

Windham

VULNERABILITY ASSESSMENT



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ACRONYMNS

ACS	American Community Survey
CDC	Center for Disease Control
CMP	Central Maine Power
DEP	Department of Environmental Protection
DWP	Drinking Water Program
EPA	Environmental Protection Agency
ERC	Environmental Resources Committee
GHG	Greenhouse Gas
Maine DOT	Maine Department of Transportation
MOCA	Maine Office of Community Affairs
MSAD	Maine School Administrative District
NCEI	National Centers for Environmental Information
NOAA	National Oceanic and Atmosphere Administration
RTP	Regional Transportation Program
SFHA	Special Flood Hazard Area
SWAP	Source Water Assessment Program
TRAPPD	Transportation Risk Assessment for Planning and Project Delivery

GLOSSARY

Acidification	The gradual lowering of the ocean's pH caused mostly by the ocean absorbing excess carbon dioxide (CO ₂) from the atmosphere.
Adaptation	The process of adjusting to or preparing for changing conditions to reduce the vulnerability of impacted assets.
Biodiversity	The variability of all living organisms and their ecosystems on Earth that is crucial to maintaining ecological balance and supporting human health and well-being.
Carbon Sink	Any natural or man-made system that absorbs more carbon dioxide from the atmosphere than it releases, helping to lower the concentration of greenhouse gases.
Climate refugee	People who are displaced due to climate hazards.
Cost-Burdened	When a household spends 30% or more of their income on housing expenses.
Crowding	A household with more people than rooms. This includes owner-occupied and renters.
Culverts	Structures that allow water to pass through under a road or railroad. They can vary in size and structure.
Disability	Defined by the ACS as those who report having serious difficulty with specific functions. The survey uses follow-up questions to capture six aspects of disability– hearing, vision, cognition, and ambulation, self-care, and independent living.
Drought	Defined as a 12-month period during which precipitation is less than 85% of the normal.
Emergency Management Plans	An outline for how to mitigate, prepare for, respond to, and recover from the effects of an emergency or disaster. Organizations, municipalities, or individuals can create their own emergency management plans.
Evapotranspiration	A crucial component to the water cycle where water vapor is released back into the atmosphere from plants and soil surfaces.
Greenhouse Gas	A gas such as carbon dioxide or methane in Earth's atmosphere that absorbs heat emitted from the planet's surface and then re-emits it back, keeping the Earth warm.
Hazard	A physical process or event, exacerbated by climate change, that can bring harm to people, communities, or ecosystems.
Impact	The potential effect a climate hazard can have on human or natural assets and systems.
Impervious surface	Hard surfaces, such as concrete or asphalt, that allow little or no stormwater infiltration into the ground.
Invasive Species	Plants and wildlife that spread to the point that they can cause harm to ecosystems, usually out-competing local species for resources or hunting prey down to dangerously low populations.
Land conservation	Setting aside parcels of land for permanent protection through fee acquisition or a conservation easement, a binding legal agreement with accompanying tax benefits that protects natural resources.
Land cover	The vegetative characteristics of the land such as forest, wetland, impervious.
Land use	Reflects how people use land such as recreational, mixed use, or conservation.
Multi-Unit Structure	A housing structure with 3 or more units.

Resilience	The capacity of communities or natural environments to adapt and/or recover quickly from impacts.
Risk	The potential for negative consequences where something of value is at stake. In the context of the assessment of climate impacts, risk can be assessed by multiplying the probability of a hazard by the magnitude of the negative consequence or loss.
Shock	Acute events occurring over a specific period of time, such as heat waves or dangerous weather events, made more severe or frequent by climate change.
Stressor	A chronic condition or trend related to climate change that can exacerbate preexisting hazards.
Stormwater	Water from rain or snowstorms that flows over streets, parking lots, and roofs and into a water body or storm drain.
Social Vulnerability	Factors that may weaken a community's ability to adapt to or recover from a disaster and it is an indicator of community resilience. Examples: Age, race, households with no vehicle, financial burden.
Urban forest	Trees within a densely populated area, including trees in parks, on streetways, and on private property.
Vector borne disease	Diseases passed to humans through non-human vectors, such as mosquitoes, ticks, fleas, and bacteria. These vectors pass diseases that are often debilitating and sometimes fatal, and most vector species thrive in high heat and high humidity environments.
Vulnerability	A measure of risk to a threat, incorporating the likelihood of the threat occurring and the severity of the impact if it occurs.
Zoning	Ordinances impact land use by limiting what developers and landowners can do with their properties.

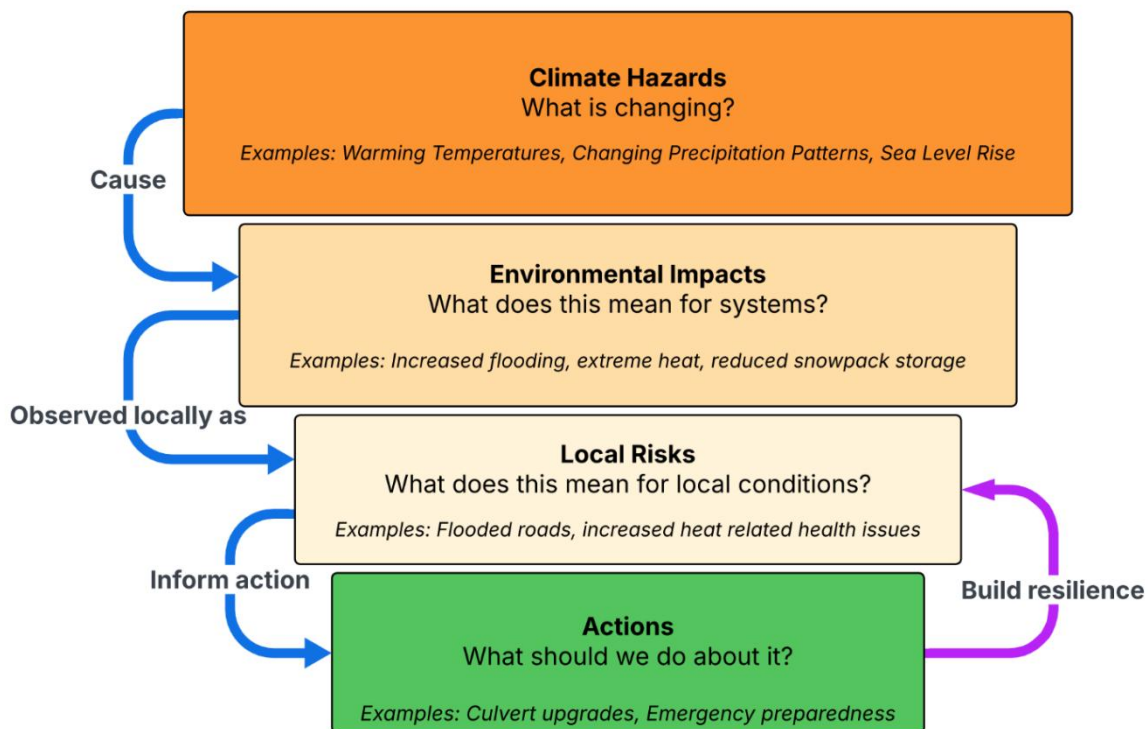
1. Introduction

Climate change is already affecting Maine by bringing rising temperatures, more frequent extreme weather events, and shifting precipitation patterns that threaten our health, infrastructure, and environment. However, local solutions through coordinated planning and action are within reach. On a community scale, we can build resilience and capacity to adapt to climate hazards, reduce existing vulnerabilities, and take steps to mitigate future impacts. Recognizing the need to prepare for these challenges, Windham is completing a climate vulnerability assessment to identify the people, places, and systems most at risk and to guide informed decisions that strengthen community resilience now and in the future.

The Vulnerability Assessment is a high-level assessment of potential risk across the entire community. It highlights areas that may need further study and does not provide site specific assessment. It is designed to be adaptive, allowing updates as new information becomes available.

1.1 Vulnerability Assessment Framework

This figure illustrates the step-by-step framework used to complete the climate vulnerability assessment. It begins with identifying **Climate Hazards**, which represent the changing environmental conditions. These hazards lead to **Environmental Impacts** that affect natural systems. The impacts then translate into **Local Risks**, highlighting specific challenges faced by communities. Finally, **Actions** are taken to address these risks and build resilience. The flow illustrates how identifying climate hazards and their cascading impacts provides the foundation for informed actions that reduce vulnerability and build resilience at the local level.



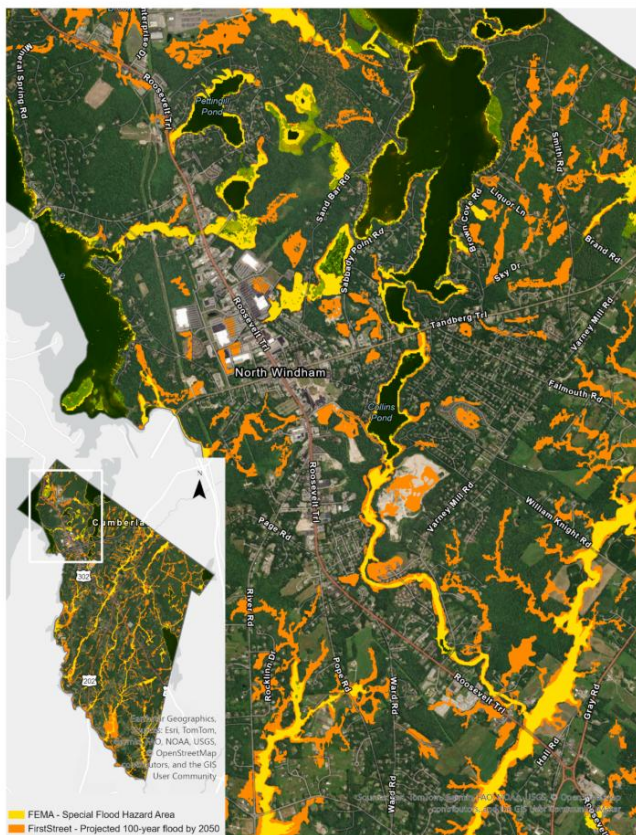
1.2 Assessment Structure

The Vulnerability Assessment was developed through a collaborative process that combined community input with available local and regional climate data. By engaging the community and utilizing available data, the assessment reflects local experiences, and the climate-related impacts Windham may experience in the future.

The Vulnerability Assessment is divided into three main sections:

1. **Identification of Climate Hazards and Impacts:** Identify regional climate hazards affecting Windham and the broader region.
2. **Analysis of At-Risk Populations and Resources:** Identify and map community populations and resources most at risk, including an explanation of importance.
3. **Action Items:** Recommended strategies based on assessment findings and community input.

Figure 1. Map comparing First Street Flood Factor model (orange) to FEMA Special Flood Hazard Zone (yellow).



1.3 Data and Methodology

1.3.1 DATA SOURCES

This report relies on national, state, regional, and local data to assess climate hazards, historical records, future projections, and impacts on local assets. There is currently limited localized data on climate hazards, and much of the modeling is conducted at the regional or state level. Therefore, this assessment relies primarily on information from the Maine Climate Council's Scientific and Technical Subcommittee "[Scientific Assessment of Climate Change and Its Effects in Maine](#)". Since there is a lack of localized data collection tools, such as air quality monitoring sites, this assessment uses regional data with specific discussions of Windham's particular context when possible.

1.3.2 QUANTITATIVE RISK ANALYSIS

The data analysis for this vulnerability assessment generated quantitative risk-based information on how the community, infrastructure, and natural resources in Windham are exposed to climate hazards, particularly inland flooding. When assessing specific resource vulnerabilities, this report uses data provided by the town of Windham, supplemented with state-owned data that was analyzed at the local level.

Inland flooding poses challenges to travel and threatens to limit access to resources, but also threatens the properties, businesses, and natural resources within Windham's boundary. Inland flooding maps show the result of flooding due to projected precipitation during severe storms, helping understand where critical assets may be flooded.

To determine the impacts of 100-year floods, particularly along inland waterways, this report uses 2050 projected 100-year flooding data from First Street Foundation's Flood Factor. ¹ A 100-year flood is a statistical term used in flood risk management to describe an event that has a 1% chance of occurring in any given year, based on historical rainfall, water levels, and other watershed conditions. As the frequency and intensity of precipitation patterns change, the historical conditions used to define 100-year floods may underestimate future flood risks.

Flood estimates are used to guide land use planning, infrastructure design, and insurance requirements. Therefore, by using the projected 2050 flood conditions, the analysis incorporates anticipated precipitation pattern changes.

1.3.3 SOCIAL VULNERABILITY ANALYSIS

To develop a better understanding of populations at risk, this analysis uses the U.S. Census data to identify populations with the potential for high social vulnerability. Demographic data in this report relies primarily on American Community Survey (ACS) 5-year estimates (2019-2023) from the U.S. Census Bureau. ACS data is collected yearly by surveying only a portion of households. As a result, the ACS estimates may be imperfect and frequently do not match exactly with local data. However, there is very little local data collected on community wide demographics, so the ACS is the best available standardized data set.

For example, people who respond to the census often have higher incomes, more education, and higher homeownership rates than those who don't, which means the census has historically undercounted underrepresented groups. Although the data is flawed, it still provides Windham with baseline information and the ability to compare shifts in demographics. Where possible, this report provides supplemental local data or anecdotes from the community to better understand the local context. Windham recognizes the limitations in this data and will try to refine its understanding of at-risk populations by working with emergency management

staff and local community organizations to continually assess community risk.

Factors for analysis were determined based on the Maine Social Vulnerability Index and the CDC's Social Vulnerability Index to highlight Windham's social vulnerability. The Maine Social Vulnerability Index developed for the Maine Climate Council identifies 19 social demographic characteristics that contribute to an individual's or household's vulnerability to climate impacts. ²

1.3.4 QUALITATIVE DATA AND COMMUNITY INPUT

Information on the sensitivity and adaptive capacity of existing assets is qualitative and provided by town staff and community engagement. Local and qualitative data relies on input from municipal staff, committees, community organizations and the public through surveys.

The Community Concerns Survey provided insight into community experiences and local priorities that may not be captured in quantitative data sets. These perspectives are incorporated throughout the report to complement the analysis.

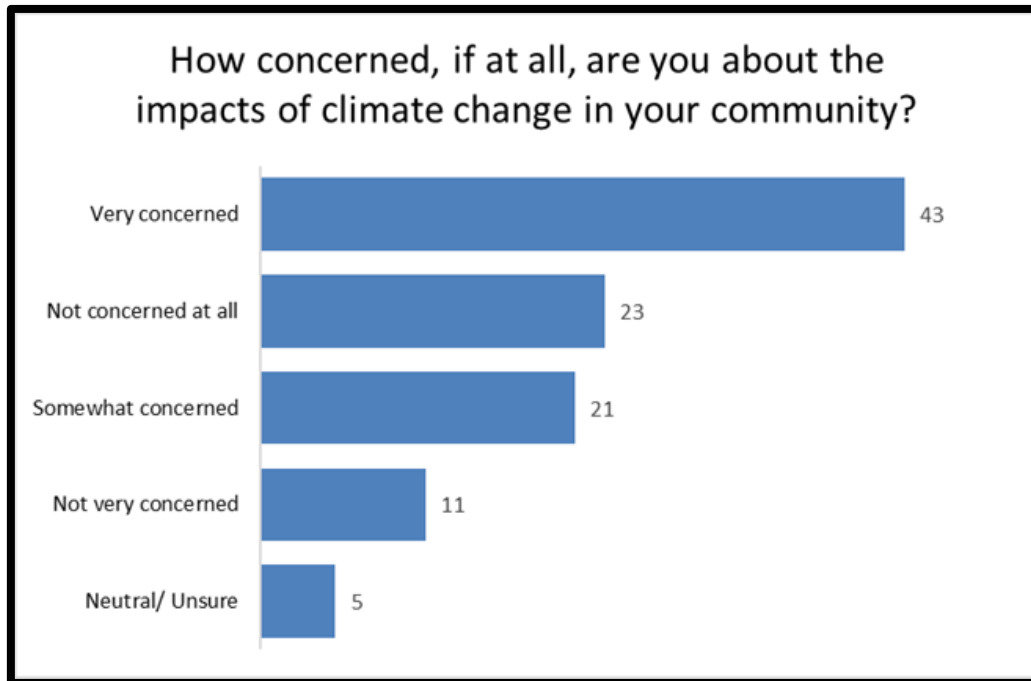
1.3.5 LIMITATIONS

This assessment uses the best available data and modeling tools; however, every dataset has limitations. The State of Maine and regional partners continue to research climate change and provide updated models, data, and resources. As improved data and more powerful models become available, this vulnerability assessment will need to be updated and refined.

1.4 Community Engagement

A Climate Concerns Survey was hosted online from December 2025 to January 2026. A total of 105 community members responded anonymously, sharing their perspectives on: 1) specific concerns about climate impacts, 2) particularly vulnerable locations or populations within the town, and 3) local resources, challenges, and priorities. The public feedback received was used to help shape the priorities listed in this report. Additional community responses are highlighted throughout the report.

SURVEY RESULTS



*Figure 2: **Level of Concern About Local Climate Change Impacts.** Among 103 total respondents, the largest share indicated that they are "Very concerned" about the impacts of climate change in their community.*

When prompted about specific weather and environmental concerns in Windham, respondents emphasized the challenge of balancing development with natural resource management, especially concerning groundwater quality. Others noted concerns about making informed energy decisions, managing excessive rainwater impacts, and the health of Highland Lake.

Approximately 22% of survey participants responded that they were "not concerned at all" about the impacts of climate change in their community. Comments from this group commonly expressed skepticism about climate change or its place in local planning. Several respondents suggested that global warming would lead to colder winters locally, or that recent weather changes are part of natural climate cycles rather than long-term changes. Others characterized climate change as exaggerated, and some expressed concern that addressing it would be a waste of time and public resources. These responses reflect a range of perspectives within the community regarding drivers, severity, and priority of climate-related issues.

2. Climate Hazards

This section provides a condensed overview of the key climate hazards affecting Windham. For a more detailed analysis of climate trends and projections, please refer to the full Maine Climate Council reports³.

Climate hazards refer to the potential occurrence of climate-related physical events or trends that cause damage and loss felt by communities. Windham is already beginning to experience warmer air temperatures, increased precipitation, more severe storms, and intense flooding and erosion from climate change. These climate hazards degrade infrastructure and pose risks to people, ecosystems, and community assets.

