Electric Infrastructure Security Council

WATER SECTOR BLACK SKY PLAYBOOK V 3.0

Draft/Sector Steering Committee Reviewed on dd mmm 2017.

ABSTRACT

This Sector Black Sky Playbook reflects collective input from numerous partners, as well as operational industry technical personnel, as a recommended framework for planning resilience investments, restoration planning and cross-sector coordination needed for long duration, multi-region power outages. This peer-reviewed document is designed as a resource for the electric subsector, addressing critical Black Sky resilience needs for Preparation/Mitigation, Response, Restoration and Recovery measures.

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V 3.0

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Role of the EPRO Sector Black Sky Playbook

The approach to building this Playbook is designed to continuously engage Water Sector utility members to contribute to an evolving framework of recommended guidelines to manage risks of long duration, multi-region power outages associated with emerging "Black Sky" hazards.

This Playbook will be continually updated and reviewed using the EPRO SECTOR steering committee process, through consultation with Water Sector utility professionals and managers. It represents the consolidated recommendations of these sector managers and professionals to address the unique challenges posed by wide area, long duration outages. It provides guidelines to help individual entities strengthen their own resilience measures, develop focused operational plans and identify vital external support needed in the event of these severe hazard scenarios.

Sector Background

Water is a lifeline sector that serves businesses and communities on a daily basis and brings them back to normal after a disaster, which makes maintaining water services and quickly restoring them a priority. Maintaining and distributing an adequate supply of both potable and water used for firefighting, is vital to ensuring success of a shelter-in-place strategy.

- Roughly 85 percent of all water and wastewater systems are publicly owned and operated by municipalities and most are small; more than 80 percent of community water systems and publicly owned treatment works serve populations of less than 3,300.
- Most State and municipal decision-makers are constrained by long-held expectations by customers that water is a low-cost, affordable service and that the cost paid by customers does not account for true life-cycle costs.
- Nearly all water infrastructure assets are out of public sight and historically reliable, leading to an underappreciation of the criticality of water services and the infrastructure that delivers them.
- Like other sectors, water has an aging infrastructure that requires massive reinvestment to upgrade pipes, mains, and equipment. Many assets are nearing or beyond their expected lifespan, leading to roughly 240,000 water main breaks, and between 23,000 and 75,000 sanitary sewage overflows per year in the United States. The estimated investment gap ranges from about $400 billion to nearly $1 trillion, just to maintain current levels of water service.
- Community water systems are not connected to adjacent systems, unlike electricity and transportation infrastructure, which are interconnected into national networks. This means that water systems cannot take full advantage of network economies that enable mutual assistance and it means that virtually each system must be treated individually, on a 'one of' basis.
- Unlike the Energy and Transportation Sectors, which each have a Federal department and Cabinet position dedicated to their sectors and infrastructure, the Water Sector has no corresponding Federal department dedicated to its sector. The U.S. Environmental Protection Agency (EPA), which serves as the Sector-Specific Agency (SSA) for the Water Sector, regulates and enforces the Clean Water Act and the Safe Water Drinking Act. While it has programs designed to improve the security and resilience of the Nation's drinking water and wastewater

infrastructure, its primary mission is ensuring water quality from a regulatory perspective and not with a perspective of overall operation and resilience of the systems.

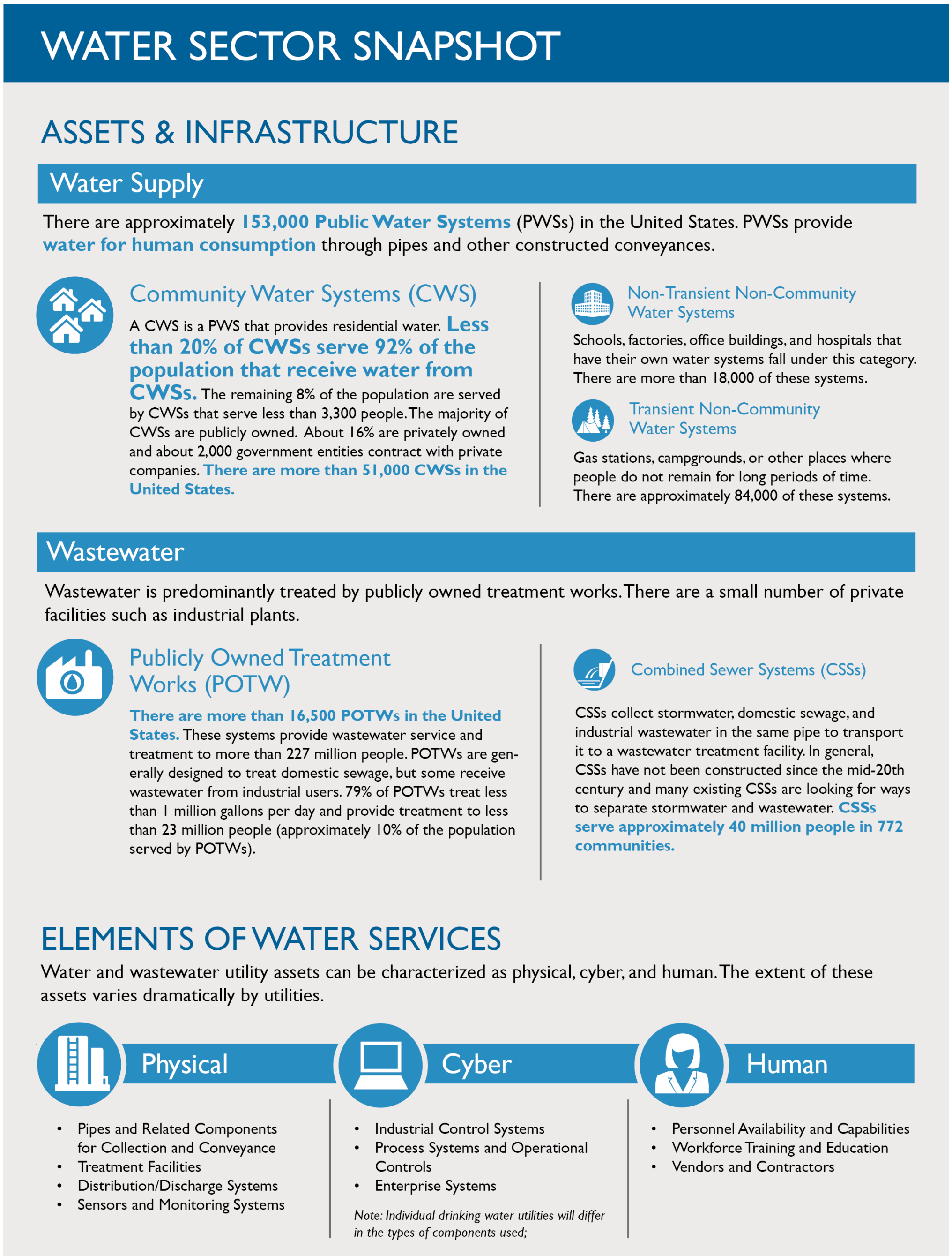

Figure 1: Water Sector Snapshot (Source: EPA, 2015 Water and Wastewater Systems Sector-Specific Plan, (2015 SSP), 2016)

Sector Black Sky Environment

Water Sector utilities require a considerable amount of energy to effect end-to-end flow, processing and distribution/collection of water and wastewater. This makes the Water Sector utilities particularly vulnerable to Black Sky hazards and increases the need to build in resilience to these hazards. Being able to maintain societal integrity following a Black Sky event will be vitally dependent on maintaining sufficient water supply and distribution system integrity to meet requirements for potable, firefighting and other uses of water, such as for businesses. In order to achieve the goal of shelter-in-place, the Water Sector utilities must able to operate systems while off of the Electric Grid and meet minimal sustainable levels of service. To support even minimal services, a large number of emergency power units will be need to be acquired and/or capable of being relocated, and their accompanying supply chains for fuel and technical support adjusted accordingly. Needed chemicals, particularly for disinfection, will be quickly depleted and their resupply will require a major logistics effort, over a deteriorated transportation network. The Sector must quickly pivot to Black Sky protocols that would enable sustaining minimal service levels to the largest number of people.

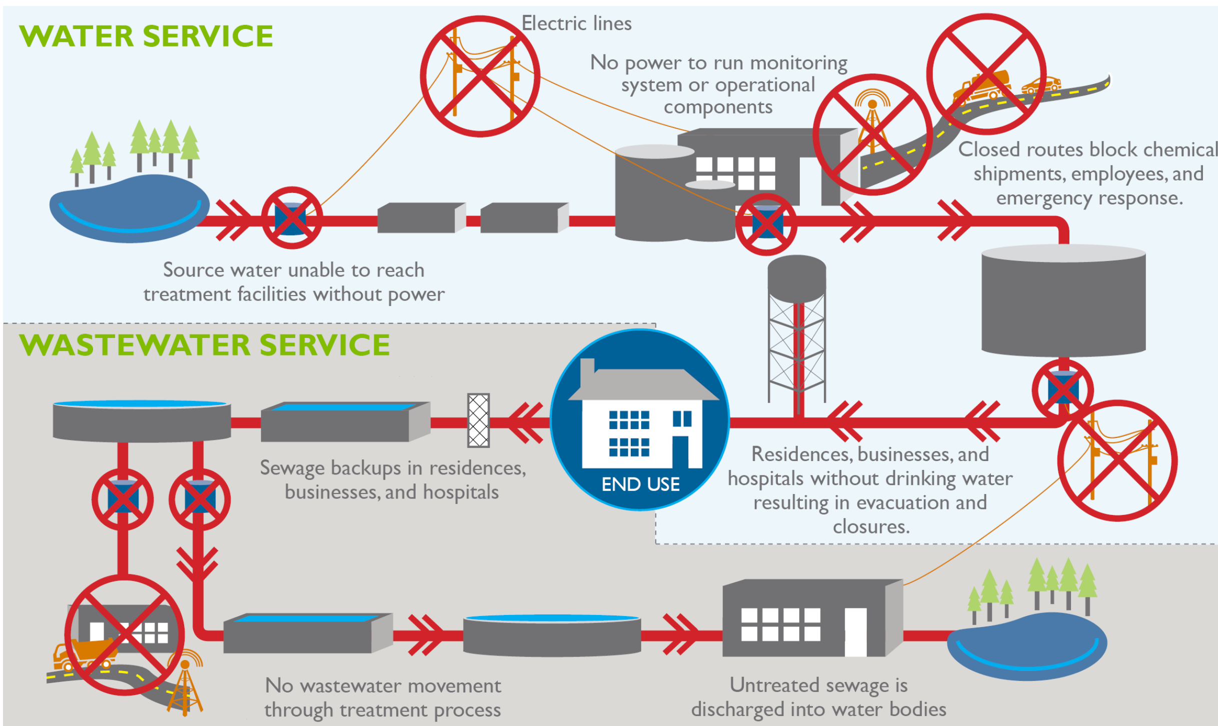

Figure 2: Water Sector Impact from Loss of Electricity (Source: NIAC Water Sector Resilience:Final Report and Recommendations)

Sector Model Overview

The Water Sector is divided into two major sets of services, Water and Wastewater. Water services include support for: drinking/cooking/bathing; firefighting; industrial use; national defense mission assurance; and wastewater systems. Wastewater services include support for treating household and industrial waste, as well as for storm flow, in the case of a combined sewer system.

Water is sourced, treated, distributed (including storage), managed and reused in compliance with standards, e.g., quality and pressure, to assure societal wellbeing. Wastewater operations include sanitary and storm water collection and treatment, as well as the treatment and disposal of the sludge (biosolids) produced by the removal processes.

Figure 3 describes the end-to-end Water Sector process, across both water and wastewater.

Water infrastructure comprises the physical and cyber assets of drinking water and wastewater systems, as defined by Homeland Security Presidential Directive 7 (HSPD-7), the *2013 National Infrastructure Protection Plan* (NIPP 2013), and the *2015 Water and Wastewater Systems Sector-Specific Plan* (2015 SSP).

