

Assessing the Vulnerability of Tennessee Transportation Assets to Extreme Weather

A Pilot Project

**Nature's Call To Action II
Kentucky Transportation Cabinet
Frankfort, Kentucky**

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MAP-21

Moving Ahead for Progress in the 21st Century



Requires states to

- **Evaluate performance of roads, traffic congestion and freight**
- **Develop a risk-based asset management plan for the National Highway System**

Assessing transportation asset vulnerability to extreme weather a key step in this process

Recent extreme weather events demonstrate the vulnerability of Tennessee's transportation assets



Sinkhole, I-24 Clarksville - August 2013



Flooding on Briley Parkway - August 2013



Polk County Rock Slide - August 2013

The Problem

- Significant transportation impacts
 - Access to jobs
 - Business continuity
 - Social lifeline
 - Regional and national mobility



Sinkhole on 1-24 between Nashville and Chattanooga, May 2010

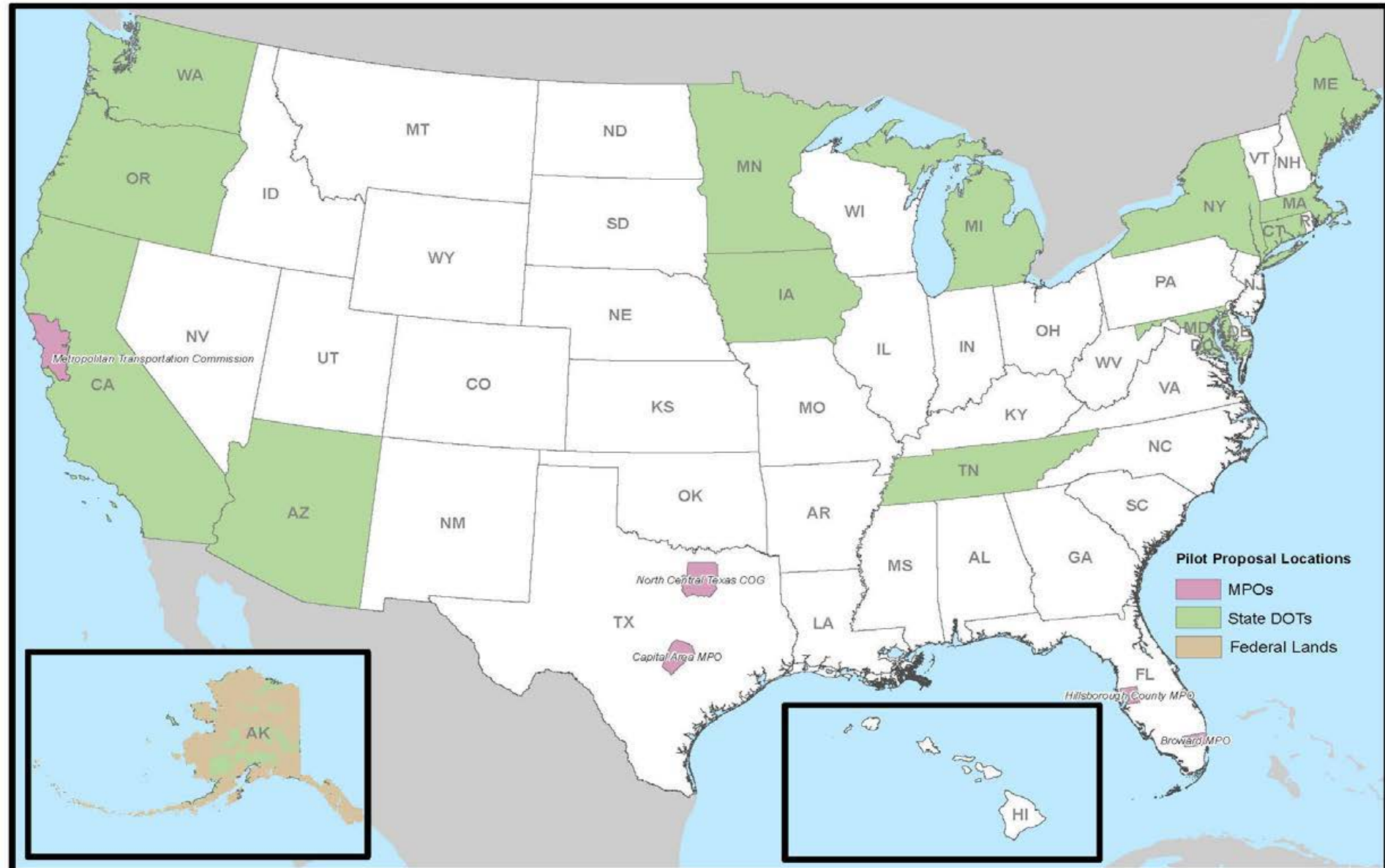
The Need

- Statewide vulnerability assessment of transportation assets to identify *critical assets vulnerable* to extreme weather
- Vulnerability includes
 - Asset damage
 - Loss of use
 - Resilience



Franklin, TN 2010

2011-2014 FHWA Extreme Weather Pilot Projects



Project Partners

- **Tennessee Department of Transportation (TDOT)**
 - Division Directors appoint senior staff as project liaisons
 - Divisions (headquarters and regions) provide information
- **TEWTAP (Tennessee Extreme Weather and Transportation Adaptation Partnership)**
 - Comprised of endorsing organizations, other government agencies, MPOs and transportation providers
 - Guide and advise project and review project results
- **Regional Focus Groups**
 - Public invited to four regional meetings
 - Obtain local/regional feedback
 - Obtain access to data



