
# Extreme Weather Events and State DOTs

**Date:** August 25, 2014

**Committee:** SASHTO

**Presenter:** Michael Meyer, Parsons Brinckerhoff

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Center for Environmental Excellence

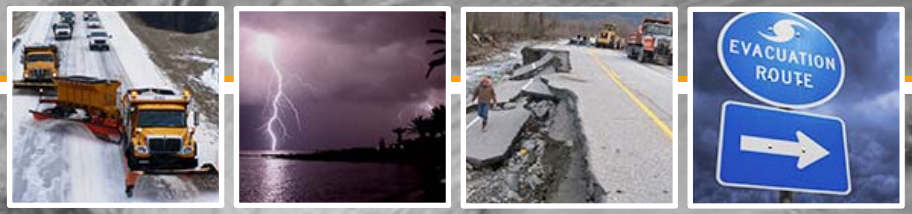
U.S. Department of Transportation
Federal Highway Administration

# AASHTO
# EXTREME WEATHER EVENTS SYMPOSIUM


## Best Practices for Extreme Weather Management

- It pays to be ready and pre-plan
- Practice, practice, practice
- Know what is out there
- Use all forms of communication media

# AASHTO's Center for Environmental Excellence Initiative




Update on Federal Programs and Recent Research

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# Transportation System Management and Operations

- Contingency Plans
- Evacuation and Emergency Routes
- Traveler Information
- Drill and Test
- Pre-position Materials & Equipment
- Back-up Communications

# Transportation System Management and Operations

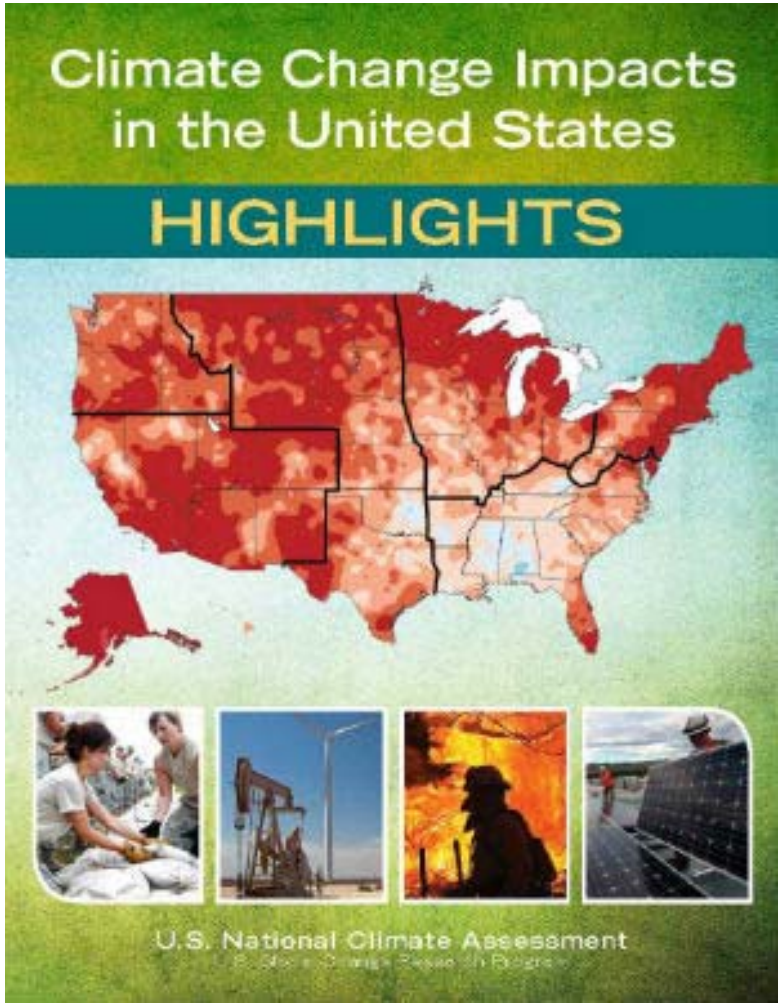
- Risk Reduction Strategies
- Early Warning Indicators
- Harden the System
- Workforce Protection

# WHAT DOES THIS MEAN FOR CONSTRUCTION?

- Construction Season
- Construction Needs (Force Majeure)
- Construction Scheduling
- Construction Site Safety
- Contingency Plans
- Resilient Power Supply

# WHAT DOES THIS MEAN FOR CONSTRUCTION?

- Back up Communications
- Work Zone Safety
- Workforce Training
- Future Protection

