: Devise and coordinate a county-wide system to effectively communicate emergency information to the community.

Target B: Address loss of cellular service and identify other means of communication that can be used when conventional systems are down.

Target C: Develop an Incidence Command System (ICS) to identify a process and/or chain of command for communication.

Goal C: Increase the ability of the public to respond/recover from extreme weather events.

Target A: Create an education program to increase public awareness of extreme weather event resources in coordination with Keene All-Health Hazard Region Annex by 2012.

Target B: Identify and designate convenient, reliable shelters for cold/warm extreme weather events by 2012.

Target C: Create excessive-heat/cold weather emergency policies.

Target D: Establish a Reverse 911 (10 towns in New Hampshire currently have it in place) automated call-back system in the community to notify residents of evacuation routes or other information in the event of an emergency or disaster.

Target E: Consider how to create and then disseminate information to the public for new extreme-weather related emergencies (e.g., what to do with toxic materials that may be in a flooded basement, what to do with the water in a basement that becomes contaminated, etc.).

Target F: Identify a waste management program for debris.

Target G: Identify distribution points for life-essential good and services.

Target H: Create programs to provide assistance beyond the event (e.g., counseling, job placement, etc.).

Goal D: Continue to train and educate staff and the public regarding current and future diseases and associated vectors.

Target A: Increase special fund for training, monitoring, and education by 100% in five years.

Opportunity: Promote a Local Climate Appropriate Economy

Goal A: Support environmentally sustainable businesses and economy.

Target A: Review and rewrite zoning code and land development regulations in five years to include sustainable building materials, design, and energy conservation measures.

Target B: Provide incentives for businesses to locate in Keene that produce sustainable and environmentally friendly products or that utilize sustainable principles in their production processes.

Target C: Create an Economic Development Coordinator position within the City to achieve Target B, above, and Goal B, below.

Goal B: Increase the vitality and competitiveness of local business.

Target A: Identify economic development policies and goals that incorporate sustainability; then seek out businesses that meet those goals.

Target B: Support business incubators to bolster local business development that provides “niche” services or products that are environmentally friendly.

Target C: Provide assistance in the creation or identification of markets for sustainable businesses or their products.

Target D: Create a media package that invites target companies to locate in Keene and highlights Keene’s commitment to the environment and sustainability.

Target E: Create a way-finding system to increase ease of movement and access to key areas (e.g. downtown, evacuation routes, warm/cool shelters) of the City via alternative transportation modes and prioritize clearing of these paths in the event of emergencies.

Opportunity: Food Security

Goal A: Support local agricultural economy.

Target A: Inventory and map existing farms (acreage and commodity) by 2010 and update every five years.

Target B: Increase local food production by 20% within five years of establishing baseline of community food production. The baseline should be completed by 2010, as part of the food security planning process.

Target C: Double the size and number of community gardens by 2027.

Target D: Identify protected and unprotected agricultural areas by 2010 and aim to protect at least 10% of unprotected lands by 2020.

Target E: Identify plants that will be compatible with future projected climate and soil conditions by 2010.

Target F: Educate the community about the relationship between food production and greenhouse gas emissions that contribute to global warming.

Target G: Provide the local farmers' market with a permanent space (land or building) for the market to occupy.

Target H: Coordinate City events with farmers' market days, when feasible.

Target I: Explore changes to the zoning code to encourage farming (on any scale) and discourage the development of open space areas that could be utilized as agricultural land.



Section V: Moving Forward

The Foundation for Further Planning

Planning, in general, is an ongoing and evolving process. Planning for climate change—whether for mitigation, adaptation, or both—is also a dynamic process. This document presents a snapshot of climate issues and concerns, of current climate science, expected climate changes and impacts in New England, and the City’s short- and long-term goals and targets for adapting to climate change. While this document is intended to support and inform the City’s land use planning, policies, growth and development, capital improvement program, and planning decisions for the next decade, it is also meant to be flexible to meet the changing needs and desires of the community. Existing and future planning efforts and City policies should incorporate and refer to this document when they are updated to ensure continuity in purpose and to ensure that these goals are carried forward. More importantly, the community has an opportunity to provide input and guidance about climate change and sustainability in general, as well as to include all relevant portions of this plan into the City’s comprehensive master planning process.

