NEW HAMPSHIRE DOT

RESILIENCE IMPROVEMENT PLAN

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prepared for

New Hampshire DOT Department of Transportation

prepared by

CAMBRIDGE SYSTEMATICS

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1.0 INTRODUCTION

State Departments of Transportation (DOTs) across the United States are tasked with the complex challenge of managing a safe and reliable transportation system to serve a growing population. The challenges associated with managing statewide transportation systems and their assets are further exacerbated by the increasing impacts of extreme weather and sea-level rise. According to the National Climate Assessment, New Hampshire is expected to experience an increase in both the frequency and severity of extreme weather events, along with ongoing sea level rise and flooding.[1] These challenges may lead to significant damage to infrastructure, increasing repair and maintenance costs and disrupting the everyday functionality of transportation systems throughout the state.

Over the last century, **New Hampshire has been experiencing rising temperatures, heavier precipitation and increasing vulnerability to storms which threaten existing, and planned, infrastructure**.[2] The impacts to the state have been well-documented. In 2022, the University of New Hampshire released the 2021 New Hampshire Climate Change Assessment[3] which forecasted future impacts across the state. Key forecasts include more than a 9.5° increase in annual average maximum and minimum temperatures, and significant increases in the frequency of extreme heat, extreme precipitation events, and total annual precipitation by the end of this century.

According to the New Hampshire Coastal Flood Risk Summary Part II: Guidance for Using Scientific Projections[4] “coastal flood risks pose an immediate and increasing threat” to New Hampshire’s infrastructure including transportation assets. As discussed in Section 3.0, New Hampshire’s State Hazard Mitigation Plan (SHMP) identified **inland and coastal flooding as two of the highest priority hazards**. In addition, many of New Hampshire’s population centers and densest communities are located in coastal or flood-prone locations such as in urbanized seacoast towns, with many recreating alongside the state’s inland waterways as well. Given that these two hazards are particularly impactful to transportation infrastructure and communities, they form the foundation for assessing transportation asset vulnerability.

As a whole, New Hampshire’s population, and corresponding transportation needs, continues to grow and evolve. **As a result, it is critical to consider and plan for resilience needs and changing patterns of movement, especially when applied to the entirety of the statewide transportation system.** Recognizing the significance of change in New Hampshire, and the potential impacts to the statewide transportation system, in 2022, the New Hampshire Department of Transportation (NHDOT) developed the Coastal Flood Risk Tolerance Framework as a methodology to assess risk to coastal assets from sea level rise. **This methodology partly forms the foundation for New Hampshire’s first Resilience Improvement Plan (RIP “or the plan”), intended to further**

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[1] Runkle, J., K.E. Kunkel, D.R. Easterling, R. Frankson, B.C. Stewart, and J. Spaccio, 2022: New Hampshire State Climate Summary 2022. National Oceanic and Atmospheric Administration (NOAA) Technical Report NESDIS 150-NH. NOAA/NESDIS, Silver Spring, MD, 5 pp.

[2] U.S EPA. “What Climate Change means for New Hampshire” (August 2016). https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-nh.pdf

[3] Lemcke-Stampone, Mary D.; Wake, Cameron P.; and Burakowski, Elizabeth, "New Hampshire Climate Assessment 2021" (2022). The Sustainability Institute. 71. https://scholars.unh.edu/sustainability/71

[4] NH Coastal Flood Risk Science and Technical Advisory Panel (2020). New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections. Report published by the University of New Hampshire, Durham, NH. https://scholars.unh.edu/ersc/211/

its effort to improve resilience of transportation assets and processes within the agency. Within this RIP, NHDOT is building upon the work done previously in the coastal region and expanding it to address risks across the entire state.

There are numerous benefits to investing in the development of a RIP. This RIP will not only facilitate a greater understanding of current transportation resilience, but it will support NHDOT's planning partners and other agencies in the state towards funding resilience projects to reduce vulnerability and risk due to current and projected extreme weather and sea-level rise impacts. The RIP will also guide resilience funding to where it is most needed and enable NHDOT to take full advantage of federal funding made available through the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program.

The PROTECT Program was authorized under the federal Bipartisan Infrastructure Law (BIL), signed in 2021. This program is the first of its kind, offering financial support to integrate resilience into DOT practices. Having a federally compliant RIP enables the DOT, and its planning partners (e.g., metropolitan planning organizations (MPOs) and regional planning commissions (RPCs)), to receive a local funding match reduction for up to 10 percent for Formula and Discretionary Program applications.[5]

Why plan for Transportation Resilience?

Resilience improves the ability of transportation assets to withstand changing climate conditions, thereby reducing the vulnerability of transportation assets to climate impacts. This Plan:

- Evaluates vulnerabilities;
- Assesses the risks associated with climate hazards; and,
- Explores strategies to improve statewide transportation resilience to climate hazards.

In developing this RIP, NHDOT seeks to further embed resilience into its ongoing mission and purpose. NHDOT's mission is as follows:

- *Transportation excellence enhancing the quality of life in New Hampshire.*

This mission is guided by an expanded purpose:

- *Transportation excellence in New Hampshire is fundamental to the state's sustainable economic development and land use, enhancing the environment, and preserving the unique character and quality of life. The Department will provide safe and secure mobility and travel options for all of the state's residents, visitors, and goods movement, through a transportation system and services that are well maintained, efficient, reliable, and provide seamless interstate and intrastate connectivity.*

The DOT's mission and purpose align to enhance the quality of life by improving the stewardship of the environment and the transportation system, along with its broader impacts. The development of this RIP recognizes that the effects of sea-level rise and extreme weather significantly impact the state's multimodal transportation system. For this reason, to continue transportation excellence in the state, an overarching resilience strategy is needed to best position the multimodal system to withstand and thrive in continuously changing conditions by minimizing disruptions and safeguarding the quality of life of residents of the state.

[5] Applicants are typically required to account for a 20 percent non-federal match for capital projects. Through the development of a RIP however, for state DOTs and MPOs this non-federal match can drop to 13 percent. Furthermore, if the RIP is integrated into the agency's long-range transportation plan (LRTP), the non-federal match drops to 10 percent.

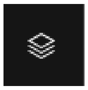
Serving as New Hampshire's first RIP, this plan seeks to establish a wide-ranging yet thorough foundation for future resilience planning initiatives. To support these efforts, NHDOT intends to update the RIP as appropriate, potentially aligning updates with future LRTP, TAMP, and other relevant planning processes.

1.1 Features of This Plan

To ensure stakeholders are well-informed with the most accurate knowledge, understand the risk-based assessment, and have access to the data and results, **this plan utilizes both static and digital maps** and makes them available for visualization purposes. As seen in Sections 4.0 through 7.0, static maps are used to display the final results of multiple analyses. As explained in Section 4.0, the assets included in this assessment are roadways, bridges, and culverts. However, the static maps within this document are only visualized at the roadway level. This is because the results for bridges and culverts are considered as part of the larger network of roadway assets for visualization and spatial analysis purposes. This applies to certain maps in particular, like Figure 5-1 Roadway Network Criticality Assessment Results, in which the scores from the roadway criticality analysis were applied to both bridges and culverts.

In addition to the static maps, this plan also utilizes ArcGIS Online (AGOL) to host digital maps that allow the user to retrieve asset-level information for a range of topics. These topics include the results from the main analyses seen in the bullet points below. There is also a data dictionary that accompanies these maps, linked below.

- Criticality and Vulnerability Assessments
- Risk Assessment
- ArcGIS Online Mapping Data Dictionary

1. Click the links to access the Map Viewer. In the top righthand corner, click "Open in Map Viewer."
2. Once the Map Viewer is open, a default map will appear. Click the layers icon  (the icon under the plus sign on the gray, lefthand toolbar) to see all layers within the map.
3. Use the eye icon to turn the layer on and off.
4. The legend may not pop up automatically. Please click the legend icon  to view the legend.
5. Click on a segment or point to view asset-level information.

Within the Risk Assessment mapping product, users can also view content dynamically from Sections 6.4 Risk Based Project Prioritization and 7.0 Community Resilience. Building out RIP analyses online facilitates a greater adoption of the results for stakeholders and statewide planning partners —particularly relevant when local and regional planning agencies are in the process of developing their region-specific RIPs.

The online maps allow for easy distribution and access across stakeholder groups and could easily be cited in other planning documents or grant applications. Also, this platform serves to offer an interactive, tailored view of the results that adapt depending on area of interest or asset of concern. Importantly, for future iterations of the RIP, these maps can be refreshed with the latest and greatest data to ensure the most current data is available to the public.

1.2 Plan Organization and Compliance with PROTECT Requirements

The PROTECT program guidance provides a list of 14 required and optional contents which are described in Table 1-1 below. At a minimum, RIPs must accomplish the following objectives:

- Define the objectives and scope of the RIP by taking a long-term planning and a system wide approach to achieving system resilience.
- Include a risk-based assessment of vulnerabilities of transportation assets and systems to current and future weather events and natural disasters, such as severe storms, flooding, drought, levee and dam failure, wildfire, rockslides, mudslides, sea-level rise, extreme weather, extreme temperatures, and earthquakes.
- Develop strategies that include both immediate and long-range planning activities and resilience investments. These strategies could include the benefits of natural infrastructure.
- Ensure that the RIP is ready for integration and implementation, consistent with and complements state and local hazard mitigation plans and incorporates codes, standards, and regulatory framework to ensure improvement.

Appendix B RIP Requirements Crosswalk serves as a guidebook for this plan, outlining how this document satisfies the requirements under the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) program, 23 U.S. Code 176(e)(2). It explains how each element listed in Table 1-1 is fulfilled and justifies why some optional elements are not addressed.

TABLE 1-1 PROTECT – RESILIENCE IMPROVEMENT PLAN COMPONENTS

The Plan Shall…	Shall, as appropriate…	May also…
1. Encompass immediate and long-range planning activities and resilience investments	5. Describe ways to improve response to impacts and changes	10. Designate evacuation routes and strategies
1. Demonstrate a system-wide approach to transportation system resilience	6. Describe the codes, standards, and regulatory framework to ensure improvements	11. Plan for response to anticipated emergencies
2. Be consistent with and complement State and local hazard mitigation plans	7. Consider benefit of natural Infrastructure	12. Describe the resilience improvement policies
3. Include a risk-based assessment of vulnerability to current and future weather events and natural disasters	8. Assess community infrastructure resilience	13. Include investment plan & priority projects
	9. Use a long-term planning period	14. Use science and data

The plan is laid out as follows:

- **Section 2.0 – Stakeholder Engagement:** Discusses NHDOT's stakeholder engagement process. This includes the list of stakeholders NHDOT engaged with, as well as the methods of engagement.
- **Section 3.0 – Alignment with Existing Resources:** Describes how this RIP aligns with key existing resources developed by NHDOT and other partner state agencies.
- **Section 4.0 – Asset Inventory:** Identifies the assets which will be analyzed as part of the risk-based assessment.
- **Section 5.0 – Criticality:** Assigns criticality for each asset, and includes a description of the process, and key outputs.
- **Section 6.0 – Vulnerability and Risk-Based Assessment:** Conducts the vulnerability and risk-based assessment for each asset, including a project prioritization process.
- **Section 7.0 – Community Resilience:** Examines opportunities for transportation resilience and offers insights to regional planning partners on how to leverage this RIP for future planning efforts.
- **Section 8.0 – Implementation Strategies:** To ensure that the RIP achieves its desired outcome in furthering NHDOT's mission and purpose, this section discusses implementation, including through the development of an implementation checklist, including key strategies and considerations.

Table 1-2 shows how each of the PROTECT requirements are satisfied across the different sections of the RIP.

TABLE 1-2 ADDRESSING OF PROTECT REQUIREMENTS BY RIP CHAPTER

PROTECT – Resilience Improvement Plan Requirements		Section 1	2	3	4	5	6	7	8
1	Encompass immediate and long-range planning activities and resilience investments	X	X	X	X	X	X	X	X
2	Demonstrate a system-wide approach to transportation system resilience	X	X	X	X	X	X	X	X
3	Consistent with and complement State and local hazard mitigation plans	X	X	X				X	X
4	Include a risk-based assessment of vulnerability to current and future weather events and natural disasters					X	X	X	
5	Describe ways to improve response to impacts and changes					X	X	X	X
6	Describe the codes, standards, and regulatory framework to ensure improvements	X		X					X
7	Consider benefit of natural Infrastructure								X
8	Assess community infrastructure resilience		X	X				X	X
9	Use a long-term planning period					X	X	X	X
10	Designate evacuation routes and strategies				X	X			
11	Plan for response to anticipated emergencies			X	X				
12	Describe the resilience improvement policies	X							
13	Include investment plan & priority projects						X	X	
14	Use science and data			X	X	X	X	X	

1.3 Key Terms Used in This Plan

The following terms are found throughout this RIP, and are defined as follows:

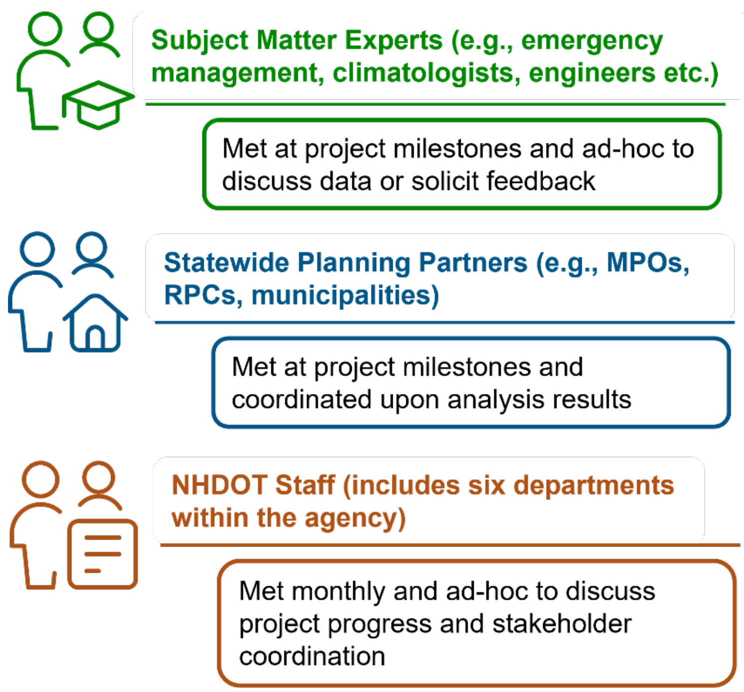
- **Adaptation**: Adjustment in natural or human systems in anticipation of or in response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects.
- **Adaptive Capacity:** The degree to which the asset can adjust or mitigate damage or disruption caused by a hazard or threat.
- **Criticality**: The degree to which a given asset is important to the unimpeded operation of the transportation system in New Hampshire.[6]
- **Consequence:** Defined as the costs that would be incurred as a result of an event happening.
- **Exposure**: When an asset or system experiences direct effects of climate variability or extreme weather events. Exposure is a prerequisite for vulnerability.
- **Hazard**: An event or long-term trend that can have a range of substantial negative effects, undermine the stability of a system, and increase vulnerability.
- **Probability:** Defined as the likelihood of an event occurring. For this risk assessment, the likelihood of sea level rise, storm surge, and flooding events are modeled through 2050 and 2100.
- **Resilience**: The ability to adapt to changing conditions and prepare for, withstand, and recover from disruption.
- **Risk**: A combination of the likelihood that an asset will experience a particular climate impact and the severity or consequence of that impact.
- **Sensitivity:** Refers to how the asset or system fares when exposed to the current or future extreme weather.
- **Stressor:** Conditions that make hazards more frequent or severe, may be tied to the climate variability or may be a non-climate stressor such as expansion of impervious surfaces or increased population growth.
- **Vulnerability**: The degree to which a system is susceptible to, or unable to cope with, adverse effects of sea-level rise, increases in precipitation and extreme weather events.

[6] The definition of criticality stems from a review of FHWA's criticality definition, and other relevant state and national best practice sources. It was then tailored to fit the needs of NHDOT and the state's multimodal transportation system.

2.0 STAKEHOLDER ENGAGEMENT

The development of the New Hampshire DOT RIP was done in close coordination with planned stakeholder engagement with members of the scientific, environmental, and transportation communities as well as state and regional planning staff. This engagement and communication supported significant efforts and milestones throughout the analysis, particularly in data collection, interpretation, and vetting of the results. The following graphic (Figure 2-1) highlights the key groups engaged throughout the RIP planning process and the contributions each group made throughout the project's analysis.

FIGURE 2-1 STAKEHOLDER INVOLVEMENT



2.1 Stakeholder List

The following stakeholders were engaged during the project:

- **New Hampshire Subject Matter Experts**: The RIP development process included outreach and engagement to New Hampshire's public and private agencies and organizations including the New Hampshire Department of Environmental Services (NHDES), University of New Hampshire (UNH), The Nature Conservancy, and the New Hampshire Department of Safety (DOS) Division of Homeland Security and Emergency Management (HSEM).
- **New Hampshire Regional Staff**: Staff members from an array of practice areas representing the state's nine RPCs and four MPOs. The Rockingham Planning Commission, the Strafford Regional Planning Commission, the Southern New Hampshire Planning Commission, and the Southwest Region Planning Commission played an active role in the RIP, providing feedback and local expertise.

- **NHDOT Staff**: The development of this plan involved a multidisciplinary team of internal stakeholders and implementation partners from various divisions within the DOT, including DOT leadership, asset management, bridge design and maintenance, highway design, multimodal planning and policy, and operations. Each division plays a distinct role within the agency. The RIP was based on the expertise of DOT staff, particularly those in the Commissioner's Office, as well as those involved in planning, asset management, and bridge design and maintenance.

2.2 Stakeholder-Enriched Planning

As part of the RIP development process, NHDOT utilized virtual forums to gather insight from the stakeholders identified above. This included the following methods:

2.2.1 NHDOT Internal Working Group

To steer the RIP development process, NHDOT worked to build a multi-functional area internal working group with DOT stakeholders to review project results while providing guidance where necessary. Given the linkage between resilience and asset management, the bridge design and maintenance teams were consistent meeting attendees, providing feedback on key elements of the analysis. For example, DOT bridge staff were included in the decision to use scour criticality and substructure condition as sensitivity factors within the vulnerability construct.

The project team met regularly with DOT staff to not only provide progress updates following the completion of key milestones, and discuss areas of improvement, but to provide clarity on resilience improvement planning as well as subject matter expertise. These working group meetings included presentations by the project team, followed by discussion and collaboration.

Internal Conversations Spark Greater Dialogue

During a call with the DOT, the highway design team brought up the topic of non-stationarity. Discussions devolved into what change factor should be used for future forecasted rainfall, shining a light on the issue of incorporating changing conditions into roadway design and policy at the DOT.

2.2.2 Project Partners Meeting

Engagement with New Hampshire's transportation, climate, and data experts outside of the DOT was invaluable throughout the project. NHDOT enlisted external stakeholders including regional planning partners and partnering agencies which specialize in key knowledge areas from climate modeling, environmental policy, infrastructure planning, permitting, coastal zone management and other relevant topic areas. Virtual meetings were held at milestone points for the project (e.g., project kickoff, drafting of the analysis constructs, and results from the vulnerability assessment) and ad-hoc as needed. NHDOT has partnered with NHDES, UNH, and other partners on the NHDOT Coastal Risk Tolerance Framework effort, which was aimed to provide consistent guidance to DOT project managers and designers for use when making project decisions and incorporating risk of coastal flooding into the process. This prior work was also helpful in communicating the needs and intent of NHDOT in conducting a risk-informed assessment of transportation infrastructure to their statewide partners and making use of the best-available climate models and data available to support the efforts.

Results from each phase of the analysis were shared via ArcGIS Online platforms so stakeholders could evaluate the results as they came. For example, after the vulnerability results were disseminated, the project team met with the DOT and NHDES to discuss the framing of the scenarios and results. NHDES provided detailed insights as to how to best frame technical topics to a public audience. In addition, NHDES and multiple regional planning partners were heavily involved in vetting the results, using knowledge of their localities to dissect areas of inconsistency or areas of concern. By providing site-specific examples, the project team was able to identify areas that had experienced flooding or overtopping in the past. The difference between real life experiences in terms of exposure and impacts in recent memory squaring off with the overall construct of vulnerability and risk fostered interesting dialogues.

Stakeholder Sourced Data

The availability and quality of data was an overarching theme throughout many internal and external meetings. At the project kickoff, participants were asked:

- What other data or resources may be available to assess inland flooding?
- Are there other recent statewide datasets that could be leveraged in this plan?

Given the earlier work done on NHDOT Coastal Flood Risk Tolerance effort, NHDOT leveraged the coastal flooding data from that analysis to harmonize and use it in the NHDOT RIP effort. The climate scenarios used for the coastal risk assessment follow the recommendation from Section 4 of the New Hampshire Coastal Flood Risk Summary Part I: Science. The RIP leverages coastal flooding scenarios and planning horizons to target 2050 and 2100, aiming to represent reasonable approximations of the lifecycles that NHDOT expects for pavements and bridges (up to 120 years).[7]

Using these two scenario years captures existing infrastructure with long remaining lifespans, current assets nearing the end of lifespans, and future projects in development or design. NHDOT's project management team decided to use the best available climate information, models, and projections for this round of the development of the RIP. Any significant enhancements and model updates to coastal flooding, to account for hydrodynamic modeling and other refinements may be considered in developing risk assessments for future RIP updates in coordination with FHWA division office and NHDOT.

This RIP was fortunate to acquire additional data from statewide stakeholders, with the project team able to learn more about the data through some of its originating agencies. For example, this RIP relies heavily on New Hampshire's Statewide Asset Data Exchange System (SADES) Geodata Portal and the SADES Stream Crossing Initiative.

The Stream Crossing initiative is a multi-agency group (spearheaded by NHDES) that collaboratively works to improve management of stream crossing infrastructure across the state. During the fomenting stages of the RIP, the project team met with stakeholders to ensure the data fields used to analyze vulnerability (see Section 6.2) were the most appropriate and to point out any noticeable inconsistencies within the data. Without the existing effort from agencies to compile this data and collaborative effort throughout the RIP to apply the data, this RIP would not be as well-supplied with the most current and advanced data sources.