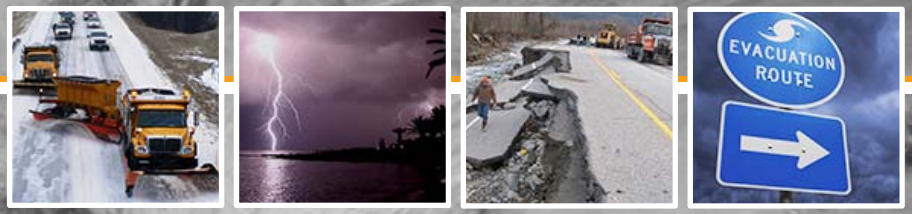



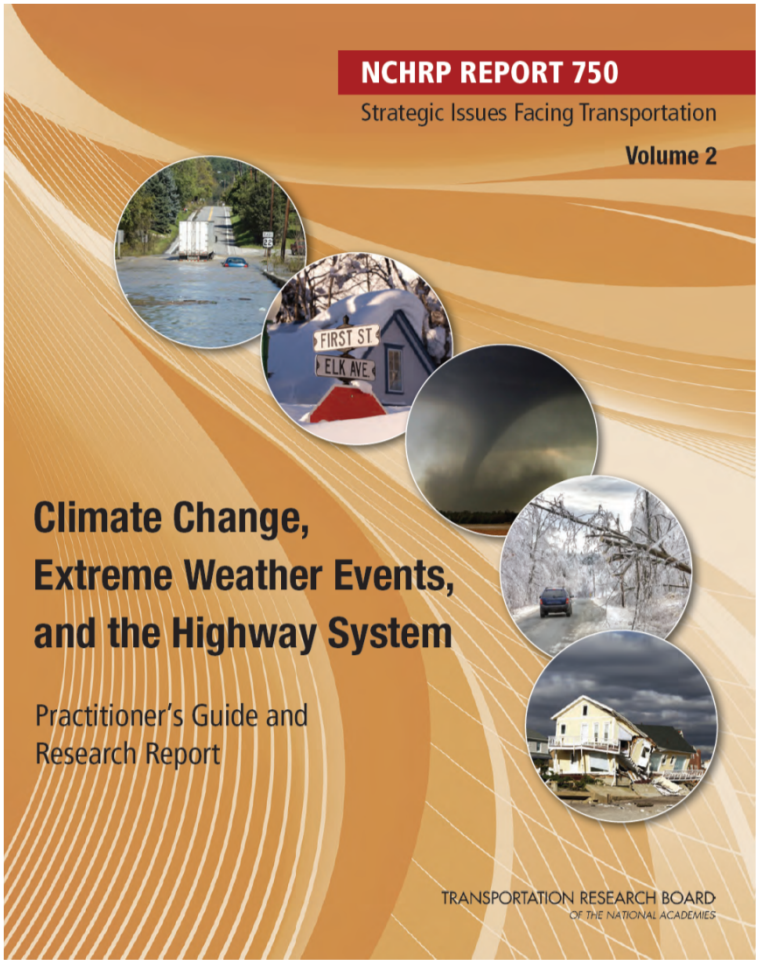

# National Climate Assessment (2014)

# NATIONAL CLIMATE ASSESSMENT (2014)

- Changing climatic conditions and extreme weather events are affecting the reliability and capacity of the U.S. transportation system in many ways.
- Major coastal impacts, including both temporary and permanent flooding.
- Extreme weather events currently disrupt transportation networks in all areas of the country; projections indicate that such disruptions will increase.
- Impacts can be reduced through a wide range of adaptive actions.

# STUDIES & RESEARCH ON EXTREME WEATHER & THE TRANSPORTATION SYSTEM




## NCHRP 750, VOL. 2

# KEY QUESTIONS

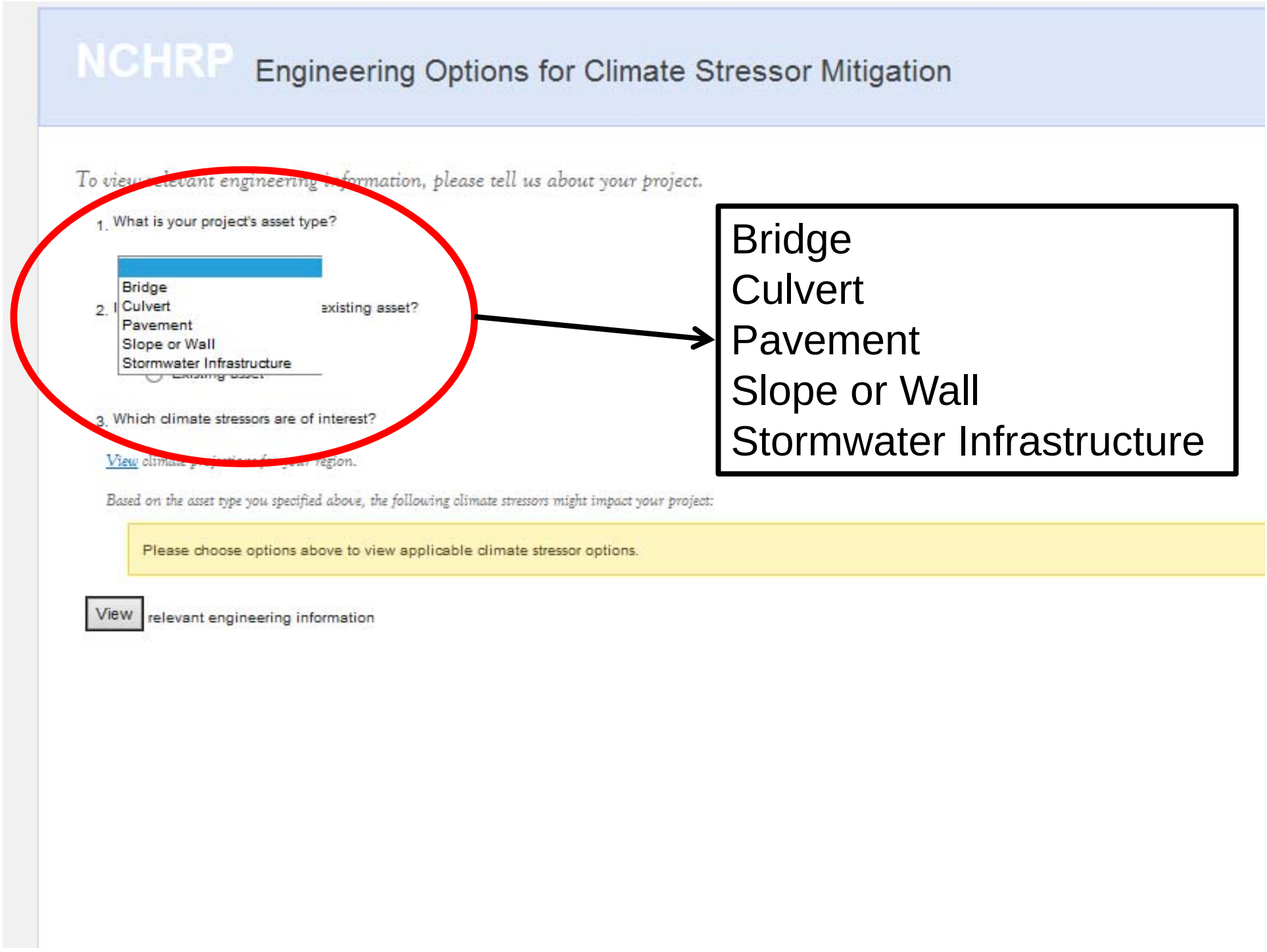
- How Could Changes in Temperature Affect Road Assets?
- How Could Changes in Precipitation Affect Road Assets?
- How Could Sea-Level Rise Affect Road Assets?
- How Could Greater Hurricane Intensity Affect Road Assets?
- How Could Stressors Affect Ecological Systems?
- What Are the Types of Adaptation Strategies that Can Be Considered by Transportation Agencies?

