Water Sector Guide to Telecommunications During Power Outages

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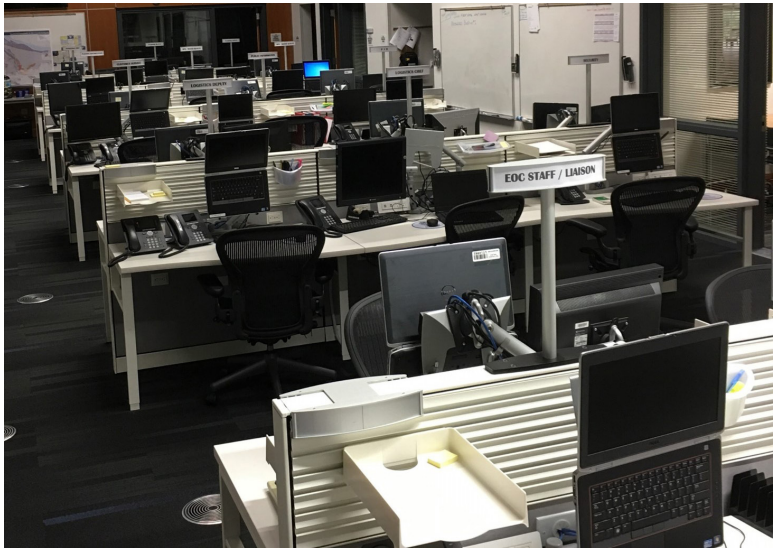
DISCLAIMER: This document provides practical solutions to help drinking water and wastewater utilities develop telecommunications plans. This document is not intended to serve as regulatory guidance. Mention of trade names, products or services does not convey official U.S. Environmental Protection Agency (EPA) approval, endorsement or recommendation for use.

Introduction

Telecommunications are essential for drinking water and wastewater utilities during routine operations and emergencies. During normal operations, utilities often use cellular phones and the internet to communicate with utility personnel and externally with contractors, other organizations, and customers. Numerous natural disasters such as hurricanes and manmade hazards can cause power outages and disrupt telecommunications. During a prolonged power outage, telecommunication options will become more limited as batteries and fuel supplies are depleted. Further, because of systemic risks and interdependencies between many vendors, multiple telecommunication services may fail at the same time.

Water utilities should ensure that restoration of power to mission critical telecommunications systems is a high priority and power restoration information is integrated into their Emergency Response Plans (ERPs), along with specific telecommunications system information. Utilities should also plan and prepare to use diverse telecommunication capabilities (e.g., cellular, satellite, landline, radio). The primary focus of this guide is to provide an overview of technologies and services to support continuity of communications during power outages – internally with utility staff, externally with response partners, and with customers.



The Portland Water Bureau's Emergency Operations Center (EOC) includes a range of telecommunications equipment, including 10 desktop style satellite phones, over 48 workstations with telephones, a landline fax machine, and a radio room with desktop long-range radios and handheld radios for EOC Responder use.

Telecommunications Principles

The Federal Emergency Management Agency (FEMA) in IS-700.B: An Introduction to the National Incident Management System (NIMS), introduces four key principles of telecommunications and information systems that support the ability of incident managers to maintain situational awareness during an incident. Water utilities should keep these principles in mind as they consider various technologies to ensure continuity of communications during a power outage. These principles are:

1. Interoperability. Interoperability is the capacity for emergency management and response personnel to communicate effectively to coordinate emergency response efforts. Interoperable telecommunications systems enable personnel to communicate:

- Within and across jurisdictions and organizations
- Via voice, data, and video systems
- In real time

As an example, for Land Mobile Radios (LMRs), Project 25 (P25) is the standard for the design and manufacture of interoperable digital two-way wireless telecommunications products.

