# **CTP – Identify Future Deficiency (Resilience)**

## Description

The purpose of this guidance is to assist transportation planners and community leaders in evaluating transportation assets' vulnerability and risk under future conditions, identifying future deficiency related to transportation system resilience, and inform the development of transportation resilience needs in the community.

#### Responsibility

Transportation Planning Division (TPD) Engineer

#### Procedure

Step	Action			
1	The data that was collected during the Comprehensive Transportation Plan (CTP) Set-Up through the Community Understanding Report (CUR), CTP Steering Committee, and NCDOT Division staff input will be used to conduct the future deficiency analysis.			
	<ul> <li>Open the Template for the CTP Resilience Map in the geodatabase.</li> <li>Add collected resilience data.</li> <li>Add your planning area boundary shapefile to the map and clip all remaining layers to your planning area boundary.</li> <li>Check to ensure the symbols for all the resilience shapefiles added to the map match the standard resilience symbols from the template.</li> </ul>			
	Save the Resilience Map(s) to the CTF lolder on the shared drive.			
2	Map forecast resilience data in future time horizons to evaluate future transportation assets' vulnerability and risk and identify locations where damage to assets and/or disruption to traffic may occurred due to impact from extreme weather and climate events under future condition.			
	This process should use results from the NCDOT Resilience Improvement Plan where available, follow state of the practice vulnerability and risk analysis frameworks, leverag resilience data and tools complied in "Collect Data" guidance, findings from relevant vulnerability analysis conducted in the CTP study area, and <u>North Carolina Climate</u> <u>Science Report (ncics.org)</u> or other predictive forecasts that convey the probability of hazard risks for NC counties.			
	Example data and tools:			
	Roadway Inundation Tool (RIT)			
	<u>Coastal Roadway Inundation System (CRIS)</u>			
	For reference, NCDOT recommends using the following forecast data to analyze the potential impact of future extreme weather or climate events on different functional classification of roadways:			
	100-year recurrence interval for interstate highways			
	50-year recurrence interval for US and NC roads			
	25-year recurrence interval for all other roads (e.g., local roads)			
	Separate maps for each recurrence event will help to carry out the future conditions and			

Step	Action	
	deficiency analysis for each road classification.	
3 Similar to the process for identifying existing deficiencies, the list of future resilience deficiencies can be further refined by evaluating whether the vul situations identified in Step 2 exceed the level of acceptable risk threshold community established for the base year analysis. This process should lev the vulnerability maps, criticality maps, and combined maps developed in Resilience Improvement Plan.		
	For example, if the level of acceptable risk threshold for flooding is 0.5 foot <sup>1</sup> in a community, locations with flooding depth over 0.5 foot under future horizons can be determined as future resilience deficiencies.	
	The list of future resilience deficiencies will highlight locations that are vulnerable under both existing and future condition, and locations that are not vulnerable under existing condition but will be vulnerable in the future.	
	These future resilience deficiencies should also be cross-referenced against the STIP and Division Engineer(s) to determine if these deficiencies will be addressed by committed capital improvements.	
4	Documents future conditions and deficiency findings from the mapping exercise in the <i>Resiliency</i> section of the Transportation Planning Data Appendix.	

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<sup>&</sup>lt;sup>1</sup> Six inches of water will reach the bottom of most passenger cars causing loss of control and possible stalling (<u>National Weather Service</u>).

## **CTP – Project Sheet Procedure (Resilience)**

## Description

This procedure outlines how to incorporate resilience-specific considerations into the project sheets to highlight resilience-related deficiencies in an area's transportation system. This may include considerations for each project (i.e., identified from the State Transportation Improvement Program (STIP) or from the closest interim year/s in the Comprehensive Transportation Plan (CTP)/Metropolitan Transportation Plan (MTP)) that indicates potential existing and future risk and vulnerability from natural hazards.

The resilience needs identified in the project sheets will be carried forward to support the evaluation of transportation improvement alternatives and inform recommendations for the CTP.

### Responsibility

It is the responsibility of the Transportation Planning Division (TPD) Project Engineer (PE) to develop the identified need as part of a CTP and to provide project sheets upon request for project development. It is also the responsibility of the TPD Project Engineer to monitor and track requests related to project sheets for project development and documentation.

#### Scheduling and Time Constraints

The project sheets should be completed based on the deficiency analysis.

