EPA REGION 1 RECOMMENDED PROCEDURES AND RESOURCES FOR THE DEVELOPMENT OF ADAPTATION PLANS FOR WASTEWATER TREATMENT SYSTEMS AND/OR SEWER SYSTEMS

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I. Overview

Wastewater Treatment Systems (WWTS) and/or sewer systems encounter many challenges related to major storm and floods events, aging infrastructure, natural hazards, and other critical priorities. Each WWTS and sewer system should consider many different options and the range of possible benefits in order to develop a comprehensive plan that satisfies utility needs without overstretching resources. Resilience planning is not a new or separate effort for WWTS and sewer systems. Strategies can provide greater resilience along with other benefits, such as more sustainable and efficient operations, cost savings, and protection of surface water designated uses, including recreational, aquatic life and drinking water uses. Implementing strategies that provide multiple benefits can be integrated into current asset management, permit compliance, emergency response planning, capacity development and other decision-making processes at utilities.

In the recent past, storm events have led to the failures of multiple wastewater treatment systems in Vermont and Rhode Island. WWTS and sewer systems are particularly vulnerable due to their locations, which are often at the lowest level in a community and adjacent to water bodies. For example, in July 2023, the state of Vermont experienced a major storm and flooding event with upwards of seven inches of rain falling in about 24 hours. Operations at 33 WWTS were disrupted, and several facilities were rendered inoperable and in need of significant rebuilding.

Resilience planning involves more than just a review of options for facility owners and operators to consider. Several technical and informational resources are required to support planning. For example, inundation maps[1], weather variability maps[2], and streamflow maps[3] may all need to be employed in the determination of thresholds for flooding and the assessment of adaptive measures to mitigate losses. An integral part of increasing WWTS and/or sewer system

[1] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=852ca645500d419e8c6761b923380663
[2] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=3805293158d54846a29f750d63c6890e
[3] https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=48dcf8ca136a49a298a60e31422d58f0

resilience is to properly assess the risk of potential major storm and flood events, evaluate options for addressing the risks and adopt a plan for implementing options that minimize those risks.

Resiliency planning should be an iterative process of identifying impacts and challenges, assessing risks from these impacts, selecting and implementing adaptive measures and then revisiting assessments when new information is available or when additional capacity to implement options is in place.

The purpose of this document is to assist owners and operators of wastewater treatment systems and/or sewer systems develop adaptation plans as required in Region 1 NPDES permits. The document provides recommendations and procedures for the use of a free EPA tool developed specifically for water utilities. However, as described in the permit itself, other approaches providing equivalent analysis may also be used.

II. Recommended Approach

EPA Region 1 recommends the use of EPA's Creating Resilient Water Utilities' (CRWU) CREAT Risk Assessment Application for Water Utilities for conducting the risk and adaptive measures assessments required as part of the Adaption Plan in EPA Region 1 NPDES permits. EPA's CRWU initiative provides drinking water, wastewater, and stormwater (water sector) utilities with practical tools, training, and technical assistance to increase resilience. CRWU assists water sector utilities by promoting a clear understanding of major storm and flood events and helping to identify potential adaptive measures, implementation options, and infrastructure financing.

CREAT is an online tool that assists water sector utilities in assessing weather-related risks to utility assets and operations. As the user works through CREAT's five modules, users consider weather-driven impacts and identify adaptive measures to increase resilience. The modules are:

1. **Climate Awareness:** User provides basic utility information. The module results provide increased awareness of weather variability impacts.
2. **Scenario Development:** Understand utility risk; design scenarios of threats based on weather data;
3. **Consequences and Assets:** Outline potential consequences; catalog critical assets;
4. **Adaptation Planning:** Inventory current actions that provide resilience; design adaptation plans; and
5. **Risk Assessment:** Assess risk from weather driven impacts to; compare risk reduction of adaptation plans.

Incorporating CREAT results into best management practices and capital investment decisions builds customer and stakeholder confidence that a utility is being proactive in identifying significant weather-related risks.

CREAT provides data, such as temperature, precipitation, and surface water flow data, for the analysis location selected. Coastal data including vertical land movement, storm surge and number of days with tidal flooding is also provided for coastal locations, which are near tidal water bodies.

