United States
Environmental Protection
Agency

Wastewater Response Protocol Toolbox:
Planning For and Responding To Wastewater Contamination Threats and Incidents

December 2011

Module 1:
Wastewater Utility Planning Guide

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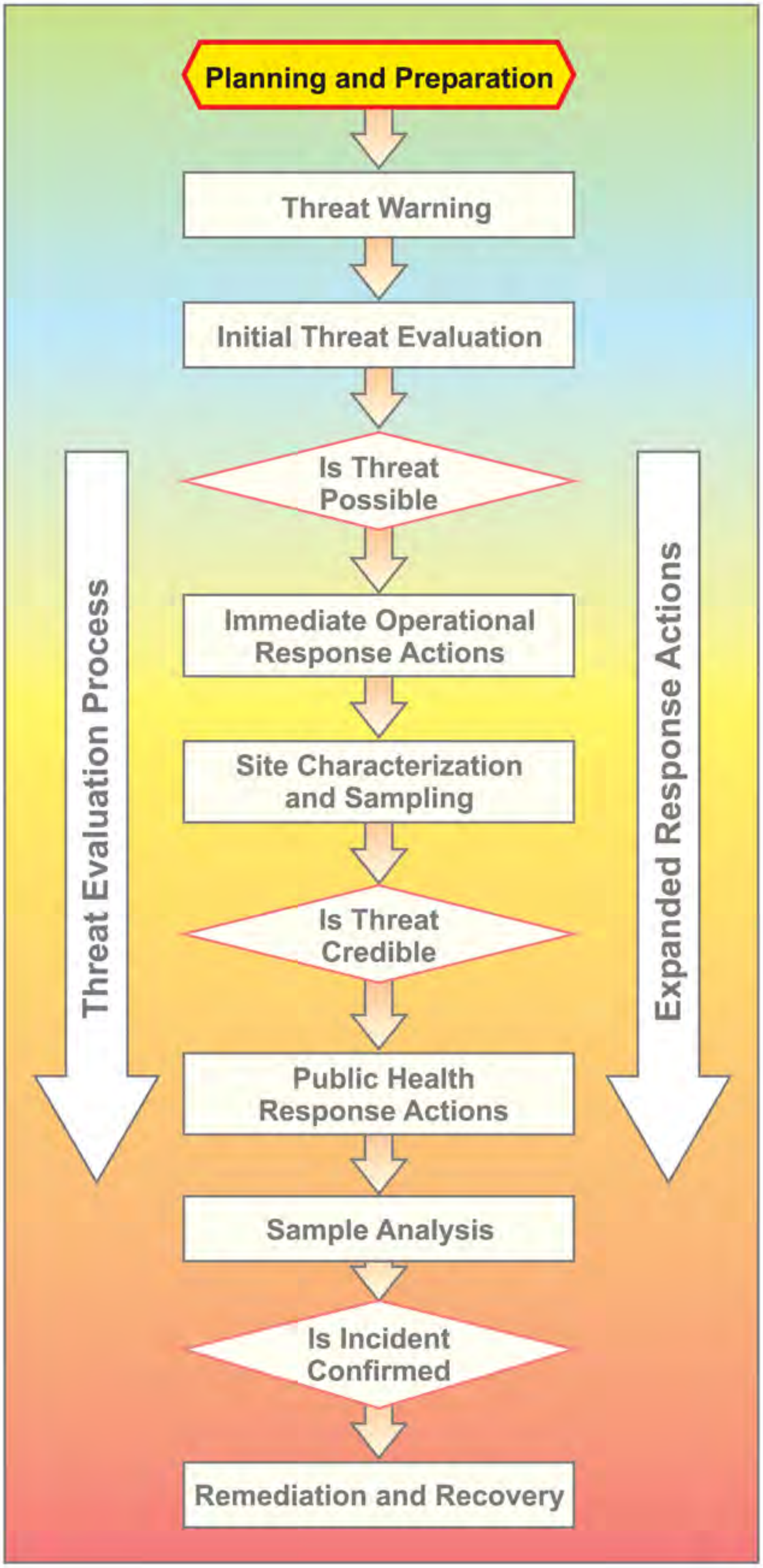
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1 Introduction

Module 1 is an overall guide to utility planning for contamination threats and incidents involving wastewater systems. The module provides a brief discussion of the nature of contamination events and describes the planning activities that a utility may undertake to prepare for a response. All stakeholders involved in planning for or responding to a contamination threat or incident should review this module. This includes utilities, emergency responders, regulators, and health agencies. Modules 2 through 6 provide information that expands on Module 1.