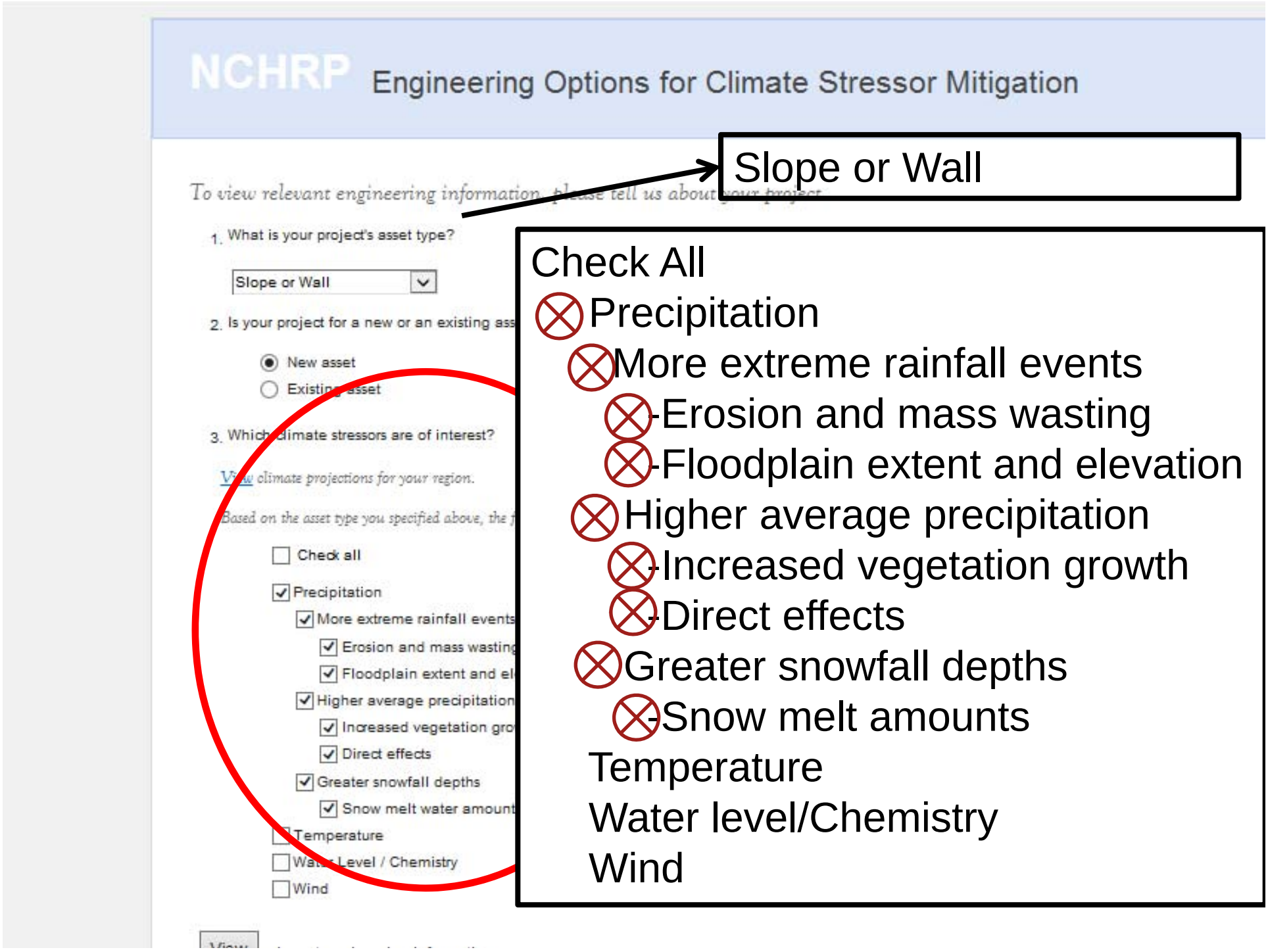
# Adaptation

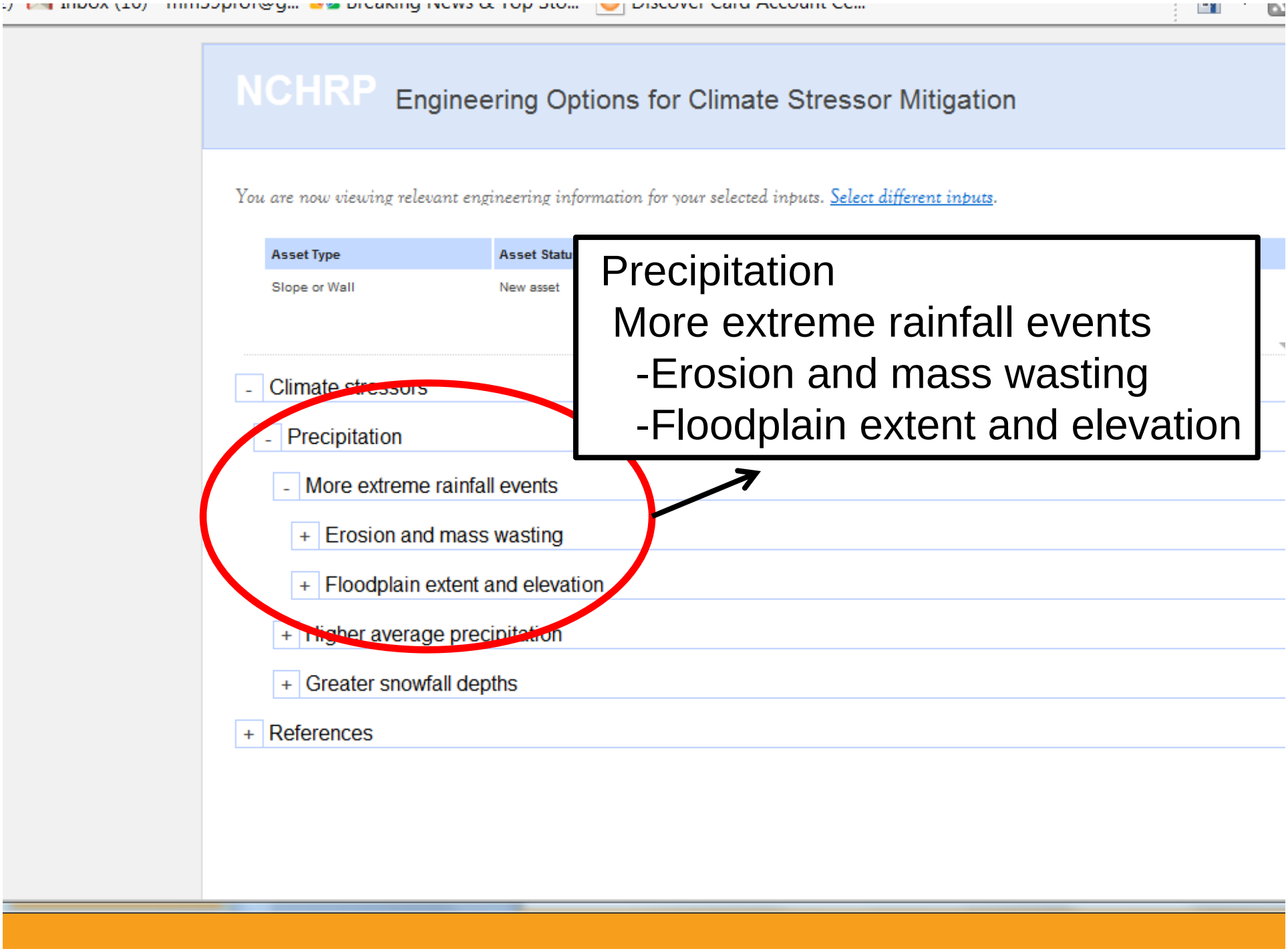
*"Actions by individuals or systems to avoid, withstand, or take advantage of current and projected climate changes and impacts. Adaptation decreases a system's vulnerability, reduces risk and/or increases its resilience to impacts."*