2. Reliability, Portability, and Scalability. Telecommunications and information systems should be designed to be:

- Reliable - familiar to users, adaptable, and dependable in most situations
- Portable - can effectively be transported, deployed, and used in support of incidents across jurisdictions
- Scalable - can be expanded to support any situation—including a major incident or several incidents that involve numerous responders from multiple jurisdictions and organizations—and that the number of users on a system can be readily increased

Disaster response may involve changes to normal routines. Operating out of tents, water utility responders found that laptops, cell phones, and radios, along with their chargers, were essential in supporting the response to Hurricane Katrina.

Radios ready for use

3. Resiliency and Redundancy. Resilient and redundant telecommunications ensure the uninterrupted flow of information.

- Resiliency - systems can withstand and continue to perform after damage or loss of infrastructure, both within the system (or water utility) and in other interdependent critical infrastructure sectors

- Redundancy - when primary telecommunication methods fail, alternative systems enable continuity through other methods

4. Security. It is important to implement cybersecurity and physical security mitigation measures to maintain information security and telecommunication systems. There are numerous resources available on protecting telecommunications equipment from jamming, ransomware, cyber incidents, and other threats. The Cybersecurity and Infrastructure Security Agency (CISA) developed the Public Safety Communications and Cyber Resiliency Toolkit as a collection of resources to assist public safety agencies and others responsible for telecommunications networks in evaluating current resiliency capabilities and developing plans for mitigating the effects of potential threats. Water utilities should also confirm that none of their communications equipment or services are on the Public Safety and Homeland Security Bureau's list of communications equipment and services deemed to pose an unacceptable risk to the national security of the United States.

Telecommunications is the transmission of information by various types of technologies over wire, radio, optical, or other electromagnetic systems.

Redundant communications equipment

CISA's Toolkit

Telecommunications in ERPs

Water utilities should include their communications plans and telecommunication technologies in their ERPs. In EPA's Emergency Response Plan (ERP) Template and Instructions, communications are covered in Section 1.3 in the Drinking Water Template and Section 2.3 in the Wastewater Template. Outlining communication procedures in your ERP will not only guide utility personnel on when and who to communicate with but also on how to communicate (e.g., cell phone, radio). Your ERP should also include information on alternative, contingency, and emergency telecommunication options (e.g., a switch to 800 MHz radios or meet at a certain location). Water utilities can also develop a Telecommunications Annex to their ERPs to describe emergency telecommunications more fully. This annex should be consistent with the supported operations and address the following:

- The primary telecommunications equipment used daily
- Backup or occasionally used telecommunications equipment
- The telecommunication system's designed period of operations, and whether it meets or exceeds the minimum continuity period for the emergency power operations it supports
- Non-cellular mobile telecommunications coverage map
- Maintenance needs, and contact information for maintenance technical support, for telecommunications equipment

Photo by Troy Squillaci from Pexels

Comparison of Telecommunications Capabilities

Given the criticality of communications for resilient drinking water and wastewater services, utilities should consider deploying redundant telecommunications capabilities as described in Table 1 below and in alignment with the NIMS principles described previously.

Table 1: Comparison of Telecommunications Capabilities

Technology	Pros	Cons	Longevity and Tips
Internet/Data A wireline internet connection uses a fiber optic cable to quickly transmit data (e.g., web browsing and sending email) and Voice over Internet Protocol (VoIP) communications. VOIP internet phone systems are dependent on internet service and VOIP equipment also requires electricity to operate.	Widely used and available	Service could degrade quickly in a prolonged power outage as batteries are depleted	Internet delivered via cable or fiber could be available initially if the internet service provider (ISP) and repeater junctions have back-up power. End users need a battery back-up system for their modem and Wi-Fi router. VoIP internet-based phones may be linked to a battery that can provide back-up power for a short (e.g., 8 hour) duration, or longer if connected to a generator.
Analog Telecom Service Plain Old Telephone Service (POTS) is the traditional phone communications that uses analog signal transmission over copper wire, with hard-wired connections from a telephone company to outside wire lines that lead to telephones. POTS, often referred to as "land line" telephones, can offer a third communications path if internet and cellular connections have failed.	Will continue to work during a power outage (assuming lines are not damaged) because POTS uses large, centralized battery banks	Availability is decreasing and costs are increasing	Corded phones linked to a copper line will work during power outages, but cordless phones may not when their batteries are depleted, unless they have a backup power source. Fax machines often have either a telephone handset or speaker function and can be used to make calls.