Sector Model Graphic

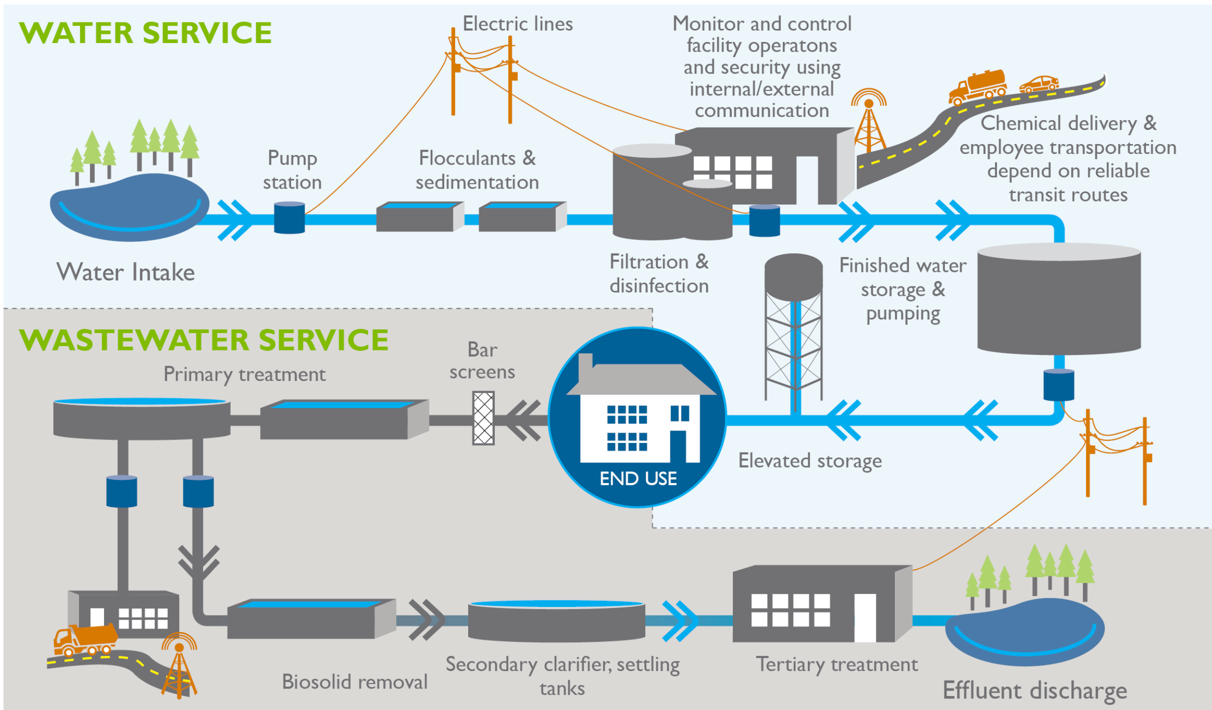

Figure 3: End to End Overview of Water/Wastewater Process (reference: NIAC Water Sector Report)

The other Lifeline Sectors also depend heavily on the Water Sector utilities for being able to maintain their sector operations, and society as a whole depends on the effective interoperability among all of these Lifeline Sectors. Figure 4, from the National Infrastructure Advisory Council Report on Water, depicts the dependency that other Lifeline Sectors have on the Water Sector.

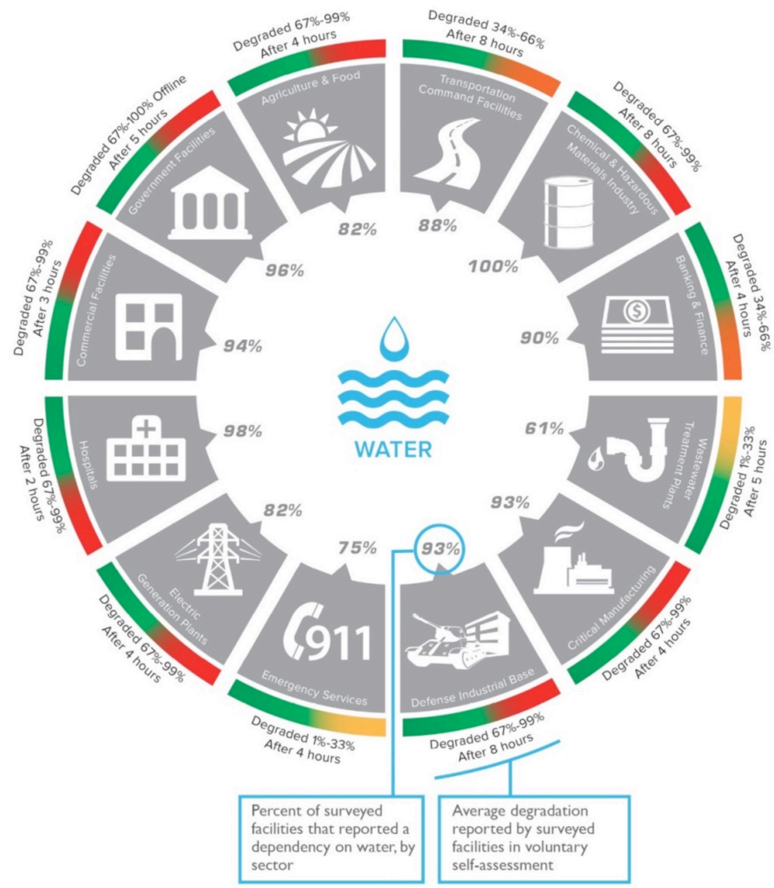

Figure 4: Lifeline Sector Interdependency with Water Sector (NIAC Water Sector Resilience: Final Report and Recommendations, 2016)

Sector Black Sky Strategic Mission Statement

In the severely disrupted, multi-region, long-duration power outages associated with Black Sky scenarios, the most critical goals for public health and safety, and societal continuity will be systematic, timely and well-prioritized power grid restoration, and maintaining the largest possible number of people in a "shelter-in-place" status during that multi-week or longer restoration.

For the Water Sector utilities, the second of these two goals represents the primary mission for the utility's Black Sky Playbook:

> **Water Sector Black Sky Mission:** Maintaining at least minimal water and wastewater service for the largest possible numbers of residents and critical facilities, in affected regions, for long durations (at least 30 days).

To achieve this mission, minimal service levels must be defined, especially for utilities serving large cities and critical facilities, because populations living in dense urban environments will be the least able to shelter-in-place if water service is severely disrupted. The 410 very large water systems in the U.S. (those serving 100,000 or more customers) offer an especially leveraged opportunity to maximize the impact of Black Sky preparedness initiatives. If the water utilities in major urban areas can sustain reduced levels of service to enable most of their customers to shelter in place, the benefits gained from averting unplanned mass migrations would be enormous. Focusing on the small number of very large systems also bounds the planning and logistics problems that Water Sector utility partners will confront. For government agencies and private contractors responsible for supplying generators, fuel, and chemicals in Black Sky events, being able to target their operations on a few hundred of the largest systems (versus the more than 40,000 small and very small systems) would significantly narrow their challenge. While all water systems and their customers are important, the limited resources and the enormous challenges of Black Sky environments require that resilience efforts focus on the (currently) greatest vulnerability to unplanned mass migration.

Preparing to implement these service levels in Black Sky scenarios requires, in turn, development of expanded resilience and operational plans, as well as specific external support measures from government and mass-care NGO partners.

These Black Sky service levels and the requirements that characterize the expanded sector planning and external support needed to prepare for them, may be summarized in three levels—Near Normal, Reduced, and No Service--and are described in detail below.

Sector Black Sky Strategic Mission Priorities Matrix

Meeting the sector's mission requirement – maintaining at least minimal water and wastewater service for the largest possible number of residents and critical facilities, for long durations – requires careful definition of service priorities as a function of customer type, geographic region and related characteristics. Decisions on Black Sky service levels—made in coordination with regulatory bodies--also vary from utility to utility.

Figure 5: Water system service levels in Black Sky emergencies

A given utility, depending on the overall system service level they choose, may define different services for customers, based on different priority criteria.

Overall system service levels will vary as a function of time and milestone. For example, immediately after a regional blackout begins, water utilities will typically begin operating according to normal "Gray Sky[1]" playbooks, optimized for normal operation during short duration power outages. To facilitate planning for emergency drinking water supply during a Gray Sky event, EPA and AWWA jointly developed "Planning for Emergency Drinking Water Supply" in 2011, for use by water systems of all sizes. Among the many external requirements defined below, a priority for the Water Sector utilities will be to receive, as early as possible, a definitive estimate of the outage class (i.e., Gray Sky / Black Sky) to enable them to convert over to Black Sky Playbook protocols and operations at the earliest possible opportunity.

Once water utilities become aware that the outage represents a long duration Black Sky scenario, each utility would then begin operating according to its unique implementation of the Black Sky Playbook recommendations. As shown in Figure 5, this would typically involve shifting, not to reduced water service levels associated with conventional scenarios, but to levels associated with Black Sky scenarios. As reviewed below, these would include preplanned changes to operate at minimum pressure levels, along with a potential for geographically-varied service, and reductions in water quality.

a. **System-wide quality reductions:** Instead of maintaining distribution system pressures and other functions necessary to provide water that meets normal drinking water quality standards, systems should use lower quality, still-potable water, or provide water that can be made drinkable by customers, given adequate community preparation, such as providing instruction about 'boiled water advisory'. Because power and natural gas will not be generally available to customers in these scenarios however, the primary means will include use of bleach, iodine or other disinfectants, or manual filters.

   As an essential element of this proposed requirement, recommended emergency purification means will be coordinated with government and NGO partners, as well as directly to customers, to ensure a maximum degree of advance preparation by the community. EPA has recently updated guidance on emergency disinfection: (See EPA instructions on emergency disinfection of drinking water, which should be distributed to all customers): https://www.epa.gov/sites/production/files/2015-11/documents/epa816f15003.pdf

b. **Geographically-varied service levels:** Rather than seeking to maintain a set service level over a utility's entire distribution system, utilities should develop plans that allow for selectively targeting areas, for example, pressure zones, for sustained service based on population density, topography, critical customers, or other criteria.

   As a starting point, this would involve assessment of whether it is more effective to operate with reduced water quality across the whole service area or to scale back service in selected areas if pressure zone isolation is feasible. Utilities obtaining water from multiple water sources may need to examine each source to determine which needs the least amount of power and chemicals to treat and deliver.

   If geographic cutbacks would be optimum for a particular utility in these scenarios, these area-based service level reductions would be identified by conducting advanced planning and exercises for these scenarios. These operational plans would require advance coordination with

[1] The term "gray sky" is used here as a counterpoint to Black Sky events. It is not intended to be a diminutive term. Gray sky events can also be very severe – such as Superstorm Sandy or the Japanese tsunami that precipitated the Fukushima disaster – but they are more localized (sub-regional) and of shorter duration (less than one month) than Black Sky events.

sector partners since, it may be necessary to move a portion of the population within the utility's service area. Inputs into the planning process would include:

1. Assessment of whether only certain zones can have water service for the duration of the event, or whether pressure zones can be alternated for several hours at a time.

2. Assessment of the viability of using emergency contingency equipment, such as mobile pumping stations, to provide intermittent service to pressure zones.

c. System-wide pressure reduction: Currently, 20 pounds per square inch (PSI) of pressure is a typical (nearly canonical) minimum standard requirement for pressure in water systems. Black Sky planning should consider the possibility of operating at even lower pressures—in consultation with regulators. Utilities should analyze their operations and determine whether a lower pressure for Black Sky operations can be feasibly achieved and whether it would still be safe (for drinking) and functional (for firefighting and sewage), and not negatively impact the physical integrity of their systems.

d. Preplanning to reduce demand: Meeting demand will be easier if demand is itself reduced. While some natural demand reduction will likely occur during emergencies, utilities should work with government and NGO partners to provide their communities with advance information, periodic media public service announcements, and other means to encourage their customers to actively reduce water use during emergencies.[2]

Advance planning for reduced-usage agreements with high-use critical facilities that would still be operating in these scenarios is also a priority. For large water customers, such as hospitals, HVAC systems are a large water consumer. Pre-negotiated plans for alternate water supply for these systems may be an option.

e. Non-Potable Water Planning: In cases where utilities are unable to provide reduced pressure, minimal-purity potable water – or water that consumers can make potable – maintaining the flow of water for fire suppression, sewerage and other non-drinking purposes will be vital for avoiding the unplanned migration tipping point in a Black Sky event. Utilities should ensure that as a fallback plan, they are able to sustain water flows sufficient to meet non-drinking needs.

f. Preplanning for controlled water and wastewater system shutdown and restoration: Despite implementing all of these Playbook options, some residual risk of "complete failure" will remain. To provide for a worst case scenario, utilities should develop plans to accelerate complete "dry start" restoration of service when the power grid returns to operation.

