

# A Case Study of Flood Protection for a Water Treatment Plant

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## WHY SHOULD UTILITIES AND COMMUNITIES MITIGATE NATURAL-HAZARD RISK?

The United States now spends an average \$100 billion annually to recover from natural disasters, a quantity that represents 8% of its annual construction expenditures. That is, disasters now effectively wipe out one month's nationwide construction cost every year. The fraction is growing geometrically, 6% per year, 10 times faster than the US population for reasons explained in Porter and Yuan (2020). That growth is unsustainable. In one year, 2017, the US lost over \$300 billion to natural disasters, effectively erasing 25% of its annual construction expenditures. Accompanying those financial losses were enormous human losses: people whose homes, livelihoods, and even lives were swept away in minutes, hours, or days. Among those losses were damage to utilities and transportation infrastructure.

Even without the threat of unsustainable growth in disaster losses, community leaders and utility managers have humanitarian and fiduciary duties to protect constituents and assets. Those duties can often be well served by engaging in natural hazard mitigation, which can lower society's long-term cost of owning its infrastructure below that of building for least first cost or deferring maintenance. The Multi-Hazard Mitigation Council (2019) shows how a variety of mitigation measures save over 10 times the up-front cost of better construction or post-construction retrofit, through avoided future losses. A 10:1 benefit-cost ratio (BCR) equates with a 900% return on investment (ROI). In an economy where a 10% ROI is admirable, 900% should be strongly compelling. But many people find long-term averages, BCRs, and ROIs abstract, hard to relate to. So, SPA offers this working paper as one of a series of short documents showing another way to look at mitigation: through the eyes of people who have done it.

## HURRICANE FLOYD EXPOSED FLOOD RISK AT A WATER TREATMENT PLANT

Greenville, North Carolina's water treatment plant abuts the Tar River just west of the Pitt-Greenville Airport. It was damaged when Hurricane Floyd dropped more than 15 inches of rain in 24 hours after making landfall at Cape Fear, North Carolina, on September 16, 1999. According to the National Oceanic and Atmospheric Administration, the hurricane killed 57 people (36 in vehicles) and caused between \$4.5 billion and \$6 billion in damage. North Carolina alone suffered 35 deaths, \$3 billion in loss, 7,000 homes destroyed, 56,000 homes damaged, requiring 1,500 people to be rescued from flooded areas, and leaving 500,000 people without electricity. Flooding on the Tar River at Greenville reached 30 feet, 17 feet above flood stage, and 9 feet above the elevation of the water treatment plant, beating the previous record by 8 feet. The unprotected water treatment plant flooded (Figure 1).

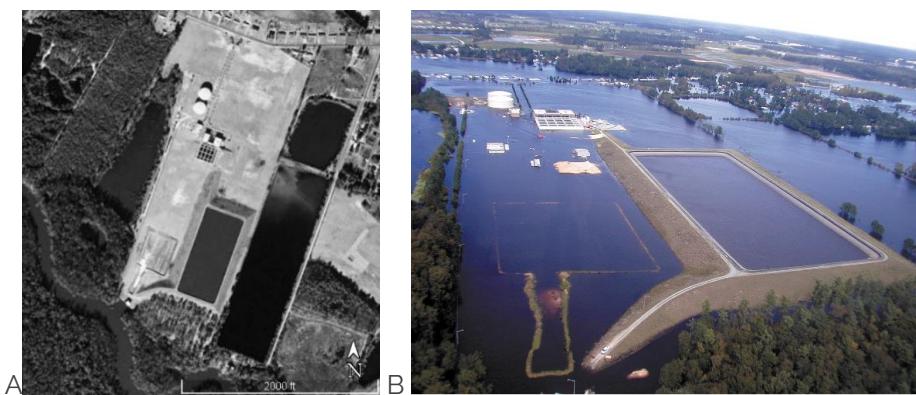


Figure 1. The Greenville, North Carolina water treatment plant (A) in January 1999, and (B) on September 22, 1999, just after Hurricane Floyd. (Image credit: (A) Google Earth, (B) Dave Gatley, public domain)

**NEW FLOOD PROTECTION WORKED IN HURRICANE MATTHEW IN 2016**

The Economic Development Administration, under its Economic Adjustment Assistance program, gave \$4.8 million (approximately \$6.8 million in 2018) to Greenville Utilities for flood protection, which included money to raise a flood protection wall and berm around its water treatment plant. Seventeen years after Floyd, the new flood protection proved its value. On October 8 and 9, 2016, Hurricane Matthew dropped up to 15 inches of rain on North Carolina. On October 14, the Tar River crested in Greenville at 24.5 ft, which is 11.5 ft above flood stage and 3.5 ft above the elevation of the water treatment plant. Floodwaters reached the water treatment plant's new floodwall to the west and flooded the field to the north, but the new berm and floodwall prevented flooding from entering the water treatment plant. Figure 2 shows outflow from pumps dewatering the plant during Hurricane Matthew and an aerial image of the plant and its new flood wall and berm the day after the Tar River peaked on October 15. We estimated the benefit-cost ratio to be 31:1 (a 3000% return on investment; Multi-Hazard Mitigation Council 2019, p. 407), but the psychological benefits may be more compelling.