To be successful, the City must extend its climate protection reach beyond its own operations. Keene has a history of collaboration with the public school system and institutions of higher learning in providing educational programs that demonstrate an increased sense of environmental stewardship among students and educators. By engaging in future institutional partnerships that provide educational tools and opportunities that focus on facilitating climate adaptation efforts, the City can help strengthen the ability to move forward as a community in realizing, and building from, all the goals described in this plan.

Implementation

The goals and targets identified previously will guide Keene towards a higher level of preparedness and resiliency to the associated impacts of climate change in the Northeast. As the City moves forward with the implementation of this document, more in-depth studies may need to be developed and updates to this document may be necessary to incorporate more specific and targeted adaptation actions.

In reviewing the goals and targets, there are many that will accomplish more than just increasing the community’s resiliency to climate change—they also offer mitigation benefits. For example, exploring and developing local alternative energy resources reduces the community’s reliance upon traditional energy resources, thus decreasing disruptions in the power supply, while also reducing greenhouse gas emissions that contribute to climate change. Knowing the community’s climate vulnerabilities and the potential impacts associated with climate change, the City can identify which goals and targets, whether coupled with mitigation efforts or not, should be pursued first.

FIRST STEPS TO BEGIN IMPLEMENTATION AND ENSURE LONG-TERM SUCCESS



To ensure the longevity of the City's climate protection planning efforts, Keene should consider hiring a Sustainability Coordinator, as recommended in the CCP Action Plan, and reiterated in this document. This staff person would assist the City in tracking and implementing its climate change and sustainability efforts. The Coordinator would also work to prioritize City sustainability goals and targets; help set up sub-groups within City government for specific tasks; coordinate with the appropriate City departments; provide updates to the City Manager and City Council; and review projects and initiatives for consistency, monitor effectiveness, and generally ensure that climate protection remains a key component of the land development and capital improvement program decision-making process in Keene.

In the mean time, an internal team within City Government should be formulated to integrate individual departmental efforts aimed at sustainability, as well as to make policy and procedural changes. This group could also identify a timeframe for implementation of policy and procedural changes and could create internal action plans for departments to follow.

The following are the first steps the City should take to successfully begin the implementation of its climate adaptation planning efforts:

1. To highlight the need for integration among mitigation and adaptation efforts, the City should formally recognize this document and the CCP Action Plan as the City's "Climate Protection Plan."
2. Allow for public input about climate change and sustainability in the comprehensive master planning process and include all relevant portions of this plan in the comprehensive master plan, as the City's guiding document.
3. Devise a financial strategy to support the creation of a Municipal Sustainability Coordinator position.
4. Create an internal team within City Government to spur departmental integration and implementation of adaptation measures.
5. Further prioritize and assess actions to pursue first, costs for implementation, and funding sources.

Perhaps most importantly, implementing this plan will require a change of focus within City government by evaluating and making changes to policy, procedures, and operations through a "Climate Lens."

Key Partners in Implementing the Plan

Partnerships are important to the success of this plan. This plan identifies connections and overlaps between the built, natural, and social environments in adapting to climate change. Implementing many of the targets will also require partnerships at a regional scale, and some may require partnerships on a state-wide scale.

To connect and weave together the goals presented in this plan, cooperation and communication between City departments is imperative. These departments, and their department heads, will be instrumental in setting the stage for successful implementation of adaptation measures for supporting changes to current policy and process, and for identifying cost-saving measures within City government. Toward that end, all City departments will need to work together to help achieve a more resilient government and community in the face of climate change.

Other key partners in implementing this plan include the Cities for Climate Protection Committee, the Cheshire Medical Group, the Southwest Region Planning Commission, surrounding municipalities, Monadnock Economic Development Corporation, local developers, the Planning and Zoning Boards, the Chamber of Commerce, Keene Public School System, Antioch New England Graduate School, Keene State College, and the Parent Teachers Association.

The above stated partners are not an exhaustive list. As this plan evolves, other groups may become partners in assisting the community and Keene in becoming a climate resilient community.

Conclusion

Adapting to climate change will require Keene to take advantage of the opportunities, as well as cope with the consequences of a changing climate. Planning for climate change today presents a considerable opportunity to enhance the community's overall resilience and adaptive capacity for future climate impacts.