The intensity and frequency of storm events and weather hazards have been unprecedented in recent history. Since 1980, the United States has experienced 403 confirmed weather disasters that each led to over a billion-dollar loss.⁴ Maine has experienced many of its own climate disasters, including storms that hit in late 2023 and early 2024. The increased severity and intensity of these events have coincided with an overall increase in Earth’s

average annual temperature due to increased greenhouse gas emissions. Climate hazards combined with existing vulnerabilities have already led to widespread and devastating loss and will continue to wreak havoc.

This section provides information on the following climate hazards Windham will face, both directly and indirectly:

- Warming, more variable temperatures
- Changing precipitation patterns

Windham is one of many communities affected by climate hazards and their impacts. Cumberland County, the region, and the state are experiencing similar trends across all hazards. Since local data is not available, this section relies primarily on regional and state data to assess the historical trends and future projections.

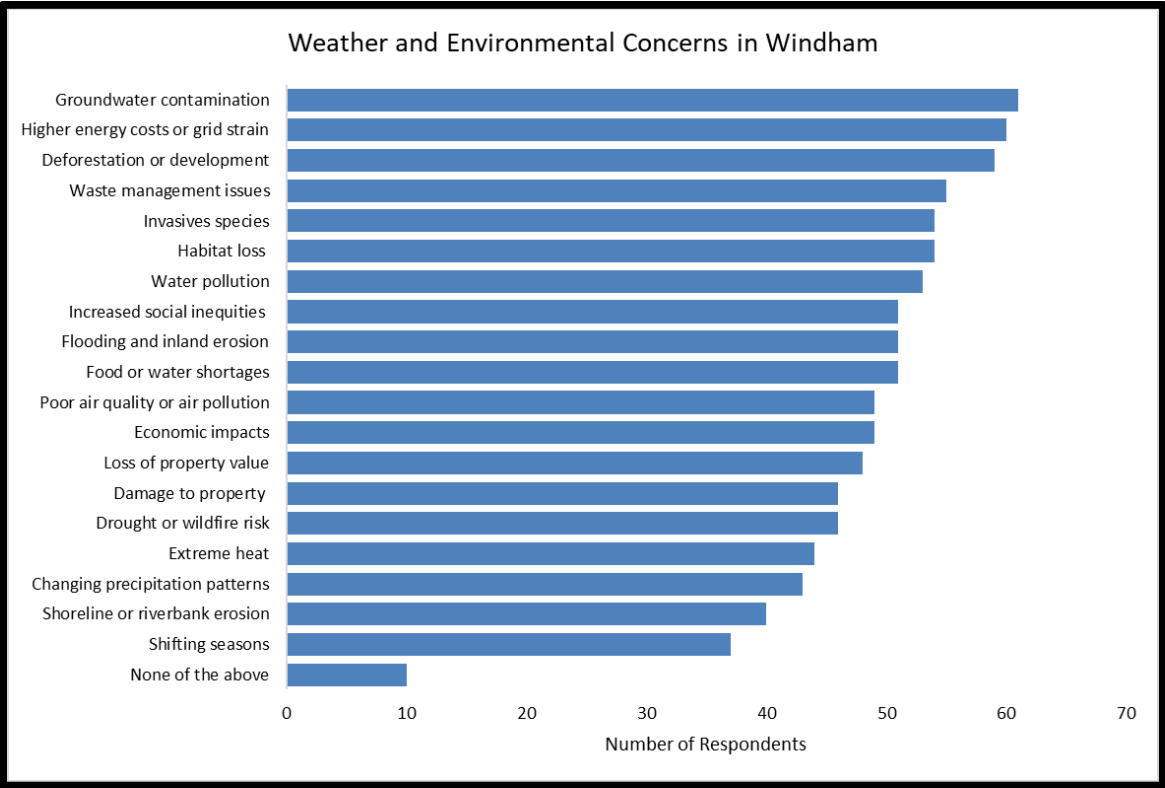


Figure 3. Weather and Environmental Concerns in Windham. Groundwater contamination, high energy costs or grid strain, and deforestation or development emerged as the top concerns in Windham among 104 respondents.

2.1 Warmer, More Variable Temperatures

Historical Trends	What we see today	Road ahead
While all regions of the globe will experience impacts from climate change, the Northeast is warming at a faster rate than the global average. ⁵ Maine has seen an average annual temperature increase of 3.2°F since 1895. ⁶ Every year since 1997 has been above the yearly average. ⁷ Winter has warmed 5°F compared to a century ago and is the fastest warming season ⁸ .	The past four years in Maine (2020-2023) have ranked among the ten warmest on record , with 2023 being the second warmest. The average warm season for 2010–2023 is about two weeks longer, and winters about two weeks shorter, in comparison to 1901–2000 the historical climate baseline. Similarly, there has been a two-week increase in the average length of the growing season since 1950. ⁹	As an inland community, Windham has experienced slightly more warming than the state average and is projected to have annual temperatures 3.3° to 4° degrees Fahrenheit higher than 1895 by 2050 and up to 10°F by 2100. The region will experience 20 to 30 more high heat days annually by 2050 and the winter season will shrink by one to two weeks. ¹⁰

2.2 Changing Precipitation Patterns

Historical Trends	What we see today	Road ahead
Annual precipitation in Maine has increased 6 inches since 1895 . ¹¹ The intensification of the hydrological cycle means Maine’s dry periods are becoming drier, and wet periods are becoming wetter ¹² .	Higher temperatures increase water evaporation from oceans and freshwater sources, resulting in overall higher humidity. Warmer air holds more moisture, causing precipitation events to become more frequent and intense, increasing total annual precipitation ¹³ . Maine now receives 1–2 additional days per year with 2+ inches of precipitation, and 2–3 more days per year with 1 inch of precipitation . Precipitation variability between years is increasing and has recently produced impactful seasonal extremes; for example, the 2020 growing season was the driest on record, and summer 2023 was the wettest. In December 2023, Maine experienced significant flood and wind damage, triggering a disaster declaration in 10 counties.	Most climate models project more intense cyclones (lower central pressure and increased heavy precipitation), but with an overall decrease in the number of storms as the climate warms. ¹⁴ However, future storm frequencies remain uncertain because of model disagreement on average future positions of North Atlantic storm tracks. While future drought trends remain uncertain, warmer temperatures and earlier snowmelt can exacerbate dry conditions when they develop.

2.3 Sea Level Rise

Sea-level rise can worsen inland flooding by affecting rivers, streams, estuaries, and lakes. Inland flooding typically follows heavy rainfall, rapid snowmelt, dam and levee failures, or any situation where water exceeds the capacity of local drainage systems. Rising seas amplify these risks. Although Windham is not directly exposed to coastal flooding, sea-level rise and shifting ocean conditions can still influence the region through economic shifts, climate migration, or disruptions to the food supply. These factors are addressed throughout this assessment where relevant.

3. Risk Assessment

The frequency and severity of these climate hazards have left many communities, ecosystems, and infrastructure unable to adequately withstand and adapt to the extreme forces, as they were not built to accommodate many of the challenges we are experiencing today. While it is difficult to adequately quantify the vulnerability or risk of various communities and resources, the following section uses available data to provide a baseline understanding of where Windham is most at risk due to climate hazards.

This section provides information on the following sectors that could be impacted with the increase in climate hazards:

- Infrastructure
- Natural Resources
- Community Resources
- People

CASCADING IMPACTS

Climate hazards often trigger cascading impacts, where effects on one resource ripple across others. For example, a flooded road not only damages the infrastructure; it also can restrict access to properties and essential services, impacting residents, businesses, the economy, and further straining critical resource availability. These interconnected effects amplify existing social, environmental, and economic challenges that disproportionately affect vulnerable populations and resources, highlighting the importance of planning for both direct and indirect consequences of climate change. While fully capturing cascading impacts is difficult, they were taken into account when determining priorities and recommendations.

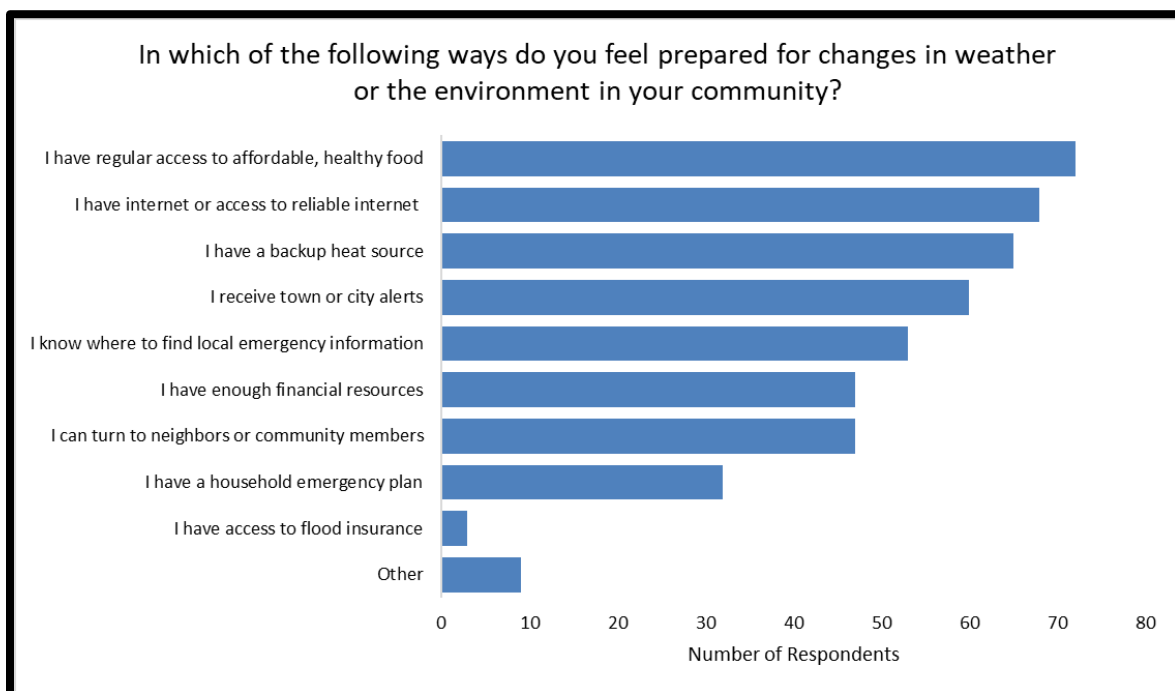


Figure 4: **Weather and Environmental Changes Preparedness.** Food, internet, and backup heat access were identified as top preparedness factors among 105 respondents.

3.1 Infrastructure

Climate hazards damage critical infrastructure such as roads, buildings, and utilities through flooding and erosion caused by extreme storms and heat. Today's infrastructure was not built to withstand the types of extreme weather we see currently, and that is predicted to occur in the future. Although a 100-year storm has a low percent chance of occurring in any given year, the most valuable infrastructure and access to neighborhoods needs to be protected given the potential impacts. Investments in resilient infrastructure can significantly reduce long-term costs. For example, every \$1 spent on hazard mitigation saves an average of \$6 in future repair and recovery costs.¹⁵

This section provides a summary of risks and impacts that Windham's infrastructure faces due to climate change. The infrastructure section contains information on the following resources:

3.1.1 Transportation

3.1.2 Buildings

3.1.3 Water Utilities

3.1.4 Power and Communication

WHAT RESIDENTS ARE SEEING...

"Stronger thunderstorms resulting in power outages and property damage."

"Rain wind power outages infrastructure damage for long periods of time."

"High wind events and property damage related to it."

WHAT RESIDENTS ARE SAYING...

"I am worried about the local climate becoming more erratic and localized, making it more difficult to predict conditions between my workplace and my home."

"Funds should be put into building better infrastructure, roads, etc. preparing for those natural disasters."

"We have a well and we've been concerned about it running dry this year. We've also had our newly paved driveway destroyed by excessive rainwater in the last couple of years. I'd love for the town to focus on addressing water issues on Dutton Hill."

Responses from the Climate Concerns Survey

3.1.1 TRANSPORTATION

Climate Hazard	Impacts
Warming Temperatures	- Excessive heat causes buckling, cracking, and softening of pavement, warps rail lines, and shortens intended lifespan of materials which increases the cost for repairs and replacements, and makes the infrastructure more susceptible to damage during extreme storms - Increased freeze-thaw cycle also hastens the degradation of materials through cracking, further shortens the intended lifespan of the infrastructure and increases costs for repairs or need for replacement.
Changing Precipitation	- Roads, bridges, culverts, and rails could be damaged during intense storms or inundated with water which disrupts service and access for community members or emergency services, prevents access for service or repair, increases costs for maintenance and repair, and disrupts the broader supply chain and transportation system. - Flooded transportation infrastructure impacts natural resources as undersized or flooded culverts create barriers for wildlife and habitat, and flooding increases amounts of runoff and sediment from impervious surfaces into water bodies.

Why this matters

Effective and efficient transportation infrastructure supports resident mobility, economic development, emergency response, and social activity, but it is highly vulnerable to destruction from climate hazards. Heavy rainfall, inland flooding, and extreme heat can damage, destroy, and increase deterioration rates of transportation infrastructure, resulting in loss of access and increased maintenance and repair costs. Protecting and adapting transportation infrastructure ensures mobility, reduces economic disruption, and supports disaster response. Planning for resilient roads, bridges, and railways helps maintain safety, reliability, and accessibility in the face of more frequent and intense climate events.

At –A-Glance: *Transportation infrastructure in Windham that is vulnerable to flooding based on projected 100-year flooding in 2050:*

Roadway	13.9 miles
Bridges	20
Culverts	11
Rail Line	2.5 miles
Bike and Pedestrian Paths	10.9 miles
Transit Corridors	0.11 miles

Risks in Windham

Roadways

Climate change threatens to bring an increased chance of flooding to roadways within Windham. The town has around 243 miles of roadway—around 50% of which are public roads.

Modeling shows that approximately 14 miles of roadway would experience some degree of flooding during a 100-year storm event by 2050.

At-risk sections of major corridors threaten to cut off access to critical resources, such as hospitals and grocery stores. The portions of following major routes that could experience flooding by 2050 include:

- Highway 302
- Highway 202

With limited roadways and few, if any, alternative routes in rural communities like Windham, flooding on even a single section of road can trap residents and completely cut off access to critical resources.

The roads with the largest sections of projected flooding by 2050 include the following. While the total amount of miles impacted is relatively small, if flooding is deep enough on small sections of road, that renders the road impassable.

- River Road (1.41 miles)
- Presumpscot Road (0.54 miles)
- Windham Center Road (0.33 miles)
- Albion Road (0.30 miles)

There are numerous other roads with sections of flooding that could additionally disrupt access to resources and trap residents.

Bridges

Climate change threatens to bring an increased chance of flooding to local and state bridges within Windham. Flooding may not only make bridges impassable, but also structurally unstable. MaineDOT has mapped 34 bridges in Windham. During storm events by 2050, 20 out of the 34 bridges in Windham are located in flood-prone areas. Many of the impacted bridges are the roads that cross the Pleasant River, including River Road. This analysis, however, cannot determine the height of the bridge and degree, if any, to which the bridge deck itself would flood. Therefore, future studies should assess the bridge elevations of the most at risk to withstand flood water levels.

Culverts

MaineDOT mapped 7 large culverts and 70 cross culverts in town. While these culverts cross many waterways at risk of flooding, the capacity and likelihood of being overtopped could not be assessed. Flooding and overtopping of culverts on

major routes, or small connector roads cut off access and severely limit those living in rural areas. This would make emergency access or evacuation difficult.

The Nature Conservancy developed an analysis of culverts at risk of overtopping in a flood: [Culvert Flood Risk Explorer | Maine](#). According to these models, **there are 11 culverts at risk of overtopping, 8 high risk and 3 medium risk culverts.**

Rail

Portions of the Maine Central Railroad Mountain Division line along the Presumpscot River are at risk of flooding during storms.

Transit

Impacts to public transportation include limited access during flooding events due to the flooded roadways, bridges, and culverts listed above.

- Lakes Regional Explorer provides bus service along Route 302.
- Regional Transportation Program (RTP) provides low-cost transportation by request only to the elderly, social service agency clients, the economically disadvantaged and persons with disabilities throughout Cumberland County.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Infrastructure		
High	Roadways	• Modify roadways during natural infrastructure life cycle replacements. • Develop an alternative access route plan for emergency services during flood events, in coordination with MaineDOT and regional partners. • Pilot a stormwater retrofit street using green infrastructure (rain gardens, bioswales, or permeable pavement) on a municipally owned road. • Install small-scale green infrastructure (rain gardens, vegetated swales) along municipal rights-of-way to reduce runoff.
	Bridges	• Complete water level analysis to ensure bridge heights (roads and rail) exceed expected flooding levels and determine structural integrity of bridges. • Coordinate with MaineDOT to assess bridge elevations and structural vulnerability and identify future upgrades consistent with DOT capital planning cycles.
	Culverts	• Conduct a culvert inventory and prioritize culvert upsizing based on TNC overtopping data, focusing on crossings in high-risk flood areas.
Low	Rail	• Coordinate with the railway owners to ensure continued viability and access (Given ownership challenges; actions for this infrastructure are outside of the scope of this project).