Table 1: Comparison of Telecommunications Capabilities (continued)

Technology	Pros	Cons	Longevity and Tips
Private wireline network A private network is typically used to either improve security or reduce costs. It generally consists of fiber but may be built or augmented using copper or wireless (e.g., microwave). It might be connected to the Internet through a gateway, which is a computer that sits between different networks and that runs computer applications that convert data from one format to another.	Fiber optic cables are typically reliable Fiber optic cabling has high data transmission rates and long distances between repeaters	Installation is expensive	Utilities can install their own fiber optic cabling when installing pipelines between facilities or can lease them from a local service provider. Water utilities serving rural communities may be able to find arrangements that support rural broadband or use alternative radio frequency (RF) communications to supplement fiber. There is federal funding available to support broadband access in rural communities. Although fiber itself is resistant to electromagnetic interference, the electronics that push and repeat the signaling are not.
Cellular This wide area network reaches most homes and businesses but may be dependent upon some of the same data connections as those used for internet access. A cellular network or mobile network is a communications network where the link to and from end nodes is wireless. The network is distributed over land areas called “cells”, each served by at least one fixed- location transceiver.	Widely used and available Can be used to provide text alerts	Service could be less reliable during prolonged power outages as backup power to towers is depleted Cellular phones need power to recharge	Texting during spotty cellular service or during high call congestion has a higher chance of successful transmission than voice calls because the data transfer rate is lower for texting. Priority services are available through WPS or FirstNet.
Land Mobile Radio (LMR) This primarily voice and low speed data network can be used at the local, metropolitan, or statewide level. Public safety personnel such as police, fire, and emergency medical services use these radios, as well as utilities. A backup power source of electricity (e.g., generator or uninterruptible power supply) is important for desktop radios to function and for handheld radios to be charged. Federal, state, and local agencies have invested billions of dollars in LMR.	Relatively inexpensive, easy to use, reliable, provides quick calling capability, and provides one-to-many communications Has very good signal strength and coverage	Limited to no capacity for data transmission	Many systems have been designed to meet specific agency missions so check with response partners to ensure compatibility. Installing signal repeaters can solve coverage issues but involves added complexity and cost. Water towers are great locations to mount the repeater antennas. There are numerous phone apps that give cellular phones push-to-talk functionality, effectively turning them into LMRs.

Table 1: Comparison of Telecommunications Capabilities (continued)

