OFFICE OF RESEARCH, DEVELOPMENT, AND TECHNOLOGY

PROGRESS TOWARD MORE RESILIENT PAVEMENTS

ASTM Webinar: FHWA Resiliency Efforts

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TURNER-FAIRBANK
Highway Research Center

ENVIRONMENTAL IMPACTS ON PAVEMENTS

- Environmental Factors Contribute to Pavement Distresses - blowups, buckling, rutting, thermal cracking
- Long-Term Pavement Performance Program Impact of Environmental Factors on Pavement Performance*
  - 36% of total damage for flexible pavements
  - 24% of total damage for rigid pavements
- Pavements designed using climatic data
  - However, engineers typically assume stationarity

*www.fhwa.dot.gov/publications/research/infrastructure/pavements/ltpp/16078/16078.pdf

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Application to Pavements

PAVEMENT ADAPTATION STRATEGIES: 1. MONITOR TRENDS

Most predicted changes to environmental variables are projected to occur relatively slowly in relation to a typical pavement lifecycle.

https://www.fhwa.dot.gov/pavement/sustainability/hif15015.pdf

Table 2. Key pavement indicators to monitor for climate change impacts.

Asphalt Pavement Indicators	Concrete Pavement Indicators
Rutting of asphalt surface	Blow-ups (JPCP)
Low temperature (transverse) cracking	Slab cracking
Block cracking	Punch-outs (CRCP)
Raveling	Joint spalling
Fatigue cracking and pot holes	Freeze-thaw durability
Rutting of subgrade and unbound base	Faulting, pumping, and corner breaks
Stripping	Slab warping
	Punch-outs (CRCP)

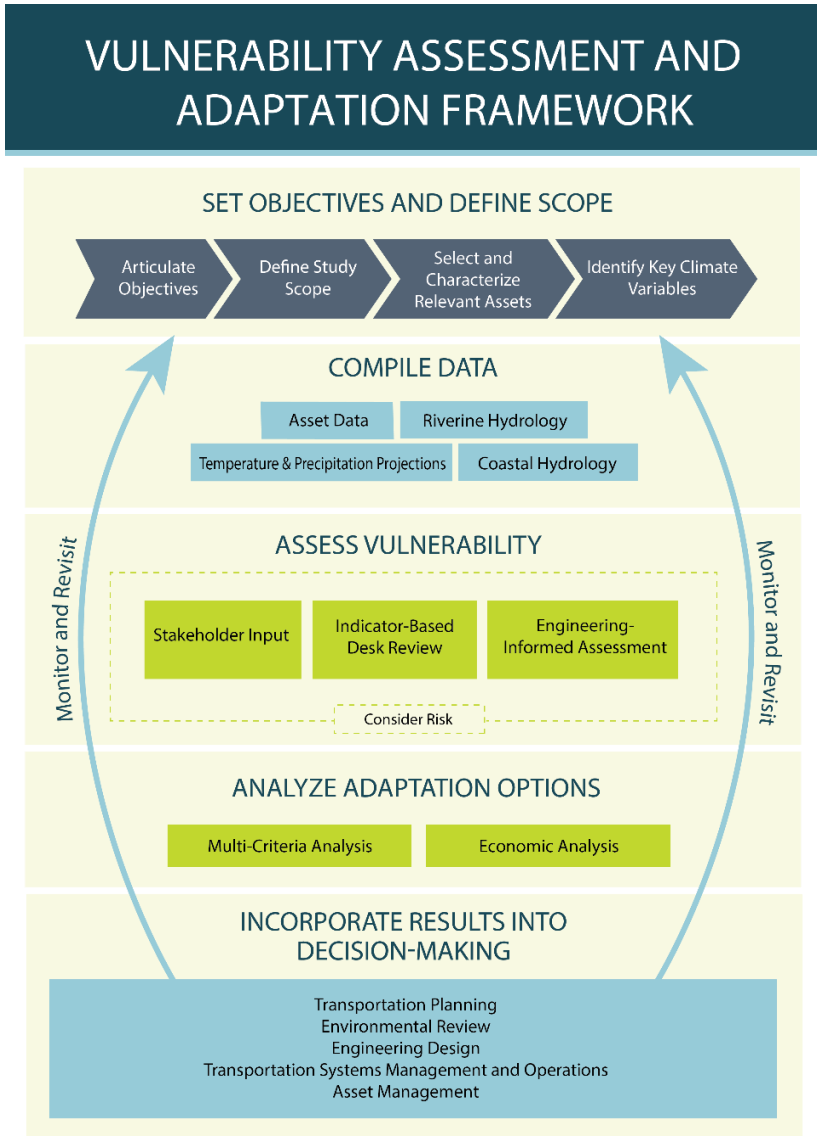
WHEN TRENDS DIFFER:
2. EVALUATE VULNERABILITY

Objective:

- Identify if pavement assets are more vulnerable than other system assets.
- Prioritize potential vulnerabilities for system.