CRWU Resources

- **EPA's CRWU** initiative provides water sector utilities (including wastewater treatment systems and sewer systems), as well as state and local governments, with the practical tools, training, and technical assistance needed to build resilience to major storm and flood events. https://www.epa.gov/crwu

- **CREAT**: Water sector utilities and stakeholders can use baseline and long-term weather variability scenarios to assess their risks. This free tool is an easy-to-use, risk assessment application that guides users through the process of identifying extreme weather events. https://www.epa.gov/crwu/climate-resilience-evaluation-and-awareness-tool-creat-risk-assessment-application-water

- **Resilient Strategies Guide:** An introductory tool to adaptation planning where utilities can explore and gather basic information on extreme weather readiness and adaptation. https://www.epa.gov/crwu/resilient-strategies-guide-water-utilities#/

- **Data Services:**
  - Storm Surge Inundation Map: https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=852ca645500d419e8c6761b923380663
  - Weather Variability Map: https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=3805293158d54846a29f750d63c6890e
  - Streamflow Map: https://epa.maps.arcgis.com/apps/MapSeries/index.html?appid=48dcf8ca136a49a298a60e31422d58f0

- Online CRWU Training for the Northeast facilities is available at: https://www.epa.gov/crwu/training-and-engagement-center#show_hide_northeast

CREAT Resources

- CREAT is free and users can register for an account at: https://www.epa.gov/crwu/climate-resilience-evaluation-and-awareness-tool-creat-risk-assessment-application-water

- EPA. 2021. CREAT Methodology Guide. https://www.epa.gov/crwu/climate-resilience-evaluation-and- awareness-tool-creat-methodology-guide

- To learn how other utilities have used CREAT, see https://www.epa.gov/crwu/adaptation-planning-action for case studies.

- CREAT Wastewater Case Studies from EPA Region 1 from the following communities are attached.

  - Montague Water Pollution Control Facility and South Hadley Water Pollution Control Division, Massachusetts
  - Manchester-by-the-Sea, Massachusetts https://youtu.be/MsNuIgFgoso
  - City of Portsmouth, New Hampshire
  - Greater Augusta Utility District, Maine

- More case studies are available at: https://storymaps.arcgis.com/stories/1b5126bb60bd495a9ff9b05a732b6e5b

III. Recommended Assumptions

Baseline Conditions

"Baseline Conditions" are the current flood elevations. EPA recommends assuming that baseline conditions are equivalent to the FEMA 100-year flood elevation when assessing the vulnerability of critical assets.

Future Conditions

"Future conditions" refers to projected flood elevations using one of two approaches:

a) Climate Informed Science Approach (CISA): The elevation and flood hazard area that result from using the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding. These shall include both short term (10-25 years forward-looking) and long term (25-70 years forward-looking) relative to the baseline conditions and must include projections of flooding due to major storm and flood events using federal, state and local data, where available;

b) Freeboard Value and 500-year floodplain Approach: The flood elevations that result from adding an additional 2 feet to the 100-year flood elevation for non-critical actions and by adding an additional 3 feet to the 100-year flood elevation for critical actions compared to the flood elevations that result from 500-year flood (the 0.2% -annual-chance flood) and selecting the higher of the two flood elevations. Federal Emergency Management Agency (FEMA) develops flood maps that delineate Special Flood Hazard Areas (SFHAs) based on flood insurance studies. There are two levels of SFHAs, the 100 and 500-year flood plain. The 100-year flood plain contains areas that are subject to inundation by a flood that has a 1 percent or greater chance of being equalized or exceeded during any given year. Areas within the 100-year flood plain are considered high risk. Between the limits of the 100-year and 500-year flood plain is an area with a 0.2 percent (or 1 in 500 chance) annual chance of flooding. These areas are considered moderate risk and subject to shallow flooding.

Infrastructure Life Expectancy

For the purposes of the development of the Adaptation Plans, users should consider component/system life expectancy to be as follows:

- Twenty (20) years for mechanical and electrical systems;
- Fifty (50) years for tankage and similar structures; and
- New infrastructure should consider longer life expectancies, especially in coastal areas subject to sea level rise and coastal erosion.

