

The Great Flood of 2010: A Municipal Response

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Abstract

On March 30, 2010, the Pawtuxet River breached the levee surrounding the Warwick Sewer Authority (WSA)'s wastewater treatment facility (WWTF), filling the campus with an estimated 75 million gallons of stormwater and wastewater. The Flood completely wiped out the treatment processes as well as six (6) pumping stations located along the banks of the Pawtuxet River. This paper chronicles the actions taken before, during and after The Flood, discusses the resulting damages, identifies vulnerabilities to be addressed with future improvements and mitigation efforts, relates lessons learned, and offers some recommendations for utility managers and emergency response professionals.

Background and Introduction

The City of Warwick's WWTF was constructed in 1965 and discharges treated effluent to the Pawtuxet River. The WWTF is designed to process 7.7 million gallons per day (mgd) of wastewater with a peak capacity of 17.7 mgd. The WWTF currently services about 65,000 residents and 1,500 businesses in the City of Warwick with an average daily flow of 5 mgd. The WSA's collection system consists of 270+ miles of pipe and forty-eight (48) sewage pumping stations, a

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Photo Credit: J. Burke

majority of which are located in low-lying areas adjacent to the City's 39 miles of coastline and the Pawtuxet River, which serves as its border with West Warwick and Cranston.

The WWTF is located in what is referred to as an "ox bow." The Pawtuxet River wraps around the WWTF on three sides, with Interstate Route 95 bordering the WWTF to the east (see Figure 1). After repetitive flood damages to the WWTF, the City constructed a protective berm, or levee, in the mid-1980s to protect the WWTF from future damages. The City's Animal Shelter is also located within the confines of the levee. The levee was designed to protect to the 100-Year Flood level, plus three feet of freeboard.

In March of 2010, record rainfall in Rhode Island caused the Pawtuxet River to crest to the highest levels ever recorded at the U.S. Geological

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Figure 1 - Aerial of Warwick WWTF

Survey (USGS) gauge on the Pawtuxet River at the Warwick-Cranston line: 14.98 feet on March 15th and 20.79 feet on March 31st. On March 30, 2010, the Pawtuxet River breached the levee surrounding the WSA's wastewater treatment facility, filling the campus with an estimated 75 million gallons of stormwater and wastewater. The Flood completely wiped out the treatment processes as well as six (6) pumping station located along the banks of the Pawtuxet River.

Like every water and wastewater utility, WSA is required to have emergency plans in place for every conceivable contingency. WSA has numerous emergency procedures detailed in Operations and Maintenance manuals. WSA has back-up power, portable generators and pumps, and other equipment needed in an emergency. But the WSA had never conceived of, and certainly had never planned or rehearsed for, a scenario where the disaster was so widespread and catastrophic that existing equipment and personnel were overwhelmed. The treatment facility was destroyed, six pumping stations were

out of service, and sewage back-ups were occurring in many areas of the City simultaneously.

The response to this level of disaster had not been scripted. WSA staff improvised, sought assistance, and found solutions to problems as they occurred. Staff was focused and flexible and did a great job with triage. Although previously not part of the City's Incident Command Structure, the WSA was pulled in and supported by the City's Emergency Management Agency (EMA) with resources immediately available from the Fire, Police, Management Information Systems (MIS) and Public Works Departments.

Despite the initial devastation, the collection system and basic treatment operations were restored in less than a week. The WWTF was in compliance with its pollutant discharge permit less than three months after The Great Flood (see Figure 2). As a result of the actions taken by many, the public health and environmental impacts of the natural disaster were shorter-term and less significant than originally anticipated.