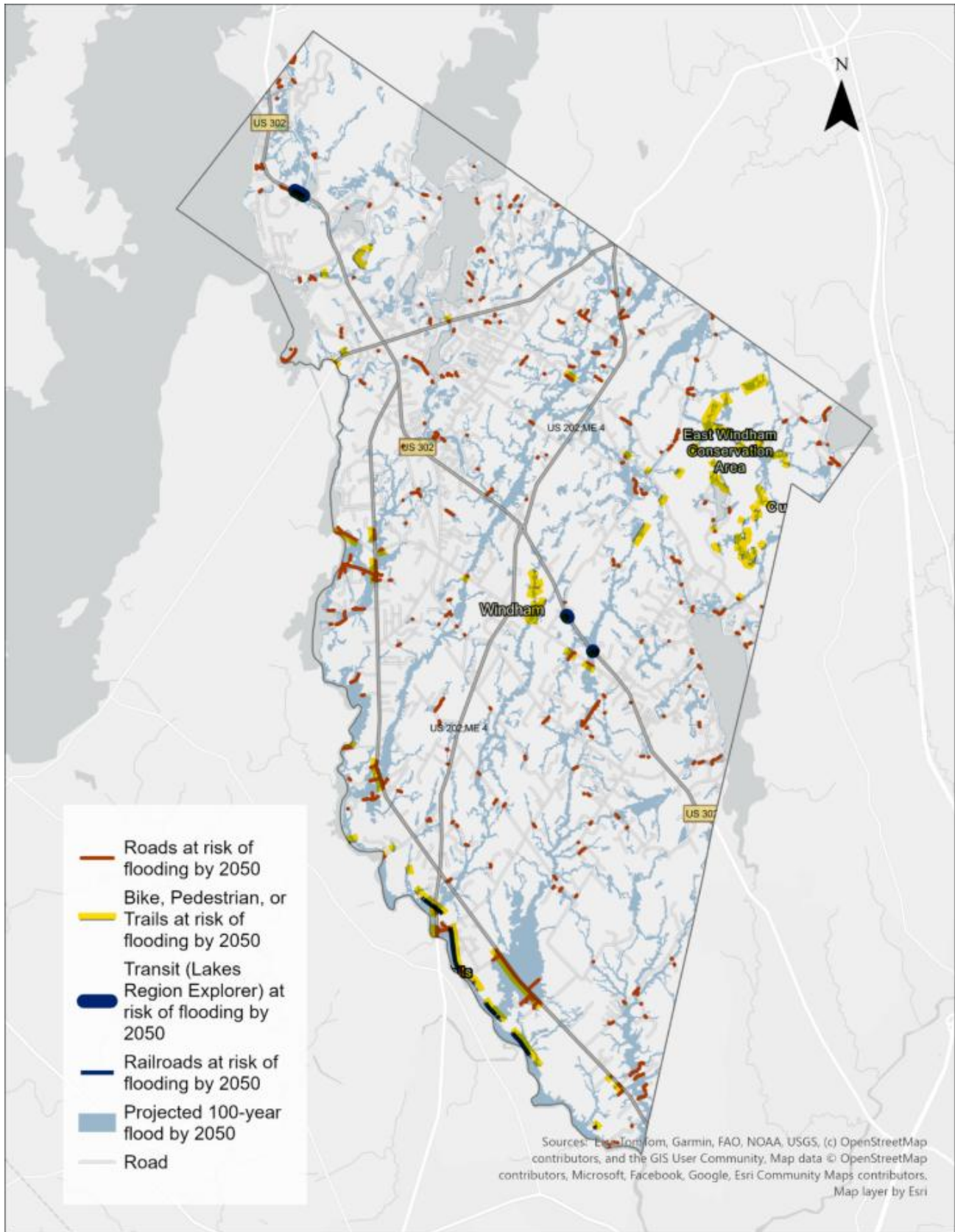


Figure 5. Roads, pathways, and transit in at-risk flooding areas during 100-year flood by 2050.

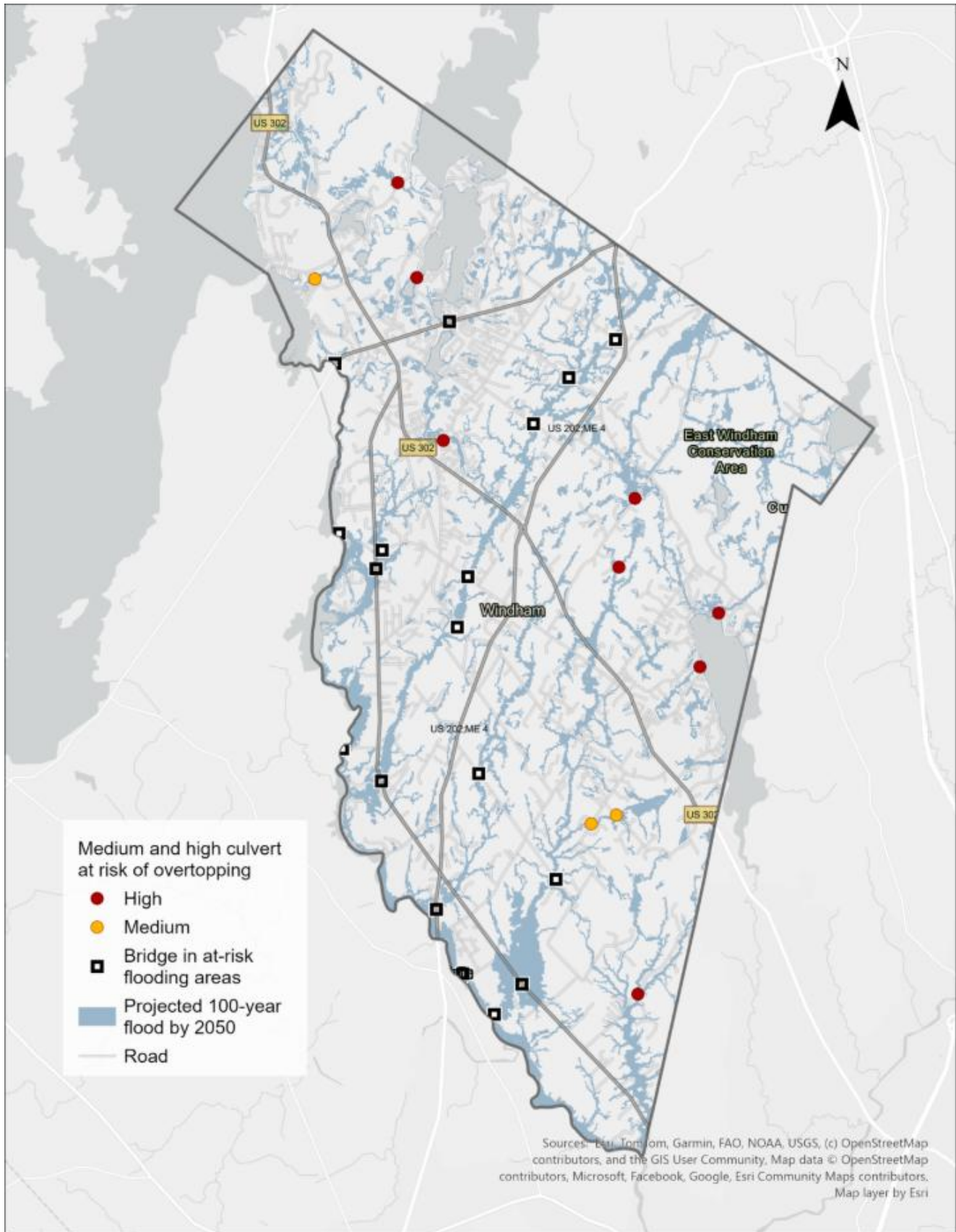


Figure 6. At-risk culverts and bridges during projected 100-year flood by 2050.

3.1.2 BUILDINGS

Climate Hazard	Impacts
Warming Temperatures	Building materials degrade faster under sustained heat. Increasing extreme temperatures strains energy demand and increases costs.
Changing Precipitation	- Flooding and extreme weather will damage buildings and degrade materials, which would require more costs for repair. Impacts to buildings will also strain the availability of community resources and services, could alter property values, displace residents/businesses, and strain surrounding resources needed for recovery. - Improper clean up after flooding can result in mold in the home, presenting health concerns in addition to the financial burden of repairs.

Why this matters

Buildings house people, businesses, and essential services, making their resilience central to community well-being and economic stability. Buildings are increasingly at risk of heat stress, flooding, and storm damage which can damage property, compromise safety, and drive-up repair costs. Older housing stock are especially susceptible to damage and higher energy costs if they have not been properly maintained or retrofitted with more resilient building materials. Buildings along waterbodies are more prone to risk from inland flooding. It will be important to plan for and design climate-resilient buildings through energy efficiency, improved materials, and adaptive design to protect communities, reduce emissions, and ensure structures remain functional during extreme weather.

Risks in Windham

At-A-Glance: *Buildings and parcels in Windham that are vulnerable to flooding based on flooding scenarios:*

Buildings	346
Parcels	3,520

According to the analysis, there are **346 buildings at risk of experiencing impacts from at least a minor degree of flooding during a 100-year storm by 2050**. The highest concentration of impacts are properties near where Maine Street intersects the Presumpscot River.

While these buildings are subject to direct flooding, it should also be noted that more buildings may be damaged by strong storms or high winds. However, this cannot be assessed through this report. Older buildings or buildings not upkept are most at risk of severe storm damage.

Over 3,500 parcels in Windham — representing 44% of all parcels — may experience flooding during a 100-year storm. This includes parcels designated as roads, rails, and utilities. It is important to note that the degree of flooding on each parcel varies, and most parcels will have minimal flooding that does not impact the overall use of the property.

Although flooding may not directly impact the principal building located on each parcel, water inundating the property still poses various risks to accessory structures and utilities. Flooding can disrupt access to buildings by overflowing driveways and sidewalks, carrying contaminants into wells, overloading septic systems, and interfering with other utilities.

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
Infrastructure		
Medium	Buildings	- Complete a resiliency audit for municipal buildings to assess floodproofing needs, HVAC upgrades, and backup power requirements. - Incorporate resilient design and on-site stormwater practices into local site plan and subdivision review standards. - Offer voluntary “Flood-Ready Building Assessments” for properties in at-risk areas, providing guidance on elevating utilities, foundation sealing, and on-site stormwater improvements.

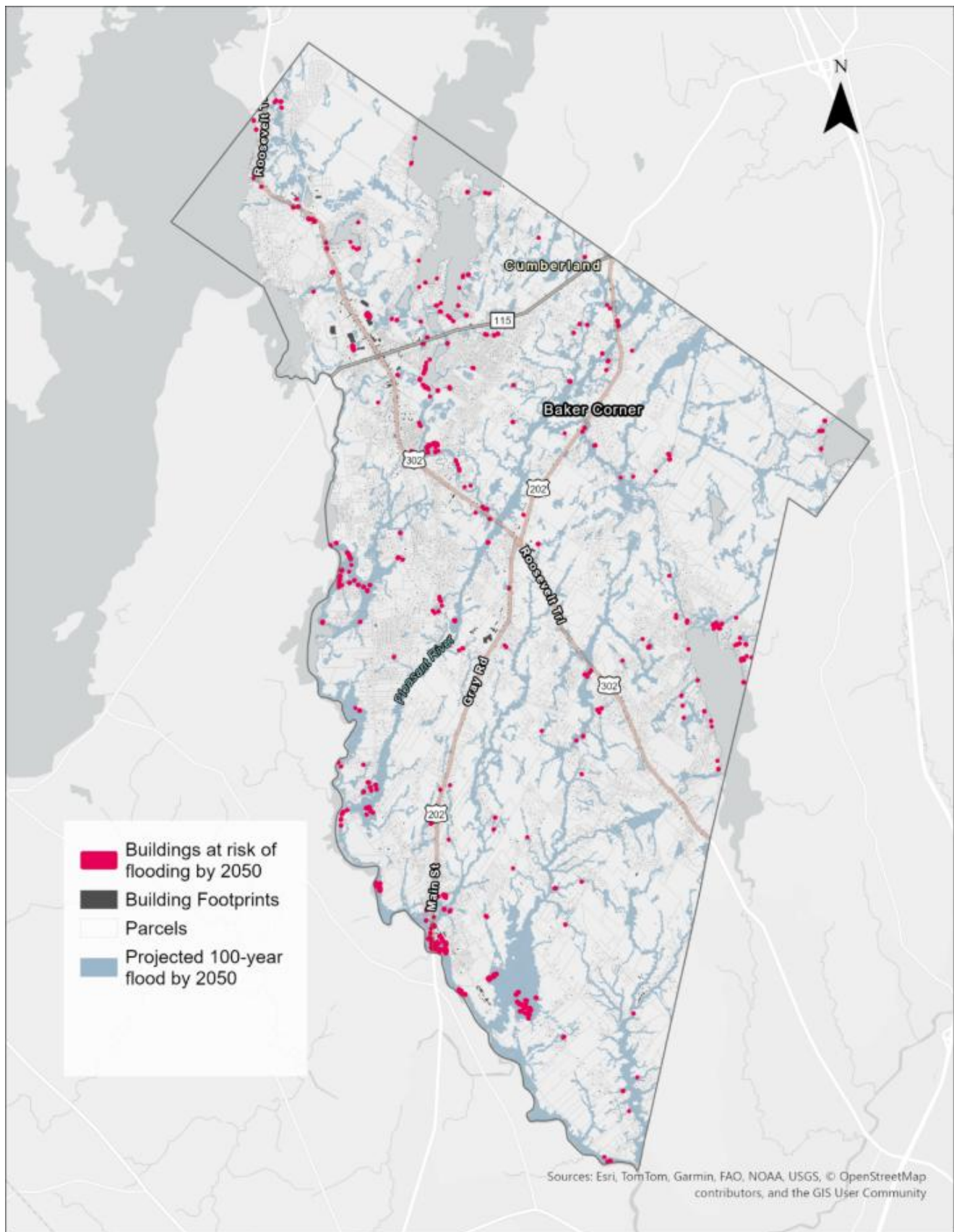


Figure 7. Buildings and properties in at risk-flooding areas during 100-year flood by 2050.

3.1.3 WATER UTILITIES

Climate Hazard	Impacts
Warming Temperatures	• Extreme temperatures, and increased fluctuations in temperatures (freeze-thaw cycles) degrade materials quicker, and can result in costly repairs. • Higher temperatures can alter the biological processes in septic tanks, plus drier soils in drought conditions can shrink and crack, reducing its ability to filter wastewater safely.
Changing Precipitation	• Flooding and extreme storms can damage structures, inundate or overwhelm systems, and restrict access for service or repair. Overwhelmed management systems lead to backups that cause localized flooding and further increase costs. • Inundated infrastructure will have reduced capacity to convey flow, creating the possibility of overflows, causing sewage to back up into homes, and threaten water quality. It may also increase leaks and create overflows into waterways, directly contaminating waterways with untreated sewage or contaminated stormwater. • Heavy rainfall and flooding can introduce contaminants, such as fertilizers or other chemicals, into wells, especially shallow or poorly maintained ones. Flooding can also damage well pumps and electrical components.

Why this matters

Climate hazards pose new risks to the daily operation and structural integrity of water systems that are the backbone of safe drinking water, sanitation, and healthy ecosystems. Failure and/or damage to these systems could degrade water quality and impact public health. Any disruptions to the water systems could further impact residents and business owners. Protecting and adapting water systems ensures reliable access to clean water, safeguards ecosystems, and prevents costly service interruptions.

At-A-Glance: *Stormwater and sewer structures in Windham that are vulnerable to flooding based on flooding scenarios:*

Catch basins	31
Drain manhole	1
Best Management Practices Inlets	19
Outlets	130
Culverts	30

Risks in Windham

Stormwater management

According to the Comprehensive Plan, stormwater runoff sources were identified as large parking lots and improper construction and maintenance of old gravel camp roads.

Septic systems

Wastewater in Windham is primarily handled by septic systems. However, the Town is actively transitioning toward more centralized wastewater infrastructure. As part of this effort, construction of a new wastewater treatment plant in North Windham is anticipated to be substantially complete and ready to accept flow by the end of May 2026. The Town is also coordinating connection for North Windham businesses to the gravity sewer collection system installed last year, with service connection construction already underway and expected to continue throughout 2026. Additionally, installation of a sewer conveyance line from the new middle school on Windham Center Road to the treatment plant on Sposedo Road is scheduled to begin spring 2026 and will continue throughout the year.

Community survey feedback also noted concerns about increasing development and limited wastewater infrastructure, specifically the reliance on private septic systems and potential groundwater quality risks as population density grows. One respondent noted, “...The land cannot support the future population density without polluting the groundwater.” These concerns highlight the need to protect and adapt water systems to support future growth and healthy water resources.

Despite the ongoing wastewater infrastructure improvements, the resilience of existing septic systems to climate-related hazards remains a concern. Septic system performance is dependent on-site conditions, such as elevation or proximity to flood-prone areas. Resiliency is challenged when the tank is in an area that floods more frequently. Flooding can saturate soils and overwhelm septic system capacity, impeding proper wastewater filtration and potentially causing untreated wastewater to

contaminate the groundwater. Therefore, properties more at risk of flooding would also have a higher vulnerability to septic system failures and associated public health and water quality concerns.

Drinking water systems

Many residents rely on private wells. Factors such as well depth, proximity to contaminant sources, age, and maintenance contribute to the vulnerability of wells. The Maine Geological Survey identified 1,184 wells in Windham.¹⁶ Based on the Maine Geological Survey data, there is a high concentration of wells around the Little Sebago Lake at-risk flooding areas that have a well depth of less than 85 feet. The highest yield aquifers are also located around Little Sebago Lake, extending towards Sebago Lake and Presumpscot River. Other aquifers are around Windham Center, River Road, and Forest Lake.

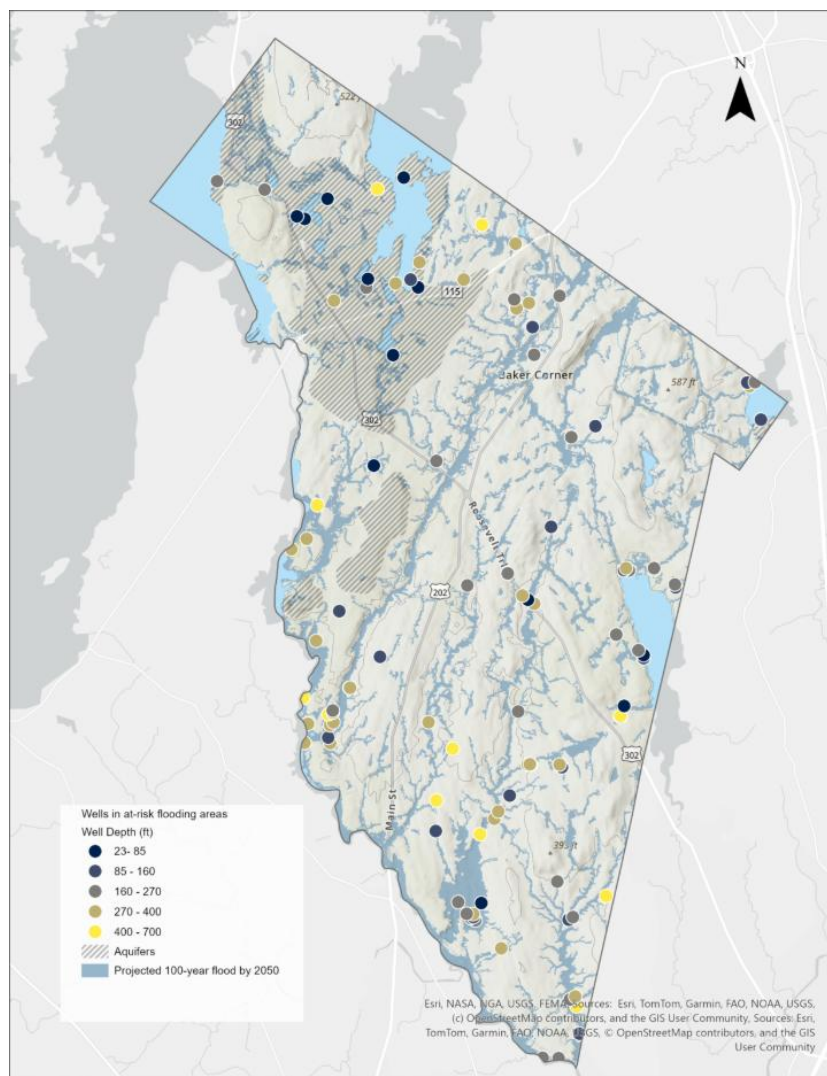


Figure 8. Wells in at-risk flooding areas, including well depth categories.

