

GENESEE-FINGER LAKES REGIONAL RESILIENCE IMPROVEMENT PLAN

PREPARED FOR
**GENESEE TRANSPORTATION
COUNCIL**

PREPARED BY
CAMBRIDGE SYSTEMATICS



GTC

JUNE 2026

TABLE OF CONTENTS

1. Introduction 5

2. Overview of The Genesee-Finger lakes Region..... 6

 2.1 Regional Transportation Assets 6

 2.2 Regional Hazards 7

3. Asset Ranking..... 12

 3.1 Criticality 12

 3.2 Risk 15

 3.3 Asset Ranking Results 17

4. Priority Projects 21

5. Hazard Mitigation Strategies 22

 5.1 Tier 1: Regional and Programmatic Strategies..... 23

 5.2 Tier 2: Project-Specific Strategies 27

Appendix A. Priority Project List 44

Appendix B. Stakeholder List 47

LIST OF TABLES

Table 1 Asset Ranking Matrix	2
Table 2 Hazards Analyzed and Impacts on Critical Surface Transportation	11
Table 3 Tier 1 General Strategies for Regional and Programmatic Resilience Improvements.....	23
Table 4 Dam Failure and Flooding Project-Specific Strategies	27
Table 5 Extreme Temperatures Project-Specific Strategies	31
Table 6 Landslide Project-Specific Strategies	34
Table 7 Severe Thunderstorm Project-Specific Strategies	36
Table 8 Severe Winter Storm Project-Specific Strategies	39
Table 9 Wildfire Project-Specific Strategies	41

LIST OF FIGURES

Figure 1 Transportation Assets Analyzed	1
Figure 2 Summary of Regional Hazards and Impacts on Critical Surface Transportation	1
Figure 3 High-Priority Roadways	3
Figure 4 The Genesee-Finger Lakes Region	5
Figure 5 Overview of Asset Ranking Process	12
Figure 6 Criticality Indicators for the Genesee-Finger Lakes Region.....	13
Figure 7 Integrating Criticality And Stakeholder EnGagement into Risk-Based Assessment.....	14
Figure 8 GTC Interactive Criticality Webmap for Stakeholder Feedback	14
Figure 9 Risk Assessment Components	15
Figure 10 GTC Regionally Significant Hazards Evaluated In Vulnerability Assessment	16
Figure 11 Risk Equation	16
Figure 12 Asset Ranking Matrix	17
Figure 13 Asset Ranking Results, Roadways	18
Figure 14 Asset Ranking Results, Bridges	19
Figure 15 Asset Ranking Results, Culverts.....	20

EXECUTIVE SUMMARY

Genesee Transportation Council developed the Genesee-Finger Lakes Regional Resilience Improvement Plan (RIP) to help the region better prepare for current and future weather events and natural hazards that may disrupt the transportation system. The plan updates and builds on prior regional vulnerability work, including the [2016 Regional Critical Transportation Infrastructure Vulnerability Assessment](#), and meets the requirements of a Resilience Improvement Plan under the Federal Highway Administration's (FHWA) Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) program.

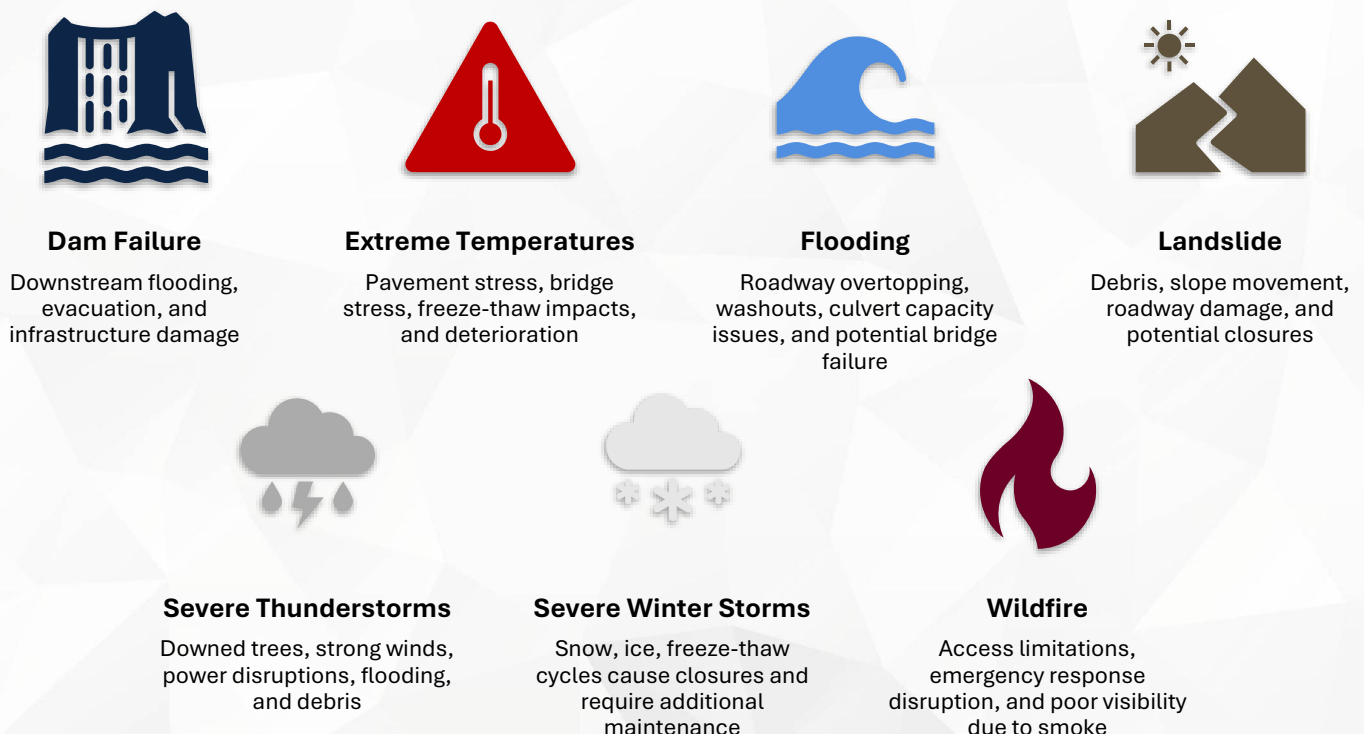
This plan provides a regional framework for identifying resilience needs, strengthening project development, and pursuing federal resilience funding opportunities. The RIP covers the nine-county Genesee-Finger Lakes Region: **Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates Counties**. The assessment focused on three categories of critical surface transportation assets:

FIGURE 1 | TRANSPORTATION ASSETS ANALYZED



The RIP evaluated natural hazards that are regionally significant, relevant to the PROTECT program, and supported by available data. The selected hazards were:

FIGURE 2 | SUMMARY OF REGIONAL HAZARDS AND IMPACTS ON CRITICAL SURFACE TRANSPORTATION



The RIP focused on transportation assets that are important to regional mobility, emergency response, freight movement, and access to essential destinations. The **asset ranking approach combined three major steps**:

CRITICALITY	RISK-BASED VULNERABILITY	PRIORITIZATION
<i>How important is the asset to the transportation system and the communities it serves?</i>	<i>How likely is the asset to be affected by hazards, and what could the consequences be?</i>	<i>Where do high-priority resilience needs overlap with planned investments?</i>
Criticality considered: ● Usage And Operational Importance, such as roadway classification, and traffic volume ● Socioeconomic Importance, including disadvantaged communities and employment density ● Health And Safety Importance, including access to hospitals, schools, emergency operations centers, and DOT facilities	Risk-Based Vulnerability was based on: ● Exposure to current and future hazard conditions ● Sensitivity based on asset condition ● Adaptive Capacity based on network redundancy and detour availability ● Likelihood of hazard occurrence ● Owner Cost if the asset is damaged	Priority Project Screening: ● The assessment screened existing Transportation Improvement Program projects against high-priority RIP assets to identify where resilience considerations may already align with programmed investments and where hazard mitigation strategies may be needed to ensure asset durability and system reliability

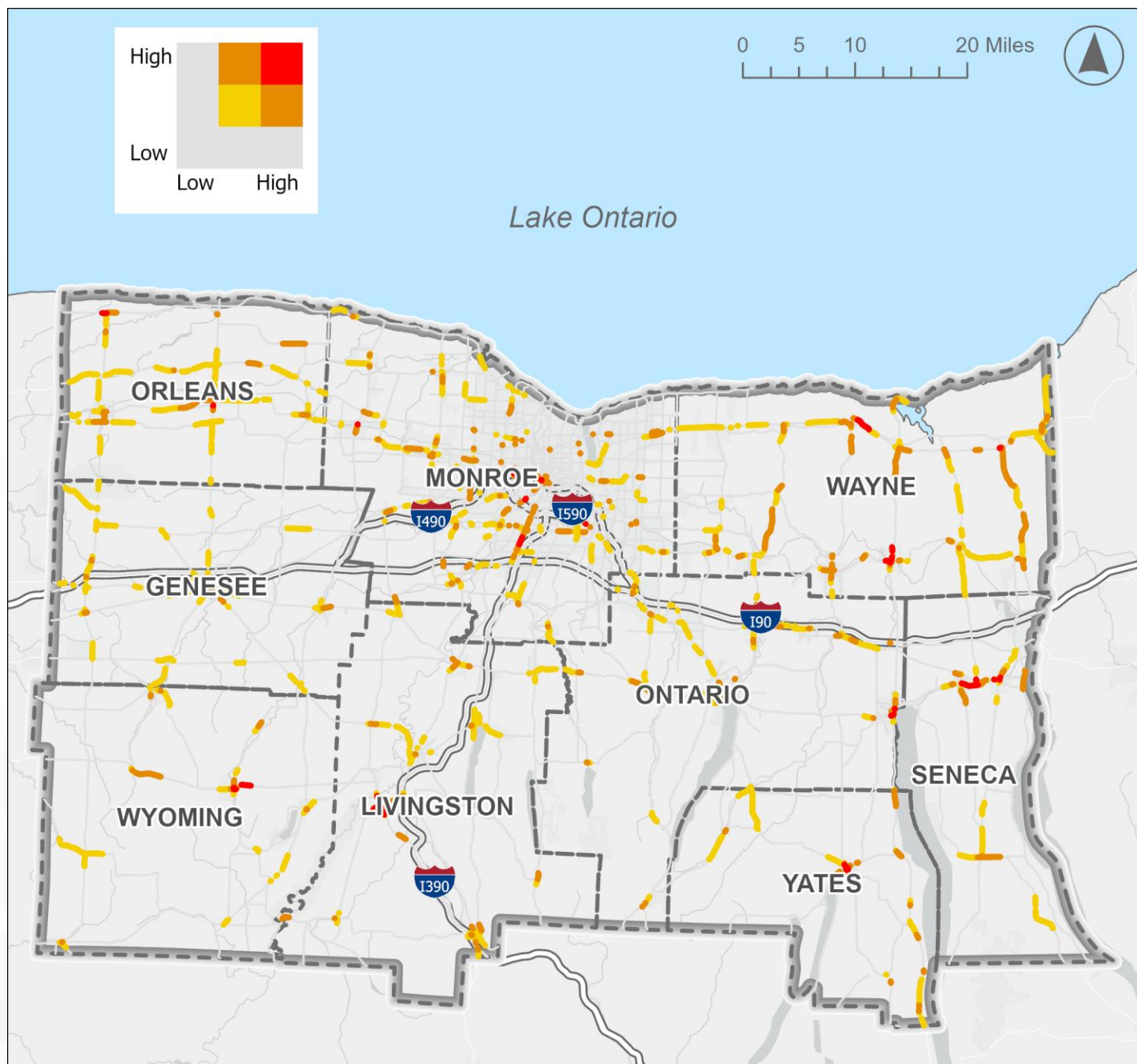
Stakeholder input from across the region was used to validate the data and refine results to align with local experience. The final asset ranking combined risk and criticality equally. Each asset was assigned to one of nine categories based on whether it had low, moderate, or high risk and low, moderate, or high criticality.

TABLE 1 | ASSET RANKING MATRIX

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

Note: Assets classified as High Risk/High Criticality, High Risk/Moderate Criticality, Moderate Risk/High Criticality, and Moderate Risk/Moderate Criticality were identified as high-priority assets for further resilience strategy development.

FIGURE 3 | HIGH-PRIORITY ROADWAYS



The asset ranking results show that resilience needs are distributed across the region. High-criticality assets are concentrated primarily in Monroe County and around the Rochester urbanized area, where travel demand, development intensity, and access to key destinations are greatest. However, priority assets are not limited to Monroe County. High-priority roadway, bridge, and culvert assets occur across all other regional counties as well.

The results identified **45 roadway segments, 8 bridges, and 40 culverts in the high-risk/high-criticality category**. The RIP also identified additional assets in the high-risk/moderate-criticality, moderate-risk/high-criticality, and moderate-risk/moderate-criticality categories. These assets may warrant further consideration as GTC and its partners advance future studies, project scoping, and programming decisions.

The RIP also screened existing Transportation Improvement Program (TIP) projects against the high-priority RIP assets. This overlay identified locations where planned investments already intersect with resilience needs, as well as locations where additional resilience strategies or project development may be needed. The resulting priority project list (see Appendix A) provides a planning-level resource for incorporating resilience into project scoping and implementation efforts.

The Genesee-Finger Lakes Regional RIP provides GTC and its partners with a shared framework for strengthening transportation resilience across the region.

Over time, GTC can leverage this plan to incorporate resilience into future studies, project development, funding decisions, and long-range transportation planning. As new hazard data, asset condition information, and local priorities emerge, the RIP can be updated to continue supporting a safer, more reliable, and more resilient regional transportation system.

THE RIP IS INTENDED TO SUPPORT REGIONAL RESILIENCE IMPLEMENTATION THROUGH THE FOLLOWING:



Identify Transportation Assets That May Need Resilience Improvements

Incorporate Resilience Into Project Scoping and Design



Support Future PROTECT and Other Discretionary Grant Applications

Inform UPWP and TIP Development



Coordinate With Counties, Municipalities, NYSDOT, and Other Regional Partners

Advance General and Asset-Specific Adaptation Strategies



1. INTRODUCTION

The Genesee-Finger Lakes Region's transportation system connects communities, supports regional travel and freight movement, and provides access to jobs, schools, health care, emergency services, and other essential destinations. As weather events and natural hazards continue to affect transportation reliability, GTC and its planning partners need a clear framework for identifying vulnerable assets and advancing projects that strengthen system resilience.