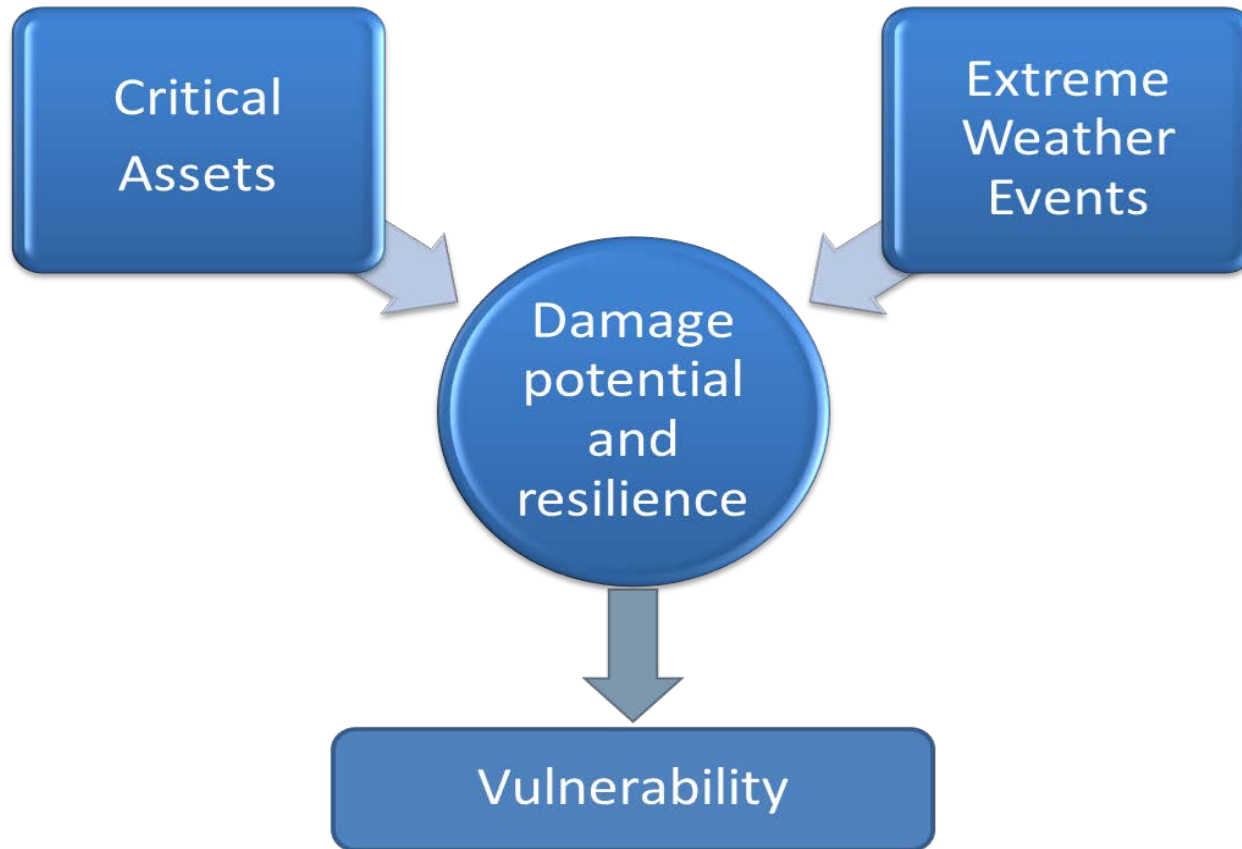
TEWTAP Member Organizations

- **Chattanooga-Hamilton County/North Georgia TPO**
- **Clarksville-Montgomery County MPO**
- **Knoxville TPO**
- **Memphis MPO**
- **Nashville Area MPO**
- **National Weather Service, Nashville Weather Forecast Office**
- **Federal Highway Administration (FHWA)**
- **TN Dept. of Economic and Community Development**
- **TN Dept. of Environment and Conservation**
- **TN Dept. of Safety and Homeland Security**
- **TN Emergency Management Agency (TEMA)**
- **Vanderbilt University**

Stakeholder Involvement

- **TDOT**
 - Meetings with TDOT Divisions to gather asset inventory data and effects of extreme weather on transportation assets
 - Meetings in each TDOT region for field staff (Regions and Districts)
- **TEWTAP**
 - Advisory group to provide oversight and facilitate stakeholder involvement
 - MPOs, State and federal agencies, Transportation providers
- **Regional Focus Groups**
 - Obtain information and insight into local conditions
 - Determine what is important to stakeholders
 - Local officials, city engineers, freight carriers, transit operators, citizens, etc.

Project Overview



Project will make extensive use of color-coded GIS maps to visually display critical assets, extreme weather exposure, impacts and overall vulnerability

Methods

- **Key Assessment Elements**

- **Critical Assets**

- Volume of use
 - Use as emergency route access/egress