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
Infrastructure: Water Utilities		
High	Stormwater	- Map and evaluate the full stormwater system and prioritize upgrades to pipes, catch basins, and outfalls to handle projected increases in precipitation. - Install green infrastructure at schools, parks, and municipal facilities to help reduce peak runoff volumes.
	Septic Systems	- Replace older or failing systems with advanced treatment technologies that perform better in saturated or shallow soils. - In flood-prone areas, elevate components or relocate septic systems farther from shorelines and high-water tables to reduce flood intrusion risks.
	Wells	- Provide well and septic maintenance workshops consistent with Maine Drinking Water Program and Maine CDC guidance. - Partner with the Portland Water District to identify and reduce inflow and infiltration in high-risk areas.

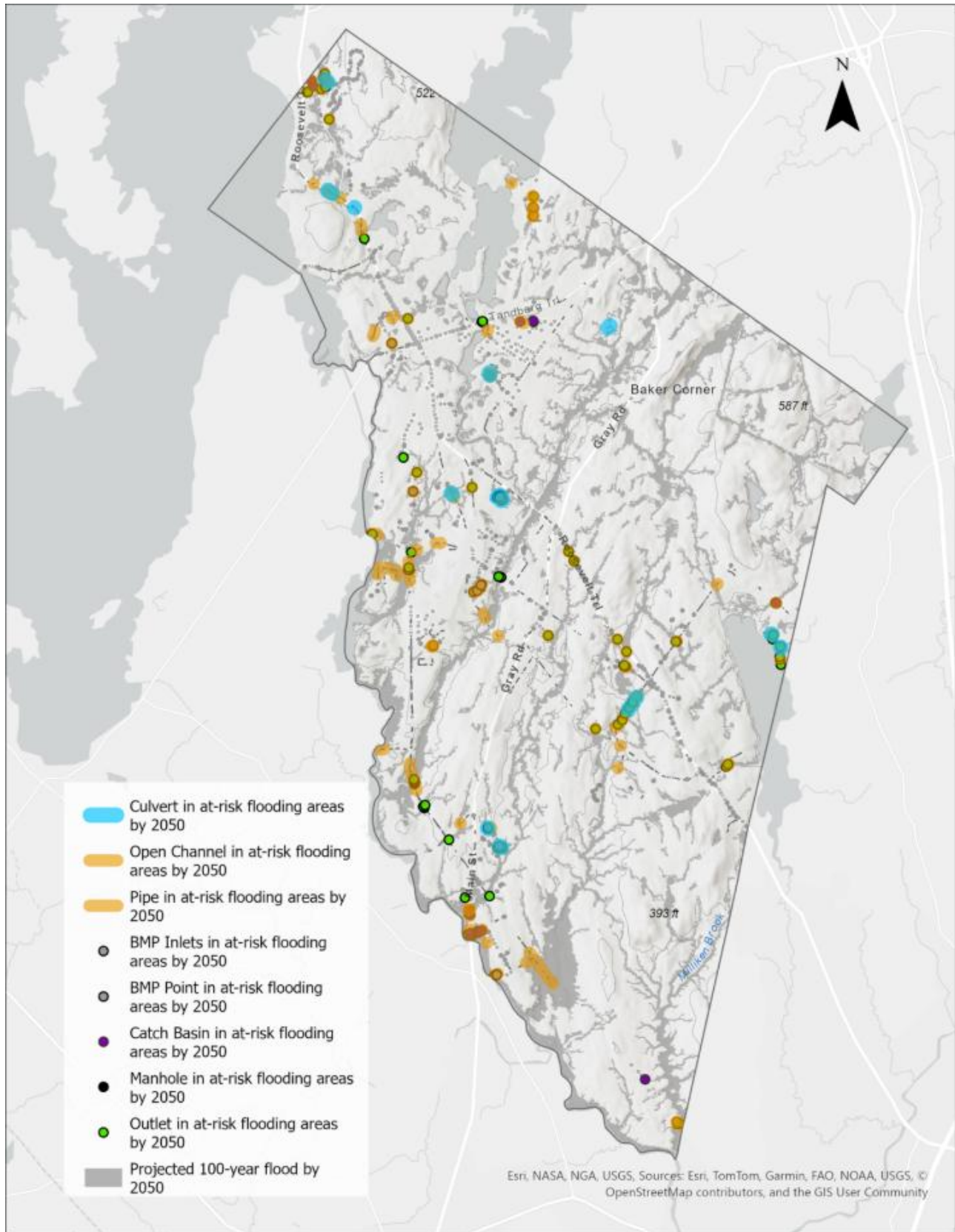


Figure 9. Stormwater infrastructure in at-risk flooding areas by 2050.

3.1.4 POWER AND COMMUNICATIONS

Climate Hazard	Impacts
Warming Temperatures	- Heat stresses power grids, reduces efficiency of transmission, and increases demand for cooling. This strains the system and increases the chance of partial power outages and brownouts on high heat days. - Strain on the energy grid from increased demand or disruptions in equipment due to climate change could create financial burdens on residents, businesses, and the town
Precipitation	Faster wind speeds, heavier precipitation events, flooding will increasingly disrupt transmission lines, inundate substations and data centers, and erode communications systems, leading to widespread outages. Power and communication failures halt water systems, disable buildings, climate control, and cripple transportation operations and coordination.

Why this matters

Energy and information systems, including radio towers, data centers, substations, transmission, and cable lines, have become lifelines for society, enabling everything from healthcare to commerce to daily life. Climate change is increasingly impacting the efficiency of the system and reliability of supply through storms or heatwaves, which can cause cascading failures across other sectors. Strengthening and adapting these systems ensures communities stay connected, safe, and operational during disruptions.

Risks in Windham

The energy and communications systems that service Windham, including cell towers, are interconnected within broader regional systems, and most assets are serviced by private utilities which have ultimate jurisdiction over any infrastructure systems. Maine's regional energy system is part of the New England regional transmission grid, which is operated by ISO-New England. Windham is supported locally by Central Maine Power (CMP). Internet service in the town is primarily through wire connections.

Damage or disruption to these systems from climate hazards could impact infrastructural assets. However, there are no specific datasets collected by the town which can be used to assess specific risk and vulnerability in this report. The town also does not have a local emergency communication system or alert system.

Understanding local infrastructure connections in the context of both the regional systems and climate hazards is necessary to determine potential actions for risk mitigation. These plans should be included in local emergency management plans.

Community survey participants report concerns about these impacts, particularly from more frequent and severe storms leading to outages and infrastructure damage. One respondent noted concern for "stronger thunderstorms resulting in power outages and property damage" and another noted "infrastructure damage for long periods of time". These responses highlight the growing vulnerability of power and communication systems and the need to improve resilience.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Infrastructure		
Medium	Power and Communication Systems	- Collaborate with CMP and regional partners to assess vulnerabilities to outages and flooding and advocate for resilience investments in local grid infrastructure. - Evaluate feasibility of solar plus battery systems at municipal buildings, subject to utility interconnection and Maine PUC requirements. - Develop layered emergency communication protocols, including low-tech options for households with limited internet or English proficiency.

3.2 Community Resources

The impacts of climate change are expected to strain many of the community resources that support Windham’s quality of life, economy, and cultural identity. More frequent extreme weather may disrupt businesses, damage homes and historic sites, and increase the need for social services while simultaneously interrupting access to them. Windham may also experience additional pressure on community resources if inland migration from coastal areas increases in response to climate impacts.

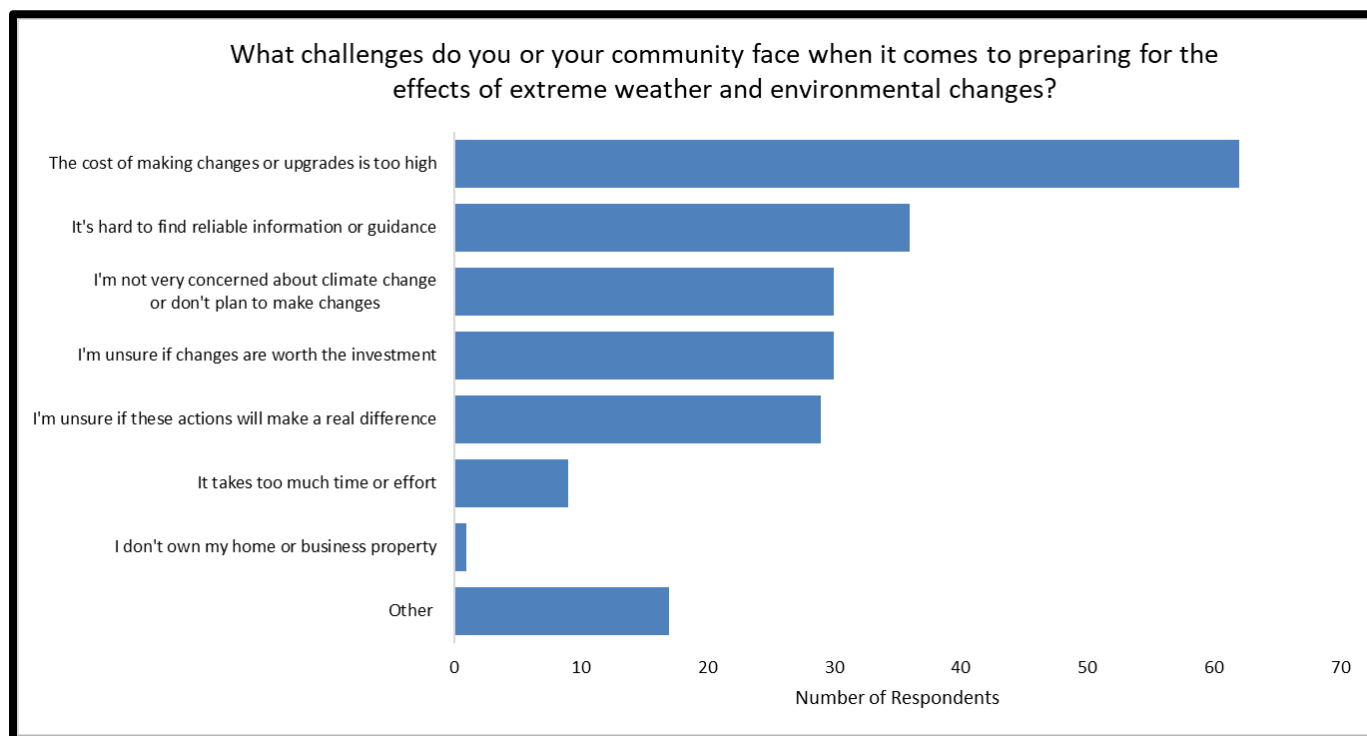


Figure 10: Challenges in Preparing for the Effects of Extreme Weather and Environmental Changes. Among 101 respondents, the largest share indicated the high cost of changes or upgrades to be the greatest challenge for themselves or the community.

WHAT RESIDENTS ARE SAYING...

Survey responses also highlighted additional challenges in preparing for these changes, specifically the need for public awareness and education. Respondents noted addressing misinformation and improving community understanding of climate risks as important strategies. One participant stated “Educating the community that the climate crisis is real and we should all be concerned” is an additional challenge. Another participant expanded on the role of misinformation, “...many people are poorly informed...” These insights assert that strengthening community education and communication is a critical component of building resilience and creating meaningful support for community resources.

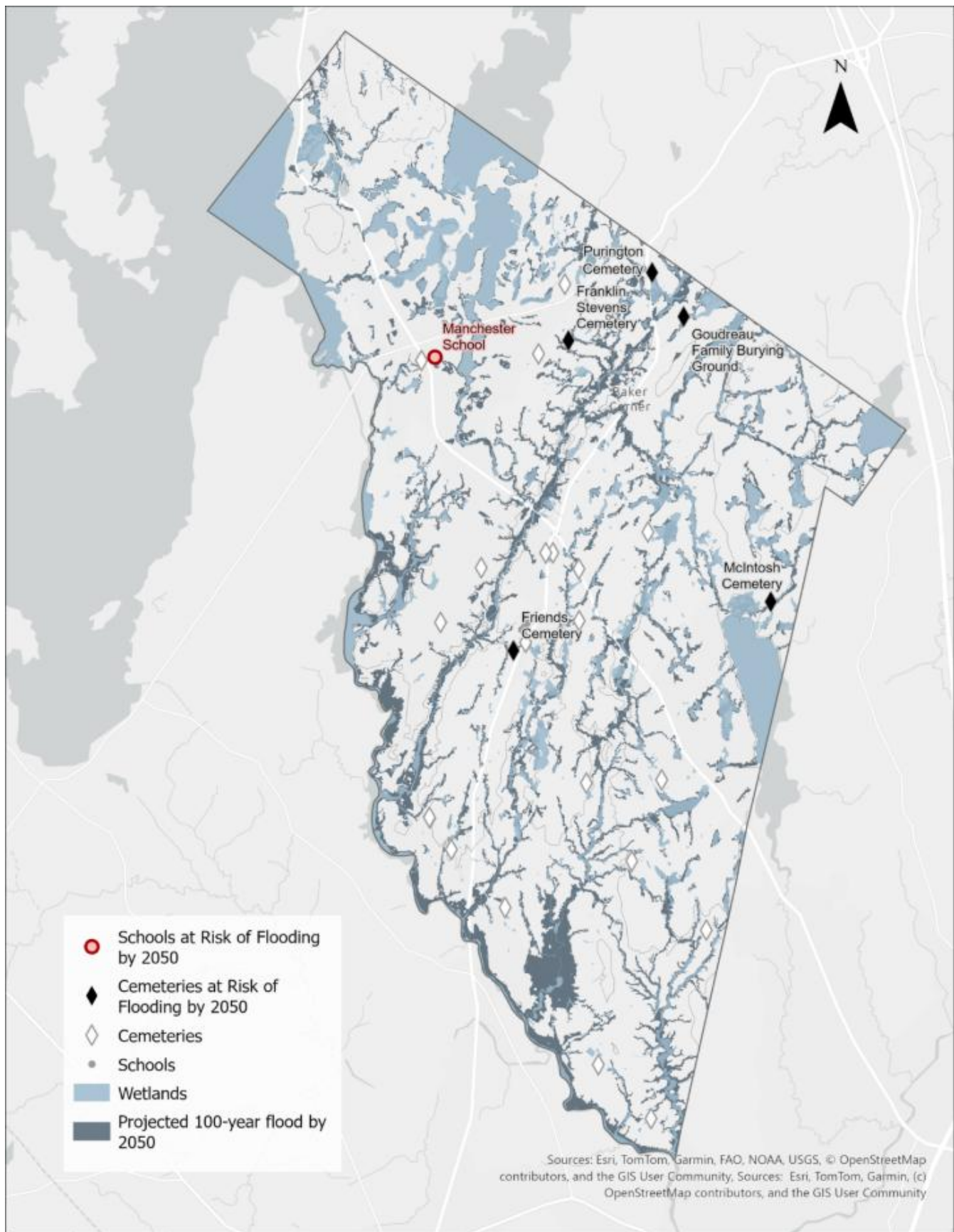


Figure 11. Community resources in Windham with projected 100-year flood zone by 2050.

3.2.1 ECONOMIES AND LIVELIHOODS

Climate Hazard	Impacts
Warming Temperatures	- As seasons shift, the number and visiting days for tourists will shift particularly impacting food service, hospitality and recreation employment. - As winters shift, businesses that rely on winter recreational activities like ice skating, snowmobiling, and skiing will be negatively impacted. - The natural resource industry will be hit particularly hard due to the physical stress of working outdoors in extreme temperatures and ecological shifts in species.
Changing Precipitation	- Extreme storms and flooding can impact access to businesses, cause property damage, and disrupt supply chains. - Those who either need to commute in or out of town for work could be impacted by flooded roadways, thereby impacting business revenue and overall economy. - Increased precipitation could impact businesses who rely on outdoor recreation.

Why this matters

Economies and livelihoods are essential to community resilience and well-being. Climate change threatens the strength and reliability of the infrastructure, industries, and services that support this foundation. Extreme weather impacts businesses' physical properties, changes the demand and type of employment, affects commuting routes, and ultimately impacts the overall economy of a town. In a region reliant mainly on private vehicle transportation, both workers and businesses are vulnerable to temporary flooding and long-lasting damage to roads. Changing temperature and ocean conditions makes the natural resource industry particularly vulnerable to shocks and stressors.

In particular, Maine's economy is heavily reliant on natural resources from forestry to fishing. As temperatures rise, these sectors are increasingly under threat. Farmers could see a shift in agricultural productivity as high temperatures and extreme precipitation damage resources. The lumber and timber industry will also become threatened by these climate hazards impacts on native trees. Individuals who rely on fisheries for their livelihoods, especially lobster, may experience economic impacts as species' ranges shift with climate change. Recreational fishing opportunities for non-commercial license holders may also be impacted, representing a significant cultural loss for the community.

At-A-Glance: Employment

Number of people living in Windham, but working outside of town	8,553
Number of people living outside of Windham but working in town	5,296
Number of people that live <i>and</i> work in town	1,296
Residents employed in the natural resource industry	< 2%

Risks in Windham

Livelihood

Windham is home to several types of small businesses, such as cafes, offices, garden centers, and many farms. The Town's Economic Development and Strategic Plan encourages economic growth that supports the needs of all its residents. Windham is also one of the communities represented by the Sebago Lakes Chamber of Commerce, established to support economic growth and prosperity throughout the Lakes region.

Property impacts and access are the biggest risks to general employment and the economy, while Windham's natural resource industry will be particularly impacted by the shifts in temperatures.

Employment

According to the U.S. Census 2022 Report¹⁷, there is a greater percentage of people who lived in Windham but were employed outside the town boundary. 86.8% of people living in Windham were employed outside of the town boundary, while 80.3% of people working in Windham were living outside the town boundary.