Technology	Pros	Cons	Longevity and Tips
Satellite This type of communications has been used mostly for limited voice communication in rural and maritime areas, but it is increasingly being used for data communications. For a hardened (or resilient) solution, Geosynchronous Earth Orbit (GEO) and Medium Earth Orbit (MEO) satellite services are typically preferred since Low Earth Orbit (LEO) satellite communication systems are more risk prone to high-altitude nuclear explosions. Additionally, LEO satellites are moving constantly and the amount of time one can connect to an individual LEO is limited.	Good worldwide coverage Will continue to work during power outages as long as ground receivers have power Can be a great backup for small data needs, such as system monitoring of distributed assets Can be cost effective for data applications in remote areas	Calls can be expensive Mobile handheld satellite phones require a line of sight with the satellite for signal transmission and cannot be used indoors Training and periodic use is suggested since satellite phones work differently than cellular or LMR handsets	Since these phones use direct satellite connections to make calls, they will work during prolonged power outages and in remote areas. Handheld mobile devices require power to recharge. There can be some delay in satellite transmission (e.g., millisecond to 0.25 seconds) so you cannot use it for systems that have tight delay parameters. While you can buy dedicated satellite service, there are also vendors that provide satellite TV and internet data services. Phones can automatically transmit their Global Positioning System (GPS) location.
High Frequency (HF) Radio Due to its low frequency band of 3 MHz – 30 MHz, which is much lower than the frequencies used by modern wireless technologies such as cellular (which starts at 698 MHz), HF can be used for long distance communications without relying upon other wired or wireless infrastructure. However, most HF systems can be disrupted by a high-altitude electromagnetic pulse (HEMP), geomagnetic disturbance (GMD) event, or large volcanic ash cloud occurrence, potentially for hours.	Can travel intercontinental distances using skywave transmission Provides hours of communication during emergencies Does not require satellite or third-party infrastructure Typically cost effective compared to satellite phones	Requires skilled operators Can miss a receiving station that is only tens of miles away Can quickly become congested during a disaster due to the limited number of frequencies Transmission quality depends on ionospheric conditions if using HF frequencies for skywave transmissions Data transmission limited by slower transmission rates	Since HF radio is not dependent on a server or tower, as long as radios have power, they will continue to work during a prolonged power outage. HF is a great resource for talking long-distances in the direst of circumstances. It is most applicable when you need to communicate across 150 miles or the country (with enough power) and not just across 10 miles (where LMR would be much more appropriate).

As Table 1 illustrates, there are advantages, disadvantages, and limitations to each of the telecommunication technologies. Water utilities should plan to have multiple options to ensure operable communications during an emergency. A useful methodology developed by the U.S. Army to build a communications plan is Primary, Alternate, Contingency, and Emergency (PACE). Water utilities can use the PACE methodology to improve continuity of communications by defining a primary telecommunications technology as well as three back-up options. When implementing PACE, each of the four telecommunication technologies should be separate and independent from the other three methods. Table 2 provides an example of a PACE plan for voice communications that uses diverse systems and networks.

Table 2: Example of a Voice Communications PACE Plan

Primary: Cell Phone
Alternate: Land Mobile Radio
Contingency: Microsoft Teams Call
Emergency: Satellite Phone

Photo by cottonbro from Pexels

Evaluating Telecommunications Capabilities

Water utilities should consider which telecommunication technologies work best for internal communication, external communication with response partners, and customers. When evaluating telecommunication technologies and strategies, consider the following:

- Coordinate with local emergency management and fire and police departments to learn about their telecommunication methods and try to procure compatible devices, such as radios that can be used on the same channels. You may also work with your utility's radio technicians to explore adding radio channels to your existing system to communicate with these agencies.
- Learn about local emergency notification systems and see if your water utility can use the systems to communicate with the public during an emergency.
- Evaluate how your utility could use social media and text messages (i.e., internet/data and cellular) to communicate with the public during an emergency.
- Install dedicated uninterruptible power supply plugs for telecommunication systems and backup telephones that are powered by emergency generators or renewable power (e.g., solar). Additionally, implement a generator maintenance and re-fueling plan for each critical system location or, at a minimum, at a centralized emergency operations center.
- Coordinate with your local power company to pre-arrange prioritized power restoration to key locations that serve as critical communications hubs. Often power companies prioritize hospitals and critical service locations to be restored promptly after power outages occur. Power companies may also deploy generators to these critical locations while power is down.

Telecommunications Programs, Services, and Case Studies

There are several programs and services available to water utilities and other critical infrastructure and emergency response personnel to make the telecommunications options in Table 1 more effective during an emergency.

Public Alert System

Integrated Public Alert & Warning System (IPAWS) is "FEMA's national system for local alerting that provides authenticated emergency and life-saving information to the public through mobile phones using Wireless Emergency Alerts, to radio and television via the Emergency Alert System, and on the National Oceanic and Atmospheric Administration's Weather Radio." The IPAWS website has information for public safety officials to contact their state IPAWS representative to request becoming an IPAWS Alerting Authority.

