Best Practices for Emergency Water Supply System (EWSS) Implementation

Introduction

In the United States, most organizations, institutions and corporations are so accustomed to constant access to clean water from the municipal supply that they fail to consider the implications of an interruption to this supply, and the potential impact it can have on basic and critical operations, level of service and their bottom line. While virtually all facilities, such as data centers, government facilities, health care facilities and corporations have a plan to handle water disruption, most do not have an adequate alternative water supply and water system solution to continue critical, and even basic, operations in the event of water disruption.

Whether from a planned event, such as maintenance of the municipal water distribution system, or unplanned events such as extreme weather, construction accidents or power outages, creating an effective contingency plan for how to handle an interruption in water supply is imperative for any facility that wishes to sustain operations during a municipal water failure. It isn't a question of if a water disruption will occur; it is a question of when and how long the disruption will last and how prepared a facility is to handle the situation if it passes by without incident or becomes a crisis.

The following paper details how to develop an objective process for preparing an emergency water supply system for water related readiness. While much of this paper details the potential impacts of water disruption on a community of health care facilities as a system, using health care facilities and recent work with the Virginia Hospital and Healthcare Association (VHHA) and ASPR's Hospital Preparedness Program, as a case study, the three phase approach to creating water related readiness can be applied to any mission critical institution, organization or business that depends on access to water to sustain operations.

The Threat of Water Disruption

From domestic uses such as food preparation, cleaning and flushing toilets to medical processes such as sterilization of equipment, laboratory needs and cooling critical medical equipment, to the heating and cooling functions of boilers and cooling towers, seen and unseen uses of water are critical to health care facilities' ability to function. Water disruption can occur from events where the hospital system has the chance to prepare, such as impending hurricanes or planned construction events, or from more spontaneous natural events, such as tornadoes, flash floods or earthquakes. Disruption of service can also occur from human error. Far more common than dramatic weather events are temporary boil orders issued by municipal districts when elements of the municipal supply have been compromised. Water may leave the municipal treatment facility at potable quality, yet a crack or break in an aging water supply system infrastructure can introduce contaminants that require water to be retreated before it can be safely used. Not only confirmed contamination to the municipal supply, yet also the threat or warning of a potential contamination event from a cracked main or domestic terrorist threat, will require a facility to enact its Emergency Water Supply Plan until the threat can be confirmed as neutralized or proven false.

Any part of the water system that is outside of the hospital's control leaves the hospital prone to a failure in that system. It is essential for a health care system to not only have an emergency water plan in place to decide how to allocate limited resources in the event of disruption, yet also to have an adequate system and alternative supply in place to ensure continuation of essential functions in the event a facility is cut off from the municipal supply.

The Joint Commission, the agency that provides accreditation to 82% of the nation's hospitals[1], recommends creating a plan that will enable an individual to operate for a minimum of 96 hours of water usage under emergency protocols.[2] Other third party accreditation agencies are following this initiative. Beyond a desire to meet these recommendations to maintain or exceed accreditation standards, creating water independence provides peace of mind that allows hospitals to focus on providing excellent care even under emergency circumstances.

According to January 2010 article in the Journal of American Water Works Association, a 2006 survey of Washington DC area hospitals reported preparing for emergencies by having 5.8 days of energy generation capability and 2.5 days of water, yet those emergency water resources were based solely on bottled water stockpiles intended for drinking purposes only.[3] Drinking water is only a small percentage of the water needed to keep a hospital functioning in the event of a water disruption. Other uses include those that are seen, such as water used for sterilization of equipment, in surgery, in sanitation and in lab processes, and those that go mostly unseen by hospital staff, such as water used to run or cool specialized medical equipment and water to supply the cooling towers..

Certain types of weather events, such as hurricanes, are most likely to hit in summer time when demands for water are highest. If an cooling system fails because of insufficient water supply to the cooling towers, the hospital leaves patients and staff prone to the ambient temperatures, which can severely compromise care and may require the potentially dangerous process of moving patients in the event that there's a need to shut down the facility, a process that is made even more dangerous by the challenging task of transport and logistics in the likely state of emergency that will be declared after a natural disaster hits an area.