IV. Developing an Adaptation Plan

The following outlines steps permittees can take to develop an Adaptation Plan, consistent with the permit requirements. Steps 1 and 2 guide permittees to create an asset inventory and to screen those assets for flooding vulnerability using FEMA FFRMS Beta Flood Standard Support Tool: https://floodstandard.climate.gov/, which are statistical evaluations of historical hydrological data. Steps 3 and 4 guide permittees through the use of the free CREAT online tool to further evaluate the most vulnerable assets (identified in Steps 1 and 2) against major storm and flood events.

Definitions are provided in Section V of this document.

Component 1: *Identification of Vulnerable Critical Assets*

Step 1: *Asset Inventory*

Inventory all critical assets (e.g. treatment units, WWTS, outfall, septage collection facilities, pump stations etc.) and related operations (referred to collectively herein as "assets") and the elevation of each asset (above sea level).

Step 2: *Identify Vulnerable, Critical Assets*

a) Compare the asset elevation to both the baseline condition flood elevation and the future condition flood elevation. See example table below.
b) Assets that are identified in Step 2 as vulnerable to flooding should be carried forward into Step 4.

Table 1: Example of Summary of Vulnerable Critical Assets Table

		Vulnerability		
Asset	**Elevation of Asset (ft)**[4]	**Elevation of baseline condition flood (ft)**	**Elevation of future Condition Flood (ft)**	**Vulnerability to Flooding (ft)**[5] **(Yes/No)**
Pump Station (floor)	52'	60.7'	63.7'	Yes
Non-submersible pump	52'	60.7'	63.7'	Yes
Power supply	62'	60.7'	63.7	No/Yes

Component 2: Adaptive Measures Assessment

Step 3: *Develop baseline and long-term weather variability scenarios for risk assessment including consequences.*

Using EPA's CREAT tool (https://www.epa.gov/crwu/climate-resilience-evaluation-and-awareness-tool-creat-methodology-guide)

Tips for using CREAT for developing an Adaptation Plan:

CREAT Module 1: Climate Awareness

- System Type = Wastewater Only
- Climate Basics = Northeast; warmer, wetter; stormier
- Current Concerns – Focus on concerns that are presently being addressed. Consider how these existing concerns might be exacerbated by weather-driven threats.

CREAT Module 2: Scenario[6] Development

- Threat Identification – at a minimum include floods, and service demand and use.
- Baseline Scenario: use built-in historical data, and/or custom data, if available, including data specific to the utility location.
- Time Period: Permittees should evaluate both short and long-term time horizons. The short-term horizon should be the basis for adaptation planning. The long-term horizon should be evaluated to inform the user of the worst case scenario.

[4] Elevation of the Asset = elevation of floor, above sea level.
[5] If the elevation of Flood Threat is higher than the elevation of the asset, then yes.
[6] In CREAT, scenarios refer to groups of threats that are defined by users based on available baseline and long-term weather data, as well as any other relevant data, such as demand forecasts.

- Scenarios: Scenarios are based on data in CREAT, and/or custom data. At a minimum Permittees in Region 1 should consider multiple scenarios to understand the range of threats that could impact utility assets and operations. Use additional data, if available, including utility specific data.
- Threat Definition: Permittees should define the selected threats in terms of the frequency, duration and magnitude based on the appropriate data for each scenario. The same threats are used in all scenarios; however, the specific threat definitions will differ based on the data used to delineate the scenario.

CREAT Module 3: Consequences and Assets

- Economic Consequences Matrix – CREAT provides default definitions for the levels of consequences in each category to use in the assessment of each asset/threat pair. Default values are based on user inputs that include system type, population served, total flow in MGD, ownership (public or private), and financial[7] condition of the utility.
- Regional Economic Consequences – CREAT estimates regional economic consequences based on location, utility type and populations along with additional databases.[8]
- Public Health Consequences – CREAT evaluates public health impacts in terms of fatalities and injuries. Values are calculated on value of a statistical life and the value of statistical injury.