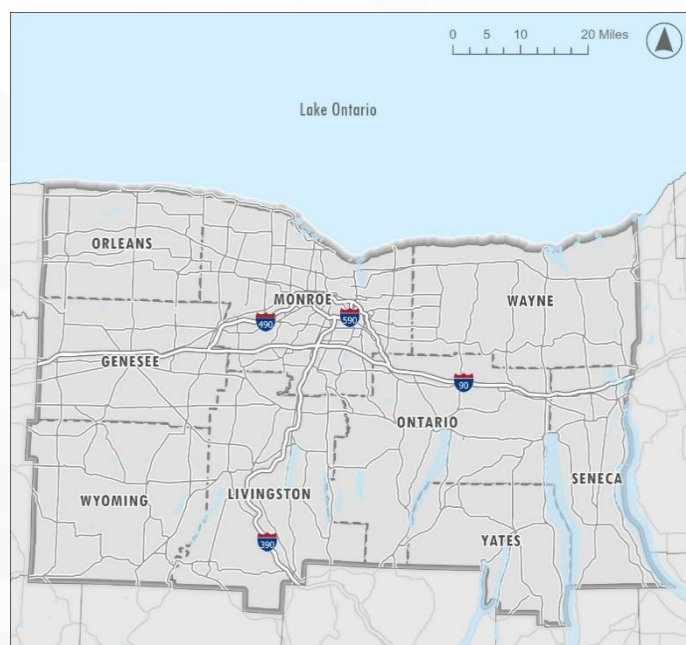
The Genesee Transportation Council developed this Regional Resilience Improvement Plan to help the region prepare for current and future natural hazards that may disrupt surface transportation infrastructure. The plan updates and builds on prior regional vulnerability work, including the 2016 Regional Critical Transportation Infrastructure Vulnerability Assessment, and meets the requirements of a Resilience Improvement Plan under the Federal Highway Administration's PROTECT program. The PROTECT program encourages states and MPOs to prepare RIPs that address surface transportation resilience to current and future weather events and natural disasters.



This RIP focuses on the nine counties that make up the Genesee-Finger Lakes Region: **Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates.** The plan evaluates **Federal-Aid roads, public bridges, and NYSDOT large culverts.**¹ These assets are central to regional mobility, emergency access, freight movement, and community connectivity.

The plan applies a risk-informed approach that combines hazard exposure, asset condition, likelihood, consequences, and criticality. This multi-dimensional approach helps identify assets that are both vulnerable to hazard impacts and important to the region's transportation system and communities. The resulting priority assets and project screening are intended to support resilience strategies, future project development, Transportation Improvement Program decisions, Unified Planning Work Program activities, and funding opportunities.

FIGURE 4 | THE GENESEE-FINGER LAKES REGION



¹ This study's scope is limited to federal-aid eligible roadways to ensure the resulting priority project list is eligible for PROTECT Formula Program funding. This scope does not reflect a judgment that non-federal-aid roads serving critical facilities are lower priority; municipalities should evaluate resiliency needs on those roads through other applicable funding sources.

2. OVERVIEW OF THE GENESEE-FINGER LAKES REGION

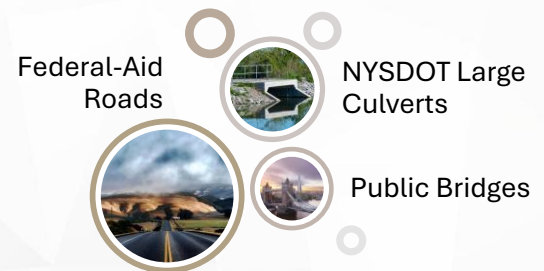
The Genesee-Finger Lakes Region is located in western New York and includes nine counties: Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates. The nearly 4,700 square-mile region includes a mix of urban, suburban, small-town, rural, agricultural, and lakefront communities and stretches south from the shores of Lake Ontario to the low rolling hills of the Appalachian Highlands. Together, these counties form a regional transportation network that supports daily travel, freight movement, emergency response, tourism, agriculture, and access to essential services, for a population of over 1.2 million residents².

The transportation system plays a central role in connecting the region's communities and supporting regional economic activity. Major corridors provide access between counties, link rural communities to employment and services, and connect the region to broader statewide and interstate travel markets. Local roads, bridges, and culverts also serve as critical lifelines, particularly in areas where alternate routes may be limited or where closures could affect emergency response, school access, freight movement, or intercounty travel.

This regional context shaped the RIP approach. The plan considers both risk and criticality from a multi-dimensional perspective, rather than focusing only on the highest traffic assets or only on the locations with the greatest hazard exposure. This allows the RIP to identify assets that are vulnerable to natural hazards and important to regional mobility, community access, emergency response, and long-term transportation system resilience.

2.1 Regional Transportation Assets

The PROTECT program is aimed at addressing surface transportation system resilience. A thorough scoping of surface transportation assets was conducted to determine geospatial data availability and granularity across the region. The identification of critical transportation assets focused on assets that are integral to the function and operation of the regional transportation system. For the purposes of this RIP, the assessment focused on surface transportation assets that are central to regional mobility and eligible for resilience planning under the PROTECT program. Across the nine-county region, the inventory included:



- Approximately 994 miles of Federal-Aid Roads – Roads eligible and designated under the [Federal-Aid Highway Program](#)
- 1,719 Public Bridges, including all public bridges on and off federal-aid eligible roads³
- 1,032 NYSDOT Large Culverts.⁴

² Regional Population Trends, 2012 - 2022 Source: CPCS analysis of American Community Survey 5-year Estimates, US Census Bureau, 2023

³ NYSDOT Inventory Bridge - Bridges included in the NYSDOT inventory carry a public highway or carry moving loads over a public highway or a navigable waterway, including those on and off federal-aid eligible highways. (Source: [NYSDOT Bridge and Large Culvert Inventory Manual](#), July 2020)

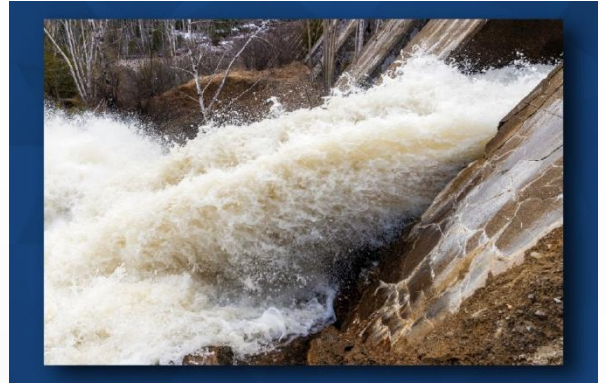
⁴ Large Culvert – A structure is considered a Large Culvert if the structure has an opening: A. measured perpendicular to its skew that is greater than or equal to 5 feet and B. measured along the centerline of the roadway that is less than or equal to 20 feet including multiple pipe structures where the clear distance between pipes is less than half of the smaller pipe diameter. (Source: [NYSDOT Bridge and Large Culvert Inventory Manual](#), July 2020)

2.2 Regional Hazards



Dam Failure

Dam failure is the collapse, breach, or other failure of a dam structure resulting in downstream flooding. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and severe property damage if development exists downstream of the dam. According to FEMA, complete dam failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled water that rushes downstream, damaging or destroying anything in its path. These events are often linked to other natural hazards such as flooding and severe storms, compounding the unpredictability of failure and increasing vulnerability. New York State Department of Environmental Conservation (DEC) uses a dam downstream hazard classification system following three classification levels. They are designated low, intermediate and high to indicate increasingly adverse consequences that a dam failure may have on downstream areas.



All transportation infrastructures within the dam failure inundation zone are vulnerable to damage. Damage to these infrastructures could cut off evacuation routes, limit emergency access, and create other critical transportation issues. Overall, dam failures pose a significant community hazard, particularly for populations residing within inundation zones, including economically disadvantaged areas and individuals over the age of 65. Impacts include potential loss of life, injury, displacement, damage to structures, agricultural losses, and utility disruptions.



Extreme Temperatures

This plan defines extreme temperatures as either extreme heat or extreme cold. Extreme heat is typically defined as an extended period of time during the summer where high temperatures are consistently 10 degrees Fahrenheit (°F) or more over the average high for the region. Extreme cold is typically defined as an extended period of time during the winter where high temperatures are consistently 10°F or more below the average high for the region.



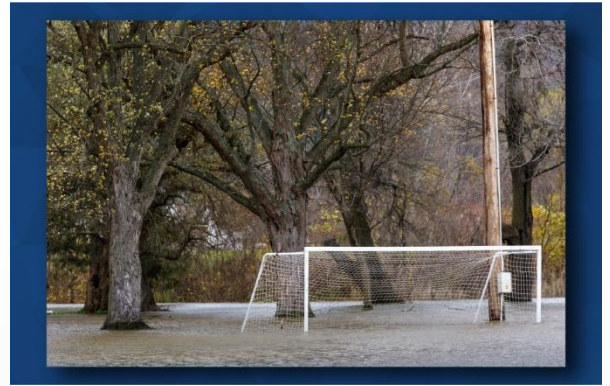
Extreme temperatures and frequent freeze-thaw cycles can impact critical transportation assets by stressing roadways, bridges, and railroads, causing them to crack, buckle, or shift, resulting in a temporary closure of a highway, railroad, or access to a critical transportation facility. The length of closure and extent of repair is dependent upon the extent of damage. Snow and ice accumulation can create hazardous driving conditions, reducing road traction and visibility and creating unsafe driving conditions that can lead to vehicle skidding, loss of control and accidents. The data includes the annual average number of hot days exceeding a 95 °F threshold, assuming a medium emissions scenario (RCP4.5)⁵ and the annual average number of cold days below a 28 °F threshold, assuming a medium emissions scenario (RCP4.5).

⁵ RCP4.5 scenario represents a future climate change scenario where climate policies limit and achieve stabilization of greenhouse gas concentrations to 4.5 W m-2 by 2100. (IPCC, 2014)



Flooding

Flooding is defined as a natural and temporary condition of partial or complete inundation of water on normally dry land. Floods can occur due to riverine and coastal overflow, dam or levee failures, poor drainage, elevated groundwater levels, or fluctuating lake levels, high intensity rainstorm events or rainstorms that extend over a long period of time. Flooding has the potential to occur across the entire region, but is most likely in areas along streams, creeks, rivers, and lake shores, particularly within designated floodplains. Other vulnerable locations include low-lying areas with poor drainage, regions with high water tables such as wetlands and poorly drained soils, and areas near drainage ways, water control structures, or culverts where runoff exceeds drainage capacity.



Flooding can impact critical transportation assets by resulting in a temporary blockage of a highway, railroad, or access to a critical transportation facility due to high water or by leaving behind mud or debris. This condition would require no or minimal repair. More substantial damage can occur if a flood washes out a portion or all of a highway, railroad, or other critical transportation facility, requiring repair, reconstruction, or replacement.



Landslide

Landslide is defined as the downward and outward movement of slope-forming materials reacting to the force of gravity. Slide materials may be composed of rock, soil, artificial fill, or combinations of those materials. The term landslide is generalized and includes rockfalls, rockslides, creep, block slides, debris slides, earthflow, mud flow, slump, and other similar terms. Landslides are prone to occur near steep slopes but are more susceptible in areas with slope of 25% or greater. Areas with loose soil are also more prone to experiencing landslides.



Landslides can impact critical transportation assets by moving earthen materials and debris onto roadways and railroads, restricting their use and potentially causing minor damage to the structure. More substantial damage can occur if a portion or all of the roadway, railroad, or transportation facility is moved as part of the landslide, requiring full reconstruction or replacement.



Severe Thunderstorm

The [National Weather Service](#) (NWS) defines a thunderstorm as a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. A thunderstorm is classified as “severe” when it produces hail that is one inch in diameter or greater, winds gusting over 58 mph, or a tornado. [FEMA](#) ranks lightning as one of the top weather killers in the United States; an average of 182 people are injured and 33 people are killed each year. Lightning can occur anywhere when there is a thunderstorm.

Severe thunderstorms can trigger cascading impacts by intensifying flooding and causing utility failures. Thunderstorms can also lead to landslides and strong winds. Roads may become impassable from flooding, downed trees or power lines, or landslides. Downed power lines can lead to utility losses, which can affect traffic control systems and other transportation electrical infrastructure.



Severe Winter Storm

According to the NOAA [National Severe Storms Laboratory](#) (NSSL), a winter storm is a weather event in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and/or dangerous wind chills. Winter storms are typically accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall.

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months, potentially causing cold temperatures, flooding, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. Roadways and other transportation infrastructure could be damaged due to the application of salt and intermittent freezing and warming conditions that cause rapid expansion and warping of the pavement. Severe snowfall requires the clearing of roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair are required ([NSSL](#), 2006)



Wildfire

A wildfire event can rapidly spread out of control and occur most often in the summer when the brush is dry, and flames can move unchecked through a highly vegetative area. Wildfires can start as a slow burning fire along the forest floor, killing and damaging trees. The fires often spread more rapidly as they reach the tops of trees with wind carrying the flames from tree to tree. Usually, dense smoke is the first indication of a wildfire.

Periods of drought, dry conditions, high temperatures, and low humidity are factors that contribute to the occurrence of a wildfire event. Areas along railroads and people whose homes are in woodland settings have an increased risk of being affected by wildfire. Emergency services may be disrupted during a wildfire if facilities are impacted, roadways are inaccessible, or personnel are unable to report for duty.



TABLE 2 | HAZARDS ANALYZED AND IMPACTS ON CRITICAL SURFACE TRANSPORTATION

Hazard	Potential Impacts to Transportation
Dam Failure 	■ Flood damage to roads, bridges, rail lines, and other transportation assets within inundation zones ■ Loss of evacuation routes and reduced emergency access ■ Utility disruptions affecting transportation operations ■ Community isolation, displacement, and access issues for vulnerable populations
Extreme Temperatures 	■ Pavement cracking, buckling, or shifting ■ Rail deformation or track issues ■ Temporary closure of highways, rail lines, or access routes to critical facilities ■ Repair needs that vary based on severity of damage
Flooding 	■ Temporary roadway or rail blockage from high water, mud, or debris ■ Restricted access to critical transportation facilities ■ Washouts of roads, rail lines, or other transportation assets ■ Repair, reconstruction, or replacement of damaged infrastructure
Landslide 	■ Debris and earthen material blocking roads and railroads ■ Restricted use of transportation corridors ■ Minor structural damage from slope movement and debris ■ Full reconstruction or replacement where roadway, rail, or facilities are displaced
Severe Thunderstorm 	■ Temporary blockage from downed trees and power lines ■ Power loss affecting transportation system operations ■ Bridge restrictions or closures for high-profile vehicles ■ Structural damage from high winds and windborne debris ■ Repair, reconstruction, or replacement of damaged assets
Severe Winter Storm 	■ Roadway, railroad, or facility blockage from snow, ice, or freezing conditions ■ Downed trees and power lines disrupting access and operations ■ Prolonged power outages affecting transportation system function ■ Damage requiring repair, reconstruction, or replacement in more severe cases
Wildfire 	■ Roadway and rail access disruptions in vegetated or woodland areas ■ Emergency response disruptions when facilities are affected ■ Inaccessible routes for responders and the public ■ Staff availability issues when personnel cannot safely report for duty ■ Increased transportation risk during drought, heat, and low-humidity conditions.