U.S. water utilities have little experience in restoring water flows after a complete service shutdown. Given the difficulties of doing so, especially in terms of replacing pipes that will break once water pressure is lost or too quickly restored, it will be imperative for systems to avoid total shutdown by severely reducing (and harshly prioritizing) levels of service in Black Sky events. Nevertheless, utilities may want to help emergency managers and other resilience stakeholders understand restoration plans, priorities, and timelines, and consider infrastructure investments that might help accelerate service restoration.

g. Alternative hydro-systems: A hydro-system network provides a potential capability for emergency management agencies, in partnership with water utilities, to provide emergency

[2] Reduction in demand planning and public outreach is the subject of existing guidance issued by AWWA in the form of "M60: Drought Preparedness & Response", designed to assist a utility in determining trigger levels for a demand reduction program.

potable water supplies to populations that cannot be served by the water distribution system. An alternative potable water distribution system, these hydro-systems (equipment and operations) could be modeled after Israel's concept of operations for furnishing potable water during water crises.

Although this would not provide an adequate solution for large cities, for smaller communities – which are more likely to face such complete water service shutdowns – this approach could provide a valid backup option. These alternative distribution systems would be designed, configured, operated and maintained to provide potable water under "No Water Service" or "Fire and Sanitation Services Only" conditions. Note: other emergency water distribution tactics, such as bottled or bulk water, are addressed under Section 3., External Requirements.

h. Key Resources: WARN and Emergency Water Supply Guidance

1. The American Water Works Association has developed the Water/Wastewater Agency Response Network (WARN), a mutual assistance network for the Water Sector utilities to prepare for and respond to disasters and other emergencies.[3]
2. The Environmental Protection Agency and AWWA have developed guidance to facilitate planning and consideration of needs under emergency conditions.[4]

EPRO Handbook II, Chapter 2 (Water) and this Playbook provide a solid foundation for emergency planning to address topics a. through h. above and can be expanded upon to address Black Sky scenarios. Mission priorities by phase are listed below.

Phase	Priority	Missions
Mitigation	1	Conduct cross-sector planning
Mitigation	2	Participate in cross-sector Black Sky exercises
Response	2	Reduce quality, system wide
Response	3	Vary service levels geographically
Response	4	Reduce pressure system-wide
Response	1	Reduce demand
Response	5	Conduct "Boil Water" operations
Recovery	`1	Coordinate with Electric Subsector
Recovery	2	Restart long-start up facilities, such as sludge digestors
Recovery	2	Execute coordinated restart with Electric Subsector

Black Sky Assumptions

Because of limited experience with Black Sky environments, planning in the Water Sector must necessarily be based on assumptions. The principal assumption is one of an electric grid outage across a very large footprint and that lasts over a month or more. Though we generally consider a large footprint to represent one of the interconnections, it is conceivable, in a cyberattack for example, that multiple

[3] http://www.awwa.org/NationalWARN.org

[4] Planning for an Emergency Drinking Water Supply
http://www.awwa.org/Portals/0/files/resources/water%20knowledge/rc%20emergency%20prep/Emergencywater.PDF

interconnections might be affected, if not directly, then as a result of being restrained from providing resources to other interconnections.

To sharpen the relevance of these assumptions, the following assumptions are taken from two sources:

DHS Power Outage Incident Annex:

- Cause Agnostic
- Multiple States/Regions; millions of people without power for long period
- Large portion of population requires sustained mass care support
- Loss of critical lifeline functions results in risks to health, personal safety, national security, and economic viability
- Impacts to other Critical Infrastructure sectors causes significant loss of services or functions and creates need for sustained operational coordination

National Infrastructure Advisory Council Water Sector Resilience:

- Black Sky events are high-impact/uncertain probability
- Utilities have built some resilience for Black Sky events, but additional preparedness is needed
- Power failure is the largest risk dependency to the Water Sector
- Available generators:
  - May not be large enough to address power requirements
  - Require extensive quantities of fuel and continuous maintenance to sustain operations

Black Sky Decisions Overview

Water and wastewater managers and operators will be required to make numerous critical decisions following a Black Sky event, most likely under a severely limited communications environment. Detailed planning and exercise of internal operations, as well as coordination with external partners, would mitigate the risks associated with being unable to obtain critical information following a Black Sky event. Preparations should focus on reducing the time required to effect decisions in the Plan-Do-Check-Act cycle. One method is to develop Standard Operating Procedures, based on the Black Sky Concept of Operations, to identify decisions and to derive and minimize critical information requirements. In addition, utilities could use hydraulic and cross-sector modeling, in support of Black Sky planning, to identify variant scenarios and develop contingency plans which could then be executed centrally with minimal information, or autonomously, bottom up, at the operator level.

Black Sky Decisions Matrix

Decisions affecting Water Sector utilities will take place at 3 basic levels, if a Black Sky event occurs: across systems (Regional/State/Federal); at system; and below system. Furthermore, while hierarchical decision making has been proven to be most efficient approach during emergencies, the decisions across these levels will be affected by the degree to which information, authority, expertise and capability-to-execute exist at any moment in time. As a rule, decisions during crises should be made at the lowest level, while each increasing level should be focused on coordinating and facilitating the actions taking place below their level. Such 'federated' approach to decision making should be well coordinated, planned and exercised.

In the event of a major loss of electrical power, a water utility must first determine whether a Black Sky event has taken place and whether the system operator must initiate Response under their predetermined, pre-planned Black Sky Protocols. If communications have failed, this decision may revert down to individual subcomponents of the system.

Phase	Priority	Decision
Response	1	Whether to initiate Black Sky Service Levels
Response	2	What changes are to be made to system operations to sustain services as long as possible
Mitigation, Response	3	Where to employ emergency power
Response	4	When to recall and where to position critical personnel

Sector Black Sky Situational Awareness Overview

Following a Black Sky event, Water Sector utilities must determine the following and incorporate the information in their Emergency Response Plan (ERP):

- **WHAT:** services must I provide and at what service levels
- **WHERE:** do I provide and/or shut services down, both externally to the public and internally, to the components of the system
- **WHO:** do I provide services to and obtain services from
- **WHEN:** do I initiate Black Sky Protocols
- **HOW:** do I sustain minimalist service levels

Priority Information Requirements Matrix

Information	Source	Priority	Confidence Level
Status of System	SCADA and on-site visits	1	LOW, initially, until all components have been inspected HIGH, subsequently
Consequences, e.g., numbers and areas affected by system	Impact analyses conducted by individual systems and their components	2	LOW, initially, until all components have been inspected HIGH, subsequently
Status of Systems across Region	Individual Systems	3	LOW, initially, until all components have been inspected HIGH, subsequently
Consequences of outage across Region	WARN, with information from individual systems	4	LOW, initially, until all components have been inspected HIGH, subsequently
Status of Systems across Outage Area	WARN, with information from individual systems	5	LOW, initially, until all components have been inspected

			HIGH, subsequently
Consequences of outage across Outage Area	WARN, with information from individual systems	6	LOW, initially, until all components have been inspected HIGH, subsequently

Sector Initial Actions

Water Sector utility actions in response to a Black Sky event will vary over time, following the event. They will also vary over individual systems, which differ markedly in how they source, treat and distribute water and wastewater. Generally, utilities will activate their Emergency Response Plans, beginning with starting emergency power units and continue to provide water/wastewater services according to pre-planned priorities. While maintaining normal services under curtailed power support, system and sub-system operators will conduct a situational assessment, so that they can determine where and to what degree to reduce service levels. Effective pre-planning, under a variety of scenarios, would greatly improve the outcome of these initial actions.

Sector Initial Actions Matrix (V3)

Priority	Initial Action	Desired/Required Outcome
1	Assess Capability to Maintain Critical Service Levels for system and sub-systems	Accurate situation awareness and estimate of time to service restoration (ETS)
2	Contact Electric Utility to determine Date/Time of Restoration	Situation awareness and determination of whether to go to Black Sky protocol
3	Assess Consequences to Population/Area Served	Maintain, or restore in minimal time, service to maximum number of people
4	Switch to Black Sky Protocols for Operations	Maintain sustainable level of services
5	Switch to Emergency Power	Maintain services at pre-designated levels
6	Recall Key Personnel	Provide Response and Recovery capability
7	Establish Sector Liaison to Emergency Operations Centers	Share situation awareness across Lifeline Sectors
8	Communicate Recovery Status to EOC	Share situation awareness across Lifeline Sectors and provide information used to coordinate recovery actions

Internal Sector Requirements

In Black Sky outages, even the best-prepared water and wastewater systems will be unable to operate all of their water pressure zones at their typical quality standards, and to provide normal wastewater flow and treatment levels, for a period of weeks without external power. Black Sky requirements will typically include hardware resilience investments and comprehensive operational planning to enable these systems to operate in degraded pressure and treatment modes, for long durations, with infrequent and uncertain deliveries of replacement diesel fuel and treatment chemicals.

A. WATER AND WASTEWATER SYSTEM: RECOMMENDED BLACK SKY HARDWARE AND FACILITY RESILIENCE REQUIREMENTS

1. Emergency Power

Water and wastewater utilities should assume that they will need their own emergency power supplies in order to function during a Black Sky event, and that even multiple power feeds will prove inadequate to help them sustain service.

During emergency power planning for Black Sky water and wastewater system operations, planners should employ hydraulic modeling tools and a variety of scenarios to determine the most effective allocation of emergency power units, and then develop operations plans to execute, according to the emergency power unit allocation.

Emergency power considerations include acquisition of sufficient inventories of emergency generators to support water treatment and pumping requirements for a designated portion of the area served, and include requirements for spare generators, to replace those that become inoperable. When generators are newly acquired, procurement specifications should call for: long-duration operation, EMP and Cyber protection, provisions for mobility, and capabilities to enable either continuous, short duration or periodic operation.

a. Plan for adequate, onsite emergency generation

"Just in time" strategies for acquiring emergency power will need thorough revamping and reassessment. Water Sector utilities should build strategies to address the enormous mismatch that will emerge in Black Sky events between the number of water and wastewater systems requesting just-in time installation of emergency generators, available generator supplies and installation technicians familiar with the installation requirements specific to that site.

Utilities should plan to acquire, at a minimum, generators for water supply and minimal treatment requirements, for lift stations, and to ensure at least one generator is available for pumping to each pressure zone to maintain the target service level, as determined by the utility. As stated above, pre-planning and funding restraints might disclose the need to shut down one or more pressure zones, and to plan for migration of the population to another supportable location.

b. Preparations and information needed to support (limited) emergency management agency generator acquisition

While major water utilities – particularly those serving large cities, should work with regulatory bodies to ensure adequate emergency generators are installed and available onsite, many smaller utilities may be unable to acquire sufficient generators. If such utilities anticipate requesting real-time delivery and installation of emergency generators during a Black Sky outage, prearranged connections for the appropriate facilities will be essential. Registration of needs in the US Army Corps of Engineers' Emergency Power Facility Assessment Tool (EPFAT) is highly recommended.

Until better data exists on Water Sector utilities' emergency power plans and capabilities, it will be impossible for emergency management agencies to develop strategies to mitigate shortages in generator supplies and installation technicians. Water Sector utilities, associations and their public sector partners (including the EPA) should conduct surveys to determine the *existing* versus *required* emergency generator inventory of U.S. water and wastewater systems in the United States. Information will be required on the available and required generator inventory – numbers and sizes of generators – in four categories:

1. Utilities that have adequate on-site emergency power generators and fuel storage tanks, or plan to acquire them, including having generator inventory information (numbers and sizes) on hand.

2. Utilities with lifts or other facilities requiring emergency generation, preconfigured for generator connection.

3. Utilities with neither generators nor preconfigured connection points.

4. Utilities with a mix of pumps, lifts and facilities requiring generators – some with generators, some preconfigured, some with neither.

An assessment should be made of this data to identify potential shortfalls, by location, and to identify potential points of competition for resources, especially since a Black Sky event will generate widespread demand across all lifeline sectors, and suppliers generally do not stock enough assets to cover peak demand.