Flooded or degraded roadways will impact access and commuting patterns, which in turn impact both employers and employees, straining the overall economy.

Natural Resource Industry

According to the U.S. Census, less than 2% of Windham residents are employed in the natural resource industry. Although there is no specific data detailing the breakdown of sectors, it can be presumed that the majority represent the agricultural sector.

There are numerous farms in Windham, with around 3,211 acres identified as farmland or tree growth areas. As of

2014, nearly 2,100 acres were enrolled in the Farmland Tax Program, including 811 acres of pasture, 241 acres of cropland, and 1,014 acres of farm woodland. Additionally, 2,490 acres were enrolled in the Tree Growth Program, and 402 acres were enrolled in the Open Space Tax Program.

Windham’s natural resource industry faces similar risks to those in the region and state, which are largely based on the changing temperatures and shifting ecosystems.

Figure: Graphic showing the inflow and outflow of Windham residents and workers. 8,553 people live in Windham but work outside of Windham. 5,296 people live outside of Windham but work in Windham. 1,296 people live and work in Windham. Source: United States Census¹⁸



SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Community Resources		
Medium	Economies and Livelihoods	• Create a business resilience toolkit to help local employers prepare for flooding, power loss, and transportation interruptions. • Coordinate with neighboring municipalities to maintain access to employment and retail centers during road closures.

3.2.2 ESSENTIAL SERVICES

Climate Hazard	Impacts
Warming Temperatures	Warming temperatures indirectly strain systems. For example, public health challenges like high heat events strain healthcare services or may overload the power grid with electricity demand for air conditioning.
Changing Precipitation	Extreme weather can cut off access to essential services, through flooded roads or bridges and downed trees or powerlines. This can slow emergency response times, prevent people from getting to their jobs, or limit the ability to receive services.

Why this matters

Essential services, such as healthcare, emergency services, supermarkets, or utilities, are vital for continued community resilience. People rely on these services to stay safe and healthy, but climate change, particularly extreme weather events, can make accessing these services difficult. In addition to both physical damages and access to the services, climate change can exacerbate strain on the systems—limiting availability or increasing financial constraints. The indirect strain placed on essential services will impact the overall system as much or more than the physical impacts of climate change. These services provide support for vulnerable populations, so changes in these services can be detrimental to those most in need.

Risks in Windham

The greatest risk for Windham is access to/from essential services during flooding events and the increased strain placed on the systems due to extreme temperatures.

The condition of many residential roads, and especially when exacerbated by extreme flooding, could limit access for residents and emergency responders to receive the necessary medical care. During severe weather events, essential workers could face difficulty getting resources to residents and businesses.

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
Community Resources		
High	Essential Services	- Produce an emergency access route map highlighting alternate routes to hospitals, EMS, and public safety buildings during floods. - Formalize and publicize cooling and warming centers with clear activation procedures.

3.2.3 SOCIAL SERVICES

Climate Hazard	Impacts
Warming Temperatures	• Extreme temperatures increase the demand for services, such as cooling centers or food assistance • Increasing energy costs create financial burdens which places further demand on social services such as general assistance
Changing Precipitation	• Flooded roads can prevent access to these services temporarily, while extreme storms can cause permanent damage to the buildings or properties

Why this matters

Social services, such as schools, libraries, town services, food assistance programs, disability services, or additional community support, are critical to maintaining a resilient community. These services are particularly important for those who may be socially or economically disadvantaged to adapt and recover from climate-related events. Demand for social services and community-provided resources will likely increase due to the financial, physical, and emotional stressors created by climate change. Climate disasters can also strain the capacity of community resources, such as food pantries or financial assistance organizations, as more people experience impacts from climate change. Overburdened social services weaken long-term recovery and deepen inequities within the community.

Southern Maine has seen an increase in in-migration over the past few years, and this could increase as we see more

movement due to climate disruptions at the national and international scale. There is little data available to understand if Maine is going to be a receiving state for climate migrants in the future. However, being prepared for growth is a key resilience strategy for communities. Social services help to reduce disparities and protect those most at risk. Ensuring access and capacity to increase community resources will be essential to maintaining a healthy and resilient community.

Risks in Windham

The biggest impact to services in Windham will be restricted access during storm events, due to flooded roads and bridges, and increased strain on resources from climate hazard impacts. As mentioned earlier, flooding along key roadways will limit residents' ability to access resources within Windham and outside of the Town boundary. People may need to find alternative routes to access these services.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Community resources		
High	Social Services	• Establish a Resilience Navigator program through community organizations to support vulnerable residents with preparedness steps. • Partner with nonprofits to strengthen service continuity plans for food pantries, libraries, and community centers in flood-prone areas.

3.2.4 AGRICULTURE AND FOOD SYSTEMS

Climate Hazard	Impacts
Warming Temperatures	- Farmers have experienced a longer growing season due to warming temperatures. However, these warm temperatures also bring an increase in pests, put heat stress on crops, and require higher water demand. - Temperature changes also lead to frost damage if the increase in growing days is not synchronized with the shift in the spring and fall frosts, or if heat waves, droughts, or other extreme weather events degrade productivity.
Changing Precipitation	- Although the growing season is lengthening, these benefits are offset by intense storms and increasing drought which lead to crop damage, erosion, soil loss, runoff, and leaching. - Extreme weather events also flood fields and make access more difficult, reducing agricultural productivity. - Greater variability between wet and dry periods can stress crops and increase crop susceptibility to pests and diseases.

Why this matters

A changing climate is predicted to disrupt food availability, reduce access to food, and affect overall food quality. Impacts will occur across the food supply system from growth to distribution. This includes increased food illness from pathogens and contaminated water, disrupting food availability, decreasing access to food, disruption in shipments, or increasing prices due to fuel or product scarcity.¹⁹ Reliance on non-domestic food increases households' vulnerability to these climate-induced impacts. Dependence on global supply chains can further reduce resilience, as disruptions from geopolitical conflicts, trade disruptions, or transportation restrictions may delay or limit food availability. Local agriculture supports the food system, supports livelihoods and boosts the economy, limits greenhouse gas emissions from long-range transportation, and often provides more sustainable, nutrient-rich food. Protecting agricultural lands is vital to maintaining cultural roots in a community.

While periodic flooding can provide some ecological and agricultural benefits, such as depositing nutrient-rich sediments, projected increases in precipitation intensity are expected to result in more frequent and intense flooding that is disruptive to natural floodplain cycles. These events can oversaturate soils, erode farmland, and delay harvesting or planting timelines. The flooding projections used in this analysis reflect conditions that go beyond the benefits of natural flooding and instead represent a growing risk to agriculture.

Risks in Windham

Food Distribution and Consumption

On average, 90% of food consumed by Mainers comes from outside the state, and the State has high grocery prices given a range of complex factors.²⁰ Similarly, Windham residents rely heavily on external food sources and will feel impacts from increased pricing, shipping disruptions, or food shortages due to climate impacts.

There are three grocery stores located in Windham, including Hannaford, Shaw's, and Walmart. The Windham Clothes Closet and Food Pantry is housed next to the Windham Fire Rescue- Central Station. Kelly's Loving Hands is located off River Road.

While these buildings are not at risk of flooding, flooded roads and bridges will make it difficult for people to access these organizations or for them to distribute their resources.

Food Production

Local agriculture activities in Windham include small-scale animal agriculture. North Star Farm raises sheep, pigs, rabbits, and chickens, and Sea Fox Farm produces lamb. These farms contribute to a more resilient, community-based food system. As of 2012, there were 274 acres (9 parcels) of farmland enrolled in Current-Use property tax programs. According to the 2022 Census of Agriculture prepared by the United States Department of Agriculture, there are a total of 56,704 acres used for farm operations in Cumberland County, resulting in commodity totals of \$62,909,000, or \$1,109.13 per acre.²¹ In 2020, the Farm Services Administration issued an emergency declaration for Cumberland County because of prolonged,

severe drought conditions, resulting in increased operational costs due to increased irrigation.²²

The USDA Plant Hardiness Zone Map serves as a standard tool to assist growers in determining which perennial plants are most likely to thrive in a specific location. The USDA Plant Hardiness Zone Map helps growers determine which perennial plants are likely to thrive in a given location, based on the coldest annual temperatures. Annual crops complete their life cycle in one season and do not need to survive the winter, so hardiness zone is less relevant to these plant types. Windham currently falls within Zone 5b. While this zone was unchanged in the 2023

update, warmer zones shifted north and will likely encroach in the area in the coming decades. Rising temperatures expand the ranges of harmful plants and insects, increasing crop loss and pest management costs, many of which introduce additional harmful chemicals into the environment.²³

Additionally, the plant hardiness zone map does not account for other factors such as extreme heat, snow fall, wind, and soil drainage that affect agricultural productivity. Survey participants noted the loss of agricultural land due to building development and solar farms as a concern in Windham.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Community Resources		
Medium	Agriculture and Food Systems	- Expand community gardens and offer climate-smart gardening workshops aligned with UMaine Cooperative Extension best practices. - Strengthen local food resilience by partnering with regional producers, food pantries, and grocers to improve supply redundancy.

3.2.5 TRAILS, PARKS, AND RECREATION

Climate Hazard	Impacts
Warming Temperatures	- Increased heat stress reduces safe use of outdoor spaces - Decreased water quality from extreme temperatures impacts property values and recreational economic benefits
Changing Precipitation	- Storms and flooding can damage or erode existing facilities and reduce access. This requires more maintenance and repair, straining municipal resources - Loss of recreational access reduces community health benefits, tourism, and local economic activity

Why this matters

Parks, trails, and other recreational areas bring many benefits for residents. Green space helps lower surrounding air temperature, promotes active living, improves public health, serves as community gathering spots, increases surrounding property values, and provides ecological benefits. Maintaining and expanding access to these spaces creates a more vibrant community and builds resilience to climate change.

Risks in Windham

Access to natural resources is vital to the community's character, and Windham hosts a diverse range of outdoor activities. In total, Windham has over 30 miles of trails.

- The town owns and manages a variety of parks and preserves open to the public, including Donnabeth Lippman Park, Dundee Park, Lowell Preserve, Deer Hollow Sanctuary, Otterbrook Sanctuary, and Claman Preserve, which all feature formal trails or opportunities to explore.

Windham also has several water recreation areas, including Sebago Lake, Little Sebago Lake, and Highland Lake.

Studies have shown that water clarity is the biggest factor impacting users' enjoyment of lakes. Results from the study by the University of Maine and Maine DEP suggest that even a minor decline in the water clarity will result in a loss recreation and economic benefit.²⁴ Protecting recreational areas, both water and land, will provide economic benefits to the town, support community health, and provide ecological protection.

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
Community Resources		
Medium	Trails, Parks, and Recreation	- Increase shade and tree canopy in parks to reduce heat exposure for users. - Implement climate-resilient trail upgrades (boardwalks, drainage, erosion control) on municipal and partner-managed trails.

3.3 Natural Resources

Climate hazards strain the health of aquatic and terrestrial ecosystems and have the potential to lead to long-term impacts. Changes in temperature and precipitation are expected to increase stress and disturbances in forests and water bodies. As ecosystems are transformed, species will migrate to more desirable habitats or face challenges to survival. Understanding how and where the environment is vulnerable can guide decision-making to conserve and protect its natural resources.

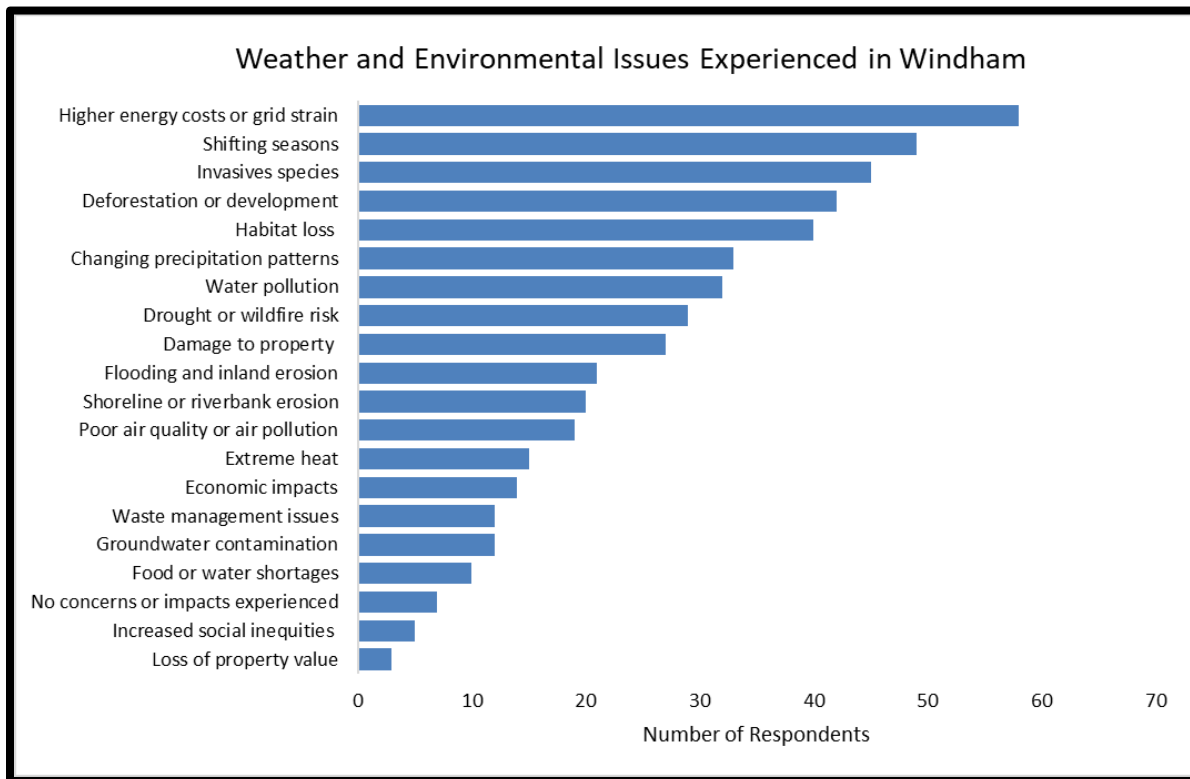


Figure 12. **Weather and Environmental Issues Experienced in Windham.** Higher energy costs or grid strain, shifting seasons, and invasive species emerged as the top weather and environmental issues experienced in Windham among 104 respondents.

3.3.1 ECOSYSTEM AND HABITAT DIVERSITY

Climate Hazard	Impacts
Warming Temperatures	Warmer air and water temperatures cause shifts in species' geographic ranges, leading to declines in native aquatic and terrestrial life while promoting the spread of invasive species, pathogens, and pests. These shifts make ecosystems more vulnerable to stressors such as habitat destruction.
Changing Precipitation	- Combined with human development, flooding will fragment or even eliminate habitats, putting greater stress on native, threatened, or endangered species. - Changing precipitation patterns impact rivers and vernal pools which affect amphibians and other aquatic creatures. - Extended drought will place pressure on plant and animal species and can damage critical habitat areas.

Why this matters

A native, biodiverse ecosystem provides a solid foundation for a healthy environment. However, climate-induced conditions force native species to shift further north, while invasive, non-native species migrate from the south into Maine. Invasive species disrupt ecosystems by developing self-sustaining populations that are dominant or disruptive to native species by outcompeting them for resources.

Risks in Windham

Windham is home to three species of special concern, the Great Blue Heron, the Upland Sandpiper, and the Brook Floater. Important habitat in town includes 5 significant vernal pools, inland waterfowl and wading bird habitat around Little Sebago Lake and Highland Lake, and Brook Floater habitat throughout the Pleasant River. Northern Windham is also home to 2 exemplary natural communities, pitch pine bogs and red maple swamps.

Cumberland County

In Cumberland County, with a 2C (3.6F) increase in temperature, 3 birds are highly vulnerable, and 57 bird

species are moderately vulnerable to changing habitat conditions.²⁵

Out of Maine's 120 resident and visiting butterfly species, 25 (21%) are listed as state endangered, threatened, special concern, or extirpated. While habitat loss to development ranks first as the leading cause of species endangerment, seven (28%) of the state's 25 at-risk butterfly species are also considered imminently threatened by climate change.²⁶

The Maine BumbleBee Atlas, a 5-year statewide bee inventory survey, found that 4 of the state's 17 historically documented bee species were absent, suggesting possible extirpation. Native bee decline is linked to habitat loss from land development and harmful chemical use such as herbicides.²⁷

In the community survey, respondents highlighted significant environmental concerns, including deforestation, wildlife displacement, and declining bird populations. Vernal pools and other habitats were mentioned as at risk, and tree canopy loss was noted as a factor affecting water quality.

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
Natural Resources		
Medium	Ecosystems	- Complete an invasive species assessment and implement removal and native replanting projects with volunteers and regional land trusts. - Pursue conservation of priority habitat areas in partnership with willing landowners and regional land trusts. - Develop a landscaping management plan or ordinance for town-owned lands that prioritizes planting native species, avoids insecticides and herbicides, and includes educational materials for residents on native landscaping.

