Research Team

ICF • WSP
South Coast Engineers

How to Consider a Changing Climate in Transportation Project Development

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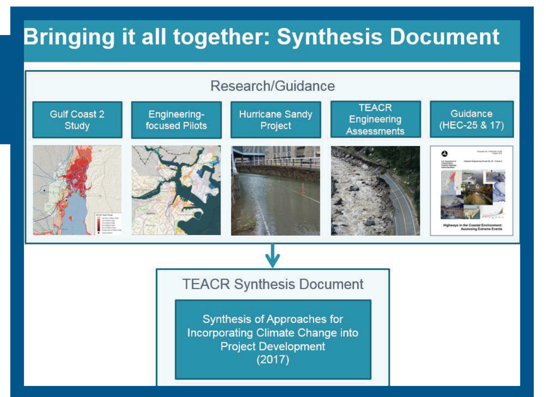
Setting the Stage



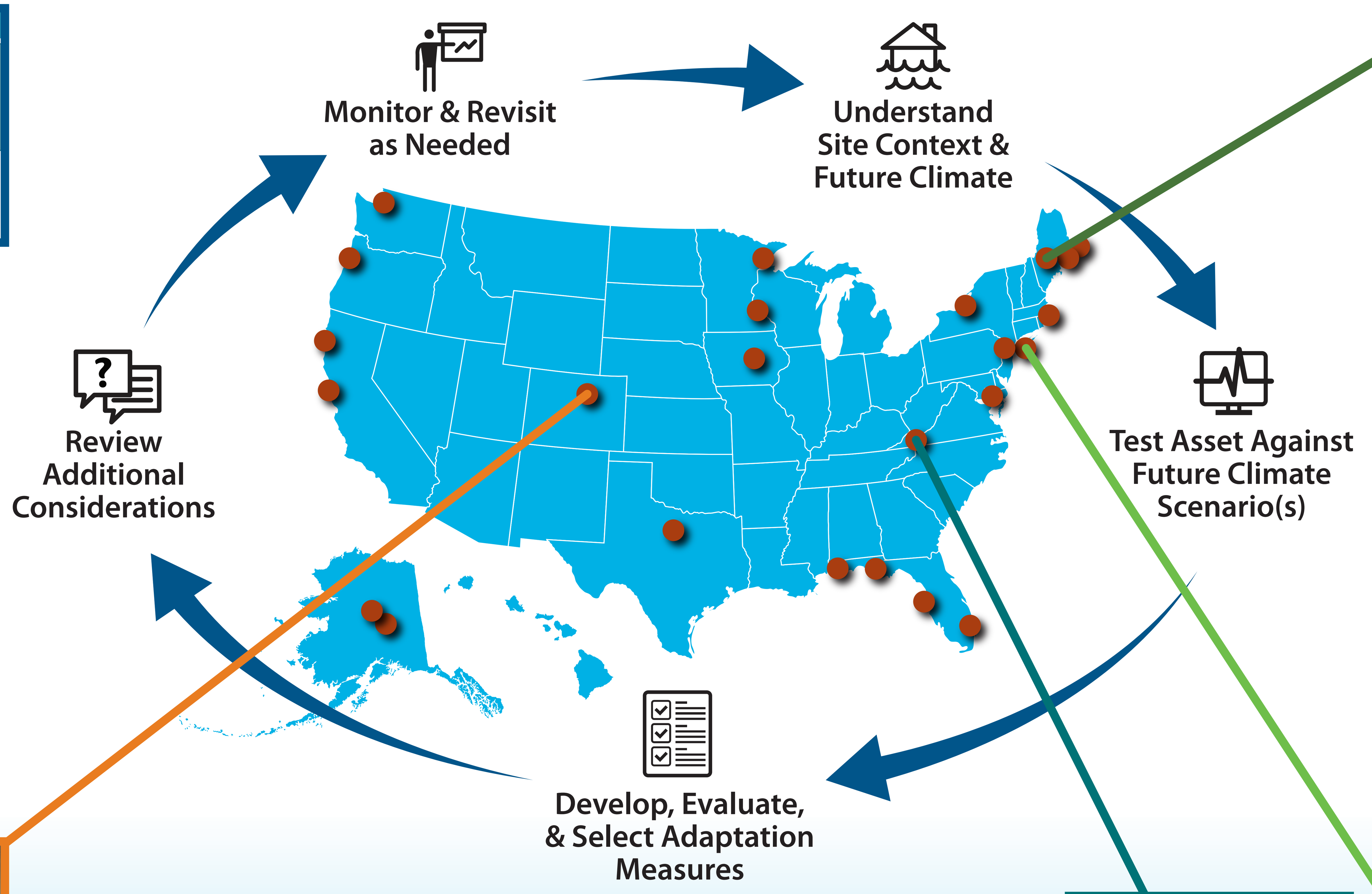
Federal Highway Administration (FHWA)'s Transportation Engineering Approaches for Climate Resiliency (TEACR) Project

Goals:

- Standardize the process for translating scientific climate projections into information applicable to project-level specifications and design.
- Develop a state of the practice set of solutions and methodologies that project engineers across the nation can use in developing transportation infrastructure.