In addition, a comprehensive assessment should be made across all regulatory body rules to determine how operations plans will be impacted, preparing for and operating under a Black Sky environment. Prime areas include: full-load testing, transportation restrictions, access restrictions.

Utilities with hydraulic modeling capabilities can use these tools to model 'what if' scenarios that vary by the number and location of emergency power generators across their system. Running a number of scenarios with only partial emergency power coverage will: enable optimal pre-placement of limited resources; familiarize personnel with potential vulnerabilities for resilience investment; and promote adaptability by creating a variety of operational contingencies that could be used to cut down decision time during response and recovery.

c. Generator requirements should take into account sparing requirements

Most backup power units are not designed to run continuously, under load. Utilities should develop dynamic (versus static) assessments of their generator requirements, and account for likely replacement requirements over time. Water systems that experienced generator failures during Sandy, for example, have increased their stockpiles of replacement generators since that event. Other utilities should consider adopting a similar approach.

When contemplating the acquisition of spares, utilities should evaluate the alternative of procuring a more expensive generator capable of continuous operation.

d. Procurement guidelines for emergency generators

Owners/Operators of some facilities without emergency backup generators may not know exactly what their emergency backup power generator requirements are. Key determinations include:[5]

- Generator size required (in kW or MW)
- Does the generator need to provide full load, or partial load? If partial, it is important to lock out other breakers so as not to overload the generator.
- Generator Output Voltage Required (e.g., 480, 120/208, 4160)
- Generator Phase Output (single or three-phase)
- Facility Electrical Connection Point: Is there an existing manual transfer switch? Will the generator connect to the main electrical panel, or another connection point? Can the connection point be pre-installed?
- Basic Order of Materials (BOM) required to physically connect the generator: Cable/Conductor (size, length, number of runs); Connection Lugs; Grounding Point (existing or needs to be installed?); Grounding Cable size and length
- CRITICAL: Facility's Commercial Power Grid Isolation Point Location (important for safety of any electrical linemen offsite, and also to ensure backup power is dedicated to the facility)
- Black Sky-compatible enhancements that need to be requested when procuring units: Designed for long duration, continuous operation, with expanded fuel tank, and designed with enhanced EMP and cyber protection.

Utilities should assess and register their emergency power requirements by using the Corps of Engineers' Emergency Power Facility Assessment Tool: http://epfat.swf.usace.army.mil/

e. Special options for low power equipment

For telemetry systems and other lower-power consumption components, some utilities have begun using solar power and battery backup systems. The use of sensors in Water Sector utilities is expanding very rapidly and EIS Council is researching sensor/communications capabilities that afford Black Sky-secured situation awareness, at an affordable cost.

f. Planning for emergency power to ensure wastewater throughput

Water and wastewater utilities--whether separate or combined--should coordinate regarding both required flows and the necessary emergency power support, to ensure that minimal wastewater flows are maintained for sewage disposal.

g. Power-conservative wastewater treatment options

Where utilities use aerated sludge operations for wastewater treatment, this approach typically consumes more than 75% of wastewater utility power requirements. In addition,

[5] Information provided by the U.S. Army Corps of Engineers.

without power for aeration, within a 48-72 hour window, microbes for sewage digestion will die, and re-establishment times are a week or longer. Working with their rate regulators, utilities should evaluate and potentially implement alternative, less power-intensive wastewater treatment methods, if available.

h. Minimal set of necessary chemicals

Significant opportunities exist for water and wastewater utilities to downsize their chemical storage and resupply requirements for Black Sky operations

Water systems maintain supplies of chemicals and other "consumable" supplies for water treatment that are primarily used to meet regulatory requirements for disinfectant residual in finished water and to achieve goals for color, odor, taste, and other characteristics that are mostly aesthetic (and not enforced by regulation), rather than necessary for preventing serious illness. Achieving these aesthetic goals will become less urgent in Black Sky outages. Instead, sustaining adequate quantities of water that meet bare minimum, health-related requirements – or that can be treated by customers to achieve that level of quality – will be of paramount importance in such events.

As water utilities determine Black Sky service levels with reduced quality of water they deliver, they should stringently prioritize the chemicals that they need to store and resupply. Such prioritization will need to be developed in agreement with appropriate regulatory entities to provide variances from chronic health standards while leaving the necessary acute health standards in place.[6] See Section 3.B. below.

i. Microgrids: Operating within a microgrid – a small section of the electric grid that can be electrically isolated from the larger power grid – is an advanced technique being pursued by a handful of water utilities, spurred by the rapid and extensive progress being made with use of renewables.

- Major wastewater systems have especially promising opportunities to establish microgrids for Black Sky operations. Anaerobic sludge digestion can generate – via captured methane emissions – enough power to operate a wastewater facility, and even give back excess power. However, for the utility to operate as a functional microgrid, the requisite electrical infrastructure must also be installed. As wastewater utilities consider the development of Combined Heat and Power (CHP) systems, utility leaders, elected officials, and other resilience stakeholders should carefully consider opportunities to provide for microgrid operations, and balance the incremental costs of doing full CHP against the potential benefits for sustaining wastewater service in long duration blackouts.
- Over the longer term, microgrids (or secure power enclaves) can provide a holistic means of strengthening water and cross-sector resilience. While electric utilities will need to make many of the investments necessary to create microgrids, water and wastewater systems should help lead cross-sector discussion on their design to ensure that minimalist water and wastewater service goals can be sustained in Black Sky events.

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[6] Such was the case during the aftermath of Hurricane Katrina, where the focus was on safeguarding against ***acute*** microbial risk while obtaining a variance from ***chronic*** 70-year life time exposure standards to arsenic in water.

2. **Emergency Fuel Tankage**

   Increased onsite emergency fuel tankage, or provisions for onsite or nearby storage and management of tanker trucks, is needed. This is a fundamental requirement to allow operations to continue despite infrequent and uncertain deliveries of diesel fuel. Water utilities should work with emergency management agencies and other water utilities, to develop regional plans (coordinated with fuel storage and delivery companies for Black Sky conditions) to ensure the delivery frequencies and volumes they anticipate will be required in a Black Sky scenario are met.

   As a default plan, where such plans are not yet available, sufficient fuel for 10 days of operation is recommended (i.e., approximately one 9000 gal. tanker truck capacity for full load operation of a 0.5 megawatt (MW) generator for 10 days). Under Black Sky conditions, backup power generators will be running under full load, which will dramatically increase fuel requirements and outstrip typical levels of on-site fuel storage. Note: Regulatory requirements will in most cases, need to be addressed to allow for additional fuel tankage. Many of the water sector utilities' Black Sky resilience investments and operational planning will require additional funding that must be approved by utility boards of directors or government officials. Other investments, including those in water and wastewater treatment, and in power generators and fuel storage, may require regulatory policy development and associated pre- or post-outage waivers of Safe Drinking Water or Clean Air Act standards and other regulatory policy changes. Developing new approaches to account for tradeoffs between Black Sky resilience and regulatory objectives will be essential for progress.

3. **Implementation approaches and considerations:**

   a. **Centralized fuel storage, or use of purchased fuel delivery trucks**

      Supporting a landscape with multiple, scattered backup generators and associated fuel storage facilities presents major challenges for expanding fuel storage, and for conducting resupply operations over a disrupted transportation network. A number of water utilities are centralizing their storage facilities to meet the fuel needs of large numbers of generators, and are purchasing or contracting for fuel delivery trucks. Contracting arrangements need pre-coordination with emergency management agencies, however, since they might create a major competition for resources, especially problematic if discovered once a Black Sky event takes place.

      These options should be examined sector-wide, with the aspirational goal of having an on-site 10- to 30-day fuel supply, as well as maintaining arrangements with multiple vendors for fuel resupply. Furthermore, utilities should trace their fuel supply chain even as far back as the refinery or port and identify the vulnerabilities throughout the supply chain.

   b. **Fuel storage partnerships**

      Fuel storage and transportation are major challenges in mitigating Black Sky hazards. In order to reduce the number of storage units and resupply trips and destinations, partnerships (for local deployment of adequate fuel) with other critical users/sectors (emergency management, hospitals, etc.) may present ideal opportunities for facility sharing and mutual-assistance agreements on fuel storage and resupply.

c. **Fuel system maintenance**

A common problem for diesel-run generators is that diesel sludge will build up over time. Fuel tanks and lines must be routinely cleaned twice per year, and fuel filters monitored and changed as needed. Filters must be drained daily, especially in cold climates, to preclude water build up and freezing.

d. **Alternative fuels**

Under emergency situations such as those following a Black Sky event, it may be necessary to use alternative fuels to operate emergency power generators. One approach is to acquire multi-fuel backup power generators, but their purchase cost is higher. Another approach is to use aviation-grade fuel--which will potentially be more available in a Black Sky environment—but only after consultation with the manufacturer, distributor or leasing agent. The use of aviation fuel as an alternate fuel source is being investigated by the EIS Council and the findings will be incorporated in a subsequent version of this Playbook.

4. **Facility preparations for reduced treatment levels:** Water and wastewater systems should be preconfigured to allow for switchover to Black Sky treatment levels, designed to assure designated treatment quality while minimizing electricity and consumables requirements. Each utility will have to establish levels specific to their system, conduct the associated planning and coordination and develop the concept of operations for reduced levels, and gain the approval of the appropriate regulatory agencies, for these Black Sky service levels.

5. **Spares:** Utilities must plan for and make investments in geographically-staged spares for vulnerable / frequently replaced components, including SCADA controllers, valves, and geographically distributed stores of basic tools. Utilities must maintain awareness of spare parts availability and supply chain vulnerabilities.

B. WATER SYSTEM: RECOMMENDED BLACK SKY OPERATIONAL PLANNING REQUIREMENTS

Operational plans for optimized use of emergency fuel to extend operations between refueling, for operation at reduced water treatment quality levels, and other changes are required to support Black Sky Service Levels. To be effective, these plans should be fully coordinated with supporting sectors and exercised frequently.

1. **Operational Plans for Transition to Black Sky Service Levels:** Utilities will need to develop operational plans to implement each of the service level changes that may be required during Black Sky emergencies. These should include:
   - **a.** Transition to reduced drinking water treatment operations, where processes for enhanced water quality (clarity, odor) are suspended during Black Sky operations.
   - **b.** Transition to limited zonal service, to include shutting down pressure zones to keep service to higher-priority or more easily serviced (lower elevation) zones.
   - **c.** Transition from full-power to reduced- or intermittent-power operations for treatment and pumping throughout the (possibly reduced) service area.
   - **d.** Transition to “Fire Suppression Only” operations.

e. Transition to recoverable system shutdown. For the most dire situations, utilities should examine methods to shut the system down while maintaining pressure within the system to allow for more rapid post-event recovery by limiting the damage that a full loss of pressure would entail. This planning should address potential pipe breaks due to loss of pressure or to transients produced during restart.

2. **Operational plans for Black Sky Service:** Once the transition to Black Sky operations is made, those operations may need to stay in effect for a month or more. Standing Black Sky Operating Procedures will need to be adopted as the "new normal" during the emergency.

3. **Operational Plans for Recovery to Normal Service Levels:** Rapid system recovery will be enhanced if recovery plans from each of the diminished Black Sky service levels back to normal levels are planned in advance, to ensure that the systems or components are not inadvertently damaged once power is restored. Close coordination with supporting electric utilities is required, in order to minimize disruptive starts/stops that may occur during black start/cranking path operations.

4. **Training**: Training is required to make critical personnel aware of all Black Sky operational plans, to address each of the Black Sky service level options. Training needs should address non-typical areas such as use of emergency power and communications means, as well as maintaining reduced water quality levels.

5. **Critical Personnel and Family Support:** Utilities will need to supplement their own critical personnel and family support, to assure their labor force will be available. Critical skills and proficiency levels, as well as family support requirements, need to be specifically addressed and provisions planned for securing them in the event of an extended emergency.
   - **a.** Identification of key personnel is essential, but for Black Sky emergencies, it is important to recognize that some key personnel may not be available as they may be caught up in the emergency themselves. Contingency plans are needed to ensure that operations can be maintained without the full complement of key personnel.
   - **b.** Utilities may need to consider internal relocation of key personnel.
   - **c.** Utilities may need to develop, coordinate and exercise emergency transportation plans that minimize the number of vehicles and that use pre-designated emergency routes used to access their place of duty. Carpooling and pre-planning the use of 4-wheel drive vehicles are best practices.
   - **d.** Pre-event coordination with the Red Cross or other disaster response and support organization is recommended to ensure that critical personnel and their families are safe and supported during an event.