#### Procedure

Step	Action
1	Following the existing CTP template and guidance, develop project sheets to communicate the existing and future resiliency-related vulnerability and risk of transportation assets based on the evaluation of constraints and future deficiencies.
2	If resilience is the primary purpose and need of a recommended CTP project, the relevant information should be documented in the <i>Identified Need</i> section of the project sheets.
	Incorporate relevant geographic data in the map on the project sheet to represent potential natural hazard risks (e.g., flood risk) with transportation assets. ArcGIS shapefiles should use relevant data from the data collection step in the CTP process.
	This section should explain the "why" behind suggested changes, pinpointing specific resilience needs identified throughout the deficiency analyses. It will serve as a rationale for proposed modifications, aligning recommendations with enhancing the overall resilience of the transportation system.
3	If resilience is not the primary purpose and need for a recommended CTP project, relevant resilience information should be included in the <i>Resiliency</i> section of the Transportation Planning Data Appendix or to the <i>Other Community Interests</i> section of the main document.
4	Any additional supporting resilience-related information not captured in a project sheet should also be documented in the <i>Resiliency</i> section of the Transportation Planning Data Appendix or to the <i>Other Community Interests</i> section of the main document.

Step	Action
	Where appropriate, use maps or descriptions to identify critical infrastructure that would be impacted if transportation services are down

**NOTE:** Avoid the use of 'mitigate' for all project sheets when referencing resilience concepts because environmental mitigation is a separate and distinct issue in NEPA (i.e., projects that may mitigate the impact of a natural hazard or future disaster). Similarly, avoid the use of "will impact" and instead use language such as "may potentially impact" as these have not been definitively quantified at this stage of the CTP process and for these types of natural hazard risks.

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# CTP – Resilience Map (Resilience)

### Description

The purpose of this procedure is to provide guidance for development of a separate Resilience Map as part of the Comprehensive Transportation Plan (CTP) maps development. The map will highlight existing and future deficiencies that should be addressed by the recommended projects and deficiencies that would not be addressed. Carrying forward a map and visual representation of the gaps will allow stakeholders to consider how the gaps can be addressed in future plans and projects.

#### Responsibility

The development of the Resilience Map should follow the guidance outlined in the map development procedure, which is included in the appendix document and states it is the responsibility of the Project Engineer assigned to the CTP study to create the base map and other CTP maps in accordance with Division Standards. The Regional Planning Group Supervisor is charged with the review and approval of the maps.

#### Procedure

Step	Action		
1	Develop a Resilience Map for the Comprehensive Transportation Plan (CTP). The map should overlay the multi-modal CTP recommended projects and infrastructure with key resilience data layers from the deficiency analyses.		
	This map should be developed in accordance with the CTP Maps Development procedure and follow guidelines for map preparation and review.		
	ArcGIS map layers in the Resilience Map should include those layers in the 'Collect Data' guidance. The following is a guiding list and should be cross-referenced with earlier Arc GIS map data collection (see 'Collect Data' guidance).		
<ul> <li>The development of the base map is embedded in this document.</li> <li>Hazard and Vulnerability Layers (i.e., flood hazard zones, storm surviildfire risk, transportation asset condition, historic disaster events</li> <li>Critical Assets and Facilities Layers that require continuity during/a hazard events (i.e., critical facilities, critical infrastructure assets, evacuation routes, shelters).</li> <li>Optional Metropolitan Planning Organization (MPO)/Rural Planning Organization (RPO) guidance and data availability (i.e., environment social layers and resilience indicators and metrics layers).</li> <li>Additional Considerations:</li> </ul>			
	<ul> <li>Add Geotechnical Asset Management (GAM) information to the flood inundation map.</li> <li>Ensure data accuracy and up-to-date information.</li> <li>Use clear and distinct symbols, colors, and line styles for easy interpretation per NCDOT map layout standards and protocols.</li> <li>Include a title. Metadata describing sources, scale, and date of data may not be included directly on the map, except for the base map, and should be saved permanently in accompanying project folders.</li> <li>Consult with stakeholders, including emergency management agencies and local governments, for validation and input.</li> <li>Other unique hazard layers specific to the project area</li> </ul>		

