COMMUNITY RESILIENCE BENCHMARKS

The Alliance for National & Community Resilience™ (ANCR™) is a 501(c)(3) national coalition of public and private sector stakeholders working to advance community resilience. Founded by the International Code Council, U.S. Resiliency Council and the Meridian Institute, ANCR's primary objective is to develop Community Resilience Benchmarks™ (CRB™s)—the first system of its kind in the United States—that will allow local leaders to easily assess and improve their resilience across all functions of a community.

Community Resilience Benchmarks are organized around the concept of a whole community that relies on 19 functional areas to deliver essential services. These functional areas have their own resilience but taken together represent the resilience of the community. CRBs will help communities assess their resilience and point them toward practical action they can take to become more resilient.

Community Resilience Benchmarks for each functional area are structured around requirements (actions, plans, policies, etc.) that have been identified as crucial to resilience within the functional area. The requirements are organized across three tiers: Essential, Enhanced, and Exceptional. Each "higher" tier demands a greater level of community commitment, investment, and/or engagement and will have greater impact on enhancing community resilience. To meet a higher tier, a community must also meet all requirements of the tiers beneath it.

Acceptable Evidence and Commentary are provided for each requirement to assist the user in understanding the overall purpose of the requirement and some of the means for demonstrating achievement. In some cases, the community may have identified or implemented strategies that meet the intent of the requirement but may not fit with the identified acceptable evidence. The community should document this alternative approach or evidence.
In this pilot phase, the Community Resilience Benchmarks are intended to provide communities with a mechanism to evaluate their current state of resilience and to identify potential actions they can take to improve. As a system, the CRB process is intended to be managed under the direction of a community leader with the functional area benchmarks evaluated by personnel with day-to-day responsibility in each functional area.

The individual benchmarks were developed based on initial work by Dr. John Plodinec, further enhanced through the engagement of subject matter experts, and approved by the ANCR Board of Directors. Lessons learned from this pilot phase will be incorporated into future versions of this benchmark and into the development of other benchmarks.

CRB Glossary

- **Community -** A group of people living in the same place - a place designated by geographical boundaries that functions under the jurisdiction of a governance structure, such as a town, city, or county – and who consider themselves part of the same entity. In some instances, organizations may be considered communities and make use of the tool from their perspective--this includes campuses or corporations.

- **Continuity of Operations Plan (COOP) or Disaster Recovery Plan (DRP)** - A COOP or DRP is a formalized document describing how the organization's functions can continue or resume quickly following a disaster. It is imperative that organizations not only develop a COOP or DRP but also test it, train personnel and document it properly before a real disaster occurs. The National Continuity Policy Implementation Plan (NCPIP) and the National Security Presidential Directive 51/Homeland Security Presidential Directive 20 (NSPD-51/HSPD-20) define a COOP in the context of the federal government as an effort within individual executive departments and agencies to ensure that Primary Mission Essential Functions (PMEFs) continue to be performed during a wide range of emergencies, including localized acts of nature, accidents and technological or attack-related emergencies.

- **Resilience** - The ability to prepare for and adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies [Presidential Policy Directive (PPD)-8 (2011) and PPD-21 (2013)].

- **Risks** – A probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through preemptive action. Risk is typically expressed as a function of threat and vulnerability.

- **Vulnerable populations** -Any individual, group, or community whose circumstances create barriers to obtaining or understanding information, or the ability to react as the general population. Circumstances that may create barriers include, but are not limited to age; physical, mental, emotional, or cognitive status; culture; ethnicity; religion; language; citizenship; and institutional enrollment (e.g., those in hospitals, nursing homes, or prisons); geography; or socioeconomic status. Iowa Public Health Preparedness Program. Emergency planning for people with disability. [cited 2008 Nov 14].

PILOT COMMUNITY RESILIENCE BENCHMARK: WATER

Preamble

Water is essential for life. Early settlements built up around locations with access to water. Today, water infrastructure is essential for delivering potable water, treating wastewater and managing stormwater. Water infrastructure is vital to a community's health and its ability to survive before, during and after a hazard event. From hospitals to hotels, schools to shopping centers, factories to farms, and restaurants to recreational facilities – entire communities would shut down without water service. Moreover, water is one of the most crucial elements in fighting fires. Without a reliable water supply, communities are more vulnerable to greater casualty losses in the event of fire and more susceptible to economic losses from business interruption.

This water benchmark focuses on the importance of a holistic approach to water management and infrastructure in a community, recognizing that responsible parties may vary widely. Water management is very local and context specific. In some communities, drinking water and wastewater may be handled by a single entity, in other communities there may be multiple organizations with responsibilities for water infrastructure. Some communities have combined sanitary and storm sewers while others have separate systems. To tackle this diversity, the benchmark is divided into sections by function, allowing the benchmark to be easily divided among organizations responsible while still supporting a holistic picture of a community's water systems. Requirements 1 and 2 cover cross-cutting issues, 2 through 9 address drinking water, 10 through 15 cover wastewater, 16 applies only to communities with combined sewers (but such communities should also complete the wastewater and stormwater requirements), and 17 through 22 address stormwater.

While the benchmark is divided by function for ease of completion, ANCR encourages communities to view water management as an integrated process across systems (e.g., a "one-water" approach). Service providers should collaborate and share results with other water systems to identify common vulnerabilities, investigate potential solutions and assure that they are planning based on the same scenarios. This collaboration should also extend regionally to help ensure that water resource planning considers water for the environment, and that there are adequate environmental flows to sustain the area's ecology. The benchmark is intended to facilitate a community/municipal government-driven assessment in collaboration with the owner(s) of the system, be they public/municipal, private/investor-owned, or another model.

Water Benchmark Glossary

- **Blackwater** – The liquid and waterborne waste derived from ordinary living processes that are free of industrial waste, and as such character as to permit proper disposal, without special treatment into either the public sewer or a private sewage disposal system. Although uncommon at the present time, recycling and reuse of this water is possible.
- **Combined sewage overflows (CSO)s** – Combined sewer systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a water body.
- **Diurnal daily peak –** The maximum flow experienced over a 24-hour period.
- **Effective Utility Management (EUM) –** An approach developed by water sector leaders for water utility management. The approach is based around the Ten Attributes of an Effectively Managed Utility and Five Keys to Management Success, and is designed to help water and wastewater utility managers make informed decisions and practical, systematic changes to achieve excellence in utility performance in the face of everyday challenges and long-term needs for the utility and the community it serves.

- **Graywater** – Untreated wastewater that has not come into contact with toilet waste, kitchen sink waste, dishwasher waste or similarly contaminated sources. Greywater includes wastewater from bathtubs, showers, lavatories, clothes washers, and laundry tubs. Also known as greywater, gray water, and grey water.
- **IDF Curve –** An intensity-duration-frequency curve is a graphical representation of the probability that a given average rainfall intensity will occur.
- **Potable water** – Water that is satisfactory for drinking, culinary, and domestic purposes and that meets the requirements of the Health Authority Having Jurisdiction.
- **Rainwater** – Natural precipitation that falls on a structure. It contains bacteria and is non-potable without treatment. It contains relatively few minerals, with a pH in the range of 5.5 to 6.
- **Reclaimed water** – Non-potable water provided by a water/wastewater utility that, as a result of tertiary treatment of domestic wastewater, meets requirements of the public health Authority Having Jurisdiction for its intended uses.
- **Stormwater** – Natural precipitation that leaves the property. It contains bacteria and is non-potable without substantial treatment. It contains minerals, and possibly heavy metals and hydrocarbons. It will have a pH in the range of 6.5 – 7.2.
- **Water main break rates –** A water pipe performance and longevity metric reported as the number of water distribution main breaks, due to age, corrosion, operator error, not leaks or third party damage, measured as the number of breaks/miles of pipe type length/(100 miles)/year.

Acronyms

- **GPCD** – Gallons per capita per day
- **IDDE** – Illicit Discharge Detection and Elimination

Additional Resources

- The AWWA Free Water Audit Software© and Water Audit Compiler©
- The Water Research Foundation **Level 1 Water Audit Validation: Guidance Manual**
- A White Paper From the American Water Works Association: The State of Water Loss Control In Drinking Water Utilities
- Committee Report: Key Performance Indicators for Nonrevenue Water—AWWA's 2020 Position
- Key Performance Indicators for Non-Revenue Water: AWWA Water Loss Control Committee Report

COMMUNITY-WIDE BENCHMARKS

1. Continuity of Operations Plans (COOP)/ Disaster Response	
Essential Requirements	**Acceptable Evidence**
a) The community's water service provider(s) are included in the community-wide COOP plan and are engaged in drafting and approving the plan.	The community has a publicly available COOP related to its water systems. This may be contained within a local government's COOP but must explicitly address the continuity of these functions. The Continuity of Operations plan should be compliant with national standards (e.g. FEMA Continuity Guidance Circular, Feb. 2018). The community's water service providers have a seat on the community COOP/emergency response/emergency management committees responsible for producing the COOP.
b) The COOP and its development process are documented electronically providing access to all water stakeholders.	Webpage dedicated to sharing information on COOP development including identifying the process and posting of the COOP.
c) The community's water service provider(s) have facility emergency response plans for drinking water and wastewater treatment plants.	A completed community emergency management plan that encompasses all water systems and is reviewed annually.
Enhanced Requirements	**Acceptable Evidence**
d) The community's water service provider(s) have adequately implemented their responsibilities under the COOP, including designating resources for implementation of the plan.	Documentation summarizing compliance with the community's written plan along with documentation on how resources for planning, funding, staffing, and training are designated to implement the plan.
e) All water utility stakeholders have the opportunity to participate in the COOP development process.	Documentation of stakeholder-facing materials (surveys, etc.) on COOP development and exercises. Documentation of stakeholder interests represented in the COOP development process, records of public input, and/or records of decision making in response to stakeholder input.

f) At least 20% (minimum of 1) of all water sector personnel have emergency management or operations credentials.	Documentation of water sector personnel with credentials in emergency management or operations. Water sector personnel have participated in FEMA's Emergency Management Professional Program
g) The community's water service provider(s) are members of a Water and Wastewater Agency Response Network (WARN) and/or participants in mutual aid agreements with other service providers.	Evidence of WARN membership and/or mutual aid agreements.
Exceptional Requirements	**Acceptable Evidence**
h) The community and water service provider(s) have developed and conducted exercises on an annual cycle, including table-top, functional, and full-scale, using threat Emergency Response Plans (ERPs) and multi-threat scenarios. Federal, state and local agencies, emergency mangers and interdependent sectors are invited to participate in the execution of exercises.	Records of water and wastewater provider participation in Emergency Management exercises including dates, agencies involved, and personnel. Documentation of developed scenarios and results of the conducted exercises, including areas for improvement of exercises.
i) The community's water service provider(s) have achieved accreditation to a recognized standard for safety and emergency management.	Public posting or other proof of Accreditation or Certification Report.
j) The community has assessed interdependencies of their water systems with other systems (e.g. power, chemical, transportation, public safety, etc.) and engages with the critical partners to ensure timely notice of disruptions and response/recovery plans in place to limit damages when they occur.	Documentation within the COOP of cooperation and consideration of interdependencies. Evidence of communication with service providers to plan for risks. Critical partners are identified in emergency response planning scenarios and participate in exercises.
k) The community participates in a regional water planning initiative involving local and regional stakeholders, including community representatives,	Public documentation of the regional water planning initiative including meeting minutes, press releases, or plans and documents published by the initiative.

economic development staff, and other agencies necessary to understand future development and growth planning.	MOU's or similar official commitments / letters of support, between the community and regional partners. Attendance and/or participation in local, regional, and national water conferences. Membership of staff or department in a regional program or related committee, like membership on an AWWA committee.