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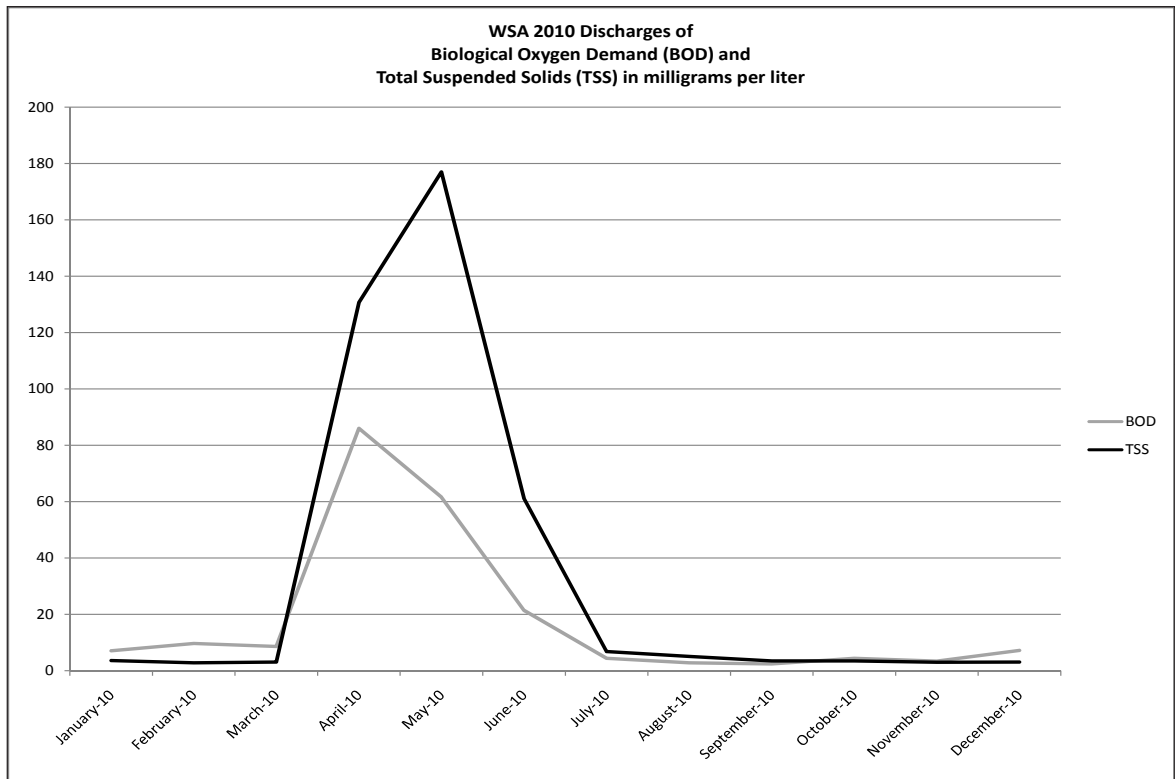


Figure 2 - WSA Effluent Data for Major Constituents

Description of Events

A “Dry” Run

The March 15th flooding was, at the time, the worst the Pawtuxet River communities had experienced. Photographs from this storm are pretty frightening. See Figures 3 and 4. The Pawtuxet River flooded its banks in numerous locations and rose to within a foot and a half of the top of the WWTF levee.

The WSA lost three (3) pumping stations in this storm and staff worked around the clock to prevent sanitary sewer overflows by setting up by-pass pumping and otherwise diverting sewage from the damaged areas of the collection system. The WSA sustained about \$50,000 in damages during “The Little Flood” and had just begun a serious analysis of flooding vulnerabilities when “The Big Flood” occurred.

The Big Flood

In late March, meteorologists and emergency management professionals started to warn local EMAs about heavy rain and flooding predictions. WSA received notification and activated its emergency plans on Sunday, March 28th. On Monday, WSA was invited to an afternoon meeting called by the City’s EMA Director that included representatives from the Police and Fire Departments, the Department of Public Works and the Mayor’s Office. Also on Monday, WSA staff began relocating all vehicles and major portable equipment to the highway overpass, out of the reaches of the Pawtuxet River. The Mayor and EMA Director issued an advisory regarding voluntary evacuations in areas that had been hard hit in The Little Flood.

On Tuesday morning, although it continued to rain hard, the National Oceanographic and

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Figure 3 - Western Side of Levee at Warwick Wastewater Treatment Facility, March 15, 2010.

Photo by Patrick Doyle



Figure 4 - Knight Street Pumping Station, located in a Pawtuxet River floodway, during The Little Flood. The station was designed like a submarine to operate in flood conditions. Note the smoke visible from the generator smokestack. This station pumped a lot of river water to the treatment plant before it was shut down in The Big Flood. *Photo by Patrick Doyle*

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Atmospheric Agency (NOAA) was still predicting Pawtuxet River elevations that were below the elevation of the WWTF's levee. During the course of that morning, the WWTF was receiving flows that were five times the average, exceeding the WWTF peak flow rating. The facility experienced intermittent but frequent power losses. The storm drain system for Interstate Route 95, which runs through the WWTF, began backing up.