3. ASSET RANKING

The ultimate goal of the RIP risk-based assessment is to determine a prioritized ranking of assets based on the following main components:

- **Criticality Assessment** which evaluates each asset's importance to the transportation system and broader community, including community need, safety, and economic considerations.
- **Risk Assessment** which incorporates the likelihood and consequences of hazard impacts in the Vulnerability Assessment.
 - **Vulnerability** examines how exposed, sensitive, or adaptive an asset is to various hazards and is subsequently incorporated into the assessment of risk.
 - **Likelihood** is the probability of an event occurring.
 - **Consequence** represents the cost to the owner in the event that a hazard damages an asset.

The asset ranking is a combination of both a risk assessment and criticality assessment to prioritize the roads, bridges, and culvert assets, revealing the assets with the highest, and lowest, risk and criticality, using a short and long term planning horizon (years 2030 and 2050). The final prioritized list represents the assets that have high vulnerabilities and also serve as an important resource for regional socio-economic well-being. These results then support the identification of key locations for resiliency projects, based on the Transportation Improvement Program (TIP) and also support the integration of resilience into future long-range planning efforts. The following subsections explain each step of the RIP asset ranking process.

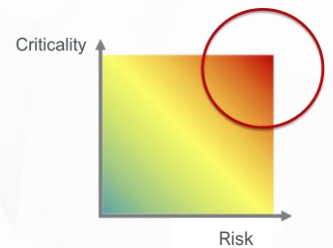


FIGURE 5 | OVERVIEW OF ASSET RANKING PROCESS



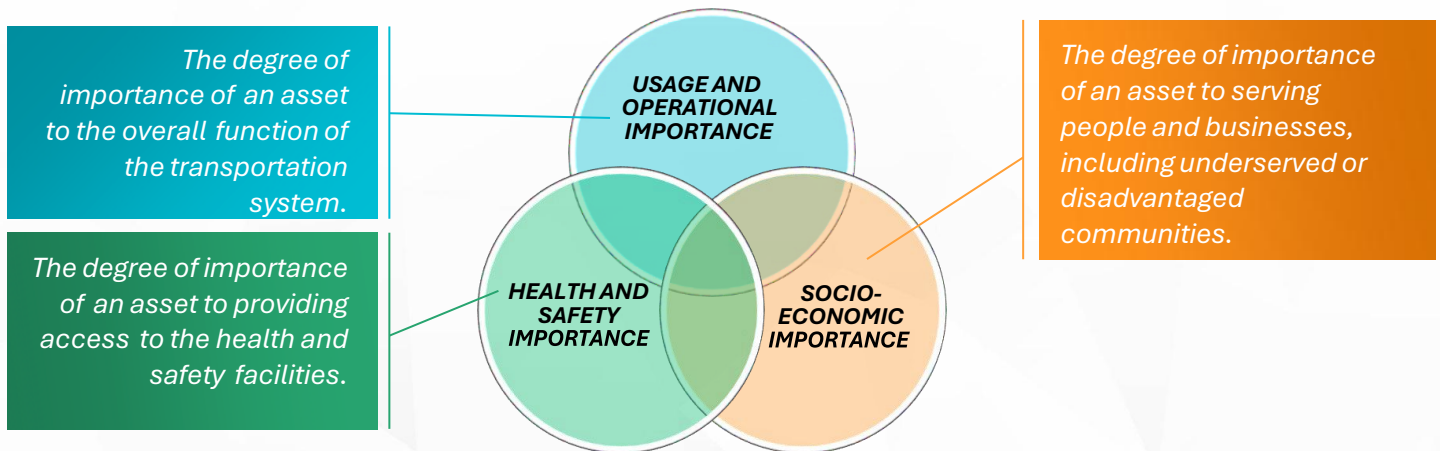
3.1 Criticality

According to USDOT, criticality is defined as the importance of a project in supporting the continued operation or rapid recovery of crucial local, regional, or national surface transportation assets and facilities served by those assets in the community. Criticality determination is an essential step in project prioritization and resilience planning to ensure GTC infrastructure investments are responsive to the needs of its population.

GTC conducted a quantitative assessment to understand the criticality of the following assets to transportation operations:

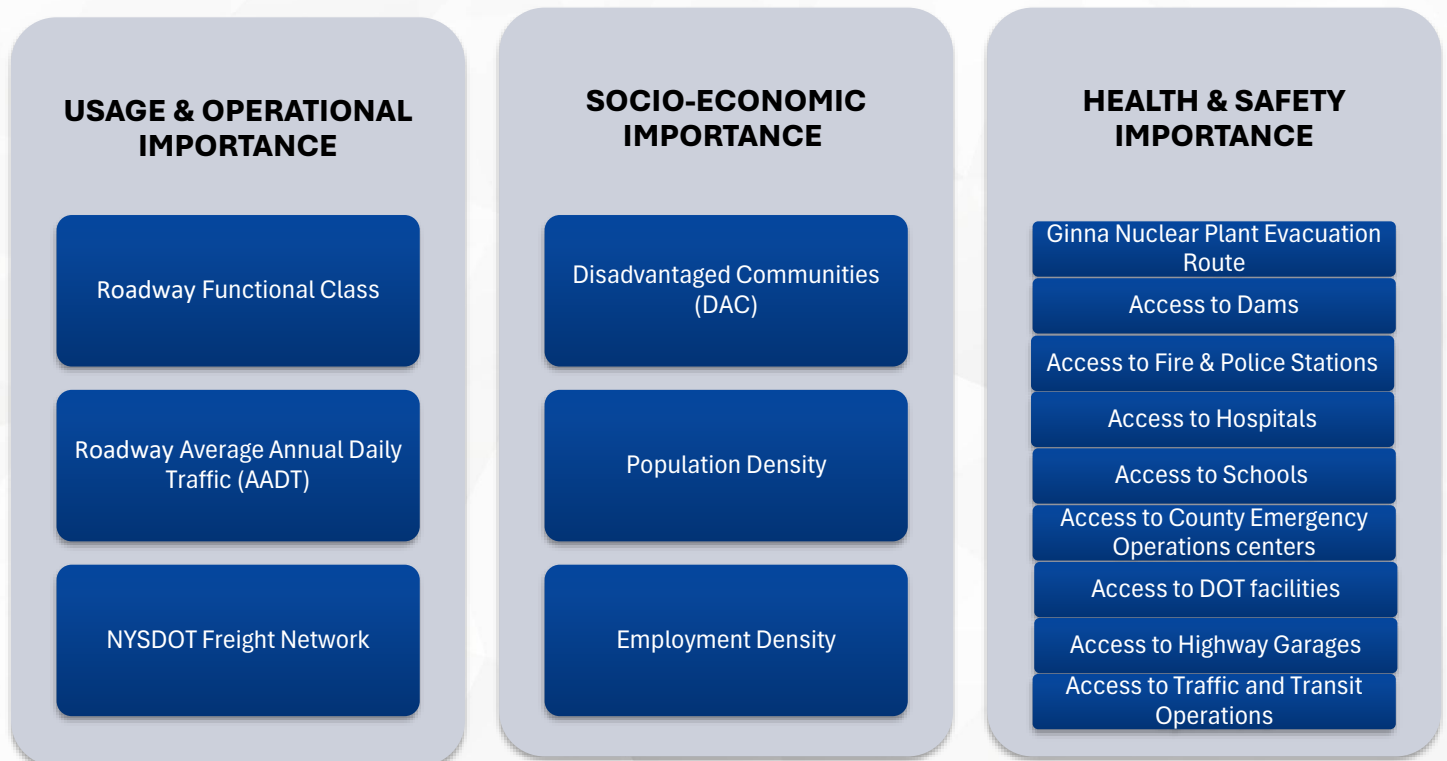
- Roads
- Public bridges
- Large Culverts (span < 20')

Criticality factors are custom to each region, address a region's unique priorities, considerations, and strengths. For the GTC Regional RIP, asset criticality was assessed using the following three equally weighted categories of indicators:



These categories are further defined using the weighted indicators shown in Figure 6:

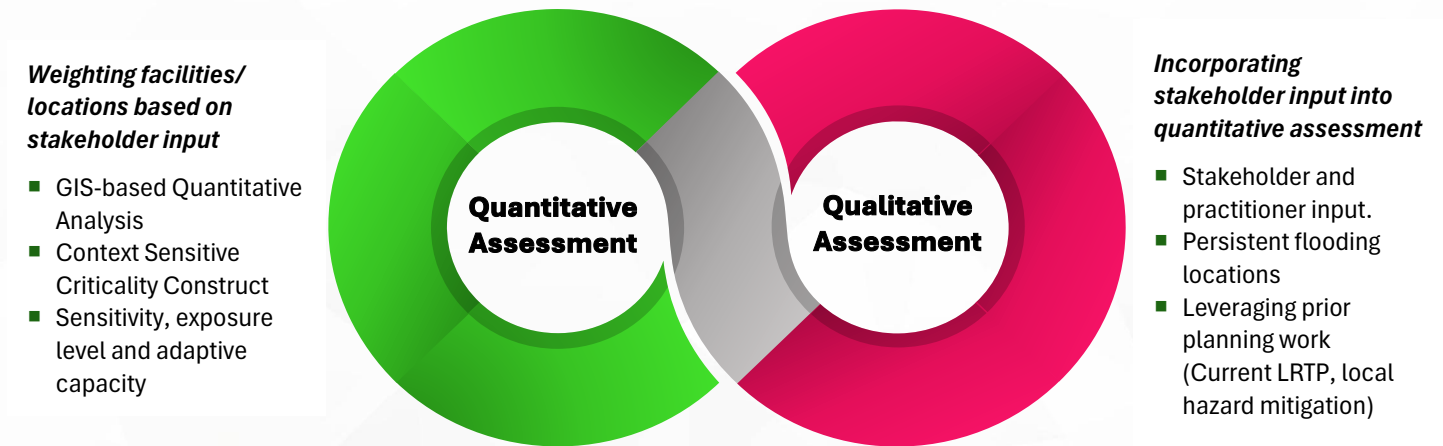
FIGURE 6 | CRITICALITY INDICATORS FOR THE GENESEE-FINGER LAKES REGION



Stakeholder Engagement

Stakeholder engagement is an integral part of the criticality assessment. While the desk-based analysis provides a consistent and regionwide method for evaluating asset importance, local agency and practitioner input is needed to verify results, identify context that may not be captured in available datasets, and refine the preliminary scoring (see figure below). This engagement effort brings in practitioner insight into what is operationally critical and highlights assets that may be overlooked in a data-only assessment but still function as vital community lifelines. Stakeholder input helps counter bias toward urban areas or easily quantifiable metrics and ensures the final criticality rankings reflect the needs and priorities of the region, county, and local communities.

FIGURE 7 | INTEGRATING CRITICALITY AND STAKEHOLDER ENGAGEMENT INTO RISK-BASED ASSESSMENT



To support this effort, GTC distributed an interactive webmap displaying the preliminary criticality results for roads, bridges, and large culverts across the Genesee-Finger Lakes Region. Stakeholders were requested to review the mapped assets and provide input on three key questions: whether any assets were missing from the analysis, whether any criticality ratings appeared too high or too low, and whether there were recent or planned changes to the assets that should be considered. Comments were collected through the interactive map interface and by email. Outreach was conducted to agency representatives across the nine-county region, as well as staff from the City of Rochester and NYSDOT.

FIGURE 8 | GTC INTERACTIVE CRITICALITY WEBMAP FOR STAKEHOLDER FEEDBACK

Feedback generally focused on whether the mapped results aligned with on-the-ground experience, particularly from the standpoint of emergency access, detour availability, and corridor continuity.

- Several stakeholders noted that some adjacent roadway segments had different criticality classifications even where the operational difference between segments appeared minimal.
 - GTC and the project team acknowledged that the preliminary classification thresholds could create abrupt changes between segments with very similar underlying scores and used stakeholder feedback to revisit these locations.



- Stakeholders also identified examples of assets that may have lower regional scores but remain highly important from a local access and public safety perspective.
 - In particular, comments highlighted facilities that could function as single points of failure, assets where closure would substantially increase emergency response times, and locations where limited redundancy could isolate communities.
 - This input was especially useful in identifying places where the desk-based methodology alone may not fully capture operational consequences at the local level.
- In addition to feedback on the criticality ratings, NYSDOT shared data on transportation facilities the state has identified as vulnerable to flooding and requested confirmation that those locations were reflected in the broader RIP analysis. This data provided an additional source of agency knowledge that informed later steps of the asset ranking process.

3.2 Risk

U.S. DOT defines risk, as a function of the likelihood of negative impacts and the consequences should the impacts occur.⁶ A risk-based vulnerability assessment identifies facilities with the most vulnerability to disruptions. Furthermore, risk considers both the probability that an asset will experience a particular impact and the severity or consequence of the impact.

In other words, the risk assessment combines asset vulnerability, the likelihood of the climate events occurring, and the consequences if the climate events were to occur.

FIGURE 9 | RISK ASSESSMENT COMPONENTS



Vulnerability

FHWA defines vulnerability as the degree to which a system is susceptible to, or unable to cope with adverse effects of extreme weather events. In the transportation context, extreme weather vulnerability is a function of a transportation system's exposure to extreme weather effects, sensitivity to extreme weather effects, and adaptive capacity. These three components of vulnerability are defined as follows:

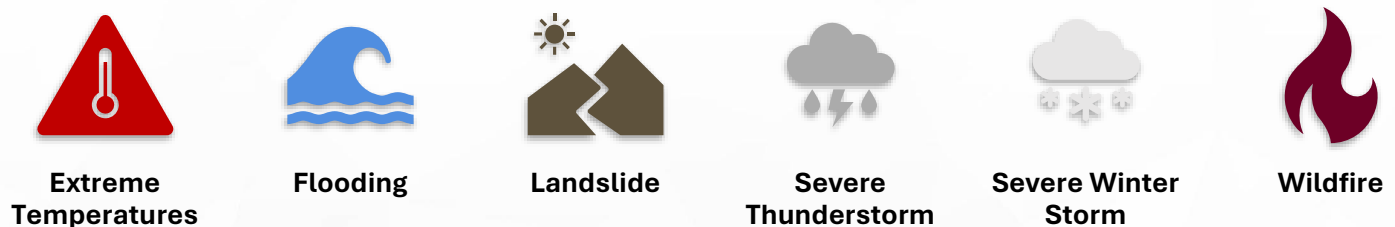
- **Exposure:** Identified whether an asset or system is located in an area experiencing direct effects of current or future extreme weather.
- **Sensitivity:** Refers to how the asset or system fares when exposed to the current or future extreme weather.