Commentary:

A Continuity of Operations Plan's (COOP) purpose is to establish policy and procedure to ensure important community functions remain operational in the face of a hazard event. To support this purpose, a COOP is necessary for the community as a whole, but should be based on the COOPs developed for each functional area to assure all key functions are addressed. Having the plans in place includes exercising them and working with local partners, including local emergency management and other community groups representing the community in recovery. Having Continuity of Operation Plans already in place and well tested/exercised will ensure a smooth transition from response to recovery and assure the community that recovery will be happening even as response continues. For the water sector, the essential functions of the water utility are maintained if daily functions are threatened (normal supply of potable water or collection and treatment of wastewater are interrupted).

COOP capabilities are critical to developing effective risk mitigation strategies and improvements to COOP processes following events need to be responsive to any progress in longer-term risk mitigation strategies. In short, there needs to be effective information/knowledge exchange between those responding to immediate events and those planning/building with future events in mind.

Regional decision-making helps ensure that water resource planning considers water for the environment, and that there are adequate environmental flows to sustain the area's ecology. Regional efforts also can support development of mutual aid agreements and WARNs.

In preparing the water utility for an interruption in normal functioning, it is important to look at every side of being prepared and staying resilient. The Emergency Preparedness Plan uses Risk Assessment to begin Mitigating any potential negative effects. The COOP is how the utility will stay online if something happens. (See chart for more explanation).

Emergency Preparedness Plan	COOP (Continuity of Operations Plan)
4 Core Elements 1. Risk Assessment & Emergency Planning (Addressing Emergency Events) 2. Communications Plan 3. Policies & Procedures (to be used during an emergency/disaster) 4. Training and testing	8 Main Elements 1. Essential Functions (those that need to continue operating or able to return in a matter of hours/days) 2. Key Personnel 3. Delegations of Authority & Orders of Succession 4. Vital records, databases, and systems and equipment 5. Alternate Facilities (Where can the people work) 6. Communication 7. Reconstitution and devolution 8. TT & E (Test, training, and exercises)

Additional information and resources can be found through the following:

- Presidential Policy Directive/PPD-21, Presidential Policy Directive-40, and *National Continuity Policy*, July 15, 2016.
- Utilities can accredit to *ISO Standard 24518:2015: Activities relating to drinking water and wastewater services — Crisis management of water utilities* to meet safety and emergency management requirements
- Information on mutual aid and WARNs is available at https://www.epa.gov/waterutilityresponse/mutual-aid-and-assistance-drinking-water-and-wastewater-utilities.
- FEMA offers guidance on exercises through their Homeland Security Exercise and Evaluation Program (HSEEP).
- FEMA has also developed a Continuity Resource Toolkit.

2. Water Service Workforce	
Essential Requirements	**Acceptable Evidence**
a) The community's water service provider(s) have staffing plans in place to provide service consistent with the essential requirements of the Benchmarks as well as during the significant hazard events facing the community.	A detailed staffing plan that covers elements including the following: staffing roster detailing number and skills of staff for different time periods, including ideal staffing capacity and minimum required staffing capacity; cross- training plan that includes an ongoing schedule, continuing education requirements and certificates for completion; succession plan for key staff positions with contact info reviewed and updated annually; and policies that foster diversity, equity and inclusiveness.
Enhanced Requirements	**Acceptable Evidence**
b) The community's water service provider(s) have a program in place to share human resources with surrounding communities to meet minimum staffing requirements if they cannot be met internally.	The community or service provider has developed MOUs/Mutual Aid agreements with other jurisdictions to assist with sharing human resources.
Exceptional Requirements	**Acceptable Evidence**
c) The community's water service provider(s) have established and implemented the ability to automate critical operations functions to reduce the need for human resources during an acute emergency or longer-term crisis (e.g., pandemic).	Documentation of which parts of the system have been automated including how it will support critical functions and any fail-safe measures in place.

Commentary:

Resilient community water systems rely on trained, equipped, and committed personnel as a key part of the system's infrastructure. Hiring the right employees in the first place and working hard to keep them engaged, learning, and growing can reduce employee turnover and improve overall organizational health. Cross-training can be an effective method of boosting team flexibility and stability by ensuring that employees are developed with knowledge and skills to understand other job functions. In emergency situations, cross-trained staff are better equipped to cover various functions beyond their primary roles.

Accordingly, a thoughtful community water system staffing plan should include an assessment of necessary staffing levels for optimized water system function, including personnel redundancy, succession planning, and established processes for hiring, management, and personnel training and development. Increasingly, technology can play a role in complementing personnel functions and expertise, especially through back-up automation that can execute essential operations of critical functions in the event of an emergency. In a disaster or pandemic situation, automation that serves as a backup to, or in parallel

with, human resources can improve the system function. Should automation be employed as a means of reducing personnel, systems can become more vulnerable, especially in emergencies.

Community water system staffing plans should also consider hiring, personnel development, and management with conscious attention to reflecting the community they serve. More diverse teams are shown to be smarter. Fostering diversity, equity, and inclusion in the workplace can further improve service by strengthening ties with the community while also providing pathways out of poverty for aspiring water managers from traditionally under-represented groups through high-road employment options.

In addition to considerations identified in the Water Benchmark, communities should consult the Public Safety Benchmark for a longer list of significant hazards to community water systems and their personnel, and the public they serve.

3. Drinking Water Risk Assessment	
Essential Requirements	**Acceptable Evidence**
a) The community's drinking water service provider has identified, and documented water system-specific risks as captured in the AWIA risk assessment compliance law. (e.g., intrusions into the water system, threats to critical infrastructure and service lines, introduction of contaminants, electricity outages, abnormally high demand due to a health crisis, permeation, cybersecurity breaches, etc.) that may impact service, with an associated likelihood of occurrence.	Copy of a Risk and Resilience Assessment in accordance with Emergency Planning for Water and Wastewater Utilities, AWWA M 19; Risk and Resilience Management of Water and Wastewater Utilities, ANSI/AWWA J100-10(R13), and or a functional equivalent.
b) The community's drinking water service provider has identified and documented system-specific risks in relation to natural hazards (drought, flood, sea level rise, seismic, and wildfire impacts) as maintained in the AWIA risk assessment compliance law.	Documentation outlining the identified system-specific risks.
c) The drinking water provider has identified and documented cascading loss-of-service events that will impact the system's ability to provide drinking water to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	Documentation outlining the identified cascading loss-of- service events. Documentation of exercises or processes undertaken to determine loss of service events.

Enhanced Requirements	Acceptable Evidence
e) The community's drinking water service provider(s) has identified and documented potential future risks, such as limits on the available water supply, changing demands for service due to either population growth or decline, or challenges to the existing water and infrastructure due to evolving climatic conditions.	Documentation of potential future risks and demonstrated links to the COOP. Documentation of long-term planning exercises or processes undertaken to assess and document potential future risks.
f) The community has developed scenarios of multiple/cascading threats that will impact the drinking water system with associated likelihood/consequences, including documentation of recent experiences with lessons learned.	Post-crisis action report of issues and how they are addressed short- and long-term. Documentation of these scenarios and demonstrated links to the COOP.
Exceptional Requirements	**Acceptable Evidence**
g) The community participates in regional water planning activities involving local and regional stakeholders, including community representatives, economic development staff, and other agencies necessary to understand future development and growth planning and move towards a collaborative, comprehensive water management plan.	Membership of staff or department in a regional program or related committee. Participation in local, regional, and national conferences. Public documentation of a regional water planning initiative including meeting minutes, press releases, or plans and documents published by the initiative.

Commentary:

A utility's capacity for resilience is directly related to its planning and risk assessment. Knowing the weak points in your system allows you to plan for stress and possible failure. Utilities need to identify worst case scenarios and the lesser events that will occur far more often. Do you know what areas of your system pose the biggest threat to life and property? Do you know how a failure in other systems will affect your system and vice versa? What will your utility's responsibility be to the greater community, and what communities might be more highly impacted? The following information will help you to begin planning to alleviate and combat threats to your system and community.

Risk assessment for water utilities is a fundamental step in providing resilient services to communities that depend on safe drinking water and clean water resources. This process is built on a series of fundamental activities, each informing the others, with the ability to improve as new information or experiences becomes available:

- Identify and document risks
- Develop and document responses/solutions
- Collaborate with others that share risks or can enable solutions

On October 23, 2018, America's Water Infrastructure Act (AWIA) was signed into law. AWIA Section 2013 requires community (drinking) water systems serving more than 3,300 people to develop or update risk assessments and emergency response plans (ERPs). The law specifies the components that the risk assessments and ERPs must address and establishes deadlines by which water systems must certify to EPA completion of the risk assessment and ERP.

Risks are further defined by AWIA and include, but are not limited to, natural hazards such as drought, flooding, earthquakes, and wildfire. They can also include longer-term trends such as changes in temperature, precipitation, and sea level, that can exacerbate acute risks. Risks also include cascading impacts due to events that may be outside of the utility's control, such as loss of power.

The community's drinking water provider's future focused plans should include water source and future capacity needs based on the community's growth projections and land use/development plans and how current risks may be impacted by climate change. Comparing the requirements for drinking water systems to those for wastewater and stormwater systems, there is an expectation that drinking water utilities should be pursuing essential actions that would represent enhanced resilience in the other sectors. This higher standard is derived, in part, from the higher level of resilience already demonstrated in parts of the water sector, plus the more direct exposures and higher consequences that failure or interruptions in service could have for drinking water, compared to sewer and stormwater.

Addressing these risks can include planning operational contingencies for emergencies as well as addressing future scenarios of population and climate change. When risks occur, it is important to document impacts and responses in order to understand potential changes if these risks occur again. Engaging multiple stakeholders in the risk assessment and response process can help ensure that plans are well understood and reflect operational and institutional knowledge.

Assessments can be conducted using several strategies. One assessment approach involves the development of scenarios that challenge system resilience. These scenarios can be defined using combinations of different threat conditions, infrastructure and operational status and supply/demand changes.

The Federal Register Notice for New Risk Assessments and Emergency Response Plans for Community Water Systems is available at https://www.epa.gov/waterresilience/americas-water-infrastructure-act-risk-assessments-and-emergency-response-plans.

Example of collaborative, comprehensive water management: http://uswateralliance.org/sites/uswateralliance.org/files/publications/Roadmap%20FINAL.pdf.

Drinking water service impacts on other services may include the following factors:

- Scarcity risks may bring rations on non-critical urban users and uses (while agricultural users tend to get a free pass, thus not necessarily impacted but exacerbating the problem).
- Quality risks may shut down a system or eliminate drinking water uses (without boiling, if bacterial).
- Thermal risks (when source waters are too warm) can cause power plant shut downs, a deadly feedback loop in the heat of summer: https://business.financialpost.com/pmn/business-pmn/hot-weather-forces-4-french-nuclear-reactors-to-shut-down

For a scenario planning resource see https://www.oxfordscholarship.com/view/10.1093/acprof:oso/9780198745693.001.0001/acprof-9780198745693.