Step 4: *Conduct a risk and adaptive measures assessment for the highest risk, vulnerable assets (identified in Step 2).*

CREAT Module 4: Adaptation Planning

- Asset Identification and Assignment of Threats – using the highest risk, vulnerable assets identified in Component 1, Steps 1 and 2, enter the selected critical assets using either the CREAT library or add custom assets. Asset definition includes a description of the asset and the assignment of relevant threats.[9]
- Adaption Plan Selection and Use in Assessments

[7] See CREAT Methodology Guide, p 23-30.
[8] See CREAT Methodology Guide, p. 30-32.
[9] See CREAT Methodology Guide, p. 33.

  - Identify Existing Adaptive Measures – use the adaptive measures library or define custom adaptive measures.
  - Potential Adaptive Measures – use the adaptive measures library or define custom adaptive measures. For each adaptive measure, cost data and threat relevance must be entered to support the calculations following the risk assessment. Users can choose to adopt default ranges for their location or provide their own estimated costs.[10]
  - Adaptation Plans – by grouping potential measures together, users develop adaptive plans.

CREAT Module 5: Risk Assessment

- Consequence Assessment Process – The final outputs from CREAT are based on a standard risk assessment process where consequences are assessed as monetary impacts. The sum of these impacts for a specific asset/threat pair provides a measure of risk, expressed as a range from minimum to maximum overall impact.
- Risk Assessment Results
  - Monetarized risk with Current Measures;
  - Monetarized risk with the Adaptation Plan implemented;
  - Monetarized risk reduction;
  - Adaptation Plan cost;
  - Regional economic consequences for both Current Measures and the selected Adaptation Plan;
  - Public health impacts for both Currents Measures and the selected Adaptation Plan.
- Scenario Likelihood Sensitivity Analysis – CREAT calculates three ranges of scenario likelihood where the comparison of cost with risk reduction would support different decisions.
  - Wait and See
  - Consider Implementing Plan
  - Implement Plan
- Plan Comparison – CREAT provides a table on adaptation plans that were considered during the risk assessment.
  - Users are asked to consider additional impacts for the adaption plans that were not considered as part of the consequence assessment earlier.
  - Users also revisit consequences categories that were previously deferred for consideration.
- Generate a Plan Report including the sub reports: Climate Awareness, Scenario Development Summary, Consequences and Assets Summary, and Adaptation Summary.

[10] See CREAT Methodology Guide, p. 34.

Component 3: Implementation and Maintenance Schedule

> Step 5: *Using the CREAT Plan Report as a baseline, prepare an Implementation Schedule.*

V. Definitions

For the purposes of this document, the following definitions apply.

Adaptive measures – physical infrastructure or actions and strategies that a utility can use to protect their assets and mitigate the impacts of threats. They may include but are not limited to building or modifying infrastructure, utilization of models (including but not limited to: flood, coastal flooding and storm surge, sewer/collection system, system performance), monitoring and inspecting (including but not limited to: flood control, infrastructure, treatment) and repair/retrofit.

Asset related operations - are elements of an asset that are critical to the function of that asset. For example, pumps and power supply are a critical operation of a pump station.

Baseline conditions – current flood elevations. See recommended assumptions above.

Critical asset – an asset necessary to ensure the safe and continued operation of the wastewater treatment system and/or the sewer systems and ensure forward flow and treatment of wastewater in accordance with the limits set forth in an NPDES permit.

Extreme/heavy precipitation - instances during which the amount of rain or snow experienced in a location substantially exceeds what is normal according to location and season.

Future conditions - projected flood elevations. See recommended assumptions above.

Impact – a strong effect on an asset and/or asset-related operation that may include destruction, damage or ineffective operation of the asset and/or asset operation. Impacts may be categorized as economic, environmental, or public health related.

Major storm and flood events - instances resulting from major storms such as hurricanes, extreme/heavy precipitation events, and pluvial, fluvial, and flash flood events such as high-water events, storm surge, and high-tide flooding.

Non-critical assets - all structures and systems not necessary for the operation of the wastewater treatment system and/or sewer systems.

Sewer System - sewers, pump stations, manholes and other infrastructure use to convey sewage to the wastewater treatment facility from homes or other sources.