6. **Emergency database:** Development and maintenance of a power-secure emergency database that provides key elements of data about the water and wastewater assets, is vital to response and restoration decisions that follow a Black Sky event.

7. **Emergency communications:** Planning for use of an appropriate emergency communication system for internal and external communication and data, and use of a synergistic emergency situational awareness and decision support tool will be essential to accommodate both internal operational plans, and coordination with external sectors. As an example, utilities may review

and utilize, as a basis for supporting these plans, the available Black Sky Coordination and Control System (BSX) architecture, being developed for this purpose.[7]

8. **Rigorous generator service and maintenance:** Black Sky emergency maintenance procedures. Generators are generally designed for short-duration emergency operations, not long-term 24 by 7 operation. Planning must consider maintenance and failure factors, and actions taken accordingly. Generators must be exercised under full load for a few hours, or a day at a time, every month. Utilities should maintain a master list of the availability status of all backup generators for use in Black Sky operational planning.

9. **Critical (External) personnel:** Utilities must plan for obtaining personnel having critical subject matter expertise needed to restore or maintain operations, such as generator maintenance and repair, electrical hookup, specialized plant operators, etc. One example is the concept of Certified Power Recovery Engineering Teams[8] (CPR) teams. In the case of water systems, these would be emergency power technicians, water system civil engineering support teams and cyber/industrial control system experts.

C. Wastewater System: Recommended Black Sky Operational Planning Requirements

Wastewater service may be even more important in achieving the key Black Sky goal of reducing mass migration than drinking water service – especially in urban areas. Recommended operational planning requirements for wastewater utilities mirror those for the drinking water utilities listed above. Utilities will need to develop operational plans to implement each of the service level changes that may be required during Black Sky emergencies. Additional considerations include the following:

1. Transition to less power-intensive wastewater treatment operations, such as filtration rather than aerated sludge, where feasible.
2. Transition to a reduced set of wastewater treatment chemicals.
3. Conduct alternative operations that ensure wastewater flows are maintained.

Internal Sector Requirements Matrix

Phase	Priority	Requirement
		Water
Response	4	Operational Plans for Transition to Black Sky Service Levels
Response	1	Operational plans for Black Sky Service
Response	8	Operational Plans for Recovery to Normal Service Levels
Mitigation	3	Training and Exercises
Response	5	Critical Personnel and Family Support
Mitigation	7	Emergency database
Response, Recovery	2	Emergency communications
Response,	9	Rigorous generator service and maintenance

[7] EIS Council, Black Sky Coordination and Control System (BSX): http://eiscouncil.org/Protection/ItemDetails/62
[8] For additional information on the CPR Engineering Team concept, see: http://eiscouncil.org/Protection/ItemDetails/63

Recovery		
Mitigation, Response, Recovery	6	Critical (External) personnel such as generator maintenance personnel and cyber experts
Wastewater		
Response	2	Transition to less power-intensive wastewater treatment operations
Response	3	Transition to a reduced set of wastewater treatment chemicals
Response	1	Conduct alternative operations that ensure wastewater flows are maintained

External and Cross Sector Dependencies Overview

Water Sector utilities will be able to meet their mission requirement only if they have assured support from other sectors, to supply those services and resources that lie outside its normal capabilities. Defining the sector's requested external requirement – and coordination with the appropriate sectors – is a crucial part of development of the Black Sky Protocol.

A. Government – Non-Regulatory Authorities and Emergency Managers

1. **National Planning for Emergency Power**: Prioritization of employment, emergency fuel deliveries, replacement generators and generator tech support will be required, and appropriate management and coordination processes associated with federal and state emergency management agencies and other government stakeholder organizations will be essential. The EIS Council's National Emergency Power Council (NEPC) Initiative[9] provides an example of such capability.

2. **National Planning for Emergency Utility Consumables:** A reduced suite of treatment chemicals will be needed for drinking water and wastewater treatment at levels required for minimal health-based quality. For an extended outage, with normal operation of chemical supply and transportation severely disrupted, delivery of such chemicals will take place only if state and federal government agencies preplan an organized process to assure effective execution. The National Emergency Utility Consumables Council Initiative[10] provides one example of how such a structure might be formulated. From the water utility perspective, it will be important to ensure this requirement is clearly articulated as a sector external requirement, to help government agencies understand the requirement that such a process will need to address. Key considerations include:

    a. Typical on-site chlorine storage is 1 – 2 weeks of needed supply. Increasing on-site storage however, poses many space and regulatory challenges, which need to be addressed in Black Sky planning.

[9] Emergency fuel deliveries, replacement generators and generator tech support will be required from the emerging **National Emergency Power Council** or equivalent organization, on a schedule that is negotiated between the relevant sectors. See: http://eiscouncil.org/Protection/ItemDetails/64.

[10] A minimal set of treatment chemicals will be needed, from the emerging **National Emergency Utility Consumables Council** or equivalent organization, providing a pre-negotiated set of chemicals and quantities. See: http://eiscouncil.org/Protection/ItemDetails/65.

- **b.** Onsite chlorine generation greatly increases electric power needs, so it is not a good option for Black Sky operation.
- **c.** Hypochlorite bleach typically requires 12 times the storage/resupply requirement compared to gaseous chlorine and may therefore be impractical when space is limited.
- **d.** Only a handful (~5) facilities now produce chlorine products in the U.S. Conducting region or industry-wide discussions with these suppliers is imperative for Black Sky planning.
- **e.** For joint water/wastewater utilities, it may be possible to sacrifice chlorine use on the wastewater side to extend chlorine for drinking water treatment. Utilities need to understand and plan for the tradeoff, and coordinate with their water or wastewater counterpart, if these functions are performed by separate utilities.
- **f.** Other essential chemicals such as coagulants must be considered in resupply and storage planning.
- **g.** Certified chemical operators and water quality analysts may be in short supply in a Black Sky emergency, and must be planned for.

3. **Community Disaster Preparation:** Media outreach, community forums and other forms of advance community preparation for long duration outages will be essential to successful implementation of many lifeline utility Black Sky plans. For example, government agencies, utilities and mass-care NGOs will need to play a pivotal role in educating the public about preparing for home-based water disinfection--by use of chlorine bleach or iodine tablets, for example--in the event of severe, long duration outages.

   Similarly, government agencies will need to provide advance information to communities about both the criticality of reducing water consumption in such disasters, and provide best practices for doing so. The Environmental Protection Agency recently launched the Community-Based Water Resiliency (CBWR) Tool to help facilitate partnerships between water utilities and the communities they serve.[11] Finally, utilities will need to coordinate with emergency managers and other resilience stakeholders regarding the utility's restoration plans, priorities, and timelines for limited or rotating service within service zones.

4. **Community Shelters:** Preparations will be required from government agencies, in coordination with the National Guard and mass care NGOs, to move people to shelters from areas predesignated by a local water company as an "unserved" location, in the event of a Black Sky hazard. Government agencies, working with water and power companies and with mass care NGOs, should pre-plan shelter locations in areas where electricity service and water service will be most easily sustained or restored following a Black Sky event.

5. **Limited emergency water supply support – Alternative Hydro-Systems:** While bottled water and other forms of emergency water supply will not be available to replace water service for a major city, government agencies should plan to provide limited emergency water support for local use, both in small communities without other means to obtain water, and for local use in unpowered "pockets" that remain without power and water, as the overall power restoration process proceeds in the aftermath of a Black Sky event.

[11] https://www.epa.gov/communitywaterresilience

An alternative distribution system (hydro-systems, including equipment and operations) could be modeled after Israel's concept of operations for furnishing potable water during water crises. These emergency systems, properly coordinated with emergency managers and local government officials, would be designed, configured, operated and maintained to provide potable water under No Water Service or Fire and Sanitation Services Only conditions.[12]

6. **Security and Transportation Support:** Provisions will need to be made for facility and personnel security, as well as for transportation, in disrupted, Black Sky environments. Furthermore, if security is not addressed, unauthorized tampering with hydrants and standpipes could lead to critical loss supply and/or pressure. Plans should include coordination with emergency managers and the National Guard to assure access by critical restoration personnel and to protect the distribution system from tampering.

7. **National Security Considerations**: Water and wastewater service is essential for national security. Civilian critical infrastructure – especially infrastructure that directly supports military installations or command and control elements – is a potential target for any adversary. Water Sector utility leaders should partner with Federal and state agencies to address resilience initiatives with regard to national security-related priorities. This will not only enhance resilience of the water utility itself, but enhance deterrence on two levels:

    a. Active deterrence--our national security apparatus will remain functional, ensuring appropriate political and military response; and

    b. Deterrence by denial – reducing vulnerability to attack and the consequences that an attack would yield; adversaries would find utilities a less desirable target and be less likely to attack in the first place.

B. Government – Regulatory Bodies

Regulatory Policy Adaptations: Utilities will need regulatory changes to recognize the needs for Black Sky resilience investment and operations, in order to procure required equipment and build appropriate plans to implement the Internal Requirements reflected in this Black Sky Playbook. These would include changes in water pressure, water quality, wastewater treatment, air quality (when using emergency backup generators) and other relevant features of planning for Black Sky operation. Provisions may also be needed to increase rates charged to customers, when significant additional investment is required to improve system resilience. Points to be considered are listed below and explained in detail in Annex B.

1. **Regulatory Mechanisms:** Utilities should look to their Associations to identify and understand regulatory requirements that may need to be changed or that require variances, due to Black Sky Black Sky operations.

2. **Emergency Standards:** Authorization to meet only acute – but not chronic – water quality standards during Black Sky emergencies.

[12] A broader strategy for such action is defined in Planning for an Emergency Water Supply, issued by EPA and AWWA in 2011.
http://www.awwa.org/Portals/0/files/resources/water%20knowledge/rc%20emergency%20prep/Emergencywater.PDF

3. **Black Sky Service Level Approval:** Black Sky service levels will require regulatory body policy decisions and corresponding rule adaptations, based on coordinated review with the utilities involved. To facilitate such coordination, utilities are recommended to develop a Black Sky CONOPS or Power Outage Annex that addresses Black Sky protocols.

4. **Air Quality Standards:** Air quality and other regulatory standards create challenges for expanded storage of fuel and chemicals. Improved air quality is an important goal. However, given the absolutely vital role that the Water Sector utility will play in saving lives during a Black Sky event, sector leaders should engage with regulators to explicitly examine the tradeoffs between improved sector resilience (through expanded storage and other infrastructure investments) and environmental regulations. At the Federal level, the EPA is both the Federal sector-specific agency responsible for the Water Sector, and is the Federal lead for making and enforcing environmental regulations. Bringing those two portions of the Agency to conduct such a tradeoff analysis between sector resilience and emissions goals could provide a model for doing so at state and local levels as well. Limited environmental quality waivers should be developed for emergency generator operation, to recognize the needs for ongoing maintenance use, as well as preplanned continuous use in severe, extended power outages

5. **Fuel Storage:** While it is estimated that 75% of water and wastewater facilities have installed emergency power generators, onsite emergency diesel fuel storage generally does not exceed supplies adequate for 48 to72 hours. In a Black Sky event, where electric power outages are expected to last weeks or longer, backup fuel will be depleted quickly and fuel resupply will be extremely challenging, and deliveries infrequent. Regulatory bodies should develop policies that permit and encourage expansion of these emergency fuel reserves, either onsite at water utilities, or stored in accessible locations where it can also be shared with other lifeline sectors and disaster responders.

6. **Chemical Storage:** At least as pressing as the need for adequate onsite emergency fuel storage, adequate availability of chemicals needed to treat water and wastewater will be essential. While these chemicals are routinely resupplied at these facilities under normal conditions, availability and delivery will be drastically reduced in severely disrupted, Black Sky scenarios.

   The U.S. EPA and responsible state departments, in coordination with utilities, should examine options for expanded onsite storage of the subset of treatment chemicals that correspond to designated, Black Sky treatment levels, to develop corresponding new regulatory policy for such chemical storage.

