

### 3.3: Transportation System Resiliency

#### Introduction

Resiliency is a process for managing complex infrastructures rather than a single outcome. It is a cradle-to-grave process for engineering, building, and operating a fault-tolerant, safe, secure, smart, efficient, and sustainable transportation infrastructure system. Resiliency is a risk-based and life-cycle process for addressing the vulnerabilities of critical infrastructure systems, making the system work smarter and better able to adapt to unexpected challenges. Resiliency is not just about a post-disaster capability for rapid recovery. Nor is resiliency only about protecting assets. Resiliency is derived from the fundamental principles of layered defense and risk mitigation. As such, a resiliency framework takes an adaptive life-cycle approach to tackling the dynamic challenges that confront today's complex infrastructure systems. Embedded in it is the capability to protect its assets, anticipate and detect threats, prevent risks of known failures, withstand unanticipated disruptions, and respond and recover rapidly when the worst does happen.

NOACA is working to integrate strategies into the planning process to be more resilient in the face of a changing climate. As the region adjusts to increasingly extreme weather events, stress on public facilities, and higher costs of services, there is growing need not only to plan for these events, but also to reduce the affects through resilience planning. Moreover, resiliency should also incorporate reducing green house gas (GHG) emissions to minimize their contribution to climate change.

Extreme weather, hurricanes, tropical storms, and prolonged intense temperatures have heightened awareness of a changing climate. Even for those who are skeptical about the long-term effects of this change, there is strong evidence to suggest that these extreme weather events are occurring more frequently, with the need for state transportation agencies to respond to the aftermath. Over the longer term, the latest climate modeling projects the climate to change at an increasingly rapid pace over the coming decades. Such change will likely alter both long-term climatic averages and the frequency and severity of extreme weather, both of which play an important role in the planning, design, operations, maintenance, and management of highways. Projected climate and weather changes will have important implications for the long-term safety and functionality of the highway system.

#### Goals, Objectives and Measures/Targets

NOACA's Regional Strategic Plan is a progressive approach for propelling the region forward in an era of changing demographics, job climate, and funding constraints. An overarching goal of the plan is to keep Northeast Ohio sustainable, competitive in a global economy, and effective at moving people and freight.

The plan embraces a vision statement, five goals, and strategies for meeting the goals and effectively allocating the region's resources.

The most important aspect to resilience planning is working together across jurisdictional boundaries. Goal 1 of the Regional Strategic Plan is Strengthen Regional Cohesion.

The strategies to achieve this goal are identified below.

- Foster collaboration on issues of transportation, air and water quality that will lead to greater regional cohesion and cooperation on other issues of regional concern.
- Work with governments in the region as well as state and federal authorities to remove barriers to joint development or maintenance of infrastructure by multiple governmental entities and by governmental and private entities.
- Work with governments in the region as well as state and federal authorities to promote cost sharing, purchasing coordination, and

consolidation of services to improve the efficiency and reduce the costs of developing and maintaining transportation and water infrastructure.

- Facilitate and promote the sharing of best practices for regional collaboration and cost sharing.
- Ensure infrastructure investments are planned and implemented to maximize transportation benefits across all impacted communities.
- Promote infrastructure investments that enhance the interrelationships of communities within the region.

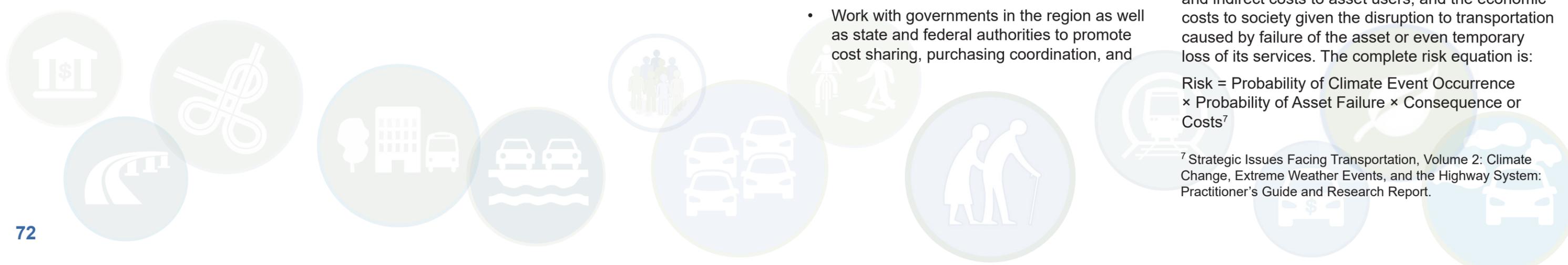
Further goals specifically dealing with mitigating climate change effects should be developed.