Specific topics covered in Module 1 include:

1. Introduction
2. Contamination threats and incidents
3. Considerations in responding to contamination threats
4. How to prepare for a contamination threat or incident

2 Contamination Threats and Incidents

2.1 Overview of Contamination Threats and Incidents

A wastewater contamination **threat** occurs when the introduction of an atypical contaminant, or abnormal volumes of a more common contaminant, is threatened or suggested by initial evidence. A contamination **incident** occurs when a contaminant has actually been added to a wastewater system. An incident may be preceded by a threat, but not always.

Intentional or accidental contamination threats and incidents are of concern to wastewater utilities due to the range of consequences that may result. These include:

- Injury, illness, or death among utility workers or the public if flammable or explosive substances are involved, or if harmful vapors or aerosols are released.
- Disruption of system operations and interruption of the collection, treatment, and disposal of wastes. This could result, for example, from the introduction of toxic substances that inactivate the microbial community that is an essential component of secondary treatment.
- Physical damage to the wastewater infrastructure. This may be caused by the introduction of flammable or explosive substances into the collection system or treatment plant. There could also be damage to streets, private property, and other utility infrastructure (drinking water, gas, electric, etc.) located near the sewer system.

- Damage to the environment or downstream users of receiving waters such as drinking water treatment systems. This could occur if contaminants were not removed by the wastewater treatment process and passed through the plant.

- Significant costs incurred for decontamination or replacement of portions of the wastewater system. These costs could result from the introduction of long lasting and difficult to remove contaminants such as radionuclides or pathogenic bacterial spores.

- Economic impact on the wastewater utility and the community associated with interruption of sanitary services.

A key question is whether it is **possible** for accidental or intentional contamination of a wastewater system to result in serious consequences. A review of documented incidents indicates that contamination events have caused significant damage in the past. Some of the events documented below were accidental while others were the result of either negligent or malevolent acts. Several major incidents have involved the introduction of **flammable** or **explosive** substances into wastewater systems:

Akron, Ohio 1977. **A deliberate, malevolent** injection of flammable substances resulted in a series of sewer explosions. A police investigation revealed that at least 3,000 gallons of petroleum naptha and isopropyl alcohol had been discharged into the sewer during the night by vandals at a strikebound rubber plant. Officials believe that when the material entered the wastewater collection system it was too rich to ignite, but as it flowed further through the system it became diluted to explosive range and finally ignited 3.5 miles from the point of introduction. Approximately one mile of sewer line was damaged. Remediation costs exceeded $10 million.

Louisville, Kentucky 1981. Around 5AM on February 13, 1981, two women going to work at a hospital drove under an overpass on Hill Street in Louisville. There was a large explosion and their car was hurled into the air and onto its side. At the same time, a police helicopter flying overhead observed a series of explosions erupting along the streets of the city. More than two miles of streets were pockmarked with craters where manholes had been located. Several blocks of Hill Street had fallen into the collapsed 12 foot diameter sewer line (Figure 1-1). Fortunately, no one was seriously hurt, but homes and businesses were extensively damaged and a number of

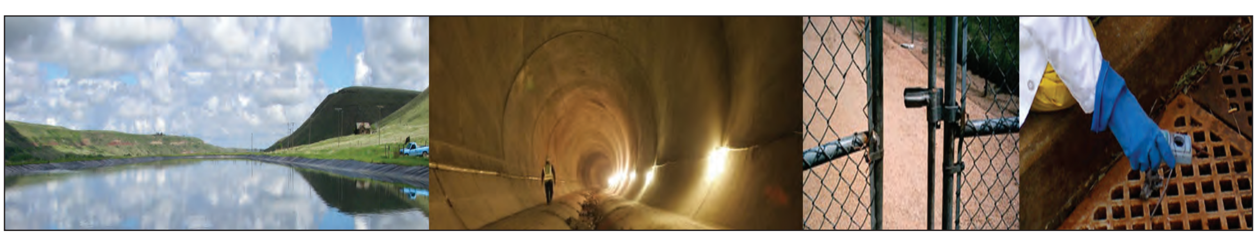

Figure 1-1. Louisville, KY explosion, February 13, 1981. (The Courier-Journal)

people had to be evacuated. The cause of the explosions was traced to a soybean processing plant where thousands of gallons of the flammable solvent hexane had **accidentally** spilled into the sanitary sewer. The fumes were presumably ignited by a spark from the car as it was being driven under the overpass. It required 20 months to repair the sewer lines, and several additional months to complete the street repairs.