[7] See the NHDOT 2022 Transit Asset Management Plan: https://www.nh.gov/dot/org/commissioner/amps/documents/nh-tamp-2022.pdf

2.2.3 Additional Engagement

Federal Highway Administration (FHWA)

During plan development, the project team also coordinated with the Federal Highway Administration's (FHWA) New Hampshire Division Office and climate resilience specialists with the Agency's Central Office to discuss the approach to the RIP and share an annotated outline of the plan. During the initial call, the project team sought to familiarize the Division and Headquarters staff with prior resilience work completed by NHDOT and the plan's intended outcomes. NHDOT shared a draft annotated outline of the RIP with FHWA to seek input and sought appropriate guidance on contents and manner of addressing PROTECT program compliance and guidance through the plan.

The FHWA was extremely helpful in providing advice from what they have learned from other states and provided guidance on how to ensure that NHDOT will receive appropriate match reduction. One of the large takeaways from this engagement was that coordination with local planning partners is essential to give resilience projects standing at the state level and coordinate efforts across jurisdictions. The project team was fortunate to continue engagement from the prior Coastal Flood Risk Tolerance Framework, fostering a continuum of engagement from one plan to the next.

3.0 ALIGNMENT WITH EXISTING PLANS AND PROCESSES

This plan combines and leverages relevant planning efforts led by the DOT and other partner agencies towards demonstrating a systemic approach - across modes, geographic regions, and critical interdependent sectors - to transportation system resilience and be consistent with and complementary of the state and local mitigation plans – as highlighted in the PROTECT Program guidance. The following planning documents provide an understanding of the hazard context that New Hampshire DOT prepares for, operates in, and responds to. The key objective of the RIP is to evaluate and determine the impacts of stressors from a transportation infrastructure and mobility perspective. The planning documents highlighted in this section are particularly relevant given their focus on the system's performance and condition, with many spotlighting the need for resiliency planning and mitigation/adaptation strategies to bolster the state's assets, presently, and in the future.

Reviewing the following statewide plans in conjunction with the RIP meets the PROTECT program requirements, which emphasize the need for coordinated support of both immediate and long-term planning activities and investments aimed at enhancing the resilience of the surface transportation system. These documents also draw attention to the actions the DOT has already taken in, such as the development of Coastal Flood Risk Tolerance Framework.

3.1 New Hampshire State Hazard Mitigation Plan (SHMP)

The New Hampshire Department of Safety (DOS) Division of Homeland Security and Emergency Management (HSEM) led the development of the State Hazard Mitigation Plan (SHMP).[8] New Hampshire's SHMP was developed in 2023 and provides a comprehensive assessment of all hazards that may pose threat or hazard to New Hampshire. The plan, in effect through 2028, identifies the hazards that have the greatest consequences as well as those that have had historical impacts. Understanding past impacts supports New Hampshire in their approach to mitigating and recovering from climatic events moving forward. The SHMP supports this notion by outlining potential mitigation strategies to reduce or eliminate the long-term risk to human life and property.

FIGURE 3-1 RAIL LINE DAMAGED DUE TO LAND SUBSIDENCE

Source: NHDOT

To determine the level of risk (or consequence) from individual hazards, the SHMP provides an overall risk rating based on a combination of potential impact and probability of occurrence. For New Hampshire, there are 24 relevant hazards (13 natural hazards, seven technological hazards, and four human-

[8] New Hampshire State Hazard Mitigation Plan

caused hazards) evaluated through the Statewide Risk Assessment process (Figure 3-2). A higher score indicates a more significant overall risk to people, property, and businesses as well as a higher probability of the threat or hazard occurring.

FIGURE 3-2 NEW HAMPSHIRE HAZARD MITIGATION PLAN STATEWIDE PLAN RISK ASSESSMENT RESULTS

Threat/Hazard	Classification	Human Impact	Property Impact	Economic/ Business Impact	Average Impact Score	Probability of Occurrence	Overall Risk
Avalanches	Natural	1	1	1	1	2	**2**
Coastal Flooding	Natural	3	6	6	5	3	**15**
Inland Flooding	Natural	6	6	6	6	3	**18**
Drought	Natural	1	3	3	2	2	**4**
Earthquakes (>4.0)	Natural	1	3	1	2	1	**2**
Extreme Temperatures	Natural	3	1	1	2	3	**6**
High Wind Events	Natural	3	6	3	5	3	**15**
Infectious Diseases	Natural	3	1	3	2	2	**4**
Landslide	Natural	1	3	3	2	3	**5**
Lightning	Natural	1	3	1	2	3	**6**
Severe Winter Weather	Natural	6	6	6	6	3	**18**
Solar Storms & Space Weather	Natural	3	1	3	2	1	**2**
Tropical & Post-Tropical Cyclone	Natural	6	6	6	6	2	**12**
Wildfire	Natural	1	1	1	1	2	**2**
Aging Infrastructure	Technological	3	6	3	4	3	**12**
Conflagration	Technological	6	6	6	6	2	**12**
Dam Failure	Technological	3	3	3	3	2	**6**
Known and Emerging Contaminants	Technological	6	6	3	5	3	**15**
Hazardous Materials	Technological	1	3	3	2	3	**6**
Long-Term Utility Outage	Technological	6	6	6	6	1	**6**
Radiological	Technological	1	1	3	2	1	**2**
Cyber Event	Human-caused	3	1	6	3	3	**9**
Mass Casualty Incident	Human-caused	6	1	3	3	1	**3**
Terrorism/Violence	Human-caused	6	3	3	3	3	**9**
Transport Accident	Human-caused	3	3	3	3	3	**9**

Source: State of New Hampshire Hazard Mitigation Plan 2023 Update

However, this RIP focuses on the hazards that have the greatest consequence to the transportation system and its assets, which includes inland and coastal flooding.

- According to the SHMP, inland flooding is tied for the highest priority hazard given New Hampshire's abundant 23,000+ miles of inland waterways. The state has faced several significant flood events since 2006 that have washed out culverts, damaged bridges and roads, and washed away streambanks. The SHMP profile highlights how all areas of the state are at risk and the high probability of future occurrences tied to climate change.

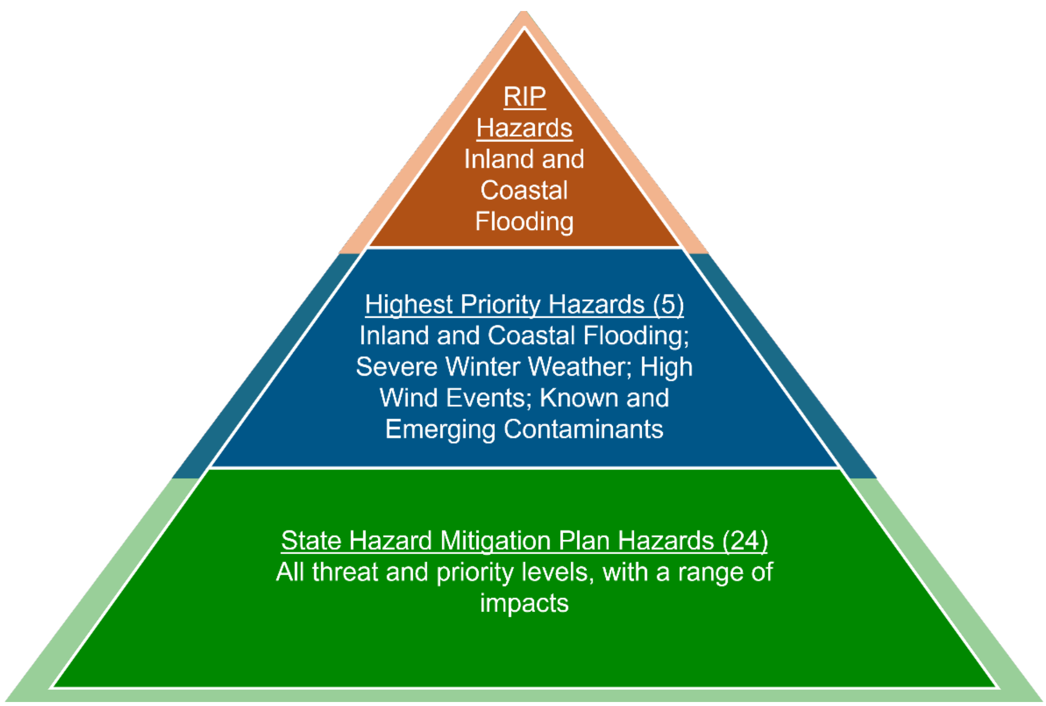
- As noted in the SHMP, the 2019 New Hampshire Coastal Flood Risk Assessment determined relative sea level in coastal New Hampshire has risen approximately 7.5 – 8.0 inches from 1912–2018. Recent events have led the DOT to work with local agencies on roadway adaptation projects.

The other three hazards (severe winter weather, high wind events, and known and emerging contaminants) were excluded from the RIP at this time since they have less consequence on transportation assets or have been addressed through existing DOT functional area operational practices. For example, high wind events tend to impact vertical structures more than roadways. Severe winter weather tends to be managed by operations and maintenance crews which have robust processes for pre- and post-recovery already in New Hampshire. Finally, known and emerging contaminants have not been flagged for consideration to be high priority at this time.

Spotlight: NHDOT Roadway Coastal Adaptation Project

Through the FY2022 & 2023 PROTECT discretionary grant award, NHDOT will receive over $20.2 million to reconstruct coastal erosion protections along three miles of Route 1A between North Hampton and Rye. The improvements will significantly reduce road closures and roadway clean-up in coastal communities vulnerable to the increasing intensity and frequency of coastal storms as well as rising sea levels.

FIGURE 3-3 TIERS OF IDENTIFIED THREATS IN RIP EVALUATION PROCESS



Although only the two highest priority transportation hazards (inland and coastal flooding) are analyzed in this plan, the RIP sets the framework for future iterations to assess additional natural and human-caused hazards as identified in New Hampshire's SHMP.

3.1.1 Community Resilience

Three new focus areas were also introduced in the latest SHMP:

- Inclusive planning for equitable outcomes,
- Impacts of climate change and,
- Community lifelines (which evaluates the importance of transportation to vulnerable communities).

These elements underscore the state's commitment to "Whole Community" planning (a concept originating from the Federal Emergency Management Agency (FEMA)), which provides a community resilience framework for individual communities to integrate this information into their Local Hazard Mitigation Plans (LHMP) and resilience planning efforts.

A municipality with a large population reliant on public transportation views transportation with a different lens than a community that has limited or no accessible public transportation. This RIP adopted this approach as seen within the indicators used in the criticality analysis (Section 5.0) and the assessment's dedication to community resilience (Section 7.0). This tactic intends to align with state priorities to equip local jurisdictions and planning partners with the tools and understanding of resilience as a holistic and evolving process based on context and need.

3.2 NHDOT Emergency Response Planning

While the SHMP offers agencies and organizations a formal opportunity to collaborate and document best practices on statewide hazard mitigation, coordination amongst state and local agencies (including NHDOT), and other stakeholders, occurs every day. NHDOT plays an active role in the SHMP and in emergency response efforts helping restore functionality, contain losses, and prevent disruptions that impact safety and mobility.

New Hampshire has the State Emergency Operations Plan (SEOP)[9], which highlights how its various annexes (the SHMP, the Continuity of Operations Plan (COOP), the Distribution Management Plan[10], and the Recovery Annex[11]) work in concert to form a united approach to hazard mitigation and emergency response and management. These plans outline specific operational roles and responsibilities for select Emergency Support Functions (ESFs) and Recovery Support Functions (RSFs). NHDOT is listed as a lead or supporting ESF or RSF within several functions.

3.2.1 State Emergency Operations Plan

NHDOT has a large and ever-growing role in the SEOP given the importance of transportation for the mobilization of resources, evacuations, and sustainment of communities during and post disasters. In the SEOP, transportation is the first ESF (ESF 1) listed, with a section dedicated to actions and roles the lead agency (the DOT) can play. This details how the state will provide transportation assistance to municipalities if needs exceed

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[9] HSEM (2019) https://www.nh.gov/safety/divisions/hsem/StateEmergencyOperationsPlan.html.

[10] HSEM (2023). https://prd.blogs.nh.gov/dos/hsem/?page_id=1411.

[11] HSEM (2015). https://prd.blogs.nh.gov/dos/hsem/?page_id=1383.

available resources during an emergency. NHDOT must ensure that through coordinated planning efforts, state and local agencies are equipped to perform emergency response tasks. DOT responsibilities include ensuring staff participation in ESF 1 meetings and trainings, maintaining resources and assets available for emergency management, coordinating evaluation and performance of missions and requests, and ensuring unified command is administered. This includes working with federal agencies on behalf of the state.

The DOT also assists in training, resource mobilization, and policy related to emergency response. For example, the DOT supports the identification of potential emergency transportation issues and advises on policy to mitigate consequences from hazards. Likewise, the DOT may be called upon to provide input on the SHMP and support/ plan for mitigation measures including monitoring and updating strategies in the SHMP. The DOT may also be requested to supply assets like vehicles and equipment and coordinate with various divisions (maritime, aviation etc.) to provide evacuation support.

3.2.2 NH Disaster Recovery Annex

The New Hampshire Disaster Recovery Annex, also called the New Hampshire Recovery Plan, is a subplan to the SEOP. In a similar function, the Recovery Plan outlines NHDOT's responsibility as a lead agency in the RSF 5 *Infrastructure Systems Recovery*. NHDOT, in conjunction with several state agencies, is cited to facilitate the restoration of infrastructure systems and services to support and improve community resilience hazard events. This plan lays out pre-disaster and post-disaster functions that NHDOT may encounter.

Pre-disaster, NHDOT is required to:

- Coordinate with other state agencies to identify representatives for the Long-Term Recovery Committee
- Procure stand-by contracts with disaster recovery and debris management contractors
- Review existing policy for budget expenditures, project approvals and develop proposed procedures to expedite the processes for post-disaster situations
- Review rules and regulations that may impede rebuilding post-disaster and prepare draft legislative language to suspend rules and regulations post-disaster
- Support planning, preparedness, training and outreach efforts to augment recovery capacity building

Also, the DOT is tasked with understanding local and state data that may be necessary to understand current conditions and obtain recovery assistance.

Post-disaster, NHDOT is required to:

- Develop an event-specific Infrastructure Systems Recovery Action Plan
- Support conflict resolution with respect to jurisdictional lines and competition for key resources
- Develop a schedule and timeframe for future infrastructure recovery projects
- Conduct infrastructure damage and needs assessments
- Support HSEM in tracking recovery progress, and leverage available financial and technical assistance, from governmental and nongovernmental sources, in the implementation of the Infrastructure Systems Recovery Action Plan.

3.2.3 *Continuity of Operations Planning*

Continuity of Operations Planning (COOP) is an effort within individual agencies to ensure they can continue their mission essential and daily functions during a wide range of emergencies. It is one piece of the larger planning process which seeks to ascertain risks and vulnerabilities associated with all hazards and create mitigation procedures to preserve critical services. New Hampshire has Chapter 21-L (Efficient Administration of Transportation Functions). The COOP requires compliance with this regulation, which can be summarized as the DOT's responsibility to maintain mobility and safety on the state's surface transportation system. For example, relocation of agency personnel and resources is a strategy to mitigate negative impacts on transportation by a disaster or disruptive emergency event. The COOP also encompasses all transportation related assets (facilities, systems, vehicles and buildings) operated or maintained by the DOT. Many of these facilities were utilized in the Criticality construct, described in Section 5.1.3.

3.3 Long Range Transportation Plan (LRTP)

Integrating resilience, and the RIP, into New Hampshire's Long Range Transportation Plan (LRTP) is a key step in its implementation. The LRTP plays a vital role in defining and formalizing the state's shared vision and objectives for the transportation system. Resilience is a core goal and principle for the agency, significantly influencing how projects are developed, prioritized for funding, and executed.

The most recent LRTP touches on multiple facets of resilience. The plan refers to key trends and themes that impact the transportation network including: system maintenance in relation to hazards, emergency response, intelligent transportation systems (ITS) opportunities and security threats, asset capacity and reliability, and a growing awareness of performance shortcomings and gaps in connectivity that may lead to community isolation or immobilization.[12]

3.3.1 *Incorporation of the RIP into the LRTP*

The incoming LRTP (currently in development) will leverage the results of the RIP planning process by addressing some of the challenges noted in the preceding LRTP. The in-development LRTP will have a dedicated resiliency section which will include key concepts, high level data points, and terminology pertaining to resilience and extreme weather, directly referencing the RIP. Thus, the LRTP will not only benefit from the work done in the RIP, but it will also be a vehicle to highlight and educate stakeholders about the most recent understanding of resiliency efforts across the state.

The LRTP planning process is supported by critical input from state stakeholders such as the nine RPCs and four MPOs. Information from RIP can be used to further enhance stakeholder understanding, benefitting local and regional project development. For example, the LRTP will refer to resilience needs and investments as identified in the RIP. Thus, when municipalities and state stakeholders are developing their projects, the LRTP will have already guided readers through that process, supporting the promotion of resilience across the state.

[12] NHDOT. https://www.dot.nh.gov/projects-plans-and-programs/long-range-transportation-plan

3.4 Project-Focused Planning

This plan is informed, and building off of, the many statewide plans that have come before it. These include New Hampshire's risk-based Transportation Asset Management Plan, the Statewide Freight Plan, and the state's unique Ten-Year Plan.

3.4.1 Ten-Year Plan (TYP)

In New Hampshire, there are standardized processes to ensure projects are incorporated into statewide programming and planning efforts. For MPOs and RPCs, the end goal is to ensure locally, or regionally significant projects are programmed into the Statewide Transportation Program (STIP) and the state's Ten-Year Plan (TYP).

The TYP is a statewide improvements plan coordinated by the DOT and steers transportation planning and programming for the next 10 years.[13] The STIP includes the fiscally constrained highest priority projects in the first four years of the most recent adopted TYP. The TYP is reevaluated every two years through a statewide process to ensure necessary transportation improvement projects are supported and aligned with federal resources. Also, it outlines projects and programs funded with state transportation dollars.[14] Notably, the PROTECT program is a funding source for the TYP given the projects listed in the TYP often augment transportation resilience.

The TYP contains project lists that include stand-alone and grouped projects, with many related to resiliency. Projects include, but are not limited to:

- Scour protection and mitigation improvements
- Culvert upsizing, rehabilitation and replacements
- Drainage repairs and upgrades
- Engineering assessments to improve resiliency and capacity of bridge assets
- Construction of floodplains and wetland mitigation implementation
- ITS improvements
- Bridge rehabilitation and replacements
- Retaining wall improvements along state highways
- **Development of a Resilience Improvement Plan** *(this plan)*

Certain projects enumerated in the TYP were used as a basis for the risk-based project prioritization exercise explained in Section 6.4. Appendix A Risk Based Prioritized Project List contains the full list of prioritized projects.

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[13] NHDOT. https://www.dot.nh.gov/sites/g/files/ehbemt811/files/inline-documents/2025-2034-ten-year-plan-presentation-public-works-2-21-24_0.pdf

[14] NHDOT. https://www.dot.nh.gov/projects-plans-and-programs/ten-year-plan

3.4.2 Transportation Asset Management Plan (TAMP)

State DOTs are well underway with risk-based asset management plans that consider extreme weather events in the development of life cycle planning processes and as a risk associated with current and future environmental conditions in risk management. For New Hampshire, the state's 2024 TAMP hones in on coastal and inland flood risks, naming extreme precipitation and sea level rise as two threats to asset preservation and performance.[15] This section of the TAMP also discusses Part 667[16] vulnerable assets.

FIGURE 3-4 IMPAIRED MOBILITY FROM COASTAL FLOODING ALONG THE COAST

Source: NHDOT

The TAMP emphasizes the integration of planning efforts and coordination between multiple agencies. For example, as inland flooding is one of the highest risks, identification of poor performing culverts has been a critical pathway for flood mitigation in New Hampshire. Agencies collaborate to identify culverts in particular watersheds with various risk factors, including some that add to flooding vulnerability. NHDOT then creates a risk-based priority list. In the 2025-2034 TYP, funding for programs that addressed culverts was increased.

As described in the TAMP, NHDOT also coordinates with other state agencies on the development of projections related to sea-level rise, precipitation, and storm surge in the coastal region. The most recent publication of those projections are contained in the NH Coastal Flood Risk Summary (2020), which led to the development of the Coastal Flood Risk Tolerance Framework and was subsequently integrated into this RIP. The vulnerabilities, risks, and strategies identified in this RIP will be incorporated into future versions of the TAMP.

3.4.3 Statewide Freight Plan

New Hampshire's Statewide Freight Plan features content related to resilience, informed through a combination of federal guidance and the state's LRTP. Multiple goal areas and objectives center on resilience. This includes improving system reliability and resiliency for the connections between New Hampshire and the domestic and international freight markets.

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[15] NHDOT. https://www.dot.nh.gov/about-nh-dot/divisions-bureaus-districts/asset-management

[16] Part 667 designates "repeatedly damaged facilities" comprised of roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to natural disasters or catastrophic failures.

New Hampshire uses their Freight Plan to quantitatively and qualitatively assess the overall freight transportation system alongside the development of projects to address previously identified needs. This effort involves the development of a series of project ranking criteria that support project prioritization methodologies. One of these criteria is related to resiliency in the form of a “posted detour route” given the fiscal impact that asset closures have on freight operations.

In conjunction with these efforts, a series of freight policies and strategies were also developed to serve as implementation steps to help support the state’s future freight planning efforts. This includes strategies to augment system resilience in urban areas and considerations for priority freight bottleneck locations during project prioritization and development of the Ten-Year Plan. Thus, the Freight Plan highlights how resilience is an important component in project screening and prioritization processes for investment decisions that roll up into statewide planning documents like the Ten-Year Plan.