7. **Fuel and Chemical Transportation:** Delivery of fuel and water treatment chemicals is often a challenge for utilities and their regulators, due to HazMat and other transportation regulations. While such regulations are necessary to limit risks and protect public safety, under Black Sky conditions, the continued functioning of lifeline infrastructures will become a crucial requirement for saving and sustaining lives. Unless treatment chemicals are addressed as a priority item to be allowed in--particularly in large cities---a health and safety catastrophe could result. However, advance planning for required transportation of these chemicals – whether by utilities or by government emergency management agencies – can take place only if such transportation requirements are embodied in prearranged regulatory policy adaptations and recognized by the regulatory agency responsible.

The U.S. EPA, Department of Transportation, and state environmental departments and other regulatory bodies should develop policies for transportation of essential chemicals under Black Sky conditions, as an essential framework for use by other government agencies and utilities in their planning for sustained water and wastewater system operation in Black Sky scenarios.

8. **Emergency Generator Procurement:** Water and wastewater utilities, in coordination with regulatory commissions, should examine their existing backup power capability. For those utilities that do not currently have sufficient emergency generation to allow for sustained operation at Black Sky service levels that are designated for that utility, the U.S. EPA should develop policies that provide for cost recovery to acquire, install and maintain the minimum additional generator inventory.

   As an intermediate step, infrastructure investment in electrical connections and manual transfer switches will allow for connection of "trucked-in" emergency generators during severe hazards. This solution is not ideal, since availability of such units is anticipated to be very limited. Nevertheless, it does take an essential step toward later acquisition and installation of dedicated emergency generators.

9. **Microgrids:** Opportunities exist for some wastewater utilities that use anaerobic sludge treatment processes to self-power, reclaiming energy through the use of combined heat and power (CHP) units, fueled by captured methane from the wastewater treatment process. Such a process is not only environmentally friendly and reduces energy costs for the wastewater utility during normal operations, but can also be a powerful driver for system resilience if the additional investment in electrical infrastructure is made to allow the utility to function as a power island or microgrid.

C. Mass Care NGOs

1. **Critical Personnel and Family Support:** Utilities will need to supplement their own critical personnel and provide family support, to assure their labor force will be available. Mass care NGOs can play a crucial role in this area, and will require such information from water utilities to enable them to plan and train to provide such support.

2. **Community Coordination:** Mass care NGOs should be asked to help communicate with the public, to notify them of water safety and usage limitations, including both pre-event and post-event coordination. NGOs can also play an important role in both preparing communities for water conservation in such emergencies, and in real-time communication of the urgency of such conservation during a major outage emergency.

   One example is that Mass Care NGOs could be tasked with distribution of iodine tablets (pre-event preferred), with instructional material on their use for home water purification.

   Finally, as with emergency managers, utilities will need to coordinate with mass care NGOs and other resilience stakeholders on the utility's restoration plans, priorities, and timelines for limited or rotating service within service zones.

3. **Shelters:** With water utilities building plans for geographic service limitations, NGOs will be an important part of planning to relocate people from predesignated, non-served areas. This need should be identified by local utilities as an important external requirement and coordinated with

NGOs. Shelters should be preplanned, located in areas where electricity service and water service will be most easily sustained or restored in Black Sky emergencies. In collaboration with emergency managers and NGOs, utilities should develop plans for mass evacuations to shelters having *assured* water and wastewater services.

D. Electricity Subsector

1. **Prioritized power restoration**: Prioritized power restoration will be essential, to minimize the duration of operation of emergency generators and related equipment. The Water Sector utilities must identify prioritized requirements and collaborate with power providers to ensure these priorities are understood, addressed, and synchronized. Currently, most power utilities prioritize power restoration on a "customers served" basis. Even though water utilities are a very large power consumer, they are often viewed by power companies as "just one customer (or meter)." Furthermore, they are typically located outside of the main population centers, and often on an electrical spur line, which lowers their restoration priority. Water Sector utilities should coordinate with electric power utilities and emergency managers to ensure they understand that returning power to the water and wastewater utilities must be a priority, as water service to homes and businesses will allow the population to "shelter in place" until power is restored.

2. **Early power restoration**: In some cases, prioritized near-immediate restoration (if available) will be needed for utilities whose emergency generators fail or are not operable, and cannot find adequate spares. Water and wastewater systems also provide a large load that could potentially be leveraged as part of the supporting electric utility's Black Start/Cranking Path Concept of Operations. Both of these opportunities should be mutually planned by the electric and water utilities.

External and Cross Sector Requirements Matrix

Requirement Area	Priority	Requirement
Manpower	5	Maintaining all critical skills needed to operate the system at sustainable minimal levels. Continually improve WARN.
Transportation	7	Assess transport requirements for all supporting supply chains, extending back through main suppliers to their suppliers. Factor into planning and maintain situation awareness of primary and alternate means of transportation supporting critical supply chains
Emergency Power	6	Identify and maintain a list of required back up power units, including replacements and maintenance requirements, provide those requirements to emergency planners and establish the required connection points and operating procedures to receive, connect, operate and maintain emergency power units. (Consider an Emergency Power Plan as an annex to the Emergency Response Plan that provides a comprehensive plan of operations)
Security	1	Provide security for facilities (including distribution system) and personnel. While part of the distribution system, hydrants and

Requirement Area	Priority	Requirement
		standpipes deserve special security planning to avoid loss associated with unauthorized access
Communications	2	Capability to communicate with key subsystems to receive situation reports and to effect control of the system. This includes maintaining SCADA capabilities, but at a minimum, oral communications with key personnel.
Information Sharing	3	Capability for water and wastewater utility managers to obtain from, and provide information to WaterISAC about potential threats and risks to the nation's water infrastructure from all hazards. This includes access through WaterISAC to other ISACs such as E-ISAC and FS-ISAC.
Communications (Physical)	4	Black Sky-secure communications capable of extending to all internal components and subsystems.
Fuel	8	Resupply of fuel necessary to maintain water/wastewater operations at designated Black Sky level of service

Sector Specialized Resource Requirements Overview

Water and wastewater treatment requires the following types of specialized resources to sustain services following a Black Sky event:

1. **Skilled manpower**: treatment plant operators; distribution system repair and maintenance personnel; cyber/ICS experts; generator operators and maintenance specialists.
2. **Disinfectant chemicals:** continuing supply to prevent the outbreak of illness and disease. Additional requirements exist for chemicals used to achieve lower priority taste and odor standards.
3. **Fuel:** for emergency power, beyond that stored on site.
4. **Bottled Water:** a supplemental supply of water provided by external parties to meet the needs of those people losing their access to potable water.

Sector Commodity Specific List Matrix

Phase	Commodity	Estimated Quantity	Potential Source
Mitigation, Response, Recovery	Skilled generator operators	Variable	WARN, Ex-Military
Mitigation, Response, Recovery	Skilled generator maintenance personnel	Variable	WARN, Ex-Military
All	Skilled treatment plant and system operators	Variable	WARN
All	Disinfectant Chemicals	Secure an initial 30-day supply	WARN, Chemical Plants, Food Stores

All	Skilled treatment plant repair personnel	TBD	WARN; local trades
All	Coagulant Chemicals	30-day supply on site	WARN, Chemical Plants
All	Fuels	Secure an initial 30-day supply	Contracts with current supply chain; alternate fuels, when necessary
Mitigation, Response	Bottled Water	TBD by: Pressure Zone shut down and where quality levels are lowered	Food Stores, NGOs

Sector Black Sky Communications Overview

Communications are very important to the operation of large-scale water and wastewater systems, because they support person to person coordination and the increasing adoption of Industrial Control and SCADA systems to manage system operations. These communications are necessary to monitor the system and provide readings to the System Operator via some form of communication (BSX would be an option here) hourly in order to maintain sustainable minimalist levels of service. Communications with WARN partners, particularly if there has been extensive prior collaboration, could be considered as extended internal communications.

Communications with Emergency Operations Centers and Law Enforcement would be next in priority and communications with components of the supply chain would follow. Communications with Government authorities would generally be with States, to provide status and to request intervention needed to facilitate operations. Communication with public will be vital for ongoing conservation efforts, home treatment needs, and potential relocation requirements.

Sector Communications Matrix

Phase	Communications Requirement	Coordinated Cross Sector Element
Mitigation, Response, Recovery	With Public	External
Mitigation, Response,	Between Operators of the sub-systems (including WARN partners)	Internal

Recovery		
All	Between Electric Subsector and Water Sector	External
Protection, Mitigation, Response, Recovery	Share threat and hazard information across sectors by using the Information Sharing and Analysis Center network of Sector ISACs	External
Protection, Mitigation, Response, Recovery	Maintain ICS/SCADA functions	Internal
Mitigation, Response, Recovery	Between Water Systems and Emergency Operations Centers	External
Mitigation, Response, Recovery	Between Water Systems and Law Enforcement	External

Sector Black Sky Assessment Tool (s) Overview

EPA, with American Water Works Association and Department of Homeland Security, has developed a number of useful tools that can be used to assess overall resilience and the resilience of components of the Water Sector.

- Risk and Resiliency Management of Water and Wastewater Systems (2014) VSAT Version 6.0
    - http://water.epa.gov/infrastructure/water_security/techtools/vsat.cfm
    - Vulnerability self-assessment tool based on ANSI-AWWA J100-10 Standard (RAMCAP). This tool is designed to assist water and wastewater utilities with determining vulnerabilities to all hazards and with evaluating potential improvements to enhance their security and resilience. It can be used to conduct or update an all-hazards risk assessment. (training videos are also available at this site).

- Water Sector Utility Incident Action Checklists (2015)
    - www.epa.gov/safewater
    - 'Rip and Run' style checklists to facilitate emergency preparedness, response and recovery actions for ten natural disaster that can significantly impact water and wastewater utilities:
        - Drought EPA 817-F-15-001
        - Earthquake: EPA 817-F-15-002
        - Extreme Cold/Winter Storm: EPA817-F-15-003
        - Extreme Heat: EPA 817-f-15-004
        - Flooding: EPA 817-f-15-005
        - Hurricane: EPA 817-F-15-006
        - Tornado: EPA 817-f-15-007
        - Tsunami: EPA 817-f-15-008
        - Volcanic Activity: EPA 817-F-15_009
- Wildfire: EPA 817-F-15-010 Emergency Water Supply Planning Guide for Hospitals and Health Care Facilities (2012)

    - www.cdc.gov/healthywater/pdf/emergency/emergency-water-supply-planning-guide.pdf
    - Centers for Disease Control and American Water Works Association Guidelines to assist health care facilities develop an Emergency Water Supply Plan (EWSP) to enable the facility to continue operations when the drinking water supply has been interrupted for any reason.

- Hazard Mitigation for Natural Disasters (A Starter Guide for Water and Wastewater Utilities) (2016) EPA 810-B-16-001
    - www.epa.gov/safewater
    - This guide provides practical solutions to help water and wastewater utilities mitigate the effects of natural disasters.

- AWWA Cybersecurity Guidance Tool (2014)
    - www.awwa.org/cybersecurity
    - This tool applies only to process control systems and not business systems. Though not an assessment tool, it uses a number of questions to characterize the utility's SCADA system, and then offers a number of 'controls' (suggestions) to harden the process control system. This tool is consistent with the federal 'Cyber Security Framework' issued by the National Institute of Standards and Technology in 2014.

- Water Research Foundation Business Continuity Plan Guidance Document (2013)
    - www.waterrf.org
    - This tool assists utilities in preparing a plan to ensure continuation of utility business activities following a disaster. The document directs the utility to identify key parameters such as: mission essential functions, critical resources, and a time frame for reaching objectives.

- Some utilities are beginning to incorporate hydraulic modeling and analysis using Geographic Information Systems (GIS) into Black Sky assessments and planning
    - Multiple tools: hydraulic modeling, GIS, simulation modeling

EIS Council works with U.S. EPA, hydraulic and GIS modeling tool companies and select utilities to develop recommendations regarding how to use hydraulic modeling combined with GIS to provide operators a deep understanding of water or wastewater system behavior under a variety of Black Sky scenarios, and to enable development of 'what if' strategies that could be used to build adaptability into Response and Recovery activities.

Sector Black Sky Planning Requirements (On-going)

As noted throughout the section on Internal Requirements above, extensive planning for Black Sky operations is very important to maintaining adequate water and wastewater services vital to preventing widespread loss of life and the continuity of society. Planning must address the requirements proprietary to each of the phases, and should continue to be refined in a structured approach that seeks that leverages "everything is learning", as well as modeling and simulation' to build and evolve a "body of knowledge". Most importantly, when performed collaboratively across sectors, Black Sky planning forces the scope to be broadened, generates discovery and serves to improve current operations.