 - Cost/time to repair or replace
 - Strategic importance
 - Proximity and condition of nearest detours
 - Environmental justice
 - Forecasted population growth over study period

- **Extreme Weather Events**

- Develop criteria to define extreme events based on thresholds (e.g., wind speed) and what thresholds cause damage (e.g., 3 seconds wind gusts of 90 mph)
 - Review maintenance records to identify when and where assets suffered significant damage and then correlate to weather event at the time

- **Damage Potential and Resilience**

- Asset damage or destruction
 - Loss of use
 - Length of delays and disruptions



Project Scope

- **Statewide vulnerability assessment will include**

- Roads (Tennessee Strategic Corridors and National Highway System)
- Rails (passenger & freight; main line & regional)
- Navigable waterways (rivers, locks, and dams)
- Airports
- Pipelines (oil and gas)
- Bridges and tunnels
- Mass transit systems
- Support systems (e.g., traffic control centers; maintenance facilities)
- Programmed transportation projects (STIP)

- **Importance of asset based on multiple criteria**

- Volume of use, economic value, strategic significance

- **Climate Stressors**

- Temperature, rain, drought, wind, tornado, ice, fog, snow



Data Gathering and Analysis

- **Data gathered**

- Networks representing major freight transportation modes and corresponding attributes
- Historical weather and forecast climate data