3.5 Coastal Flood Risk Tolerance Framework

To make the state’s coastal transportation assets more resilient to the impacts of sea level rise, NHDOT undertook the creation of a Coastal Flood Risk Tolerance Framework in 2023. This framework was based on a vulnerability and risk assessment of roadways and bridges along the coastal region for their vulnerability and risk to sea level rise and sea level rise plus a one percent storm surge event. The purpose of this framework was to help NHDOT’s project managers determine the risk tolerance to apply to assets in the coastal region of the state that is based on the criticality of those roadways as well as their vulnerability and risk to the impacts of sea level rise. The Coastal Flood Risk Tolerance Framework has been incorporated into the statewide framework used for this RIP.

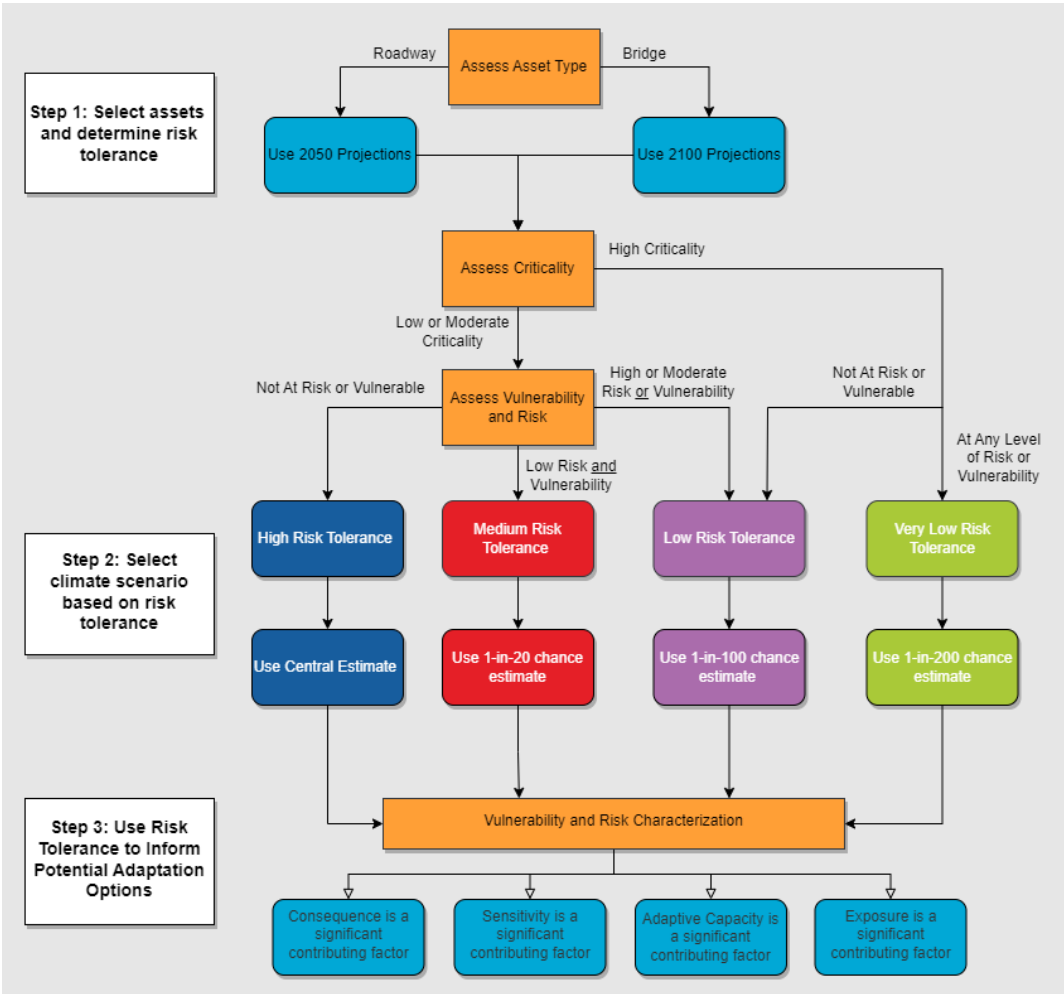
Figure 3-5 shows the process diagram for applying the framework. It consists of three steps, each of which is explained in more detail in the Implementation Guide for the framework:

1. **Select the assets** that are being evaluated and determine their risk tolerance based on the asset type, their criticality to the transportation system, and their vulnerability and risk to coastal flooding hazards.

2. Use the risk tolerance level to **select a climate scenario** for determining flood elevation, where assets with a lower risk tolerance would be designed to withstand more extreme possible climate scenarios.

3. Use the risk tolerance level, as well as the characteristics of the asset that make it vulnerable and at risk to sea level rise hazards, to **inform possible adaptation options**.

FIGURE 3-5 COASTAL RISK TOLERANCE FRAMEWORK PROCESS DIAGRAM



Source: NHDOT (2023)

This framework connects with climate science conducted by the University of New Hampshire in their New Hampshire Coastal Flood Risk Summary process for determining risk tolerance of an asset and designing to a climate scenario that reflects that risk tolerance. As shown in Figure 3-5, *very low risk tolerance* assets should use the 1-in-200 estimate of relative sea level rise; *low risk tolerance assets* should use the 1-in-100 chance estimate; *medium risk tolerance* assets should use the 1-in-20 chance estimate; and *high risk tolerance* assets should use the central estimate.

Figure 3-6 lists the sea level rise value that assets should be designed to, ranging from the central estimate for high risk tolerance assets to a 1-in-200 chance estimate for very low risk tolerance assets. For example, if a roadway is determined to have low risk tolerance and is being designed out to 2080, it should be designed to withstand 3.9 feet of sea level rise. As another example, if a bridge is determined to have a high-risk tolerance and is being designed out to 2120, it should be designed to withstand 3.6 feet of sea level rise.

FIGURE 3-6 UNIVERSITY OF NEW HAMPSHIRE'S RECOMMENDED DECADAL RELATIVE SEA LEVEL RISE ESTIMATES BASED ON RISK TOLERANCE

TIMEFRAME	**HIGH** TOLERANCE FOR FLOOD RISK	**MEDIUM** TOLERANCE FOR FLOOD RISK	**LOW** TOLERANCE FOR FLOOD RISK	**VERY LOW** TOLERANCE FOR FLOOD RISK
	Plan for the following RSLR estimate (ft)* *compared to sea level in the year 2000*			
	Lower magnitude, Higher probability	⟵	⟶	Higher magnitude, Lower probability
2030	0.7	0.9	1.0	1.1
2040	1.0	1.2	1.5	1.6
2050	1.3	1.6	2.0	2.3
2060	1.6	2.1	2.6	3.0
2070	2.0	2.5	3.3	3.7
2080	2.3	3.0	3.9	4.5
2090	2.6	3.4	4.6	5.3
2100	2.9	3.8	5.3	6.2
2110	3.3	4.4	6.1	7.3
2120	3.6	4.9	7.0	8.3
2130	3.9	5.4	7.9	9.3
2140	4.3	5.9	8.9	10.5
2150	4.6	6.4	9.9	11.7

Source: Step 3 Table A, New Hampshire Coastal Flood Risk Summary – Part II: Guidance for Using Scientific Projections

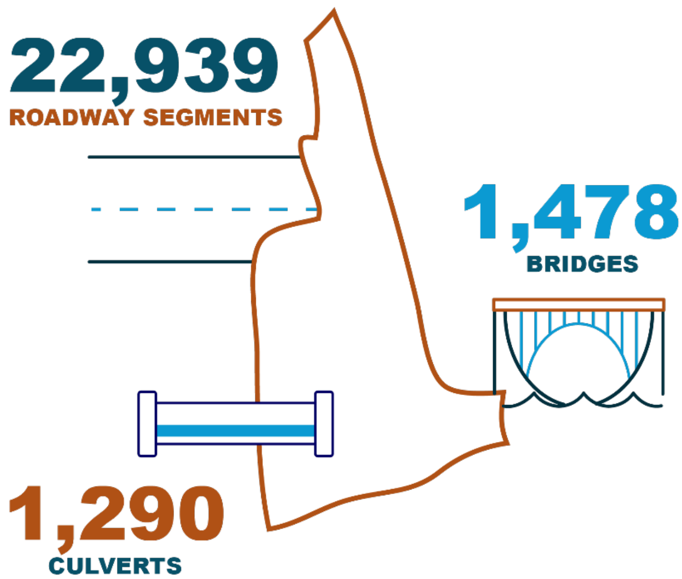
This framework was created based on the evaluation of the criticality and vulnerability of New Hampshire's coastal transportation assets and characterizes consequences and risk to provide a basis for making improvements and investment decisions. Applying the framework includes considering why the asset is vulnerable and at-risk when making decisions about mitigation and adaptation options. For example, if an asset's vulnerability is driven by a high exposure score, that means that asset is likely to be inundated due to rising sea levels. Mitigation measures for this asset may include raising the profile of the roadway, prioritizing maintenance to ensure it can withstand hazard events, or working with stormwater managers to construct flood mitigation infrastructure. This initiative supports transportation planners, asset managers, and engineers at NHDOT to make such determination using a risk-informed process for projects and assets in coastal New Hampshire.

4.0 ASSET INVENTORY

Building upon the approach from the recently developed NHDOT Coastal Flood Risk Tolerance Framework, the RIP included a systemwide criticality assessment (Section 5.0) and a vulnerability and risk-based assessment (Section 6.0) to locate and prioritize assets that may be at-risk and suitable for resilience improvements.

The first step of the analysis was to compile a statewide asset inventory. The analysis focused on the system's network of roadways, bridges, and culverts —given the new focus on inland flooding within this RIP and coastal flooding from prior work. This plan's assessment focused on transportation assets owned and operated by the DOT; including Tier 1, 2, 3 and federal aid eligible roadways, and the bridges and culverts that are integrated into the state's roadway system. These assets are visualized in Figure 4-1 and spatially mapped below in Figure 4-2.

FIGURE 4-1 ASSETS INCLUDED IN THE RIP



The inclusion of these asset classes fulfills the PROTECT program requirements which request a systemic approach to improving the resilience of surface transportation assets. Combined, these assets form the majority of the state's surface transportation system, as well as ancillary infrastructure (i.e. culverts), which are critical to functionality and performance of roads and bridges during hazard events and daily travel. Transit routes are included in the assessment by incorporating them into the criticality determination framework which assigns an additional level of importance to roadways that have transit service on their right-of-way.

This section also highlights the state's 14 emergency evacuation routes[17] along the southeastern coast (Figure 4-3). Evacuation routes are primarily designated on high volume transportation corridors including, I-95, US-1, and US-4. In light of the coastal flooding already occurring in New Hampshire, these evacuation routes are critical to emergency response and community mobility pre-, during, and post-event.

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[17] New Hampshire HSEM. https://www.nh.gov/safety/divisions/hsem/nuclearpowerplants/documents/evacuation-routes.pdf

FIGURE 4-2 STATEWIDE ASSET INVENTORY

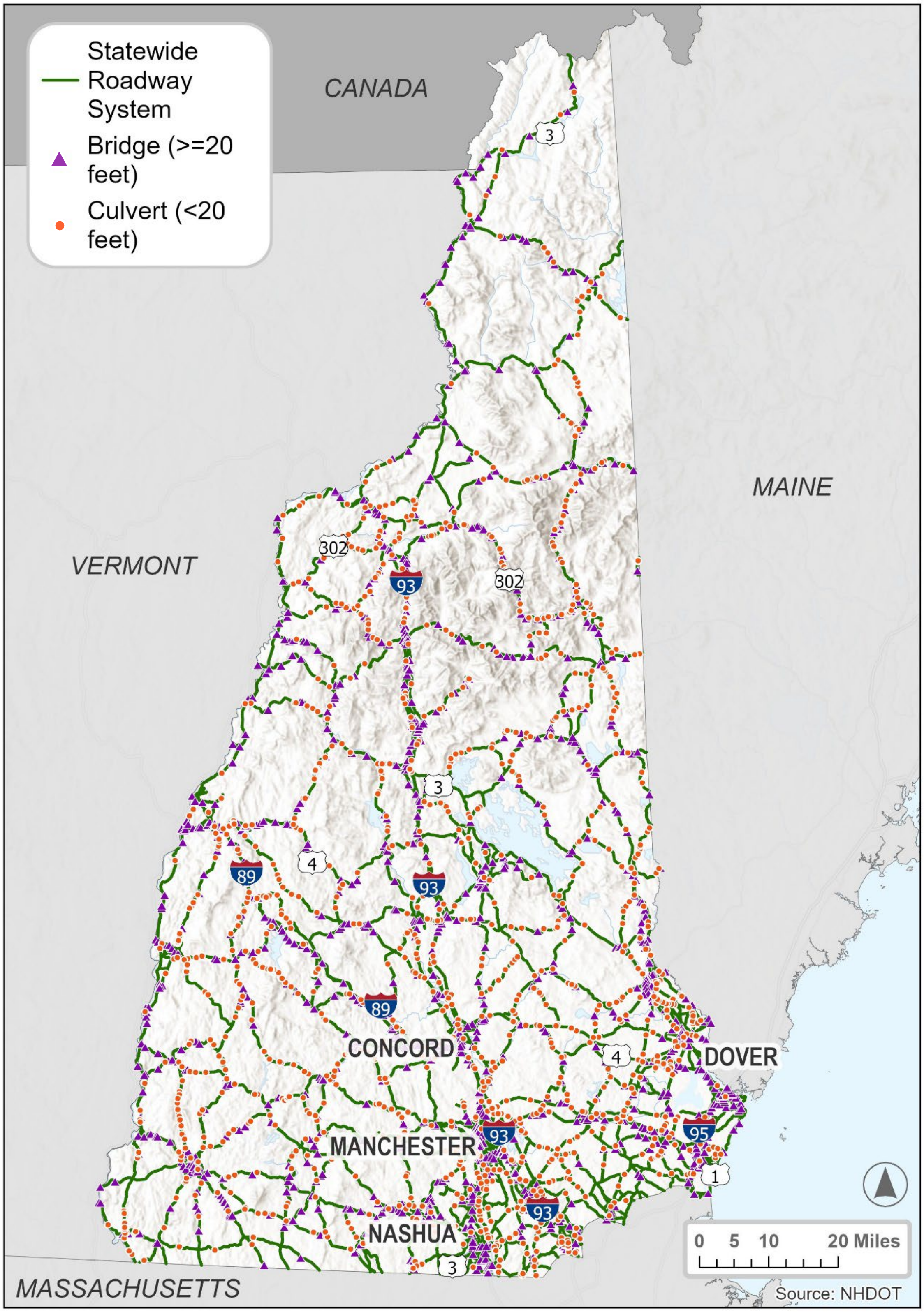
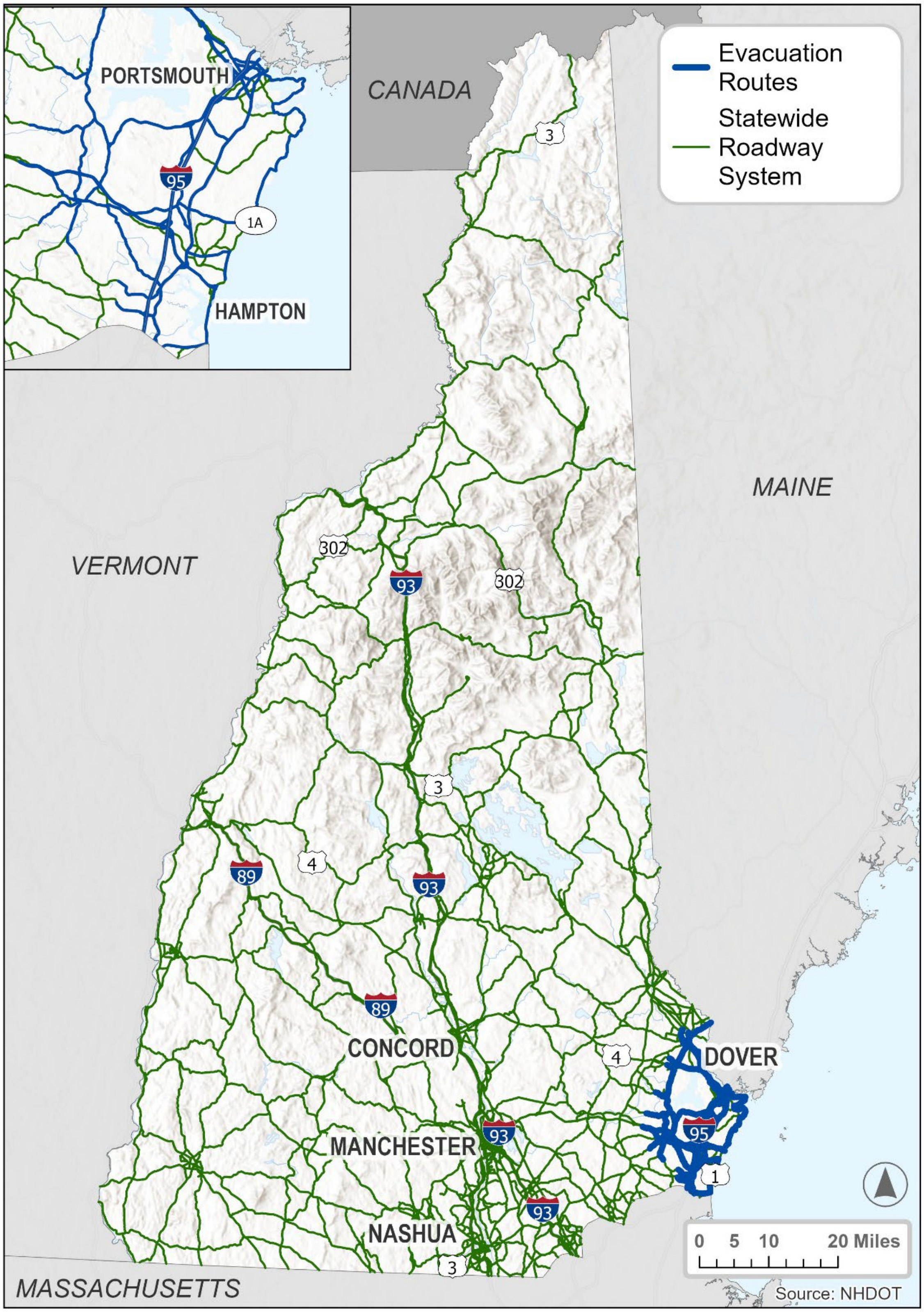


FIGURE 4-3 STATEWIDE ROADWAY INVENTORY AND EVACUATION ROUTES



5.0 CRITICALITY

With the inventory of considered asset types identified, Section 5.0 assigns criticality to each individual asset. Criticality refers to the overall importance of each asset as a component of the entire New Hampshire multimodal transportation system, based on multiple criteria. Criticality forms an important foundation in the vulnerability and risk-based assessment through the identification of those assets which play the most significant roles in the statewide transportation network and is helpful in supporting NHDOT in screening and prioritization of potential risks and investments based on their importance as determined for this purpose.

5.1 Indicators of Criticality

For the purposes of this RIP, criticality is formally defined as follows:

- *The degree to which a given asset is important to the unimpeded operation of the transportation system in New Hampshire.*[18]

NHDOT's proposed criticality approach and use of this definition is informed by experience leveraged from transportation criticality assessments successfully completed across the U.S., through the development of FHWA's resilience pilots, and through additional related studies. Based on these considerations, criticality, identified for each asset, is comprised of three indicator categories that signify the importance of each transportation asset. These indicator categories are as follows:

- **Usage and Operational Importance** – How important is the asset to the overall use and operation of the transportation system?
- **Socioeconomic Importance** – To what extent does the asset serve the population of the state, including underserved or disadvantaged communities?
- **Health and Safety Importance** – How important is the asset to the health and safety facilities located in the state?

5.1.1 Usage & Operational Importance

Usage and operational importance refers to the overall use, designation and operation of the asset as part of the transportation system, primarily applied to roads. This category contains three individual factors, including the following:

- **Functional Classification System:** Represents the function of a roadway based on several factors including volume of traffic and types of trips served.
- **Average Annual Daily Traffic (AADT):** An average of the total number of vehicles that travel on a roadway or bridge on a given day.

[18] The definition of criticality stems from a review of FHWA's criticality definition, and other relevant state and national best practice sources. It was then tailored to fit the needs of NHDOT and the state's multimodal transportation system.

- **Transit Route:** Whether or not the road is classified as part of a regional transit system or intercity bus.

The scoring method for usage and operational factors is shown in Table 5-1. For each factor, a scoring method is assigned for each infrastructure classification. The infrastructure classification for Functional System ranges from local and collector roads to principal arterials and interstates, with a criticality scoring factor ranging from (1) to (4). AADT infrastructure classification is based on figures from below 5,000 vehicles on the least busy roads to over 20,000 vehicles on the busiest roads. The scoring factor is also assigned with a range of (1) to (4) accordingly. Lastly, transit route infrastructure classifications are assigned based on whether the asset is located along a transit route (scoring factor of (1)), or not (scoring factor of (0)). The highest total possible points for Usage and Operational factors is (9).

To ensure multimodality and community mobility are integrated into the framework according to the PROTECT Program guidance in taking a comprehensive, multi-modal approach to planning, the presence of transit routes was a new element that was added beyond what has been done in the prior Coastal Risk Tolerance Framework effort.

TABLE 5-1 SCORING METHOD FOR USAGE AND OPERATIONAL IMPORTANCE FACTORS

Factor	Infrastructure Classification	Score
Functional System	Local, Major, and Minor Collector	1
	Minor Arterial	2
	Principal Arterial	3
	Interstate	4
AADT	0 - 5,800	1
	5,801 - 13,300	2
	13,301 - 28,500	3
	28,501 - 57,000	4
Transit Route	If Transit Route, 1; otherwise, 0	1
	Total Possible Points	**9**

5.1.2 Socioeconomic Importance

Socioeconomic importance refers to the extent that the asset serves key populations, including underserved and disadvantaged communities, as well as locations of economic importance as measured by employment density. The three individual factors comprising overall socioeconomic importance include:

- **Population Density:** Based on the population per square mile from the U.S Census American Community Survey (ACS) 2016-2020 5-year Estimates.