4. Drinking Water Risk Mitigation	
Essential Requirements	**Acceptable Evidence**
a) The community's drinking water service provider monitors and maintains any protective infrastructure (e.g., dams, natural ecosystem barriers) for which it is responsible.	Maintenance records and engineering reports documenting water systems and service schedules and protocols.
b) The community's drinking water service provider has implemented flushing, cleaning and reinstatement-to-service protocols to bring water distribution systems back into service quickly after a contamination event.	Copies of the relevant policies and procedures.
c) The community's drinking water service provider has developed and implemented plans to mitigate water system-specific risks as captured in the AWIA risk assessment compliance law. (e.g., intrusions into the water system, threats to critical infrastructure and service lines, introduction of contaminants, electricity outages, abnormally high demand due to a health crisis, permeation, cybersecurity breaches, etc.) that may impact service.	Documentation demonstrating the application of mitigation measures to address the risks identified in the Risk and Resilience Assessment.
d) The community's drinking water service provider has developed and implemented plans for addressing system-specific risks in relation to natural hazards (drought, flood, seismic, sea level rise, and wildfire impacts) as maintained in the AWIA risk assessment compliance law.	Documentation demonstrating the application of mitigation measures to address the risks identified in the Risk and Resilience Assessment.

e) The community has established a plan for back-up water supply in the case of disruptions to the main water supply.	The community has defined and documented its minimum threshold for water supply and can provide documentation of the community's back-up supply to meet it. Agreement in place to procure additional water through contingent water rights.
f) The drinking water provider has developed plans to mitigate identified cascading loss-of-service events that will impact the system's ability to provide drinking water to customers.	Copies of the plans for addressing cascading loss-of-service events.
Enhanced Requirements	**Acceptable Evidence**
g) The community's drinking water service provider has developed plans for addressing potential future risks, such as limits on the available water supply, changing demands for service due to either population growth or decline, challenges to the existing water infrastructure due to evolving climatic conditions, or conservation issues related to intense weather events such as droughts or floods. Plans are updated on a regular schedule.	Copies of the plans addressing potential future risks.
h) The community has developed and implemented plans to mitigate scenarios of multiple/cascading threats that will impact the drinking water system.	Copies of the reports, plans, contracts, or timelines documenting the steps taken and investments made to mitigate multiple/cascading threats. This recordkeeping is conducted in a way that is useful for other organizations.
i) The community or drinking water service provider partners with academic institutions or organizations to identify and pursue research priorities related to mitigating risks to community drinking water (e.g. emerging pollutants such as PFAS, chemicals, micro plastics, pesticides or medicines; climate change impacts; new water infrastructure financing models, new technologies, nature-based solutions, and new governance schemes).	Evidence of a partnership via a formal agreement, MOU, or public announcement.

Exceptional Requirements	Acceptable Evidence
j) The community's drinking water service provider has taken steps to implement plans for addressing future risks, including protecting facilities and assets mitigating the risks themselves, and/or improving the water-use efficiency of the community.	Copies of the reports, plans, contracts, or timelines documenting the steps taken and investments made to mitigate future risks. This recordkeeping is conducted in a way that is useful for other organizations.
k) The community's drinking water service provider actively monitors emerging technologies and research that may trigger updates to risk mitigation plans.	Copies of policies or practices on monitoring emerging technologies, attendance records for relevant conferences or webinars or examples of incorporation of emerging technologies in mitigation plans.
l) The community has initiated a system evaluation and convened a stakeholder group to evaluate the presence, viability, safety, and risks of distributed drinking water systems (rainwater, hauled water, reclaimed water).	Public documentation of distributed drinking water infrastructure evaluation and stakeholder discussions and evidence of collaboration with state and national drinking water and health regulators or other documentation that demonstrates a public stakeholder group has been established.

Commentary:

Providing clean, uninterrupted drinking water supply is a fundamental goal common to all water utilities. Monitoring and maintaining critical infrastructure is a primary way to mitigate risks, but utilities must also plan contingencies to ensure that service is quickly restored should an interruption occur. Risk mitigation also builds on effective risk assessment through the implementation of responses to anticipated impacts, along with the measurement of performance to inform any further mitigation in the face of increasing or new risks. Utilities should consider risks as described in the Drinking Water Risk Assessment section and in accordance with America's Water Infrastructure Act (AWIA).

As part of a mitigation strategy, utilities should consider impacts to customers during an outage as well as options for providing backup water supply. These plans should be well documented and communicated to appropriate stakeholders. In addition to dealing with emergencies, utilities should plan for longer-term changes such as population and climate change, and unexpected risks such as emerging contaminants. Evaluation of distributed systems should include collaborating with and reporting back to the state and national (regional EPA) offices to explore ways to evolve Safe Drinking Water Act regulations in ways that enable the safe expansion of distributed drinking water supply.

Once the risk assessment data is collected and analyzed, an implementation plan can be developed to lessen those risks. Plans need to include how risks will be mitigated and how mitigation will be funded. Plans also need to communicate with and be able to incorporate the plans and projections of other utilities

and services in the area. They need to be easily accessible and easily communicated and include an outreach plan to educate potentially impacted entities. Plans also need to identify challenges to implementation faced by the utility.

The community's drinking water provider's future focused plans should include water source and future capacity needs based on the community's growth projections and land use/development plans, including an implementation timeline to increase capacity for any projected population growth. The plan also includes contingencies for a back-up water supply in the case of disruption. The plan is publicly available online and updated on a regular basis. By developing plans to optimize and protect critical water resources and committing to monitor these risks and periodically update risk mitigation plans, utilities are better equipped to prevent interruptions and mitigate impacts when they occur. Successful risk mitigation strategies include thorough documentation, communication, and stakeholder engagement.

Communities must also appropriately harden their infrastructure to reflect the effects of natural hazards. A functional water system in a time of crisis becomes more than just a water system: it becomes a lifeline for the community and its first responders. For example, some of the greatest risk of damage due to an earthquake is in the fires immediately following the seismic event. Ensuring water functionality for emergency responders is key to stopping the spread of further damage. Fifty to 75 percent of earthquake-initiated fires start immediately after the event.

Presently, there are several guidelines and standards available to help drinking water and wastewater utilities design more resilient systems that can better withstand risks to viability.

- Hazard Mitigation For Natural Disasters: A Starter Guide for Water and Wastewater Utilities:, US EPA: https://www.epa.gov/sites/production/files/2016-08/documents/160815-hazardmitigationfornaturaldisasters.pdf.

- International standards for earthquake and subsidence-resistant design of certain water pipelines, and more seismic design standards are being created by organizations such as AWWA, ASCE, and ASTM.

5. Drinking Water System Function	
Essential Requirements	**Acceptable Evidence**
a) The community's drinking water service provider has developed and is implementing a plan for the periodic testing of system components consistent with its asset management plan, specifications, hazard mitigation plans and manufacturer instructions.	Copy of the testing plan and documentation of implementation
b) The drinking water service provider has conducted a water loss audit including a Level 1 Validation of data inputs.	Copy of the water loss audit conducted within the last 3 years including documentation of data validation.
c) The water system maintains sufficient pressure protection and flow capacity to ensure the community's ability to fight fires.	Documentation of a regular/routine water main and hydrant flushing program with evidence of adherence to the program.
d) The community's drinking water service providers have implemented system specifications appropriate for local conditions and needs for new construction or replacement of critical drinking water infrastructure that are aligned with current industry standards.	Documentation of system specifications including documentation of what standards the community specifications are aligned with.
e) The community's drinking water system is able to provide at least 88 gallons of potable water per day at a constant pressure of 20 psi for indoor usage to every member of the community.	Documentation of community drinking water service. Documentation of the drinking water system capacity and number of community members.
Enhanced Requirements	**Acceptable Evidence**
f) The drinking water service provider has conducted a water loss audit including a Level 1 Validation of data	Copy of the water loss audit conducted within the past year with data validation documentation and technical and economic analysis results.

inputs and conducted a technical and economic analysis to determine opportunities to reduce losses.	
Exceptional Requirements	**Acceptable Evidence**
g) The drinking water service provider has developed and implemented a Non-Revenue Water Management Program to reduce losses based on their technical and economic analysis.	Copy of the water loss audit conducted within the past year with data validation documentation, technical and economic analysis results, a copy of the Non-Revenue Water Management Program along with a demonstration of projects implementing the program.

Commentary:

A community's drinking water system is a mission critical asset that must remain operational at all times in order to protect the public health and ensure the sustainability of the community. The need for a reliable drinking water system has been underscored by the recent COVID-19 crisis. Accordingly, the community must make sure that its drinking water system is operated and maintained, with reliable backup systems in place at all times in the event of unanticipated circumstances.

An optimized asset management system is a foundational component of a sustainable drinking water system. At a minimum, the asset management plan must identify the critical components of the system and call for ongoing, regular, assessment of those components with plans for timely, preventative, replacement. These assessments should also evaluate the system with respect to vulnerability to typical hazards such as corrosion, water hammer, ground settlement, and extreme weather events.

A sustainable drinking water system must reliably provide 88 gallons per capita per day (gpcd) (see https://www.epa.gov/watersense/statistics-and-facts) at a pressure of 20 psi on a consistent basis, with backup plans in the event of emergencies. Maintaining pressure is essential not only to ensure service, preserve water quality, and avoid infiltration and ingestion of contaminants. In addition, the community needs to include future capacity in the planning for its drinking water system to ensure its viable performance.

A sustainable, well managed, drinking water system should be run with minimal physical (leakage) and commercial (unbilled and underbilled revenue) losses. This begins with regular water loss audits and also includes plans to identify and correct significant leaks and unbilled connections. In this way, the community can ensure a sufficient, and equitable, revenue stream to support operations, maintenance and management of its drinking water system. Water loss audits can be conducted using the procedures outlined in the most recent edition of the AWWA Manual of Practice M36, Water Audits and Loss Control Programs and the AWWA Free Water Audit Software (FWAS).

Validation of water loss audit inputs assures that the water provider and regulators can rely on the data provided to make meaningful decisions. Details on Level 1 Validation processes are provided in the Water Research Foundation report 4639. Following conduct of the audit, the water provider can undertake analysis to determine the basis for the losses due to the system infrastructure and the economic impacts of those losses on the provider. Once the water

provider has conducted a technical and economic analysis they can identify and implement a strategy based on a sound technological and economic basis. While the completion of projects based on the Non-Revenue Water Management Program will take time, the water provider should be able to demonstrate progress based on the program and a regular evaluation of progress.

The function of the water system will also be affected by the system attributes. These should be defined in specifications. The community should regularly monitor and update standards related to system specifications as needed. Many of these standards are promulgated by relevant state agencies. At a minimum, specifications should include:

- Piping systems (pipes and joints) to provide an expected lifecycle of 100 years or more by minimizing the effects of corrosion, tuberculation, leakage, water freeze, water hammer, fatigue, ground settlement, earthquakes, hurricanes, and other stressors.

- Recognition of the primary hazards faced by the community and the necessary specifications to remain operational or quickly recover following experiencing one of those hazards.

6. Drinking Water System Management	
Essential Requirements	**Acceptable Evidence**
a) The critical assets owned by the community's drinking water service provider are maintained as part of an asset management program.	Documentation of the asset management plan with water main break rates.
b) The drinking water service provider has adopted the principles of Effective Utility Management, that include accounting for the full operational and capital costs of providing water as a commodity and a service.	Copy of the policy outlining adherence to the principles of Effective Utility Management.
c) The community has implemented a real-time sensing system (e.g., SCADA) to manage, monitor, and maintain operations.	Documentation demonstrating installation and maintenance of a real-time sensing system.
Enhanced Requirements	**Acceptable Evidence**
d) The community's water service provider(s) have remote access capability so that critical facilities can be monitored and/or operated remotely.	Documentation of remote access mechanisms.
e) The community's drinking water provider has established a community advisory board to address ratepayer concerns, including environmental justice and expectations regarding level of service to disadvantaged communities.	Community advisory board charter, meeting notices or minutes, or documentation of decisions.
f) The community's water service provider(s) have a recordkeeping system that tracks maintenance, repairs, and complaints.	Documentation of the recordkeeping system and its capabilities.
g) The governance structure of the community's drinking water service provider reflects the racial,	Documentation illustrating the drinking water service provider's policies for diversity, equity and inclusion.

ethnic, and gender diversity of the customers it serves.	
Exceptional Requirements	**Acceptable Evidence**
h) The community's drinking water service provider is actively implementing a plan to increase the number of building meters, submetering for major consumptive uses, and "smart" meters and monitoring devices monitoring water usage, leaks, and water quality in the community.	Written records detailing the scope of building and smart metering structures in need of monitors, and a plan for expanding metering that includes funding.
i) The community's drinking water service provider has a recordkeeping system that integrates with GIS.	Documentation of the recordkeeping system and its capabilities.