# Concepts

- Asset vulnerability
- System resiliency
- Adaptation
- Risk
- Flexible design
- Operations/maintenance


NCHRP
Engineering Options for Climate Stressor Mitigation
To view relevant engineering information, please tell us about your project.
1. What is your project's asset type?
Bridge
Culvert
Pavement
Slope or Wall
Stormwater Infrastructure
existing asset?
3. Which climate stressors are of interest?
View
Based on the asset type you specified above, the following climate stressors might impact your project:
Please choose options above to view applicable climate stressor options.
View
relevant engineering information
Bridge
Culvert
Pavement
Slope or Wall
Stormwater Infrastructure


NCHRP
Engineering Options for Climate Stressor Mitigation
To view relevant engineering information, please tell us about your project.
1. What is your project's asset type?
Slope or Wall
2. Is your project for a new or an existing ass
New asset
Existing asset
3. Which climate stressors are of interest?
View climate projections for your region.
Based on the asset type you specified above, the
Check all
Precipitation
More extreme rainfall events
Erosion and mass wasting
Floodplain extent and el
Higher average precipitation
Increased vegetation gro
Direct effects
Greater snowfall depths
Snow melt water amount
Temperature
Water Level / Chemistry
Wind
View
Slope or Wall
Check All
Precipitation
More extreme rainfall events
-Erosion and mass wasting
-Floodplain extent and elevation
Higher average precipitation
-Increased vegetation growth
-Direct effects
Greater snowfall depths
-Snow melt amounts
Temperature
Water level/Chemistry
Wind


NCHRP
Engineering Options for Climate Stressor Mitigation
You are now viewing relevant engineering information for your selected inputs. Select different inputs.
Asset Type
Asset Statu
Slope or Wall
New asset
- Climate stressors
- Precipitation
- More extreme rainfall events
+ Erosion and mass wasting
+ Floodplain extent and elevation
+ Higher average precipitation
+ Greater snowfall depths
+ References
Precipitation
More extreme rainfall events
-Erosion and mass wasting
-Floodplain extent and elevation

| Design Option | Cost | Special Considerations | E-mail Suggestions |
|---|---|---|---|
| Use or enhancement of stormwater conveyance away from slope face | $ - $$ | | |
| Flatter slope inclinations | $ - $$$ | | |
| Use of (deeper) catch ditches (and/or ditches with modified shapes) along with (higher) rock fences to retain increased volume and velocity of rock fall and landslide debris | $ - $$ | | |
| Use of slope face protection such as shotcrete, walls, wire mesh, etc. | $ - $$ | | |
| Installation of landslide warning systems | | | |
| Enhanced maintenance regime in specs | | | |

Suggest a new option

Use of enhancement of stormwater conveyance away from slope face

**Alternative Design Options**

| Design Option | Cost | Special Considerations | E-mail Suggestions |
|---|---|---|---|
| Construct tunnel instead of road cut | $$$ - $$$$ | | |
| Obtain ROW for future expansion and access | $ - $$$ | | |

Suggest a new option

## - Climate influenced design inputs

**Simulations**

| Affected Design Input | Traditional Data Source | Preferred Projected Data Source | Alternative Projected Data Source |
|---|---|---|---|
| IDF curves | NOAA Atlas 14, TP-40, or state specific sources | Utilize IDF curves reflecting projected climate change if available | Use relative increases in precipitation totals following the Clausius-Clapeyron relationship |

Suggest a new option

## - Climate influenced design inputs

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## + Floodplain extent and elevation

## + Higher average precipitation

## + Greater snowfall depths

## - References


1. Canadian Standards Association. Development, Interpretation and Use of Rainfall Intensity-Duration-Frequency (IDF) Information: Guideline for Canadian Water Resource Practitioners (Second Edition). Toronto: Canadian Standards Association, 2012 (release pending ).
2. Meyer, O., M. Werlen, C. Pfammatter, and E. Eyar. "The Raisable Saltina Bridge [translation]." Schweizer Ingenieur und Architekt, no. 50 (1997). [Translation at http://www.rhone.ch/cygnus/siahub_e.htm]
3. (NRC) National Research Council. Climate Change: Evidence, Impacts, and Choices. http://www.scribd.com/doc/98458016/Climate-Change-Lines-of-Evidence (accessed July 17, 2012)
4. (NRC) National Research Council Committee on Hydrologic Science. Global Change and Extreme Hydrology: Testing Conventional Wisdom. http://www.nap.edu/catalog.php?record_id=13211#toc (accessed July 18, 2012).
5. Solaiman, T.A. and S.P. Simonovic. Development of Probability Based Intensity-Duration-Frequency Curves under Climate Change. Water Resources Research Report No. 072, The University of Western Ontario Department of Civil and Environmental Engineering, London, Ontario, 2011.
6. (USDA) United States Department of Agriculture, Natural Resource Conservation Service, Conservation Engineering Division. Urban Hydrology for Small Watersheds: Technical Release 55. Washington, DC: United States Department of Agriculture, 1986.
7. (USGS) United States Geologic Survey. Guidelines for Determining Flood Flow Frequency: Bulletion #17B of the Hydrology Subcommittee. http://water.usgs.gov/osw/bulletin17b/dl_flow.pdf (accessed July 18, 2012).