As stated earlier, the impacts associated with climate change are expected to become more frequent as increases in global average temperatures occur. While Keene has taken the first steps in planning for climate change through its CCP Action Plan, Keene—as well as the rest of the world—has to take the next steps in preparing for the impacts from changes in climate that are already underway. Taking action today can also save the community money in the long run, as the costs to replace infrastructure and rebuild from climate impacts continues to rise.

Keene is a unique community, with a colorful history and a bright future. While the community has yet to go through a complete comprehensive master planning process, at the core of conversations throughout the current process, it became clear that City government's main objective for Keene is to support and develop the community's sustainability and high quality of life throughout periods of growth and change. The community is poised to move ahead by taking advantage of new opportunities to not only adapt to climate change, but to create a sustainable community by balancing social, economic, and environmental priorities.

Adapting to climate change includes many different facets. It includes planning to reduce the risks while simultaneously identifying and capturing opportunities. It includes adjustments in the built, natural, and social environments to reduce greenhouse gas

Adapting is about making choices today to be prepared for the potential changes of tomorrow.

emissions; create more energy efficient buildings, ensuring a healthy food supply; and much more. It also includes identifying opportunities for making existing infrastructure and policies more resilient to climate impacts. Adapting is about making choices today to be prepared for the potential changes of tomorrow and to maintain or improve the ability of a community's systems to withstand them. These choices affect the community's energy security, food security, air quality, public health, employment opportunities, and overall economic well-being into the future.

Keene is at the beginning of its adaptation planning and this document provides a basic foundation for further climate protection planning work.

Section VI: Lessons Learned

In developing this plan, there were a few lessons learned that we recommend other communities explore first in the scoping of the process to create a municipal climate adaptation strategy.

Regular Meetings

Set up a regular meeting schedule with the Committee appointed to assist in the development of the plan. Inconsistency in the schedule can lead to sporadic attendance, which is ultimately reflected in the quality of the plan and can also affect an ongoing commitment to implementing the plan. While we have not been overly affected by an inconsistent meeting schedule, there was much work done in between meetings to ensure that all participants were able to provide input and participate in some way—whether they attended meetings or not.

In addition, it is important to understand that this group met a total of six times; five meetings were related to the process and one was to review a draft of this document. The process in its entirety can be best described as brief compared to other planning processes. It is recommended that other communities devise and follow a more detailed planning process. Given that this group was assisting ICLEI in testing the Milestones, the level of involvement and times they met appeared to be adequate for this purpose.

Get a Climate Scientist on the Team

Establish a relationship with a climate scientist early on and get their commitment to attend the Committee meetings and provide input. Some communities may not have access to the same scientific community resources that Keene had available for this process. Communities in need of a representative of climate science on their Committees should explore local university staff, state planning or department of energy staff, non-profit science groups or climate groups, or any other institutions that may be able to provide climate science assistance. Much of the process is imbedded in the ability of the Committee to understand the conversation and the current science of climate change. Partnering with ICLEI was invaluable to our Committee in discussing, understanding, and learning about climate change.

Prioritization of Vulnerabilities

Create a clear set of criteria for ranking and prioritizing actions and ensure enough time for the Committee to go through the process of ranking and prioritizing actions. The Committee struggled with what the criteria meant and how it was supposed to be applied to the identified vulnerabilities. In the end, the ranking was not as useful as it could have been. It essentially allowed the Committee to start with a group of five vulnerabilities to then brainstorm goals and targets to adapt to that particular community vulnerability.



Time was also an issue with the prioritization workshop. Only one prioritization workshop was conducted, and the Committee was not able to address all the vulnerabilities with goals and targets. Committee members were asked to go through this process for the remainder of the vulnerabilities in their own time and submit their results. Only a few members responded. In retrospect, it may have been prudent to have multiple prioritization workshops so that the full Committee

could work towards identifying goals and targets for all the vulnerabilities. Due to time limitations, there was no further discussion with the group about which actions should be prioritized, and how, beyond the results of the ranking exercise. Additional follow-up and opportunity for Committee member discussion on this would have been useful.

In identifying targets, the group was also asked to assign a timeline for completion of each target. Important in this assigning, however, is whether Committee members are asked what projects could be finished in a certain time period versus what projects should be finished in a certain time period. The subtle difference in how the question is asked can result in strikingly different timeline assignments, if any at all.