Approach:

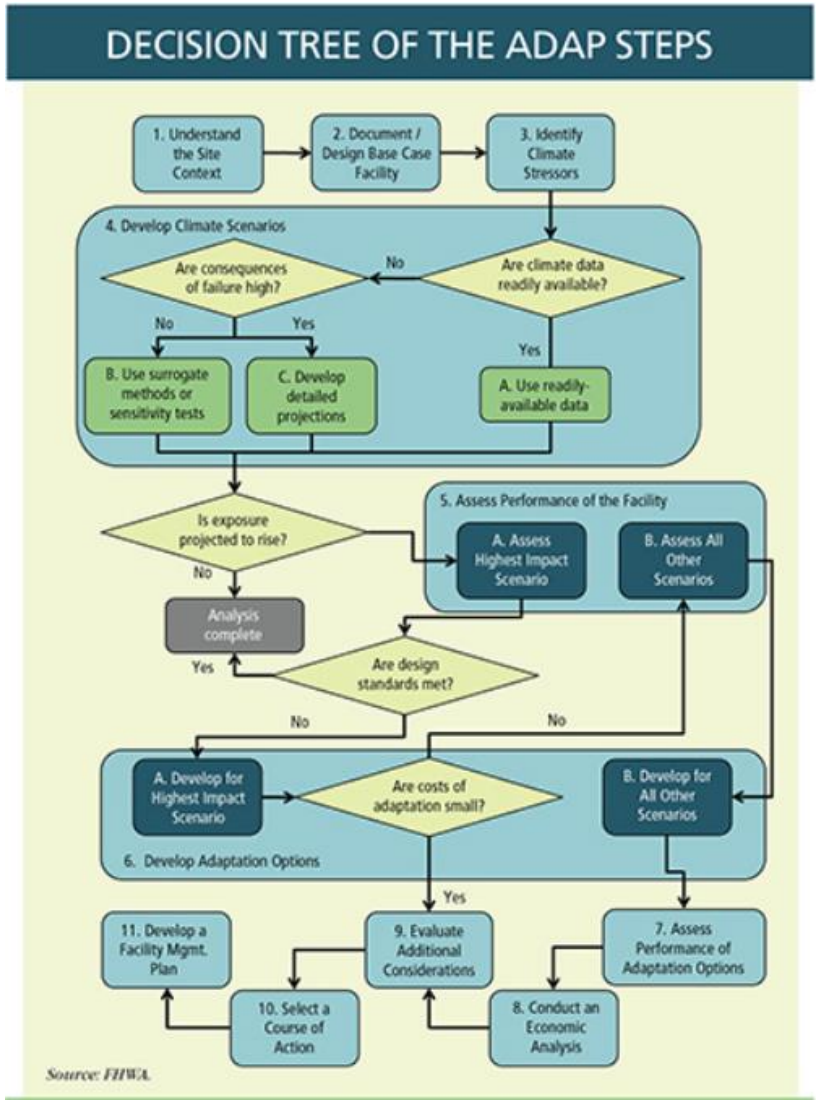
- Use Vulnerability Assessment Scoring Tool.
- Input local asset data.
- Output relative vulnerability score per asset.



3. PLAN AND DESIGN INFRASTRUCTURE TO MEET FUTURE CONDITIONS

- Adaptation Decision-Making Assessment Process (ADAP).
- Risk-based approach for planners, designers, or engineers.
- Tailored to state.
- Aids decision makers in determining which project alternative best **(life cycle costs, resilience, regulatory and political settings).**

www.fhwa.dot.gov/environment/sustainability/resilience/tools



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Case Studies

PAVEMENTS: ADAPTATION CASE STUDIES

These are some examples of recent projects.