Threats – climatic, hydrologic, geophysical, and geochemical changes in terrestrial and aquatic ecosystems that alter the operating environment of utility facilities and operations.

Wastewater Treatment System (WWTS) - any devices and/or systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature. It does not include sewers, pipes and other conveyances to the wastewater treatment facility.

VI. Other Resources

Executive Order 11988, *Floodplain Management*, May 1977
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https://www.epa.gov/sites/default/files/2015-08/documents/flood_resilience_guide.pdf

EPA. 2009. Synthesis of Adaptation Options for Coastal Areas.
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https://resilientma.mass.gov/rmat_home/designstandards/index.html

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https://neiwpcc.org/learning-center/tr-16-guides-design-wastewater-treatment-works/

NEIWPPC. 2016. Preparing for Extreme Weather at Wastewater Utilities: Strategies and Tips.
https://neiwpcc.org/wp-content/uploads/2017/06/9-20-2016-NEIWPCC-Extreme-Weather-Guide-for-web.pdf

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https://toolkit.climate.gov/content/northeast-climate-hub

U.S. Global Change Research Program (USGCRP). 2018. Fourth National Climate Assessment, Volume II: https://nca2018.globalchange.gov/

U.S. Global Change Research Program (USGCRP). In development. Fifth National Climate Assessment: https://www.globalchange.gov/nca5

ATTACHMENT A

Case Studies

MANCHESTER-BY-THE-SEA, MASSACHUSETTS

Background

Manchester-by-the-Sea, Massachusetts provides drinking water and wastewater services to residents, tourists and local businesses. The wastewater treatment plant (WWTP) is located at Manchester Harbor and is designed for an average daily flow of 1.2 million gallons per day (MGD), a maximum daily flow of 3 MGD and an instantaneous maximum flow of 5 MGD. The WWTP is permitted to discharge a monthly average of 1.2 MGD from December through May and 0.67 MGD from June through November. The WWTP has an 8,900 foot outfall that discharges outside of the harbor.

Challenges

Manchester-by-the-Sea is concerned with flooding from heavy precipitation events, coastal storm surge and sea-level rise. The sanitary collection system serves about half of the community, but has a high rate of inflow and infiltration (I&I) during heavy precipitation events. The WWTP is also not permitted to bypass wastewater treatment, even during heavy flows. Most of the WWTP is located within the 100- and 500-year flood zones, including the headworks building, which is at a high risk of flooding. The parking lot adjacent to the WWTP has also flooded during especially high tides and storm surge events in the past.

Planning Process

To better understand the vulnerability of its wastewater infrastructure and operations, Manchester-by-the-Sea assessed potential climate change impacts using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). The CREAT assessment brought together individuals from EPA, various departments within Manchester-by-the-Sea, state agencies and local environmental organizations to think critically about potential climate impacts, prioritize assets and consider possible adaptation options.

Resilience Strategies and Priorities

Manchester-by-the-Sea considered the potential consequences of extreme flooding events on its wastewater utility infrastructure and operations. To assess each of these potential threats, Manchester-by-the-Sea considered how potential adaptive measures would help lower consequences. See the table below for potential adaptive measures that were considered.

Type	Resilience Strategies
Flooding from coastal storm surges	Relocate WWTP to higher ground to avoid damage from coastal storm surge
	Construct a sea wall on Manchester Harbor to protect the WWTP from coastal storm surge
	Green infrastructure at the facility to reduce parking lot flooding
	Join the mutual aid network, Massachusetts Water/Wastewater Agency Response Network
Flooding from heavy precipitation events	Relocate WWTP to higher ground to avoid damage from flooding
	Green infrastructure in the community to capture stormwater flows
	Future infiltration and inflow reduction activities to complement existing efforts
	Incorporate leakage reduction into ongoing utility maintenance

Contact Information

For more information regarding Manchester-by-the-Sea's resilience planning, contact Greg Federspiel at federspielg@manchester.ma.us.