Prioritized Communication Service

CISA provides priority telecommunications services for landline and cellular phones to support national security and emergency preparedness communications for government officials, emergency responders, critical infrastructure personnel, and industry members. These services are:

- Government Emergency Telecommunications Service (GETS) prioritizes calls when using a landline phone
- Wireless Priority Service (WPS) prioritizes calls when using a cellular phone
- Telecommunications Service Priority (TSP) for priority provisioning and restoration of critical telecommunications circuits

The websites above have more information about the services, including eligibility and any charges.

Voice and Broadband Wireless for Public Safety

First Responder Network Authority (FirstNet®) is a nationwide, high-speed broadband communications platform built for public safety, including essential government services such as electric, gas, water, and sewer utilities. FirstNet subscribers have access to all bands on the network with priority and pre-emption over non-FirstNet users, including Band 14, a portion of the spectrum that can be cleared for FirstNet subscribers during an emergency. In addition to FirstNet, there are similar services available from other providers such as Verizon Frontline.

Case Study: FirstNet

Del Oro Water Company in California serves about 23,000 customers, including schools, fire departments and local businesses. Like many water utilities, Del Oro depends on a Supervisory Control and Data Acquisition (SCADA) system to help run its operations and keep water flowing. When the Camp Fire broke out in November 2018, critical communication systems such as cell service, internet, and phones began to fail. Without these services, Del Oro's SCADA system went down along with its ability to monitor and change operations remotely. The utility had no way to communicate with staff and it was using Post-It Notes at pumping sites to communicate information on flow rates, stopped pumps, and power outages. Fortunately, Del Oro then leveraged FirstNet. FirstNet provided Del Oro with a field-ready router with SIM card. Once connected, Del Oro was able to use its SCADA system again to respond to alarms, see the status of each pump and its tank levels, communicate with fire and police departments, and better provide water to firefighters.

Case Study: Land Mobile Radio

In September 2013, heavy rains over several days caused floods that damaged the Upper Thompson Sanitation District (UTSD) in Colorado. Public information and emergency communications were extremely limited. When cell service was lost, staff spent a lot of time driving back and forth just to talk to each other. To help, the Larimer County Emergency Management Agency assigned two public information staff to help UTSD develop incident web and Facebook pages for the utility as well as write press releases. After the incident, UTSD worked with local law enforcement to buy 800 MHz radios via a grant. USTD procured the radios and their own separate channel on the system.

HF Radio Programs and Services

HF radio is a low-cost resource but requires operational skill and an understanding of basic radio communications including antenna theory, radio wave propagation, and electronics.

Government Emergency Radio Communications

- If deploying HF radio, it is recommended that your utility join the SHAred RESources (SHARES) Program, administered by the Department of Homeland Security (DHS). The SHARES HF Radio Program provides an additional means for users with a national security or emergency preparedness mission to communicate when landline and cellular communications are unavailable. More than 2,400 HF radio stations, representing over 400 federal, state, county, and industry organizations located in all 50 states, the District of Columbia, and several locations overseas, are resource contributors to the SHARES HF Radio Program. SHARES promotes interoperability between HF radio systems and provides awareness of applicable regulatory, procedural, and technical issues.

Civilian Emergency Radio Communications

The National American Amateur Radio Relay League (ARRL) is the national organization for Amateur Radio in the US. It can provide information on the amateur radio support and contacts in your local area. Additionally, there are several programs and services that can support your utility in using HF Radios during an emergency.

- Amateur Radio Emergency Service (ARES) is a national association of trained licensed amateur radio operators who have voluntarily registered their qualifications and equipment for communications duty in the public service when disaster strikes. At the local level, ARES leaders make direct contact with the ARES member-volunteers and officials of the agencies to be served, such as utilities. Water utilities should reach out to the local ARES Emergency Coordinator (EC). ARES is supported by ARRL.