Define the Process

In advance, it is important to have a rough idea of how the process will move forward, what steps to take, and how to include the general public. Identify the level of public participation that is appropriate for your community; for some it may mean a series of workshops, for others, it may mean representation on a Committee. For Keene, this process was internal to City government, and outside of community members that were included on the Committee, there was no other public input into the process or this document. As noted in the implementation section, to move adaptation efforts forward, the public should have the opportunity to review, reflect on, and comment on the ideas in this document to strengthen it and create public support of the City's future. One way to accomplish this is to incorporate discussions about climate change and sustainability into the comprehensive master planning process, which will ultimately guide city government and the community into the future.

It is the City of Keene's hope that this document becomes a foundation for which local governments can develop their local climate adaptation work and further the shared goals of integrating climate protection planning into everyday municipal operations and community planning.

Appendix A: References and Suggested Readings

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Appendix B: Glossary

The following key terms are used throughout the report and/or serve as assistance in understanding the climate resiliency planning process.

Definitions are based on *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (<http://www.cses.washington.edu/cig/fpt/planning/guidebook/gateway.php>) and (*) from the EPA's *Glossary of Climate Change Terms* (<http://www.epa.gov/climatechange/glossary.html>).

***Adaptation/Adaptive Capacity**

Describes the ability of built, natural, and human systems to accommodate changes in climate (including climate variability and climate extremes) with minimal potential damage or cost. As a general rule, systems that have high adaptive capacity are better able to deal with climate change impacts. For instance, agriculture in a given region will have greater adaptive capacity if the farms of that region have a choice of water sources for irrigation (i.e., in the face of water shortage) and the financial ability and training to switch crop types (i.e., if another crop were proven to grow better based on new climate characteristics).

***Climate**

Climate in a narrow sense is usually defined as the “average weather,” or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years. The classical period is three decades, as defined by the WMO. These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

***Climate Change**

Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from:

1. Natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun
2. Natural processes within the climate system (e.g. changes in ocean circulation)
3. Human activities that change the atmosphere's composition (e.g. through burning fossil fuels) and the land surface (e.g. deforestation, reforestation, urbanization, desertification, etc.)

Climate Resilient Community

A community that takes proactive steps to prepare for (i.e., reduce the vulnerabilities and risks associated with) climate change impacts.

***Deforestation**

Those practices or processes that result in the conversion of forested lands for non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: (1) the burning or decomposition of the wood releases carbon dioxide; and (2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present.

***Ecosystem**

Any natural unit or entity including living and non-living parts that interact to produce a stable system through cyclic exchange of materials.

***Emissions**

Substances released (usually a gas when referring to the subject of climate change) into the atmosphere.

***Food Security**

The United Nations Food and Agriculture Organization defines food security as follows: "Food security means that food is available at all times; that all persons have the means of access to it; that it is nutritionally adequate in terms of quantity, quality, and variety; and that it is acceptable within the given culture. Only when all these conditions are in place can a population be considered food secure."

***Global Warming**

Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases from human activities.

Goals

Broad, general statements leading to accomplishments from priority planning areas. Goals are not measurable; rather, they provide direction for the program, project, or activity.

***Greenhouse Effect**

Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

***Greenhouse Gas (GHG)**

Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O₃), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆).

***Intergovernmental Panel on Climate Change (IPCC)**

The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

Measure of Resilience

A quantitative or qualitative judgment that you make and track over time to determine how well your actions meet the preparedness goals you have set.

Opportunities

The planning areas that the community or government determines to be most important for focusing preparedness efforts, based on the community's vulnerabilities to climate change and associated risk.

Planning Areas

Planning areas describe the areas in which a government or community manages, plans, or makes policy affecting the services and activities associated with built, natural, and human systems. Planning areas can be as broad or as specific as necessary. Examples of planning areas include water supply, wastewater treatment, public health, road operations and maintenance, forestry, and parks. Planning areas are a subset of sectors.

Priority Areas for Action

The planning areas that a community or government determines to be most important for focusing preparedness efforts, based on the community's vulnerabilities to climate change and associated risks.

Sector

A general term used to describe any resource, ecological system, species, management area, activity, or other area of interest that may be affected by climate change. General examples include forests (a resource), wetlands (an ecological system), water supply (a management area), agriculture (an activity), or human health. The term may also be used to describe more specific aspects of these examples that are important to the community, such as water quality or local crop production.