WESTERN MASSACHUSETS – MONTAGUE WATER POLLUTION CONTROL FACILITY AND SOUTH HADLEY WATER POLLUTION CONTROL DIVISION

Background

Montague Water Pollution Control Facility (Montague) and South Hadley Water Pollution Control Division (South Hadley) are wastewater utilities in Western Massachusetts communities along the Connecticut River. Montague, which serves 2,000 residents, has an average influent flow of 0.83 million gallons per day (MGD). South Hadley, which serves 17,000 residents, has a rolling average flow value of 2.8 MGD. While only Montague's system is a combined wastewater and stormwater system (South Hadley having largely completed separation of their stormwater and sewer systems by the date of the assessment), both experience large spikes in flow after heavy rainfall events. Montague has eight pump stations along with two combined sewer overflow (CSO) outfalls, which discharge directly into the adjacent Connecticut River when rainfall events over one inch occur. The wastewater treatment facility is located along the banks of the river, with aging pumps that are vulnerable to failure under extremely high flows. All of South Hadley's collection system flows through the Main Street pump station, a multi-level facility located in a 100-year flood zone. While there are four pumps in the station, there is insufficient electrical capacity to run them all simultaneously during heavy precipitation events at this time. The multi-level treatment facility is located mid-slope on a high embankment overlooking the Connecticut River.

Challenges

Montague and South Hadley have been experiencing impacts to their service due to increasing frequency and intensity of heavy, short-duration rainfall events. Along with rising annual temperatures, climate models indicate that heavy precipitation events, particularly short-duration events, are projected to increase in frequency and intensity. This could lead to the worsening of spikes in wastewater flowing into collection systems, pump stations, and treatment facilities, CSOs, sediment loading, and flooding. Additionally, Western Massachusetts is projected to experience shorter winters, resulting in a greater portion of precipitation falling as rain and earlier snow melt.

The increasing flows from storms threaten utility operations for Montague and South Hadley. Montague's eight pump stations are vulnerable to heavy inflows, and local flooding. A portion of the collection system runs through a swampy area and is thought to contribute significantly to infiltration. The utility has also experienced power outages due to extreme weather events; an ice storm in October 2020 caused Montague to lose power for over 36 hours. A recently added storage tank provides some short-term storage capacity but does not fully mitigate CSO discharges during short-duration, high-volume rainfall events. South Hadley experiences significant increases in influent flows during rainfall events, which can remain elevated for a number of days following the storm. Sections of the collection system are known or suspected to experience significant inflow and infiltration. Additionally, much of the town is low-lying with high water tables, which increases susceptibility to flooding.

Planning Process

To better understand and plan for the impacts of increased precipitation and influent flow in the region, Montague and South Hadley worked with the Massachusetts Department of Environmental Protection and the Pioneer Valley Planning Commission to assess their climate risks. With technical assistance from EPA's Creating Resilient Water Utilities (CRWU) team, the utilities and partners conducted an assessment using EPA's Climate Resilience Evaluation and Awareness Tool (CREAT). The CREAT exercise brought these teams together to consider the potential climate impacts, priority assets, potential adaptive measures, and possible reduced monetized risk resulting from implementing the adaptive measures.

Resilience Strategies and Priorities

Both Montague and South Hadley cited significant increases in influent flows due to heavy, short-duration precipitation events as their primary concern. Montague recently installed a wet weather chlorine contact tank to act as a secondary treatment bypass to accommodate large spikes in inflows during storms and reduce CSOs. While it has helped, it does not eliminate impacts to the facility from short-duration, high-flow events. Similarly, South Hadley is currently working with the electric utility to increase grid power to the Main Street pump station and plans to install a new emergency generator with sufficient capacity to power all four pumps in their Main Street pump station, which they hope will better manage peak flows from severe storm events even when power is lost. The utility seeks to understand how effective this will be and what other vulnerabilities they may have under future increased precipitation conditions.

Using the results of their CREAT assessments, Montague and South Hadley evaluated the costs of several potential climate adaptation strategies that, if implemented, could strengthen the operational and financial resilience of their systems. For Montague, under a wetter and stormier future scenario, implementing natural flow improvements in the Montague City Road Area where the collection system runs through a swampy area would provide the highest total monetized risk reduction. The assessment for South Hadley suggested that, under a wetter and stormier future scenario, installing the emergency generator sized to operate all four pumps at the Main Street pump station would result in the greatest reduced risk.