#### Impacts/Risks

An asset is vulnerable to climatic conditions if conditions such as intense precipitation and extreme temperatures and their aftermath result in asset failure or sufficient damage to reduce the functionality of the asset. Climate-related risk relates not only to the failure of that asset but also to the consequences or magnitudes of costs associated with that failure. In this case, a consequence might be the direct replacement costs of the asset, direct and indirect costs to asset users, and the economic costs to society given the disruption to transportation caused by failure of the asset or even temporary loss of its services. The complete risk equation is:

$$\text{Risk} = \text{Probability of Climate Event Occurrence} \times \text{Probability of Asset Failure} \times \text{Consequence or Costs}^7$$

<sup>7</sup> Strategic Issues Facing Transportation, Volume 2: Climate Change, Extreme Weather Events, and the Highway System: Practitioner's Guide and Research Report.



Projected climate changes by 2050:

- Increased temperature; estimated increase in the NOACA region of 4 to 5 degrees.
- Increased precipitation; estimated increase in the NOACA region of 5%<sup>8</sup>

As shown in Figure 3.3-1, the projected climate changes will affect the transportation system in many ways. Increased temperatures and prolonged heat waves could cause premature deterioration of infrastructure, damage to asphalt roads from buckling and rutting, and stress the steel in bridges through thermal expansion. The increase in precipitation poses an increased risk of flooding, and if the precipitation falls as rain rather than snow, there is an increased risk of landslides and road washouts. If the soil moisture levels become too high, the structural integrity of roads and bridges could be compromised.

The uncertainty associated with changing conditions are risks. Risk management is a process of

integrating mitigation actions and strategies into an agency’s transportation asset management plan.

Risk refers to events, such as performance failure, weather events, cost controls, the selection of suboptimal preservation projects, regulatory delays, construction delays, etc., that interfere with NOACA’s ability to perform its mission.

Risk management for NOACA involves systematically identifying, analyzing, assessing, and managing the risks that threaten the ability to achieve their organizational objectives.

NOACA has five risk categories. These categories include:

- Infrastructure damage
- Environmental and Extreme Weather
- Funding
- Internal (including training and staff characteristics)
- External (including political, stakeholder reputation, and regulatory)

A Transportation Asset Management Risk Workshop was held in July 2015. . At the workshop, regional stakeholders identified these risks as having the highest priority:

- Bridges are structurally damaged by motor vehicle crashes, accelerating repair/rehab
- Lack of regular maintenance leads to deteriorated infrastructure and more costly repairs
- Bridges fail or are posted for weight restriction (NOT rendered in-serviceable)
- Bridges or pavement are damaged due to overweight/overheight loadings
- Extreme snowfall causes major disruptions in mobility
- Federal officials reduce funds across the board for transportation
- State officials increase maintenance obligations without identifying a funding stream
- No new dedicated capital funding streams are instituted

- Inability to provide local match prevents scheduled projects from coming to fruition
- State officials earmark or mandate capital projects
- Major events force change in priorities
- Lack of coordination between other infrastructure projects, which deteriorates pavements more quickly or disrupts schedules

NOACA maintains a risk register, which was developed for the TAMP. Managing the risks identified in the risk register will be part of the general long range planning, research, and policy development work. Raising awareness of long-term risks and communicating potential consequences to regional decision makers is also a valuable responsibility.

NOACA maintains a risk register, which was developed for the TAMP. Managing the risks identified in the risk register will be part of the general long-range planning, research, and policy development work. Raising awareness of long-term risks and communicating potential consequences to regional decision makers is also a valuable responsibility.

Climate change has the potential to have major impacts on the infrastructure and environmental assets. Increased precipitation may require additional on-site capacity to manage storm water and off-site infiltration and storage to free capacity on storm water conveyance systems. Multimodal transportation networks will reduce greenhouse gas emissions from mobile sources and diversify travel options for local residents.