- **Community Resilience:** Based on the proportion of population in Census tracts with at least three of the following risk factors based on Census Community Resilience Estimates (CRE)[19] data:
    - Income-to-poverty ratio is below 130 percent
    - Single or zero caregiver household
    - Unit-level crowing is greater than 0.75 persons per room
    - Communication barrier, defined as no one in the household has received a high school diploma or no one in the household speaks English “very well”
    - Age 65 or older
    - No one in the household is employed full-time, year-round (not applied if all residents in a household are 65 years or older)
    - Disability
        - No health insurance coverage
        - No vehicle access
        - Households without broadband internet access
- **Employment Density**: Based on the number of jobs per acre within defined US Census block groups or areas, as defined by U.S. Census Longitudinal Employer Household Dynamics data.

The scoring method for socioeconomic factors is shown in Table 5-2 below. For population density, community resilience, and employment density, a criticality scoring factor between (1) and (3) is assigned. For both population density and employment density, the highest score is assigned for those locations with the highest total densities, as described above. For areas with lower community resilience, the highest score is assigned for those Census tracts with the highest proportion of at least three or more of the risk factors described above. The highest total possible points for Socioeconomic factors is (9).

[19] The dataset is the U.S. Census Bureau Community Resilience Estimates (CRE). This dataset is specifically used to estimate the capacity of individuals and households to absorb the external stresses of the impacts of a disaster, as may happen due to coastal flooding.

TABLE 5-2 SCORING METHOD FOR SOCIOECONOMIC IMPORTANCE FACTORS

Factor	Infrastructure Classification	Score
Population Density	≤ 2,000	1
	2,001 – 8,000	2
	8,001 +	3
Community Resilience	≤ 15%	1
	16% - 24%	2
	24% +	3
Employment Density	≤ 5	1
	6 – 15	2
	15 +	3
	Total Possible Points	**9**

5.1.3 Health & Safety Importance

Health and safety importance factors assess the degree of importance of an asset, measured by distance, to providing access to facilities indispensable for the health and safety of New Hampshire, including in relation to emergency response. This includes access to the following five categories of facilities:

- **Proximity to Power Plants & Dams:** Important in the case of an emergency, given the need for electricity generation and the management and storage of water.
- **Proximity to Emergency Shelters:** Important in the case of an emergency, given the need for shelters and safe physical locations in the event of a natural disaster or disruption
- **Proximity to Fire Stations, Hospitals, and Trauma Centers:** Important in the case of an emergency, given the need for prompt access to healthcare, and resources to extinguish potential fires.
- **Proximity to DOT Facilities[20]:** Important given the need to quickly clear roads and expedite recovery following a natural disaster or disruption.
- **Evacuation Routes:** Provide access to vulnerable communities in the event of a natural disaster or disruption.

The scoring method for health & safety factors is shown in Table 5-3. For proximity to the various identified facilities, a criticality scoring factor between (0) and (2) is assigned based on driving distances to the facilities. The highest score of (2) is assigned for those locations within the closest proximity of under one mile to each facility. Similarly, locations over five miles away from a key facility are not assigned any points. An additional point is

[20] Note, this analysis considers the following DOT facility types: Administration Building, Bridge Maintenance Facility, Fueling Facility, Patrol Shed, Rest Area, Satellite Garage, Storage Shed, Transportation Center, Welcome Center.

This analysis excludes the following DOT facility types: Park & Ride, Toll Plaza, Toll Booth, Patrol Shed (Closed), Pit, Pit (Closed), and 'Other' designated facilities.

assigned for locations along designated evacuation routes. The highest total possible points for health & safety factors is (9).

Key public assets (e.g. fire stations, hospitals etc.) not directly owned or operated by NHDOT were also collected and included in the criticality assessment to establish an understanding of the assets that are critical to the preservation of communities. In respect to emergency management, DOT facilities operational during hazard events (pre-, during and post-), were also mapped and included in the criticality assessment.

TABLE 5-3 SCORING METHOD FOR HEALTH & SAFETY IMPORTANCE FACTORS

Factor	Infrastructure Classification	Score
Proximity to Power Plants & Dams	5+ Miles	0
	1 – 5 Miles	1
	< 1 Mile	2
Proximity to Emergency Shelters	5+ Miles	0
	1 – 5 Miles	1
	< 1 Mile	2
Proximity to Fire Stations, Hospitals & Trauma Centers	5+ Miles	0
	1 – 5 Miles	1
	< 1 Mile	2
Proximity to DOT Facilities	5+ Miles	0
	1 – 5 Miles	1
	< 1 Mile	2
Evacuation Route	If designated an Evacuation Route, 1; otherwise, 0	1
	Total Possible Points	**9**

5.2 Determining Asset Criticality

To compute criticality scores, the individual indicators comprising each category of importance were summed to generate a value for that particular criticality factor, as described above. Following the summation of scores for each category, the overall scores were combined. An equal weighting of each category was applied, including given a maximum score of 9 for each individual category. As a result, the maximum achievable criticality score is 27, which would be indicative of an asset with the highest possible scores for usage & operational importance, socioeconomic importance, as well as health & safety importance.

TABLE 5-4 TOTAL CRITICALITY SCORING

Criticality Level	Total Criticality Score
High	14+
Medium	11-13
Low	<11

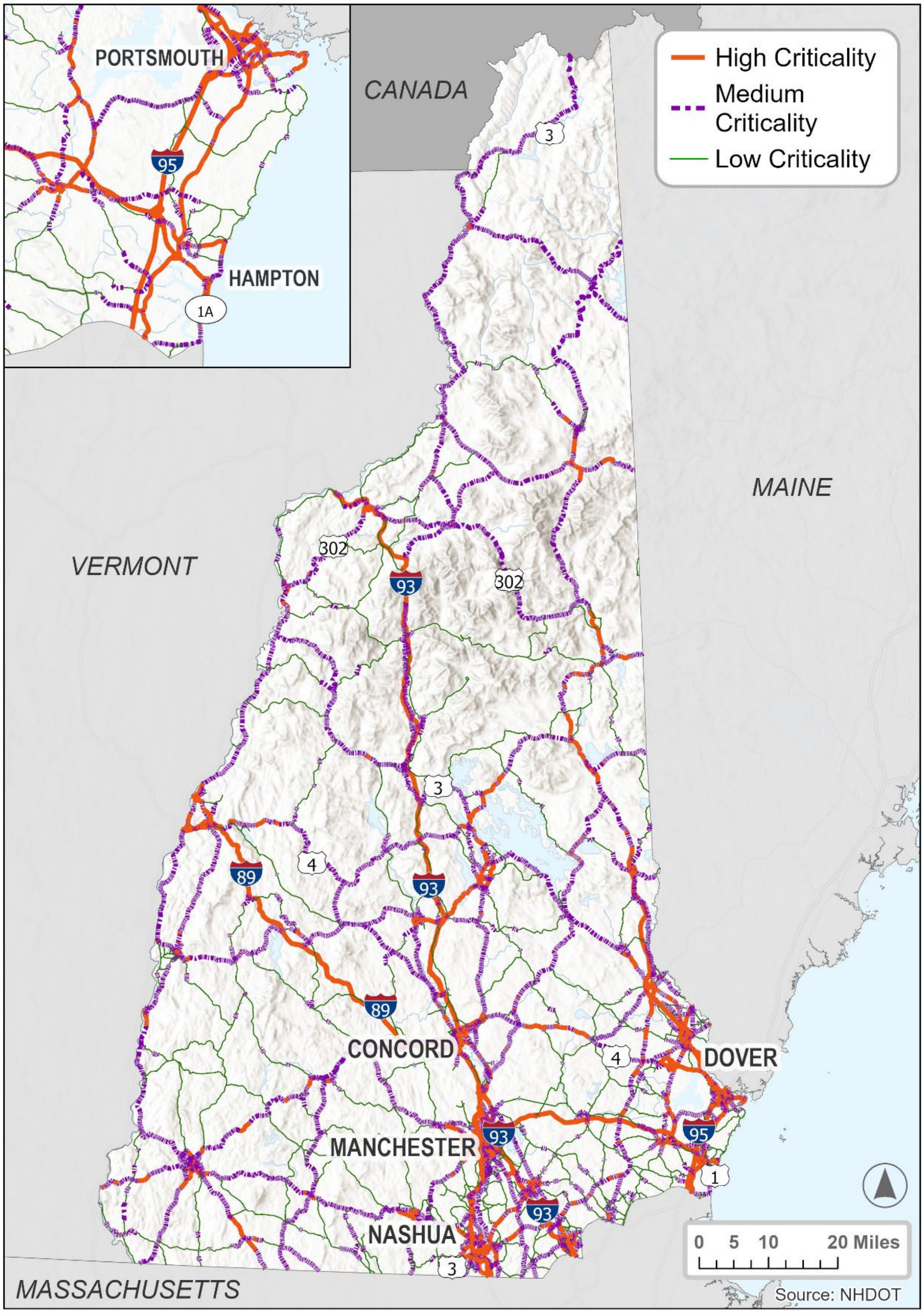
The NHDOT groups its road network into tiers based on connectivity, regional significance, winter maintenance requirements, and other factors. Roadways such as interstates and turnpikes are categorized as Tier 1, while statewide corridors are categorized as Tier 2, and so on. To reflect the use and significance of the tier system and to promote consistency along corridors, a minimum classification for Tier 1 as highly critical and Tier 2 as medium criticality was incorporated. Criticality scores for Tier 2 and lower tiers can still raise the criticality of those facilities above those minimum classifications.

Overall criticality, comprised equally of usage & operational importance, socioeconomic importance, and health & safety importance, across the New Hampshire highway network, including bridges and culverts is shown in Figure 5-1.[21] Those portions of the New Hampshire highway network with the highest levels of criticality include large portions of the state's interstate thoroughfares, as well as many of the routes into and out of the state's urban centers. The assignment of criticality to the state's highway network sets the stage for the vulnerability and risk-based assessment which can be found in the following chapter.

For more information and asset-level criticality designation, please view the ArcGIS Online Map for the Criticality results.

[21] Criticality results for bridges and culverts are considered as part of the larger network of roadway assets for mapping and spatial analysis purposes.

FIGURE 5-1 ROADWAY NETWORK CRITICALITY ASSESSMENT RESULTS



6.0 VULNERABILITY AND RISK-BASED ASSESSMENT

With criticality assigned for each asset, and in accordance with PROTECT Formula Funding Implementation Guidance, Section 6.0 provides an assessment of vulnerabilities and risk to current and future coastal and inland flooding. This process is aimed at quantifying the magnitude of related threats to New Hampshire's surface transportation assets and an assessment of the most vulnerable locations across the state. A quantitative assessment is performed so that it provides a basis for evaluating proposed resilience improvements against the drawdown of risk.

FIGURE 6-1 PAVEMENT WASHOUT AND ROAD COLLAPSE FROM RIVERINE FLOODING

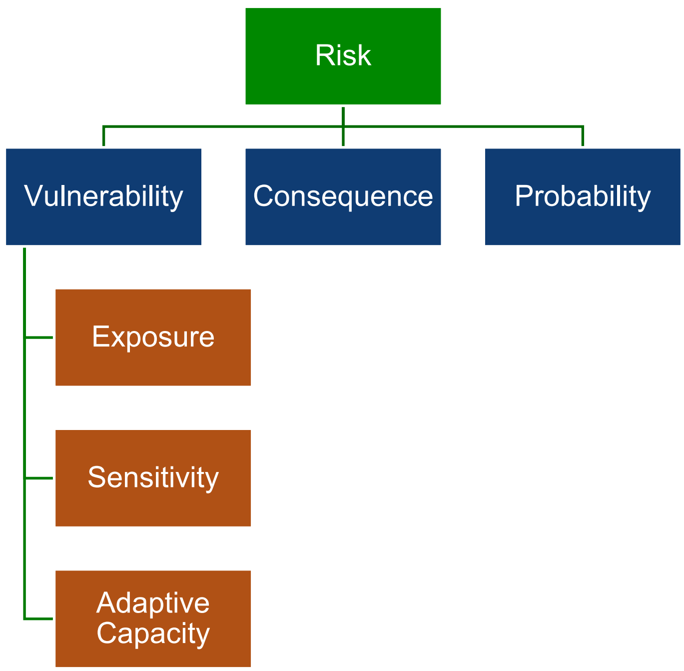
Source: NHDOT

The assessment focused on the impacts from the highest priority hazards, inland and coastal flooding (including sea level rise and storm surge), as they were identified as having the highest risk by the State Hazard Mitigation Plan and other state-level climate research and studies. The assessment framework established through this plan can apply to assessing risk from other hazardous events and other types of assets in future updates of the RIP.

6.1 Overall Approach & Hazards

The purpose of the vulnerability and risk-based assessment is to quantify the risk to the NHDOT-maintained transportation network consisting of roads, bridges, and culverts. The quantification of risk for each asset is a function of the probability of a hazard occurring, consequences associated with the hazard occurring, and the vulnerability of the asset to the hazards. Vulnerability of the asset itself is a function of exposure, sensitivity, and adaptive capacity of the asset, as is explained next. A construct of the risk-based assessment used in this effort is shown in Figure 6-2.

FIGURE 6-2 RISK-BASED ASSESSMENT FRAMEWORK

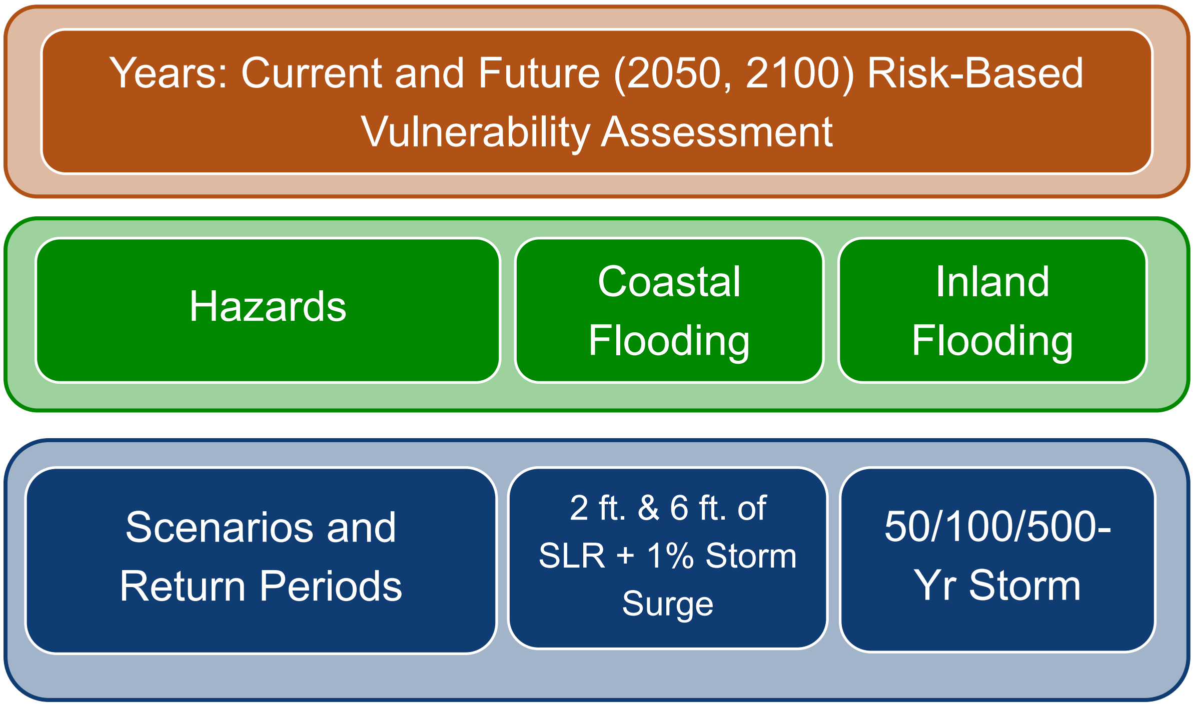


Adapted from: FHWA Vulnerability Assessment and Adaptation Framework

As discussed in Sections 1.0 and 3.0, alignment with existing resources is a key component of the resilience planning process. The review of the New Hampshire SHMP identified a wide range of hazards ranging from technological, to natural and human caused. For the purposes of this RIP, NHDOT has prioritized those hazards which can physically impact and damage the state's multimodal transportation system, and in particular, those assets managed by NHDOT which include roads, bridges, and culverts – and can potentially impact the mobility on a regional or statewide scale. The SHMP identified inland and coastal flooding as a highest priority threat. Given that these threats are particularly impactful to physical infrastructure, they are considered directly relevant to resilience planning for NHDOT. Through the development of the Coastal Risk Tolerance Framework, NHDOT further identified coastal sea level rise and corresponding storm surge as key hazards for those agency-maintained assets. This RIP expands on the Coastal Risk Tolerance Framework to also include inland flooding across the state and also carry out this methodology through this vulnerability and risk-based assessment.

The assessment considers current and future risk for the years of 2050 and 2100 for a range of return periods (current and projected) for each hazard. These hazards and scenarios are shown in Figure 6-3. This entire process, and corresponding results are detailed in the following sections.

FIGURE 6-3 HAZARDS AND SCENARIOS



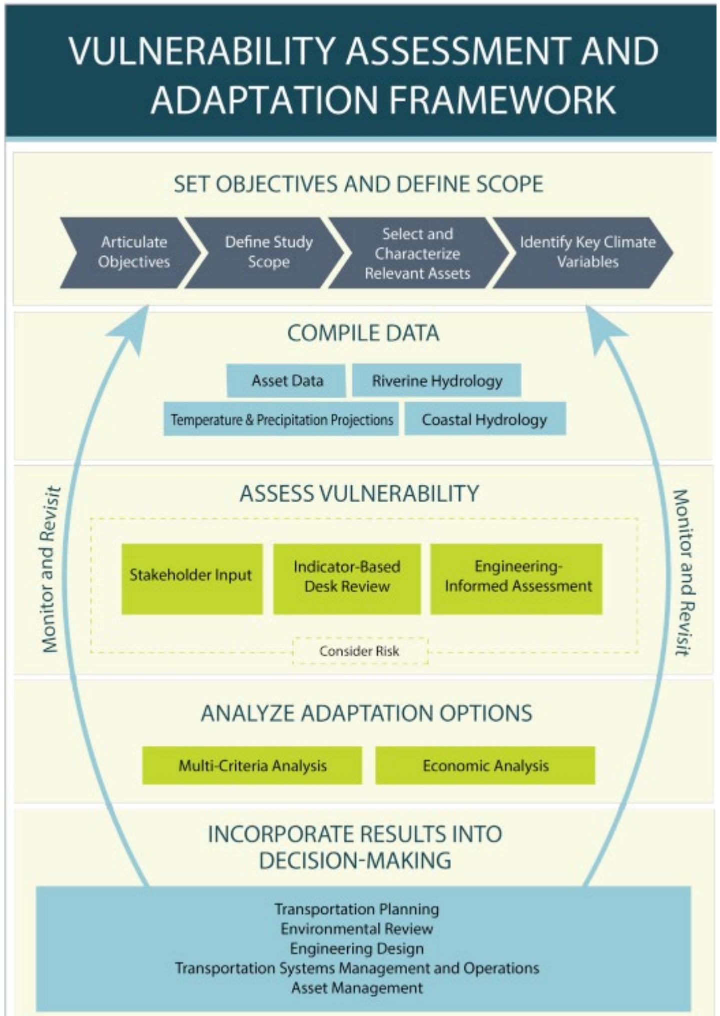
6.2 Vulnerability Assessment

The vulnerability assessment is the first component of the risk assessment to be calculated. NHDOT has adopted FHWA's definition of vulnerability:

- *Vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes (IPCC).*

As a whole, this definition is adopted as a part of the FHWA's overall vulnerability and adaptation framework, as shown in Figure 6-4 below.

FIGURE 6-4 FHWA VULNERABILITY ASSESSMENT AND ADAPTATION FRAMEWORK



Source: [Federal Highway Administration Vulnerability Assessment and Adaptation Framework]

This recommended process for assessing transportation asset vulnerability involves the defining of objectives and scope, compilation of data, the assessment of vulnerability through quantitative data analysis and quantitative/qualitative stakeholder input, the analysis of adaptation options (described further in Sections 7.0 and Section 8.0, and the incorporation of results into decision-making. NHDOT has taken steps to integrate these recommendations into this assessment. The vulnerability assessment expands on the best practices identified in the Coastal Risk Tolerance Framework to consider inland flooding and is guided by consistently updated state and federal data sources. The FHWA also recommends a process of monitoring and revisiting this process on a periodic basis and when updated data is available. The process NHDOT will undertake to revisit the vulnerability assessment and adaptation framework is discussed in Section 8.0, and will take the form of future RIP iterations.

Overall, the vulnerability of an asset is directly a function of three components:

- **Exposure:** Identified whether an asset or system is located in an area experiencing direct effects of current or future extreme weather.

- **Sensitivity:** Refers to how the asset or system fares when exposed to the current or future extreme weather.
- **Adaptive Capacity:** The degree to which the asset can adjust or mitigate damage or disruption caused by a hazard or threat.

These three components are further described alongside key guiding questions in Figure 6-5.

FIGURE 6-5 VULNERABILITY ASSESSMENT COMPONENTS

Exposure — ***Measured by asset location relative to flooding and inundation depth***

- Where is the asset located?
- Is this location prone to hazards?

Sensitivity — ***Measured by infrastructure condition***

- What will happen to this asset if it's exposed to a hazard?
- Does the predisposed condition of the asset make it more difficult to withstand hazards?

Adaptive Capacity — ***Measured by ability of the asset to cope or recover and available redundancy***

- What will happen to the entire system if an asset is disrupted as a result of a hazard?
- Can the system recover smoothly if an asset is disrupted as a result of a hazard?