In addition to the requirements stated above, there are three other areas that need to be addressed:

- Critical Support Requirements. Black Sky events will precipitate work requirements far exceeding capabilities, requiring response and recovery actions to be prioritized. EPRO Handbook III, Black Sky Coordination and Communication, advocates for identifying/designating critical facilities to provide focus and prioritization for response and recovery efforts. Lists of designated critical facilities should form a common outcome-based set of targets used for Black Sky planning.
- Modeling and Simulation. Modeling and simulation should be used extensively as an adjunct to support Black Sky planning. Each sector has developed intra-sector capabilities to model its systems and simulate operations. In the Water Sector, for example, EPA has developed a tool called WNTR that utilities can use to model a variety of scenarios to determine a rich set of vulnerabilities and their impact on pressure and water/wastewater quality. Modeling and simulation can be used for example, to determine optimal disposition of a limited supply of emergency generators, workforce, and equipment. It can be used also to assess the effectiveness of planned sequencing and resourcing of restorative actions. Most importantly, when modeling and simulation incorporates cross-sector operations, such as with GINOM, it can be used to assess the impacts of interdependencies throughout all phases. Finally, when used in conjunction with the metrics appropriate to each reporting activity, model and simulation provides a very powerful means of validating investments in Black Sky resilience.

- Water/Wastewater Black Start Project Plans. One of the key elements of complete Black Sky planning is recovery planning, that is, a utility's plan for restoring services to pre-event—or otherwise specified---levels. The size and complexity of Water/Wastewater Sector facilities requires well-planned activities, a well-considered resource allocation plan that incorporates contingent resource availability, and risk-based scheduling. Each of these components—activities, resources, schedule—are not only inter-related but also must be "risk-adjusted" meaning each project plan must incorporate probabilities to provide a range of durations, in addition to maximum likelihood of resource availability or duration. The probabilities can be used in modeling and simulation tools such as GINOM to provide "worst/best case" planning parameters essential to deciding among courses of action, and to establish their sequencing. The set of these project plans constitute a "running estimate" of recovery durations within and across sectors.

Sector Best Practices Matrix (On-going)

Area of Operations	Recommendation	Expected Improvement
Water and Wastewater and Electrical	Develop comprehensive Power Outage Incident Annex to Emergency Operations Plans	Greater awareness and understanding of water/electric nexus will result in improved resilience to Black Sky hazards
Water and Wastewater	Develop comprehensive emergency power plan	Optimizes capability to identify, plan for and maintain

and Electrical		sustainable minimalist levels of service
Water	Use hydraulic modeling and GIS to support resilience planning and investment	Improved situation awareness, response planning and resilience investments
Water and Wastewater	Maximize WARN opportunities	Enhances resilience by adding additional capabilities at reduced levels of cost. Improves the quality of resilience by leveraging the ‘two heads are better than one’ principle
All	Coordinate and manage interdependencies among sectors intensively.	Improved resilience and greater efficiency in the allocation of resources

Integrated and Shared Planning Actions (3.5/V4)

Maintaining Water Sector services following a Black Sky event, even at reduced levels, requires extensive planning, collaborating and exercising across all sectors. Integration with other sectors, classified by type is as follows:

Planning and Coordination Actions Matrix

	Water	Electric	Federal	State	Regulatory	Telecommunications	NGO
Water							
Support		• Priority for Restoration of Grid Power • Technical Knowledge • Inclusion in Planning, Training, Exercises • Coordinated Black Start planning • Support for Microgrids and Secure Enclaves • Coordinated Modeling	• Provided Federal Emergency Assistance • Water Infrastructure Finance and Improvement Act (WIFIA) Funding • Tools • Modeling Support • Set Design Standards for Sustained Emergency Operations • NERC-equivalent	**Primacy Agency Support** • Compliance Guidance • Laboratory Services • Damage Assessments • Technical knowledge • Representation in EOC • Incident Field Support • Support to WARN • Financing (SRF) **Emergency Management Support** • Access to Sites • Credentialing • Evacuation Plans • Protection of Assets • State-level Coordination • Inclusion in Planning, Training, and Exercises • Requesting Federal Assistance • Set Design Standards for Emergency Operations	• Relief from Water Quality Standards (SDWA) • Relief from Clean Air Act • Relief from Fuel Storage Limitations • Relief from highway and Inter-state transportation restrictions • Plans for facilitating movement of equipment and personnel	•	• Incorporate Water Sector into all Evacuation Planning, Training and Exercises • Identify evacuation locations
Information		• Estimated Restoration Time	•	• Emergency Response Plans • EOC location • Planned Evacuation Sites	•	•	•

Sector Black Sky Resilience Considerations Overview (3.5/V4)

The Water Sector has identified a number of potential resilience actions, activities and investments that would strengthen the sector's resilience to Black Sky hazards and are listed in the table below.

In general, Water Sector utilities are municipally owned and rates are regulated to keep them low. This situation hinders their ability to make the types of investment in resilience that would be required for Black Sky hazards.

Resilience Initiatives Matrix

Tooling and capabilities prepared in advance: Define those categories of advance planning, investment and effort required to make infrastructure restoration and population sustainment possible, when the nation finds itself thrust into a highly disrupted, Black Sky scenario.

Initiative Title	Initiative Description/Cost	Expected Outcome
Water/Energy Nexus	Participate in DOE initiative to analyze the relationships between energy and water use and conduct research on water and energy systems.`	Deeper collaborative relationship between Water Sector and Electric Subsector
EPRI	Review and leverage EPRI's published research on Water Sustainability and seek to establish a partnership between EPRI and the Water Sector.	Deeper relationship between Water Sector and Electric Subsector
Hydraulic Modeling/Geographic Information System (GIS)	Promote hydraulic modeling and GIS to support Black Sky planning. Hydraulic modeling can assist a utility in gaining a full realization of capabilities, vulnerabilities and responses, to a variety of 'what if' scenarios, while GIS can provide information on land use, population, critical customers, shelter locations, etc.	Improved Black Sky planning and Situation Awareness
Emergency Power Annex to Emergency Response Plan	Conduct an in-depth analysis of emergency power requirements; incorporate hydraulic modeling to determine numbers and placement of emergency power units. Assess supporting requirements such as fuel, maintenance, and unit replacements.	Detailed executable plan for restoring sustainable minimalist service levels, and beyond.
Cyber-Secure Water and Wastewater Operations	Develop plans for a cyber-based attack on Water and Wastewater systems, particularly in conjunction with an accompanying attack on the Electric Grid	Reduced time to recover

Supply Chain Resilience Assessment (commodities)	Develop a deep understanding of the capabilities and vulnerabilities the supply chains that support continued	With an improved understanding of the vulnerabilities, threats, and consequences, owners and operators of utilities can continue to thoroughly examine and implement risk-based approaches to protect, detect, respond to, and recover from all hazards better
Financing Resilience Initiatives	Identify means to finance resilience measures into new and existing capabilities.	Overcome current obstacles posed by requirement to use rates to pay for resilience
NIAC Water Sector Resilience Measures	Adopt and support the resilience recommendations contained in the NIAC Water Sector Resilience Final Report and Recommendations, dated June 2016.	Blends NIAC and EIS Council efforts and opens the opportunity to broaden Black Sky considerations in future NIAC recommendations.

Sector Black Sky Regulatory Impacts and Issues Overview (On-Going)

Black Sky regulatory issues are described above, in External and Cross Sector Dependencies Overview, Part B., Government-Regulatory Bodies, and are summarized as follows. They are further detailed, on an item by item basis, in Annex B, Regulatory Issues Detail Statements.

Sector Regulatory Matrix

Area of Operations	Issue	Recommended Solution/Resolution
Water Treatment	Limits on use of specific water sources	Identify, and coordinate with Regulatory officials to use, specific sources of water during Black Sky response and recovery
Water Treatment	Water Quality Standards under Black Sky Conditions	Identify and carefully consider impacts of standards to be relaxed under Black Sky environment (e.g., taste and odor, and acute vs chronic exposure)
Wastewater Treatment	Relax discharge standards for wastewater systems	Identify and carefully consider impacts of standards to be relaxed under Black Sky environment (e.g., taste and odor, and acute vs chronic exposure)
Water and	Response and recovery personnel should be	

Area of Operations	Issue	Recommended Solution/Resolution
Wastewater	provided First Responder status	
Emergency Power	Limits Placed on Running Emergency Power	Partial Exemption from Clean Air Act
Water and Wastewater Treatment	Limits on on-site chemical storage	Identify and carefully consider impacts of standards to be relaxed under Black Sky environment (e.g., taste and odor, and acute vs chronic exposure)
Emergency Power	Limits Placed on on-site fuel storage	Identify and carefully consider impacts of standards to be relaxed under Black Sky environment (e.g., taste and odor, and acute vs chronic exposure)

Sector Black Sky Essential Critical Infrastructure (MC) Overview (3.5/V4)

The most essential elements of water utilities' infrastructure to achieve resilience are detailed below. These include items that are unique or mission essential to the Water Sector.

Sector Critical Infrastructure Matrix (V3.5/V4)

Element	Function
Pumps	Draw from source, convey, lift, maintain pressure: high energy
Distribution Pipelines	Convey water: no to low energy
Storage Tanks	Store: energy to lift but not once stored
Water Treatment Settling Tanks	Clarification by mixing and settling; no to low energy (mixing and settled solid removal)
Water Ozonation	Use ozone to kill micro-organisms: high energy
Water Filtration: membrane	Improve quality; desalination: high energy
Water Filtration: media filter	Improve quality: no to low energy
Water Disinfection	Disinfect water: low energy
Wastewater Primary	Primary Sewage Treatment capabilities: low to no energy
Wastewater Secondary	Secondary sewage treatment capabilities, especially biosolid removal: medium to high energy
Wastewater Tertiary	Sewage discharge treatment capabilities: low to medium

Element	Function
Sludge Processing	Sludge conveyance and disposal: high energy
SCADA	Control system operations: low to medium energy

Sector Black Sky Specialized Skill Training Requirements Overview (V3.5/V4/V5)

To be Black Sky resilient, the Water Sector, including its water and wastewater systems should identify mission critical skills/positions that must be trained to accomplish Black Sky resilience, starting with Assessment and moving through, Response, Restoration and Recovery. The American Water Works Association has outstanding training programs for Water and Wastewater operators, and consideration should be given to either incorporate special Black Sky skill requirements into existing courses or 2) start a separate track for Black Sky operations.

AWWA has developed a resource typing catalog for WARN that can serve the dual purpose of specifying the skills required during an emergencies. Resource typing is the categorization and description of response resources that are commonly exchanged in disasters through mutual aid and assistance agreements. Resource typing definitions can give utilities the information they need to ensure that they request and receive the appropriate resources during an incident. The resource typing protocol provided by the National Incident Management System or NIMS describes resources using the parameters of category, kind, components, metrics, and type. Utility and system planners should consult this typing catalog, identify their specialized skill requirements and include them in their respective Black Sky emergency and continuity of operations plans.
http://www.awwa.org/Portals/0/files/resources/water%20knowledge/rc%20emergency%20prep/rc%20warn%20resources%20pdf/typingmanual.pdf

Sector Specialized Skill Training Requirements Matrix (3.5/V4/V5)

Phase	Position/Skill	Training/Certification Requirement
All	Emergency Planner	TBD
Mitigation	Hydraulic Modeler	TBD
Prevention, Protection Mitigation	Vulnerability Assessment	TBD
Response	Emergency Power Operator	TBD
Response	Emergency Power Mechanic	TBD
All	SCADA Technical Architect	TBD

Annex A – Assessments (On-going)

Sector Overall Resilience Assessment

Most of the larger water and wastewater systems have conducted a vulnerability assessment using the Vulnerability Self-Assessment Tool (VSAT) 6.0. VSAT Version 6.0 complies with the Water Sector risk assessment standard and can offer liability protection under the Department of Homeland Security's Support Anti-Terrorism by Fostering Effective Technologies (SAFETY) Act program.