Sensitivity

The degree to which a built, natural, or human system is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., sea level rise, increased water temperature). If systems in a planning area are likely to be affected as a result of projected climate change, then that system should be considered sensitive to climate change. For instance, the northern hardwood forest species of its range is highly sensitive to changes in climate, because even a slight warming may make its habitat unsuitable. In turn, regional economies based on northern hardwood species would also be highly sensitive to changes in climate such as the maple sugar industry.

Systems

Refer to the built, natural, and human networks that provide important services or activities within a community or region. Built systems can refer to networks of facilities, buildings, and transportation infrastructure such as roads and bridges. Natural systems can refer to ecological networks of fish, wildlife, and natural resources like water. Human systems can refer to networks of public health clinics, courts, and government.

Targets

Specific statements that provide a standard of measurement to evaluate progress toward the stated goal, a performance measure, a scope, a performance goal, and a completion date.

Vulnerability

The susceptibility of a system to harm from climate change. Vulnerability is a function of a system's sensitivity to climate and the capacity of that system to adapt to climate changes. In other words, systems that are sensitive to climate and less able to adapt to changes are generally considered to be vulnerable to climate change impacts. For example, the ski industry in the Northeast is vulnerable to a decline from climate change impacts, as the amount of snowpack is sensitive to changes in climate and the industry has limited capacity to adapt to those changes.

Appendix C: Summary of Keene's Climate Adaptation Opportunities, Goals, and Targets

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
Building and Development	Reduce the likelihood of structural damage resulting from predicted increases in severe weather events.	Encourage more pitched roofs and incorporate design standards that consider snow stacking (zones and increase in roof loads) and ice falling zones.	X		
		Identify a 200-year floodplain and prevent future development in these areas.	X	X	
		Investigate design standards for buildings that currently handle weather conditions similar to the climate forecast New England can expect in the future (e.g., buildings constructed in the southern states).	X		
		Continue to research and allow City staff to participate in educational opportunities to learn about advances in green building design and practice.	X		X
	Creates, adopt, and implement a City building and energy code that incorporates sustainability, green building materials, and energy conservation principles by 2012.	Research and review existing information and how similar codes have been developed and implemented in other communities.	X		
		Improve existing energy conservation standards by a minimum of 25% through implementation of the code in both commercial and residential development.	X		
		Garner input from the development community and other stakeholders to ensure the development of a code that is easy to understand and easy to implement, while simultaneously achieving the City's sustainable development and energy conservation goals.	X		
		Explore the use of traditional and alternative building materials for added strength and durability of construction to improve the longevity of buildings and then incorporate these materials into building code requirements.	X		

