# Orange-Inal: An Applied Framework to Assess MBTA Rapid Transit Line Vulnerability and Inform Capital Planning

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**Background/Objectives.** The Massachusetts Bay Transportation Authority (MBTA) has demonstrated a commitment to understanding system-wide vulnerabilities and enhancing its resilience to the impacts of climate change. As part of this ongoing effort, the MBTA completed a climate change vulnerability assessment (CCVA) for the Orange Line in August 2021. The assessment follows the completion of a similar evaluation for the Blue Line and was conducted in parallel with a vulnerability assessment of the Red Line. The overall intent of the assessment was to advance and document the MBTA's understanding of its climate vulnerabilities as well as to evaluate the anticipated near- and long-term vulnerability of the Orange Line system to the climate hazards of coastal flooding and sea level rise, extreme precipitation, extreme heat, wind, and winter weather. The MBTA focused on developing a standard CCVA methodology, which will allow the MBTA to conduct comparable assessments for all its assets and infrastructure and integrate resilience considerations into the asset management and capital planning decisions.

**Approach/Activities.** The GIS-based assessment included the stations between Oak Grove and Forest Hills, railway tracks, headhouses, as well as other supporting infrastructure assets. Vulnerability is described as a function of exposure, sensitivity, and adaptive capacity. For the exposure assessment, the project team considered the potential impacts from sea level rise and storm surge, heavy precipitation events and inland flooding, extreme heat, high winds, and winter weather events related to extreme cold, snow, and ice. Sensitivity was assessed through asset complexity, history of exposure, and location. Adaptive capacity was determined by asset redundancy, distance from maintenance and back-up supplies, and existing flood protection systems. Composite vulnerability scores for all assets were then evaluated, based on those three components, for the 2030 and 2070 planning horizons.

**Results/Lessons Learned.** The results of this work included a detailed final report, online ArcGIS map viewer to navigate across exposure, sensitivity, adaptive capacity, and vulnerability scores, as well as an interactive ArcGIS StoryMap, which summarized the findings of the CCVA. These products recommended priority areas for additional studies and considerations for adaptation strategies. Recommendations included considering the infrastructure itself and the people who rely on the system, specifically the MBTA employees who operate and maintain the system, as well as the riders and dependent communities. Future phases of work are expected to include refining the flood model at specific sites along the Orange Line and providing recommendations for making the Orange Line more resilient to climate change.