Commentary:

Optimal operations, maintenance and management of a community's water treatment and conveyance system are essential for the protection of public health. This includes, at a minimum, following EPA's Effective Utility Management (EUM) guidelines (https://www.epa.gov/sustainable-water-infrastructure/effective-utility-management-primer-water-and-wastewater-utilities). Asset management, including timely replacement of mission critical equipment, is a foundational component of a well-run, sustainable water management system. An effective asset management program includes sufficient redundancies and includes maintaining an inventory of spare parts. The asset management program also includes maintaining information about critical assets (such as location, elevation, age, material etc.) that helps to manage assets, conduct preventative maintenance, and/or assess level of risk. Asset management plans should include plans to maintain or reduce water main break rate. A helpful reference may be the AWWA Partnership for Safe Water Distribution System Optimization Program.

In addition, the community must ensure that the system has reliable and robust emergency backup systems in the event of emergencies, power outages, extreme weather events, etc., in order to protect the public health and environment. Moreover, the system must be resilient in the face of climate change, including more severe storms, river level rise, etc.

Lastly, the community must plan for the future to ensure that the system has sufficient capacity for the projected growth. In addition, the community must institute full cost pricing so that there is sufficient revenue for optimal operation of the system, timely replacement of aging infrastructure and resiliency against the challenges associated with climate change.

7. Drinking Water System Customer Engagement	
Essential Requirements	**Acceptable Evidence**
a) The drinking water service provider has communication systems in place for customers to monitor their own usage, for the utility to convey information about disruptions to service and provide public education information including lead awareness.	The community has an online portal, social media accounts, websites, SMS notifications, examples of bill mailers, employment of a dedicated communications person, and/or a written communications plan. Hotlines, webpages, or apps for community reporting of water-related issues. Examples of past communications or notices.
b) The community addresses equity issues in drinking water access to ensure water service to all vulnerable populations.	Documentation of programs or initiatives to address equity issues in drinking water access. Initiatives can include programs to avoid shutoffs, provide financial assistance, or other measures.
Enhanced Requirements	**Acceptable Evidence**
c) The drinking water service provider has a process to identify vulnerable populations and communities affected by projects and engage them in decision-making.	Documentation outlining the process and reports from community meetings or other strategies deployed to engage vulnerable populations.
d) The drinking water service provider publishes an annual report of its financial condition developed through Effective Utility Management, including an assessment of the full cost of providing water and wastewater services relative to the rates charged in the community.	Copy of the Annual Report.
e) The community's drinking water service provider communicates risk mitigation actions to customers and partners.	Copies of reports, notices or other communications.

Exceptional Requirements	Acceptable Evidence
f) The community provides water system users the opportunity to buy insurance for repairs of service line breaks.	Evidence of insurance availability or other relevant documents. Community participation in a program such as the National League of Cities' Service Line Warranty Program.

Commentary:

Communicating frequently with customers and alerting water consumers to hazards within the water system builds trust between the rate payer and water utility. This trust is vital for situations in which the utility needs to make difficult decisions or engage customers in undertaking individual action to support resilience. Recommended alerts to customers include boil water notices, water contamination, and leaks. Customers should also be able to report water-related issues such as taste and odor issues and contamination from hazardous chemicals and materials. The communications system should also alert customers about public meetings and has a process in place to address customers' questions and concerns. The drinking water system manager should have a way of notifying renters of boil water alerts or other risks to drinking water safety. In the case of rentals, typically only landlords are notified, not the renters.

AWWA's Public Communications Toolkit is a helpful resource for water system operators seeking to make the most of their communications efforts. Clearly communicating the full cost to maintain, upgrade, and expand the system can help build public awareness of the need for investment in system infrastructure. Communities can further benefit from boosting awareness of water conservation efforts and contribute to a more resilient community water system.

8. Drinking Water Quality	
Essential Requirements	**Acceptable Evidence**
a) The community's drinking water service provider(s) are in 95% compliance with state water quality regulations, EPA's guidance for primary and secondary contaminants, and state and federal reporting guidelines.	Community demonstrates evidence of permits and satisfaction of regulatory compliance. For example, a certificate or a report that states the service provider is complying with state and federal requirements.
b) The community's drinking water service provider conducts water quality tests, including monitoring for taste, odor, discoloration, and hazardous chemicals and materials, and reports results to customers annually via their water bill. The service provider also monitors customer water quality complaints.	Documentation of water quality testing and reporting.
c) The community's water service provider has identified all lead service lines and is in compliance with the Environmental Protection Agency's Lead and Copper Rule.	Report documenting compliance with the rule including sampling protocols and results, consumer outreach and service line replacement plans.
Enhanced Requirements	**Acceptable Evidence**
d) The community has developed and is implementing a plan that exceeds the requirements of the EPA's Lead and Copper Rule.	Report documenting system processes and procedures that exceed requirements in the rule including sampling protocols and results, consumer outreach and service line replacement plans.
e) The community has funding in place to replace all lead service lines within 10 years.	Service line replacement plan including details on funding.
f) The community has plans for water treatment changes during source water quality changes (e.g. changes in environmental conditions or water source).	Written water treatment plans.

Exceptional Requirements	Acceptable Evidence
g) The community educates building owners and/or operators about operations and maintenance needs for maintaining water quality in the building water system.	Examples of information and outreach materials used to educate building owners.
h) The community has replaced or is in the process of replacing all lead service lines.	Documents demonstrating removal of lead service lines.

Commentary:

The purpose and function of a reliable and sustainable drinking water system is foundationally based on the quality of the drinking water that the system delivers to its customers. Nothing is more important. Accordingly, the community must take all necessary measures to guarantee drinking water quality. The most essential component of this obligation is optimizing operations at the potable water treatment plant to ensure continual compliance with all federal and state regulations and requirements.

In addition to optimal treatment, the community must ensure that its distribution system is properly maintained to make sure that the safe, compliant, water that leaves the treatment plant is delivered to its customers safely as well. This work includes protecting the distribution pipes from scaling, corrosion, etc. In addition, lead service lines can be a health hazard to consumers. A review of state-level policies addressing lead contaminating piping in schools: https://www.usgbc.org/sites/default/files/2018-Lead-in-School-Drinking-Water-Full-Final-20181108_0.pdf.

Lastly, the community should educate the public about the risks associated with internal lead piping and fixtures. Similarly, the community should educate building owners about the proper operation of water systems to prevent against mold, salmonella and other disease bearing bacteria. The CDC has issued guidance to minimize the risk of mold and *Legionella* after a prolonged building shutdown: https://www.cdc.gov/coronavirus/2019-ncov/php/building-water-system.html. Ultimately, it is essential that the community take all necessary measures to protect drinking water quality throughout its journey from the water treatment plant to the consumers' taps.

9. Drinking Water Conservation	
Essential Requirements	**Acceptable Evidence**
a) The community and/or the water provider engages with building owners, developers and builders to educate them on the benefits of water conservation.	Examples of data and information about benefits of water efficiency and conservation the community or water provider have circulated to building owners, developers, and builders. Community has established partnerships with landowners, companies, and adjacent communities that share water resources to eliminate barriers when resource issues occur. Documentation of an outreach plan.
b) The community has adopted building codes, standards or guidelines for water conservation that are substantially equivalent to the requirements contained in a model code that is not more than 6 years out of date.	Legislation, regulation, ordinance, or other statute showing adoption of water conservation codes that are no more than 6 years out of date relative to the most recently published edition.
c) The fee structure for water service encourages conservation and recognizes the potential impacts on vulnerable populations.	Documentation of the water service fee structure.
Enhanced Requirements	**Acceptable Evidence**
d) The community and/or water service provider(s) promote water conservation technologies, have implemented incentive programs designed to reduce total water consumption to a goal level set by the community, and regularly inform target users about those incentive programs.	Documentation of the community's water conservation goal and the programs and related actions being taken to meet it. Examples of information about water conservation incentive programs circulated to target users (e.g., building owners, developers, builders).
e) The community has identified cost effective water conservation technologies and strategies, including methods for on-site water reuse and rainwater capture and established a consumer facing program	Documentation of the strategies identified and the program materials.

including incentives to support their implementation.	
f) The community has adopted building codes, standards or guidelines for water conservation that are substantially equivalent to the requirements contained in a model code that is not more than 3 years out of date.	Legislation, regulation, ordinance, or other statute showing adoption of water conservation codes that are no more than 3 years out of date relative to the most recently published editions.
g) The community allows for permitting of rainwater catchment systems consistent with nationally recognized consensus-based standards.	Excerpt from community code or permit documents demonstrating compliance paths for rainwater catchment systems.
h) The drinking water utility (in consultation with the wastewater utility) has assessed the potential for reducing potable water use through non-potable/reclaimed supply.	Copy of an engineering, economic or similar study.
Exceptional Requirements	**Acceptable Evidence**
i) The community has adopted codes, guidelines, or standards that require buildings (or a subset of buildings) to exceed the water efficiency requirements contained in a model code that is no more than 3 years out of date.	Legislation, regulation, ordinance, or other statute showing implementation of water conservation measures that exceed the requirements of the most recently published editions.
j) The drinking water utility in cooperation with the wastewater utility has implemented programs for reducing potable water use through non-potable/reclaimed supply, including permitting for rainwater catchment for non-potable use.	Program documentation and copies of ordinances allowing such systems.

Commentary:

Optimization of existing resources is one of the first lines of defense for periods of water shortage or interruption. Efficiency has been increasing with the introduction of building codes and standards to promote water-saving fixtures and practices. Furthermore, monitoring and communications of water use has enhanced consumer understanding and market signals to reduce consumption and detect and eliminate leaks.

Still, there are opportunities to enhance water conservation through adoption of new standards and policies, establishing goals and incentives, and substitution of potable water with non-potable water where possible. Savings can be achieved through community engagement and embracing emerging efficiency technologies, including low-flow fixtures, rainwater harvesting, and non-potable/reclaimed water systems. Conservation programs may include: Aerator giveaways, rebate programs for water-efficient appliances or holistic efficiency practices, turf "buy back" programs, public recommendations on drought-tolerant landscape options, landscape irrigation restrictions, and/or temporary bans on at-home car washing. Additional resources on water conservation incentives have been collected by the U.S. Water Alliance at http://www.uswateralliance.org/initiatives/commission/resources.

Relevant water conservation codes could include the International Plumbing Code (IPC), International Energy Conservation Code (IECC), International Green Construction Code (IgCC) and/or ASHRAE Standard 90.1. Relevant above code programs could include WaterSense for Homes, Water Efficiency Rating Score (WERS), WE Stand, and HERSh2O. Standards for rainwater harvesting systems include CSA B805/ICC 805 Standard for Rainwater Harvesting Systems.

Communicating conservation opportunities, setting savings targets, and updating codes and guidelines are some of the most fundamental ways to save water. Even when efficiency opportunities are maximized, there may be opportunities to offset potable water uses such as toilet flushing with non-potable water. However, appropriate standards must be in place to ensure that buildings are enabled to safely implement these types of systems in accordance with local regulations.

Fee structures should provide customers with an accurate accounting of the cost of water and not distort its value. The U.S. EPA provides guidance on pricing of water services at https://www.epa.gov/sustainable-water-infrastructure/pricing-and-affordability-water-services.