Figure 3.3-1: Potential Impacts of Climate Change

	Roads	Railways	Ports and waterways	Airports
Temperature Change	More rapid road asphalt deterioration due to prolonged heat Substructure damage and buckling due to permafrost thaw Increased maintenance and construction costs	Expansion and buckling of railway tracks, joints Overheating of rail electrical systems and communications equipment	Thermal expansion of bridge joints, paved surfaces Higher land-slide electricity consumption to meet increased refrigeration needs	Asphalt deterioration on the runways Length of runways inadequate due to increasing air density
Precipitation Change	Increased flooding of roadways Increased soil erosion and washout of road- and tunnel-supporting culverts during flash floods	Increased flooding of tracks and stations Washout of track supports (ballast)	Changes in scour rates in response to increased peak stream flow Channel closures due to increased silt deposit from flooding Reduced navigability due to low water levels	Travel disruptions due to storms and runway closures due to flooding Damage to airport infrastructure due to inundation

Source: Addressing-Climate-Change-Impacts-on-Infrastructure-report

<sup>8</sup> Based on output from MAGICC/SCENGEN, which reports data in 2.5 degree grid boxes. Each grid box is approximately 150 miles across and contains an average change in temperature and precipitation for the entire grid box. The data are interpolated and smoothed to make them more presentable. Since the data are smoothed, transitions between different changes in precipitation (and temperature) should not be taken as being exact model output.

The uncertainty associated with changing conditions are risks. Risk management is a process of identifying sources of risk, evaluating them, and integrating mitigation actions and strategies into an agency's transportation asset management plan.

Risk refers to events, such as performance failure, weather events, cost controls, the selection of suboptimal preservation projects, regulatory delays, construction delays, etc., that interfere with NOACA's ability to perform its mission.

Risk management for NOACA involves systematically identifying, analyzing, assessing, and managing the risks that threaten the ability to achieve its organizational objectives.

NOACA has five risk categories:

- Infrastructure damage
- Environmental and Extreme Weather
- Funding
- Internal (including training and staff characteristics)
- External (including political, stakeholder reputation, and regulatory)

A Transportation Asset Management Risk Workshop was held in July 2015. At the workshop, regional stakeholders identified these risks as having the highest priority:

- Bridges are structurally damaged by motor vehicle crashes, accelerating repair/rehab
- Lack of regular maintenance leads to deteriorated infrastructure and more costly repairs
- Bridges fail or are posted for weight restriction (NOT rendered in-serviceable)
- Bridges or pavement are damaged due to overweight/overheight loadings

- Extreme snowfall causes major disruptions in mobility
- Federal officials reduce funds across the board for transportation
- State officials increase maintenance obligations without identifying a funding stream
- No new dedicated capital funding streams are instituted
- Inability to provide local match prevents scheduled projects from coming to fruition
- State officials earmark or mandate capital projects
- Major events force change in priorities
- Lack of coordination between other infrastructure projects, which deteriorates pavements more quickly or disrupts schedules

NOACA maintains a risk register, which was developed for the TAMP. Managing the risks identified in the risk register will be part of the general long-range planning, research, and policy development work. Raising awareness of long-term risks and communicating potential consequences to regional decision makers is also a valuable responsibility.

Climate change has the potential to have major impacts on the infrastructure and environmental assets. Increased precipitation may require additional on-site capacity to manage storm water and off-site infiltration and storage to free capacity on storm water conveyance systems. Multimodal transportation networks will reduce greenhouse gas emissions from mobile sources and diversify travel options for local residents.

### Recommendations

- Implement the following strategies to reduce the vulnerability to natural disasters:
- Coordinate with agencies in natural disaster risk reduction
- Develop an adaptation framework
- Assess the vulnerability of transportation assets to types of natural disasters
- Identify at-risk assets and potential impacts of disasters
- Evaluate approaches to system management, operations, and maintenance
- Determine assets to retrofit, rehabilitate, or relocate
- Analyze appropriate areas to build new facilities
- Prioritize funding using costs, benefits, risks, and impacts
- Develop systems for monitoring and reporting
- Educate and engage decision makers, partners, and the public
- Integrate resilience concepts into asset management
- Reduce transportation greenhouse gases (GHGs)

### Implementation Action Areas

- Projects that decrease greenhouse gases
- Expand transit
- Transit vehicle replacements with CNG buses

- Nonmotorized improvements
- Signal timing optimization projects
- Ramp metering
- Reduce bottlenecks
- Congestion reduction
- Reduction of single occupancy vehicle trips
- Rideshare
- Vanpools
- Projects that create redundancy of critical infrastructure
- Redundant highway or bridge constructed\
- Enhance intelligent transportation systems (ITS)
- Projects that adapt to the effects of climate change on infrastructure
- Additional on-site capacity to manage storm water and off-site infiltration and storage to free capacity on storm water conveyance systems
- Extreme temperature pavement design

### Monitoring, Assessing and Documenting Performance

Performance measures and targets will be established through the development of a steering committee consisting of local partners, ODOT, FHWA, DHS, and local safety forces. This committee will also establish the monitoring, assessing and documenting the progress towards the targets.