- **How has data been processed for use in the project?**

- Using vulnerability assessment tools developed for FHWA Gulf Coast Study
 - CMIP Climate Data Processing Tool (climate model translator)
 - Sensitivity Matrix
 - Vulnerability Assessment Scoring Tool
- Based on these tools, developing Tennessee sensitivity matrix specific to TN assets
- Developing criteria to determine critical infrastructure/extreme weather events
- Working with University partners to obtain downscaled climate data for 2040

- **Lessons learned**

- Meaningful data can be difficult to obtain and integrate
- Combination of qualitative and quantitative methods likely

Asset Inventory

- Roads (Tennessee Strategic Corridors and National Highway System)
- Rails (passenger and freight; main line and regional)
- Intermodal freight terminals (including ports)
- Navigable waterways (rivers, locks and dams)
- Airports
- Pipelines (oil and gas)
- Bridges and tunnels
- Mass transit systems
- Support systems (e.g., traffic control centers; maintenance facilities)
- Programmed transportation projects (STIP)






Importance of asset based on multiple criteria (e.g., volume of use, economic value, strategic significance)

National Freight Network: Tennessee Primary Freight Network



LEGEND

PFN Features

-  Primary Freight Network (PFN) of 27,000 miles (based on statutory cap and criteria)
-  Comprehensive PFN (approx. 41,000 miles based on statutory criteria)
-  Remainder of the Interstate System (not part of PFN)

Extreme Weather Impacts

- High temperatures
- Heavy rain
- Drought
- Wind
- Tornado
- Ice
- Fog
- Snow



High temperatures



Ice



Heavy rains



Wind

Historical data and future weather conditions used to determine plausible extreme weather events through 2040

Weather Event Thresholds

- Thresholds based on materials analysis, historical information on when damage occurred, or local knowledge
- **Temperature**
 - Trains generally slowed at 90° day; risk of rail buckling increases significantly above 110 °
 - Road asphalt may soften with temperatures above 100 ° during the day without sufficient cooling at night
 - Restrictions on maintenance crew work outdoors at 85 °, maintenance work often restricted above 110 °
- **Precipitation**
 - Heavy rain reduces roadway speed by 4-7%
 - 4" rain within two days increases risk of landslides
- **Wind**
 - Docking of large vessels impacted at winds over 23 mph
 - Overhead signs designed to withstand 3-second gusts of 90 mph winds

Damage Potential and Resilience

- How much asset damage and loss of use is caused by the extreme weather event?
- How resilient is the asset/system in returning to normal operations following the extreme weather event?



Hannah River 2010



Stewart County Flooding April 2013



I-75 Sinkhole 2012

Project Questions

Identifying Important Assets

- What transportation asset inventory data exists?
 - Homeland Security Infrastructure Program (HSIP Gold)
- What criteria have been used to determine if an asset is critical?
- Any data available?