The Superintendent, in an effort to reduce flows and save the plant, decided to shut down several pumping stations located in low-lying areas along the Pawtuxet River. They were mostly pumping river water and a lot of the neighborhoods had been evacuated, which greatly assisted emergency efforts. The WSA coordinated this action with its insurance company and then Reverse 911 calls were made to the areas serviced by these pumping stations, explaining the decision and asking customers not to flush or use their facilities until further notice. A media advisory was issued by the Mayor's Office about the calls and the evacuation of the Animal Shelter.

The City's MIS department was called upon to back-up all files on the WSA's computer servers. Operations staff were relocating computer systems and important documents and maps to the second floor of the Operations Building and attempting to secure everything they could. All non-essential staff were ordered by the EMA Director to evacuate the facility at 1:00 pm. At approximately 1:15 pm, the Pawtuxet River breached the western side of the levee and began flooding the treatment facility. There was nowhere for the water to go and it quickly filled up the approximately 18 acres located within the confines of the levee and the highway (it later forced its way up onto the highway). Essential staff remained to remove and/or secure as many pieces of equipment and documents as possible but had to evacuate at about 1:45 pm on March 30th.

Shortly after the treatment facility flooded, the Mayor of Warwick declared a State of Emergency and activated the City's Incident Command Structure (ICS). WSA was hurriedly added to the ICS organizational chart and briefed



Figure 5 - Pawtuxet River crests the western side of the levee at approximately 1:15 PM on Tuesday, March 30, 2010, and begins flooding the treatment facility. *Photo by Peter Ginaitt.*

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on ICS procedure. WSA staff moved to the City's Emergency Operations Center (EOC), located in the Fire Department, and were assigned emergency response duties.

WSA had to wait for the Pawtuxet River to recede before beginning restoration work on the treatment facility. In the interim, staff came up with a plan of action in conjunction with engineering consultants and contractors who had been hired under emergency purchasing procedures. Equipment, especially pumps, and other resources were mobilized. The Operations and Maintenance (O&M) staff, with no plant left to operate or maintain, was divided up into five different groups and assigned to complete an assessment of every pumping station. Pretreatment personnel were sent out to investigate blockages. Laboratory personnel dispatched pumping services for residents. An emergency hotline was established and billing and administrative staff fielded a huge number of calls and questions.

The WSA, in conjunction with the Mayor's press office, began issuing statements about the situation along with instructions and up-to-date information for residents. The information included requests to reduce all water usage until further notice. The schools and many businesses complied willingly by shutting down or curtailing operations. The Mayor briefly ordered the City's laundromats to close. The Rhode Island Airport Corporation and other large companies brought in portable restrooms and utilized paper products to eliminate the need to use water for flushing and cleaning. People were warned that discharging storm water into the sewer system was illegal. Cooperation and understanding from the public was excellent.

Figure 6 shows the organizational structure implemented by the WSA as part of the City's ICS. During the State of Emergency, the WSA Executive Director reported to a Fire Chief. A

Collection System Manager was assigned to work directly for the Director during the emergency response and was responsible, working with the Assistant Superintendent, the Lead Maintenance person and many contractors, for numerous pump stations that were inoperable. The Superintendent was in charge of supervising the treatment facility reconstruction efforts.

WSA staff and hired consultants devised a "critical path" plan to restore treatment facility operations. This plan identified the critical processes and equipment that needed to be restored and in what order. The critical path included establishing temporary electrical power, dewatering the treatment facility and process tanks, restoring preliminary treatment or screening/removal of solids from the incoming wastewater, reestablishing forward flow through the process tanks, setting up a temporary location for disinfection of wastewater before discharge to the Pawtuxet River, and getting rid of sludge and solids to restore primary treatment. Reestablishing communications with 48 pumping stations was also a priority. After these initial emergency actions, longer-term actions included much electrical work and rebuilding blowers to provide air to the biological process.

On Thursday, April 1st, portable electrical power was set up. With the River starting to recede enough by late afternoon, dewatering operations were immediately initiated with any available pumping equipment. O&M staff continued to monitor the 48 pumping stations around the clock as all alarms/communications systems were destroyed. Maintenance crews worked to repair the damaged pumping stations to restore wastewater collections throughout the City.

On Friday, April 2nd, large 12-inch pumps obtained by contractors began arriving from as far away as Indiana. Once these large pumps were set up, the dewatering operations picked up speed.