To determine vulnerability, each of these components was evaluated using the Vulnerability Assessment Scoring Tool (VAST) developed by the U.S. Department of Transportation. The tool measures vulnerability as a function of exposure, sensitivity, and adaptive capacity and uses certain characteristics of transportation assets as indicators to reflect different assets' exposure, sensitivity, or adaptive capacity, and operationalizes this information into relative vulnerability scores. This was done for the combination of study hazards and asset types within this Microsoft Excel®-based tool (with macros).

6.2.1 Exposure

Exposure refers to the geographic location of an asset in relation to a hazard or threat. As defined by FHWA, exposure is determined by whether an asset or system is located in an area experiencing direct impacts from extreme weather. Determination of exposure to current and future weather events and natural disasters is being done on the basis of the best available natural hazard and climate information available at this time.

As part of this vulnerability and risk assessment, exposure for each asset class is derived from impacts from each hazard, across multiple scenarios of inundation:

- **Sea Level Rise Exposure**: Measured by the inundation depth of the mean higher high water (MMHW)[22] level plus two feet or six feet of sea level rise. Data for sea level rise exposure is derived from the National Oceanic

[22] MMHW is defined by NOAA as the average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch

and Atmospheric Administration (NOAA) sea level rise dataset for New Hampshire.[23] It was determined that MHHW will be used as the base elevation reference for inundation by flood hazards, since this was the tidal datum that UNH and NHDES modeled in the available sea level rise scenarios that were leveraged for the NHDOT Coastal Risk Tolerance Framework project and used for this plan.

Table 6-1 illustrates sea level rise estimates for the New Hampshire Coastal Flood Risk Summary, NOAA Sea Level Rise Viewer, and the closest sea level rise scenarios modeled in the NH Coastal Viewer. In the New Hampshire Coastal Flood Risk Summary Part II: Guidance for Using Scientific Projections, the "Low" tolerance for flood risk corresponds to a 1-in-100 chance (one percent probability) that sea level rise will meet or exceed the estimate. The "Very Low" tolerance for flood risk corresponds to a 1-in-200 chance (0.5 percent probability) that sea level rise will meet or exceed the estimate. The NOAA Sea Level Rise Viewer presents 2050 and 2100 sea level rise estimates for Seavey Island, NH, in which the "High scenario" is based on two meters of global sea level rise by 2100. However, exact sea level rise guidance estimates were not available in the NH Coastal Viewer data, which had modeled scenarios for one, two, four, six, and eight feet of sea level rise.

TABLE 6-1 SEA LEVEL RISE ESTIMATES FOR 2050 AND 2100

Year	New Hampshire Coastal Flood Risk Summary		NOAA Sea Level Rise Viewer	Closest Sea Level Rise Modeled in NH Coastal Viewer
	Low Tolerance for Flood Risk (1-in-100 Chance)	Very Low Tolerance for Flood Risk (1-in-200 Chance)	"High" Sea Level Rise Scenario for Seavey Island, NH	
2050	2 feet	2.3 feet	1.38 feet	2 feet
2100	5.3 feet	6.2 feet	5.94 feet	6 feet

Based on current science, guidance, sea level rise scenarios project two feet sea level rise in 2050- and six-feet sea level rise in 2100. These levels of sea level rise approximate the 1-in-100 chance of sea level rise under RCP 4.5 in 2050 and the 1-in-200 chance of sea level rise under RCP 4.5 in 2100. These projections were used from the NHDOT Coastal Risk Tolerance project for application in this plan to evaluate the impacts of projected sea level rise on coastal assets.

- **Storm Surge Exposure:** Storm surge information was leveraged from the NH Coastal Viewer that estimate the level of storm surge corresponding to a 100-year storm (i.e., a storm that has a one percent probability of occurrence in a given year). These values are based on the April 2014 preliminary Digital Flood Insurance Rate Maps for Rockingham County and the September 2015 effective Digital Flood Insurance Rate Maps for Strafford County. NH Coastal Viewer has modeled scenarios that combine MHHW, sea level rise, and the one percent storm surge estimates. Based on the level of confidence in the storm surge outputs (until the availability of a more accurate hydrodynamic modeling effort that is currently underway), the NHDOT team decided to apply storm surge to FEMA VE, AE, and AO zones, as identified in FEMA 100-Year Coastal Flood Maps.

[23] National Oceanic and Atmospheric Administration (NOAA). https://coast.noaa.gov/slrdata/

- **Flooding Exposure:** This assessment considers whether an asset is located within regulatory floodplains (existing/current flood hazard) and projected floodplain information. Assets are ranked based on data from the New Hampshire Statewide Asset Data Exchange System (SADES).[24] Data for flooding exposure is derived from the Federal Emergency Management Agency (FEMA) National Flood Hazard Layer geospatial database,[25] FEMA Flood Risk Map products[26], and Aqueduct Floods.[27] All the regulatory floodplain datasets refer to current floodplain extents, which has limited base flood elevation information. Where available, gridded FEMA Flood Risk Map products were used to ascertain the potential inundation over roadway extent to accurately determine whether an asset is exposed to flooding as opposed to a determination through two-dimensional review of whether an asset is within a floodplain (which is not the best indicator of exposure as it does not take actual elevation of asset with respect to water surface elevation into consideration). For projected floodplain extents, NHDOT used Aqueduct, an online tool, developed by the World Resources Institute that evaluates both riverine and coastal flood risks under present conditions, as well as future scenarios for 2030, 2050, and 2080. Given NHDOT's desire to use the best available data and balancing it with variations in data coverage between these sources, a three-step "quilted" approach was employed to comprehensively analyze the flooding exposure.

Why a "Quilted" Approach to Data?

Available, high-quality data is often one of the largest impediments to performing risk and resilience analyses. The lack of statewide data coverage for New Hampshire led to the development of a three-step "quilted" approach that leveraged multiple data sources to ensure all portions of the state were covered.

Stakeholders across New Hampshire aided RIP development by providing the richest data currently available. For future RIPs, NHDOT hopes to use improved data when available. For example, NOAA's Atlas 15 to incorporate non-stationarity and hydrodynamic modeling that NHDES is currently undergoing for advanced predictive modeling of coastal flooding.

Flooding Exposure Analysis

Step 1: SADES Stream Crossing Initiative

SADES Stream Crossing Initiative ranks culverts according to their risk of overtopping and failure, degree of aquatic organism passage, and impacts to stream geomorphology and general river environment for different flooding scenarios (ranging from 2-year to 100-year floods). These vulnerability ratings are then applied to intersecting culverts and roadways. If a roadway intersects multiple stream crossings, the highest (worst) exposure rating is assigned. Any asset not included in the SADES stream crossing vulnerability ratings proceeds to Step 2 of the exposure analysis.

Step 2: FEMA Flood Risk Map Products

FEMA 500-year Water Surface Elevation (WSE) raster data is available for the coastal region and the Dover area only, while FEMA 100-year WSE data covers the coastal region, Dover, and the central to south-central areas. To calculate flood depth, the asset elevation from the New Hampshire LiDAR-Derived Digital Surface Model (DSM)[28]

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[24] New Hampshire Stream Crossing Initiative (2021). https://www4.des.state.nh.us/NH-Stream-Crossings/

[25] The National Flood Hazard Layer (NFHL), FEMA Flood Data Viewers and Geospatial Data https://www.fema.gov/flood-maps/national-flood-hazard-layer

[26] FEMA Flood Risk MAP Products. https://www.fema.gov/flood-maps/tools-resources/risk-map/products

[27] Aqueduct Floods Hazard Maps, World Resources Institute (2020). https://www.wri.org/data/aqueduct-floods-hazard-maps

[28] University of New Hampshire (May 2022) https://granit.unh.edu/datasets/9511ca942eac4f8b9c08877b30ec91a2/explore

is subtracted from the water surface elevation. This resulting flood depth is then assigned to the assets as their exposure value. In areas where 500-year WSE data is unavailable, the 100-year flood depth is set as a floor and is used as the flood depth.

Bridges in general are stripped out of the DSM; in such cases, the maximum elevation of the bridge's approach is used as the asset's elevation. Assets not covered by FEMA Flood Risk raster data proceed to Step 3 of the exposure analysis.

Step 3: Aqueduct and FEMA Floodplain

This final step involves an in-and-out (two dimensional) analysis for the assets that are not covered in Steps 1 or 2. Assets are assigned exposure scores based on whether they are within FEMA floodplains or Aqueduct floodplain.

6.2.2 Sensitivity

As defined by FHWA, sensitivity refers to how an asset or system fares when exposed to natural hazard and climate impacts. A highly sensitive asset will experience a large degree of impact even from a relatively minor hazard or climate variation, whereas a less sensitive asset could withstand relatively higher levels of hazard or climate variation before exhibiting a significant degree of deterioration. As an example, a road with poor pavement condition is considered to be more sensitive to flooding damage than a road whose pavement condition is rated good.

The process to develop sensitivity scores for each asset and asset class is based on structural condition. For roadway segments, this includes a weighted combination of built condition, pavement condition, and whether or not the asset has been previously damaged. For bridges this includes a weighted combination of substructure condition and scour condition. For culverts, this includes a weighted combination of bankfull width, whether the asset has been flagged for flooding based on past occurrences (NHDES BlackFlag database)[29], and whether the asset has been previously damaged (23 CFR Part 667)[30].

6.2.3 Adaptive Capacity

As defined by FHWA, adaptive capacity refers to the ability of a transportation asset or system to adjust, repair, or flexibly respond to damage caused by climate variability or extreme weather. For example, alternative routes that could be used to reach the same location would increase adaptive capacity compared to a route that lacks redundancy.

The indication of adaptive capacity for a given asset and asset class was considered to be based on the overall significance of each asset and the ability to cope with disruptions, including availability of additional capacity or redundancy in the system to provide detours and alternative routes. For roadway segments, this includes a

[29] Data was created from the NH Flood Hazard Mitigation Areas, as derived from NH Town Flood Hazard Mitigation Plans, and updated through plan updates and Town meetings.

[30] See more information in the 2022 NHDOT Transportation Asset Management Plan, page 40.

weighted combination of highway functional class, average annual daily traffic (AADT), and network density[31]. For bridges and culverts, this includes functional class and AADT.

6.2.4 Results

The results of the vulnerability assessment highlight areas across New Hampshire that have a range of vulnerability (none, low, medium, and high) for the years 2050 and 2100. These results are visualized at the roadway level in Figure 6-6 (below). Vulnerability throughout the state is driven by a combination of factors: inland flooding and coastal flooding (i.e. exposure), asset condition (i.e. sensitivity) and network density statewide (i.e. adaptive capacity). For example, if there is a lack of redundancy in a rural area, with minimal to no detour availability, the vulnerability of the available facility will rise. Therefore, it is not just exposure to flooding that leads to higher vulnerability, but it is also driven by these additional, practical factors like lack of redundant roadways and poor roadway condition that can increase vulnerability.

Also, given the nature of this desk-based analysis, the results from this assessment need to be augmented with practitioner input and ground-truthing. At a statewide scale, highly vulnerable assets, or areas rise to the top (as seen in the bulleted list of areas below); yet, it is important that local planning partners, more familiar with their respective areas, use these results in a context-sensitive manner that speaks to their priorities and needs.

The results highlight prominent and higher functional classification assets (at a statewide scale) that have been designated as being vulnerable to inland and coastal flooding, including:

Stakeholder-Reviewed Results

The online AGOL maps gave statewide partners opportunities to dynamically review the results of the Vulnerability Assessment. Stakeholders provided insights into the assessment with first-hand knowledge of their respective areas based on lived experiences (i.e. known areas of concern). The project team responded to the stakeholder comments, which improved participant understanding into RIP methodology while allowing the project team to hear from direct observation and experience.

- **US-1A:** Located along New Hampshire's Seacoast, nearly 100 percent of the urbanized corridor between Hampton and Portsmouth is classified as having a medium or high level of vulnerability.
- **Northwest New Hampshire:** Located near Woodsville in the White Mountains, large portions of the western terminus of NH-112 are designated as highly vulnerable. Sizable portions of NH-116 around Franconia are designated as highly vulnerable. Most of US-202 between Woodsville and Littleton is designated as having a medium level of vulnerability. Lastly, large portions of I-93 between Littleton and the New Hampshire – Vermont State Line are designated as having a medium level of vulnerability.
- **Conway – Ossipee:** Large portions of the highways located between Conway and Ossipee are classified as having a medium or high degree of vulnerability.
- **I-93 / I-293:** Large proportions of these two interstates in and around Manchester and Concord are classified as having a medium or high degree of vulnerability. These facilities are in areas with flood controls that have not been integrated into this analysis at this time.

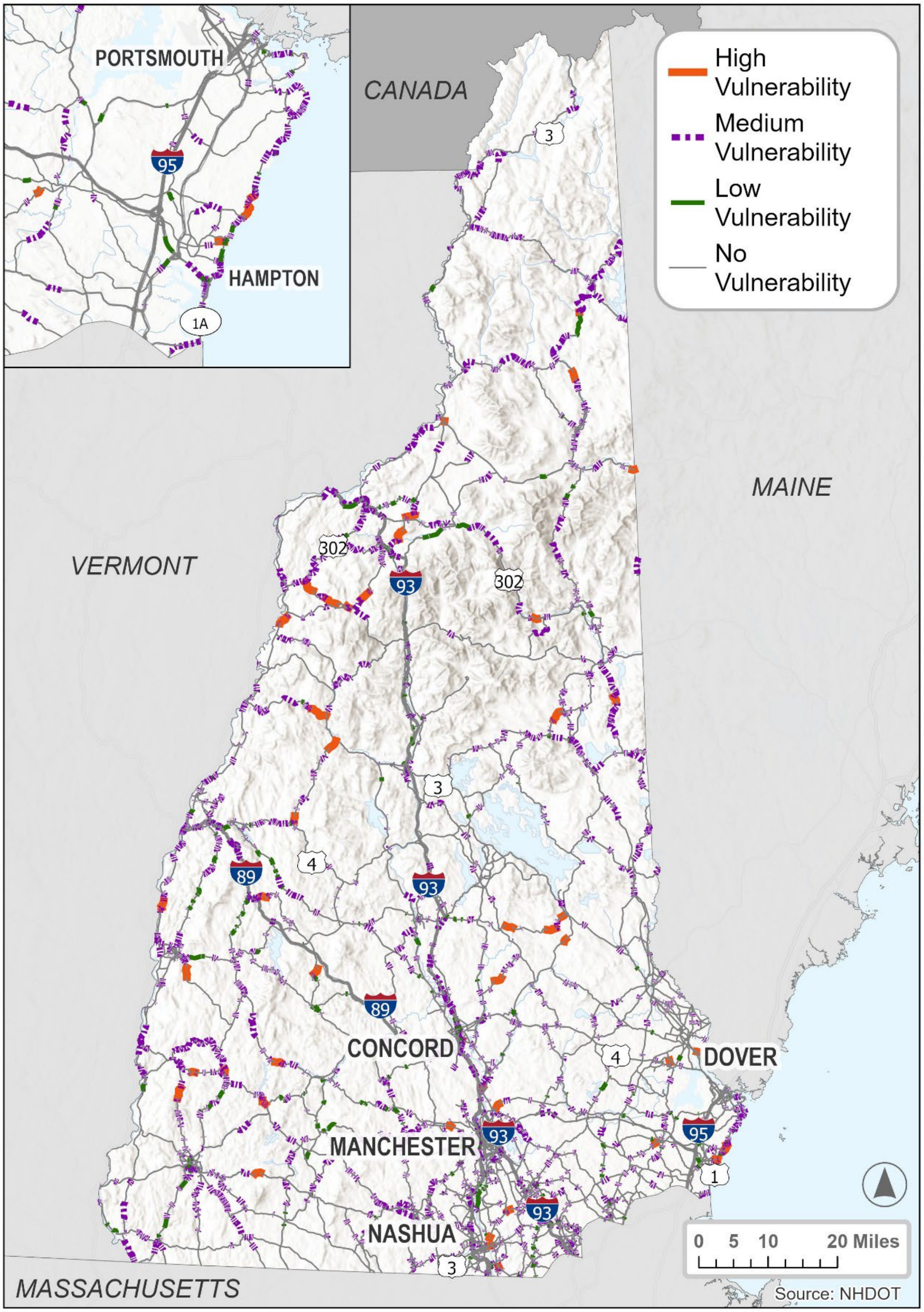
[31] In this analysis network density has been used as a measure of total length of available public roadway in miles within a square mile area of the asset.

- **Everett Turnpike:** Large portions of the highway between Manchester and Nashua are classified as having a medium degree of vulnerability.
- **NH-12A:** Large portions of this primarily rural highway between Alstead and Keene are classified as having medium or high degrees of vulnerability.
- **NH-140:** Sizable portions of the primarily rural highway between Alton and Belmont are classified as highly vulnerable.

When considering vulnerability through 2050, it is noted that there is not a significant change from 2050 to 2100. Partly, this has to do with the application of coastal flooding in the FEMA coastal zones (until the development of a hydrodynamic model that could provide more confidence in projected flooding due to connected hydrological features and more precise modeling availability). It also has to do with the resolution of the projected Aqueduct data that was used, which only shows marginal changes from the 2050 and 2100 scenarios.

Designations for bridge and culvert vulnerability can be found in the ArcGIS Online Map for the Vulnerability results. Users can also view future projections for vulnerability (for 2100) and the change from 2050 to 2100 online.

FIGURE 6-6 ROADWAY VULNERABILITY ASSESSMENT RESULTS THROUGH 2050



6.3 Risk Assessment

With vulnerability determined for each asset, the last step in the assessment involved calculation of risk. Incorporation of risk is important to consider the probability that an asset will experience the impact, and the consequence of that impact – which is key information for transportation practitioners to make decisions on prioritizing projects based on need and importance. This fulfills the objectives of the PROTECT Program guidance to develop a risk-based assessment which considers probabilities and consequences of potential impacts, one of the requirements of developing resilience improvement plans. Risk is often represented as probability or likelihood of the occurrence of hazardous events or trends multiplied by the consequence or severity of impacts if these events or trends occur. The risk equation is shown in Figure 6-7:

FIGURE 6-7 RISK EQUATION

$$Risk = C \times V \times T \qquad Equation\ 1$$

Where,

R = Potential loss due to analyzed event, $
C = Outcome of an event occurrence, $
V = Given event has occurred, probability of that estimated consequences will be realized, %
T = Likelihood event will occur, %

Source: NCHRP Research Report 986, Implementation of the AASHTO Guide for Enterprise Risk Management

The risk equation takes into account the following components:

- **Vulnerability:** As defined in the previous section, the degree to which a system is susceptible to, or unable to cope with adverse effects of climate change or extreme weather events. Vulnerability, a function of exposure, sensitivity, and adaptive capacity, is assessed for each asset class through different measurements.
- **Probability:** Defined as the likelihood of an event occurring. For this risk assessment, the likelihood of sea level rise, storm surge, and flooding events are modeled through 2050 and 2100.
- **Consequence:** Defined as the costs that would be incurred as a result of an event happening. For this risk assessment, consequence is annualized and modeled for sea level rise, storm surge, and flooding events for forecast years of 2050 and 2100. For this RIP, consequence is identified for the asset owner, in this case – NHDOT.

With vulnerability already defined, probability and consequence are further explained below, followed by the results of the risk assessment.

6.3.1 Probability

Probability is the likelihood of an event occurring. As a component of the risk, it represents the chances of a hazard occurring. This assessment considers the likelihood of coastal and inland flooding occurring based on their exposure and magnitude/severity. Depending on the exposure tier of assets used (see Section 6.2.1) and corresponding data source, probabilities were calculated for each asset to correspond to their return periods – for example 1 in 50, 1 in 100, and 1 in 500-year storms for current events and also for projected climate events in 2050 and 2100. As it relates to inland flooding, probabilities associated with regulatory flooding products and SADES data do not account for non-stationarity and reflect FEMA definitions of base flood return periods.

The Aqueduct data on the other hand incorporates impacts of natural hazard variability and corresponds to projected 1 in 100 chance of flooding in the year 2050 and 0.2 percent chance of flooding in the year 2080 (used as the closest proxy for application for the scenario year 2100 for this plan) under the representative concentration pathway (RCP) 4.5. NHDOT has not conducted any analysis pertaining to the FEMA regulatory floodplain data to account for projected natural hazard variability or develop return periods for the future years and used the Aqueduct data to identify the extents of future flooding instead.

For the coastal flooding projections, NHDOT followed the New Hampshire Coastal Flood Risk Summary Part II: Guidance for Using Scientific Projections for selecting appropriate coastal flooding projections for the year 2050 and 2100. For sea level rise, the probabilities are associated with the chance of sea level rise will meet or exceed the estimate considered for a climate scenario (a combination of future year and an RCP). For sea level rise, it is a 1-in-100 chance of two feet of sea level rise in 2050, and a 1-in-200 chance of six feet of sea level rise in 2100. The storm surge scenarios are defined as 1-in-100 events, and this study incorporates conditional probability to calculate the chance of a storm surge event given the probability of sea level rise.[32]

6.3.2 Consequence

Consequence is defined as the outcome of an event occurrence (in this case, the hazards). For this plan consequences were calculated as costs that would be incurred as a result of the hazard occurring. The calculation of consequences in monetary terms allows NHDOT to square off reduction in risk alongside proposed investments to increase resilience. This will allow for prioritization to best allocate finite resources to meet resilience needs. For this plan, NHDOT has determined that only owner costs would be accounted for towards the consequences. In future iterations, user costs may also be considered. The consideration of owner costs only towards consequences has also to do with maintaining consistency with the risk calculations as part of the NHDOT Coastal Risk Tolerance Framework effort.

The process to calculate consequence for each asset is based on the vulnerability level of each asset, and tier of each asset. For assets with low vulnerability, minimal hazard impacts are assumed, and preservation costs are applied as the consequence. For assets with medium vulnerability, a serious hazard impact is assumed, and rehabilitation costs are used as the consequence. For assets with high vulnerability, severe hazard impacts are assumed, and replacement costs are applied as the consequence. Tables 6-2, 6-3, and 6-4 outline the costs assigned as consequences for roadways, bridges, and culverts. For roadways, the costs are applied based on level of vulnerability and NHDOT roadway tier. For bridges, it is dependent on the type of bridge and proposed treatment type (corresponding to vulnerability). For culverts, it is a function of vulnerability (determining the treatment type) and the size of the culvert.