Resilience Strategies for Montague

TYPE	RESILIENCE STRATEGIES
Current Measures	Inflow and Infiltration Study
	Portable Pump
	Pump Station Upgrades
	Storage Tanks
Potential Adaptive Measures	Natural Flow Improvements in the Montague City Road Area
	New Emergency Generator at the Wastewater Treatment Facility
	Pump Replacement at the Wastewater Treatment Facility

Resilience Strategies for South Hadley

TYPE	RESILIENCE STRATEGIES
Current Measures	Fourth Pump
	Elevate Electrical Equipment
	Emergency Bypass Valve
Potential Adaptive Measures	Inflow and Infiltration Assessment
	Judd Brook Pipe Lining
	New and Larger Emergency Generator

Contact Information

For more information regarding Montague's resilience planning, contact Chelsey Little, Superintendent, at WPCF.SUPT@montague-ma.gov.

For more information regarding South Hadley's resilience planning, contact Melissa LaBonte, Superintendent, at mlabonte@southhadleyma.gov.

Case Study:
Water and Wastewater Utilities Planning for Resilience

GREATER AUGUSTA UTILITY DISTRICT (GAUD)
AUGUSTA, MAINE

Background

The Greater Augusta Utility District (GAUD) provides drinking water, wastewater, and stormwater treatment services to approximately 20,000 customers in the city of Augusta, Maine. The GAUD combined wastewater system has a maximum wet weather capacity of 40 million gallons per day (MGD) and consists of a wastewater collection system, stormwater system, and secondary treatment wastewater plant rated capacity of 12 MGD. A portion of the system's critical infrastructure is located adjacent to the Kennebec River. This includes the wastewater treatment facility with an average daily flow of 4 MGD and two wastewater pumping stations.

Challenges

Due to its proximity to the Kennebec River, GAUD is primarily concerned about the impacts of flood conditions on its wastewater infrastructure. In 1987, elevated stage levels on the Kennebec flooded and damaged the wastewater treatment facility and one of its wastewater pump stations. As a result, flow through the facility backed up and the facility was forced to shut down. Although the flood waters retreated within 24 hours, operations at the facility were reduced for one month following the event. GAUD continues to be concerned about the impact of future flooding conditions on interdependent sector reliability and its ability to provide service during peak demand conditions.

Planning Process

To evaluate the resilience of its wastewater treatment systems to flood conditions, GAUD used the U.S. Environmental Protection Agency's (EPA's) CREAT. The assessment brought together individuals from various departments within GAUD and EPA staff to think critically about potential vulnerabilities, priority assets, and strategies for strengthening infrastructure and operational resilience.

Resilience Strategies and Priorities

Based on its experiences with previous severe flooding conditions, GAUD has already taken action to protect its critical infrastructure and improve its overall resilience. These measures have included developing and refining its flooding emergency response and recovery plans, adding hydrologic barriers to its treatment facilities such as berms and flood gates, and installing combined sewer overflow (CSO) tanks to increase its treatment capacity during flooding events.

Type	Resilience Strategies
Current Measures	Developing flooding emergency response and recovery plans
	Constructing a berm to serve as a hydrologic barrier against flooding
	Adding CSO tanks to increase wastewater and stormwater treatment capacity
	Adding flood gates, sandbags, and plywood to serve as temporary flood barriers
	Integrating weather forecast monitoring into operations to inform projected climate conditions
	Building storage for peak flow diversion to increase system capacity by one million gallons
Potential Adaptive Measures	Installing a generator to serve as back-up power for wastewater treatment facility
	Relocating electrical plant house to a higher elevation to reduce the risks from flooding

Contact Information

For more information regarding GAUD’s resilience planning, contact Andy Begin at abegin@greateraugustautilitydistrict.org.