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
	Make all new development in Keene "green" (i.e., sustainable).	Build a green building (City-owned or private) in Keene that can serve as an example for the community that incorporates sustainable design and materials and is 50 to 70% more energy efficient than a conventionally designed building, within five to seven years.	X		X
		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.	X	X	
		Explore, craft, and implement design standards that will support development that creates a smaller ecological footprint for municipal and public buildings (e.g., LEED certification for municipal buildings) while enhancing their resiliency to severe weather events.	X	X	
	Lower the ecological footprint of existing buildings.	Update City code to include green building standards for all major renovations by 2012.	X		
		Include options and incentives in the building and energy code for developers and homeowners: alternative building materials, alternative energy sources, HVAC system designs that achieve, at a minimum, 50% greater energy efficiency, by 2012.	X		
		Update the City's Infrastructure Standards to ensure public safety in the event of major flooding or severe storm events.	X		X
	Reduce sprawl and promote infill development/redevelopment.	Identify areas within the City that have infill or redevelopment potential and are outside an area of potential significant impact to flooding. Aim to have 50% of these areas developed by 2027.	X	X	X
		Adopt smart growth principles in the comprehensive master plan to support this goal, which provide for growth boundaries to avoid new or continued development in areas that are deemed high risk through a vulnerability assessment.	X	X	X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
		Revise conservation subdivision regulations to create incentive for the developer to provide greater densities and community services in this type of development, while achieving open space conservation.	X	X	
		Devise incentives to foster infill development in areas within the City that have been identified as being at low risk for flooding.	X	X	
Transportation Infrastructure	Create alternative route options for movement of goods and people.	Identify alternate routes and modes for goods transport and evacuation efforts during emergency situations.	X		
		Incorporate requirements into site plan, subdivision, or zoning regulations that require a grid system for future street layout patterns.	X		
	Design and reconstruct roadways to handle changes in temperature and precipitation as a result of a change in climate.	Change design requirements for new or refurbished roadways to include different pitches combined with stormwater design and/or use of more permeable surfaces to effectively remove water from the roadway.	X		
		Explore roadway materials that may be utilized in road construction that are more tolerant to quick changes in hot or cold weather in order to decrease repair costs, enhance safety, and increase longevity of road surfaces.	X		X
	Provide sustainable transportation mode choices (locally and regionally).	Identify and implement Transportation Demand Management (TDM) techniques.	X		
		Increase multi-modal trail infrastructure throughout the City to connect people from where they live to services and work through walking, bicycling, etc. Changes in site plan, subdivision, and land use policies may support the development of a more comprehensive system.	X		X
		Identify and obtain funds (local, state, federal) for the development of a local public transportation system that connects with the regional transportation system.	X		
		Lobby policy makers to make changes in transportation policy to support the development of state-wide multi-modal transportation infrastructure in areas less susceptible to significant climate impacts.	X		X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
Stormwater Systems	Safely and efficiently remove stormwater from the built environment.	Work with the Regional Planning Commission to create a regional management plan for future stormwater runoff levels. Aim to develop and have all municipalities endorse or adopt the plan by 2015.	X		
		Research, create, and begin the implementation of a green streets and a sustainable infrastructure program in Keene, similar to those developed by the City of Portland, Oregon and the City of Seattle, Washington by 2012.	X		
		Adequately assess the need for new culvert capacity in the City; identify where capacity and infrastructure upgrades are needed; and begin a replacement program.	X		
		Include the reassessment of stormwater infrastructure into the City's Comprehensive Master Plan and Capital Improvement Program to replace failing or antiquated infrastructure (inclusive of Three Mile Reservoir, Ashuelot River, Surry Mountain, and Otter Brook dams).	X	X	
		Approach Army Corps of Engineers for reassessment, using climate change scenarios, of the capacity of existing dams and recommend changes to ensure the ability of these systems to withstand increases in precipitation by 2009.	X		
		Devise and implement a process for coordination of stormwater, utility, and streetscape improvements to occur in sync with the City's capital improvement schedule for road repairs by 2009.	X		
		Identify stormwater treatment and management standards to minimize discharge from private property and from public improvement projects.	X		
	Decrease stormwater runoff and flash flooding.	Foster innovative storm water design requirements (on and off site) and include these in site plan requirements.	X		
		Adopt a Net Zero Runoff site plan requirement.	X		
		Identify areas where increased infrastructure capacity is needed to hold/divert water and include replacement or upgrade in Capital Improvement Program.	X		