The 2010 article on emergency planning for water providers and healthcare facilities from the Journal of AWWA cited the challenges faced by some New Orleans hospitals in the wake of Hurricane Katrina in 2005:

> *"When the municipal water supply eventually failed, it resulted in a cascading failure of other critical systems, such as the hospitals' central cooling systems. Ambient temperatures soared, and the hospitals found that the conditions became intolerable for critically ill patients, particularly young children and neonates in intensive care."*[4]

The high frequency of tornados across the southeast illustrated the need for water preparedness for all types of institutions, including the April 27th tornado that hit Tuscaloosa, Alabama. With heavy structural damage throughout the region, DCH Hospital in Tuscaloosa reported treating over 600 patients within hours.[5] In addition, the tornado damaged two municipal water tanks in Tuscaloosa, prompting a boil-water advisory for much of the city[6] that remained in effect for six days (144 hours).[7] While having to treat a high volume of patients the hospitals in the region had to manage the threat of a potentially contaminated municipal water supply. The hospital was faced with incredibly high demand for their services in a time when access to clean water was compromised.

On April 9th, 2011, a tornado touched down in Pulaski County, VA afflicting moderate damage, yet enough to require enacting the local hospital's Emergency Water Plan. The experience further highlighted vulnerabilities that the hospital had already identified and was already seeking to address. This came just days after the March 28th 4.8 level earthquake that also affected Pulaski County. Both events required the local hospital to enact their Emergency Water Plan.

Given the nature of natural disasters and extreme weather, facilities may be forced to depend upon on-site, alternative water supplies and systems to provide adequate, safe water at times of greatly heightened demand. In the case of health care facilities, when a community is devastated by a natural event, even individuals who do not need medical care may seek the hospitals as a refuge for shelter, water and food until alternative facilities can be established by disaster relief agencies. Facilities must be prepared not only with an Emergency Water Supply Plan, yet also with adequate alternate supply and systems in order to meet the challenge of maintaining safe and effective operations and service to their communities.

Not Just an issue of Sufficient Water: Preparing Your Facility to have the Right Type of Water

As the example from Hurricane Katrina illustrates, in addressing an emergency water supply system, it isn't just having water available when the facility is cut off from the municipal supply, it's essential to have the *right* type of water available for necessary functions under a water emergency. While the New Orleans hospital continued to provide care for their patients and had sufficient drinking water on hand, it was a failure in supply of water to the cooling towers that compromised their ability to administer effective care.

Onsite Water Management (OWM) has found is that it is important to understand both how a facility uses water and where that water is sourced from in order to develop the right alternative supply and water system solution. For health care facilities, OWM divides water usage into three categories:

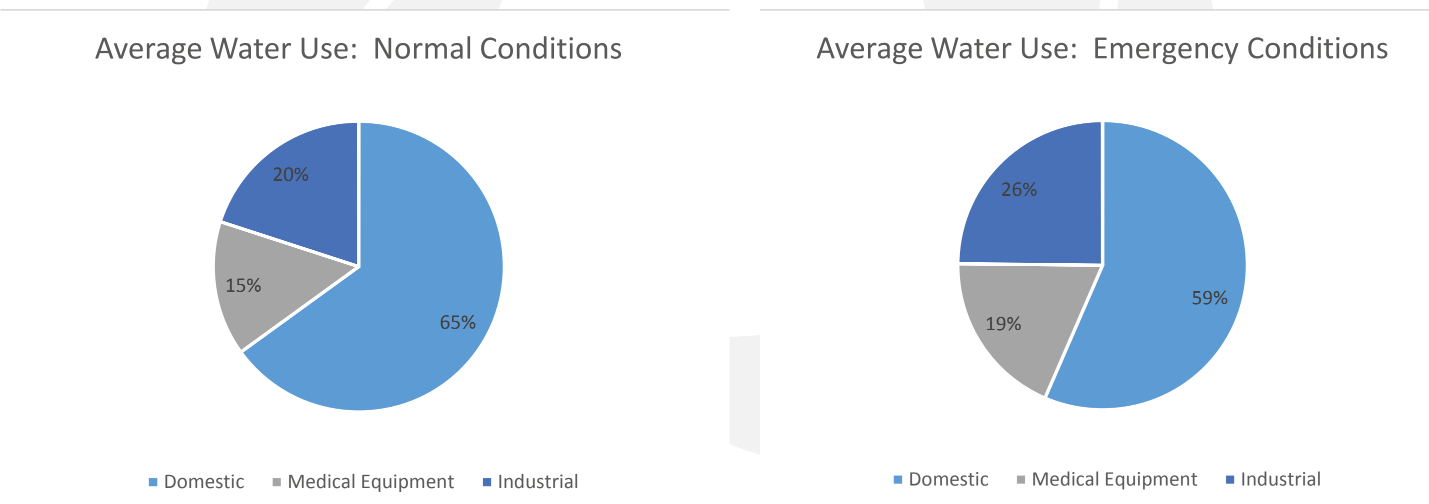
Domestic: Domestic classifies water that does not need to be treated (when it is uncompromised) from the municipal water supply before use. This includes drinking water and those used in the tasks of cleaning, flushing toilets, laundry, basic sanitation needs and food preparation (may include irrigation and "other").