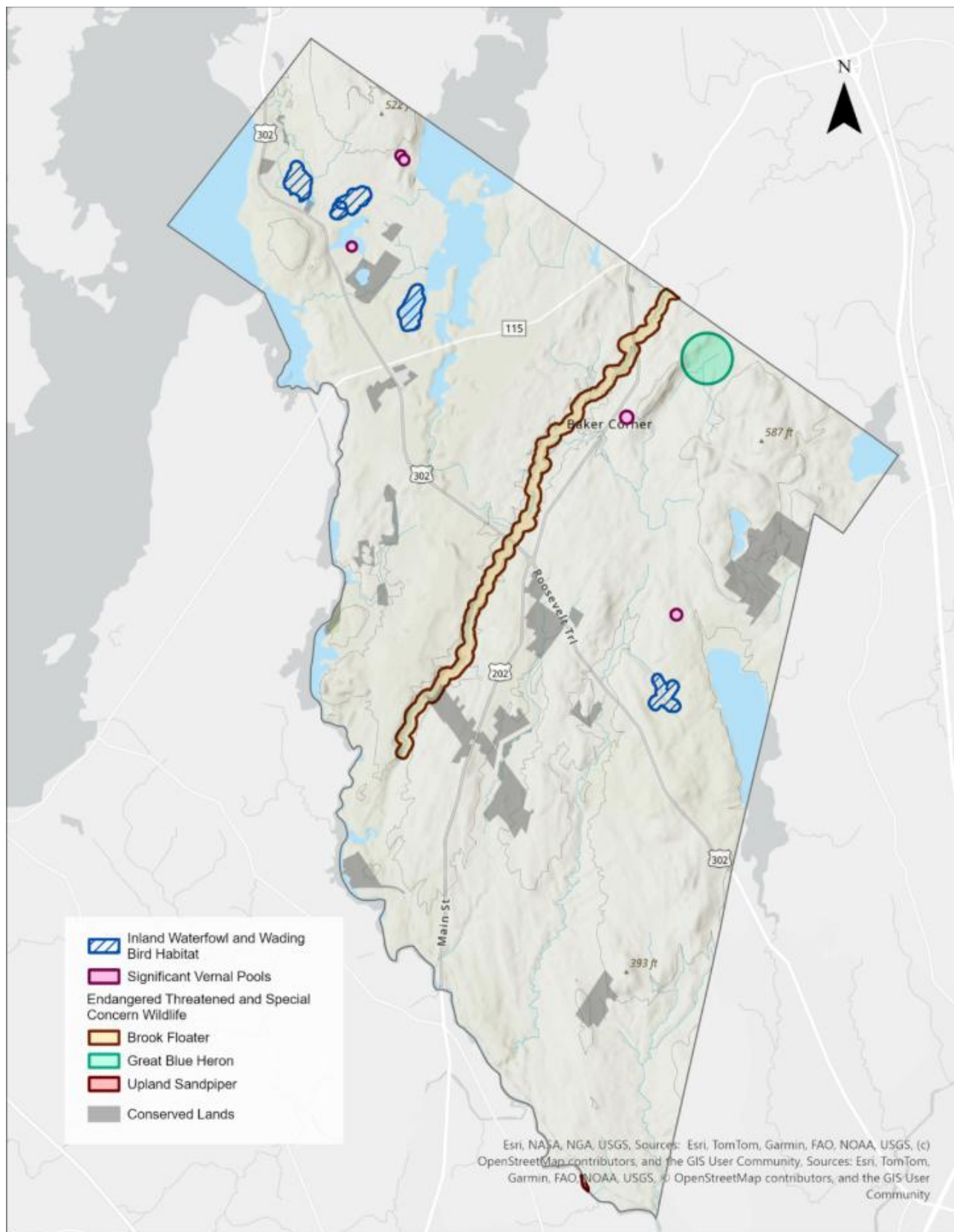


Figure 13. Critical habitat and conserved lands in Windham.

3.3.2 OPEN SPACE AND CONSERVED LANDS

Climate Hazard	Impacts
Warming Temperatures	- Warming temperatures put these natural resources at risk by shifting the ecosystem (i.e., impacts which species can grow in the area), increasing the presence of invasive species, and contributing to erosion and sedimentation from drier soils - Loss of open space will also increase the urban heat island effect, which strains public health and increases risk of heat-related illnesses
Changing Precipitation	- Heavy flooding can damage the land, prevent access, degrade habitats, and cost the town money for repairs. - Frequent or prolonged droughts have the potential to alter these areas by limiting biodiversity and interrupting natural drainage patterns. - Flooding to natural areas also impacts recreation, public health, and public access

Why this matters

Open space, or undeveloped lands such forests and fields, provide numerous benefits to humans and the environment that are all threatened by climate change:

- Critical habitat for native species
- Flood mitigation
- Recreational space that supports public health
- Maintains good water and air quality
- Act as a carbon sink to remove carbon dioxide from the atmosphere

The U.S. Forest Service estimates that every acre of forested land on average absorbs between 1 to 2 tons of carbon every year based on the forest type, age, and management practices.²⁸

Conserving open space protects these lands from development and allows them to continue mitigating climate change and enhancing the resilience of climate impacts.

Risks in Windham

Windham has demonstrated a strong commitment to conserving land. There are over 1,300 acres of conserved lands in Town, constituting 4.2% of total town land. One of the largest areas of conserved land is the East Windham Conservation Area, which includes 700 acres of land conserved in 2023.²⁹ The Presumpscot Regional Land Trust holds a conservation easement on the land, supporting wildlife habitat, clean water, and recreational trails.

In addition to the stress extreme temperatures will place on the lands, almost all the conserved lands in town will experience some degree of temporary flooding from a 100-year storm by 2050. This will negatively impact the overall ecosystem, ability to maintain and access the spaces, and public health of Windham.

There are several undeveloped blocks of land, which are areas of land that are 50 acres or larger that help protect essential habitat for plants and wildlife. Undeveloped blocks have the potential to be conserved which would help maintain open space and support habitat retention. There are several undeveloped blocks of conserved land throughout town, including the East Windham Conservation Area.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Natural Resources		
High	Open Space and Conserved Lands	- Review the recommendations and goals identified in the Windham Open Space Master Plan to ensure future projects align with and advance the priorities outlined in the Open Space Plan. - Implement urban forest restoration projects on municipal land using native species.

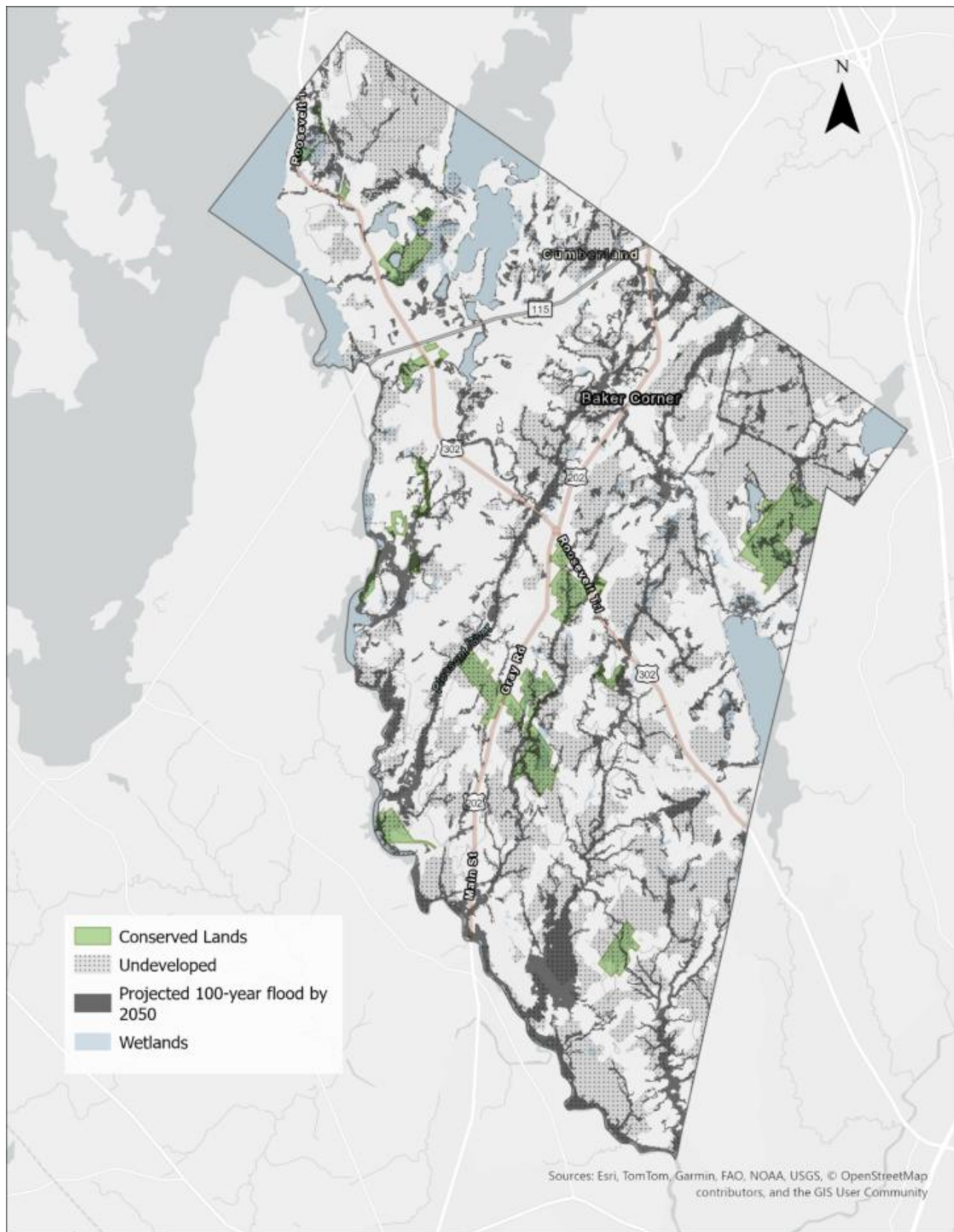


Figure 14. Conserved land and undeveloped blocks of habitat with projected 100-year flooding.

3.3.3 WATER RESOURCES AND DRINKING WATER QUALITY

Climate Hazard	Impacts
Warming Temperatures	- Warming waters lead to lower dissolved oxygen levels, foster algal blooms, and strain aquatic ecosystems. - Extended drought can lower well water levels or dry up shallow wells, increasing contaminant concentrations in the water that remains. - Higher temperatures can increase the release and concentration of contaminants like algal toxins and nitrates.
Changing Precipitation	- Increased precipitation and more intense storms create a greater volume of stormwater runoff, which delivers pollutants such as nutrients, sediment, bacteria, and trash into waterbodies. These pollutants and excess nutrients impair waterbodies and increase the likelihood of water-related illnesses. - More intense rainfall and flooding can also mobilize contaminants in soils, including PFAS, allowing them to spread into surface and groundwater supplies. - Increased flooding can alter stream and river geomorphology by reshaping stream channels, eroding banks, increasing sediment deposition, and damaging aquatic life. - Heavy rainfall causes flooding, raises groundwater, and saturates the soil, which can undermine septic systems and reduce their ability to effectively treat wastewater

Why this matters

Healthy water resources—including rivers, streams, lakes, wetlands, and groundwater—are essential for public health, ecosystem health, wildlife habitat, recreation, local businesses, and the community’s economic well-being. Wetlands also provide flood mitigation and act as carbon sinks. Residents face direct risks from contaminated water, including exposure to harmful chemicals and waterborne diseases, while increased precipitation and higher temperatures threaten both water quality and supply by affecting sources, wells, and treatment systems. Emerging contaminants such as PFAS, which persist in the environment and can accumulate in water supplies, further increase concerns about long-term exposure to chemicals. Rising temperatures and shifting conditions can harm aquatic life, encourage invasive species, and increase harmful algal blooms³⁰, which can lower property values³¹. Protecting and maintaining clean water is critical for public health, community character, and sustainable growth.

Risks in Windham

Little Sebago Lake, The Presumpscot River, Pleasant River, and Highland Lake are primary water resources in Windham. These waterbodies and their surrounding areas offer important locations for wetland ecosystems, recreation, and critical species habitat.

All rivers and streams in Windham meet water quality standards and there are no designated impaired waterways in town.³² However, according to the Maine

Department of Environmental Protection’s Nonpoint Source Pollution Priority Watershed list, Highland Lake was identified as an “MS4 Priority Water, Watch List, Sensitive” water body and Forest Lake and Little Sebago Lake were identified as “Sensitive”. “Watch list” lakes are recently impaired water bodies or have water quality data near the impairment threshold, while “Sensitive” lakes describe water bodies that are projected to have a significant increase in phosphorus concentrations over the next 25 years.³³

Survey participants expressed concerns about the safety and reliability of town water and private wells. Many open responses mentioned bacterial growth, risks of flooding, water scarcity, contamination in local brooks, and PFAS contamination as concerns. Black Brook was mentioned specifically for contamination concerns.

- As waters warm, water bodies in Windham will see a decrease in dissolved oxygen that will further stress fish species.
- To maintain the high quality of Windham’s water, it is important to address stormwater runoff. Stormwater runoff from impervious cover is likely the largest source of pollution to these water bodies. The surrounding area is largely developed, which causes stormwater to flow quickly off the impervious surface, carrying dirt, oil, road sand, and other pollutants into the nearby streams.
- Elevated phosphorus levels also come from septic tank runoff, fertilizers, and erosion.

Drinking Water Quality

Portland Water District supplies (PWD) the town's public drinking water sources. The Maine Drinking Water Program (DWP) evaluates public water supplies as part of the Source Water Assessment Program (SWAP) to assess how likely drinking water sources are to be contaminated by human activities in the future. The PWD 2024 Consumer Confidence Report listed no contaminants above the allowable limit in drinking water. ³⁴

However, many households rely on private wells for drinking water. According to the Maine Geological Survey, Windham has approximately 1,184 wells. Households which rely on private wells for drinking water are specifically at risk for degraded water quality. Private wells are not regulated under the Federal Safe Drinking Water Act (SDWA) or state laws, which means well owners are responsible for testing and maintaining water quality. ³⁵

Most areas in town are subject to naturally occurring contaminants in well water, such as radon, arsenic, and uranium.

In addition to naturally occurring contaminants, Windham's groundwater faces risks from emerging contaminants such as PFAS. State investigations include samples from private wells in Windham. While most of the wells tested were below Maine's drinking water standard, a small number exceeded the guideline. This research highlights that households relying on private wells are particularly vulnerable to water contaminants, as private wells are not subject to routine regulatory monitoring. Climate-related stressors, including drought and heavy precipitation, can further concentrate or mobilize these contaminants, increasing the potential exposure risk to residents. ³⁶

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Natural Resources		
High	Water Resources and Drinking Water Quality	- Partner with the Presumpscot Regional Land Trust, University of Southern Maine, or local groups to expand water quality monitoring on the Presumpscot River and nearby streams. - Restore riparian buffers using native vegetation consistent with Maine's Shoreland Zoning and DEP permitting. - Provide educational outreach materials/programs on water conservation methods, safe well and septic system maintenance (for private wells and septic), and emergency preparedness.

3.3.4 EROSION

Climate Hazard	Impacts
Warming Temperatures	Warmer temperatures dry out the soil and reduce plant growth, destabilizing the land. This, in combination with wind and rain from increased storms, exacerbates erosion.
Changing Precipitation	- Increased precipitation threatens the integrity of inland waterways and makes them prone to landslides. - Inland flooding can change the composition of soil along riverbanks and compromise the integrity of pre-existing structures built along inland waterways. - During extreme storms, the rainfall that soaks into the slope adds weight and reduces strength, and the excess water undermines the slope with additional flooding.³⁷

Why this matters

Unstable riverbanks or bluffs leads to an increased risk of erosion and landslides. Erosion and landslides threaten water quality, native habitats, recreation, and infrastructure. Therefore, mitigating the risk of erosion is vital to protect the surrounding properties and maintain a healthy riverine ecosystem. Maintaining stable riverbanks and abating pollutants protects surrounding infrastructure and habitat and prevents excess soil or nutrients from eroding into waterways and degrading water quality.

Risks in Windham

The slope of land, sediment type, vegetation, bedrock, surrounding upland use, and development pressure can all impact vulnerability of bank stability and erosion. Soils in Cumberland County, including Windham, consist of loams, sandy loams, and fine sands. These soils are more prone to surface erosion when vegetative cover is lost, as water can infiltrate quickly and carry particles downslope. Many of Windham's soils have moderate K values,

indicating moderate erosion potential on sloped areas or where protective vegetation is not established. The K-factor is a measure of the soil's susceptibility to erosion due to rainfall and runoff.³⁸

Steeper slopes and soils with shallow layers limit root penetration and reduce natural stabilization, increasing erosion risk along waterways. Windham's Comprehensive Plan notes how steep slopes and hydric soils impact drainage and land use decisions, highlighting the need to include soil stability considerations into sustainable development practices.

Infrastructure and properties alongside all waterbodies are particularly vulnerable to erosion. With storm damage and increasing rain intensities, soil loss and destabilization are likely to become more prominent along larger waterways in town, including the Presumpscot River, Pleasant River, Little Sebago Lake, and Highland Lake.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Natural Resources		
High	Erosion	- Complete the current riverbank stability assessment of vulnerable reaches of the Presumpscot and prioritize areas for bioengineering stabilization (within state and federal permitting rules). - Provide shoreland protection education for residents on vegetation, buffers, and erosion prevention.

3.3.5 LAND USE, FORESTS, AND CARBON SINKS

Climate Hazard	Impacts
Warming Temperatures	The full impacts of climate change on forests are variable as the longer spring and summer season will help spur growth, but the warmer winters and decreased snowmelt will harm some forest species, particularly the spruce-fir forests.³⁹
Changing Precipitation	Disturbances such as flooding, ice storms and wildfires can open forest canopies, expose mineral soil, and reduce tree cover, providing greater opportunities for invasion.⁴⁰

Why this matters

Unstable riverbanks or bluffs leads to an increased risk of erosion and landslides. Erosion and landslides threaten water quality, native habitats, recreation, and infrastructure. Therefore, mitigating the risk of erosion is vital to protect the surrounding properties and maintain a healthy riverine ecosystem. Maintaining stable riverbanks and abating pollutants protects surrounding infrastructure and habitat and prevents excess soil or nutrients from eroding into waterways and degrading water quality.

Risks in Windham

Land Use

Windham contains ample tree canopy with some areas of impervious surfaces. The maps of impervious surface and tree canopy provide a proxy for understanding which areas of town may be most at risk. Forestry is an important resource for the town, with almost 3,000 acres enrolled in Maine's Tree Growth tax program.

Since most of Windham is forested, this improves the town's ability to mitigate and adapt to climate change. However, the area is still at risk of losing critical forests and open space.

Forests currently cover nearly 89% of Maine and sequester over 60% of the state's annual carbon emissions, in addition to supporting the state-wide economy.⁴¹ According to the NOAA Coastal Change Analysis Program Land Cover Atlas, between 1996 and 2021 Cumberland County lost 3.4% of forest land cover with over 7 square miles of loss being converted to developed land.⁴²

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
Natural Resources		
High	Land Use, Forests, Carbon Sinks	- Consider updating zoning to account for climate changes, such as increased precipitation. - Use land-use planning to limit development in high-risk areas and to preserve forests, wetlands, and open space as natural carbon sinks. - Consider investing in green infrastructure to absorb carbon and reduce heat.