10. Wastewater System Risk Assessment	
Essential Requirements	**Acceptable Evidence**
a) The community's wastewater service provider has identified and documented water system-specific risks (e.g., threats to critical infrastructure and service lines, flood, sea level rise, seismic, pollutants, and wildfire impacts, cybersecurity breaches) that may impact public health or service, with an associated likelihood of occurrence.	Maintenance and testing records for water systems. Documentation outlining the identified system-specific risks.
Enhanced Requirements	**Acceptable Evidence**
b) The community's wastewater service provider has identified and documented cascading loss-of-service events that will impact the system's ability to provide service to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	A report documenting potential cascading loss-of-service events impacting the system. Documentation of exercises or processes undertaken to determine loss of service events.
c) The community's wastewater service provider has identified and documented potential future risks, such as emerging pollutants or changing demands for service due to either population growth or decline, or challenges to the existing water and infrastructure due to increasing development and impervious surfaces and evolving climatic conditions.	Documentation of potential future risks and demonstrated links to the COOP. Documentation of long-term planning exercises or processes undertaken to assess and document potential future risks.

Exceptional Requirements	Acceptable Evidence
d) The community's wastewater service provider's risk assessments include impacts on other services, such as downstream impacts on recreation and/or public health when wastewater systems do not function properly.	A report documenting potential impacts on other community functions. Documentation of exercises or processes undertaken to determine impacts on other community functions.

Commentary:

A utility's capacity for resilience is directly related to its planning and risk assessment. Knowing the weak points in a system allows planning for stress and possible failure. Utilities should identify worst case scenarios and the lesser events that will occur far more often. What areas of the system pose the biggest threat to life and property? How will a failure in other systems will affect the system and vice versa? What is the utility's responsibility to the greater community, and what communities might be more highly impacted? The following information will support planning efforts to alleviate and combat threats to wastewater systems.

Risk assessment for wastewater utilities is a fundamental step in providing resilient services to communities that depend on clean water resources. This process is built on a series of fundamental activities, each informing the others, with the ability to improve as new information or experiences becomes available:

- Identify and document risks.
- Develop and document responses/solutions.
- Collaborate with others that share risks or can enable solutions.

Risks include, but are not limited to, natural hazards such as drought, flooding, earthquakes, and wildfire. They can also include longer-term trends such as changes in temperature, precipitation, and sea level, that can exacerbate acute risks. Risks also include cascading impacts due to events that may be outside of the utility's control, such as loss of power. Specific to the wastewater and stormwater sectors, extreme rain events, may overload systems or other watercourses may become flash points, posing not only risks to the systems but also to public health and safety.

The community's wastewater provider's future focused plans should include receiving water quality and future treatment capacity needs based on the community's growth projections and land use/development plans and how current risks may be impacted by climate change. Comparing the requirements for wastewater systems to those for drinking water systems, there is an expectation that drinking water utilities should be pursuing essential actions that would represent enhanced resilience in the other sectors. This higher standard is derived, in part, from the higher level of resilience already demonstrated in parts of the water sector, plus the more direct exposures and higher consequences that failure or interruptions in service could have for drinking water, compared to sewer and stormwater.

Addressing these risks can include planning operational contingencies for emergencies as well as addressing future scenarios of population and climate change. When risks occur, it is important to document impacts and responses in order to understand potential changes if these risks occur again. Engaging multiple stakeholders in the risk assessment and response process can help ensure that plans are well understood and reflect operational and institutional knowledge. Assessments can be conducted using several strategies. One assessment approach involves the development of scenarios that challenge system resilience. These scenarios can be defined using combinations of different threat conditions, infrastructure and operational status and technology changes.

As part of risk assessment process, the local GIS department can help map complaints, flooding, planned and unplanned maintenance calls, etc. by location to inform assessment and planning.

11. Wastewater System Risk Mitigation	
Essential Requirements	**Acceptable Evidence**
a) The community's wastewater service provider has developed plans to mitigate wastewater system-specific risks (e.g., threats to critical infrastructure and service lines flood, sea level rise, seismic, pollutants, and wildfire impacts, cybersecurity breaches) that may impact public health or service.	A plan outlining strategies to mitigate water system-specific risks.
b) The community's wastewater service provider appropriately monitors and maintains any protective infrastructure (e.g., bioswales, natural ecosystem barriers, green and grey infrastructure) for which it is responsible.	Maintenance records and engineering reports documenting water systems and service schedules and protocols.
c) The community's wastewater service provider has backup and redundancy plans in the case of electricity outages that threaten the wastewater management and treatment system.	A copy of the emergency response plan.
Enhanced Requirements	**Acceptable Evidence**
d) The community's wastewater service provider has implemented plans to mitigate wastewater system-specific risks (e.g., flood, sea level rise, seismic, pollutants, and wildfire impacts, cybersecurity breaches) that may impact public health or service.	Documentation demonstrating implementation of the plans to mitigate water system-specific risks.

e) The community's wastewater service provider has developed plans for addressing cascading loss-of-service events that will impact the system's ability to provide service to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	Copies of the plans for addressing cascading loss-of-service events.
f) The community's wastewater service provider has developed plans for addressing potential future risks, such as changing demands for service due to either population growth or decline, emerging pollutants, challenges to the existing water infrastructure due to evolving climatic conditions, or issues related to intense weather events such as droughts or floods. Plans are updated on a regular schedule.	Copies of the plans addressing potential future risks.
Exceptional Requirements	**Acceptable Evidence**
g) The community's wastewater service provider has implemented plans for addressing cascading loss-of-service events that will impact the system's ability to provide service to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	Copies of the reports, plans, contracts, or timelines documenting the steps taken and investments made to address cascading loss-of-service events. This recordkeeping is conducted in a way that is useful for other organizations.
h) The community's wastewater service provider has implemented plans for addressing future risks, including protecting facilities and/or assets mitigating the risks themselves.	Copies of the reports, plans, contracts, or timelines documenting the steps taken and investments made to mitigate future risks. This recordkeeping is conducted in a way that is useful for other organizations.
i) The community's wastewater service provider actively monitors emerging technologies such as systems, materials, monitoring systems, and/or	Copies of policies or practices on monitoring emerging technologies, attendance records for relevant conferences or webinars or examples of incorporation of emerging technologies in mitigation plans.

research that may trigger updates to risk mitigation plans.	
j) The community's wastewater service provider has implemented on-site energy generation strategies such that its treatment facilities are either disconnected from the electrical grid or can remain operational when grid-supplied electricity is lost.	Copies of engineering plans or other documents outlining on-site energy generation strategies.

Commentary:

Monitoring and maintaining critical infrastructure is a primary way to mitigate risks, but utilities must also plan contingencies to ensure that service is quickly restored should an interruption occur. Risk mitigation also builds on effective risk assessment through the implementation of responses to anticipated impacts, along with the measurement of performance to inform any further mitigation in the face of increasing or new risks.

As part of a mitigation strategy, utilities should consider impacts to customers during an outage as well as options for providing alternate operational strategies to limit consequences. These plans should be well documented and communicated to appropriate stakeholders. In addition to dealing with emergencies, utilities should plan for longer-term changes such as population and climate change, and unexpected risks such as emerging contaminants. Wastewater service providers need to know when it will meet its permit caps (for nutrient discharge for example) and should start planning a decade or more in advance. Evaluation of systems should include collaborating with and reporting back to the state and national (regional EPA) offices to explore ways to evolve Clean Water Act regulations in ways that enable the safe expansion of wastewater conveyance and treatment.

Once the risk assessment data is collected and analyzed, an implementation plan can be developed to lessen those risks. Plans need to include how risks will be mitigated and how mitigation will be funded. Plans also need to communicate with and be able to incorporate the plans and projections of other utilities and services in the area. They need to be easily accessible and easily communicated and include an outreach plan to educate potentially impacted entities. Plans also need to identify challenges to implementation faced by the utility.

The wastewater service provider should develop future-focused plans that include future capacity needs based on the community's growth projections and land use/development plans, including an implementation timeline to increase capacity for any projected population growth. The plan is publicly available online and updated on a regular basis. By developing plans to optimize and protect critical water resources and committing to monitor these risks and periodically update risk mitigation plans, utilities are better equipped to prevent interruptions and mitigate impacts when they occur. Successful risk mitigation strategies include thorough documentation, communication, and stakeholder engagement.

Communities must also appropriately harden their infrastructure to reflect the effects of natural hazards. A functional collection system in a time of crisis becomes more than just a wastewater system: it becomes essential public health protection for the community and its first responders.

Presently, there are several guidelines and standards available to help drinking water and wastewater utilities design more resilient systems that can better withstand risks to viability.

Hazard Mitigation For Natural Disasters: A Starter Guide for Water and Wastewater Utilities:, US EPA: https://www.epa.gov/sites/production/files/2016-08/documents/160815-hazardmitigationfornaturaldisasters.pdf.

International standard for earthquake and subsidence-resistant design of certain water pipelines, and more seismic design standards are being created by organizations such as AWWA, ASCE, and ASTM.

12. Wastewater System Function	
Essential Requirements	**Acceptable Evidence**
a) The community's wastewater service provider maintains sufficient function to limit and respond to backups into residences and businesses and prevents untreated wastewater discharges.	IDDE maintenance survey including plans for replacement for sewer system components as needed. Documentation of community administered consumer programs to prevent wastewater backflows.
b) The community's wastewater service provider has a program in place to manage and reduce inflow and infiltration (I&I) to the system.	Documentation outlining the providers' current I&I management program.
c) The community's wastewater service provider or other relevant agency has conducted an assessment of current septic tank use and septic tank conditions.	A copy of the assessment.
d) When septic systems are necessary due to local conditions, the community has implemented codes for safe installations complying to the latest edition of the International Private Sewage Disposal Code, the Uniform Plumbing Code or locally administered environmental codes.	A copy of the ordinance implementing relevant code provisions.
Enhanced Requirements	**Acceptable Evidence**
e) The community requires that all newly constructed sewers and storm sewers remain separated.	Regulations on construction of sewer and storm systems.
f) The community's wastewater service providers have implemented system specifications appropriate for local conditions and needs for new construction or replacement of critical sewerage infrastructure that are aligned with current industry standards.	Documentation of system specifications including documentation of what standards the community specifications are aligned with.

g) The community's wastewater service provider has conducted a feasibility study on connecting properties currently using septic tanks to collection systems.	Copies of the feasibility study.
Exceptional Requirements	**Acceptable Evidence**
h) The community has implemented zoning codes to limit new septic tanks within possible service areas.	Copy of the ordinance implementing these restrictions.

Commentary:

A community's wastewater system is a complex set of infrastructure with many points of potential weakness, exacerbated by age and the relative obscurity of the underground conveyance system. Nevertheless, wastewater system function is always critical for maintaining public health and environmental quality, and is frequently put under stress by weather, age, and continuous use.

A resilient community water system will carefully monitor system integrity to ensure limited incidences of illicit discharge into watercourses, back-ups into buildings, or infiltration into groundwater. System repairs and upgrades provide an opportunity to make material and design choices to optimize performance based on current knowledge. Selecting the right pipe for the job is a complex undertaking to manage for corrosion, tuberculation, leakage, freezing, water hammer, fatigue, ground settling, earthquakes, hurricanes, and changes to the water table. Community wastewater system managers can be better prepared by identifying the primary hazards to system function and establishing the needed specifications to remain operational and, in the event of system failure, to quickly recover from predictable shocks.

With a changing climate, historical hydrogeological patterns are poor predictors of the future, and extremes of greater frequency and intensity should be considered. System performance data should be compared to modeled capacity, flow, and known risks to identify aberrations in the sewerage system's functions and plan ahead for repairs.

Key strategies for improved wastewater system function include the separation of storm and wastewater sewers and the connection of septic system users into the municipal wastewater system. Further, a resilient community water system will monitor the development and evolution of standards related to wastewater system specifications. Wastewater system managers should look to state governments for information on evolving standards, helpful guidelines, and available resources.