⁶ Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Notice of Funding Opportunity (NOFO) [Discretionary - PROTECT - Environment - FHWA \(dot.gov\)](https://www.fhwa.dot.gov/procurement/procurement-notice/2019/01/2019-01-01-PROTECT-Environment-FHWA-dot.gov)

- **Adaptive Capacity:** The degree to which the asset can adjust or mitigate damage or disruption caused by a hazard or threat.

GTC employed an indicator-based desk review approach to assess vulnerabilities across the following regional assets: Roads, Public bridges, and NYS Large Culverts. This vulnerability assessment approach provides a high-level overview of the potential future exposure and consequences of all six climatic hazards⁷ on transportation assets.

FIGURE 10 | GTC REGIONALLY SIGNIFICANT HAZARDS EVALUATED IN VULNERABILITY ASSESSMENT



Risk is calculated as a monetary value, with Figure 11 presenting the risk equation which relates (R) risk to (C) consequence, (V) vulnerability, and (T) likelihood.

FIGURE 11 | RISK EQUATION

$$Risk = C \times V \times T \quad \text{Equation 1}$$

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

For this assessment, **consequence** represents the cost to the owner in an event that the hazard damages an asset. The NYSDOT Transportation Asset Management Plan (TAMP), National Bridge Inventory (NBI) cost information, and NYSDOT Construction Opportunities bid tabulations were referenced to assign planning-level treatment costs for roads, bridges, and culverts. These costs reflect increasing levels of vulnerability, ranging from maintenance and minor preservation treatments to major rehabilitation or replacement.

Likelihood corresponds to the probability of a hazard event occurring in a given year. For hazards represented in the FEMA National Risk Index, county-level annualized frequency values were converted to annual probability and applied to current flooding, landslide, wildfire, severe thunderstorms, and severe winter storms. FEMA National Risk Index strong wind data were used as a proxy for severe thunderstorms, and winter weather data were used as a proxy for severe winter storms. For extreme heat, extreme cold, and future flooding, likelihood assumptions were informed by LOCA climate projections, NYSERDA and ClimAID projections. The risk assessment resulted in an estimated impact of each hazard on roadway, bridge, and culvert assets, with impacts ranging from minor

⁷ Dam failure was considered separately through the criticality assessment, by assigning higher health and safety importance to transportation assets that support access to dams and related emergency response functions.

maintenance needs to major repair or replacement costs. To estimate overall asset risk, hazard-specific results were combined and used to classify assets into low, medium, and high risk categories.

3.3 Asset Ranking Results

The final phase of the risk-based assessment involved asset ranking/prioritization, merging both risk assessment and criticality factors to identify roadway and bridge assets with varying vulnerability levels. This categorization, from high risk/high criticality to low risk/low criticality, helps pinpoint locations crucial for resilience projects. The prioritization approach considers both risk and criticality, categorizing assets into nine categories to distinctly highlight high, moderate, and low risk/criticality combinations. See Figure 12 for how risk and criticality combine to produce this asset ranking.

FIGURE 12 | ASSET RANKING MATRIX

Risk	High	5 High Risk Low Criticality	2 High Risk Moderate Criticality	1 High Risk High Criticality
		7 Moderate Risk Low Criticality	4 Moderate Risk Moderate Criticality	3 Moderate Risk High Criticality
		9 Low Risk Low Criticality	8 Low Risk Moderate Criticality	6 Low Risk High Criticality
	Low			
	Moderate			
	High			
	Criticality			

Assets with the highest risk and criticality are focused primarily in and around Monroe County, with additional priority segments distributed across Livingston, Ontario, Seneca, Wayne, and Yates Counties. These areas generally correspond to parts of the regional network with greater connectivity, higher travel demand, and access to key destinations and services. At the same time, these segments were also associated with relatively higher risk, reflecting greater consequence and likelihood compared to other roadway assets across the region.

APPROACH TO RESILIENCE ASSET RANKING IS MULTI-DIMENSIONAL

Some assets may have high hazard-related risk but limited regional function. Others may have moderate risk but provide critical access to communities, emergency services, or intercounty travel. Thus, the RIP combines risk and criticality to identify assets that are both vulnerable and important to the region.

There are 45 roadway segments that fall within the high-risk, high-criticality category. These segments are located in Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates Counties. In addition, there are 349 roadway segments that fall within the combined high-risk, moderate-criticality and moderate-risk, high-criticality categories. There are 835 roadway segments that fall within the moderate-risk, moderate-criticality category. These assets represent an additional set of priority segments that may need additional consideration in future planning, programming, and project development.

Bridges have 8 assets in the high-risk, high-criticality category, including bridges in Genesee, Monroe, Ontario, and Wayne. Culverts also have 40 assets in the high risk, high criticality category, including culverts in Livingston, Monroe, Ontario, Seneca, Wayne, Wyoming, and Yates.

FIGURE 13 | ASSET RANKING RESULTS, ROADWAYS

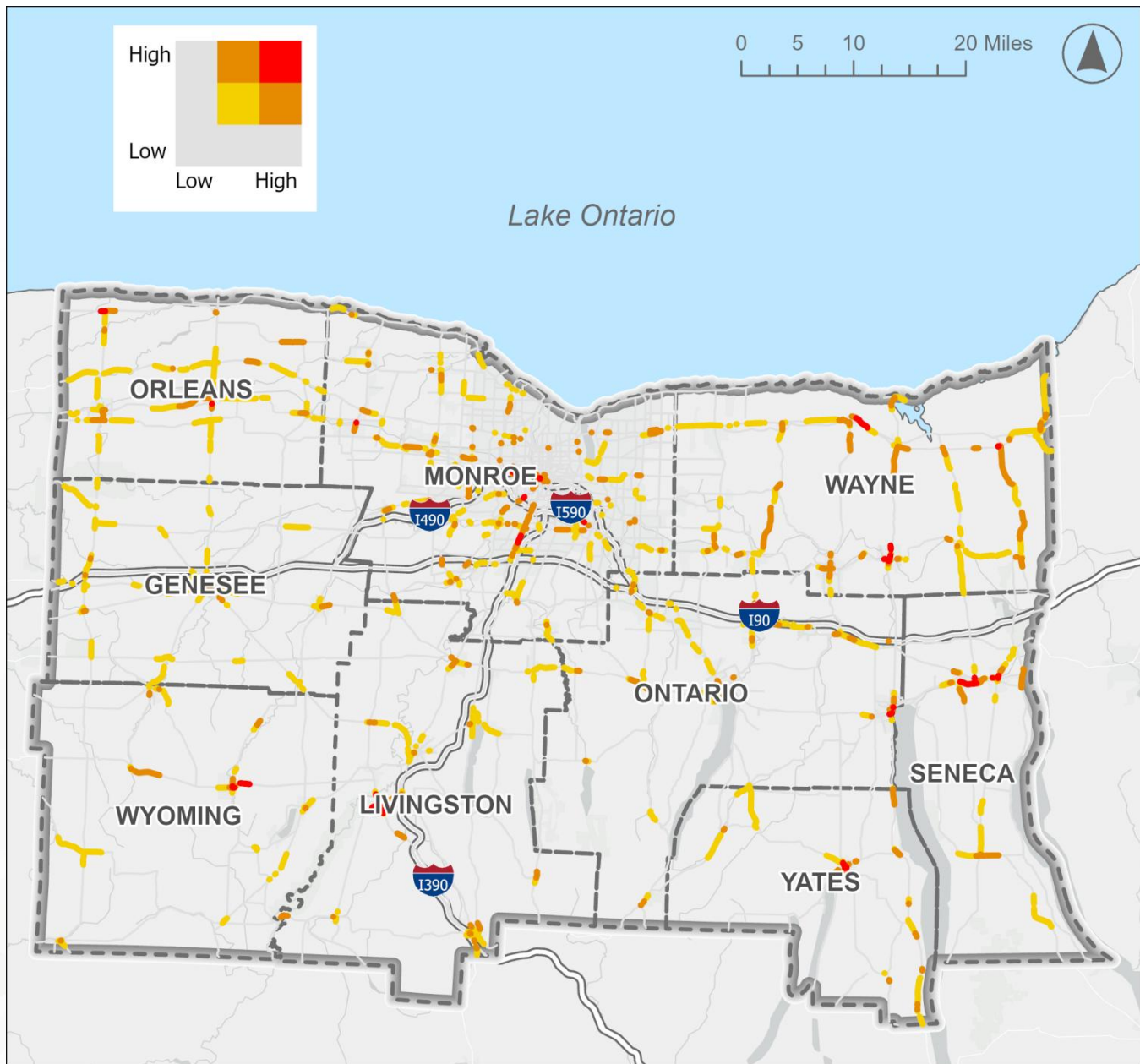


FIGURE 14 | ASSET RANKING RESULTS, BRIDGES

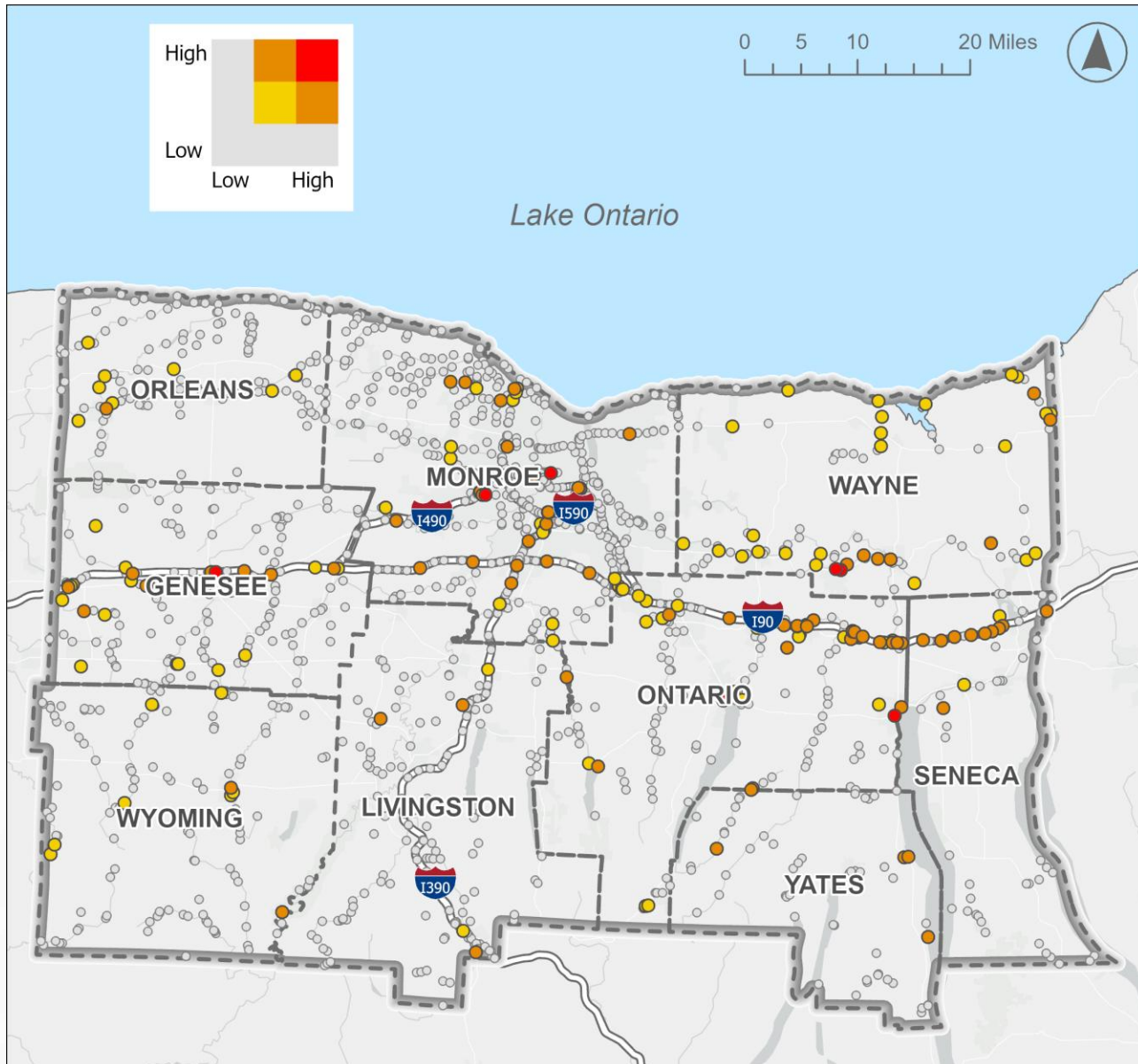
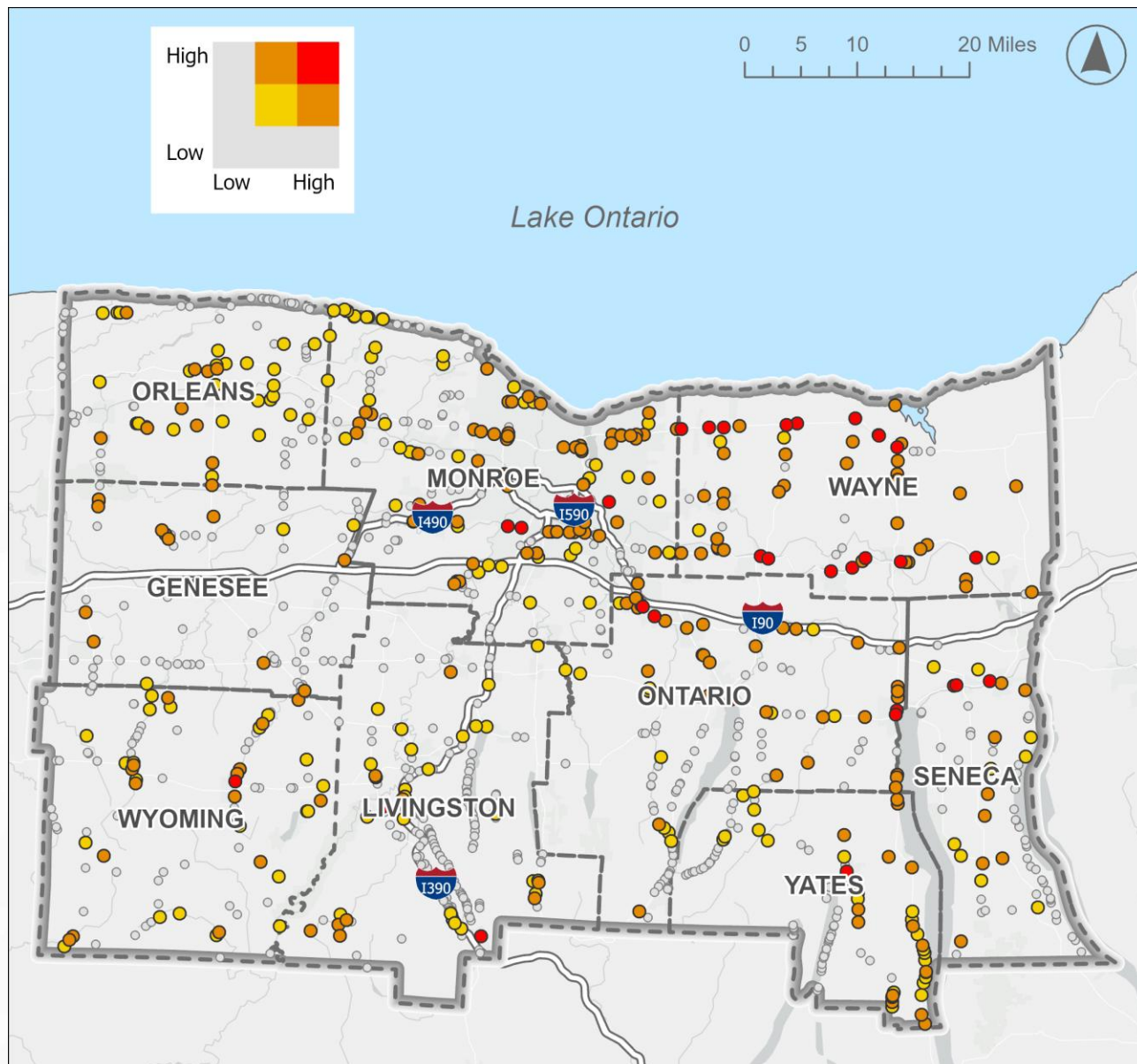