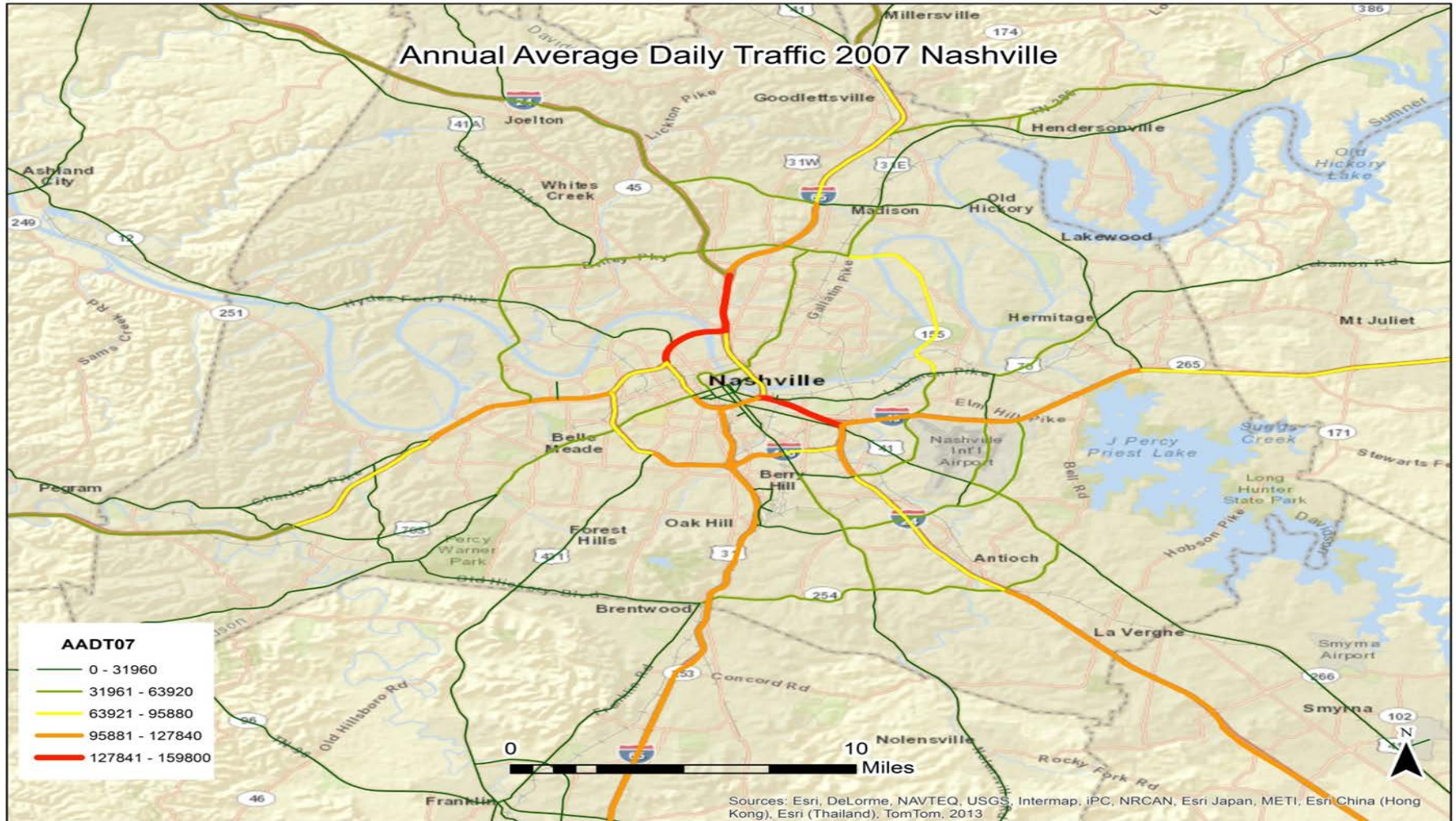
Understanding Extreme Weather

- What type of events have been defined as “extreme weather?”
- Are there particular weather thresholds that have been identified as producing more serious impacts?