[32] See NCHRP Research Report 986, Implementation of the AASHTO Guide for Enterprise Risk Management, UDOT Documents and Tools, Appendix A, Part B, Aggregated Threat Probability by Road Segment.

TABLE 6-2 COST APPLIED PER SQ. FT ROADWAY

NHDOT Road Tier →	Tier 1 - NHS	Tier 2/5 - NHS	Tier 2 – Non -NHS	Tier 3 through 5 – Non-NHS
Preservation *(Low Vulnerability)*	$23	$14	$13	$8
Rehabilitation *(Moderate Vulnerability)*	$55	$28	$28	$14
Reconstruction *(High Vulnerability)*	$280	$206	$206	$187

TABLE 6-3 COST APPLIED PER SQ. FT OF BRIDGE DECK AREA

Bridge Type	Preservation = Low Vulnerability *Unit Cost ($/sf deck)*	Rehabilitation = Moderate Vulnerability *Unit Cost ($/sf deck)*	Replacement = High Vulnerability *Unit Cost ($/sf deck)*
Girder	$165	$435	$930
Truss	$250	$565	$715
Culvert	$250	$1,695	$3,185
Moveable	$210	$545	$1,165
Timber	$165	$435	$940

TABLE 6-4 COST APPLIED PER CULVERT

Vulnerability →	Replacement = High Vulnerability			Rehabilitation = Moderate Vulnerability	Preservation = Low Vulnerability
Culvert Size →	24" - 48"	> 48"	> 60" or Multi-Dimensional	All sizes	All sizes
Tier 1	$ 191,900	$ 479,700	$ 1,019,350	$\frac{1695}{3185} \times RC$	$\frac{250}{3185} \times RC$
Tier 2/5	$ 156,000	$ 383,750	$ 719,550	$\frac{1695}{3185} \times RC$	$\frac{250}{3185} \times RC$

Vulnerability →	Replacement = High Vulnerability			Rehabilitation = Moderate Vulnerability	Preservation = Low Vulnerability
Tier 3	$ 143,950	$ 312,000	$ 599,650	$\frac{1695}{3185} \times RC$	$\frac{250}{3185} \times RC$
Tier 4	$ 119,950	$ 299,850	$ 479,700	$\frac{1695}{3185} \times RC$	$\frac{250}{3185} \times RC$

Note: RC stand for replacement cost which depends on culvert size (<48'', <60'' and 60"+). For preservation and rehabilitation costs, the proportion to replacement costs are used (1695/3185 and 250/3185) from Table 6-3.

6.3.3 Results

Risk was calculated as a function of vulnerability, probability, and consequence and quantified for each of the NHDOT-maintained roadways, bridges, and culverts. Composite risk[33] – assessed for coastal and inland flooding hazards in 2050 and 2100 respectively was compiled for each asset. The results of this analysis are summarized in Table 6-5 below. Through 2050, approximately 22 percent of the analyzed road network, or 1,014 miles, is expected to have some degree of risk. Through 2100, this increases to 23 percent, or 1,049 miles. Of that mileage deemed to be at risk, just over 400 miles is considered to be low risk, just over 350 miles is considered to be moderate risk, and just under 250 miles is considered to be high risk. These risk tiers were retained to be consistent with those developed for the Coastal Risk Tolerance Framework to enable a consistent application of risk tiers and prioritization and tolerance levels for application statewide.

Risk values may appear lower compared to other instances (compared to other states or studies) as only owner risk has been quantified for this plan. Between 2050 and 2100, an additional 14 miles of roadway are expected to increase from low risk to moderate risk, and an additional 8 miles are expected to increase from moderate risk to high risk. There is a marginal increase in exposure and risk by mileage and percentage between 2050 and 2100. The FEMA 500-year flood risk map covers only coastal regions. Therefore, in other cases, 100-year flood information was used as a proxy. This approach results in no changes between the two scenario years. Additionally, there is minimal variability between the 2050 and 2080 aqueduct data, due to the limited granularity of the dataset.

[33] Defined as combined coastal and inland flooding risk.

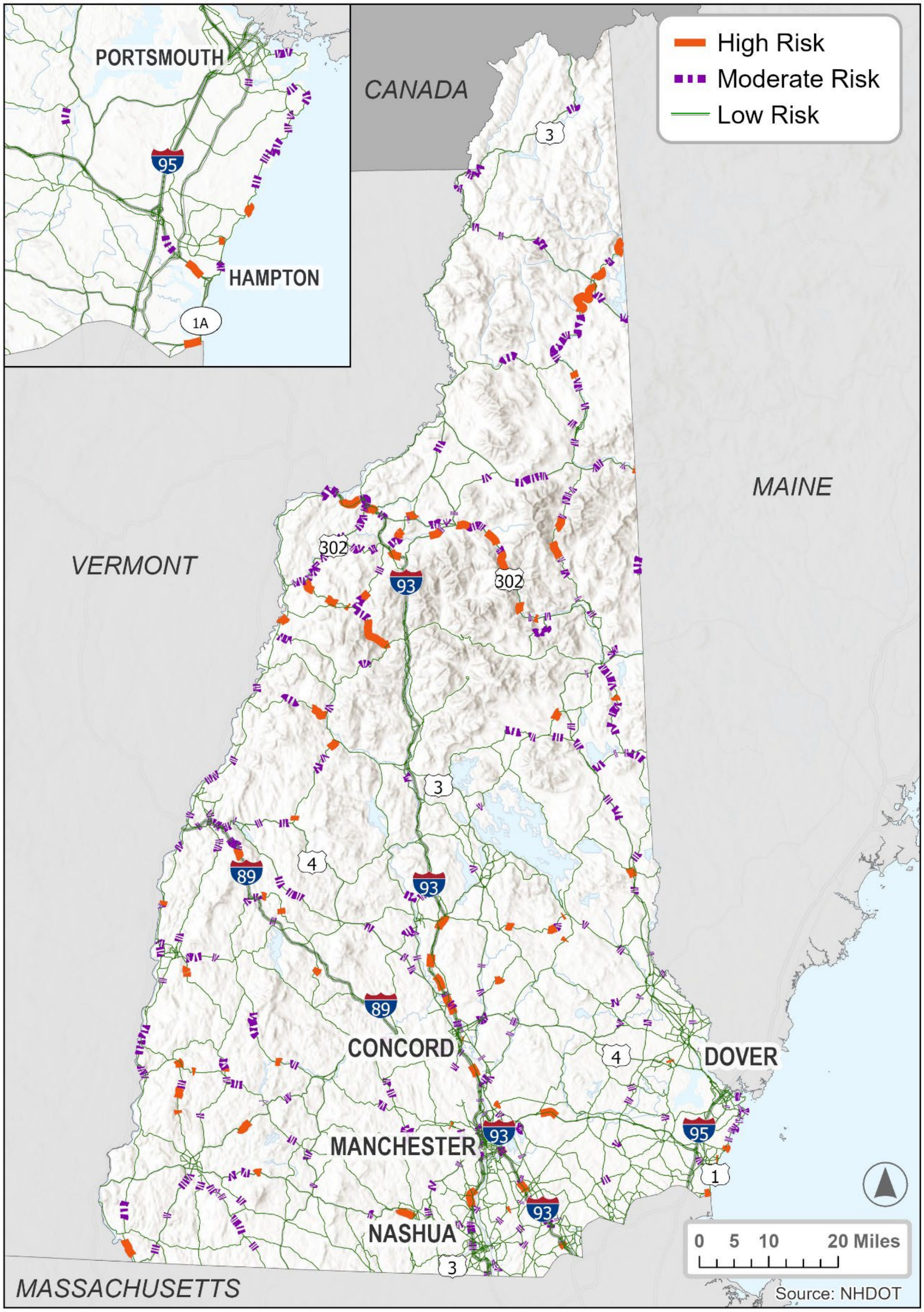
TABLE 6-5 CHANGE IN ROADWAY MILEAGE BY RISK LEVEL BETWEEN 2050 AND 2100

Risk Level	2050 – Roadway Mileage	2100 – Roadway Mileage	2050 – Roadway Mileage Percentage of System	2100 – Roadway Mileage Percentage of System
Low	425	438	9%	10%
Moderate	357	371	8%	8%
High	232	240	5%	5%

Figure 6-9 (below) identifies current composite risk (in the year 2050), geographically across New Hampshire's statewide assets. When considering risk associated with roadway segments, the highest concentration of high-risk assets can be found in the northern portion of the state, especially those thoroughfares into and out of Littleton. This includes a substantial portion of US-302, and portions of NH-112, and NH-16. In the southern portion of the state, high-risk roadway segments include large portions of I-93 north of Concord, as well as portions of the F.E. Everett Turnpike between Nashua and Manchester, in addition to smaller segments of multiple thoroughfares in proximity to municipalities such as Keene, Hampton, Milford, and Rochester. Roadway segments identified as moderate risk can also be found throughout the state, especially in northern New Hampshire. When factoring in bridges and culverts, high-risk assets are spread across the state. In addition to those locations in northern New Hampshire, clusters of high-risk bridges and culverts can be found across the more urbanized portions of the state, including in and around Concord, Manchester, Keene, and Portsmouth. To view risk associated with culverts and bridges, please view the ArcGIS Online Map for the Risk Assessment results. Future composite risk is also featured in the online map.

Overall, these results indicate that risk associated with coastal and inland flooding is not isolated to a particular geographic portion of New Hampshire. Instead, roadway segments of moderate and high risk are across the entire state, indicating the overall importance for proactive resilience planning. As indicated in earlier portions of Section 6.0, risk takes into account asset vulnerability, the probability of coastal and inland flooding, and consequences as a result of impacts from these hazards. Those questions identified in Figure 6-5 further help to frame and better understand these results, as well as the reasons for the risk levels assigned for each asset. These points for consideration are further discussed in the following section on prioritization, an important component of resilience planning, given limited resources and capacity for undertaking improvements.

FIGURE 6-8 COMPOSITE RISK FOR ROADWAYS THROUGH 2050



6.4 Risk Based Project Prioritization

A combination of criticality and risk was proposed for prioritization of projects for the Coastal Risk Tolerance Framework. This plan also adopted the same factors for prioritization of resilience projects statewide. As shown in Figure 6-10, prioritization is based on a combination of the results from the risk and criticality assessments. The red outline in Figure 6-10 highlights the highest tiers of risk and criticality, indicating projects that could be prioritized from a need's perspective.

Also, from the preceding work, a risk tolerance framework (see Figure 3-5) was specifically created for the coastal region. This was developed to support planning efforts along the state's coast, creating a uniform standard for all projects related to coastal flooding to follow. This provides additional guidance for the design of coastal highway assets based on risk tolerance and characterization.

FIGURE 6-9 PRIORITIZATION MATRIX

Risk	High	High Risk Low Criticality	High Risk Moderate Criticality	High Risk High Criticality
	Moderate	Moderate Risk Low Criticality	Moderate Risk Moderate Criticality	Moderate Risk High Criticality
	Low	Low Risk Low Criticality	Low Risk Moderate Criticality	Low Risk High Criticality
		Low	Moderate	High
		Criticality		

Source: NHDOT (2023)

6.4.1 Attributing Asset Risk to Current and Future Projects

A spatial overlay of the asset-level risk assessment with NHDOT's current project list enabled the matching of existing projects to the results of the risk assessment. This list resulted in the matching of 117 planning and design phase projects (Figure 6-12 below) that were deemed appropriate for considerations to incorporate resilience improvements in their project development and design processes, and qualified towards potential PROTECT funding considerations. Projects related to operations, maintenance, and preservation were not included in this list. See Appendix A Risk Based Prioritized Project List for the full list of the risk-informed prioritized projects.

The 117 projects listed in Appendix A are prioritized and sorted by total composite risk in the year 2050. This RIP retains risk as tiers (low, moderate, high) from the preceding coastal work to be consistent for project prioritization. While annualized risk values have been developed and is available to NHDOT staff to evaluate investment decisions, they are not displayed in Appendix A.

This list helps NHDOT to determine which projects have the highest risks of no action and how that risk relates to potential improvements and prioritization. Having these results and an understanding of risk at a statewide scale allows NHDOT to set acceptable risk thresholds and prioritize investments. NHDOT's programming process will balance several factors including project readiness, design or service life of the improvement, and potential risk reduction.

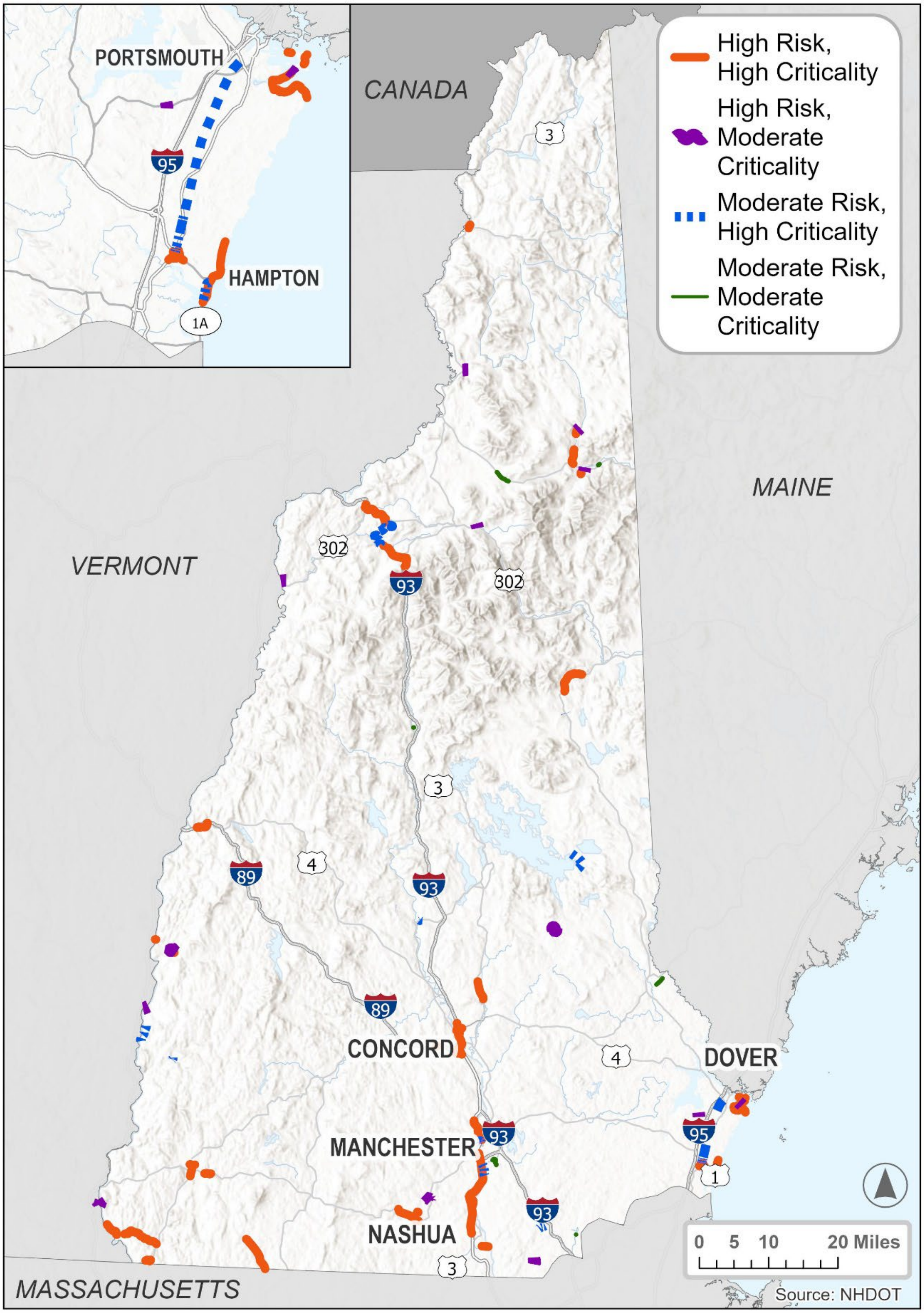
Future risk (i.e. risk in the years 2050 and 2100) is included as attributes in the project list. Since NHDOT builds infrastructure with extended service lives (e.g. bridges with service lives of 60-120 years), there needs to be an assessment of risk extending to their service life. This process is in alignment with PROTECT Program guidance that requires a risk-informed project prioritization. Additional factors like project readiness will be considered on a case-by-case basis by the DOT in consideration of projects for PROTECT formula and potential discretionary grant funding.

Determining which projects have the highest resilience needs offers insights for NHDOT to consider when programming projects so that community needs are met and balanced alongside projects which are important from a statewide significance. The identification of at-risk infrastructure allows for resilience improvements to be scoped early while informing local planning partners and other agencies of projects that would enhance resilience.

After the RIP is approved, NHDOT will continue to maintain and update the prioritized project list (as appended to this plan) on a mutually agreed schedule with the FHWA Division Office as it continues to evolve, and resilience improvements are undertaken. Higher risk locations that do not align with existing projects will have an avenue to be discussed as part of TYP development for future projects. NHDOT could refine the project list based on any major updates to climate models, or availability of richer projected climate data that enriches the risk-based vulnerability assessment of state transportation infrastructure.

In addition to Figure 6-12 below, users can also view this map and additional layers online via Risk Assessment.

FIGURE 6-10 RISK-INFORMED PROJECT PRIORITIZATION (2050)



7.0 COMMUNITY RESILIENCE

NHDOT has worked collaboratively with the regional RPCs and other partners to conduct this risk-informed vulnerability assessment at the state level. NHDOT realizes the balance between a desk-based statewide assessment and positioning its local and regional planning partners and other agencies to identify assets that are critical to their mobility needs that may not rise to the level of a statewide significance. For this purpose, an acknowledgement of community resilience and its importance to local communities has been included in this plan.

7.1.1 Community Resilience in Relation to Lower Criticality Assets

Assets with varying degrees of criticality and risk shed light on another facet of community resilience. As displayed in Figure 7-1 (below), across the state, there may be gaps in the resilience of low criticality (but high and moderate risk) assets that might need to be addressed to preserve community safety and mobility. These two categories—high risk, low criticality and moderate risk, low criticality—are highlighted because they represent assets that may have higher associated risks but are considered less critical at a statewide scale.

These facilities may serve critical lifeline functions and have limited redundancy. For example, there may be a road with lower AADT or designated as a lower-level functional class which may be a “lifeline route”, or the key connection, for a community to connect to other communities or resources. This occurs in particularly rural or low-density areas which rely on singular bridge or roadway infrastructure that provide the only ingresses or egresses to isolated communities. To address these potential needs, NHDOT proactively identified these opportunities for regional planning partners and for future resilience project programming purposes at the DOT.

7.1.2 Planning Partners Leveraging the RIP

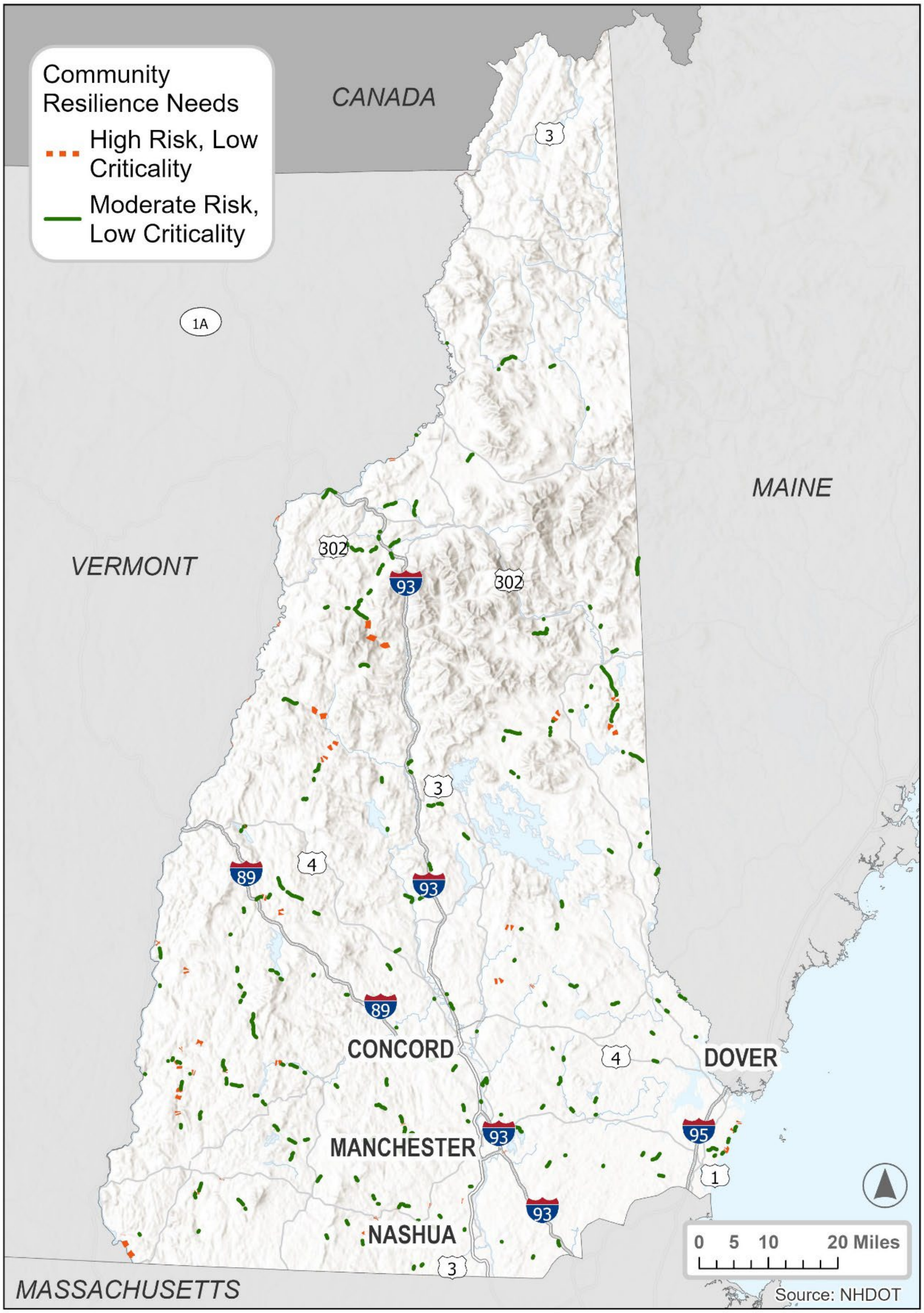
To ensure the most robust understanding of the state’s transportation needs are met and communities across the state can leverage this analysis, this RIP emphasizes that this effort is a foundational action in a series of evolutionary actions towards resilience planning for state and local planning partners. Section 7.0 aims to provoke the discussion regarding balancing community needs with a statewide resilience vision and how statewide analyses can potentially overlook certain assets due to low criticality indicators.