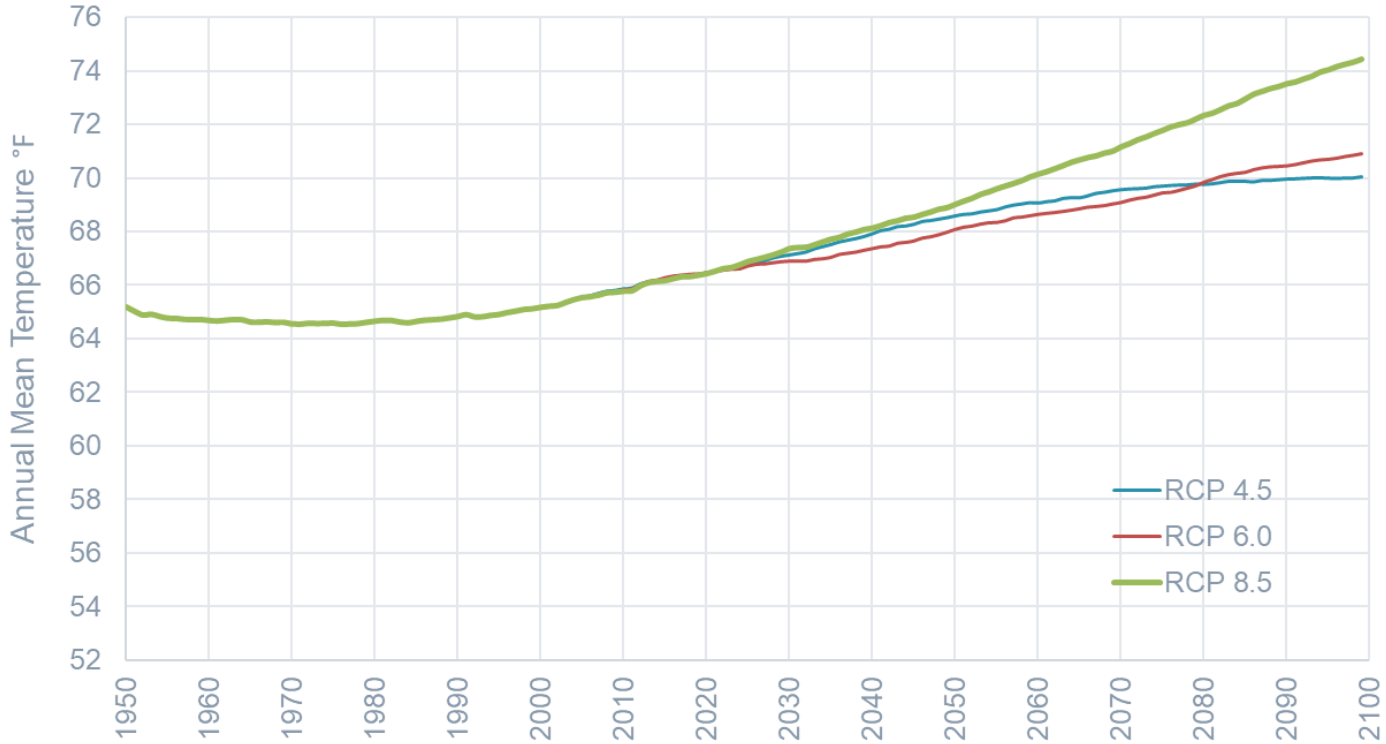
Study Name	Location	Stressor(s) Studied
TEACR Pavement Shrink-Swell	State Highway 170, near Dallas, Texas	Temperature, precipitation
TEACR Pavement Freeze-Thaw	St. Rte. 6/ St. Rte. 15/ St. Rte. 16, Guilford, Piscataquis County, Maine	Temperature, precipitation
GC2 Pavement	Mobile, Alabama	Temperature
WFLHD/Alaska DOT & PF Pilot	Dalton Highway Mile Post (MP) 9 to MP 11, Alaska	Temperature, precipitation
TEACR Slope Stability	I-77, MP 1.8 to MP 6.3, Carroll Co. Virginia	Precipitation, temperature

TEXAS SH 170 – CASE STUDY

- Study Focus
  - Evaluate temperature and precipitation affect on pavement performance.
- Project Scope
  - Dallas, Texas – area expansive soils
  - Proposed project – new construction
- Approach
  - Estimated pavement performance using mechanistic empirical pavement performance prediction models.
  - Used projected climate data for temperature and precipitation.