- Radio Amateur Civil Emergency Service (RACES), administered by local, county and state emergency management agencies, and supported by FEMA, is a part of the Amateur Radio Service that provides radio communications for civil-preparedness purposes only, during periods of local, regional, or national civil emergencies. These emergencies are not limited to war-related activities, but can include natural disasters such as fires, floods, and earthquakes. RACES operation is authorized for use by emergency management officials only, so it is important to maintain a good working relationship with your local emergency management officials to use RACES. If you are not sure who your local emergency management official is, contact your state emergency management agency.

Case Study: Amateur Radio Emergency Service

The Prince William County Service Authority has a great relationship with two local amateur radio clubs. Both clubs have their primary repeater sites on Service Authority property, including antennas on top of water towers. The Service Authority, county, and radio clubs are working to establish alternative communications paths between the Service Authority Department Operations Center (DOC), the Prince William County Emergency Operations Center (EOC) and the Service Authority's Advanced Water Reclamation Facility. In November 2018, the Service Authority and the Prince William County Amateur Radio Emergency Service (PWCARES) entered into a Memorandum of Understanding (MOU) for emergency cooperation. During a widespread power outage when land lines and cellular phones may no longer work, amateur radio operators can provide vital communication services to the Service Authority.

Training and Exercises

Water utilities may only use emergency telecommunication systems on rare occasions. Regular training and exercises utilizing these systems will ensure familiarity despite infrequent use. Training could include a combination of presentations and/or demonstrations (e.g., in-person, online, archived videos) and hands-on instruction to ensure that basic functions are familiar to all. For example, utility personnel could practice how to speak, listen, and change channels on an 800 MHz radio, or discuss the importance of line-of-sight in operating a mobile satellite phone.

Training should also be combined with exercises designed to place utility staff in simulated and realistic emergency situations where they will need to use emergency telecommunication systems to respond to the test incident and resolve the situation. Table 3 summarizes three types of exercises and typical lessons learned.

Table 3: Types of Exercises

Training Type	Typical Lessons Learned
Internal Communications Drill: This could be designed and conducted to simply test a utility's ability to contact employees, contractors, and visitors using available emergency telecommunication systems.	Staff do not receive or acknowledge receipt of emergency messages for various reasons Internal public address systems do not operate in certain utility facilities Lack of written procedures or a communications annex that documents the process for notifying employees, contractors, and visitors in an emergency
Scenario-based Functional Exercise or Table-Top Exercise: Based on a storyline or scenario, such as a hazardous material spill into a reservoir or other utility source water, a functional exercise can involve many utility departments, customers, and response partners such as local police and fire as well as the utility's state regulatory agency.	Inaccurately populated email listservs Information overload via email through the "reply all" function Out-of-date cell phone numbers Need to designate points of contact for communications between utility and external partners Lack of recommended schedules for regular situational update meetings
Field-based Full-scale Exercise: This type of exercise is also based on a storyline and is conducted in real time in a field environment. Scenarios can range from responding to localized water quality incidents or to regional natural disasters. Like a functional exercise, a full-scale exercise frequently involves multiple external response partners.	Uncharged or inoperable telecommunications equipment Identification of "dead zones" where telecommunication systems cannot operate Lack of mobile solutions for data entry Incompatible telecommunications equipment between agencies or jurisdictions

Conclusion

Communications are critical to maintaining water utility operations, both during routine times and emergencies. Numerous water utilities shared that they did not have all the emergency telecommunication systems they would have liked or all the backup plans needed when they lost primary and secondary telecommunication systems. Having a communications plan that includes functionally redundant equipment and trained operators will allow you to coordinate your disaster response, communicate with response partners and utility customers, and make needed repairs quickly during prolonged power outages. Technologies continue to evolve, with new capabilities and sometimes lower cost equipment and services, so water utilities should reevaluate their options periodically, such as when they review and update their ERPs.

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