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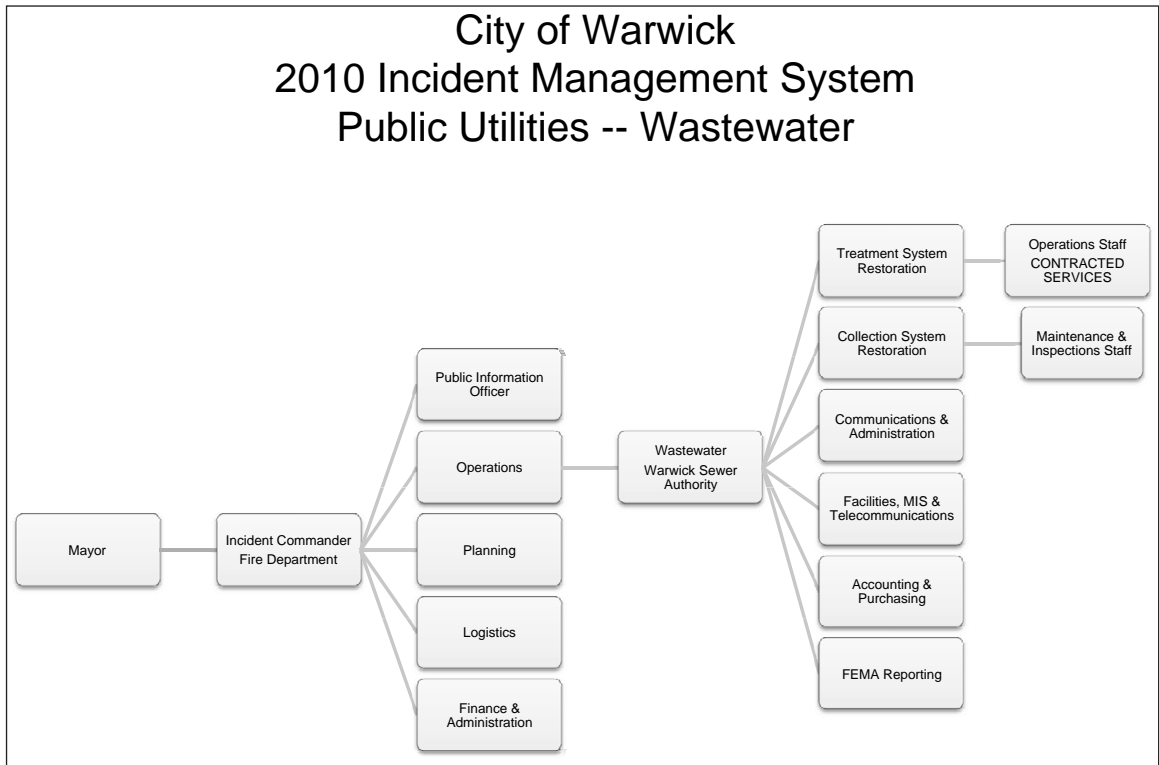


Figure 6: WSA IMS in response to The Great Flood.

Damage assessments were initiated as soon as equipment became accessible. Problem areas in the collection system had been successfully bypassed while repairs could be completed.

On Saturday, April 3rd, more permanent but still temporary electrical power was established with the cooperation of National Grid. As tanks were dewatered, wastewater flow was directed through the plant to a point at the back of the facility where a temporary chlorine disinfection process was assembled. Calls coming into the EOC started to be referred to United Way 211, which had set up a hotline and compiled a variety of information to assist Rhode Islanders dealing with The Great Flood.

On Easter Sunday, April 4th, maintenance crews succeeded in restoring all remote pumping operations and flushing restrictions were eased. Operations staff and disaster recovery contractors

and advisors restored primary treatment and continued the damage assessments. The water was gone at this point, leaving behind thick layers of sludge over everything. Cleaning and disinfection efforts picked up speed. WSA's insurance provider stepped in and took charge of quickly gutting and restoring all the buildings.

Soon operations staff were set up in trailers on the site. Administrative staff continued to work in the EOC but more permanent temporary office space was quickly located for WSA and the Animal Shelter staff at a vacant State-owned building not too far from the treatment facility. WSA moved in within about a week, with MIS and other personnel hustling to get telecommunications and computer servers set up at the new location.

Another two months of work was required to restore the secondary treatment process and once that was on-line, it was only another two weeks

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until the biological nutrient removal process became operational, 81 days after the facility was flooded. At the same time, building cleaning and restoration, which was spearheaded by the City's insurance company, allowed staff to re-occupy administrative, laboratory, and treatment facility buildings by mid-July.