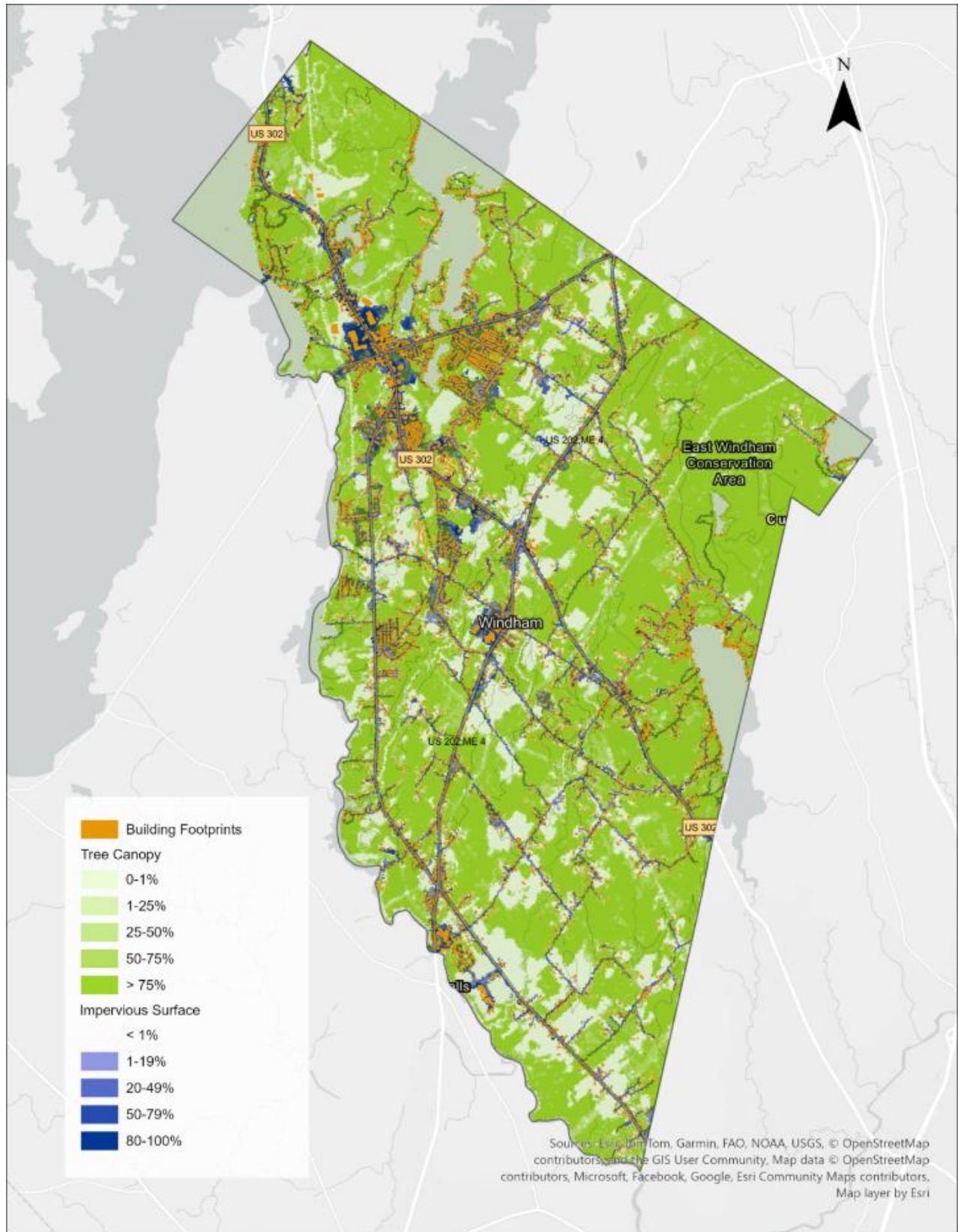
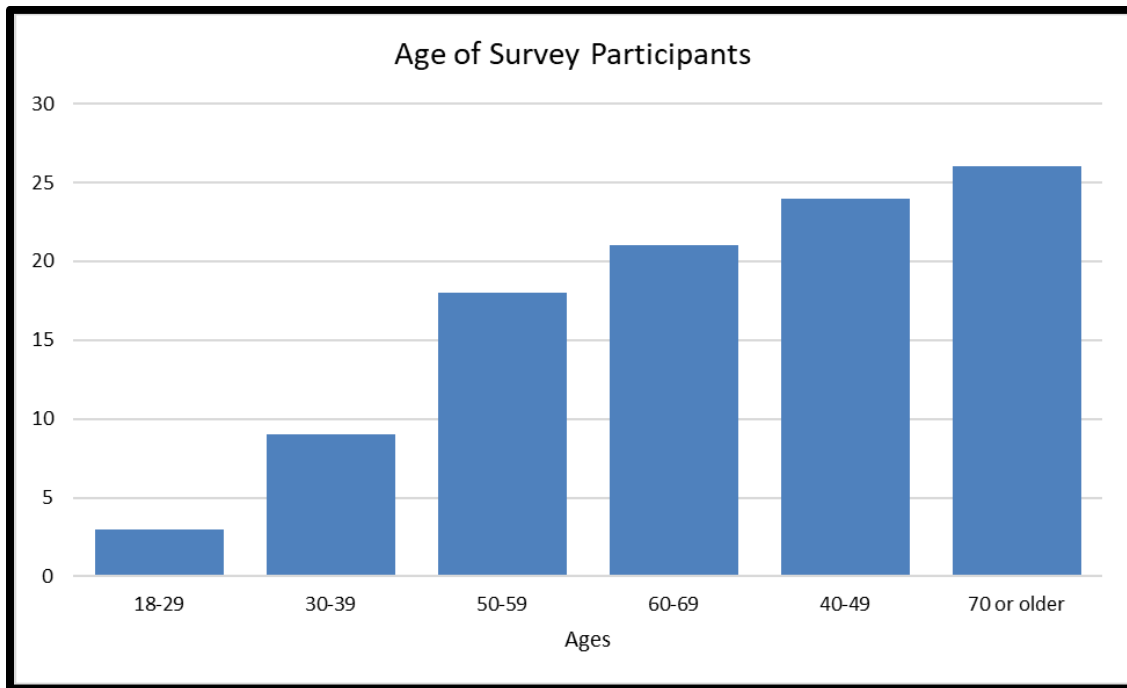


Figure 15. Canopy cover and impervious surface in Windham.

3.4 People

Climate hazards will directly impact Windham’s social and public health systems and may trigger economic shocks, with the greatest impact falling on the most vulnerable residents. Climate change could deepen existing inequities by intensifying current vulnerability factors. To prepare, Windham will need to strengthen its capacity to support vulnerable populations and ensure equitable processes and outcomes in future climate-resilience planning.



*Figure 16: **Age of Survey Participants.** Among 101 respondents, the greatest share indicated that they were 70 or older, followed by 40-49, and 60-69 years old.*

3.4.1 SOCIAL VULNERABILITIES

Social vulnerabilities describe factors that may weaken a community's ability to adapt or recover from a disaster, and it is an indicator of community resilience. Examples include age, race, households without access to a vehicle, and financially burdened households. Due to existing social vulnerabilities, the burden of climate change will not be felt equally across the community. People with existing social vulnerabilities will be disproportionately impacted by climate hazards. Communities with higher populations of at-risk individuals will be less resilient to climate hazards, and have less capacity to prepare for, respond to, or recover from climate events. Using demographic information to identify the populations most vulnerable to climate hazards allows Windham to better direct planning and resources when preparing for future climate impacts.

Survey responses indicate that certain populations and areas in Windham are more vulnerable to the impacts of extreme weather events, such as flooding and heatwaves. Respondents most frequently identified older adults, low-income households, and individuals with disabilities as being at higher risk. Residents living in floodplains or homes without adequate heating or cooling systems were also identified as at risk.

This sub-section discusses the following social vulnerabilities for Windham:

- Demographic
- Socioeconomic
- Housing characteristics

3.4.1.1 DEMOGRAPHICS

Climate Hazard	Impacts
Warming Temperatures	• These populations are likely to face heat-related illnesses such as heat stroke, have a higher prevalence of asthma, and exacerbate existing health conditions.
Changing Precipitation	• These populations could have a harder time accessing resources during extreme storms. For example, older individuals may not have the technology or societal connections to receive storm alerts or recovery resources. Similarly, people who are linguistically isolated or have limited English proficiency may be less likely to hear about upcoming events or have challenges communicating their needs during an emergency.

Why this matters

Age, race, ethnicity, and disability are strongly correlated with disparities in health, exposure to environmental pollution, and vulnerability to natural hazards. Older and younger populations are more at risk for climate-related health impacts due to weakened immune systems and pre-existing conditions. Also, both populations are more likely to rely on caregivers for basic needs. Climate risks are even greater for elderly residents who live alone, as they are less likely to receive the necessary help during emergencies. Structural and historical inequities have resulted in socioeconomic conditions that increase the vulnerability of communities of color to climate-related impacts. Residents with poor health or a lack of access to health care will be inherently more susceptible to dangers such as high heat, worsening air quality, and power outages caused by intense storms. The social marginalization of people with disabilities further increases the threat of isolation during a climate-related event.

Risks in Windham

Percents are rounded to one significant figure.

- 19% of Windham's population is under 18
- 16% of Windham's population is over the age of 65
- 28% of adults who are 65 and over live alone, this is around 5% of the total town population
- 19% of individuals in Windham's live with a disability
- 11% of the population are People of Color
- 8% of the population speak English less than well
- 12% of households are single parent households

Although some of these numbers represent a small percentage of the community, in addition to the potential for compounding vulnerabilities, pressure on these populations will lower the resilience of the overall community and can further strain community resources. Windham will need to consider uplifting all areas of their community to ensure the town can adapt to climate change.

3.4.1.2 SOCIOECONOMIC

Climate Hazard	Impacts
Warming Temperatures	- Financially burdened households will have a harder time paying for higher energy costs from extreme temperatures or upgrading to energy efficient appliances to offset the costs - Shifts in the ecosystem from warming temperatures put pressure on those in the natural resource industry
Changing Precipitation	Property damage from flooding or extreme storms will create additional financial insecurities

Why this matters

Added expenses of climate change, such as increasing energy costs or repairs due to storm damage, are particularly detrimental to those who are already financially burdened. Financially insecure households are less likely to have property insurance or savings for added or unexpected expenses or evacuate or relocate in case of a disaster.

Employment status, especially those who work in a natural resource industry, are seasonal workers, live on a fixed income, or are unemployed are also more vulnerable to the stressors of climate change and may have a harder time recovering from a climate emergency.

Finally, lack of access to key resources, such as broadband, limits a household's ability to communicate, respond, and recover during a climate crisis. Without access to technology, communities miss crucial warnings, evacuation notices, and other disaster-related information.

Risks in Windham

Percents are rounded to one significant figure.

- 3% of the population is living below the federal poverty line. As of 2023, 10% of Maine's population lived below the federal poverty line
- 19% of total households are cost burdened, while 24% of renters are cost burdened (cost burdened households include those that spend 30% or more of their income on housing expenses)
- 1% of the working age population is unemployed
- 2% of the population does not have a high school diploma
- 2% of Windham's population works in a natural resource occupation
- 11% of the population is self employed
- 3% of the population does not have health insurance
- 4% of households have no internet subscription. Some households may elect not to have internet even if it is available

3.4.1.3 HOUSING CHARACTERISTICS

Climate Hazard	Impacts
Warming Temperatures	Extreme temperatures degrade building materials faster, strain energy systems, and increase energy costs.
Changing Precipitation	Storms and flooding damage properties, restrict access, and create unsafe conditions for residents.

Why this matters

During a climate disaster, housing type and household characteristics will impact how individuals are able to adapt and recover. For example, renters have far less freedom in preparing for climate hazards than homeowners, as major renovations or upgrades are ultimately decided by the property owner. During a climate disaster, individuals living in multi-unit housing have limited access and limited ability to evacuate due to their dense population. Crowded structures also increase the psychological stress of residents, contribute to the spread of disease, and impact the overall health of residents. Sometimes these properties are also not as well maintained and less likely to be retrofitted or weatherized. Households without a vehicle lack the mobility to evacuate during a climate disaster and obtain necessary resources.

Risks in Windham

Percents are rounded to one significant figure.

- 15% of housing in Windham's is occupied by renters
- 12% of houses in Windham are multi-unit
- Windham has over 200 mobile homes, which is 2% of the housing stock
- 0.3% of households are considered crowded, or have more people than rooms
- 3% of households in Windham have no vehicle
- 28% of houses in Windham were built before 1970

SUGGESTED ACTIONS

Priority	Resource/Concern	Action Items
People		
High	Social Vulnerability	- Implement targeted emergency preparedness outreach for renters, older adults living alone, mobile home parks, and households without vehicles. - Support development of neighborhood-scale resilience hubs hosted by trusted community or faith organizations.

3.4.2 PUBLIC HEALTH

Good public health supports economic stability and community participation, while reducing the burden on healthcare systems. Climate change threatens public health through extreme heat, worsening chronic conditions like asthma and heart disease, and increased risk of waterborne illness from heavy storms. Flooded roads and properties can limit access to emergency and essential services. These

factors collectively reduce the community’s ability to withstand and recover from climate hazards.

This sub-section discusses the following public health concerns for Windham:

- Air Quality
- Extreme temperatures

3.4.2.1 AIR QUALITY

Climate Hazard	Impacts
Warming Temperatures	• Higher annual temperatures and the shifting seasons are likely to bring earlier flowering, boost pollen production, and the potential for a longer pollen season. • Increases in temperature and humidity will influence air pollution, affecting the number of cases and severity of respiratory conditions.⁴³
Changing Precipitation	• Increased wildfire, even from sources located hundreds of miles away, will bring smoke and fine matter to the state. • Increased flooding and humidity can also lead to mold growth in homes and buildings, impacting air quality, and triggering health problems.

Why this matters

Climate change will likely exacerbate poor air quality over time, as rising temperatures speed up the chemical reactions that create smog, and changes in wind patterns may potentially reduce local air circulation, trapping pollution at the ground level.⁴⁴ Residents with existing health conditions will be more vulnerable to poor air quality. These changes worsen asthma, allergies, and other respiratory conditions, while also causing serious cardiovascular problems.⁴⁵ In 2021, 12.5% of adults in Maine had asthma.⁴⁶ The elderly, children, those with preexisting health conditions, and those who primarily work outside are particularly vulnerable to worsening air quality. These health impacts can also increase healthcare costs, which can be particularly challenging for individuals who are already cost-burdened.

Risks in Windham

There is no specific air quality measurement for Windham, however, the Environmental Protection Agency (EPA) maintains a monitoring station in Portland for Cumberland County. **Overall, Cumberland County has relatively clean air.** The EPA’s Air Quality Index report is an indicator of overall air quality and considers all the criteria air pollutants measured at the monitoring station.⁴⁷ The County has not experienced any “Very Unhealthy” or “Hazardous” days in the last 20 years. Cumberland County has experienced 7 years (2001-2003, 2005, 2007, 2010, 2013) where the 8-hour ozone daily maximum concentration exceeded the National Ambient Air Quality Standard of 0.070 ppm which was set in 2015.⁴⁸

3.4.2.2 EXTREME TEMPERATURES AND HEALTH

Climate Hazard	Impacts
Warming Temperatures	• Extreme temperatures exacerbate existing health conditions, and create higher risks for heatstroke, dehydration, and cardiovascular stress.
Changing Precipitation	• Increased flooding and humidity can also lead to mold growth in homes and buildings, impacting air quality, and triggering health problems. • Combined storm and power disruptions can limit access to medical care, refrigeration for medications, and cooling or heating during extreme temperatures.

Why this matters

Climate change leads to more intense and longer-lasting heat events. Elderly, children, individuals with preexisting health conditions, and those who work outside are at greater risk of health-related impacts such as dehydration, heat exhaustion, or worsening of chronic illnesses.⁴⁹ To combat heat, officials often recommend staying in air-conditioned buildings. However, many Maine homes and businesses lack air conditioning, making people more vulnerable to heat stroke in the summer. Additionally, those with financial and mobility burdens are less able to afford air conditioning or access to cooling centers.

To compound this, “heat islands,” or areas of town with more impervious surfaces like buildings, roads, or parking lots, retain more heat and have higher surface temperatures. Residents who live or work in high-impervious areas are at greater risk of heat-related illnesses.⁵⁰ Areas with more trees and vegetation reduce the effect of heat islands and remain cooler. Historically, the most vulnerable populations within a community have the least access to open, green spaces.

Extreme cold-related illness also poses a serious threat to residents, especially the more vulnerable populations such as the elderly, children, individuals with preexisting health conditions, and those who work outside. Hypothermia and frostbite are the two most common cold-related illnesses in Maine, but there are also concerns related to slip and fall injuries and respiratory infections. It is important to have reliable sources of heat and access to warm and safe spaces.

All of this can increase hospitalization rates, strain health care systems and emergency response, increase demand for public cooling services, or strain the power grid and cooling systems.

Risks in Windham

Based on the heat severity map, most of the developed areas along Route 302, Route 202, and River Road are at a moderate to high risk from heat. By maintaining conserved lands and maximizing green spaces across the town, Windham can work to decrease the impact of rising temperatures. With varying humidity levels, there may be many more days that “feel” very hot despite what the thermometer says.

There is no data or information specific to Windham regarding the impacts of either extreme hot or cold temperatures. According to the Maine Tracking Network, in Cumberland County, there were 69 heat-related and 204 cold-related emergency department visits in 2024. While cold-related ED visits were higher, it is important to also understand confounding variables, such as how an increase in viruses can cause an increase in numbers (see callout box). Windham should consider the impacts of both extreme temperatures on vulnerable populations and ensure adequate resources are available. As increased temperatures alter cold weather precipitation patterns, the more intense storms could create additional hazards for community members. Ensuring access to reliable heating sources, proper maintenance of infrastructure, and the availability of warming centers within the community help reduce the risks of severe winter weather.