# Climate Change Construction Considerations: Michigan DOT

- More intense storms – protect motorists, workers, and the environment from hazards created in work zone by strong weather events
- Stronger specifications for protection of work under construction

Gregory C. Johnson, Michigan Department of Transportation, November 17, 2012

# Michigan DOT, cont'd

- Encourage more night/cooler weather work to prevent damage such as slab curling, premature cracking, loss of air entrainment in concrete pavements, rutting, and flushing in asphalt pavements
- Stronger specifications that require contractor response plans for work zone impacted by high intensity storms

Gregory C. Johnson, Michigan Department of Transportation, November 17, 2012

# Michigan DOT, cont'd

- More closely monitor moisture in aggregate piles
- Incorporate materials whose performances are less variable in weather extremes
- Modify vegetation planting periods to ensure optimal growth and survival
- Stronger specifications for dust control and wind erosion

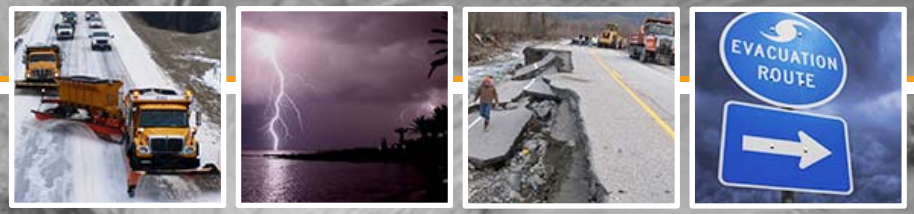
Gregory C. Johnson, Michigan Department of Transportation, November 17, 2012