FIGURE 15 | ASSET RANKING RESULTS, CULVERTS



4. PRIORITY PROJECTS

Priority projects were identified through a GIS overlay of the region's existing Transportation Improvement Program (TIP) projects with roadway, bridge, and culvert assets classified through the RIP asset ranking as high priority. This screening was used to identify locations where planned investments intersect with assets exhibiting relatively high risk and criticality, as well as locations where no programmed projects are currently aligned with identified resilience needs.

The results of this overlay serve as a data-informed decision support tool to incorporate the RIP results into GTC's existing planning and programming framework. By comparing the high-priority RIP assets with planned TIP investments, the analysis helps identify opportunities where resilience considerations may already be advancing through programmed projects, as well as locations where additional resilience and adaptation strategies or project development are needed. The priority project list also indicates where planned investments may be well positioned for resilience funding opportunities.

Additional considerations, such as the type of improvement, project timing, scope, implementation cost, feasibility, and potential resilience benefit, will help determine the level of resilience need associated with each priority project. This screening supports the hazard mitigation and adaptation strategies in the following section. The resulting priority project list is provided in Appendix A.

5. HAZARD MITIGATION STRATEGIES

The strategy toolbox identifies planning, policy, operational, maintenance, natural infrastructure, and capital improvement strategies that GTC and its partners can use to reduce hazard impacts on transportation assets. The toolbox builds on the GTC region's 2016 Vulnerability Assessment and updates the strategy framework to address current and future weather events and natural disasters and reflect the results of the risk-based assessment, stakeholder input, and asset ranking developed as part of this effort.

The toolbox is organized in two tiers (Tier 1 and Tier 2) as follows:

- Tier 1 strategies outline general regional, programmatic, and policy actions that can be applied across multiple assets or jurisdictions.
- Tier 2 strategies detail project-specific actions that can be considered for priority roadway, bridge, and culvert locations identified through the asset ranking process.

The strategies are further divided in the following five mitigation categories to facilitate scanning and selection:

1. **Planning and Policy:** Plans, policies, regulations, and coordination processes that guide resilience actions and reduce development or infrastructure exposure in hazard-prone areas.
2. **Communication, Education, and Awareness:** Information-sharing tools and outreach efforts that help agencies, stakeholders, and the public understand hazards and take action before impacts occur.
3. **Infrastructure and Construction:** Physical improvements that strengthen, retrofit, protect, or relocate transportation assets to reduce damage from hazard events.
4. **Natural and Land Resource Protection:** Nature-based or land conservation actions that use floodplains, wetlands, buffers, open space, and other natural systems to reduce hazard impacts on transportation assets.
5. **Operations and Maintenance:** Routine inspection, maintenance, monitoring, and preparedness activities that help prevent or minimize hazard-related disruptions to the transportation system.

The strategy toolbox was developed using four sources of information:

- Existing hazard mitigation and resilience practices, including county and state hazard mitigation plans, as well as a systemic review of GTC's existing policies, procedures, manuals, tools, and guidance documents related to planning, communication, infrastructure, natural systems, operations, and maintenance.
- Prior GTC vulnerability assessments, including the 2016 Regional Vulnerability Assessment and the 2019 Local Bridge Vulnerability Assessment.
- RIP asset ranking results, prioritizing assets with higher combined risk and criticality.
- Stakeholder input, including feedback on local access, emergency response, detour limitations, and known flooding hotspots.

This toolbox maintains continuity with GTC's prior planning and assessment efforts, aligns with regional and state efforts, and ultimately ensures that the strategies are directly applicable for regional implementation.

5.1 Tier 1: Regional and Programmatic Strategies

Tier 1 strategies are regional, programmatic, or policy-oriented actions that can be applied across multiple assets, jurisdictions, or planning processes. These are broader actions that GTC, NYSDOT, counties, municipalities, and other partners can apply to embed infrastructure resilience into transportation procedures, programs, and investment decisions across the region. The strategies are intended to guide project scoping, future studies, maintenance priorities, local coordination, and funding decisions. Strategies are organized by general strategy category, consistent with GTC's existing mitigation strategy framework (2019 assessment). See Table 3, each strategy includes a brief description, potential lead and partner agencies, an estimated implementation timeline, and a relative cost range. Timeline and cost are planning-level indicators that can help with comparing actions and contextually identifying which strategies align with existing programs, future planning efforts, capital projects, or grant opportunities.

TABLE 3 | TIER 1 GENERAL STRATEGIES FOR REGIONAL AND PROGRAMMATIC RESILIENCE IMPROVEMENTS

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T1-1	Leverage RIP to secure PROTECT funding/additional resilience funding opportunities	- Identify and position priority assets and projects for future grant funding, including formula and discretionary PROTECT opportunities and other applicable federal or state funding sources. - Work with GTC member agencies/municipalities to identify additional resources and documents to assist with mitigation efforts.	GTC, NYSDOT, NYSTA, counties, municipalities	 Near	
T1-2	Maintain and update regional resilience data inventory and assessments	- Regularly maintain asset, hazard, criticality, risk, and project datasets to capture new asset condition data, hazard information, flood mapping, project information, and stakeholder input as they become available. - Work with appropriate agencies to maintain an updated and accurate mapping and assessment of hazards throughout the Genesee-Finger Lakes Region. - Collaborate regionally to standardize methodology and datasets, and provide technical assistance to municipalities conducting localized vulnerability and risk assessments. - Conduct downstream study of potential hazards resulting from failure of high hazard dams. - Support NYSDOT's program to assess a bridge's vulnerability to various modes of structural failure (scour, overloads, steel detail deficiencies, collision, concrete detail deficiencies, and earthquakes). - Support local municipalities in seeking funding to conduct more localized vulnerability assessments, as needed. - Create a consistent process for documenting closures, overtopping, washouts, debris issues, detour use, emergency access issues, maintenance costs, and repair needs after hazard events in order to update the RIP and refine priority project needs over time.	GTC, NYSDOT, counties, municipalities NYSTA, emergency management	 Ongoing	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T1-3	Establish criteria for advancing resilience needs into project development	- Develop a consistent process/criteria for determining when high-priority assets should advance as maintenance actions, planning studies, project scope additions, or capital projects, considering RIP asset ranking, feasibility, cost, and project readiness. - Establish policies that require hazard mitigation and adaptation strategies to be incorporated in capital improvements and public expenditures in known high hazard vulnerability areas.	GTC, NYSDOT, NYSTA, counties, municipalities	 Near	
T1-4	Strengthen interagency coordination	- Improve coordination among transportation, emergency management, law enforcement, public works, transit, and local agencies throughout the Genesee-Finger Lakes Region before hazard events occur. - Review mutual aid agreements and identify potential enhancements to support inter-municipal sharing of capabilities resource sharing, special equipment needs, and roles for emergency detours, closures, and recovery support. - Strengthen coordination between federal officials, State and local law enforcement officials, and local Emergency Management officials regarding the management of critical transportation assets prior to, during, and after a hazard event. - Adopt and enforce ordinances that protect stormwater retention and floodplain areas through regulations on development and land use.	GTC, NYSDOT, NYSTA, NYSOEM, RGRTA, county emergency management, county/local highway departments, law enforcement	 Near	
T1-5	Coordinate emergency detour and access planning	Review and document detour routes for critical corridors and single-point-of-failure assets, including locations where closures could affect emergency response, school access, freight movement, or intercounty travel. Include signed Thruway detours, local detour constraints, weight-restricted bridges, and known access limitations.	GTC, NYSDOT, NYSTA, counties, municipalities, emergency management	 Near to Mid	
COMMUNICATION, EDUCATION, AND AWARENESS					
T1-6	Align with other regional strategic plans such as the ITS, TSMO, and HMPs	- Implement ITS/TSMO strategies and tools to improve communication during closures and hazardous events. - Improve emergency preparedness and response using road closure alerts, variable message signs, traveler information systems, speed restrictions, detour information, and coordination between traffic operations and emergency management. - Encourage counties and municipalities to incorporate risk-based vulnerability assessment results from this RIP into considerations for local hazard mitigation plans, comprehensive plans, emergency response plans, capital improvement plans, stormwater plans, and floodplain management programs.	GTC, G/FLRPC, NYSDOT, NYSTA, Monroe County DOT, RGRTA, emergency management	 Near to Mid	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T1-7	Improve flood risk information and warning systems	- Monitor forecasts for severe weather and issue speed and travel restrictions on roadways that are historically impacted by various hazards. - Set up mobile informational systems to warn the traveling public of emergency situations. - Improve access to current flood risk information for local officials, transportation agencies, and the public through updated web maps, flood warning systems for frequently flooding waterways, and procedures for tracking high-water marks after events.	FEMA, USACE, NYSDEC, NYSOEM, GTC, counties, municipalities	 Mid	
T1-8	Develop a recurring resilience training and public outreach program	- Provide periodic training for local agencies on resilience planning, interpreting risk and criticality results, identifying resilience strategies, and incorporating resilience into project scoping. - Develop school curricula and public outreach materials to educate the public about resilience, adaptation, and hazard mitigation, including protocols and evacuation routes during emergencies and hazard events. - Educate property owners about keeping storm drains clear and securing debris and loose yard items that may be swept away during storms. - Encourage farmers to implement soil and water conservation practices including contour farming, cover cropping, and constructing windbreaks. - Ensure drivers of hazmat materials can easily obtain information on hazmat transport routing and any travel restrictions due to severe weather or other hazard events.	GTC, G/FLRPC, NYSDOT, NYSTA, counties, municipalities, DEM, NYS Police, NYSDEC, NYSDAM, County Soil & Water Conservation Districts	 Near to Ongoing	
NATURAL AND LAND RESOURCE PROTECTION					
T1-9	Protect and restore natural floodplain, wetland, and open-space functions	- Preserve or restore natural areas that can store floodwater, reduce runoff, slow flows, and reduce downstream impacts to transportation infrastructure through floodplain preservation, wetland restoration, spill areas, riparian buffers, and coordination with landowners or conservation partners. - Purchasing land or permanent easements to expand floodplain areas (create spill areas) in areas of little to no development to act as flood water retention to lessen the impact of flooding downstream in more developed areas.	NYSDEC, NYSDOT, NYSTA, counties, municipalities, G/FLRPC, landowners, conservation partners	 Long	
INFRASTRUCTURE AND CONSTRUCTION					

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T1-10	Develop critical facility resilience guidance	- Establish guidance for protecting transportation and emergency-response facilities, including highway garages, operations centers, emergency management facilities, police/fire facilities, traffic operations centers, communications equipment, generators, and fuel systems. Actions may include floodproofing, elevating mechanical/electrical equipment, backup power, anchoring fuel tanks, or relocation where needed. - For facilities in flood hazard areas, apply applicable flood-resistant design standards, including ASCE 24 Flood Resistant Design and Construction, in coordination with the 2025 NYS Uniform Fire Prevention and Building Code. - For facilities exposed to high-wind conditions, consider applicable wind-resistant design guidance, including ICC-600 Standard for Residential Construction in High-Wind Regions, where relevant and consistent with State and local code requirements. - For critical facilities in flood-prone areas, incorporate applicable floodplain management requirements, including Federal Executive Order 11988, local floodplain regulations, and elevation/freeboard requirements such as locating critical facilities at least one foot above the 500-year flood elevation where required or appropriate.	NYSDOT, NYSTA, RGRTA, counties, municipalities, emergency management, facility owners	 Mid to Long	

5.2 Tier 2: Project-Specific Strategies

Tier 2 strategies identify asset- and project-specific actions that can be applied to priority locations identified through the RIP asset ranking process. While Tier 1 strategies focus on regional programs and policies, Tier 2 strategies are intended to support project scoping, design, maintenance, capital programming, and future grant applications.

The Tier 2 tables are organized by hazard type and the following mitigation categories: Planning and Policy; Communication, Education, and Awareness; Operations and Maintenance; Natural and Land Resource Protection; and Infrastructure and Construction. For each priority asset, agencies can identify the primary hazard concern, review the relevant table, and select strategies that match the asset type, local context, feasibility, and funding opportunity.