Assessing Damage and Resilience

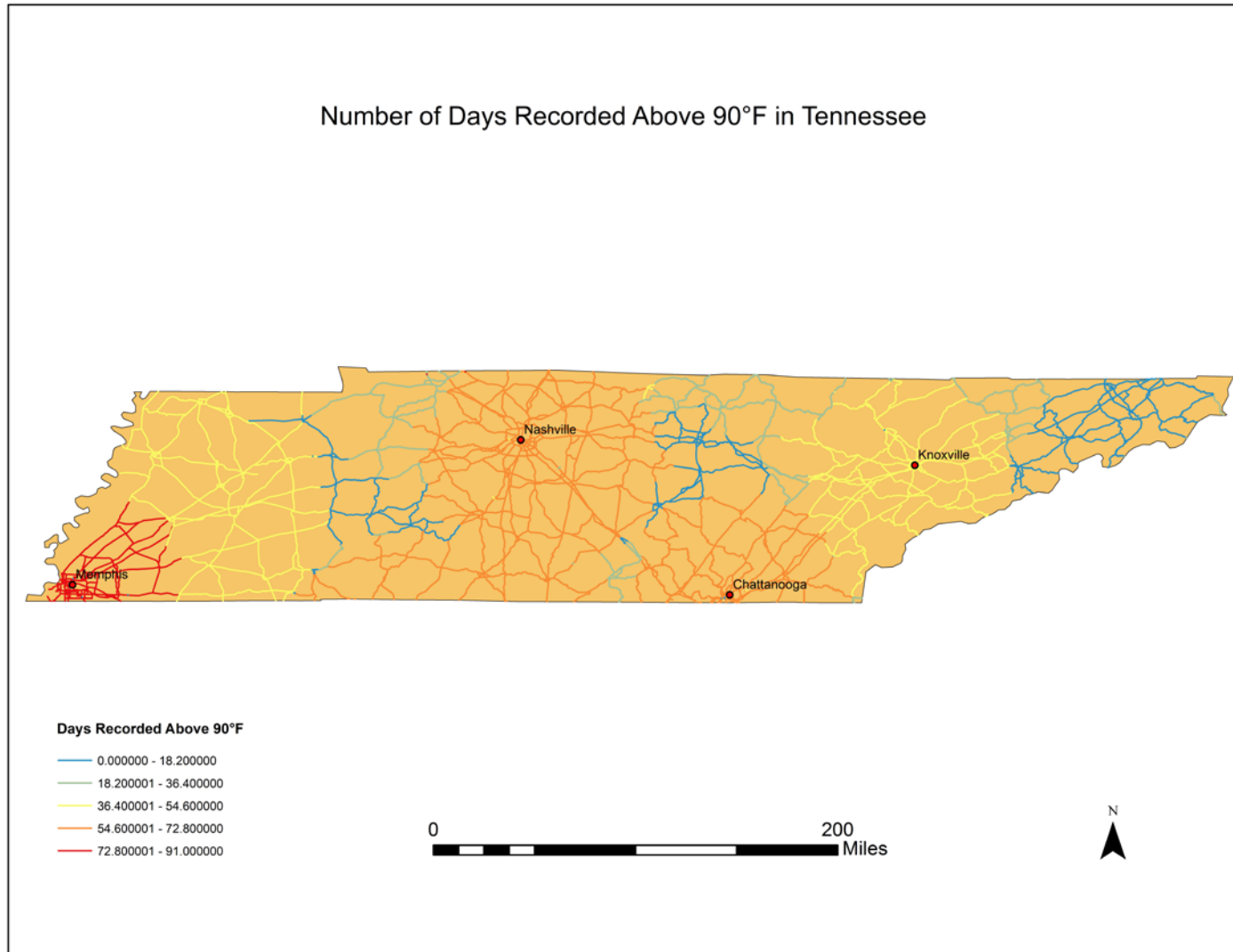
- Are there established criteria for “excessive damage?”
- Are there records that describe weather events and the resulting damage?

Sample Critical Asset Map



Critical highway assets based on average daily traffic

Sample Extreme Weather Map



Excessive heat based on days temperature above 90 degrees

Next Steps

- **Near Term**

- Schedule and hold TEWTAP and regional focus group meetings
- Begin assimilation of climate data into useful format and define extreme weather thresholds
- Continue working with FHWA tools

- **Anticipated Challenges**

- Scheduling necessary meetings
- Acquiring requested data in timely fashion

- **Project deadline**

- December 2014

Utilizing Project Results

- Feeds into and creates template for MAP-21 risk-based asset management plan
- Integrates knowledge of extreme weather “hot spots” into agency methods and practices
- Lays the groundwork for identifying and evaluating potential risk mitigation (adaptation) strategies



Bottom Line

- Pilot project is first step in determining what can be done to reduce transportation asset vulnerability to extreme weather events
- Will provide important information for TDOT's development of a risk-based transportation asset management plan
- Will create an important tool to
 - Inform decision-makers
 - Promote “no regrets” planning
 - Enable responsible stewardship of Tennessee's transportation assets