SH 170 – FUTURE TEMPERATURE CHANGES

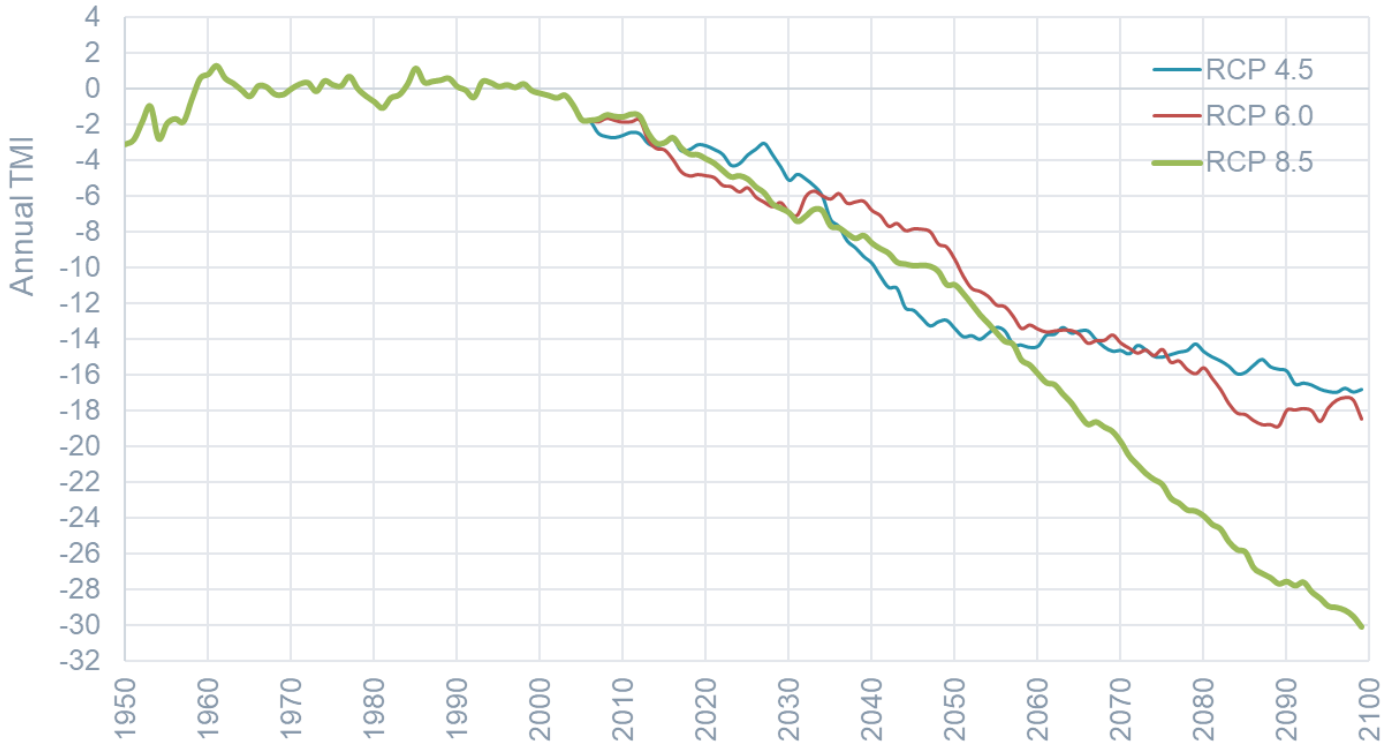
20-Year Moving Average of Annual Mean Temperature at Fort Worth, Texas.



Increase in annual mean temperature by 4 to 6°F
for RCPs 4.5 and 6.0 and by 9 to 10°F for RCP 8.5