13. Wastewater System Management	
Essential Requirements	**Acceptable Evidence**
a) The critical assets owned by the community's wastewater service provider are maintained as part of an asset management program.	Documentation of the asset management program.
b) The community's wastewater service provider has adopted the principles of Effective Utility Management, that include accounting for the full operational and capital costs of providing wastewater services.	Copy of the policy outlining adherence to the principles of effective utility management.
c) The wastewater service provider has developed and follows a system maintenance and cleaning plan for the sewers and related infrastructure components to preserve the system's conveyance capacity.	A copy of the cleaning plan and records demonstrating adherence to the plan.
d) The community's wastewater service provider has implemented a real-time sensing system (e.g., SCADA) to manage, monitor, and maintain operations.	Documentation demonstrating installation and maintenance of a real-time sensing system.
Enhanced Requirements	**Acceptable Evidence**
g) The community's water service provider(s) have remote access capability so that critical facilities can be monitored and/or operated remotely.	Documentation of remote access mechanisms.
h) The community's wastewater service provider has established a community advisory board to address ratepayer concerns, including environmental justice and expectations regarding level of service to disadvantaged communities.	Community advisory board charter, meeting notices or minutes, or documentation of decisions.

i) The community's wastewater service provider has conducted an assessment of nutrient and energy losses through the wastewater system and the economic and environmental feasibility of nutrient and energy recovery.	Documentation of energy and nutrient waste and recovery assessment.
j) The community's water service provider(s) have a recordkeeping system that tracks maintenance, repairs, and complaints.	Documentation of the recordkeeping system and its capabilities.
k) The governance structure of the community's wastewater service provider reflects the racial, ethnic, and gender diversity of the customers it serves.	Documentation illustrating the wastewater service provider's policies for diversity, equity and inclusion.
Exceptional Requirements	**Acceptable Evidence**
l) The community's wastewater service provider has a recordkeeping system that integrates with GIS.	Documentation of the recordkeeping system and its capabilities.
m) The community's wastewater service provider has implemented a plan to recover nutrients and energy from the wastewater system and the wastewater.	Copy of the plan and records of the measures taken to implement it.

Commentary:

Optimal operations, maintenance and management of a community's wastewater treatment and conveyance system are essential for the protection of the public health and the water quality of receiving streams. This includes, at a minimum, following EPA's Effective Utility Management (EUM) guidelines for wastewater systems (https://www.epa.gov/sustainable-water-infrastructure/effective-utility-management-primer-water-and-wastewater-utilities). Asset management, including timely replacement of mission critical equipment, is a foundational component of a well-run sustainable wastewater management system. An effective asset management program includes sufficient redundancies and includes maintaining an inventory of spare parts. The asset management program also includes maintaining information about critical assets (such as location, elevation, age, material etc.) that helps to manage assets, conduct preventative maintenance, and/or assess level of risk.

In addition, the community must ensure that the system has reliable and robust emergency backup systems in the event of emergencies, power outages, extreme weather events, etc., in order to protect the public health and environment from raw sewage spills and overflows. Moreover, the system must be resilient in the face of climate change, including more severe storms, river level rise, etc.

Nutrient and energy recovery can help remove phosphorus, nitrogen, ammonia and biogas from the effluent, protecting receiving waters from eutrophication while also potentially developing a revenue stream for the wastewater service provider. See *Global and regional potential of wastewater as a water, nutrient and energy source* and Resource Recovery Roadmaps from the Water Environment Federation.

Lastly, the community must plan for the future to ensure that the system has sufficient capacity for the projected growth. In addition, the community must institute full cost pricing so that there is sufficient revenue for optimal operation of the system, timely replacement of aging infrastructure and resiliency against the challenges associated with climate change.

14. Wastewater System Customer Engagement	
Essential Requirements	**Acceptable Evidence**
a) The community's wastewater service provider has communication systems in place to alert customers of public meetings, address customers' questions and concerns, provide educational information, and report water related issues such as sewage backups and flooding.	Social media accounts, websites, SMS notifications, examples of bill mailers, employment of a dedicated communications person, and/or a written communications plan. Hotlines, webpages, or apps for community reporting of water-related issues. Examples of past communications or notices.
Enhanced Requirements	**Acceptable Evidence**
b) The community's wastewater provider has a process to identify vulnerable populations and communities affected by projects and engage them in decision-making.	Documentation outlining the process and reports from community meetings or other strategies deployed to engage vulnerable populations.
c) The community's wastewater service provider publishes an annual report of its financial condition developed through an Effective Utility Management process, including an assessment of the full cost of providing services relative to the rates charged in the community.	Examples of past communications or notices, plans, and annual reports.
d) The community's wastewater service provider communicates risk mitigation actions to customers and partners.	Copies of the communication and documentation on the dissemination methods.
Exceptional Requirements	**Acceptable Evidence**
e) The community provides water system users the opportunity to buy insurance for repairs of service line breaks.	Evidence of insurance availability or other relevant documents.

Commentary:

Customer engagement is another important aspect of a well-run, sustainable, wastewater utility. It is critical that customers know that their wastewater utility is actively protecting the public health and the environment, on a continual basis, from raw sewage overflows and backups. When the wastewater utility is transparent about its purpose, and the associated cost of completing its public health and environmental protection mission, ratepayers are far more likely to support the rates necessary to ensure a sustainable operation. In addition, it is important that the wastewater utility be inclusive of all communities, including low income communities, in its engagement endeavors, in order to be equitable as well as sustainable.

A communication and outreach plan is an important part of good governance as well as organizational, infrastructure and financial management. Residents have a right to be informed and government as well as utilities have a responsibility to inform them. Alerting water consumers to hazards within the water system builds trust between the rate payer and water utility. This trust is vital for situations in which the utility needs to make difficult decisions.

AWWA's Public Communications Toolkit is a helpful resource for water system operators seeking to make the most of their communications efforts. A thoughtful approach to public communications and customer engagement will invest time and attention to identifying areas within the wastewater service system where underperformance of the system may have an outsized impact on vulnerable populations. Clearly communicating the full cost to maintain, upgrade, and expand the system can help build public awareness of the need for investment in system infrastructure.

15. Wastewater System Water Quality	
Essential Requirements	**Acceptable Evidence**
a) The community's wastewater service provider is in full compliance with applicable state and federal water quality regulations and reporting guidelines.	Community demonstrates evidence of permits and satisfaction of regulatory compliance. For example, documentation that states the service provider is complying with state and federal requirements.
b) The community's wastewater service provider has an industrial effluent pre-treatment program.	Written documentation of an industrial effluent pre-treatment program
Enhanced Requirements	**Acceptable Evidence**
c) The community's wastewater service provider's water quality performance exceeds permit compliance requirements.	Copies of water quality reports.
d) The community wastewater service provider has a plan detailing wastewater limits for nutrient discharge and other variables, when limits will be reached, and what measures will be implemented to ensure continued compliance.	Copies of the nutrient management plan.
e) The community allows for permitting of graywater systems and provides water quality standards and requirements for such systems.	Copies of the ordinance allowing such systems and the required parameters such systems must meet.
Exceptional Requirements	**Acceptable Evidence**
f) The community's wastewater service provider's water quality performance is optimized to the extent of best available technology and practices.	System plans, water quality reports and other documentation demonstrating achievement of water quality and practices deployed.
g) The community allows for permitting of blackwater systems and provides water quality standards and requirements for such systems.	Copies of the ordinance allowing such systems and the required parameters such systems must meet.

Commentary:

In our world where water cycles around and around, we are all downstream. Wastewater treatment is an essential component to modern day public health systems, protecting source waters for downstream drinking water systems. The critical function performed by the wastewater treatment facility is to keep water safe for people and ecology, protected from pathogens and pollutants that are sent down the drains to the plant.

As such, it is imperative that any resilient community water system is fully compliant with all state and federal water quality regulations, with plans to best the minimum requirements and employ current best management practices to the greatest extent practicable. Water quality is likely to be at risk, especially during emergency events, without a state and local partnership to administer an industrial effluent pretreatment program. According to EPA, an industrial effluent pre-treatment program is designed to "reduce conventional and toxic pollutant levels discharged by industries and other nondomestic wastewater sources into municipal sewer systems and into the environment." Even communities without heavy industry can benefit from such a program since many nondomestic pollutants can degrade water quality or compromising the wastewater system with similar results (e.g. grease from restaurants).

The National Pollutant Discharge Elimination System (NPDES) is a federal program, managed by EPA, regulating point sources that discharge into watercourses. Most states are authorized to implement the program on EPA's behalf, issuing licenses to facilities (such as municipal wastewater treatment plants) to discharge a limited amount of pollutants. NPDES regulates peak flows and sewer overflows and, in certain NPDES permits, offers water quality trading as a compliance option for water quality-based effluent limitation.

Nitrogen and phosphorous are natural nutrients that, through human activity and both water and land management, are driving deteriorating water quality across the United States. Community water systems have a role to play in avoiding the nutrient overloading of watercourses by establishing limits for nutrient discharge and plans for further action when environmental systems are at their maximum nutrient levels. See EPA's web page on nutrient pollution for further information, solutions, and case studies.

Communities can reduce strain on the wastewater system by establishing policies and guidelines for water reuse (including grey water and blackwater). Communities can find helpful guidance and resources on the design, installation, management, and integration of distributed water reuse systems safely deployed at buildings from the National Blue Ribbon Commission on On-Site Water Reuse, including guidance for utilities, cities, and states and how-to guides on developing and implementing regulations.

Staying current with best available technology and practices for wastewater quality is important for community water system managers, and essential for those seeking to enhance resilience. National industry associations such as the American Water Works Association and the Water & Wastewater Equipment Manufacturers Association are two of many forums to keep up with new developments. Academic partnerships and regular review of academic journals can also provide key insights.

16. Combined Storm/Sanitary Sewer System Management	
Essential Requirements	**Acceptable Evidence**
a) The combined sewer service provider has developed and follows a system maintenance and cleaning plan for the combined sanitary and storm sewers, outfalls, regulators, tide gates and related infrastructure components to preserve the system's conveyance capacity and control the amount of combined sewer flow that goes to the treatment plant versus overflow outfalls.	Copy of the plan and documentation that demonstrates compliance with the plan.
b) The wastewater service provider has added netting systems to the combined sewer outfall pipes in order to capture solids and reduce water quality impacts.	Records documenting use of netting systems.
c) The community's combined sewer system is designed to convey the diurnal daily peak plus combined sewage flow associated with a 1-year storm.	System permits, design documents or other documentation that includes IDF curves reflecting the 1-year storm and the system parameters that demonstrate required capacity.
Enhanced Requirements	**Acceptable Evidence**
d) The community offers incentives for capturing or infiltrating rainwater on-site to reduce pressure on the combined sewer system.	Copies of incentive program materials, how those materials are disseminated and information on how consumers access the program.
e) The community's waste and stormwater service providers have completed cost and feasibility analysis of separating the systems.	Copies of the feasibility study.
f) The community's combined sewer system provider has identified the risks associated with a 5-year storm and implemented strategies to address those risks.	Study identifying risks and documentation of strategies deployed to address those risks.

Exceptional Requirements	Acceptable Evidence
g) The community's wastewater and stormwater service providers have a plan to separate the sanitary and storm sewer systems.	Copy of the plan.
h) The community's combined sewer system provider has identified the risks associated with a 10-year storm and implemented strategies to address those risks.	Study identifying risks and documentation of strategies deployed to address those risks.

Commentary:

Where combined sanitary and storm sewers exist, the system must be managed holistically. This requirement is intended to address the specific needs of these combined systems. The requirements in both the wastewater and stormwater system subsets should also be followed.

Optimal operations, maintenance and management of a combined sewer system is essential to protection of the public health and environment, because of the adverse impacts associated with raw sewage backups, overflows and spills. The wastewater utility must optimize the conveyance and treatment capacity of the system in order to reduce the probability of raw sewage overflows. In addition, the systems must be kept clean and well maintained at all times in order to preserve the volumetric capacity of the system and bring it to bear to capture and contain the increased sewage volumes that result during wet weather events.