Medical Process: Medical process water is potable water for human use that requires further treatment or purification after it arrives from the municipal water supply to removed additional elements that are safe for human consumption, yet damaging to medical processes. End uses of this water include laboratory processes, sterilization of equipment for surgery, water for use in medical equipment and treatment, medical air compressors and magnetic resonance imaging units.

Industrial: Industrial uses of water include many functions that are out of sight to most people within the facility, such as supplying the cooling towers, and providing hot water and steam. Municipal water, water that is treated to drinking level quality, is often unfit for industrial use and must be retreated, often with chemicals or water softeners, to prevent minerals within the water from damaging industrial equipment.

When an Emergency Water Plan is enacted, the relative proportions of these three types of water changes. According to a fact sheet by the US EPA[8], during normal operating times, 65% of a hospital's water use falls under domestic (kitchen/dishwashing, restrooms, laundry, irrigation, and "other"), 15% medical process, and 20% heating and cooling. During summer months, the percentage of water used for heating/cooling and irrigation may be even higher. When an Emergency Water Plan is enacted in a hospital, non-essential operations such as laundry, irrigation, and food preparation, may be terminated, and domestic water use reduced. Entire outpatient or office wings may be closed and domestic water use further reduced. Thus, domestic water use can be reduced by up to 30% while medical process and industrial water use remains constant. The following two charts reflect the shift in proportions of domestic, medical process, and industrial water use in times of emergency:

Average Water Use Under Normal and Emergency Conditions



Note: Average water use during normal conditions is adopted from a US EPA fact sheet (see works cited) while the average water use during emergency conditions is based on a 30% reduction in domestic water use.

Simply stockpiling bottled water on site will not enable a health care facility to continue providing the level of care that patients require if there is not sufficient water available to heat or cool the building, especially in times of extreme temperatures. As noted by the graphs, one of the largest water needs for both intermediate and large scale facilities is industrial water, and even in times of water stress, these levels cannot be reduced or rationed without causing a failure to the heating or cooling system overall.

Emergency Water Supply Planning

The American Water Works Association and Centers for Disease Control and Prevention outlined a four step process for the development of an Emergency Water Supply Planning (EWSP) guide in their 2010 report titled "Emergency Water Supply Planning Guide for Hospitals and Health Care Facilities." The four steps they recommend following are:

1. Assemble the appropriate ESWP Team and the necessary background documents for your facility;
2. Understand your water usage by performing a water use audit;
3. Analyze your emergency water supply alternatives; and
4. Develop and exercise your EWSP

While the report and recommendations were geared specifically to health care facilities, these recommendations are relevant to any mission critical entity that requires clean, reliable and uninterrupted water to maintain critical health, security or economic functions. Our extensive experience has revealed that the majority of facilities, while they have in depth Emergency Water Plans, do not have adequate alternative water supply and system infrastructure in place to meet those plans.

The Onsite Water Management Approach to Emergency Water Supply Planning

With Emergency Water Supply System technology and planning used at over 65 facilities across the United States, Onsite Water Management has helped institutions and organizations both prepare for times of water crisis and implement emergency solutions. OWM has the experience and knowledge to thoroughly evaluate all sites, no matter the human, environmental or geographic challenges they may face. Creating an Emergency Water Supply System for a facility is not a one size fits all solution. Even if facilities are broken down into size categories using metrics such as number of hospital beds, the plan is far more dependent upon geographic location, distance to the local municipal water reservoir or utility plant, availability of an alternative water supply on the property, potential partners that can assist the hospital in time of crisis, natural disasters that the area is subject to face based on geography, and the physical layout of the facility (plumbing, electrical, HVAC).