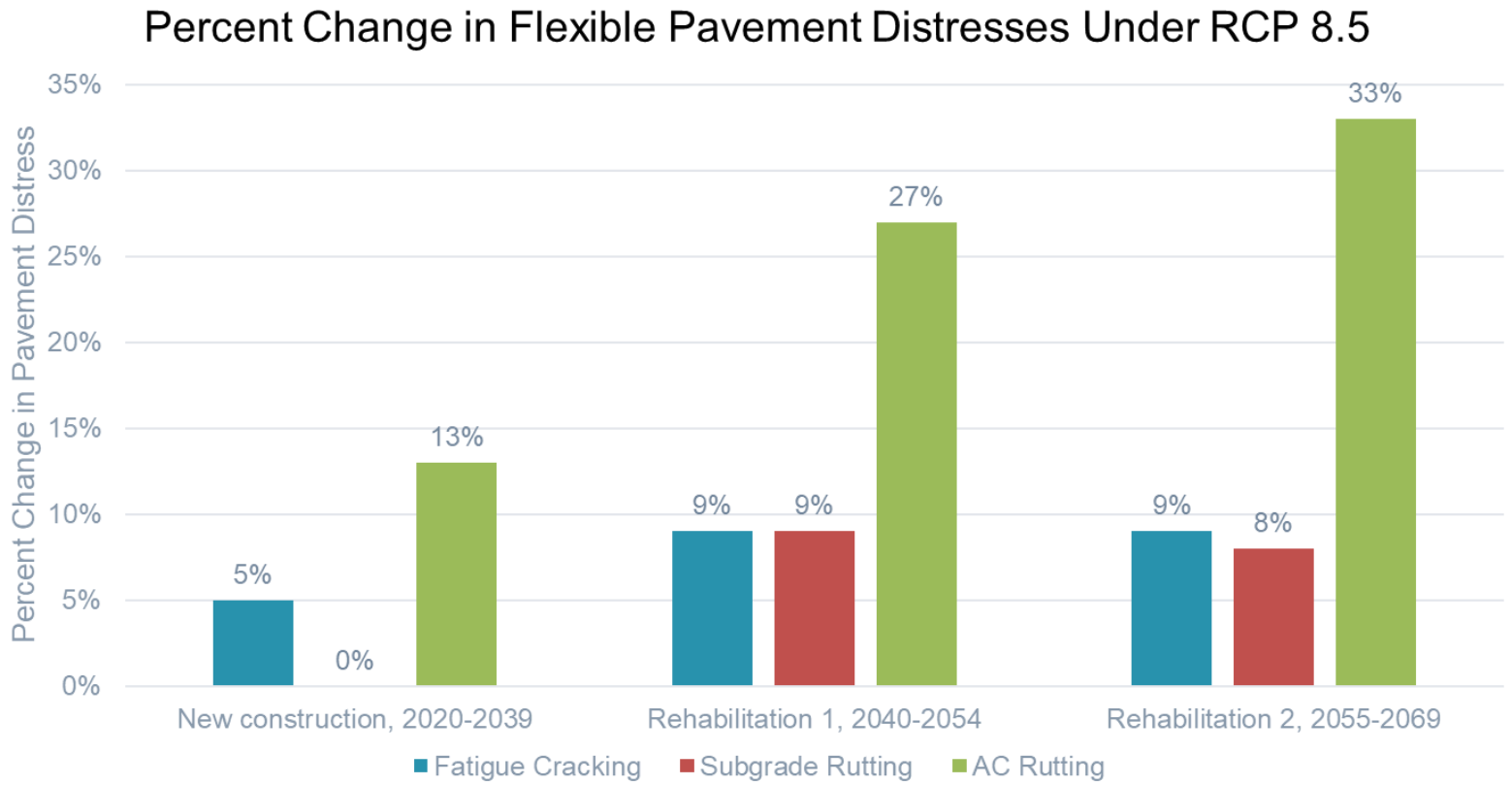
SH 170 – FUTURE MOISTURE CHANGES

20-Year Moving Average of Thornthwaite Moisture Index at Fort Worth, Texas.



Annual TMI will decrease to -18 by 2099 for RCPs 4.5 and 6.0 and -30 for RCP 8.5

SH 170 – IMPACTS TO FLEXIBLE PAVEMENTS



Stiffer asphalt binder grade (from PG 70-YY to PG 76-YY)

SH 170 – IMPACTS TO RIGID PAVEMENTS

- Drying Shrinkage
  - Increase 2.5% per 1% decrease in ambient relative humidity
  - Accelerated by increasing ambient temperature
- Warping Stresses
  - No difference
- Curling Stresses
  - Ambient temperature increases expected to increase temperature gradient
  - Increased curling, 1% increased strains per 1°F increase in temperature
- Crack Width
  - 6% increase due to 3.7% decrease in relative humidity and 3.1°F increase in annual mean air temperature

Higher steel in Continuously Reinforced Concrete Pavements

SH 170 – LESSONS LEARNED

- Increasing temperature and aridity will affect material properties
  - Drying of soils – increased subgrade support
  - Softening of asphalt – increased rutting
  - Shrinkage in concrete – increased crack width
- Study Limitations
  - Effect of soil shrink/swell on pavement roughness
  - Shrinkage cracking in concrete due to drying
  - Vegetation-induced cracking due to arid weather
- More Resilient Pavements Strategies Exist
- Not major cost increase

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Ongoing Efforts

PAVEMENT RESILIENCY PRACTICES

- Joint Project with:
  - Office of Preconstruction, Construction, and Pavements
  - Office of Planning, Environment, & Realty
  - Office of Infrastructure Research and Development

- Project Duration: 2018-2021
  - Literature Review & Gap Analysis
  - Peer Exchange
  - Summary of Practices

HOW CAN YOU HELP?

- Encourage Agencies to Consider Resiliency in Planning, Designs, and Operations
- Help Disseminate FHWA Resiliency Resources
  - Case Studies
  - Vulnerability Assessment
  - Adaptation Decision-Making Assessment Process
- Continue Research

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