TABLE 4 | DAM FAILURE AND FLOODING PROJECT-SPECIFIC STRATEGIES

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T2-DF-1	Confirm asset-level exposure and future risk before project scoping	- For priority assets located in flood-prone areas or near high-hazard dams, confirm the specific exposure, likely flow path, access impacts, and design assumptions before advancing a project. - Conduct a focused drainage, hydrologic, or hydraulic review to determine whether the existing asset can accommodate current and future flow conditions to determine whether the asset should be maintained, upsized, elevated, armored, or monitored.	GTC, Asset owner, dam owner/operator, NYSDEC, NYSDOT, counties, municipalities, emergency management, design engineers, Soil and Water Conservation Districts	 Near	
COMMUNICATION, EDUCATION, AND AWARENESS					
T2-DF-2	Install permanent closure and warning infrastructure at vulnerable crossings	For flash flood or dam failure hotspots, install permanent or pre-planned closure and warning features such as gates, barricade staging areas, flood-depth markers, warning signs, detour signs, or message boards that can be activated quickly during an emergency.	NYSDOT, NYSTA, county/local highway departments, municipalities, emergency management, law enforcement	 Near to Mid	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-DF-3	Add asset-specific monitoring at high-priority crossings	Where appropriate, install or connect water-level sensors, stream gauges, remote cameras, or alert systems at priority crossings downstream of high-hazard dams or in flooding hotspots. Ensure monitoring is linked to established closure, inspection, and notification procedures for rapid emergency management and response when water levels or dam conditions change drastically.	Dam owner/operator, NYSDEC, NYSOEM, county emergency management, NYSDOT, county/local highway departments	 Mid	
OPERATIONS AND MAINTENANCE					
T2-DF-4	Maintain drainage systems, ditches, culverts, and catch basins with debris and vegetation management	- Establish or reinforce routine inspection and cleaning of drainage ways, culverts, roadside ditches, catch basins, and underpasses, especially in flood-prone locations and ahead of seasonal storm periods. - Identify culverts that are undersized and/or inadequate/ failing to develop a prioritized list of culvert replacement projects for inclusion in an agency's Capital Improvement Program. - Reduce blockage and damage risks by routinely removing dead trees, branches, sediment, and debris near drainage features, culverts, stream crossings, bridge openings, and road shoulders. Include vegetation management where downed limbs, debris, or sediment can block flow, damage assets, or worsen flooding. - Conduct regular testing and maintenance of Emergency Response Systems, communication systems, and backup generators.	NYSDOT, NYSTA, county/local highway departments, NYSDEC	 Ongoing	
T2-DF-5	Establish post-event inspection and rapid recovery protocols for priority assets	Establish asset-specific post-event inspection and reopening procedures. Protocols should identify who inspects the asset, what conditions trigger closure or reopening, what debris or sediment removal may be needed, and what temporary repair materials or emergency contracts may be required to restore access.	NYSDOT, NYSTA, county/local highway departments, municipalities, bridge inspection teams, emergency management	 Near to Ongoing	
T2-DF-6	Develop a bridge scour and hydraulic monitoring program	Prioritize high-risk and high-criticality bridges for scour review, monitoring, and follow-on hydraulic assessment where needed.	NYSDOT, counties, municipalities	 Mid	
NATURAL AND LAND RESOURCE PROTECTION					

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-DF-7	Protect and restore natural floodplain, wetland, and open-space functions	- Consider site-specific natural system improvements including reconnecting floodplain areas, restoring riparian buffers, stabilizing eroding streambanks, creating flood storage, or removing local flow constrictions near the asset to mitigate erosion and downstream flooding. - Use bioengineered bank stabilization techniques such as deep rooting vegetation, live stakes, geotextile fabric, riprap, or vegetative walls. - Use a hybrid of hard/soft engineering techniques (i.e., combine low-profile rock, riprap, or wood structures with vegetative planting or other soft stabilization techniques).	NYSDEC, counties, municipalities, G/FLRPC, landowners, conservation partners, NYSDOT, NYSTA	 Long	
INFRASTRUCTURE AND CONSTRUCTION					
T2-DF-8	Incorporate green infrastructure and low-impact design into transportation projects	Encourage use of permeable pavement, rain gardens, bioswales, vegetated swales, and other stormwater practices where appropriate to reduce runoff, improve infiltration, and reduce flood impacts near transportation assets.	NYSDOT, NYSTA, counties, municipalities, NYSDEC	 Mid to Long	
T2-DF-9	Elevate or armor low-lying roadway segments and approaches	- Consider raising the roadway profile, armoring embankments, reinforcing shoulders, or using overtopping-resistant treatments. - Where raising the entire roadway or structure is not feasible, consider project-specific overflow or relief features that reduce damage during high-flow conditions, such as armored overflow sections, relief culverts, reinforced shoulders, or flood relief channels designs that allow water to pass with less damage to the transportation asset. - Install “V” shaped flow deflectors on or immediately upstream from the upstream sections of bridge piers and abutments to reduce flow velocities and protect footings from scouring. - Install bridge entrance and outlet wingwalls. Design wingwalls to redirect the flow into the bridge opening and eliminate erosion under the bridge piers, abutments, and embankment. Use flared wingwalls angled to coincide with the stream. - Armor inlets and outlets with stone fill. - Install shoulder subsurface perforated drains placed near the bottom of a gravel-filled, geotextile-lined ditch with pipes directed to catch basins at collection and discharge locations. - Improve subgrade using geotextile drainage blankets between the pavement section and subbase, for roadway strength and durability.	NYSDOT, NYSTA, county/local highway departments, municipalities, dam owner/operator NYSDEC, design engineers	 Mid to Long	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-DF-10	Increase hydraulic capacity and improve drainage at constrained culverts and drainage crossings	- Replace, upsize, or modify culverts and other constrained drainage crossings where dam failure-related flows could overtop the roadway, wash out the crossing, or block emergency access. - Install multiple culverts at an existing single culvert crossing site at either the same or at differing elevations or cross culverts to connect ditches to provide overflow capacity to handle high volume water flows. - At priority bridges exposed to flooding, evaluate whether the bridge opening, approach roadway, abutments, piers, or superstructure may need modification. - Construct an endwall, wingwalls, and/or flared end section at culvert openings to direct water flow into and out of the culvert and protect embankment slopes. - Install flow diverters (barbs) in the stream to redirect water flow to a preferred location. Design barbs to redirect the flow away from the embankment and into the culvert. - Installation of bar gates or trash racks at culvert openings to keep debris from entering the culvert. - Install debris deflectors around culverts to prevent debris buildup around culvert openings.	NYSDOT, NYSTA, county/local highway departments, municipalities, NYSDEC, asset owners	 Mid to Long	
T2-DF-11	Install scour, streambank, and channel stabilization countermeasures	- Use scour protection and stabilization treatments at bridges, culverts, and roadway embankments exposed to high-flow or erosive conditions, by using riprap, toe protection, articulated concrete blocks, retaining structures, vegetated stabilization, streambank repair, culvert aprons, baffle structures, or channel stabilization where needed to protect the transportation asset. - Alter the angle of an embankment slope through shoulder rounding and slope reduction to reduce erosion. Reducing the angle of slope generally reduces the velocity of the water running across it. - Increase tailwater depth by excavating a discharge pool or stilling basin to control turbulent flow at the culvert discharge.	NYSDOT, county/local highway departments, municipalities, NYSDEC, Soil and Water Conservation Districts	 Near to Mid	
T2-DF-12	Improve alternate access where flooding or dam failure could isolate communities or essential services	Where a flooding or dam failure could close a single access route or isolate residents, emergency services, schools, health care, or other essential destinations, evaluate proactive improvements to alternate routes (e.g., strengthening detour routes, improving turnarounds, adding emergency access connections, or upgrading local roads that may be needed during a closure.)	Counties, municipalities, NYSDOT, NYSTA, emergency management, school districts, public safety agencies	 Mid to Long	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-DF-13	Protect or relocate critical transportation equipment and system interdependencies in inundation areas	For critical transportation system interdependencies such as, traffic operations assets, ITS equipment, and mechanical/electrical equipment located near high-hazard dams or flood inundation zones, consider floodproofing, elevating, anchoring, protecting, or relocating vulnerable components to curb equipment failure that may affect emergency response, traffic operations, or disaster recovery.	NYSDOT, NYSTA, RGRTA, counties, municipalities, emergency management, facility owners		

TABLE 5 | EXTREME TEMPERATURES PROJECT-SPECIFIC STRATEGIES

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T2-ET-1	Confirm asset-level exposure and future risk before project scoping	- For priority assets exposed to extreme temperatures, confirm the specific exposure, appropriate resurfacing or maintenance schedule, and design assumptions before advancing a project. - Review pavement condition, bridge condition, drainage conditions, shaded or exposed locations, maintenance history, and known locations of pavement buckling, cracking, heaving, or accelerated deterioration.	GTC, Asset owner, NYSDEC, NYSDOT, counties, municipalities, design engineers		
COMMUNICATION, EDUCATION, AND AWARENESS					
T2-ET-2	Install asset-specific monitoring for temperature-sensitive locations	Consider monitoring pavement surface conditions, bridge expansion joints, bridge bearings, mechanical/electrical systems, or other temperature-sensitive components.	NYSDOT, NYSTA, counties, municipalities, facility owners		
OPERATIONS AND MAINTENANCE					

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-ET-3	Prioritize pavement preservation and maintenance on high-priority roads	- Apply pavement preservation treatments at high-priority roadway locations where extreme heat or freeze-thaw cycles may accelerate cracking, rutting, potholes, or surface deterioration. - Treat pavements using crack sealing, joint sealing, patching, resurfacing, surface treatments, or other preservation actions selected based on pavement condition and roadway function. - Establish maintenance procedures and material availability for responding to pavement buckling, potholes, heaving, cracking, or surface failures caused or worsened by extreme temperatures, especially where pavement damage could affect emergency access, freight movement, transit operations, or major regional travel routes.	NYSDOT, NYSTA, county/local highway departments	 Ongoing	
T2-ET-4	Maintain bridge joints, bearings, decks, and drainage features	- Inspect and maintain expansion joints, bearings, decks, scuppers, and drainage features that may be affected by thermal movement, freeze-thaw cycles, water intrusion, or deicing-related deterioration. - Focus on preventing water from entering bridge components and reducing damage from repeated expansion, contraction, freezing, and thawing.	NYSDOT, NYSTA, county/local highway departments, municipalities, bridge inspection teams, emergency management	 Near to Ongoing	
T2-ET-5	Address drainage issues that worsen freeze-thaw damage	Correct localized drainage problems that allow water to pond, infiltrate pavement layers, or freeze near the asset by cleaning drainage features, restoring ditch function, improving shoulder drainage, repairing underdrains, or correcting low spots that contribute to freeze-thaw deterioration.	NYSDOT, counties, municipalities	 Near to Ongoing	
NATURAL AND LAND RESOURCE PROTECTION					
T2-ET-6	Incorporate context-sensitive shade and vegetation near transportation assets	- Add or preserve roadside vegetation, tree canopy, or landscaped buffers near priority assets to reduce localized heat exposure, manage runoff, and improve comfort for pedestrians, bicyclists, transit users, and maintenance personnel. - Select and site trees/ vegetation to avoid sight distance issues, root damage, debris problems, or conflicts with drainage and maintenance operations. - Encourage installation of green roofs, which remove heat from the roof surface and surrounding air and also provide stormwater management.	Municipalities, counties, NYSDOT, NYSTA, RGRTA, NYSDEC, landowners	 Mid to Long	
INFRASTRUCTURE AND CONSTRUCTION					

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-ET-7	Incorporate temperature-resilient pavement materials and treatments	Consider pavement materials and treatments that are better suited to extreme heat, extreme cold, and freeze-thaw conditions, including modified asphalt binders, improved surface mixes, concrete pavement treatments, reflective or cool pavement treatments, and materials selected to reduce rutting, cracking, potholes, or thermal stress.	NYSDOT, NYSTA, county/local highway departments, municipalities, design engineers	 Mid to Long	
T2-ET-8	Improve pavement base, subbase, and underdrain systems	Consider reconstructing or improving the pavement base, subbase, underdrains, or subsurface drainage to reduce water infiltration, frost heave, cracking, and repeated maintenance needs where surface treatments alone are not sufficient.	NYSDOT, NYSTA, county/local highway departments, municipalities, design engineers	 Mid to Long	
T2-ET-9	Retrofit or replace bridge components affected by thermal movement and freeze-thaw cycles	- For priority bridges, consider replacing or retrofitting expansion joints, bearings, deck surfaces, approach slabs, drainage systems, or other components affected by thermal movement, water intrusion, freeze-thaw cycles, or deicing-related deterioration. - Coordinate resilience improvements with bridge inspection findings and planned rehabilitation or replacement projects.	NYSDOT, county/local bridge owners, municipalities, bridge engineers	 Mid to Long	
T2-ET-10	Protect transportation facilities and equipment from extreme temperatures	For transportation support facilities, traffic operations assets, signals, ITS equipment, communications infrastructure, generators, and mechanical/electrical systems, consider upgrades that reduce exposure to extreme heat or cold. Actions may include insulation, ventilation, HVAC improvements, backup power, weatherproof enclosures, equipment relocation, or protective housing for temperature-sensitive systems.	NYSDOT, NYSTA, RGRTA, counties, municipalities, facility owners, emergency management	 Mid to Long	
T2-ET-11	Add heat-mitigation features at transit stops and pedestrian access points	Where priority corridors include high-frequency transit stops, sidewalks, or pedestrian access to essential services, consider heat-mitigation features such as shade structures, shelters, tree canopy, reflective materials, seating, or other comfort and safety improvements, especially in urbanized areas, disadvantaged communities, and locations with high transit or pedestrian activity.	RGRTA, municipalities, counties, NYSDOT, and GTC	 Mid to Long	
T2-ET-12	Improve tolerance to extreme temperatures	- Reduce fleet-washing activities during drought conditions. - Encourage drought-tolerant landscape design, especially in areas where landscaping is designed to support slopes or provide stormwater management.	NYSDOT, NYSTA, NYSDEC, County and local jurisdictions	 Near to Ongoing	