Total damages from The Great Flood are currently estimated at \$14 Million, \$10 Million of which has been covered by insurance. The City hopes to recoup 90% of the remainder of the damages from the Federal Emergency Management Agency (FEMA). By far, the majority of damages were related to electrical systems. As a result of The Flood, new energy-efficient blowers and controls were installed with a large grant from the Rhode Island Office of Energy Resources.

The WSA has taken steps to mitigate the vulnerabilities identified during The Great Flood. A Community Development Block Grant disaster relief program grant is paying for engineers to study the flood plains around the WWTF and come up with a plan to better protect the WWTF from future flooding. Plans are on the table for the relocation of the Knight Street and Bellows Street pumping station out of the floodway and above the 100-year flood plain. The WSA has applied for other grants from FEMA (hazard mitigation program) and the Economic Development Administration (supplemental disaster relief funds), and has explored numerous other grant opportunities that resulted from the flood devastation.

Lessons Learned and Recommendations

Have a Plan

Utilities need to plan for the worst. They need to perform honest assessments, identify vulnerabilities with critical infrastructure and come up with a plan for what to do when those fail. This information is also helpful for prioritizing

mitigation measures and grant proposals. Consider problems such as accessibility to infrastructure and localized events that affect employee availability. In The Great Flood, Interstate 95 was shut down just north of the WWTF. Access to the Knight Street and Bellows Street pumping stations could only be done by boat.

Create an organizational chart for emergencies and make sure it is incorporated into your City's Incident Management Structure. Figure 6 shows how the WSA organized itself for emergency response to The Great Flood. Think about appropriate roles for employees. Get someone trained to be Incident Commander. Assign an Emergency Information Officer. Conduct Table Top exercises of various disaster scenarios. There are resources and table top exercises readily available from EPA.ⁱ Before a disaster strikes, run through a critical path for restoring services in different scenarios. Know what kind of documentation is required to be reimbursed by FEMA and have someone trained to jump into that role. The WSA was lucky to have qualified professionals employed at the time of The Great Flood who took on all these roles and more in the emergency response.

Make a list of critical documents. Have back-ups for computer records and paper records. Digitize as much as possible. If you still have a lot of paper records, consider how you would haul it off site in an emergency. Have a plan for backing up computer records so you are able to access them remotely if necessary. Luckily for WSA, the company brought in to get the plant back on-line had been previously responsible for plant upgrades and had all the as-built drawings for the facility readily available. But the WSA spent precious time trying to locate the drainage plans for the Animal Shelter before finding out that the drains were connected to catch basins and would not be helpful in draining the campus. Not having the information you need when you have

ⁱSee <http://water.epa.gov/infrastructure/watersecurity/climate>

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to make a quick decision could be catastrophic in an emergency.

Have access to a dedicated telephone number for everyone to call in the event of an emergency. Make sure you have enough emergency response equipment or know where to get it when you need it. Think about what you would do for office space if yours is completely destroyed. Would you bring in temporary office trailers? Work out of another City Department?

Have back-up procedures in place in the event that computers, especially Supervisory Control and Data Acquisition (SCADA) systems are down. Plan for operators doing rounds with clipboards and checklists to monitor and report plant conditions. Periodically train everyone on the back-up procedures.

Don't forget to plan for loss of revenues. Having the utility or a section of the utility out of service for an extended period of time while also incurring large expenses could be another major disaster.

Communicate

Effective communications is an absolute necessity during a major disaster. A message focused on public health issues seems to resonate with the public. Have a central number for people to call. Have a fact sheet ready to go with disaster information for residents related to sewer or water outages. There needs to be a script for clerical staff and others to assist in answering the public's questions.

The City's website and a message with updates on the main telephone line were helpful. Using Reverse 911, the City of Warwick was able to reach lots of people very quickly (over

60,000 phone calls in short timeframe were made during The Great Flood). Some problems with the system include not being able to reach people who might be working or commercial businesses located in the City. Also, no cell phones were on the call list. The local Chamber of Commerce was a great resource, helping WSA reach the business community with important messages.

Ask For Help

Have a list of contacts readily available for a variety of emergency needs. Develop good relations with local and State EMA offices in times of calm. When disaster strikes, don't hesitate to use the ICS system to call on the resources of FEMA, the U.S. Army Corps of Engineers (USACOE) and the National Guard.