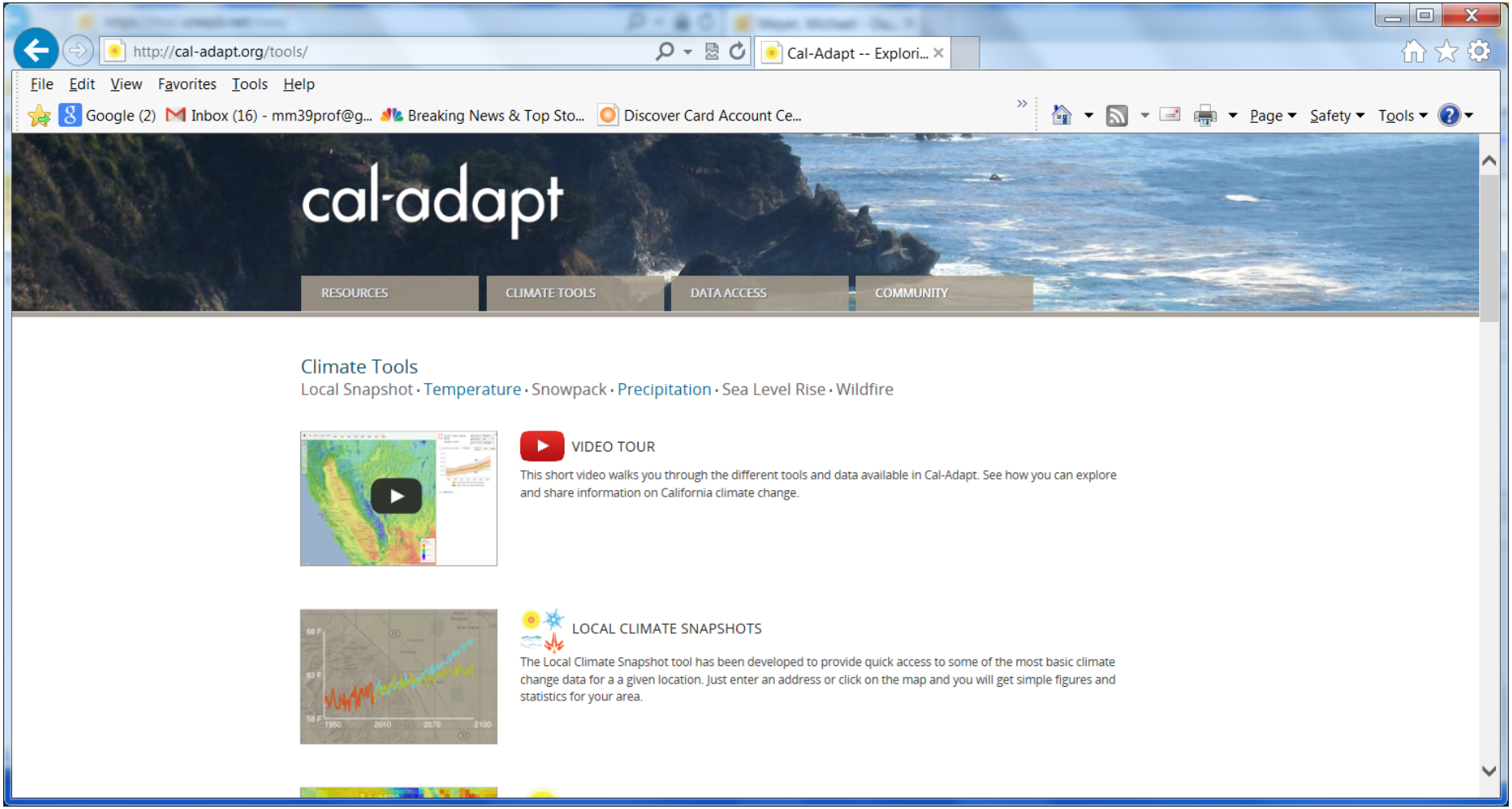
# Michigan DOT, cont'd

- Worker safety during extreme heat periods must be addressed


Gregory C. Johnson, Michigan Department of Transportation, November 17, 2012

# California


EVACUATION
ROUTE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Discover Card Account Ce...
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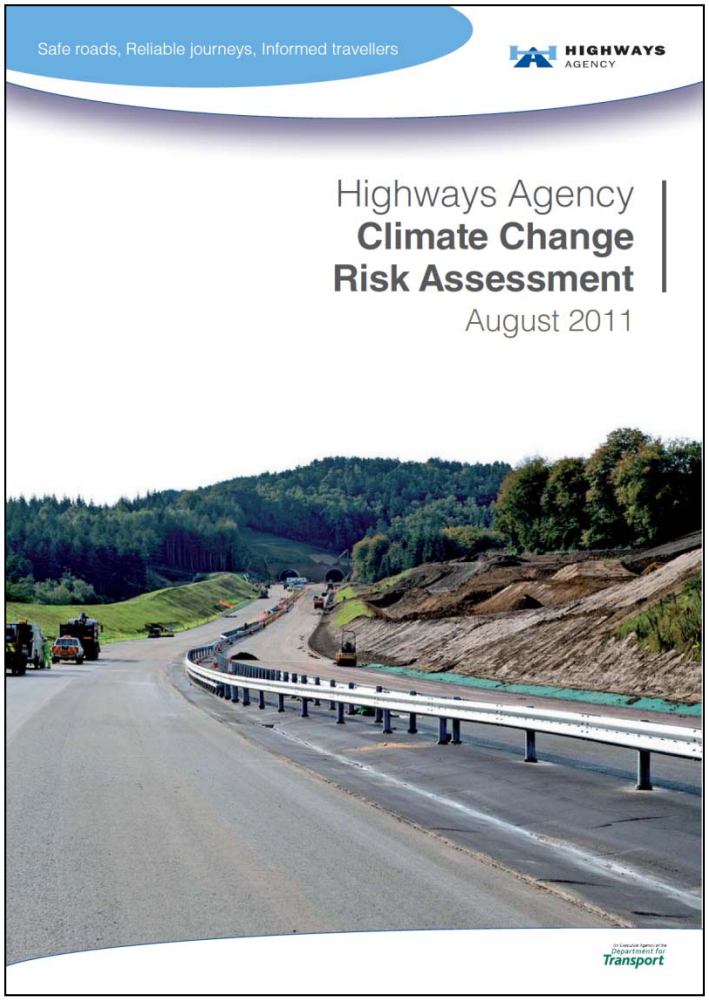
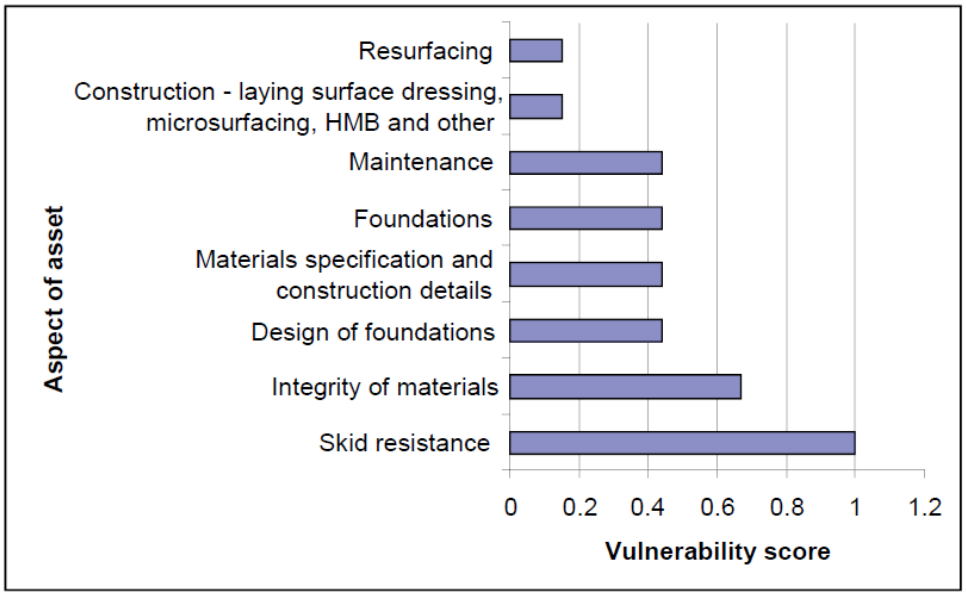
Safety
Tools
cal-adapt
RESOURCES
CLIMATE TOOLS
DATA ACCESS
COMMUNITY
Climate Tools
Local Snapshot · Temperature · Snowpack · Precipitation · Sea Level Rise · Wildfire
VIDEO TOUR
This short video walks you through the different tools and data available in Cal-Adapt. See how you can explore and share information on California climate change.
LOCAL CLIMATE SNAPSHOTS
The Local Climate Snapshot tool has been developed to provide quick access to some of the most basic climate change data for a a given location. Just enter an address or click on the map and you will get simple figures and statistics for your area.

# Highways Agency (England)




Vulnerability of Pavement Asset




http://www.highways.gov.uk/publications/climate-change-mitigation/

# Highways Agency: Design Implications

| | | |
|---|---|---|
| Design and construction of new or replacement assets | Pavements | Materials specification and construction details |
| | | Design of foundations |
| | Structures (including gantries) | Wind actions (loads) applied to superstructure |
| | | Design for increased scour risk for foundations |
| | | Design of bearings and expansion joints |
| | Drainage | Surface Water Drainage Systems |
| | | Attenuation |
| | | Outfalls |