From a community resilience standpoint, planners should be acutely concerned about asset potential to surmounting risk. To ensure facilities are not overlooked, local planning partners, more familiar with their respective facilities should examine assets of varying criticality with high to moderate risk and identification of lifeline assets that do not rise to the level of highest criticality or risk. This offers planning partners a prime opportunity to contextualize the results of this plan.

In addition to the data and analysis this RIP provides, regional planning partners can refer to the RIP to develop their own prioritization framework for project selection to the risks and priorities unique to their region. They can use this framework and methodology to develop their own RIPs, ensuring the assets that are locally significant are represented to reflect their planning objectives and needs. Planning partners in New Hampshire have already begun preparing regional RIPs. Stakeholders have noted this RIP is an exciting jumping off point to continue planning for enhancing regional and community-specific resilience.

For a dynamic view of the data in this section, see the “Community Resilience” layer in the ArcGIS Online Map, Risk Assessment. This will allow users to interactively access the risk-based assessment results and the prioritized project overlays by zooming in and selecting facilities.

FIGURE 7-1 STATEWIDE COMMUNITY RESILIENCE OPPORTUNITIES



8.0 RESILIENCE IMPROVEMENT IMPLEMENTATION FRAMEWORK

Through this point, this RIP has provided NHDOT with an overview of risk for NHDOT-maintained assets across the state. This includes an assessment of risk, and a prioritization process that relates risk and criticality to help identify priority locations for resilience projects. The purpose of this section is to outline implementation considerations following the assessment of risk to programmed projects. Risk assessment should be followed by characterization of the contributing elements that are driving the risk – which has the potential to provide insights into potential adaptation options. Detailed engineering assessments are needed for an appropriate selection of proposed adaptation strategies. However, with the planning-level information available, the specificity that can be attributed to any specific location or project is limited and more generic until a project-level engineering and design determination can be made.

FIGURE 8-1 BRIDGE NEARLY OVERTOPPING FROM FLASH FLOODING

Source: NHDOT

8.1.1 Selecting an Adaptation Strategy

As discussed in Section 6.4, a prioritized list of locations has been identified, tiered by risk and criticality. With this list in mind, the next step in the resilience planning process will be to determine what type of project or adaptation strategy will be needed for each priority location. This is achieved by taking into consideration the unique characteristics, including design and engineering considerations of each identified asset, as well as potential hazards, community needs, and other localized considerations as discussed above.

An initial step in selecting a site-specific adaptation strategy would be to determine what the desired outcome would be. For example, an asset located along the seacoast would likely have differing needs from an inland asset prone to varying degrees of flooding. For roadway assets, this can include desired outcomes of protecting coastal assets, protection from inundation, and general asset strengthening. For overpasses, bridges and culverts desired outcomes can include improved flow, erosion and scour countermeasures, and the reduction of debris damage. Potential adaptation strategies related to these themes are identified at a high level in Table 8-1 and Table 8-2 for roadway assets as well as bridges and culverts.

TABLE 8-1 ROAD ADAPTATION STRATEGIES

Theme	Description	Example Adaptation Strategies*
Coastal Asset Protection	Strategies aimed at protecting assets in coastal locations from damage from sea level rise and especially storm surge. This can include onshore and offshore infrastructure strategies.	-Beach Nourishment ● -Vegetation Planting ● -Dune Restoration ● -Revetments / Sea Walls -Wave Attenuation Devices
Inundation Protection – Minor & Moderate	Strategies aimed at protecting assets prone to extended inundation from coastal and inland flooding.	-Hot Mix Asphalt Layer Upgrades -Shoulder & Median Enhancement -Permeable Pavement
Inundation Protection - Severe	Strategies aimed at protecting assets prone to extended inundation from coastal and inland flooding, and where drainage improvements alone wouldn't be sufficient.	-Profile Raising -Complete Infrastructure Rebuild

*Source: Resilient Tampa Bay: Transportation Pilot Program Project and *● denotes nature-based strategy*

TABLE 8-2 BRIDGE & CULVERT ADAPTATION STRATEGIES

Theme	Description	Example Adaptation Strategies*
Improve Flow Under Bridge Crossing	Strategies aimed at increasing and improving flow underneath bridges when the opening is too small or is prone to being blocked.	-Replacement of a multi-span deck with a single-span deck -Elevating Bridge Deck -Increase Bridge Length -Construction of a Relief Opening
Erosion & Scour Countermeasures	Strategies aimed at improving bridge approach slabs to reduce erosion from debris flowing underneath.	-Installation of Riprap ● -Construction of Bridge Wingwalls -Construction of Spur Dikes -Realign Piers & Abutments -Increase Footing Depth -Installation of Flow Detectors
Reduce Debris Damage	Strategies aimed at reducing debris from building up underneath a bridge or culvert.	-Installation of Debris Deflectors -Installation of End Noses -Installation of Steel Batters -Minimize Below-Deck Framing -Installation of Debris Catchments & Sweepers

*Source: FEMA and *● denotes nature-based strategy*

The above tables are meant to highlight the wide range of potential adaptation strategies available to address resilience needs and key hazards. Site-specific project and strategy selection will involve a much more detailed study, including the consideration of alternatives. Nevertheless, the identified adaptation strategy themes can help provide an important starting point for implementation. In considering an adaptation strategy, NHDOT will consider and prioritize nature-based strategies where applicable. Such strategies offer advantages in terms of overall effectiveness, and environmental sustainability. The feasibility of nature-based strategies should be evaluated on a case-by-case basis and with due considerations to state and local regulations along with permitting needs. For example, NHDOT evaluated the flood reduction and ecological options of a range of options including nature-based solutions as part of the U.S. Route 1B causeway in New Castle, NH – enhancing marsh habitat in the vicinity of the causeway – as highlighted in the FHWA's Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide.[34]

8.1.2 Implementing Resilience Projects

NHDOT's core function consists of managing the state's multimodal transportation system, centered around the state's comprehensive roadway network. To maintain a fully functional, safe, and advanced transportation system requires proactive thinking, sound planning, and a multitude of projects developed and carried out by multiple branches of the NHDOT. As this RIP has demonstrated, New Hampshire's transportation network is expected to incur an increasing amount of risk in relation to sea level rise, storm surge, and flooding. As a result, it will be increasingly important for resilience to be a forefront theme associated with all agency-wide decision-making. NHDOT will consider the following processes and actions in implementing resilience projects:

- Projects selected for implementation at NHDOT are first identified through the agency's planning processes as discussed in Section 3.0. As a result, the functional components and working mechanisms of these documents have a substantial impact on the types of projects implemented across the state. As discussed, NHDOT's upcoming LRTP will include a resiliency section which references the Resilience Improvement Plan and showcases key concepts, data points, and terminology. In addition to this incorporation into the LRTP, NHDOT will examine opportunities to further integrate resilience concepts across all stages of project conceptualizing and planning, including the TYP.

- The DOT is in the process of developing a Coastal Hydrology Manual that will integrate with the Coastal Risk Tolerance Framework and this RIP. This will help provide detailed and consistent guidance for projects in the coastal region of New Hampshire.

At the broadest level, resilience is a cross-cutting theme across the agency. There is a broad recognition of the importance of enhancing system resilience to current and future priority hazards. This includes the fields of planning, design, construction, operations, and emergency management – each of which stand to benefit from increased incorporation of resilience. This plan provides a concerted effort for planning, scheduling, and prioritizing resilience improvements while taking a systemic approach to enhancing transportation system resilience in the State of New Hampshire.

[34] Nature-Based Solutions for Coastal Highway Resilience: An Implementation Guide https://www.fhwa.dot.gov/environment/sustainability/resilience/ongoing_and_current_research/green_infrastructure/implementation_guide/fhwahep19042.pdf

8.1.3 Codes, Standards, and Regulatory Framework Facilitating Implementation

A suite of codes, standards, and regulations at federal, state, and local levels guide the implementation of resilience investments and projects across New Hampshire. These include environmental regulations, design guidelines, state codes and manuals, and federal standards that guide the planning and implementation of resilience improvement projects addressing a range of natural hazards. NOAA's most recent review of New Hampshire Coastal Program[35] administered by NHDES provides an overview of regulations, legislations, and codes related to coastal risks, some of which are pertinent to transportation infrastructure. Some relevant codes, standards, and regulations are listed below:

- *2025-2026 Update of the New Hampshire Coastal Flood Risk Summary*
  - An update of the 2019-2020 *New Hampshire Coastal Flood Risk Summary* is currently underway and will fulfill the requirements of RSA 483-B:22, which directs NHDES to supervise updates to the 2014 Coastal Risk and Hazard Commission Science and Technical Advisory Panel report, *Sea-Level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire, Analysis of Past and Projected Future Trends*, at least every five years.
  - *RSA 483-B:22* states that "New Hampshire state agencies involved in planning, siting, and design of state-funded structures and facilities, public works projects, and transportation projects, as well as land acquisition and management, and other environmental activities in the coastal and Great Bay regions of New Hampshire, shall reference the Coastal Risks and Hazards Commission report, "Sea-level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire: Analysis of Past and Projected Trends," for guidance on all potentially affected activities."
  - The *New Hampshire Coastal Flood Risk Summary* is comprised of two parts, including "Part I: Science" and "Part II: Guidance for Using Scientific Projections, both of which are featured in this plan.

- New Hampshire has standardized definitions for coastal hazards and coastal flood risk, as defined in *N.H. Admin. Code § Env-Wt 602.08 - Coastal hazards and N.H. Admin. Code § Env-Wt 602.10 – Coastal flood risk*.
  - "Coastal hazards" means natural phenomena in coastal areas, such as sea level rise, coastal storms, hurricanes, flooding, and erosion that occurs rapidly in a single event or gradually, that have the potential to damage property including infrastructure, degrade the environment including habitat displacement, and threaten human life or safety.
  - "Coastal flood risk" means the likelihood and adverse consequences of flooding from seawater and is a function of the coastal flood hazard at a location and the exposure and vulnerability of people and their assets to that hazard.

- NHDES has published design guidance for stream crossings under the *Env-Wt 904.01* considerations.[36]

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[35] Final Evaluation Findings New Hampshire Coastal Management Program, Published March 2024: https://coast.noaa.gov/data/czm/media/NewHampshireCMP.pdf

[36] Stream Crossing Design: Building Structures that are Compatible with People, Streams and Wildlife https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/2020-01/wb-23.pdf

- These considerations ensure that projects involving dredge or fill or the placement of structures on or within the banks or bed of surface waters require permitting from the NHDES Wetlands Bureau and are designed in compatibility with the hydrology, geomorphology, and the passage of aquatic organisms of the stream.

- NHDOT is in implementation of resilience-informed codes and design guidelines, including:
  - The aforementioned NHDOT Coastal Hydrology Manual, which incorporates the guidance from the Coastal Risk Tolerance Framework and specific project level design guidelines.
  - NHDOT follows the federal guidance as part of *Hydraulic Engineering Circulars (HEC) 17 and 25* for riverine and coastal environments respectively.
  - NHDOT's *Manual on Drainage Design for Highways* [37] consists of several provisions for incorporating climate projections and resilient design and consideration of climate modeling as part of engineering discretion.

- New Hampshire's Office of Planning and Development has developed three state model floodplain ordinances, which contain the minimum regulations that a community must adopt in order to participate in the National Flood Insurance Program (NFIP) as detailed in Title 44 of the Code of Federal Regulations. This guidance also includes example floodplain regulations that go beyond the minimum NFIP regulations, sourced from New Hampshire communities that have already adopted higher floodplain regulations.
  - Funding from NOAA enabled the expansion of these resources to include additional higher standards that have been adopted in coastal communities such as regulations that account for future coastal flood risk including sea-level rise and storm surge.

- Municipalities in New Hampshire are progressively taking steps to adapt to natural hazard variability, with a large focus on the highest priority hazards. New Hampshire adopted *RSA 674:21*, authorizing municipalities to adopt, administer and enforce land use mechanisms to manage coastal flooding through regulations and mechanisms such as impact fees. Coastal municipalities have the flexibility to choose regulations based on their geographic characteristics, goals, or local issues.

[37] NHDOT Manual on Drainage Design for Highways (HDM) https://www.dot.nh.gov/sites/g/files/ehbemt811/files/inline-documents/manual-drainage-design.pdf