In addition, the wastewater utility can further reduce the probability of combined sewage overflows by correspondingly reducing the amount of impervious surface in the watershed via implementation of green infrastructure like parks and rain gardens. Moreover, the wastewater utility can reduce the adverse impact of combined sewage overflows into receiving streams by equipping outfalls with netting systems that capture the majority of solid waste that would otherwise pollute the stream. Risk mapping could help target solutions for system segments not designed to meet the designated storm events. Policy changes may be required to allow such strategies.

Combined sanitary and storm systems will benefit from storm water mitigation strategies further discussed under the Stormwater Benchmarks below.

Lastly, because combined sewer systems are especially vulnerable to climate change impacts, such as river level rise and more severe storms, the wastewater utility must implement resiliency plans to reduce the community's vulnerability to climate impacts.

Storm events are identified under the Public Safety Benchmark.

17. Stormwater System Risk Assessment	
Essential Requirements	**Acceptable Evidence**
a) The stormwater service provider has identified and documented stormwater system-specific risks (e.g., threats to critical infrastructure, flood, sea level rise, seismic, pollutants, and wildfire impacts, cybersecurity breaches) that may impact public health or service, with an associated likelihood of occurrence.	Maintenance and testing records for water systems. Documentation outlining the identified system-specific risks.
Enhanced Requirements	**Acceptable Evidence**
b) The stormwater service provider has identified cascading loss-of-service events that will impact the system's ability to provide service to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	A report documenting potential cascading loss-of-service events impacting the system. Documentation of exercises or processes undertaken to determine loss of service events.
c) The stormwater service provider has identified and documented potential future risks, such as changing demands for service due to either population growth or decline emerging pollutants, or challenges to the existing water and infrastructure due to increasing development and impervious surfaces and evolving climatic conditions.	Documentation of potential future risks and demonstrated links to the COOP. Documentation of long-term planning exercises or processes undertaken to assess and document potential future risks.

Exceptional Requirements	Acceptable Evidence
d) The stormwater service provider's risk assessments include an assessment of impacts on other services (e.g. if stormwater systems are overwhelmed and there is flooding, what might be the impacts on power infrastructure, recreation, private and public property, etc.?).	A report documenting potential impacts on other community functions. Documentation of exercises or processes undertaken to determine impacts on other community functions.

Commentary:

A utility's capacity for resilience is directly related to its planning and risk assessment. Knowing the weak points in your system allows managers to plan for stress and possible failure. Utilities need to identify worst case scenarios and the lesser events that will occur far more often. What areas of the system pose the biggest threat to life and property? How will a failure in other systems will affect the system and vice versa? What is the utility's responsibility to the greater community, and what communities might be more highly impacted? The following information will support planning efforts to alleviate and combat threats to the stormwater system.

Risk assessment for stormwater utilities is a fundamental step in providing resilient services to communities that depend on clean water resources. This process is built on a series of fundamental activities, each informing the others, with the ability to improve as new information or experiences becomes available:

- Identify and document risks
- Develop and document responses/solutions
- Collaborate with others that share risks or can enable solutions

Risks include, but are not limited to, natural hazards such as drought, flooding, earthquakes, and wildfire. They can also include longer-term trends such as changes in temperature, precipitation, and sea level, that can exacerbate acute risks. In the case of extreme rain events, some systems may overload or other watercourses may become flash points, posing not only risks to systems but also to public health and safety. Risks also include cascading impacts due to events that may be outside of the utility's control, such as loss of power.

The community's stormwater provider's future focused plans should include receiving water quality and future treatment capacity needs based on the community's growth projections and land use/development plans. Comparing the requirements for stormwater systems to those for drinking water systems, there is an expectation that drinking water utilities should be pursuing essential actions that would represent enhanced resilience in the other sectors. This higher standard is derived, in part, from the higher level of resilience already demonstrated in parts of the water sector, plus the more direct exposures and higher consequences that failure or interruptions in service could have for drinking water, compared to sewer and stormwater.

Addressing these risks can include planning operational contingencies for emergencies as well as addressing future scenarios of population and climate change. When risks occur, it is important to document impacts and responses in order to understand potential changes if these risks occur again. Engaging multiple stakeholders in the risk assessment and response process can help ensure that plans are well understood and reflect operational and institutional knowledge.

Assessments can be conducted using several strategies. One assessment approach involves the development of scenarios that challenge system resilience. These scenarios can be defined using combinations of different threat conditions, infrastructure and operational status and technology changes. The results of the risk assessment should be provided in a publicly available report that documents risks and provides recommendations for improvements needed.

18. Stormwater System Risk Mitigation	
Essential Requirements	**Acceptable Evidence**
a) The stormwater service provider has developed plans to mitigate stormwater system-specific risks (e.g., threats to critical infrastructure, flood, seismic, pollutants, and wildfire impacts, cybersecurity breaches) that may impact public health or service.	A plan outlining strategies to mitigate water system-specific risks.
b) The stormwater service provider monitors and maintains any protective infrastructure (e.g., bioswales, natural ecosystem barriers, green and grey infrastructure) for which it is responsible.	Maintenance records and engineering reports documenting water systems and service schedules and protocols.
Enhanced Requirements	**Acceptable Evidence**
c) The stormwater service provider has implemented plans to mitigate water system-specific risks (e.g., flood, seismic, pollutants, and wildfire impacts, cybersecurity breaches) that may impact public health and service.	Documentation demonstrating implementation of the plans to mitigate water system-specific risks.
d) The stormwater service provider has developed plans for addressing cascading loss-of-service events that will impact the system's ability to provide service to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	Copies of the plans for addressing cascading loss-of-service events.

e) The stormwater service provider has developed plans for addressing potential future risks, such as changing demands for service due to either population growth or decline, emerging pollutants, challenges to the existing water infrastructure due to evolving climatic conditions, or issues related to intense weather events such as droughts or floods. Plans are updated on a regular schedule.	Copies of the plans addressing potential future risks.
Exceptional Requirements	**Acceptable Evidence**
f) The stormwater service provider has implemented plans for addressing cascading loss-of-service events that will impact the system's ability to provide service to customers. This determination should consider events both within the water functional area and events originating outside the functional area (e.g., power loss).	Copies of the reports, plans, contracts, or timelines documenting the steps taken and investments made to address cascading loss-of-service events. This recordkeeping is conducted in a way that is useful for other organizations.
g) The stormwater service provider has implemented plans for addressing future risks, including protecting facilities and/or assets mitigating the risks themselves.	Copies of the reports, plans, contracts, or timelines documenting the steps taken and investments made to mitigate future risks. This recordkeeping is conducted in a way that is useful for other organizations.
h) The stormwater service provider actively monitors emerging technologies such as systems, materials, monitoring systems, and/or research that may trigger updates to risk mitigation plans.	Copies of policies or practices on monitoring emerging technologies, attendance records for relevant conferences or webinars or examples of incorporation of emerging technologies in mitigation plans.

Commentary:

Providing clean water services is a fundamental goal common to all water utilities. Monitoring and maintaining critical infrastructure is a primary way to mitigate risks, but utilities must also plan contingencies to ensure that service is quickly restored should an interruption occur. Risk mitigation also builds on effective risk assessment through the implementation of responses to anticipated impacts, along with the measurement of performance to inform any further mitigation in the face of increasing or new risks.

As part of a mitigation strategy, utilities should consider impacts to customers during an outage as well as options for providing alternate operational strategies to limit consequences. These plans should be well documented and communicated to appropriate stakeholders. In addition to dealing with emergencies, utilities should plan for longer-term changes such as population and climate change, and unexpected risks such as emerging contaminants. Evaluation of systems should include collaborating with and reporting back to the state and national (regional EPA) offices to explore ways to evolve Clean Water Act regulations in ways that enable the safe expansion of stormwater collection and conveyance.

Once the risk assessment data is collected and analyzed, an implementation plan can be developed to lessen those risks. Plans need to include how risks will be mitigated and how mitigation will be funded. Plans also need to communicate with and be able to incorporate the plans and projections of other utilities and services in the area. They need to be easily accessible and easily communicated and include an outreach plan to educate potentially impacted entities. Plans also need to identify challenges to implementation faced by the utility.

The stormwater service provider should develop future-focused plans that include future capacity needs based on the community's growth projections and land use/development plans, including an implementation timeline to increase capacity for any projected population growth. The plan is publicly available online and updated on a regular basis. By developing plans to optimize and protect critical water resources, and committing to monitor these risks and periodically update risk mitigation plans, utilities are better equipped to prevent interruptions and mitigate impacts when they occur. Successful risk mitigation strategies include thorough documentation, communication, and stakeholder engagement. Plans should include requirements for periodic review and updates, who is responsible for what actions, and a timeline.

Stormwater systems are unique when compared with drinking and wastewater systems, as they can additionally allow for interventions at smaller scales, and will not always require the utility be involved. Stormwater mitigation strategies have been deployed in many communities that help to decrease the amount of stormwater entering the system and therefore reduce the amount of risk to system during a storm event. These strategies include:

- Stormwater fees, which encourage owners to reduce the amount of run off from their property by assessing fees based on the estimated runoff (calculated based on the amount of impervious surface on a building site)
- Stormwater construction requirements, which require owners to maintain a certain amount of water onsite, typically calculated in inches/site area or volume of water, over a certain time period.
- Green roof requirements, which may be directed at or secondarily benefit some stormwater mitigation strategies
- Enabling the reuse of storm or gray water in plumbing systems where potable water is not a requirement. This strategy has the additional benefit of alleviating pressure on the drinking water system as well.

Presently, there are several guidelines and standards available to help drinking water and wastewater utilities design more resilient systems that can better withstand risks to viability.

- Hazard Mitigation for Natural Disasters: A Starter Guide for Water and Wastewater Utilities, US EPA: https://www.epa.gov/sites/production/files/2016-08/documents/160815-hazardmitigationfornaturaldisasters.pdf.

- International standard for earthquake and subsidence-resistant design of certain water pipelines, and more seismic design standards are being created by organizations such as AWWA, ASCE, and ASTM.

19. Stormwater System Function	
Essential Requirements	**Acceptable Evidence**
a) The community's stormwater system is designed to convey the peak flow associated with the 1-year storm.	System permits, design documents or other documentation that includes IDF curves reflecting the 1-year storm and the system parameters that demonstrate required capacity.
b) The stormwater service provider has developed and follows a system maintenance and cleaning plan for the sewers, outfalls, regulators, tide gates and related infrastructure components to preserve the system's conveyance capacity.	A copy of the cleaning plan and records demonstrating adherence to the plan.
c) The community's stormwater service providers have implemented system specifications appropriate for local conditions and needs for new construction or replacement of critical stormwater infrastructure that are aligned with current industry standards.	Documentation of system specifications including documentation of what standards the community specifications are aligned with.
Enhanced Requirements	**Acceptable Evidence**
d) The community offers incentives for capturing or infiltrating rainwater on-site to reduce pressure on the storm sewer system.	Copies of incentive program materials, how those materials are disseminated and information on how consumers access the program.
e) The stormwater service provider has remote access and electronic monitoring capability so that critical facilities can be monitored and/or operated remotely.	Documentation of remote access mechanisms.
f) The community has implemented plans for managing extensive stormwater.	Passage of an ordinance requiring improved infiltration of stormwater in new neighborhoods/developments and/or installation of stormwater retrofits in existing neighborhoods/developments consistent with recognized stormwater management practices. Stormwater utility plan, including maps identifying areas of flooding history via utility records and complaints.

g) The community incentivizes new and existing buildings to provide onsite stormwater management.	Copies of incentive program materials, how those materials are disseminated and information on how consumers access the program.
h) The community's stormwater system provider has identified the risks associated with a 5-year storm and implemented strategies to address those risks.	Study identifying risks and documentation of strategies deployed to address those risks.
Exceptional Requirements	**Acceptable Evidence**
i) The community's stormwater service provider has implemented a real-time sensing system (e.g., SCADA) to manage, monitor, and maintain operations.	Documentation demonstrating installation and maintenance of a real-time sensing system.
j) The community has implemented a stormwater management requirement for all new construction projects.	Copy of the ordinance establishing stormwater management requirements.
k) The community's stormwater system provider has identified the risks associated with a 10-year storm and implemented strategies to address those risks.	Study identifying risks and documentation of strategies deployed to address those risks.