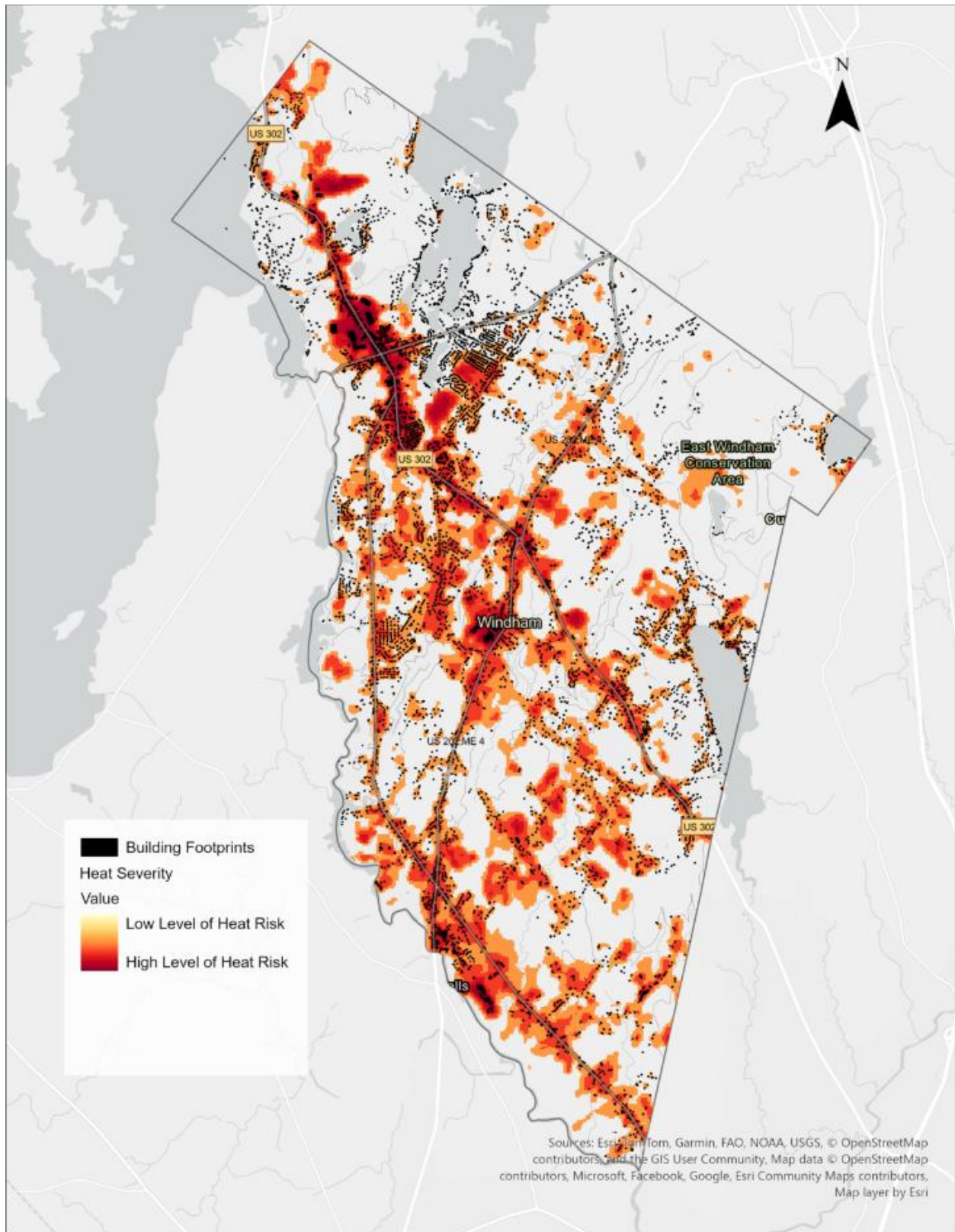


Figure 17. Heat severity and level of risk across Windham.

3.4.3 HOUSING AND AFFORDABILITY

Climate Hazard	Impacts
Warming Temperatures	• Hotter summer temperatures increase the demand for air conditioning, resulting in higher electricity bills. • Vulnerable groups may face unsafe living conditions in overheated homes.
Changing Precipitation	• Heavy precipitation can impact the integrity of a home, reduce insulation effectiveness, and increase energy loss. • Disaster displacement from intense storms increases homelessness and reduces housing availability.

Why this matters

Efficient homes use less energy, resulting in cost savings, improved comfort, and reduced emissions. Climate change threatens home efficiency by stressing infrastructure, which often lacks efficient updates. Older buildings, especially those built before 1970, tend to be less energy efficient and struggle to regulate home temperatures, increasing energy costs and safety risks.

The source of heating for a house impacts both vulnerability and greenhouse gas emissions. Cost of fuel varies by heating source and can put further stress on financially insecure households.⁵¹ Fuel oil, kerosene, propane, and natural gas all release carbon dioxide into the atmosphere. Heating (or cooling) the home using electricity provides a more cost-effective, sustainable solution to help combat climate change.

Climate change is lowering property values and raising the costs associated with home ownership and renting, worsening the affordable housing crisis. Severe weather events cause physical damage to homes, leading to increased rents, higher home insurance premiums, and more frequent insurance market instability. These rising costs place financial strain on renters and homeowners, especially low-income households, making housing less affordable overall. Displacement from climate disasters also increases competition for affordable housing.

Cost-burdened homeowners and renters already face financial insecurities. As climate hazards damage properties, force temporary or permanent evacuation, or require increased maintenance it will continue to increase housing costs. Investing in flood insurance, retrofitting buildings, or investing in flood-resistant properties is often unattainable for cost-burdened households. A lack of affordable housing will continue to push people out of town and place financial burdens on those who stay, making responding to climate change difficult. Elderly residents who live on fixed income, those in affordable housing complexes, and people living in manufactured homes are vulnerable to housing impacts.

Risks in Windham

At-A-Glance: Breakdown of home heating fuels in Windham	
Fuel Type	% of households using as primary heating fuel
Fuel Oil or Kerosene	61.3%
Natural Gas	5%
Electricity	7.6%
Propane	19%
Wood	5.3%

The majority of Windham homes are heated by fuel oil or kerosene. This is both one of the more costly heating sources and a greater emitter of greenhouse gases. Conversion away from oil will both reduce emissions and increase resiliency for the residents.

Out of the 8,657 households in Windham, 27.5% of these homes are categorized as “old,” meaning they were built before 1970. After the 1970s, many building codes and energy efficient standards changed; homes built before then typically have less insulation and outdated design and technology. Repairs or alterations made to homes can cost significant amounts of money with the need for materials, consultants, permits, and time. This poses barriers to having safe and energy efficient homes, ultimately increasing vulnerability.

A lack of available or affordable housing, not only in Windham, but also in the surrounding region, means a growing percentage of the labor force will have to commute further for work. As housing prices also rise regionally, workers may need to commute from outside the region, leading to both higher greenhouse gas emissions and greater vulnerability for climate-related transportation interruptions over time. Currently affordable housing options in Windham include Little Falls Landing, Marcus Woods, New Marblehead Manor, New Marblehead North, and Unity Gardens.

SUGGESTED ACTIONS

Priority	Resource/ Concern	Action Items
Public Health		
Low	Air Quality	• Install low-cost sensors at municipal buildings to track air quality and heat trends.
Medium	Extreme Temperatures	• Expand heating and cooling centers for resident use during extreme temperature days • Increase tree canopy in heat-vulnerable neighborhoods to reduce heat island effects.
High	Housing and Affordability	• Connect residents and landlords with weatherization and heat pump programs through Efficiency Maine and energy navigator support. • Update zoning and land use regulations to promote the development of affordable, climate-resilient housing in areas with lower environmental risks.

4. Priority Action Areas

Based on the analysis presented in the report, conversations with town staff, and public feedback, the following resource areas have been identified as the following priority areas. Since these areas are all interconnected, beginning to address one area can have an impact across multiple resources.

1. Protect transportation access during flood events

By 2050, approximately 14 miles of roadway, 20 bridges, and at least 11 culverts in town are projected to be at risk during a 100-year storm. Segments of major routes, such as Route 302 and 202, are at risk. Presumpscot Road alone has more than half a mile of projected inundation, and the Pleasant River crossings along River Road are among the most structurally vulnerable. With a majority of Windham residents commuting out of town and businesses depending on Route 302 traffic, even a single flooded crossing can impact the economy and community safety.

Windham should prioritize upgrading flood-prone roads, bridges, and culverts to withstand more intense precipitation and storm events, and tie upgrades into the capital planning process so work happens proactively rather than reactively. Windham can also consider enhancing emergency access planning to reduce service disruptions.

2. Improved Stormwater Management

Windham is in the middle of a major wastewater infrastructure transition as a new treatment plant in North Windham is coming online and businesses are connecting to the new sewer system; but the town's stormwater network still has areas at risk of being undersized for projected rainfall increases. Overwhelmed stormwater infrastructure means runoff carrying pollutants directly into surrounding waterbodies. Flooding also increases the risk of septic system failures and contamination of private wells.

To reduce these risks, the town should prioritize upgrading and expanding stormwater infrastructure. This includes culverts and catch basins that are sized to handle projected storms. Incorporating green infrastructure, such as rain gardens and permeable surfaces, at municipal sites and along roadways can help absorb and reduce runoff volume. Upgrading culverts, investing in stormwater best management practices, and implementing green infrastructure practices are a priority to protecting the environment and surrounding infrastructure.

3. Defend water resources from contamination

Windham's waterbodies are central to the town's ecosystem and recreation. Windham's waterbodies are increasingly at risk from rising temperatures and stormwater runoff. Highland Lake, Forest Lake, and Little Sebago Lake are on the State's watch or sensitive lists and all at risk of significant increases in phosphorus concentrations over the next 25 years. Many residents rely on private wells, which are also vulnerable to contamination from flooding.

While Windham has already taken steps for watershed protection, the town can continue to partner with local organizations to expand water quality monitoring, restore riparian buffers, and develop outreach programs for high-risk areas. Protecting these water resources will require reducing runoff volume through improved stormwater management and supporting well and septic system maintenance. Proactive efforts are essential to protect water quality and public health.

4. Build community resilience and enhance public health efforts

Climate change will stress public health and strain community resources. Windham has a number of vulnerable populations which increase impacts to climate change including 16% of residents over 65, 19% of residents living with a disability, and 8% of the population which speaks English less than well.

Windham should strengthen community resilience through targeted education, outreach, and emergency preparedness efforts. This includes improving communication and alert systems, supporting vulnerable residents during extreme temperatures and weather events, expanding access to emergency shelters, and providing guidance on well and septic system maintenance. Strengthening social networks and community-based support systems will be critical to ensuring residents feel prepared for and respond to climate-related health risks.

5. Grow conserved land

With over 1,300 acres of conserved land, or about 4% of the town, Windham falls well short of the State's goal to have 30% conserved land. These conserved areas provide forest cover and critical habitats around Little Sebago Lake in addition to providing ecosystem services such as water filtration and flood mitigation. Most of these lands are projected to experience flooding during major storm events by 2050, increasing pressure on these natural systems and degrading critical ecosystem services.

Windham should continue to ensure that land use ordinances foster smart growth while advancing shoreland and critical resource protection areas. The town can work to increase dedicated conserved land to ensure water quality is maintained throughout the watershed, and residents have access to open space. Similarly, the town should focus on managing invasive species and protecting habitat for native species to thrive. Focus should be given to areas not currently in conservation that have species and habitat of concern.

4.1 Next Steps

Building on the priority areas and recommendations, Windham should focus on moving from assessment to implementation. The recommendations identified in this plan can be incorporated into municipal policies, planning documents, and capital projects. It is essential to define clear roles across town departments, set measurable objectives, and identify funding sources and community partnerships to support implementation. Engaging residents and stakeholders throughout the process will foster public support, enhance local climate awareness, and ensure the plan addresses the needs of vulnerable populations.

Suggested next steps include:

1. Apply for another round of State funding through the Community Resilience Partnership's Community Action Grant. The grant sources provide up to \$75,000 to fund community climate action, or up to \$175,000 when applying with another community. This could support emergency management planning, culvert assessments, or education and outreach campaigns.
2. Develop awareness campaigns and educational outreach to expand and deliver information to residents about climate change impacts and actions, energy efficiency, and local resilience building.
3. Establish an order of prioritization for at-risk public works infrastructure. This could also coincide with culvert studies or additional infrastructure assessments such as bridge ratings or routine maintenance.

The town should also establish a system for tracking progress and regularly revisiting the assessment and adaptation strategies to respond to new data and evolving climate conditions. Through these efforts, the town can effectively reduce climate vulnerabilities, protect critical assets, and build a more resilient Windham.

ENDNOTES

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- ¹ First Street Foundation. [Flood Factor Methodology](#)
- ² [A lifeline and social vulnerability analysis of sea level rise impacts on rural coastal communities](#)
- ³ [Maine Climate Council Reports | Office of Policy Innovation & Future](#)
- ⁴ NOAA's National Centers for Environmental Information (NCEI). [Billion-Dollar Weather and Climate Disasters](#)
- ⁵ Karmalker and Bradley (2017). [Consequences of Global Warming of 1.5 °C and 2 °C for Regional Temperature and Precipitation Changes in the Contiguous United States](#)
- ⁶ Arnold et. al. [Maine Climate Council 2024 Updates](#)
- ⁷ Arnold et. al. [Maine Climate Council 2024 Updates](#)
- ⁸ NCEI. [Maine State Climate Summary](#)
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Appendix A: Comprehensive List of Prioritized Action Items

Priority	Resource/ Concern	Recommendations/ Action Items
Infrastructure		
High	Roadways	• Modify roadways during natural infrastructure life cycle replacements. • Develop an alternative access route plan for emergency services during flood events, in coordination with MaineDOT and regional partners. • Pilot a stormwater retrofit street using green infrastructure (rain gardens, bioswales, or permeable pavement) on a municipally owned road. • Install small-scale green infrastructure (rain gardens, vegetated swales) along municipal rights-of-way to reduce runoff.
	Bridges	• Complete water level analysis to ensure bridge heights (roads and rail) exceed expected flooding levels and determine structural integrity of bridges. • Coordinate with MaineDOT to assess bridge elevations and structural vulnerability and identify future upgrades consistent with DOT capital planning cycles.
	Culverts	• Conduct a culvert inventory and prioritize culvert upsizing based on TNC overtopping data, focusing on crossings in high-risk flood areas.
Low	Rail	• Coordinate with the railway owners to ensure continued viability and access (Given ownership challenges; actions for this infrastructure are outside of the scope of this project).
Medium	Buildings	• Complete a resiliency audit for municipal buildings to assess floodproofing needs, HVAC upgrades, and backup power requirements. • Incorporate resilient design and on-site stormwater practices into local site plan and subdivision review standards. • Offer voluntary “Flood-Ready Building Assessments” for properties in at-risk areas, providing guidance on elevating utilities, foundation sealing, and on-site stormwater improvements.
High	Stormwater	• Map and evaluate the full stormwater system and prioritize upgrades to pipes, catch basins, and outfalls to handle projected increases in precipitation. • Install green infrastructure at schools, parks, and municipal facilities to help reduce peak runoff volumes.
	Septic Systems	• Replace older or failing systems with advanced treatment technologies that perform better in saturated or shallow soils. • In flood-prone areas, elevate components or relocate septic systems farther from shorelines and high-water tables to reduce flood intrusion risks.
	Wells	• Provide well and septic maintenance workshops consistent with Maine Drinking Water Program and Maine CDC guidance. • Partner with the Portland Water District to identify and reduce inflow and infiltration in high-risk areas.
Medium	Power and Communication Systems	• Collaborate with CMP and regional partners to assess vulnerabilities to outages and flooding and advocate for resilience investments in local grid infrastructure. • Evaluate feasibility of solar plus battery systems at municipal buildings, subject to utility interconnection and Maine PUC requirements.

		Develop layered emergency communication protocols, including low-tech options for households with limited internet or English proficiency.
Community Resources		
Medium	Economies and Livelihoods	- Create a business resilience toolkit to help local employers prepare for flooding, power loss, and transportation interruptions. - Coordinate with neighboring municipalities to maintain access to employment and retail centers during road closures.
High	Essential Services	- Produce an emergency access route map highlighting alternate routes to hospitals, EMS, and public safety buildings during floods. - Formalize and publicize cooling and warming centers with clear activation procedures.
High	Social Services	- Establish a Resilience Navigator program through community organizations to support vulnerable residents with preparedness steps. - Partner with nonprofits to strengthen service continuity plans for food pantries, libraries, and community centers in flood-prone areas.
Medium	Agriculture and Food Systems	- Expand community gardens and offer climate-smart gardening workshops aligned with UMaine Cooperative Extension best practices. - Strengthen local food resilience by partnering with regional producers, food pantries, and grocers to improve supply redundancy.
Medium	Trails, Parks, and Recreation	- Increase shade and tree canopy in parks to reduce heat exposure for users. - Implement climate-resilient trail upgrades (boardwalks, drainage, erosion control) on municipal and partner-managed trails.
Natural Resources		
Medium	Ecosystems	- Complete an invasive species assessment and implement removal and native replanting projects with volunteers and regional land trusts. - Pursue conservation of priority habitat areas in partnership with willing landowners and regional land trusts. - Develop a landscaping management plan or ordinance for town-owned lands that prioritizes planting native species, avoids insecticides and herbicides, and includes educational materials for residents on native landscaping.
High	Open Space and Conserved Lands	- Review the recommendations and goals identified in the Windham Open Space Master Plan to ensure future projects align with and advance the priorities outlined in the Open Space Plan. - Implement urban forest restoration projects on municipal land using native species.
High	Water Resources and Drinking Water Quality	- Partner with the Presumpscot Regional Land Trust, University of Southern Maine, or local groups to expand water quality monitoring on the Presumpscot River and nearby streams. - Restore riparian buffers using native vegetation consistent with Maine's Shoreland Zoning and DEP permitting. - Provide educational outreach materials/programs on water conservation methods, safe well and septic system maintenance (for private wells and septic), and emergency preparedness.
High	Erosion	Complete the current riverbank stability assessment of vulnerable reaches of the Presumpscot and prioritize areas for bioengineering stabilization (within state and federal permitting rules).

		• Provide shoreland protection education for residents on vegetation, buffers, and erosion prevention.
High	Land use, forests, carbon sinks	• Consider updating zoning to account for climate changes, such as increased precipitation. • Use land-use planning to limit development in high-risk areas and to preserve forests, wetlands, and open space as natural carbon sinks. • Consider investing in green infrastructure to absorb carbon and reduce heat.
People		
High	Social Vulnerability	• Implement targeted emergency preparedness outreach for renters, older adults living alone, mobile home parks, and households without vehicles. • Support development of neighborhood-scale resilience hubs hosted by trusted community or faith organizations.
Low	Air Quality	• Install low-cost sensors at municipal buildings to track air quality and heat trends.
Medium	Extreme Temperatures	• Expand heating and cooling centers for resident use during extreme temperature days • Increase tree canopy in heat-vulnerable neighborhoods to reduce heat island effects.
High	Housing and Affordability	• Connect residents and landlords with weatherization and heat pump programs through Efficiency Maine and energy navigator support. • Update zoning and land use regulations to promote the development of affordable, climate-resilient housing in areas with lower environmental risks.