http://www.highways.gov.uk/publications/climate-change-mitigation/

# Priorities for Adaptation of Highways Agency Assets

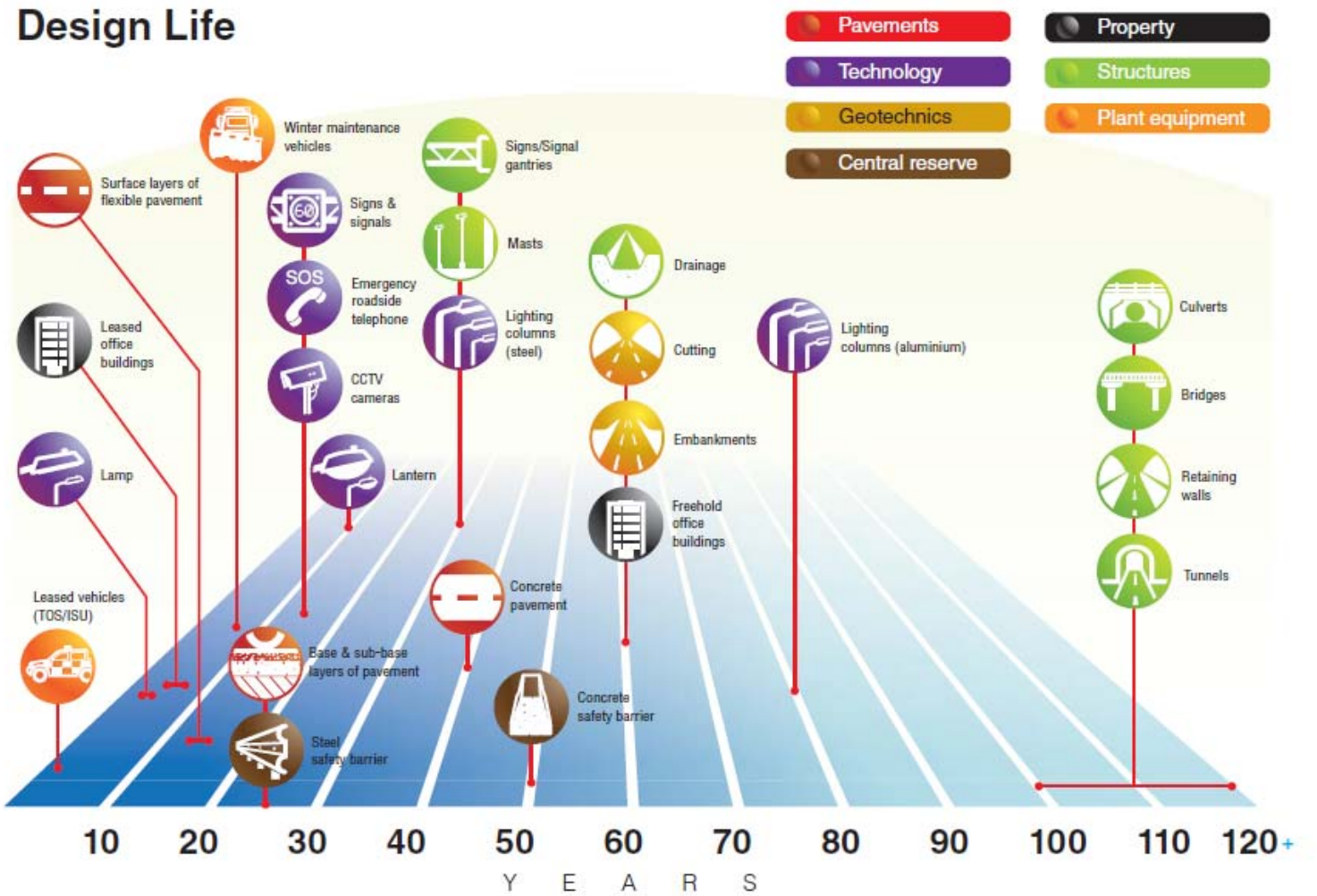
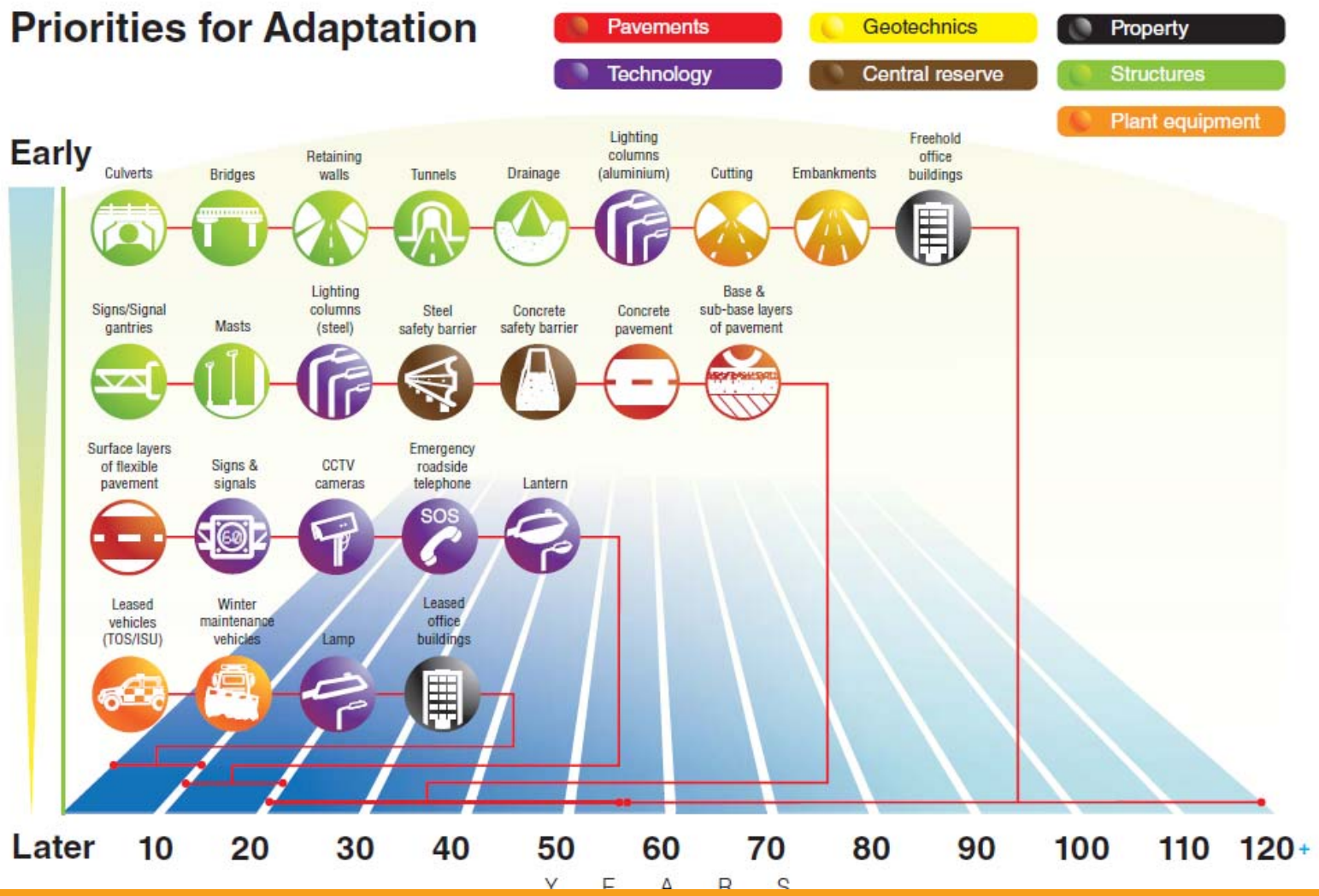
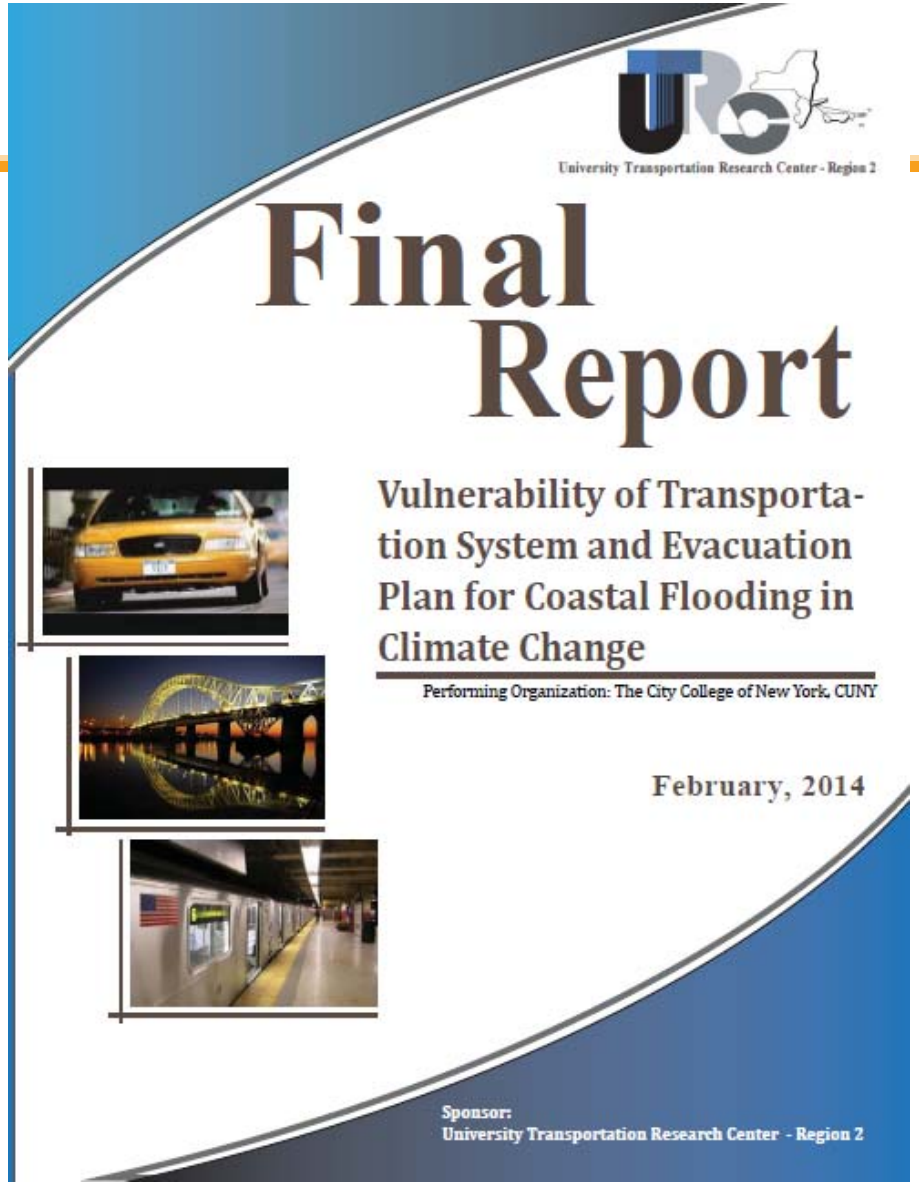