Commentary:

A community's stormwater system provides valuable services to protect the community from disruption due to flooding. In many communities, the system is under appreciated until there is an issue. The stormwater system function is always critical for maintaining public health and environmental quality, and is frequently put under stress by weather, age, and continuous use.

It is important to track progress, both from the purpose of adaptive management and future funding. The data collected to assess the risks and formulate the plan can be helpful for developing an evaluation and assessment of plan implementation. Planning for how to collect and how to store data will improve the ease and outcome of recordkeeping. Future expenditures may require the utility to show improvement over time. Additionally, good record keeping is the basis for adaptive management, or change of the plan over time.

A resilient community water system will carefully monitor system integrity to ensure limited incidences of illicit discharge into watercourses, back-ups into buildings, or infiltration into groundwater. System repairs and upgrades provide an opportunity to make material and design choices to optimize performance

based on current knowledge. Community stormwater system managers can be better prepared by identifying the primary hazards to system function and establishing the needed specifications to remain operational and, in the event of system failure, to quickly recover from predictable shocks.
With a changing climate, historical hydrogeological patterns are poor predictors of the future, and extremes of greater frequency and intensity should be considered. System performance data should be compared to modeled capacity, flow, and known risks to identify aberrations in the stormwater system's functions and plan ahead for repairs.

The community should pair passive stormwater mitigation strategies with active systems or enlargement of systems in critical stormwater system failure areas of the community. Passive strategies such as detention systems, permeable pavement systems, and bioretention can assist in targeted areas as well as across the full system to reduce strain on the stormwater runoff system. Communities may find ways to encourage through incentives or require through policy the implementation of onsite stormwater mitigation strategies in areas that are prone to flooding.

Communities may find that a reference document on how to calculate stormwater retention and detention across a variety of strategies would be beneficial. Washington DC has developed a stormwater guidebook: https://doee.dc.gov/swguidebook.

20. Stormwater System Management	
Essential Requirements	**Acceptable Evidence**
a) The critical assets owned by the stormwater service provider are maintained as part of an asset management program.	Documentation of the asset management program.
b) The stormwater service provider has adopted the principles of Effective Utility Management, that include accounting for the full operational and capital costs of providing services.	Copy of the policy outlining adherence to the principles of Effective Utility Management.
c) The community's stormwater management system has a dedicated source of funds budgeted for capital costs and operations and management.	Copy of ordinance or budgeting documents outlining sources of funding.
Enhanced Requirements	**Acceptable Evidence**
d) The community's stormwater management agency has established a community advisory board to address community concerns, including environmental justice.	Community advisory board charter, meeting notices or minutes, or documentation of decisions.
e) The community's wastewater service provider has a recordkeeping system that tracks maintenance, repairs, and complaints.	Documentation of the recordkeeping system and its capabilities.
f) The community's stormwater management system has a dedicated source of capital and O&M funds that cannot be re-allocated to other community functions.	Copy of ordinance or budgeting documents outlining sources of funding and how those funds are protected from non-stormwater system uses.
g) The governance structure of the community's water service provider(s) is representative of the community that it serves in terms of racial and gender diversity.	Documentation illustrating the wastewater service provider's policies for diversity, equity and inclusion.

Exceptional Requirements	Acceptable Evidence
h) The community's wastewater service provider has a recordkeeping system that integrates with GIS.	Documentation of the recordkeeping system and its capabilities.
i) The community's stormwater management system has a dedicated source of capital and O&M funds established through a drainage or stormwater fee and has an independent body responsible for management of the funds.	Copy of ordinance or budgeting documents outlining sources of funding and how those funds are protected from non-stormwater system uses.

Commentary:

The failure of stormwater systems, frequently due to inadequate volume capacity, is one of the more conspicuous deficiencies of any of an under-performing community water system. Historically underfunded, undervalued, and under-designed, when failure occurs, stormwater problems are obvious to everyone and a present source of danger to life and property. The community needs to be involved to better understand the magnitude of the problem and more importantly, to be a source of potential solutions. Stormwater is rarely able to be handled fully on public land, so residents and businesses need to be involved in the planning process to become part of the solution. In the rare case it is all handled on public land, the utility or local government is responsible to steward that land for its residents, thereby involving them in planning for its use. As a part of public involvement in the process, information and needs to be readily available and presented in a manner the public can receive it.

Effective management includes at a minimum, following EPA's Effective Utility Management (EUM) guidelines (https://www.epa.gov/sustainable-water-infrastructure/effective-utility-management-primer-water-and-wastewater-utilities). Asset management, including timely replacement of mission critical equipment, is a foundational component of a well-run, sustainable water management system. An effective asset management program includes sufficient redundancies and includes maintaining an inventory of spare parts. The asset management program also includes maintaining information about critical assets (such as location, elevation, age, material etc.) that helps to manage assets, conduct preventative maintenance, and/or assess level of risk.

In addition, the community must ensure that the system has reliable and robust emergency backup systems in the event of emergencies, power outages, extreme weather events, etc., in order to protect the public health and environment. Moreover, the system must be resilient in the face of climate change, including more severe storms, river level rise, etc.

Lastly, the community must plan for the future to ensure that the system has sufficient capacity for the projected growth. In addition, the community must institute full cost pricing so that there is sufficient revenue for optimal operation of the system, timely replacement of aging infrastructure and resiliency against the challenges associated with climate change.

Paired with any plans for replacement, expansion or projected growth must be policies that require best management practices on building site and in key public areas of anticipated capacity need. Practices such as green roofs, rainwater harvesting, permeable pavement, bioretention, and storage can be paired with larger infrastructure projects where needed, but alone have the capability to make a real impact on stormwater hazard events by slowing, and in some cases stopping, the flow of water into the storm system.

21. Stormwater System Customer Engagement	
Essential Requirements	**Acceptable Evidence**
a) The stormwater service provider has communication systems in place to alert customers of public meetings, address customers' questions and concerns, provide educational information, and report water related issues such as flooding.	Social media accounts, websites, SMS notifications, examples of bill mailers, employment of a dedicated communications person, and/or a written communications plan. Hotlines, webpages, or apps for community reporting of water-related issues. Examples of past communications or notices.
Enhanced Requirements	**Acceptable Evidence**
b) The stormwater service provider has a process to identify vulnerable populations and communities affected by projects and engage them in decision-making.	Documentation outlining the process and reports from community meetings or other strategies deployed to engage vulnerable populations.
c) The stormwater service provider publishes an annual report of its financial condition developed through Effective Utility Management, including an assessment of the full cost of providing services relative to the rates charged in the community.	Examples of past communications or notices, plans, and annual reports.
d) The stormwater service provider communicates risk mitigation actions to customers and partners.	Copies of the communications and documentation on the dissemination methods.
e) The community and/or the community's stormwater service provider has an established program and/or partnership to engage customers in basin drainage education, including litter clean-up activities, downstream ecology education, and promotion of stormwater mitigation practices and incentives.	Evidence of partnership via a formal agreement, public announcement, or program website.

Commentary:

Of all the community water services, customers may be least connected to, engaged with, and aware of the work of the stormwater system. Utilities manage their entrusted responsibility on behalf of their users. A communication and outreach plan is an important part of good governance as well as organizational, infrastructure and financial management. Residents have a right to be informed and government as well as utilities have a responsibility to inform them. Customers are not ignorant, however, of the consequences of a stormwater system that fails to match the customer's expectations for swift and complete drainage. With increased frequency and intensity of extreme weather events driven by climate change, including rains that can quickly overload a system's design capacity, communities can get ahead of predictable risks and frustrations by developing a productive relationship with stormwater system customers. Alerting water consumers to hazards within the water system builds trust between the rate payer and water utility. This trust is vital for situations in which the utility needs to make difficult decisions.

Back-ups in the streets can create mobility hazards and, in combined systems, also indicate elevated risk of backflow into homes and businesses. Combined systems may also overflow in rain events, adding water quality risks to public waterways that may impact recreation for hours or days. These and other results of overloaded stormwater systems compel education, communication, and engagement with the public to protect public health and set expectations about risks, disruptions, and abnormal system functionality.

AWWA's Public Communications Toolkit is a helpful resource for water system operators seeking to make the most of their communications efforts. A thoughtful approach to public communications and customer engagement will invest time and attention to identifying areas within the stormwater service system where underperformance of the system may have an outsized impact on vulnerable populations. Clearly communicating the full cost to maintain, upgrade, and expand the system can help build public awareness of the need for investment in system infrastructure. Communities can further benefit from boosting awareness of basin drainage and promoting steps customers can take to alleviate system pressures, protect property, and contribute to a more resilient community water system.

Further engaging the community in more localized solutions or "green" infrastructure to support the community's stormwater goals can help community members see the need for attention to the issues, and teach solutions that can be used in their own homes. An example of a community engagement framework from Gary, Indiana focused on stormwater issues can be found here: https://www.epa.gov/sites/production/files/2017-03/documents/2_gary_stormwater_community_engagement_framework_011817_508.pdf.

22. Stormwater System Water Quality	
Essential Requirements	**Acceptable Evidence**
a) The community's stormwater management service provider is in full compliance with applicable state and federal water quality regulations and reporting guidelines.	Community demonstrates evidence of permits and satisfaction of regulatory compliance. For example, documentation that states the service provider is complying with state and federal requirements.
Enhanced Requirements	**Acceptable Evidence**
b) The wastewater service provider has added netting systems to the sewer outfall pipes in order to capture solids and reduce water quality impacts.	Records documenting use of netting systems.
Exceptional Requirements	**Acceptable Evidence**
c) The community has integrated stormwater BMPs and nature-based solutions into the design of public infrastructure and deployed nature-based solutions or other innovative stormwater management technologies/practices as part of a green infrastructure plan to reduce stormwater impacts on water quality and flooding.	List of installed nature-based projects and copy of green infrastructure plan. Policy requirements outlining use of nature-based solutions first or requiring analysis of why they will not work and why traditional grey infrastructure is required.

Commentary:

A community's stormwater system performs valuable functions to convey water away from homes and business and protect the receiving waters from contaminants or activities that may undermine public health, recreation and ecology. As such, it is imperative that any resilient community water system is fully compliant with all state and federal water quality regulations, with plans to best the minimum requirements and employ current best management practices to the greatest extent practicable.

As the utility has the responsibility to protect personal property, it also has the responsibility to protect individuals and to protect nonmarket public goods, such as water quality. While direct health hazards from runoff pollution may be the priority, secondary impacts from decreased water quality can include loss of fish consumption, reduced quality of life, and lowered market value for home prices. If utilities want to include residents in the solution to stormwater management, they need to exhibit responsibility for the environment in the public trust.

Nature-based solutions have been identified as economical and effective strategies that can reduce pressure on the stormwater infrastructure and can also serve as community amenities.

Stormwater quality from municipal separate storm sewer systems and other sources is regulated under the U.S. EPA National Pollutant Discharge Elimination System (NPDES). In many states, the NPDES permitting requirements are delegated to the state which will have its own guidance. The U.S. EPA provides a Menu of Best Management Practices (BMPs) for Stormwater that includes examples of effective stormwater management practices.

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