Through gaining local knowledge of the facility and the resources available to the hospital in time of water stress, and how the operations function by speaking with on-site maintenance staff, a set of recommendations can be developed that will function effectively when a water disruption occurs.

Onsite Water Management Recommends a Three Phased Approach:

Phase I:

Phase I is the assessment period to understand the current state and need of each facility, plus identify the most effective, efficient and cost conscious way of implementing a combination of infrastructure, services and technology to ensure water readiness in the event of a disruption in the municipal water supply, as well as identify ways in which a facility can become more sustainable (and therefore cut costs related to water) in terms of overall water use.

- **Pre-Audit:** Before a site visit, extensive information can be gathered and readily available data analyzed, so that, upon arrival, an audit team is well informed about the individual challenges facing the facility. We recommend the pre-audit have two components: A facility questionnaire to be completed by the owner, and a vulnerability assessment.

    1. The facility questionnaire asks the owner to provide data about the cooling tower complex specifications, water usage (for all metered uses), water and sewer costs, basic plumbing and electrical system data, and existing Emergency Water Plan. This data allows OWM's team of analysts to understand how water is used on a 24/7 basis and how water demands change under emergency conditions at a facility level. This further provides an understanding of how real levels and relative percentages of potable, medical process and industrial water will change when a water disruption occurs.

2. The vulnerability assessment identifies relative risk to a compromised municipal water supply. The assessment reviews the frequency and intensity of extreme weather and natural disasters, susceptibility to national security threats, and age, condition, and location of the municipal water supply and infrastructure.

Both the data from the owner questionnaire and the vulnerability assessment will inform the Emergency Water Supply System design parameters and recommendations.

- **On Site Audit:** The on-site audit is used to gain an intimate knowledge of the facility's plumbing, HVAC, and electrical systems, as well as to identify potential alternative water supplies.

1. Field technicians will visit the facility for up to one week to gain an intimate knowledge of the facility's plumbing, HVAC, and electrical systems as well as to confirm the existence of alternative water supplies identified in the pre-audit. The location of certain existing system features will be confirmed. These typically include: on-site water storage facilities, emergency connections, backflow preventers that separate domestic and industrial distribution systems, emergency power panels, and points of connection to the boilers and cooling tower make up lines.

2. Identification of alternative water supplies: The audit team will also review readily available precipitation data and, while on site, identify other potential alternative water supplies. ***Many facilities do not realize the breadth of alternate water supplies available to them, such as low yielding irrigation wells, active dewatering operations, rainwater capture, onsite stormwater runoff and retention ponds, surface water, and industrial water discharge and condensate.***

- **Formal Consultant's Report**: The formal report presents the findings of the pre-audit and on-site audit along with recommendations and budgetary estimate for an Emergency Water Supply System. Recommendations typically identify: alternative water sources to augment the municipal supply, potable and industrial water demands under emergency conditions, quantity of storage, and anticipated filtration regime. Best practices attempt to divide the hospitals water usage between potable, medical process, and industrial to allow for segmented or phased resiliency in our recommendations.

  In addition, to providing a set of emergency solutions OWM looks to highlight opportunities for greater water conservation and reuse that may be more specific to economic or sustainability objectives as well. Because an emergency system can be a costly investment for what would be limited and intermittent use, we often include an additional recommendation for conservation or a reuse system that would operate on a continuous basis (for industrial operations only) and provide a facility with cost savings that would repay its investment over time and then produce savings beyond that initial investment.

  Finally, the report will identify potential grants that would pay for part, if not all of the emergency system design and installation costs. OWM's clients have been able to install emergency water systems and purification units with the help of a number of FEMA grants including the Emergency Management Performance Grant Program, the Hazard Mitigation Grant Program, Urban Areas Security Initiative, and the Assistant Secretary for Preparedness and Response (ASPR) Hospital Preparedness Program (HPP).