CITY OF PORTSMOUTH, NEW HAMPSHIRE

Background

The city of Portsmouth, New Hampshire provides drinking water, wastewater and stormwater services to residents and local businesses. The utility provides drinking water to nearly 8,300 customers in the communities of Portsmouth, Greenland, Rye, New Castle and Newington, with a number of large industrial water users spread throughout the area. About 60 percent of production goes towards commercial or industrial customers, including the decommissioned Pease Airbase which is now an office park, two power plants, two gypsum factories, a pharmaceutical company, golf courses and breweries. Average potable water production from both groundwater and surface water sources totals roughly 3.5 to 6.5 million gallons per day (MGD), with a maximum of 8 MGD. The Bellamy Reservoir is the main source of surface water for the city and has 900 million gallons of storage, with a safe yield of 3.5 to 5 MGD.

The city of Portsmouth treats wastewater for nearly 6,300 customers in the communities of Portsmouth, New Castle, Greenland and Rye. The city's wastewater treatment consists of two wastewater treatment facilities (WWTF): the Pierce Island WWTF and the Pease WWTF. The city has recently completed construction of major upgrades to its combined sewer overflow long-term control plan, and is in a post-construction monitoring phase.

Challenges

Flooding from coastal storm surge, sea-level rise and short-term drought are the primary climate-related concerns of the city. While the Pierce Island WWTF is above the 500-year flood zone elevation, multiple wastewater pumping stations are currently at risk from coastal flooding. Additionally, the access road to the Pierce Island WWTF floods during king tides and storm surges which may become more frequent and intense in the future due to sea-level rise, preventing access to the WWTF during those periods.

Water supply is also of concern to the city due to projected temperature increases and changes to precipitation patterns. From 2001 to 2002 the city experienced a hot and dry period with little groundwater recharge, which was repeated during the summer of 2014 when the city of Portsmouth again faced a period of intense heat and reduced precipitation for approximately six to eight weeks. Demand approached the maximum capacity of the water system – nearly 8 MGD – however, the city did not need to implement demand reduction measures. A short-term drought is expected to only affect surface water, which makes up roughly 60 percent of the city's water supply, but a longer-term drought – drought exceeding one year – would also affect its groundwater. In terms of water recharge, the city found that reservoir levels tend to increase quickly after a moderate rain event of two inches, but groundwater recharges much more slowly.

The city of Portsmouth has a number of ongoing planning efforts to increase overall sustainability, including a green infrastructure program and the Coastal Resilience Initiative, designed to reduce the impacts of extreme flooding and to increase the resilience of infrastructure to coastal flooding and sea level rise. In May 2015, the city received the New Hampshire Department of Environmental Services' "Source Water Sustainability" award for a variety of water conservation measures being implemented, including New Hampshire's first customer rebate program that provides incentives for customers to install more water-efficient appliances.

Planning Process

To better understand the vulnerability of their utility infrastructure and operations, the city of Portsmouth assessed potential climate change impacts using the U.S. Environmental Protection Agency's (EPA) Climate Resilience Evaluation and Awareness Tool (CREAT). The CREAT assessment brought together individuals from EPA and various departments within the city of Portsmouth to think critically about potential climate impacts, prioritize assets and consider possible adaptation options.

Resilience Strategies and Priorities

The city of Portsmouth considered the potential consequences of drought and extreme flooding events on their drinking water and wastewater utility infrastructure and operations, respectively. To assess each of these potential threats, the city considered how potential adaptive measures would help lower consequences. See the table below for potential adaptive measures that were considered.

Type	Resilience Strategies
Pumping station flooding	Relocate pump station to a 2- to 5-foot higher elevation to prevent flooding from coastal storm surge and sea-level rise
	Temporary flood barriers such as sandbags to prevent flooding from coastal storm surge and sea-level rise
	Develop and utilize a flood risk management plan
Drought	Develop new groundwater sources to help ensure continued reliability of water supplies
	Watershed management
	Update drought contingency plans that would identify triggers for the utility to encourage or enforce water conservation actions
	Establish adaptive rates that are use- or customer-based
	Conduct supply risk management to help ensure continued reliability of water supplies
	Monitor surface water quality to identify additional treatment needs during periods of drought

Contact Information

For more information regarding the city of Portsmouth's resilience planning, contact Al Pratt at anpratt@cityofportsmouth.com.