APPENDIX A RISK BASED PRIORITIZED PROJECT LIST

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
63	29597	Albany	NH 16	Widen & resurf for install of centerline rumble strips from Tamworth T/L to Conway T/L (~ 4.5m)	Design	4.5	High Criticality	High	High	Inland Flooding Mitigation
15	44611	Alton	NH 140	Emergency repair drainage studies - NH140@Eliot & Coffin Brk Roads (B58 storm #s STM77693/STM77695)	Planning	0.5	Moderate Criticality	High	High	Inland Flooding Mitigation
57	44351	Amherst	NH 122	Con multimodal path 3,611 linear ft along north side of Rd to bridge a gap in multimodal facilities	Planning	0.7	Moderate Criticality	High	High	Inland Flooding Mitigation
17	44841	Bath	NH 112	NH 112 over Waterman Brook Bath 153/053 repair undermining of eastern abutment	Planning	0	Low Criticality	High	High	Inland Flooding Mitigation
46	43523	Berlin	NH 16	NH 16 Roadway improvements from Cleveland Bridge/Hutchins Street to Exchange St.	Planning	0.5	High Criticality	High	High	Inland Flooding Mitigation
64	44142	Berlin	Mason Street	Mason Street Bridge - As identified in CDS 2022 Legislation	Design	0	Moderate Criticality	High	High	Inland Flooding Mitigation
9	42437	Bethlehem-Littleton	I-93	Rehabilitation (4R) on I-93 from MM 120.5 to MM 125.0 including ramps at Exits 40, 41, & 42.	Planning	12.6	High Criticality	High	High	Inland Flooding Mitigation
1	13742	Bow - Concord	I-93	I-93 widening from south of I-89 to Exit 14 (Toll) and Exit 14 to Merrimack River Bridge (FHWA).	Design	24	High Criticality	High	High	Inland Flooding Mitigation
39	44416	Carroll	US 302	Address bridge (162/127) carrying US 302 over Ammonoosuc River in Town of Carroll	Planning	0	Moderate Criticality	High	High	Inland Flooding Mitigation
35	41478	Charlestown, NH - Springfield, VT	NH 11	Address bridge carrying NH 11 over Conn River between Charlestown, NH and Springfield, Vt (135/052)	Design	0.1	Moderate Criticality	High	High	Inland Flooding Mitigation
58	43852	Claremont	NH12/NH103/Main St.	Main St (NH12/103) Phase 2 from Westside Ave to Elm St - full depth, drainage, sidewalks	Planning	0.5	High Criticality	High	High	Inland Flooding Mitigation
62	43530	Claremont	NH 103	Roadway Reconstruction (Phase 1) of NH 103 from Citizen to West St. intersections.	Planning	0.3	Moderate Criticality	High	High	Inland Flooding Mitigation
12	41467	Claremont, NH - Weathersfield, VT	NH 12 & NH 103	Bridge Preservat, bridge carrying NH 12 & 103 over CT River between Claremont NH & Weathersfield Vt	Design	0.1	High Criticality	High	High	Inland Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
36	40640	Colebrook	US 3 / Main Street	Reconst. approx. 2700' of US 3/Main St & Sidewalks from South Main St. traffic island to Beaver Brk	Design	0.5	High Criticality	High	High	Inland Flooding Mitigation
2	41468	Concord	I-93 NB & SB	Address Priority Bridges carrying I-93 NB & SB over Merrimack River (136/117 & 136/116) in Concord	Design	0.3	High Criticality	High	High	Inland Flooding Mitigation
10	41212	Concord	NH Route 9 (Loudon Rd) over Merrimack River	Bridge Rehabilitation-NH Route 9 (Loudon Rd) over Merrimack River Br. #163/111 (SAB+MOBRR) Red List	Planning	0.1	High Criticality	High	High	Inland Flooding Mitigation
31	43732	Concord	N/A - Rail Trail	Const. 1.79 miles of 10' wide paved multi-use path between Sewalls Falls Rd. and Boscawen Town line	Planning	1.8	Low Criticality	High	High	Inland Flooding Mitigation
48	43428	Concord	I-89 NB & SB	Address 2 red list brs. (pier repairs) carrying I-89 over Turkey Pond (Br. Nos. 165/029 & 166/029)	Planning	0.1	High Criticality	High	High	Inland Flooding Mitigation
47	41402	Conway	Washington Street over Swift River	Bridge Rehabilitation-Washington Street over Swift River Br. #164/063	Planning	0	Low Criticality	High	High	Inland Flooding Mitigation
42	44417	Cornish	Cornish Toll Bridge Road	Address the Red List bridge (064/108) carrying Cornish Toll Bridge Road over Connecticut River	Planning	0.1	Low Criticality	High	High	Inland Flooding Mitigation
22	41433	Dover, NH - South Berwick, Maine	Gulf Road	Address Red List bridge carrying Gulf Rd over Salmon Falls River between Dover & S Berwick (182/123)	Design	0.1	Low Criticality	High	High	Inland Flooding Mitigation
11	40514	Franconia	I-93	Rehab (4R) of I-93 from MM 111.6 (south of Exit 35) to MM 116.1. Includes ramps at 35, 36, & 37.	Design	11.9	High Criticality	High	High	Inland Flooding Mitigation
19	44216	Gorham	NH 16	Construct ~1.5M sidewalk & bike shoulder from ~2400' N of US 2 to ~1400 S of Pisani St.	Planning	2.2	High Criticality	High	High	Inland Flooding Mitigation
40	42239	Gorham	US 2	Recon railway-highway crossing, roadway approaches & protect. devices (Gorham 170-984F & 170-985M)	Design	0	Moderate Criticality	High	High	Inland Flooding Mitigation
45	42598	Gorham	Rte 16	Drainage and retaining wall improvements alongside NH 16 one quarter mile south of Libby Street	Planning	0.2	High Criticality	High	High	Inland Flooding Mitigation
53	43849	Greenland	NH 33	Engineering assessment to improve resiliency and capacity to NH33 bridge over Winnicut River.	Planning	0	Moderate Criticality	High	High	Inland Flooding Mitigation
3	40797	Hampton	NH 1A (Ocean Boulevard)	Improvements to NH 1A (Ocean Boulevard) from State Park Road to NH 27 (High St).	Design	3.3	High Criticality	High	High	Coastal Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
59	41584	Hampton	NH 101/US 1	NH 101/ US 1 interchange reconfiguration	Design	3.6	High Criticality	High	High	Coastal Flooding Mitigation
29	44608	Harts Location	US 302	Harts Location US 302 over Willey Brook (069/081) Wingwall Repair	Planning	0	Moderate Criticality	High	High	Inland Flooding Mitigation
27	43445	Haverhill - Bath	NH135	NH 135 Bridge Preservation efforts for NH135 over Ammonoosuc River in Bath (Br. No. 071/063).	Design	0.1	Moderate Criticality	High	High	Inland Flooding Mitigation
26	12210D	Hinsdale, NH - Brattleboro, VT	NH Route 119	Bridge Rehab of bridges carrying NH Route 119 over Conn River between Hinsdale and Brattleboro	Design	0.2	Moderate Criticality	High	High	Inland Flooding Mitigation
23	44187	Hinsdale/ Winchester/ Fitzwilliam	Route 10/12/119	Guardrail upgrades in Hinsdale, Winchester, and Fitzwilliam, Routes 10, 12 and 119.	Design	13.9	High Criticality	High	High	Inland Flooding Mitigation
38	41590	Keene	NH 101	Reconstruction of NH 101 from 0.4 mi east of Optical Ave to Branch Road.	Design	1	High Criticality	High	High	Inland Flooding Mitigation
51	43543	Keene	West St.	Corridor improvements to West St. from intersection of NH 9/10/12 to School Street	Planning	0.7	High Criticality	High	High	Inland Flooding Mitigation
56	40666	Keene-Swanzey	NH 10 (Winchester Street)	Reconstruct Winchester St: NH 101 to Market Basket (Swanzey) and replace Ash Swamp Brook Bridge.	Design	0.9	High Criticality	High	High	Inland Flooding Mitigation
49	44234	Lebanon	Hanover St.	Complete St. imprvs to Hanover St. from NH120 to High St (~1400lf) inc bk lns/sdwlks/intrsct improv	Planning	0.3	High Criticality	High	High	Inland Flooding Mitigation
52	43437	Lebanon	I-89, NH 10 SB	Address bridge (099/111) carrying I-89, NH 10 SB Ramp over Mascoma River in the Town of Lebanon	Planning	0	High Criticality	High	High	Inland Flooding Mitigation
54	44016	Lebanon	Mechanic St.	Mechanic Street Sidewalk Project- As identified in CDS 2022 Legislature	Design	1	High Criticality	High	High	Inland Flooding Mitigation
65	40794	Lebanon	US 4 (Mechanic St)	Reconstruct Mechanic St / High St / Mascoma St Intersection	Design	0.1	High Criticality	High	High	Inland Flooding Mitigation
13	43809	Littleton	I-93	Preservation of 4 bridges in Littleton carrying I-93 over Ammonoosuc River and NHRR(ABD).	Design	0.1	High Criticality	High	High	Inland Flooding Mitigation
28	27711	Littleton, NH - Waterford, VT	NH Route 18	Deck replacement and painting of Red List Bridge carrying NH 18 over Connecticut River (109/134)	Design	0.1	Low Criticality	High	High	Inland Flooding Mitigation
30	29613C	Loudon - Canterbury	NH Rte 106	NH 106 Roadway Widen(Ph 3) Hemlock Hill Dr to approx. Clough Pond Rd (~2.7m)	Design	2.7	High Criticality	High	High	Inland Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
14	24212	Manchester	Salmon St. EB Over Rd, Bmrr, Merrimack River and Ramp	Amoskeg East Bnd - SALMON ST OVER RD,RR,& RIVER (Brg#107/072) and Adjacent Ramp "E" (Brg#107/071)	Planning	0.2	High Criticality	High	High	Inland Flooding Mitigation
16	24206	Manchester	Salmon Street WB over Rd, BMRR, Merrimack River and Ramp	Bridge rehab-Salmon St WB over rd., bmrr, Merrimack River, ramp-br. #106/072	Planning	0.2	High Criticality	High	High	Inland Flooding Mitigation
20	43730	Manchester	Canal Street	Const. 4,800 LF of multi-use path along Canal Street.	Planning	1	High Criticality	High	High	Inland Flooding Mitigation
32	16099A	Manchester	Reconstruct and widening of Exit 6 (Amoskeag)	Reconstruct and widen Exit 6 (Amoskeag) in Manchester.	Planning	1.6	High Criticality	High	High	Inland Flooding Mitigation
37	16099	Manchester	I-293 / FE Everett TPK	Preliminary engineering & row for reconstruction of the F.E. Everett Turnpike at exits 6 and 7	Design	3.9	High Criticality	High	High	Inland Flooding Mitigation
24	44339	Merrimack	US 3	Rehabilitate/Restore Historic US 3 Bridge over Souhegan River (Br#116/120)	Planning	0	High Criticality	High	High	Inland Flooding Mitigation
25	43733	Merrimack	US Route 3	Const. 3,600 LF of sidewalk along US3 from Chamberlain Bridge to Merrimack 360 plaza.	Planning	0.8	High Criticality	High	High	Inland Flooding Mitigation
60	44595	Milan	NH 110	NH 110 over Upper Ammonoosuc River (Milan 077/133) wingwall, abut repair and deck preservation	Planning	0	Moderate Criticality	High	High	Inland Flooding Mitigation
21	42470	Milford	NH 101A & NH 13	Improves to the ""Oval"" to improve traffic flow [Sec1702 - Demo id NH038 & NH058]	Design	0.6	High Criticality	High	High	Inland Flooding Mitigation
44	13692G	Milford	NH Route 101	Study feasibility of median barrier along the Milford By pass	Planning	3.5	High Criticality	High	High	Inland Flooding Mitigation
4	43545	Nashua	Canal St.	Study and implement Complete Streets improvements on Canal St from RR Square to Taylors Falls Bridge	Planning	1	High Criticality	High	High	Inland Flooding Mitigation
5	13761	Nashua-Merrimack-Bedford	FE Everett Turnpike	FE Everett Turnpike widening of 2-lane sections from Exit 8 (Nashua) to I-293 (Bedford).	Design	24.8	High Criticality	High	High	Inland Flooding Mitigation
6	13761B	Nashua-Merrimack-Bedford	FE Everett Turnpike	Replace Wire Road and Baboosic Lake Road Bridges over the FE Everett Turnpike (Merrimack).	Planning	0.1	High Criticality	High	High	Inland Flooding Mitigation
7	13761C	Nashua-Merrimack-Bedford	FE Everett Turnpike	FE Everett Turnpike widening in Merrimack of a 2-lane section from Exit 11 to south of Exit 13.	Planning	10.5	High Criticality	High	High	Inland Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
18	16127	New Castle - Rye	NH 1B	Bridge replace, Single Leaf Bascule Bridge, NH 1B over Little Harbor (Red List) Br No 066/071	Design	0.1	Moderate Criticality	High	High	Coastal Flooding Mitigation
8	44493	New Castle Nh Route 1b Causeway	NH Route 1B	Modifications to the portion of Route 1B that runs from Goat Island to New Castle Island	Planning	0.2	High Criticality	High	High	Coastal Flooding Mitigation
34	41713	New Castle-Rye	NH 1A & 1B	Bike shldrs Svy Creek-OSP/ NH1B-NH1A/Sdwlks Wild Rose-Beach Hill/Shldrs Wild Rose-USCG (~4.2m)	Design	4.2	High Criticality	High	High	Coastal Flooding Mitigation
116	42312A-D	North Hampton-Rye	NH-1A	Reconstruct NHDOT stone revetment seawalls/berms	Design	3.2	Low Criticality	High	High	Coastal Flooding Mitigation
33	44651	Northumberland	US 3	Address preservation needs of bridge 106/112 carrying US 3 over Upper Ammonoosuc River.	Planning	0	Moderate Criticality	High	High	Inland Flooding Mitigation
50	16145	Pelham	Main Street	Main St over Beaver Brook - bridge replacement (Br.No.110/090) and culvert replacement (Br.No.111/090)	Design	0.2	Moderate Criticality	High	High	Inland Flooding Mitigation
43	44406	Piermont, NH - Bradford, VT	NH 25	Rehabilitation of Bridge carrying NH 25 over Connecticut River (Br. No. 032/103)	Planning	0.1	Low Criticality	High	High	Inland Flooding Mitigation
55	42599	Shelburne	US 2	Culvert Upgrades	Planning	0	Moderate Criticality	High	High	Inland Flooding Mitigation
41	40370	Troy	NH Route 12	Bridge Replacement of bridge carrying NH 12 over S Branch Ashuelot River (Br No 089/114)	Design	0	Moderate Criticality	High	High	Inland Flooding Mitigation
61	41471	Weare	NH 77	Address bridge carrying NH 77 over Canal 2 Choate Brook in the Town of Weare (159/178)	Design	0.1	Low Criticality	High	High	Inland Flooding Mitigation
Moderate Risk 2050										
74	43566A	Alstead	NH 123A	NH 123A Roadway and slope stabilization repair at approximately MM 2.0 (B58 project storm STM77350)	Design	0.3	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
75	43566B	Alstead	NH 123A	NH 123A Roadway and slope stabilization repair at approximately MM 0.2 (B58 project storm STM77350)	Design	0.2	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
78	44003	Andover	NH 11	Andover 212/138 NH 11 over Sucker Brook - Rebuild headers, repair arch edges and centerline joint	Planning	0.4	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
82	40664	Bedford	US 3	US 3 Widening from Hawthorne Drive North to Manchester Airport Access Road	Design	1.7	High Criticality	Moderate	Moderate	Inland Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
67	44813	Bethlehem	NH 142	NH 142 over Ammonoosuc River - Bethlehem 099/152 Truss Repairs	Planning	0	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
68	41575	Bethlehem	NH 142	Address Red List bridge (099/152) carrying NH 142 over Ammonoosuc River in Town of Bethlehem	Design	0	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
85	44160	Bethlehem-Sugar Hill-Franconia	NH 18	On-Rd (NH18) & Off-Rd trail connecting centers of Bethlehem & Franconia. Demo ID: NH097	Planning	6.4	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
83	41472	Campton	NH 49	Address bridge carrying NH 49 over Pemigewasset River in the Town of Campton (124/129)	Design	0.1	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
70	40667	Charlestown	NH 12	Reconstruct or Rehabilitate from NH 12A in Southern Charlestown to Almar Street (Approx 2.4 miles)	Design	2.4	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
91	42574	Concord	US Route 202 & NH Route 9	Address Red List bridge (147/028) carrying US 202 & NH 9 over Ash Brook in the City of Concord	Design	0	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
93	44349	Durham	NH 155A/Main St/Mast Rd	Upgrade 4-way-inters. to improve service, safety & reduce wait times with road redesign or roundabout	Planning	0.1	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
73	42513	Franklin	Trestle Bridge Mill City Park Trail	Construct a pedestrian walkway on the existing Trestle Bridge to connect to Mill City Park Trail	Design	0.1	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
77	44226	Hampton	Ashworth Ave.	Construct bike/ped improvements (incl. sidewalks and bike lanes) btwn Nudd & Dunston Aves (~4750lf)	Planning	0.9	High Criticality	Moderate	Moderate	Coastal Flooding Mitigation
92	26485A	Hampton-Portsmouth	Hampton Branch Rail Corridor	Construct the NH Seacoast Greenway, from Drakeside Rd north to the Hampton/North Hampton Town line	Design	11.4	High Criticality	Moderate	Moderate	Coastal Flooding Mitigation
72	44294	Hopkinton	NH127	Replace NH127 bridge over Penstock (Unit 1) (BR#057/111)	Planning	0	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
81	13602C	Jefferson - Randolph	US 2	Roadway reconstruction and safety improvements from NH 115 to Jefferson/Randolph Townline. (`2.2m)	Design	2.2	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
87	22192	Lancaster	Mount Orne Road	Mount Orne Road over Connecticut River; Mount Orne Covered Bridge #039/105	Planning	0	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
69	44776	Lebanon	Route 10	Replacement of 3.5’ H x 4’ W conc. box culvert, under Route 10, located 0.5 mi. south of Wilder Dam	Planning	0	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
76	42509	Manchester	Perimeter Rd. South Willow St. Harvey Rd.	Const. ADA compliant pedestrian bicycle trail along Perimeter Rd., South Willow St. and Harvey Rd.	Design	1.5	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation

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RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
84	44780	Manchester	NH Route 121	Replacement of 3' H x 4' W concrete box culvert, under Route 121, just east of traffic circle.	Planning	0	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
89	14771	New Boston	Gregg Mill Road	Bridge Replacement Gregg Mill Rd over South Branch Piscataquog River - Br. #132/138	Planning	0	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
90	27729	New Boston	NH Route 13	Culvert Replacement for Red List Bridge carrying NH 13 over Cochrane Brook (Br No 122/120)	Planning	0	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
79	43728	Rochester	Portland Street	Construct new ADA compliant sidewalk along Portland St from Prospect Street to Salmon Falls	Design	1.3	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
94	44309	Salem	Bridge Street	Replace Bridge St Bridge over Spicket River (Brg #115/097)	Planning	0	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
88	44215	Shelburne	US 2	Raise profile of US2 ~2,100' S of North Rd. to ~2,350' N of Grumpy Old Man Rd. (reflection pond)	Planning	0.3	Moderate Criticality	Moderate	Moderate	Inland Flooding Mitigation
66	44389	Somersworth NH - Berwick Maine	Salmon Falls Rd over Salmon Falls River	Rehabilitate Salmon Falls Rd bridge over Salmon Falls River Brg #078/124 Eddy Bridge Maine DOT Lead	Planning	0	Low Criticality	Moderate	Moderate	Inland Flooding Mitigation
117	NHDES-1	Statewide	Statewide	Planning, prioritization, and coastal project design	Planning	Various	Low Criticality	Moderate	Moderate	Inland and Coastal Flooding Mitigation
86	41813	Tamworth	NH 16	NH16 over Chocurua River (097/165) - Install riprap protection	Planning	0	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
80	40663	Windham	NH 111	NH111 Corridor Engineering Study from Wall St intersection to Ledge Rd/London Br Rd intersection	Design	1	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
71	29615	Wolfeboro	NH 28	NH28 imprvs from Pleasant Vlley Rd to NH109 (pave cond, drain & h20 qual, mbility, & sfty)(~1.4m)	Design	3.1	High Criticality	Moderate	Moderate	Inland Flooding Mitigation
Low Risk 2050										
99	40636	Bristol	NH 104	Roadway widening and shoulders for bike/ped travel from School St to west of Danforth Brook Rd	Design	1	Moderate Criticality	Low	Moderate	Inland Flooding Mitigation
112	41399	Canaan	Potato Road over Indian River	Potato Road: Bridge Replacement, Br. #147/055. Floodplain Work: equalizer culvert & roadway work	Planning	0.3	Moderate Criticality	Low	Low	Inland Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
109	44133	Concord	I393, US202, US4	Concord- I393, US202, US4 over I93 (152/108) Repair pier concrete pedestals, lube bearings	Planning	0.1	High Criticality	Low	Low	Inland Flooding Mitigation
106	13065C	Derry-Londonderry	Tsienneto Road	Construction of Tsienneto Road from 13065B easterly to the NH Route 102 intersection	Design	1.7	High Criticality	Low	Low	Inland Flooding Mitigation
104	41373	Dover	Rte 155, Rte 108, Bellamy Rd. Daley Dr. Durham Rd	Construct multi-use path from Knox Marsh Rd. to Bellamy Rd.	Design	1.3	Moderate Criticality	Low	Moderate	Inland Flooding Mitigation
111	41597	Goffstown	Center Street over Harry Brook	Bridge Replacement-Center Street over Harry Brook-Br. #129/116	Planning	0.1	Moderate Criticality	Low	Low	Inland Flooding Mitigation
95	41368	Hillsborough	West Main Street / NH Rte 149	Construct approximately 4,600 feet of sidewalk along Route 149 from Edgebrook Road to 77 W. Main.	Design	0.8	High Criticality	Low	Low	Inland Flooding Mitigation
110	40573	Hollis	NH 122	NH 122 over Witch Brook (087/150) - Replace Deck and new curb and rail.	Planning	0	Low Criticality	Low	Low	Inland Flooding Mitigation
113	29611	Hooksett	US 3 / NH 28	Reconstruction and widening from NH 27 / Whitehall Rd / Martin's Ferry Rd to W Alice Ave / Alice Ave	Design	1.3	High Criticality	Low	Low	Inland Flooding Mitigation
105	44329	Keene	Maple Avenue	Replace Maple Avenue Bridge over Black Brook (Br#090/101)	Planning	0	Moderate Criticality	Low	Low	Inland Flooding Mitigation
114	16099B	Manchester	Exit 7 FE Everett Turnpike	Reconstruct Exit 7	Planning	0.5	High Criticality	Low	Low	Inland Flooding Mitigation
96	40088	Marlow	NH 10, NH 123	Address bridge carrying NH 10 & NH 123 over Ashuelot River (Br No 116/091)	Planning	0.1	Low Criticality	Low	Low	Inland Flooding Mitigation
108	29174	Merrimack	US 3 from Wire Rd to Baboosic Brook	Bridge replacement US-3 over Baboosic BRK (BR#118/135) & Reconstruct Wire Rd / US-3 Intersection	Planning	0.3	High Criticality	Low	Low	Inland Flooding Mitigation
115	42517	New Castle	Wentworth Road NH1B Beach Hill Road Neals Pit Lane	Construct bicycle shoulders and SW along Wentworth Rd, NH 1B from Beach Hill Rd. To Neals Pit Ln	Design	0.1	High Criticality	Low	Low	Coastal Flooding Mitigation
100	40856	Orford	NH 25A	NH 25A over Jacobs Bk (121/091) - Repair curbs strip, patch, membrane deck and install new wingwall	Planning	0	Low Criticality	Low	Low	Inland Flooding Mitigation
101	41390	Orford	NH Route 25A	Bridge Rehab or Replacement of the bridge carrying NH Route 25A over Baker Pond Brook (219/112)	Design	0	Low Criticality	Low	Low	Inland Flooding Mitigation

RIP ID	NHDOT Project Number	Project Location	Roadway	Project Description	Project Phase	Project Length (Miles)	Criticality	Current Risk, 2050	Future Risk, 2100	Resilience Improvement Strategy
97	43002	Rye	NH Route 1A	Replacement of 4 ft x 5.5 ft stone walled, concrete deck culvert just north of Locke Rd.	Design	0.1	Low Criticality	Low	Low	Coastal Flooding Mitigation
103	42885	Salem	Rte 28	Construct Rail Trail parallel to NH 28 for approx. 1 mile - Main St south to Rockingham Park Blvd	Planning	1	High Criticality	Low	Low	Inland Flooding Mitigation
102	44125	Sandwich	NH 25	NH 25 over Meadow Brook, Sandwich 233/066 Raising headwall & wingwalls on North side	Planning	0	Moderate Criticality	Low	Low	Inland Flooding Mitigation
98	27692	Swanzey	NH Route 32	Address Red List Bridge (149/072) carrying NH Route 32 over Martin Brook in the Town of Swanzey	Design	0	Low Criticality	Low	Low	Inland Flooding Mitigation
107	43443	Troy - Jaffrey	NH Route 124	Replacement of a crossing of 3 cmp pipes under Route 124 at Perkins Pond.	Design	0	Low Criticality	Low	Low	Inland Flooding Mitigation

APPENDIX B RIP REQUIREMENTS CROSSWALK

The NHDOT RIP aims to satisfy the RIP requirements under the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) program, 23 U.S. Code 176(e)(2). The table below explains how each element will be fulfilled in the plan, and justifies why some optional elements are not addressed.

A RESILIENCE IMPROVEMENT PLAN…	APPROACH TO FULFILLMENT
Shall	
(A) shall be for the immediate and long-range planning activities and investments of the State or metropolitan planning organization with respect to resilience of the surface transportation system within the boundaries of the State or metropolitan planning organization, as applicable;	Plan demonstrates alignment with planning activities across the state, including LRTP/TYP (long range), near term projects, and others. This covers NHDOT's planning process and how the RIP reviewed existing projects and can add future projects. This will be included Section 3.2 Long Range Transportation Plan (LRTP) / Section 3.3 Ten-Year Plan (TYP) and Section 6.4 Risk Based Project Prioritization
(B) shall demonstrate a systemic approach to surface transportation system resilience and be consistent with and complementary of the State and local mitigation plans required under section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5165);	Section 3.0 spotlights the SHMP and the DOT's role in emergency response planning. Section 4.0 considers statewide transportation infrastructure at the system level, analyzing both roads, bridges, culverts, and transit routes. Risks to the system across interdependent sectors are considered through criticality assessment. (power plants, hospitals, etc.). Consistent with SHMP, which guided the selection of hazards.
(C) shall include a risk-based assessment of vulnerabilities of transportation assets and systems to current and future weather events and natural disasters, such as severe storms, flooding, drought, levee and dam failures, wildfire, rockslides,	Following FHWA definition of risk, Section 6.0 Vulnerability and Risk-Based Assessment evaluates vulnerability, likelihood and consequence of transportation assets to current and future hazards (SLR, storm surge, and inland flooding).

A RESILIENCE IMPROVEMENT PLAN…	APPROACH TO FULFILLMENT
mudslides, sea level rise, extreme weather, including extreme temperatures, and earthquakes;	
Shall, as appropriate-	
(i) include a description of how the plan will improve the ability of the State or metropolitan planning organization- *(I) to respond promptly to the impacts of weather events and natural disasters; and* *(II) to be prepared for changing conditions, such as sea level rise and increased flood risk;*	Plan includes a comprehensive risk-based assessment to improve understanding of vulnerabilities and risk of the state's transportation system, to coastal and inland flooding. Plan introduces a framework for the state to integrate resilience and preparedness into future projects.
(ii) describe the codes, standards, and regulatory framework, if any, adopted and enforced to ensure resilience improvements within the impacted area of proposed projects included in the resilience improvement plan;	Section 8.1.3 Codes, Standards, and Regulatory Framework Facilitating Implementation outlines the regulatory environment that projects are developed within.
(iii) consider the benefits of combining hard surface transportation assets, and natural infrastructure, through coordinated efforts by the Federal Government and the States;	Section 8.0 Implementation Strategies
(iv) assess the resilience of other community assets, including buildings and housing, emergency management assets, and energy, water, and communication infrastructure;	Section 5.0 highlights the criticality determination process included non-transportation assets including critical destinations, community assets representing other aligned and critical sectors. Assessment of risk incorporates access to these critical facilities and destinations. Section 7.0 Community Resilience draws connections between other community assets and transportation resilience.

A RESILIENCE IMPROVEMENT PLAN…	APPROACH TO FULFILLMENT
(v) use a long-term planning period; and	2050 and 2100 horizon years were used in the Coastal Food Risk Tolerance Framework analysis. Inland flooding used 2050 and 2080 (as a proxy for 2100).
(vi) include such other information as the State or metropolitan planning organization considers appropriate.	The process for adding MPO projects to the prioritized project list is discussed in Section 6.4.Prioritized Vulnerable Locations List.
May-	
(i) designate evacuation routes and strategies, including multimodal facilities, designated with consideration for individuals without access to personal vehicles;	Map of evacuation routes included in Section 4.0 Asset Inventory and their inclusion in the Criticality construct is within Section 5.0 Criticality.
(ii) plan for response to anticipated emergencies, including plans for the mobility of- *(I) emergency response personnel and equipment; and* *(II) access to emergency services, including for vulnerable or disadvantaged populations;*	DOT facilities involved in emergency response are included as part of the Criticality Construct explained in Section 5.0 Criticality. Role of NHDOT in emergency response covered under the State Hazard Mitigation Plan in Section 3.1 New Hampshire State Hazard Mitigation Plan (SHMP).
(iii) describe the resilience improvement policies, including strategies, land-use and zoning changes, investments in natural infrastructure, or performance measures that will inform the transportation investment decisions of the State or metropolitan planning organization with the goal of increasing resilience;	Section 8.0 Implementation Strategies, including reference to the NHDOT design manuals.
(iv) include an investment plan that- *(I) includes a list of priority projects; and*	Section 6.4 Risk Based Project Prioritization and Appendix B RIP Requirements Crosswalk

A RESILIENCE IMPROVEMENT PLAN…	APPROACH TO FULFILLMENT
(II) describes how funds apportioned to the State under section 104(b)(8) or provided by a grant under the program would be invested and matched, which shall not be subject to fiscal constraint requirements; and	
(v) use science and data and indicate the source of data and methodologies; and	Section 6.0 Vulnerability and Risk-Based Assessment