  The report and recommendations are based on data received from the facility staff, confirmed where possible by site visits, and are intended as a realistic budget planning guide to establish options for levels of improvement to harden the facility against loss of water from their normal municipal source. Recommendations are presented in a written report that is designed to be implemented in phases. All recommended projects can be implemented simultaneously, or implemented in stages over time as funding is available. The submittal of the Consultant's Report is then followed up with as much dialogue as is needed to support the client through their decision making and funding processes.

<u>Phase II:</u>

During Phase II, the alternative water supplies are developed and detailed design and engineering are completed. Development of an alternative water supply includes confirming how much water the source can supply, and what quality the water will be. For example, if a water well is recommended in Phase I, it will be drilled in Phase II, along with completion of a drawdown test (to determine sustainable yield) and water quality analysis. Quantity and quality of the alternative water supply will inform the final system design and filtration specifications.

While phased implementation is always possible, it is best practice to complete the design of a continuously operating reuse system (also referred to as a 24/7 system) simultaneously with the emergency water supply system during this phase, so as to save costs associated with additional design and engineering, future upgrades to equipment, and construction mobilization. In reality, a 24/7 system would be an upgrade to the Emergency Water Supply System as the two use much of the same equipment; the 24/7 system is simply more robust.

The deliverable for this phase would be a set of construction drawings and specifications for use by the owner to bid out to a general contractor or mechanical – plumbing – electrical contractor.

Phase III:

Phase III is the actual installation of the EWSS. Commissioning the same consultant for construction administration that prepared the construction drawings and specifications, and that also has experience overseeing all stages of the installation process, from managing the bidding process, to the procuring and installation of specialized purification equipment, will help ensure a high quality installation, commissioning, and training program. In working with larger systems, such as a network of hospitals, utilizing one consultant also ensures consistency of the recommendations, both programmatic and specifications, and provides economies of scale that are difficult to realize if each facility independently subcontracts out the work.

At OWM, post-installation, we continue to work in partnership with each facility's maintenance staff in order to create ownership and understanding of the new equipment and protocols to follow in event of a water disruption. Our continued relationship with the facility not only supports the system put in place, yet also enables us to work with clients, staff and management to identify additional opportunities and applications for water conservation, efficiency, reuse and alternate supply in all phases of their business and operations. These can sometimes yield spectacular results. In the past, we have helped clients save tens of millions of gallons of water a year, as well as millions of dollars in costs to purchase, treat, and dispose of water.

Best Practices learned by OWM through working alongside the VHHA:

In working with the VHHA system of hospitals, OWM learned a series of best practices that are applicable not only to other hospital systems, yet to any entity for which a safe supply of adequate water is mission critical at all times. In addressing multiple facility sites that may need to function as a larger unit from a central command during a time of crisis and for which cost efficiency in installing alternative water supply systems is a key factor, following these best practices will both make the process more efficient and economical.

1. **A Universal and Neutral Assessment Process:** Having a single, universal and neutral assessment process is more cost effective and generates a common basis for evaluating potential solutions. Parties responsible for disbursement of funds receive consistent and compatible reports and make cost efficient decisions based on real, normalized recommendations instead of individual hospitals obtaining contracting for independent proposals and then competing for limited funds. That said, it is critical that all final system designs be sit-specific in nature, so that their installation and operation is specific to an individual facilities' existing conditions and water supply needs.

2. **System-Wide Thinking:** Use of system-wide thinking should be utilized to evaluate what should be and is approved. Emergency water plans across the different facilities are aligned with the overall big picture perspective, including surge planning, evacuation plans and other critical care decisions. System wide thinking enables a central agency to prioritize, and make funding decisions for implementation based on high level planning and goals. For example, a central agency may choose to prioritize installing an alternate water system adequate for a level one trauma facility that serves an entire region before implementing systems at other, less critical facilities within the region.

3. **Cost Efficiencies:** By developing a system wide approach to the implementation the VHHA was able to generate cost efficiencies as well as standardized systems for consistent emergency planning, design specifications, and methods of installation.