*Figure 10: Design life of Highways Agency assets*

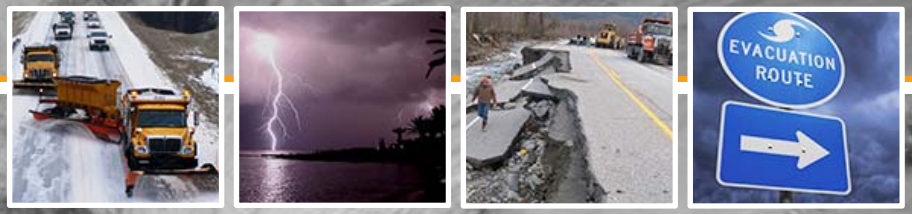
# Priorities for Adaptation of Highways Agency Assets



# University Research



# EXTREME WEATHER & THE TRANSPORTATION SYSTEM RESOURCES




## AASHTO RESOURCES

- Transportation and Climate Change Resource Center (See especially State DOT Climate Change Programs)

  http://climatechange.transportation.org/

- *Adapting Infrastructure to Extreme Weather Events: Best Practices and Key Challenges*, Workshop Summary Report, 2012

- *Integrating Extreme Weather Risk into Transportation Asset Management*, Technical Paper, 2012

- Impacts of Extreme Weather on Transportation: National Symposium Summary, 2013


# Transportation Research Board Efforts

- NCHRP 25-25 (94): *Integrating Extreme Weather and Adaptation into Transportation Asset Management Plans*
- ACRP SYNTHESIS 33, *Airport Climate Adaptation and Resilience A Synthesis of Airport Practice*
- *Risk-Based Adaptation Frameworks for Climate Change Planning in the Transportation Sector*, Research Circular E-C181
- *Adapting Transportation to the Impacts of Climate Change: State of the Practice 2011*


# NCHRP
## SYNTHESIS 454

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

# Response to Extreme Weather Impacts on Transportation Systems

*A Synthesis of Highway Practice*

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

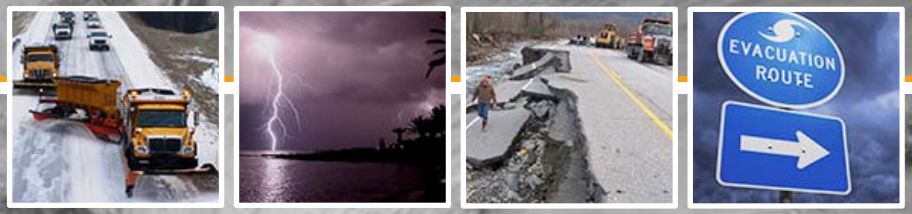

# With respect to construction….


- Fully repairing key areas using emergency contractors and working with the planning side of the house for on-call design contracts — NJ
- Acceleration of the drafting and letting of contracts for repair work so that repairs could begin as soon as inspections were completed — TN
- Rebuilding 4 miles of a washed-out interstate, using predetermined contract rates, incentive clauses, and contracted inspection services — IA


- Giving consideration to developing “off-the-shelf” contractual terms for emergency situations — TN
- Enabling shifts in construction schedules to accommodate new priorities — VT
- Adopting an approach to rebuilding that completely closes a road or bridge for safer and faster construction, rather than choosing a partial closure (that maintains access during construction) — VT


- Articulating the existing technical and policy foundation for projects that support better resiliency (e.g., rewriting hydraulic manual to underscore existing practices) VT
- Exploring new construction techniques—for example, prefabrication of structure components, advanced new materials, and new contract/management techniques VT
- Supporting the burial of utility lines to avoid downed utility poles on the highway right-of-way AK

# EXTREME WEATHER & THE TRANSPORTATION SYSTEM RESOURCES



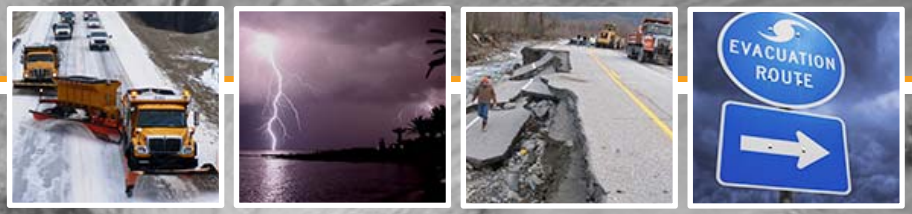

**U.S. DOT:**
http://climate.dot.gov/

**FHWA:**
http://www.fhwa.dot.gov/environment/climate_change/index.cfm

**USGS:**
https://www.pwrc.usgs.gov/CCWG/Resource_USag.htm

**Georgetown Climate Center:**
http://www.georgetownclimate.org/resources/transportation-and-climate-change-clearinghouse-tccc

**EU:**
http://ec.europa.eu/clima/policies/adaptation/index_en.htm




# Questions?/Comments?