TABLE 6 | LANDSLIDE PROJECT-SPECIFIC STRATEGIES

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T2-LS-1	Confirm asset-level exposure and future risk before project scoping	- For priority assets located near steep slopes, erodible soils, streambanks, embankments, or known landslide-prone areas, confirm the specific exposure, slope condition, drainage condition, and access impacts before advancing a project. - Review available landslide susceptibility data, geotechnical information, maintenance history, local reports of slope movement, and known locations of roadway settlement, shoulder loss, erosion, or embankment instability. - Conduct geotechnical and slope stability assessments at high-priority locations to determine the likely cause of instability and identify appropriate treatments. Assessments may include review of soils, groundwater, drainage, slope geometry, streambank erosion, retaining structures, and the condition of nearby roadway, bridge, or culvert infrastructure.	GTC, Asset owner, NYSDEC, NYSDOT, counties, municipalities, design engineers, geotechnical engineers		
COMMUNICATION, EDUCATION, AND AWARENESS					
T2-LS-2	Add monitoring at locations with recurring slope movement or erosion	Consider installing or formalizing monitoring procedures to include visual inspections, slope markers, survey points, remote cameras, crack tracking, erosion tracking, or other methods appropriate to the asset and hazard condition.	NYSDOT, NYSTA, counties, municipalities, bridge inspection teams, geotechnical engineers		
T2-LS-3	Install closure, warning, or restriction features at vulnerable slope locations	At asset locations where landslide could create unsafe travel conditions, install permanent or pre-planned warning and closure features. These may include warning signs, gates, barricade staging areas, reduced speed advisories, rockfall warning signs, or detour information for locations where failures could affect safe travel or emergency access.	NYSDOT, NYSTA, county/local highway departments, municipalities, emergency management, law enforcement		
OPERATIONS AND MAINTENANCE					
T2-LS-4	Maintain drainage systems that affect slope stability	Inspect and maintain ditches, culverts, underdrains, catch basins, slope drains, and outlet structures near priority assets where poor drainage could saturate soils, undermine slopes, or accelerate erosion. Maintenance should focus on keeping water away from vulnerable slopes, embankments, bridge approaches, and culvert outlets.	NYSDOT, NYSTA, county/local highway departments		

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-LS-5	Inspect and maintain retaining walls, embankments, and bridge approaches	Regularly inspect and maintain retaining walls, reinforced slopes, embankments, shoulders, bridge approaches, and roadway edges at priority locations. Maintenance should identify cracking, settlement, leaning walls, shoulder loss, erosion, blocked drains, or other early signs of slope instability before they lead to larger failures.	NYSDOT, NYSTA, county/local highway departments, municipalities, bridge inspection teams	 Ongoing	
T2-LS-6	Establish post-storm inspection and rapid response protocols for landslide-prone assets	For priority assets exposed to landslide, erosion, or slope failure risk, establish post-storm inspection and response procedures that include who inspects the asset, what conditions trigger closure or restrictions, what emergency stabilization materials may be needed, and how debris, sediment, or slope failures will be cleared or stabilized to restore access.	NYSDOT, counties, municipalities	 Near to Ongoing	
NATURAL AND LAND RESOURCE PROTECTION					
T2-LS-7	Stabilize erosion-prone slopes and streambanks using nature-based treatments where feasible	Where priority assets are affected by erosion, streambank migration, or shallow slope instability, consider vegetation-based or nature-based stabilization treatments including native vegetation, live staking, riparian buffer restoration, bioengineering, erosion control matting, floodplain reconnection, or streambank restoration to reduce erosion near the asset.	NYSDEC, Soil and Water Conservation Districts, counties, municipalities, landowners, conservation partners, asset owner	 Mid to Long	
INFRASTRUCTURE AND CONSTRUCTION					
T2-LS-8	Stabilize landslide, erosion, and slope hazard areas near transportation assets	- Implement structural or engineered stabilization treatments. Potential actions include slope regrading, retaining walls, soil nails, rock bolts, gabion walls, crib walls, mechanically stabilized earth walls, toe protection, riprap, slope benches, or reinforced embankments. - Strengthen and retrofit non-reinforced masonry transportation facility buildings and non-ductile concrete facilities that are vulnerable to ground shaking.	NYSDOT, NYSTA, county/local highway departments, municipalities, design engineers, geotechnical engineers, NYSDEC	 Mid to Long	
T2-LS-9	Improve stormwater drainage and subsurface drainage on vulnerable slopes	Where runoff, groundwater, or poor drainage contributes to landslide or erosion risk, incorporate drainage improvements into project design including interceptor ditches, underdrains, slope drains, drainage blankets, culvert outlet improvements, check dams, ditch lining, and stabilized drainage outlets that direct water away from vulnerable slopes and embankments.	NYSDOT, NYSTA, county/local highway departments, municipalities, design engineers, geotechnical engineers	 Mid to Long	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-LS-10	Protect bridge and culvert approaches from erosion and slope failure	At priority bridges and culverts, protect approaches, abutments, wingwalls, outlets, and adjacent embankments from erosion or slope instability by applying approach reconstruction, wingwall repair or replacement, outlet armoring, headwalls, toe protection, slope paving, vegetated stabilization, riprap, or retaining structures.	NYSDOT, county/local bridge owners, municipalities, NYSDEC, Soil and Water Conservation Districts, design engineers	 Mid to Long	
T2-LS-11	Use rockfall protection or debris-control measures where applicable	- Where priority assets are located below steep rock slopes or areas with debris movement risk, consider rockfall or debris-control treatments. Potential actions include catchment ditches, rockfall fencing, mesh, scaling, rock bolts, barriers, debris racks, or other treatments based on site-specific geotechnical review. - Install catch-fall nets for prone landslide areas and at steep slopes near roadways	NYSDOT, NYSTA, counties, municipalities, geotechnical engineers, design engineers	 Mid to Long	
T2-LS-12	Relocate, realign, or remove infrastructure from high-risk landslide areas where stabilization is not practical	Where repeated slope movement, erosion, or geotechnical constraints make stabilization impractical or cost-prohibitive, evaluate relocating, realigning, or removing vulnerable infrastructure from the hazard area. This may include roadway realignment, relocation of facility components, removal of unused infrastructure, or conversion of the area to open space or stabilized natural area where appropriate.	NYSDOT, NYSTA, counties, municipalities, NYSDEC, landowners, design engineers	 Long	

TABLE 7 | SEVERE THUNDERSTORM PROJECT-SPECIFIC STRATEGIES

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T2-ST-1	Confirm asset-level exposure and future risk before project scoping	Review local history of high winds, intense rainfall, lightning, hail, downed trees, debris blockage, power outages, traffic signal outages, drainage issues, and short-duration closures that may affect the asset.	GTC, asset owner, NYSDOT, NYSTA, counties, municipalities, emergency management, design engineers	 Near	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-ST-2	Incorporate severe storm resilience into project design assumptions	Consider whether design assumptions should account for intense rainfall, high winds, debris loading, short-duration flooding, lightning, hail, and loss of power or communications. This may include reviewing stormwater capacity, roadside clear zones, overhead signs, signals, ITS equipment, lighting, facility systems, and emergency access needs during project scoping and design.	NYSDOT, NYSTA, counties, municipalities, RGRTA, design engineers, emergency management	 Near to Mid	
COMMUNICATION, EDUCATION, AND AWARENESS					
T2-ST-3	Install closure and warning infrastructure at storm-prone locations	- At asset locations that may become unsafe during severe thunderstorms, install permanent or pre-planned closure and warning features such as warning signs, gates, barricade staging areas, flood-depth markers, detour signs, message boards, or other features that can be activated quickly during high winds, heavy rain, or storm-related closures. - Where appropriate, install or connect cameras, water-level sensors, wind sensors, road weather information systems, or signal/ITS status monitoring at priority locations, linked to inspection, closure, notification, and response procedures so agencies can respond quickly when severe storm conditions occur.	NYSDOT, NYSTA, county/local highway departments, municipalities, emergency management, law enforcement	 Near to Mid	
OPERATIONS AND MAINTENANCE					
T2-ST-4	Prioritize pre-storm inspection and clearing at storm-sensitive assets	Before forecasted severe storm periods, inspect and clear drainage features, culverts, ditches, catch basins, bridge openings, and known debris collection points at priority assets, especially at locations where intense rainfall, debris, or blocked drainage can quickly create unsafe roadway conditions or interrupt emergency access.	NYSDOT, NYSTA, county/local highway departments, municipalities	 Near to Ongoing	
T2-ST-5	Formalize tree, debris, and vegetation management near vulnerable corridors	Reduce severe storm impacts by removing dead or unstable trees, managing overhanging limbs, clearing sediment and debris, and maintaining roadside vegetation near priority asset locations.	NYSDOT, NYSTA, county/local highway departments, municipalities, utility providers, NYSDEC	 Ongoing	
T2-ST-5	Inspect and maintain signs, signals, lighting, and overhead assets	Regularly inspect and maintain traffic signals, sign structures, lighting, overhead signs, poles, cabinets, and related equipment that may be damaged by high winds, hail, lightning, or debris. Maintenance should focus on reducing failure risk and improving restoration time after storm events.	NYSDOT, NYSTA, counties, municipalities, traffic operations agencies, utility providers	 Ongoing	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-ST-6	Establish post-storm inspection and rapid response protocols for priority assets	For priority assets exposed to landslide, erosion, or slope failure risk, establish post-storm inspection and response procedures that include who inspects the asset, what conditions trigger closure or restrictions, what emergency stabilization materials may be needed, and how debris, sediment, or slope failures will be cleared or stabilized to restore access.	NYSDOT, NYSTA, county/local highway departments, municipalities, emergency management, law enforcement, utility providers	 Near to Ongoing	
NATURAL AND LAND RESOURCE PROTECTION					
T2-ST-7	Use site-specific vegetation and stabilization treatments to reduce storm impacts	- Where thunderstorms contribute to erosion, debris movement, or localized runoff near priority assets, consider site-specific vegetation, stabilization, or natural drainage treatments. Potential actions include vegetated swales, riparian buffers, erosion control plantings, and stabilized outlets - Consider context-sensitive vegetation management that reduces runoff and debris while avoiding sight distance and maintenance conflicts. - Construct windbreaks along critical roadways, in the form of fences or “living windbreaks” which can include rows of trees or other vegetation to limit blowing and drifting snow on roadways	NYSDEC, Soil and Water Conservation Districts, counties, municipalities, landowners, conservation partners, asset owner	 Mid to Long	
INFRASTRUCTURE AND CONSTRUCTION					
T2-ST-8	Improve stormwater drainage capacity at priority locations	Consider drainage improvements that increase capacity and reduce roadway overtopping or localized flooding, including upsizing culverts, adding relief culverts, improving inlets and outlets, restoring ditch capacity, adding underdrains, improving shoulders, or modifying storm sewer systems where needed.	NYSDOT, NYSTA, county/local highway departments, municipalities, design engineers, NYSDEC	 Mid to Long	
T2-ST-9	Harden traffic signals, ITS, lighting, and communications equipment	- Retrofit or replace storm-sensitive electrical and communications equipment to reduce damage from lightning, high winds, hail, water intrusion, or power disruption using weatherproof cabinets, surge protection, stronger poles or mast arms, backup power, communications redundancy, and elevated or protected equipment placement. - Construct or retrofit critical transportation facilities to avoid the use of flat or low pitch roofs, especially in areas prone to lake effect snow.	NYSDOT, NYSTA, counties, municipalities, Monroe County DOT, RGRTA, utility providers, traffic operations agencies	 Mid to Long	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-ST-10	Use wind-resistant design for signs, signals, lighting, and overhead structures	For priority locations exposed to high winds, consider wind-resistant design or retrofits for overhead signs, signal supports, lighting poles, traffic control devices, and related roadside infrastructure.	NYSDOT, NYSTA, counties, municipalities, design engineers, traffic operations agencies	 Mid to Long	
T2-ST-11	Protect transportation facilities and equipment from severe storm impacts	- Consider upgrades that reduce critical transportation equipment exposure to wind, hail, lightning, water intrusion, and power disruption, such as roof or envelope improvements, backup power, surge protection, equipment anchoring, drainage improvements, weatherproof enclosures, or relocation of vulnerable components. - Retrofit existing traffic lights to withstand high winds. - Convert traffic lights to mast arms where possible	NYSDOT, NYSTA, RGRTA, counties, municipalities, facility owners, emergency management, utility providers	 Mid to Long	
T2-ST-12	Improve alternate access and temporary traffic control for storm-prone closures	- Where severe thunderstorms could close a priority roadway, bridge, underpass, or intersection, evaluate targeted improvements to alternate routes and temporary traffic control plans. - Consider improving detour route readiness, addressing constraints on alternate routes, staging temporary signs or barricades, improving turnarounds, or upgrading local roads that may be needed during storm-related closures.	Counties, municipalities, NYSDOT, NYSTA, emergency management, law enforcement, public safety agencies	 Long	

TABLE 8 | SEVERE WINTER STORM PROJECT-SPECIFIC STRATEGIES

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T2-SW-1	Confirm asset-level exposure and future risk before project scoping	Review local history of winter weather and storms to pinpoint the specific winter issue before advancing a project. This may include recurring bridge deck icing, blowing or drifting snow, refreeze at low spots, limited plow access, insufficient snow storage, steep grades, poor visibility, blocked shoulders, or access limitations during winter closures.	GTC, asset owner, NYSDOT, NYSTA, counties, municipalities, emergency management, design engineers	 Near	
T2-SW-2	Design projects to support snow and ice control operations	During project scoping and design, account for how the asset will be maintained during winter storms. Consider plow turnarounds, shoulder width, pull-off areas, snow storage, sight distance, intersection geometry, steep grades, drainage/refreeze locations, and maintenance vehicle access.	NYSDOT, NYSTA, counties, municipalities, county/local highway departments, design engineers	 Near to Mid	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
COMMUNICATION, EDUCATION, AND AWARENESS					
T2-SW-3	Use targeted winter condition data at recurring problem locations	- Use existing RWIS, traffic camera, weather forecast, pavement condition, maintenance, and closure data to identify priority locations with recurring bridge deck icing, black ice, blowing snow, poor visibility, or refreeze concerns. - Where existing data is insufficient and the location has a documented safety or operational need, consider targeted monitoring such as pavement temperature sensors, bridge deck sensors, cameras, or wind/visibility sensors. - At locations with recurring winter closures or icing, install warning or closure features such as bridge icing warning signs, variable message signs, flashing beacons, reduced speed advisories, closure gates, barricade staging areas, or pre-planned detour signs.	NYSDOT, NYSTA, county/local highway departments, municipalities, emergency management, law enforcement	 Near to Mid	
OPERATIONS AND MAINTENANCE					
T2-SW-4	Prioritize snow and ice control on critical access routes	Where snow and ice control is especially important for emergency response, transit, freight movement, access to hospitals and schools, and intercounty travel adjusting plowing priorities, anti-icing practices, salt/material staging, staffing plans. Also ensure cross-jurisdictional coordination where priority routes cross agency boundaries.	NYSDOT, NYSTA, county/local highway departments, municipalities, RGRTA, emergency management	 Ongoing	
T2-SW-5	Fix drainage and snowmelt conditions that create refreeze hazards	At priority assets, improve drainage conditions that allow water to pond and refreeze, employing appropriate actions such as cleaning bridge scuppers, restoring ditches, repairing underdrains, correcting low spots, improving shoulder drainage, and keeping snow storage away from drainage pathways.	NYSDOT, NYSTA, county/local highway departments, municipalities	 Near to Ongoing	
T2-SW-6	Manage snow storage where it affects safety, access, or drainage	Adjust snow removal, hauling, shoulder clearing, and storage practices where piled snow blocks sight distance, narrows travel lanes, blocks sidewalks, or stops, limits emergency access, obstructs drainage, or creates refreeze hazards affect reliability or safety.	NYSDOT, NYSTA, county/local highway departments, municipalities, RGRTA	 Ongoing	
T2-SW-7	Strengthen winter preparedness for maintenance facilities and priority routes	For maintenance facilities serving priority routes, confirm that salt storage, brine systems, fuel access, generators, vehicle storage, communications, and access roads can function during severe winter storms.	NYSDOT, NYSTA, counties, municipalities, facility owners, emergency management	 Near to Mid	
NATURAL AND LAND RESOURCE PROTECTION					