While a universal and system-wide approach ensures an efficient and economical process, it is equally important to implement all EWSS system design and operation protocols on a site-specific basis. The following site-specific best practices will ensure the design, installation, and operation of an EWSS be most suitable for an individual facility:

1. **Site Specific System Design:** When completing the final system design and specification for an EWSS, it is critical the system be of a site-specific nature. Many factors will affect the final system design such as: site density, facility age, existing plumbing and electric networks, hydrogeology, presence or absence of existing alternative water sources, alternative water source quality and quantity, vulnerability (to a municipal water outage), rainfall and weather patterns, and local water reuse and materials regulations and requirements.

2. **Maintaining Lines of Communication:** While the installation of an Emergency Water Supply System may seem small compared to a capital improvement such as an additional emergency room or outpatient wing, the number of individuals involved in such a project is many, and their coordination and collaboration key. At a minimum, OWM recommends the following individuals be involved throughout the design and implementation process: a representative from the organization leading the initiative (in the case of VHHA, the Regional Manager); the hospital's engineer or facilities director, emergency manager, one care taker, preferred subcontractors (general contractor, plumbers, electricians); local regulatory representatives from the Health Department, Zoning, and Inspections; and the Consultant's Project Manager.

3. **Training & Maintenance:** In an emergency situation, trained staff and a reliable EWSS are essential to maintaining operations and caring for patients. Additionally, like any other piece of equipment in a facilities' mechanical room, reliable operation depends on routine maintenance. OWM incorporates a one-day system training session into their commissioning and includes system operating and equipment maintenance instructions in their commissioning packages. At a minimum, OWM recommends pressure testing the system quarterly, running the well pump (if one exists) monthly, and replacing filters and/or media per the manufacturer's recommendations.

SUMMARY:

- Water disruption is a real threat to basic and critical operations of any facility that has mission critical operations that include the need for water. Simply stocking up on bottled, potable water does not provide adequate alternative system or supply in the face of even a brief water disruption.
- The three phase process outlined in this paper applies to anyone responsible for overseeing organizations, facilities, government agencies, institutions and corporations that have mission critical operations that include the need for water.
- The Commonwealth of Virginia is a model for how to solve that problem of water disruption on a systemic basis, rather than with facilities operating as individual entities.
- By implementing a centralized and neutral water auditing process in addressing emergency water supply system planning, emergency and engineering personnel and resources have the opportunity for a true win-win: to advance a business case that not only meets their responsibility to ensure water independence during a water disruption, yet also delivers economic and sustainability benefits to their peers and the organizations that they serve as a whole.
- Site-specific system designs are critical to successful installation and operational efficacy. There are no one-size-fits-all solutions and while the three-phased approach can be applied to any facility looking to gain water resilience, site-specific considerations must inform the final Emergency Water Supply System design.

If you have any questions about auditing, implementation process or how you could potentially partner with Onsite Water Management to address providing an emergency water supply system to an individual facility or large system of facilities, or if you have specific water use challenges that need a highly experienced and specialized approach, please contact us at Onsite Water Management.

Works Cited (Endnotes)

1. http://www.jointcommission.org/assets/1/18/Hospital_Accreditation_1_31_11.pdf

2. Joint Commission, Hospital Accreditation Program: Emergency Management. The Joint Commission, Oakbrook Terrace, Ill. 2009.

3. Gregory Welter, Steven Bieber, Heidi Bonnaffon, Nicholas DeGuida and Myra Socher, "Cross-Sector Emergency Planning for Water Providers and Healthcare Facilities," Journal of American Water Works Association January 2010: 68-78.

4. Gregory Welter, Steven Bieber, Heidi Bonnaffon, Nicholas DeGuida and Myra Socher, "Cross-Sector Emergency Planning for Water Providers and Healthcare Facilities," Journal of American Water Works Association January 2010: 68-78.

5. Verna Gates, "Tornados Inflict Grim Toll on Alabama Children" Reuters, April 29th, 2011. Accessed via http://www.reuters.com/article/2011/04/29/us-usa-weather-children-idUSTRE73S7MU20110429 on June 8, 2011.

6. Campbell Robertson and Kim Severson, "Storms' Toll Rises as Scale of Damage Becomes Clear," The New York Times April 29, 2011.

7. http://www.awwa.org/publications/StreamlinesArticle.cfm?itemnumber=56858&showLogin=N

8. http://www.epa.gov/watersense/commercial/docs/factsheets/hospital_fact_sheet_508.pdf