Products:

- Nine additional ***case studies*** of asset-level engineering and economic analyses of climate change vulnerability and adaptation options.
- Lessons learned ***synthesis report*** drawing from set of 23 case studies, and covering:
  - Basic **how-to's** for using climate science and economic analysis
  - **Coastal hydraulics** and climate resilience
  - **Riverine flooding** and climate resilience
  - **Pavement and soils** and climate resilience
  - **Mechanical and electrical systems** and climate resilience



Case Study 1

Dyke Bridge, Maine

Comparison of Economic Analysis Methodologies and Assumptions

Focus: Determine how economic assessment methods, discount rates, and climate stressor-damage relationships affect the estimated benefits of adaptive measures

Key Lessons Learned

- Considering a range of climate change scenarios and adaptation options in economic analyses is a useful way to ensure the selection of a robust adaptation option.
- Either Monte Carlo analysis or the area-under-the-curve technique can be used to estimate project benefits without significant differences in outcomes.
- Economic analysis findings on cost-effectiveness are highly sensitive to the discount rate and climate stressor-damage relationship used.
- When there is uncertainty in the preferred course of action, it is wise to conduct sensitivity tests of different climate stressor-damage relationships to ensure selection of the most robust option.

Case Study 4

Sediment Deposition Inside the US 34 Culvert

Wildfire and Precipitation Impacts on a Culvert

Focus: Combined impacts of changing precipitation and wildfire risk

Adaptation Options

- Pre-fire replacement of existing twin cell concrete culvert with:
  - A larger culvert; - Multi-cell culvert; or - A single span bridge
- Post-fire culvert adaptation
- Post-fire watershed treatment (e.g., debris basin, silt fence, log erosion barriers, hydromulching)

Key Lessons Learned

- The inclusion of wildfire impacts on watershed land cover greatly increases the volume of watershed precipitation-induced stream flow runoff.
- Averaging across climate models to develop precipitation projections masks the fact that plausible future conditions range from wetter to drier conditions. To capture the range of possible futures, a binned approach that pulled out samples of future conditions was used.
- Even though there are risks, adapting the culvert after a fire (rather than preemptively) is recommended because the probability of a wildfire event in the watershed is expected to be low and replacement costs are high.
- If the culvert is scheduled for replacement, upsizing it would be a minor increase in cost and therefore may be worthwhile.

Case Study 3

Completed Toe Wall at the Base of the Sliding Mass, Virginia

Precipitation and Temperature Impacts on Rock and Soil Slope Stability

Focus: Soil slope stability analysis

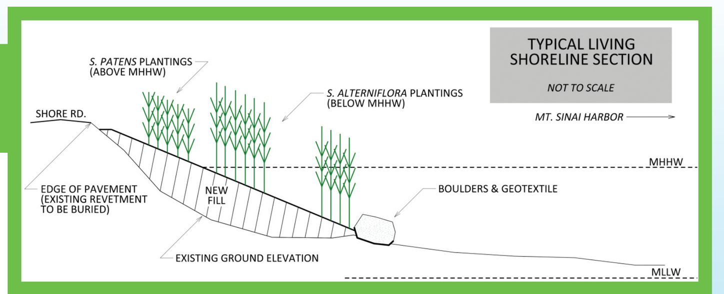
Adaptation Options

- VDOT has taken an adaptive design approach (i.e., they are taking adaptive action in phases, monitoring the results and the environmental projections, and adapting accordingly). The adaptive design approach is strongly recommended when the level of uncertainty is high and budgets are constrained.
- Continued monitoring will ensure that a phased adaptation plan can be used, and that adaptation measures can be refined based on advancements in climate change projections.

Key Lessons Learned

- Detailed climate change projections are not necessary to conduct a screening level assessment of precipitation impacts on soil slope stability. Analyzing the "worst case scenario" can be completed without site-specific climate data.
- The timing and amounts of precipitation immediately preceding a freezing event influences the severity of freeze-thaw damage. Local temperature and precipitation projections must be considered together when projecting the potential for rock slope failure.

Case Study 2



Typical Living Shoreline Section

Living Shoreline along Coastal Roadways Exposed to Sea Level Rise

Focus: Feasibility of living shorelines for coastal road protection

Adaptation Options

- Traditional Protection (Armoring)
- Elevation and Armoring
- Relocation
- Living Shoreline Protection
- Abandonment

Key Lessons Learned

- Natural and nature-based adaptation strategies, like living shorelines, have the potential to reduce vulnerabilities.
- Existing sea level rise projections and frequency-based storm surge data provide suitable information for conducting adaptation assessments.
- Even where living shorelines may not provide comprehensive protection in the long term, they can be used as cost- and environmentally-appropriate measures to provide initial resilience until a more traditional, engineered structure is added for greater protection.
- Living shorelines can be used in conjunction with traditional engineering protection to provide a more complete and resilient system of protection.