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CLIMATE CHANGE ADAPTATION IN A COASTAL NEW HAMPSHIRE WATERSHED: IMPROVING CULVERT INFRASTRUCTURE FOR INCREASED STORM FREQUENCY AND INTENSITY

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Extreme precipitation events have increased in frequency and magnitude over the past two decades across the Northeastern United States. Global climate change models predict that this trend will continue over the next fifty to one hundred years regardless of future reductions in global greenhouse gas emissions. In addition, due to ongoing development, watersheds throughout the coastal zone are becoming increasingly altered by impervious surfaces (roads, roofs, parking lots, etc.). The combination of these changes means that many of the region's road-stream crossings will experience stormwater flows that they have not been designed to safely convey. Failures of culverts during peak flow events can lead to extensive damage to road infrastructure and property, severe degradation of aquatic habitat, and sometimes even loss of human life.

The Piscataqua Region Estuaries Partnership (PREP) is one of twenty-eight programs included in the U.S. Environmental Protection Agency (EPA) National Estuary Program. The EPA is developing climate change adaptation strategies through its "Climate Ready Estuaries" initiative. As part of this initiative, PREP convened a technical team to conduct a climate adaptation pilot project in the Oyster River watershed in southeastern New Hampshire. The project identified specific road/stream crossing culverts that are threatened with failure as a result of impacts from increasingly extreme storm events due to climate change, as well as from future hydrologic modifications due to watershed development. The intent of the project was to develop a practical adaptation strategy to proactively reduce negative climate change impacts on stream habitat and road infrastructure.

The study approach utilized geographic information system (GIS) watershed modeling techniques to examine the hydrologic impact of several climate change and land use scenarios on existing culvert infrastructure. Through the efforts of local project partners, all the major culverts in the watershed (110 culverts) were assessed and mapped with a standardized protocol. Data on culvert capacity, vegetation cover, slope, soils, permeability, roads, and land use were used to create a nested GIS model that calculates runoff volumes for the 24-hour, 25-year precipitation event for current and projected future precipitation patterns. For the model of future conditions, two build-out analyses were developed for the study watershed based on current zoning ordinance regulations: one that assumes full build-out based on existing patterns of development, and one that incorporates available Low Impact Development (LID) techniques. The Geophysical Fluid Dynamics Laboratory CM-2.1 climate model output was used as the basis to estimate mid-21st century storm event magnitudes and return intervals for the A1B and A1Fi global greenhouse gas emission scenarios developed by the Intergovernmental Panel on Climate Change.

Utilizing the model results, the project team is developing recommendations for culvert improvements based on risk, cost, and infrastructure lifespan considerations. Project results provide a specific climate adaptation plan strategy to local communities, evaluate the contribution of LID techniques in mitigating development impacts at the watershed scale, and provide a repeatable methodology for application to other coastal watersheds.

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