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-SW-8	Use snow fences or living windbreaks at recurring drifting snow locations	- Where priority corridors experience recurring blowing or drifting snow, consider structural snow fences, living snow fences, or vegetation windbreaks. - Consider context-sensitive vegetation management that reduces runoff and debris while avoiding sight distance and maintenance conflicts. - Construct windbreaks along critical roadways, in the form of fences or “living windbreaks” which can include rows of trees or other vegetation to limit blowing and drifting snow on roadways	NYSDOT, NYSTA, counties, municipalities, Soil and Water Conservation Districts, landowners	 Mid to Long	
INFRASTRUCTURE AND CONSTRUCTION					
T2-SW-9	Reduce bridge deck icing and winter-related bridge deterioration	At priority bridges with recurring icing, refreeze, or deicing-related deterioration, consider targeted improvements such as bridge deck sealing, joint repair, scupper improvements, approach drainage improvements, deck overlays, or bridge deck monitoring.	NYSDOT, county/local bridge owners, municipalities, bridge inspection teams, design engineers	 Mid to Long	
T2-SW-10	Winterize equipment needed for traffic operations and emergency response	- Protect traffic signals, ITS equipment, lighting, communications equipment, fuel systems, and generators from snow and ice using weatherproof cabinets, protected conduits, communications redundancy, and improved access for repairs during storms. - Construct or retrofit critical transportation facilities to avoid the use of flat or low pitch roofs, especially in areas prone to lake effect snow.	NYSDOT, NYSTA, counties, municipalities, Monroe County DOT, RGRTA, utility providers, traffic operations agencies	 Mid to Long	

TABLE 9 | WILDFIRE PROJECT-SPECIFIC STRATEGIES

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
PLANNING AND POLICY					
T2-WF-1	Confirm asset-level exposure and future risk before project scoping	Review emergency access needs, detours, proximity to critical facilities, and whether the asset would support evacuation, fire response, or recovery operations.	GTC, asset owner, NYSDOT, NYSTA, counties, municipalities, emergency management, design engineers	 Near	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
T2-WF-2	Coordinate emergency access and closure planning for wildfire-prone locations	Confirm emergency access, staging areas, turnaround locations, detour routes, and closure procedures.	Counties, municipalities, NYSDOT, NYSTA, emergency management, fire departments, law enforcement, park/land managers	 Near	
COMMUNICATION, EDUCATION, AND AWARENESS					
T2-WF-3	Add targeted warning and closure features where wildfire could affect safe travel	- At asset locations where wildfire, smoke, emergency response activity, or roadside fire conditions could affect safety, consider warning and closure features such as fire danger signs, smoke/visibility warning signs, closure gates, barricade staging areas, detour signs, or variable message signs. - Use existing traffic cameras, weather data, road closure systems, and emergency communications to support situational awareness during wildfire or brush fire events.	NYSDOT, NYSTA, county/local highway departments, municipalities, emergency management, fire departments, law enforcement	 Near to Mid	
OPERATIONS AND MAINTENANCE					
T2-WF-4	Manage roadside vegetation and combustible debris near priority assets	At priority wildfire locations consider removing dead vegetation, clearing brush, maintaining shoulders, managing overgrown rights-of-way, and removing debris near structures, signs, guardrail, culverts, utility poles, and equipment cabinets.	NYSDOT, NYSTA, county/local highway departments, municipalities, NYSDEC, utility providers, landowners	 Ongoing	
T2-WF-5	Maintain emergency access, shoulders, and turnarounds for fire response	At priority locations where fire response access may be constrained, maintain shoulders, access roads, gates, pull-offs, and turnaround areas so emergency vehicles can reach affected areas and operate safely.	Counties, municipalities, NYSDOT, NYSTA, fire departments, emergency management, park/land managers	 Ongoing	
NATURAL AND LAND RESOURCE PROTECTION					
T2-WF-6	Create defensible space around transportation facilities and equipment	- Around priority transportation facilities, traffic operations assets, communications equipment, fuel systems, generators, and other critical support infrastructure, maintain defensible space where wildfire or brush fire exposure is present. - Consider vegetation treatments that reduce fire risk such as selective thinning, mowing, fuel breaks, native low-flammability plantings, or coordinated vegetation management with adjacent landowners.	NYSDEC, Soil and Water Conservation Districts, counties, municipalities, landowners, conservation partners, asset owner	 Near to Mid	

ID	Strategy	Description	Lead / Partners	Timeline	Relative Cost
INFRASTRUCTURE AND CONSTRUCTION					
T2-WF-7	Protect transportation facilities and equipment from fire, smoke, heat, and power disruption	- For priority transportation facilities, traffic signals, ITS equipment, communications infrastructure, generators, fuel systems, and mechanical/electrical equipment with wildfire exposure, consider protective upgrades that reduce damage and support continuity during fire events. Actions may include weatherproof or fire-resistant enclosures, backup power, protected conduits, equipment relocation, ventilation/filtration improvements, or vegetation clearance around equipment. - Consider fire-resistant or less combustible materials during asset repair, replacement, or rehabilitation. This may include fire-resistant signposts or poles, protected utility/communications conduits, non-combustible facility materials, or replacement of vulnerable timber or combustible components where appropriate.	NYSDOT, NYSTA, county/local highway departments, municipalities, design engineers, NYSDEC	 Mid to Long	
T2-WF-8	Improve access and water availability for emergency response where transportation assets support fire operations	Where a priority transportation asset supports access to wooded areas, parks, rural communities, or critical facilities with wildfire exposure, consider targeted improvements that support emergency response. Potential actions include access road improvements, turnarounds, pull-offs, gated access coordination, hydrant or water access coordination, and staging areas for fire apparatus where appropriate	Counties, municipalities, NYSDOT, NYSTA, fire departments, emergency management, park/land managers, water authorities	 Mid to Long	

APPENDIX A. PRIORITY PROJECT LIST

PIN	Project Name	TIP Project Description	Criticality, Risk	Potential Resilience Improvements to Consider ⁸
ROADS				
401553	Rt 15 from Rt 253 to Rt 252	This project will repave Rt. 15 from Rt. 253 to Rt. 252 in the Town of Henrietta, Monroe County, to extend the surface life of the pavement.	High Criticality, High Risk	Flooding, Extreme Heat, Winter Weather Mitigation
40C101	Rt 31 from I-590 to the Vil of Pittsford (WL)	This project will repave Rt. 31 from I-590 to the Village of Pittsford (western line) to extend the surface life in the Towns of Pittsford and Brighton, Monroe County.	High Criticality, High Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
401450	Rt 14 from Rt 31 to the Former Village of Lyons (North VL)	This project will repave and provide improvements to the sidewalk and signal networks along Rt. 14 within the limits of the former Village of Lyons, in the Town of Lyons, Wayne County.	High Criticality, High Risk	Landslide, Extreme Heat, Winter Weather Mitigation
428613	Rt 286 from City of Rochester to Qualtrough Rd	This project will repave Rt. 286 from the City of Rochester to Qualtrough Road to extend the surface life in the Town of Penfield, Monroe County.	Moderate Criticality, High Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
403967	Vil of Arcade, Roadway Project	This project will repave Rt. 39 and Rt. 98 in the Town and Village of Arcade, Wyoming County, to extend the service life of the roadway.	Moderate Criticality, High Risk	Flooding, Extreme Heat, Winter Weather Mitigation
400578	Rte. 5, 33, 63, & 98 in the city of Batavia preventative main	This project will repave Rt. 5, 33, 63, and 98 in the City and Town of Batavia, Genesee County.	High Criticality, Moderate Risk	Flooding, Extreme Heat, Winter Weather Mitigation
410496	Rt 104 from Irondequoit Bay Bridge to Five Mile Line Rd	This project will repave Rt. 104 from the Irondequoit Bay Bridge to Five Mile Line Road in the Towns of Irondequoit and Webster, Monroe County.	High Criticality, Moderate Risk	Flooding, Extreme Heat, Winter Weather Mitigation
401547	Rt 15 from Jefferson rd. to I-390 corridor safety enhancement	This project will enhance the Rt. 15 corridor from Jefferson Road to I-390 in the Towns of Brighton and Henrietta, Monroe County.	High Criticality, Moderate Risk	Flooding, Extreme Heat, Winter Weather Mitigation
476153	North Main Street Reconstruction, Village of Newark	This project will reconstruct North Main Street within the limits of the Village of Newark, Wayne County.	High Criticality, Moderate Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation

⁸ Refer to Chapter 5 for detailed strategies by hazard.

PIN	Project Name	TIP Project Description	Criticality, Risk	Potential Resilience Improvements to Consider ⁸
410D02	Rt 104 from Rt 250 to the Wayne County Line Preventive Main	This project will repave Rt. 104 from Rt. 250 to the Wayne County line in the Town of Webster, Monroe County.	High Criticality, Moderate Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
401556	Rt 15a from Rt 252 to Erie canal	This project will repave Rt. 15A from Rt. 252 to the Erie Canal in the Towns of Brighton and Henrietta, Monroe County.	Moderate Criticality, Moderate Risk	Extreme Heat, Flooding, Winter Weather Mitigation
476150	Big tree rd. pedestrian improvement project (Livonia)	This project will improve the sidewalks, crosswalks, curbing, and drainage infrastructure on Big Tree Road from West Lake Road to Rochester Road in the Town of Livonia, Livingston County.	Moderate Criticality, Moderate Risk	Flooding, Extreme Cold, Extreme Heat Mitigation
4V2651	Rt 98 from Rt 104 to Lake Ontario state parkway	This project will repave Rt. 98 from Rt. 104 to the Lake Ontario State Parkway in the Towns of Gaines and Carlton, Orleans County.	Moderate Criticality, Moderate Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
4V2671	Rt 78 from Wyoming/Erie Cl to east end of Rt 98/77 overlap	This project will repave Rt. 78 from the Wyoming/Erie County line to the eastern end of the Rt. 98/NY-77 overlap in the Towns of Sheldon and Java, Wyoming County.	Moderate Criticality, Moderate Risk	Winter Weather, Extreme Heat, Extreme Cold Mitigation
4V2611	Rt 98 from Edgerton rd. to orl cl and Rt 262 from Rt 63 to Rt 98	This project will repave Rt. 98 from Edgerton Road to the Orleans County line, and Rt. 262 from Rt. 63 to Rt. 98, in the Towns of Oakfield and Elba, Genesee County.	Moderate Criticality, Moderate Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
4V2661	Rt 104 from furnace rd. to pound rd.	This project will repave Rt. 104 from Furnace Road to Pound Road in the Towns of Ontario and Williamson, Wayne County.	Moderate Criticality, Moderate Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
CULVERTS				
4LC104	Culvert Replacement at Various Locations	This project will deliver seven large culvert replacements in Livingston, Monroe, Wayne, and Ontario Counties. CINs: C480008, C430048, C450010, C440060, C420064, C075808, and C440017.	High Criticality, High Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
4LC105	Culvert Replacement/Rehab at Various Locations in Livingston	Culvert replacement/rehabilitation at various locations in Livingston, Monroe, and Wayne Counties. CINs: CA00240, C420086, C430032, C440072, C480006, C480009. This project complies with the PROTECT funding eligibility matrix.	High Criticality, Moderate Risk	Flooding, Extreme Heat, Extreme Cold Mitigation
4LC101	Culvert Replacement at Various Locations in Livingston and	This project will replace culverts at various locations in Livingston and Wyoming Counties. CINs: C420015, C420020, C420105, C420117, C470013, C470014.	Moderate Criticality, Moderate Risk	Extreme Heat, Winter Weather, Extreme Cold Mitigation
BRIDGES				

PIN	Project Name	TIP Project Description	Criticality, Risk	Potential Resilience Improvements to Consider ⁸
40N014	Ontario County Bridge Preventative Maintenance	Conduct preventive maintenance on three bridges in the Towns of Phelps and Victor, Ontario County.	Moderate Criticality, High Risk	Flooding, Winter Weather, Extreme Heat Mitigation
40R008	Orleans County Bridge Preventive Maintenance No. 2	Conduct preventive maintenance on nine bridges in the Towns of Carlton, Murray, Kendall, and Shelby, Orleans County.	Moderate Criticality, Moderate Risk	Winter Weather, Extreme Heat, Extreme Cold Mitigation

APPENDIX B. STAKEHOLDER LIST

As part of the RIP development process, GTC contacted regional stakeholders to review draft materials and provide local input on transportation resilience needs. The project team appreciates the time and feedback provided by these stakeholders, which helped ground the analysis in local knowledge and strengthen the final plan recommendations.

County/Area	Stakeholder Agencies/Offices Engaged
Genesee County	Genesee County Planning Department; Genesee County Department of Public Works; Genesee County Office of Emergency Management
Livingston County	Livingston County Highway Department; Livingston County Planning Department; Livingston County Office of Emergency Management
Monroe County	Monroe County Department of Transportation; Monroe County Planning Department; Monroe County Office of Emergency Management
Ontario County	Ontario County Department of Public Works; Ontario County Planning Department; Ontario County Office of Emergency Management
Orleans County	Orleans County Emergency Management; Orleans County Planning Department; Orleans County Department of Public Works
Seneca County	Seneca County Highway Department; Seneca County Planning Department; Seneca County Office of Emergency Management
Wayne County	Wayne County Highway Department; Wayne County Planning Department; Wayne County Emergency Management
Wyoming County	Wyoming County Highway Department; Wyoming County Office of Emergency Management; Wyoming County Planning Department
Yates County	Yates County Highway Department; Yates County Planning Department; Yates County Office of Emergency Management
City of Rochester	City of Rochester Department of Environmental Services/City Engineer; City of Rochester Office of Emergency Management; City of Rochester Planning Department
NYSDOT Region 4	New York State Department of Transportation, Region 4