Step	Action			
	$\circ$ Hazard probability (e.g., flood probability) if available			
	The following is a resource list for the types of hazard map layers and/or tools that the review team should be looking for to accurately assess the Resilience Map. This information is also included in the 'Collect Data' guidance and is included here as a cross-reference tool only.			
	North Carolina Specific Datasets			
	<ul> <li>NCORR (<u>https://www.resilienceexchange.nc.gov/</u>)</li> </ul>			
	<ul> <li>Flood Inundation Mapping and Alert Network for Transportation (FIMA T) (<u>https://espgis.com/FIMAN_T/</u>)</li> </ul>			
	<ul> <li>DriveNC (<u>https://drivenc.gov/#incidents</u>)</li> </ul>			
	<ul> <li>Geotechnical Asset Management (GAM) (<u>https://ncdot.maps.arcgis.com/home/item.html?id=6908e4d9497d462c90</u> <u>c0101b50308bd1</u>)</li> </ul>			
	<ul> <li>Bridge Watch</li> </ul>			
	<ul> <li>Request data from Kurt P. Golembesky (kpgolembesky@ncdot.gov), NCDOT Statewide Programs – Highway Floodplain Program Engineer.</li> </ul>			
	<ul> <li>Disaster Recovery</li> </ul>			
	<ul> <li>Request inventory of repair work and emergency relief funding locations from Keith Billy, NCDOT Disaster Recovery Engineer.</li> </ul>			
	<ul> <li>NCDOT Resilience Improvement Plan Data</li> </ul>			
	<ul> <li>Flood zones and coastal management</li> </ul>			
	<ul> <li>Federal Emergency Management Agency's (FEMA) National Flood Hazard Layer provides detailed data layers for Special Flood Hazard Areas (including Zone A, V, A99 and Zone AE, AO, AH, VE, AR; 0.2% - 1% Annual Chance Flood Hazard; Zone X; and Other Areas of Flood Hazard: Zone D). Data can be accessed directly from FEMA (https://www.fema.gov/flood-maps/national-flood-hazard-layer).</li> </ul>			
	<ul> <li>NOAA's Sea Level Rise Viewer provides interactive maps with downloads of potential future sea level rise scenarios and includes layers for sea level rise, vulnerability, and high tide flooding (<u>https://coast.noaa.gov/slr/#/layer/slr/0/-</u> <u>8362447.791970231/4323208.275956043/6/satellite/none/0.8/2050/inter</u> <u>High/midAccretion</u>).</li> </ul>			
	Storm surge			
	<ul> <li>The National Oceanic and Atmospheric Administration (NOAA) provides storm surge inundation maps through its Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. These maps are available for coastal areas and can be accessed through NOAA's Digital Coast platform (<u>https://coast.noaa.gov/digitalcoast/data/home.html</u>)</li> </ul>			
	<ul> <li>NOAA's National storm surge risk map data</li> <li>(https://www.pho.page.gov/actionalsurge/)</li> </ul>			
	( <u>nttps://www.nnc.noaa.gov/nationalsurge/</u> )			
	<ul> <li>The National Hurricane Center Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model (<u>https://www.nhc.noaa.gov/surge/slosh.php</u>)</li> </ul>			
	Wildfire risk			

Step	Action
	<ul> <li>Geospatial Multi-Agency Coordination (GeoMAC) provides near real-time data on active wildfires across the United States. The data includes fire perimeters and hotspots (<u>https://www.usgs.gov/media/images/wildland-</u><u>fire-map-geomac</u>).</li> </ul>
	<ul> <li>LANDFIRE is a program that provides national-scale geospatial data for wildfire risk assessment and fuel management. The data includes vegetation, fire regimes, and historical fire data (<u>https://www.landfire.gov/getdata.php</u>).</li> </ul>
	<ul> <li>United States Geological Survey (USGS) Post Wildfire Debris Flow Hazard Assessment Viewer provides estimates of the probability and volume of debris flows that may be produced by a storm in a recently burned area. The dashboard provides fire location, likelihood, volume, and a combined hazard rating (<u>https://usgs.maps.arcgis.com/apps/dashboards/c09fa874362e48a9afe79</u> <u>432f2efe6fe</u>).</li> </ul>
	Landslide susceptibility
	<ul> <li>The USGS Landslide Hazards Program offers data on landslide susceptibility, landslide incidents, and potential landslide areas. This data can be used to assess landslide risks and plan mitigation efforts (<u>https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=ae1209</u> <u>62f459434b8c904b456c82669d</u>).</li> </ul>
	Earthquakes
	<ul> <li>The United States Geological Survey (USGS) provides a range of earthquake-related data, including seismic hazard maps, earthquake catalogs, and fault line data. These can be accessed through the USGS Earthquake Hazards Program website (<u>https://www.usgs.gov/programs/earthquake-hazards</u>).</li> </ul>
	Sinkholes
	<ul> <li>The USGS provides a national karst map that identifies areas with karst and pseudokarst terrains, or areas prone to sinkhole formation (<u>https://www.usgs.gov/media/images/karst-map-conterminous-united- states-2020</u>).</li> </ul>
	<ul> <li>FEMA Hazus potential disaster loss (https://msc.fema.gov/portal/resources/hazus)</li> </ul>
2	The Resilience Map should be included in the <i>Resiliency</i> section of the Transportation Planning Data Appendix.

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