Governing Board cooperation will be essential to authorize emergency purchases and help in making other necessary decisions. You will have to contact your regulatory agencies but don't be afraid to reach out to them for help as well. The regional office of the U.S. Environmental Protection



Figure 7: WFD assists WWTF mechanics to boat over 500 feet to the Knight Street pumping station for a check after the March 30th storm. Photo by Earl Bond.

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Agency (EPA) and the Rhode Island Department of Environmental Management (RIDEM) sent WSA resources to assist with everything from old-school effluent testing to FEMA reporting. They established an ad hoc task force to deal with disaster recovery at the three Pawtuxet River WWTFs. Their experience and perspective were helpful.

Have established relationships with vendors as well as bids in place for emergency services which helps in a pinch to quickly mobilize resources. WSA had bids in place for pumping services and electrical services. WSA quickly re-directed on-going engineering services to disaster recovery services. Insurance companies can be very knowledgeable and helpful in dealing with disasters. It's a good idea to make sure all existing vendors have contingency plans as well. You cannot afford any delays in products or services because vendors are affected by the same natural disaster.

The people and organizations that reached out to help the WSA after The Flood are too numerous to name but we thanks them all.ⁱⁱ

Mitigate

Prioritize critical infrastructure susceptible to flooding. Consider elevations and relocations of critical infrastructure or look at increasing redundancy or system capacity as alternatives. Look throughout the system at influent pipes, force mains on private property, and main lines serving

hospitals or other critical facilities, which are just a few things the WSA needs to consider as part of its mitigation plans. Prepare Hazard Mitigation Plans in conjunction with your municipality's Incident Command or Emergency Management Agency.

Improving Responses to Natural Disasters

Public Utilities need to push for better predictive flooding data and warning systems.ⁱⁱⁱ We need to be aware of the numerous sources of information and understand their limitations. We need as much information as possible in order to make the best decisions for our utilities when disaster strikes. We need to be at the table when emergency management scenarios are being discussed and responses practiced.

Better coordination between and among neighboring communities could lead to improvements. And full implementation of a State-wide WARN system should be a priority. Your state EMA should be involved in that effort. We need to be able to access equipment and human resources in an emergency and it needs to be fast and simple.

Keeping the public informed regularly during an emergency response is crucial. Consider tools like the Reverse 911 program and special messages on web sites and main phone lines. Develop relationships with local news outlets and they can really help you get the word out in an emergency. Better customer notification systems are still needed.

ⁱⁱPartial listing of those assisting in WSA response to The Great Flood: Mayor Scott Avedisian, the WSA Board of Directors, employees and families of the WSA, City Council members, other City departments, especially the Fire Department, Public Works, MIS and Purchasing, Hart Engineering, Fall River Electric, AECOM, RIEMA, FEMA, RIDEM, USEPA, Rhode Island Department of Health, Rhode Island Department of Administration, National Grid, Kent County Electric, The Rhode Island Interlocal Risk Management Trust, New England Interstate Water Pollution Control Commission, Rhode Island Department of Transportation, Rhode Island Airport Corporation, Rhode Island National Guard, U.S. Army Corps of Engineers, Senator Jack Reed's Office, United Way 211, Father Marciano, Central Rhode Island Chamber of Commerce, and the Pawtuxet River Authority.

ⁱⁱⁱIn the case of The Great Flood, the model based on the Cranston USGS river gauge was sensitive to "poor pool elevation data". The storm had excellent lead time but was under-forecast which seems to point to the predictive model as an issue.

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Conclusion

The Great Flood of 2010 has given public water utilities a reason to re-examine our existing emergency response plans. We need to imagine and prepare for worst-case scenarios. We cannot pretend this will not happen again and we need to stop using terms like “500-year” flood which lulls people into a state of amnesia and denial. We need to perform an honest assessment of flooding vulnerabilities (risk versus cost to adapt/mitigate). We need to identify critical facilities and infrastructure and determine ways to mitigate potential damages. We need to practice what to do in various emergency scenarios.

We do important work but usually only get recognition when something goes wrong. In over a decade working in wastewater, I have seen that the worst can happen. And I have seen that natural disaster events are all too real and frequent. Climate change is here and if we do not start to adapt, there will be more and more interruptions in critical utilities and services in the future. If you cannot adapt or mitigate then you must be prepared to respond to minimize service interruptions when the worst happens.

As the fortune from a Chinese cookie advised me shortly after The Great Flood: “Over prepare, then go with the flow.”