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
Energy Systems	Decrease the ways in which energy supplies could be interrupted.	Identify low-risk areas that would allow for the safe burial of existing power lines (coordinate with road improvement projects and upgrades in the Capital Improvement Program) to avoid interruptions due to increased precipitation events.	X		
		Establish the requirement that new construction builders bury utilities during the construction phase.	X		
	Increase the resiliency of emergency energy systems.	Connect emergency centers with onsite renewable energy sources to reduce susceptibility to lapses in the conventional energy supply.	X		X
	Increase municipal and community energy security, use of renewable resources, and overall energy efficiency.	Provide 50% of municipal and community energy needs locally through local renewable energy resource development (such as small scale wind, micro hydro, solar, geothermal, and other renewable resources) by 2027.	X	X	X
		Take steps to decrease municipal and community energy consumption by 25% and decrease greenhouse gas emissions caused by the production of energy by 75% through energy conservation measures and the development of renewable energy resources by 2027.	X		
		Create a wind assessment specific to Keene that identifies sites for wind generation facility development, if feasible, including the City's recycling center, by 2010.	X		
		If assessment results in adequate wind availability for a wind generation facility to be installed at the recycling center, the City should install such a facility and seek grants, other funds, or partnerships to leverage local dollars to cover the cost of purchase and installation of a wind generation facility by 2011.	X		
		Incorporate solar hot water heating into 20% of households by 2020.	X		X
		Incorporate passive solar, micro hydro, geothermal, and micro wind into residential and commercial development and zoning codes by 2012.	X		X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
		Provide training for developers and designers to include these technologies (e.g., wind generation, solar, geothermal) into development design.	X		X
		Expand City's green fleets program.	X		
		Develop alternative energy supply demonstration projects including micro hydro, wind, alternative fuels, etc.	X		
	Engage energy providers to enhance local renewable generation opportunities.	Encourage the state to increase amount of renewable energy produced in the state and to keep that energy in the state.	X		
		Work with local energy providers to provide incentives for the development of renewable energy resources for residents and local businesses.	X		X
Wetlands and Sub-surface Waters Protection and Management	Increase the protection of existing and future wetlands to maintain the ability of these systems to naturally recharge aquifers and decrease stormwater run-off.	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.	X	X	X
		Develop a City-wide hydrologic study identifying the hydrologic areas, particularly those most susceptible to changes in climate and develop management plans, by 2010.	X	X	
		Incorporate wetland and sub-surface waters protection into the comprehensive master plan.		X	
		Update all relevant City standards to consistently support the protection of wetlands and sub-surface waters, whether during plan review, construction, or during operations.		X	
	Educate the public about wetland protection as a climate adaptation strategy.	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.		X	X
		Devise a public outreach campaign/presentation.		X	X
		Incorporate wetland education into Earth Week and Community Planning Month activities.		X	X
	Increase Keene's water storage capabilities in the face of drought conditions.	Create a watershed management plan.		X	
		Protect aquifer recharge areas.		X	