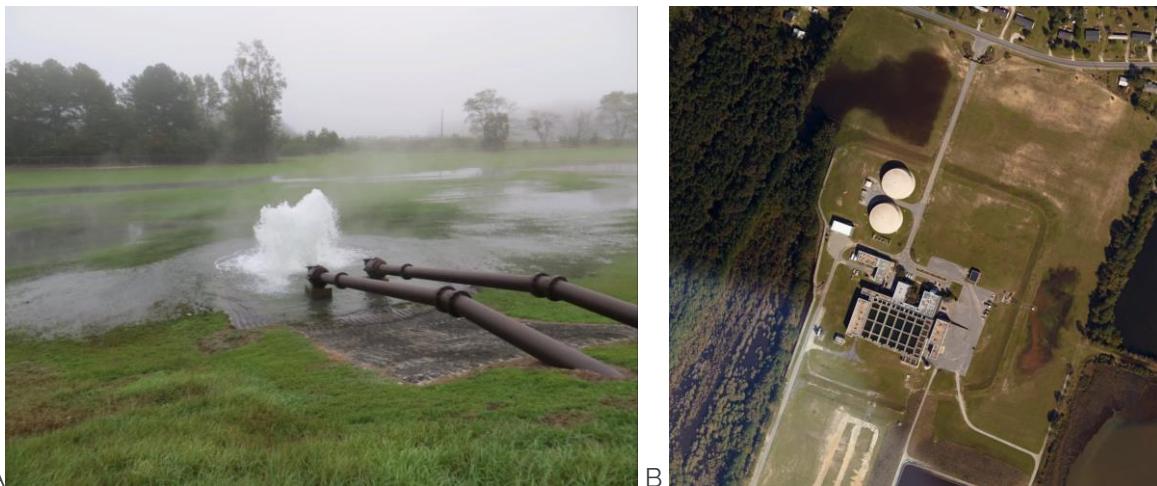


Figure 2. (A) The new pumping station at the water treatment plant dewatering the plant during Hurricane Matthew. (B) The new floodwall and berm surrounding the facility. Standing water from the Tar River can be seen north of the plant and water removed by the pumps can be seen to the east of the plant. (Image credit: (A) Greenville Utilities, use claimed under Fair Use Doctrine (B) NOAA National Geodetic Survey, October 15, 2016)

In two employee-appreciation lunches that the Greenville Utilities Commission held in November, 2016, after Hurricane Matthew, General Manager/CEO Tony Cannon spoke at length about the employees' exemplary performance and their success in safely and quickly returning electric service to customers, but said nothing about the water treatment plant and how well the new flood protection had worked. Maybe the reason is that the best protection is the one that performs so well that it never even occurs to you to worry that it might have gone otherwise. But when I asked Greenville Utilities Commission Public Information Officer and Communications Manager Steve Hawley to reflect on the berm and floodwall in July 2019, he replied,

*When we heard the first projections for the flooding that Hurricane Matthew would bring, it was unnerving – the similarities to Hurricane Floyd. It was a comforting feeling though, to know that our team had had the foresight to make sure that when the flood waters come again, our drinking water supply would be just fine. We were very confident the berm would protect our water treatment plant. Last year, it was sad to see communities in North Carolina who have not protected their water plants. They were overrun by flood waters caused by Hurricane Florence. Our hearts went out to them and, once the waters receded, our crews went to assist them.*



Greenville Utilities PIO  
Steve Hawley

## REFERENCES CITED

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## ABOUT THE AUTHOR



Keith Porter, PE PhD F.SEI is a principal of SPA Risk LLC, and research professor at the University of Colorado Boulder. He serves as principal investigator of Natural Hazard Mitigation Saves and led the engineering of the USGS's ShakeOut, ARKStorm, Tsunami, and HayWired scenarios. He helps organizations understand, measure, manage, and reduce risk from earthquake, hurricanes, floods, and other natural disasters.