The EIS Council is evaluating the current tool to determine the modifications required for Black Sky resilience. It is unlikely that more than a few systems have made a Black Sky resilience assessment, though Las Vegas Valley Water District has begun to conduct Black Sky planning. Lessons learned from the LVVWD experience will be used to refine assessment requirements in future updates of this Playbook.

Annex B – Regulatory Issues Detail Statements (On-Going)

Issue Statement 1: Testing Emergency Generators

- **Statement:** Clean Air Act restricts the testing of emergency power units. Relief is sought to allow proper testing.
- **Decision Authority:** Environmental Protection Agency
- **Required Documentation:** obtain/compile manufacturers' literature regarding testing
- **Resiliency Investment statement:** generators must be periodically tested under full load for extended duration to assure they will properly function during emergency operations
- **Plan Requirements:**
- **Training Requirements:**
- **Liability Statement/3rd Party Protection Issue:**
- **Explicit requested legislative changes/Insurance/Assurance/3rd Party Indemnification:**

Issue Statement 2: Reduced Water Quality Levels

- **Statement:** Safe Drinking Water Act establishes water quality standards, many of which are determined by effects of long-term use. Relief is sought for Black Sky conditions.
- **Decision Authority:** Environmental Protection Agency
- **Required Documentation:** list of variances
- **Resiliency Investment statement:** reducing water quality levels for Black Sky operations may extend the sustainability of water and wastewater operations
- **Plan Requirements:**
- **Training Requirements:**
- **Liability Statement/3rd Party Protection Issue:**
- **Explicit requested legislative changes/Insurance/Assurance/3rd Party Indemnification:**

Annex C – Communications Requirements (V3/V4)

Communications Requirement 1: Internal Coordination

- Internal/Planned Format/Path: Internal communications
- External/Planned Format/Path: N/A
- Explicit Model
    - Who: designated sites and mobile teams of the utility
    - What: coordination with internal resources
        - Status of key components
        - Damage to assets
        - Emergency power generator status—including maintenance
        - Fuel status
        - Personnel status
        - Tank levels
        - Pressure at key points
        - Quality measurements
        - Fire hydrant operations
        - Operations orders
        - Valve operations
    - When: as occurs; follow up until provided
    - Strategies (back up): walkie/talkie
    - Bandwidth requirement (actual and notional): HF/UHF/VHF
    - Format: voice
    - Priority: High

Communications Requirement 2: External Support Requirements

- Internal/Planned Format/Path: Internal communications
- External/Planned Format/Path: BSX
- Explicit Model
    - Who: designated sites and mobile teams
    - What: Intervention requested from Emergency Operations Center
        - Access to sites
        - Law Enforcement
        - Generators
        - Technical Support by Type
        - Fuel
        - Treatment Chemicals
        - Bottled Water
        - Other
    - When: as occurs; follow up until provided
    - Strategies (back up): physical presence
    - Bandwidth requirement (actual and notional): HF/UHF

- Format: Voice
- Priority: High

Communications Requirement 3: Status of Services

- Internal/Planned Format/Path: SCADA
- External/Planned Format/Path: BSX
- Explicit Model
  - Who: System Operator
  - What: System Map updated with SCADA-reported Status
  - When: Initial, within 1 hour of Black Sky incident; follow up, twice daily
  - Strategies (back up): Courier to Emergency Operation Center
  - Bandwidth requirement (actual and notional): Low
  - Format:
    - Number of People without water service
    - Pressure zones (designators) without service (preregistered with EOC)
    - Critical facilities (designators) without adequate fire flow/pressure
    - Reduction or forecasted loss of service over next 24 hours
  - Priority: High

Communications Requirement 4: Damage to Components

- Internal/Planned Format/Path: SCADA
- External/Planned Format/Path: BSX
- Explicit Model
  - Who: System Operator
  - What: SCADA-reported Status
  - When: Initial, within 1 hour of Black Sky incident; follow up, twice daily
  - Strategies (back up): Voice, following physical inspection
  - Bandwidth requirement (actual and notional): TBD
  - Format:
    - Assets inoperable (select from prepositioned list of system's assets)
    - Prioritized list of asset replacements (required to optimize level of service): use AWWA Resource Type
  - Priority: High

Communications Requirement 5: Request for Personnel

- Internal/Planned Format/Path: Supervisor reports using internal communications
- External/Planned Format/Path: BSX to WARN
- Explicit Model
  - Who: Utility Manager
  - What: Request for additional support, by Resource Type
  - When: Initial, within TBD hours of Black Sky incident; follow up, twice daily
  - Strategies (back up): Voice, following physical inspection
  - Bandwidth requirement (actual and notional): TBD
  - Format:

        - Prioritized list of asset replacements (required to optimize level of service): use AWWA Resource Type
    - Priority: High

Communications Requirement 5: Request for Resupply of Treatment Chemicals

- Internal/Planned Format/Path: Internal
- External/Planned Format/Path: BSX
- Explicit Model
    - Who: Logistics Manager
    - What: Treatment resupply requirements
    - When: 3 days and whenever supplies fall below reorder point (continuously updated based on experience gained during Black Sky response and recovery
    - Strategies (back up): Preplanned ‘push’ supply
    - Bandwidth requirement (actual and notional): TBD
    - Format:
        - Estimated chemical supply by quantity, projected over a 30-day period
    - Priority: Medium

Annex D: Resilience Requirements by Layer

Identify requirements for each phase, including both (A) Generic required elements for all Black Sky hazards, and (B) Hazard-specific required requirements. Note, however, that many requirements will exhibit heavy overlap among sectors, with many infrastructure sectors, and their partners, requiring the same resilience measures.

Area	Phase	Black Sky Generic	Black Sky Hazard Specific	Notes/ Status
Emergency Communication	Mitigate Respond Recover	• Plan for communications without cellular • Plan for non-grid power for communications • Train/rehearse using frequencies available during Black Sky	• BSX capabilities(EMP hardened and prolonged non-grid power) • Plan for communications without cellular and satellite (EMP) • Store equipment in Faraday boxes (EMP)	Meeting all requirements will have MAJOR impact on meeting system's mission
Cross-sector situational awareness, coordination and decision support requirements	Mitigate Respond Recover	• Identify key metrics for monitoring internal sector operations • Identify key metrics for monitoring cross-sector operations • Perform all-hazard , multiple-scenario modeling and simulation to support Black Sky planning • Incorporate GINOM-furnished information into all planning	• Ensure Black-Sky secure (EMP/GMD hardened and long-term power supply) to GINOM capabilities	Meeting all requirements will have MAJOR impact on meeting system's mission

Emergency Fuel	Mitigate
	Respond
	Recover
		• Develop fuel plan for extended power outage contingency
		  ○ Coordinate plan with suppliers
		  ○ Identify potential competition for resources with suppliers
		  ○ Invest in fuel tankers to support long-term fueling operations
		• Maintain at least 7 days of fuel for fleet and emergency power
			• Plan for disrupted fuel and chemical transportation in the event of flooding or earthquake	Meeting all requirements will have MAJOR impact on meeting system's mission

Operational Fuel (e.g., natural gas) Requirements	Mitigate Respond Recover	• Plan/invest in fueling capabilities for emergency vehicles, using on hand capabilities	• Plan for disrupted fuel transportation due to flooding or earthquake	Meeting all requirements will have MAJOR impact on meeting system's mission
Emergency Generators (Black	Mitigate	• Plan/invest in sufficient emergency power capability to maintain	• Invest in EMP/GMD-hardened generators	Meeting all requirements will have MAJOR impact on meeting system's mission

Sky hazard-hardened, designed for long duration continuous operation)	Respond Recover	minimal service levels • Use hydraulic modeling to identify optimal deployment of emergency power • Register requirements in EPFAT • Provision hookups for mobile and externally-provided units • Invest in generators used for long-duration, continuous operation • Invest in alternative energy sources(wind, PV and co-generation) • Plan for specialized maintenance support • Invest in multi-fuel capability • Secure the availability of replacement generators		
Protective measures: Hardware, software, operational procedures	Mitigate Respond Recover	• Protect electric facilities from flooding • Strengthen distribution system to minimize earthquake damage	• Protect SCADA from EMP • Protect emergency generators and vehicles from EMP/GMD	Meeting all requirements will have MAJOR impact on meeting system's mission
Health / damage assessment diagnostics:	Mitigate Respond Recover	• Develop/exercise comprehensive damage assessment CONOPS/CONPLAN • Incorporate asset management into Black Sky planning • Perform comprehensive modeling with multiple scenarios (all hazards) to assess the range of potential damage to system • Leverage IoT to design a comprehensive and integrated sensor plan based on situation awareness goals • Plan/install health checks for emergency power units	• Protect diagnostic capabilities from EMP/GMD	Meeting all requirements will have MAJOR impact on meeting system's mission
Pre-deployed, automated self-powered remote reporting to central assessment controllers	Mitigate Respond Recover	• Pump station power outage • Tank-level indicator • Pressure indicator at critical points in distribution system	• Invest in EMP/GMD-secure sensing/communications capabilities	Meeting all requirements will have MAJOR impact on meeting system's mission
On-site diagnostics	Mitigate	• Manual	• N/A	Meeting all requirements will

providing easy 1st order damage assessment for an onsite, deployed restoration team	Respond Recover	water/wastewater quality testing kits		have MAJOR impact on meeting system's mission
Diagnostic tooling designed for manual use by a deployed restoration team	Mitigate Respond Recover	• Plan for enhanced water/wastewater quality testing • Plan for water/wastewater quality testing capability • Provide capability to reconfigure hydraulic modeling tools in response to damage	• Secure EMP/GMD/vulnerable diagnostic equipment	Meeting all requirements will have MAJOR impact on meeting system's mission
Restoration / emergency tooling	Mitigate Respond Recover	• Develop black start plan for system –for several outage scenarios • Identify specialized support for restoring system following a prolonged power outage • Develop resourced project plan for system restart	• Incorporate modeled EMP/GMD/earthquake and flood damage forecast into recovery plans •	Meeting all requirements will have MAJOR impact on meeting system's mission
Black Sky Exercise and Training Requirements and Plans	Mitigate Respond Recover	• Develop Power Outage Incident Annex (POIA) CONOPS or CONPLAN for conducting operations following extensive grid outage • Plan/conduct sector POIA exercise • Plan/conduct cross-sector POIA exercise • Identify and document training requirements for POIA operations	• Incorporate hazard-caused damage (in addition to effects of power outage) into water/wastewater sector response and recovery plans	Meeting all requirements will have MAJOR impact on meeting system's mission
Materiel	Mitigate Respond Recover	• Enhanced water/wastewater quality testing capability • Treatment chemicals and supplies • Supplies to maintain workforce	• Protect electronic equipment from EMP/GMD • Protect electrical equipment from flooding • Invest in hardening measures for earthquake and flooding	Meeting all requirements will have MAJOR impact on meeting system's mission

1. **Spares, *with advance field deployment requirements***: In three categories
   a. **Inexpensive, common use** hardware that will be hard to find in Black Sky conditions unless pre-deployed (i.e., "For want of a nail …")
   b. **Inexpensive to moderately expensive hazard-vulnerable hardware elements** for different Black Sky hazard scenarios
   c. **Expensive, long lead hazard-vulnerable hardware and associated installation tooling** for different Black Sky hazard scenarios
2. **Personnel support requirements**: What teams, and how many teams, will be required by each stakeholder organization, with what team makeup and what deployment, for each hazard type and for each phase?

   Note 1. This assessment will drive, for example, the requirements for prearranged, pre-certified, external Certified Power Recovery (CPR) Engineering Teams to add substantially to the core organizational teams for that sector.

   Note 2. A supplemental requirement: given the number, makeup and deployment of the requisite teams, what will be required for associated family support?

   Note 3: These personnel / team requirements should be provided as a function, at least crudely, of the level of availability of diagnostics (in (g) i. -> iii. Above). E.g., if there are remotely pre-deployed, Black Sky hardened, self-powered, embedded and remotely reporting diagnostics in all important power gird substations and generating substations and water system and gas pipeline key facilities, vastly fewer restoration teams would need to be deployed, those that are deployed would be far more effective, and the entire damage assessment phase would be far quicker.
3. **Black Sky Operational Plans and Procedures:** Supplementing existing hazard plans and procedures for conventional hazards
4. **Black Sky Exercise and Training Requirements and Plans**: Supplementing existing hazard exercise and training requirements