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
		Devise greywater storage and reuse systems to recycle and utilize water resources more efficiently.		X	
Fauna and Flora	Integrate into recently published state wildlife action plan.	Align City policies to support goals of New Hampshire wildlife action plan by 2010.		X	
	Protect habitats and migration routes.	Identify existing and future potential animal migration routes and techniques for crossing protection, and coordinate installation of crossing route protection in infrastructure, by 2012.		X	
		Develop a habitat protection program and finance options by 2010.		X	
		Establish conservation-related standards for rural development to protect migration routes. Utilize these regulations to ensure habitat connections, or corridors, to allow animal movement.		X	
	Devise land use regulations to preserve forests.	Require sustainable forest management plans for all commercial logging conducted in the City.		X	X
		Create a ban on clear-cutting existing forested areas for building lots in the City and create standards for preparing a forested site for development.		X	
Agriculture	Increase Keene's food security.	Develop a food security plan for Keene by 2010.		X	X
		Incorporate the food security policy and actions into planning efforts by 2012.		X	X
		Create a local food security baseline and increase local food production by 20% within five years. The baseline should be completed by 2010, as part of the food security planning process.		X	X
		Identify and protect prime agricultural soils through ordinance, conservation measures, or other protection measures.		X	
	Research and identify what crops will be productive in our region with a warmer climate and changing soil composition.	Identify research currently underway.		X	
		Develop a "Farmer's Guide," and a residential growers guide that will identify appropriate crops by 2010.		X	X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
	Encourage value added economic activities for agricultural products.	Develop a micro/incubator business program focused on agriculture and value-added agricultural products.		X	
		Create wood processing opportunities locally.		X	
		Create co-generation opportunities locally.		X	
		Develop a downtown food co-op by 2012.		X	
		Link local farmers with food-related businesses within the community and devise a public education campaign to link the public with establishments that support local farms.		X	X
Economy	Create support services for people who lose their jobs (e.g., snowplowing, sugaring) as a result of climate change.	Establish retraining programs.			X
		Establish scholarship programs.			X
		Establish loan programs for citizens who need to revamp their businesses.			X
		Prepare for possible in-migration of affected coastal populations as a result of rising sea level. All areas of social support will be impacted, including housing, jobs, social services, and food supply.		X	X
Public Health	Increase public awareness about the public health implications of climate change, including risks and the need for emergency preparedness.	Provide public education on mosquito and tick protection and disease prevention.			X
		Provide public education on emergency preparedness (e.g., creating an emergency food supply, community evacuation procedures, etc.). In developing a public education program, consider the methods available to effectively communicate the issue to a general audience.			X
		Provide public education on how to handle flood emergency situations (e.g., toxic substances in basement, electrical lines, etc.).			X
		Develop a program that identifies various vector control methods and policies to apply those methods.			X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
		Anticipate the arrival of new vectors and associated diseases and identify alternative methods to control or eradicate those vectors (develop early detection and warning systems, review the use of spraying and consider the health implications of those actions, etc.).			X
	Train and Educate Emergency/ Human Services/Public Health officials and workers.	Establish training programs for public health workers to deal with the emotional aspects associated with loss of life and property caused by extreme weather events.			X
		Establish a support system to identify and manage emergency worker burnout.			X
Emergency Services	Improve the reliability of emergency communications during severe weather events.	Inventory the telephone land-line availability in local businesses and private residences by 2009.			X
		Devise a plan to effectively identify community communications vulnerabilities and options by 2010.	X		X
	Increase community communication for emergency events.	Devise and coordinate a county-wide system to effectively communicate emergency information to the community.			X
		Address loss of cellular service and identify other means of communication that can be used when conventional systems are down.	X		X
		Develop an Incident Command System (ICS) to identify a process and/or chain of command for communication.	X		X
	Increase the ability of the public to respond/recover from extreme weather events.	Create an education program to increase public awareness of extreme weather event resources in coordination with Keene All-Health Hazard Region Annex by 2012.			X
		Identify and designate convenient, reliable shelters for cold/warm extreme weather events by 2012.			X
		Create excessive-heat/cold weather emergency policies.			X
		Establish a Reverse 911 (10 towns in New Hampshire currently have it in place) automated call-back system in the community to notify residents of evacuation routes or other information in the event of an emergency or disaster.	X		X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
		Consider how to create and then disseminate information to the public for new extreme-weather related emergencies (e.g., what to do with toxic materials that may be in a flooded basement, what to do with the water in a basement that becomes contaminated, etc.).			X
		Identify a waste management program for debris.			X
		Identify distribution points for life-essential good and services.			X
		Create programs to provide assistance beyond the event (e.g., counseling, job placement, etc.).			X
	Continue to train and educate staff and the public regarding current and future diseases and associated vectors.	Increase special fund for training, monitoring, and education by 100% in five years.			X
Promote a Local Climate Appropriate Economy	Support environmentally sustainable businesses and economy.	Review and rewrite zoning code and land development regulations in five years to include sustainable building materials, design, and energy conservation measures.	X		X
		Provide incentives for businesses to locate in Keene that produce sustainable and environmentally friendly products or that utilize sustainable principles in their production processes.			X
		Create an Economic Development Coordinator position within the City.			X
	Increase the vitality and competitiveness of local business.	Identify economic development policies and goals that incorporate sustainability; then seek out businesses that meet those goals.			X
		Support business incubators to bolster local business development that provides “niche” services or products that are environmentally friendly.			X
		Provide assistance in the creation or identification of markets for sustainable businesses or their products.			X
		Create a media package that invites target companies to locate in Keene and highlights Keene’s commitment to the environment and sustainability.			X

OPPORTUNITY	GOAL	TARGET	BUILT ENVIRONMENT	NATURAL ENVIRONMENT	SOCIAL ENVIRONMENT
		Create a way-finding system to increase ease of movement and access to key areas (e.g. downtown, evacuation routes, warm/cool shelters) of the City via alternative transportation modes and prioritize clearing of these paths in the event of emergencies.			X
Food Security	Support local agricultural economy.	Inventory and map existing farms (acreage and commodity) by 2010 and update every five years.			X
		Increase local food production by 20% within five years of establishing baseline of community food production. The baseline should be completed by 2010, as part of the food security planning process.		X	X
		Double the size and number of community gardens by 2027.		X	X
		Identify protected and unprotected agricultural areas by 2010 and aim to protect at least 10% of unprotected lands by 2020.		X	X
		Identify plants that will be compatible with future projected climate and soil conditions by 2010.			X
		Educate the community about the relationship between food production and greenhouse gas emissions that contribute to global warming.			X
		Provide the local farmers' market with a permanent space (land or building) for the market to occupy.			X
		Coordinate City events with farmers' market days, when feasible.			X
		Explore changes to the zoning code to encourage farming (on any scale) and discourage the development of open space areas that could be utilized as agricultural land.			X

FOR MORE INFORMATION:

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