Guadalajara, Mexico 1992. There was an especially tragic accident in Guadalajara in April 1992. Nine separate explosions occurred, over a four hour period, in the sewer collection system beneath the city's downtown area. The explosions were caused by gasoline **accidentally** leaking from an underground pipeline into the sanitary sewer. Local residents had complained for several days about a strong gasoline odor wafting up from the sewer drains. Officials could not find the source of the problem, did not order an evacuation, and called off their investigation several hours before the series of explosions began. The explosions killed 206 people, injured 1,460 persons, damaged 1,148 buildings, destroyed 250 businesses and 500 vehicles, left 15,000 people homeless, and forced the evacuation of a total of 25,000 people. Seven miles of sewer pipe were destroyed, some of which was 18 feet in diameter (Figure 1-2). A number of victims were buried alive. Damages exceeded $75 million United States dollars. It was eventually concluded by investigators that the ultimate cause of the explosions was the installation of a drinking water main, several years earlier, which leaked onto the gasoline line lying underneath. The

Figure 1-2. Gasoline-sewer explosion, Guadalajara, Mexico, April 22, 1992.
Reprinted with permission from the Disaster Recovery Journal (Vol 5, #3).

subsequent corrosion of the gasoline pipeline caused leakage of gasoline and allowed vapors to accumulate in the sanitary sewer system.

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Conroe, Texas 1994. The owner of a convenience store/gas station learned that his 8,000 gallon underground storage tank was cracked and ground water was infiltrating the tank. Rather than dispose of the diluted gasoline properly, the business owner rented a small pump and **intentionally discharged** a mixture of approximately 5,000 gallons of gasoline and 500 gallons of water onto the street in front of his store. The gasoline/water mixture entered both the sanitary and storm water collection systems and essentially formed a three-mile long pipe bomb.

Fortunately, there was no explosion. However, several schools were evacuated the next day as a precaution. The gasoline in the storm water collection system flowed into a creek. Utility officials were able to divert the gasoline in the sanitary sewer collection system to a lagoon to protect the wastewater treatment plant. The perpetrator was prosecuted for violation of the Clean Water Act.

Documented incidents have also occurred that involved the introduction of **toxicants** into the wastewater system:

Louisville, Kentucky 1977. Workers at a municipal wastewater treatment plant reported a strong chemical odor that was making them ill. After more than a week of investigation it was determined that the odor was coming from a mixture of hexachloropentadiene and octachlorocyclopentene, two highly toxic chemicals used in the manufacture of pesticides. The mixture had been **intentionally** discharged into a sewer system manhole by a local chemical disposal company improperly dumping industrial waste. The contaminated sewage treatment plant had to be shut down for a three month period during which time 100 million gallons per day of raw sewage was released to the Ohio River.

Philadelphia, Pennsylvania 2006. Employees at a suburban wastewater treatment plant noticed fluctuations in the chlorine levels in the plant's discharge. Shortly thereafter, a fish kill was observed downstream of the plant. It was subsequently determined that a pharmaceutical company had **inadvertently** discharged to the sanitary sewer approximately 25 gallons of potassium thiocyanate. It is believed that the cyanate compound combined with the chlorine used to treat the wastewater plant discharge and formed cyanogen chloride, a chemical highly toxic to fish. The unexplained fish kill forced drinking water officials to temporarily close one of the City of Philadelphia's downstream drinking water plant intakes as a precaution.

In addition to the well publicized cases described above, there are numerous smaller scale incidents that have resulted in contamination of wastewater systems across the United States. For example, many accidental discharges to sanitary or storm water collection systems have occurred as a result of spills from chemical tanker trucks involved in highway accidents and railroad tank cars involved in derailments.

2.2 Malevolent Acts

As illustrated by the deliberate introduction of flammable substances into the Akron, Ohio sewage collection system described above, contaminants may be intentionally added to a wastewater system as part of a malevolent act. The intentional contamination could be carried out by vandals as in the Akron incident. It is also conceivable that domestic or international terrorists could attack a municipal wastewater system to harm people or property.

Possible reasons why terrorists might target a wastewater system include:

- Wastewater systems are a major part of the infrastructure of this country.

- Interference in the collection, treatment, or disposal of sanitary wastes would impact public health, disrupt daily life for the affected populations, result in significant economic losses, and negatively affect the environment.

- Wastewater systems have many components, are spread out geographically, and are therefore difficult to protect.

- Wastewater systems, like drinking water systems, are perceived to be associated with the government.

Although the focus of the WWRPTB is contamination events, it should be noted that wastewater systems, like drinking water systems, are also potentially susceptible to other types of deliberate attacks. These could include physical assaults on facilities or staff, cyber attacks, or the intentional release of hazardous treatment chemicals like chlorine gas.

2.3 Wastewater Systems as an Indirect Target

Wastewater systems also could become the indirect victim of an intentional act aimed at another target in the community. For example, an intentional contamination of the public drinking water supply would almost certainly result in contaminants eventually flowing into the wastewater collection and treatment system. This could occur through normal use of drinking water or remedial flushing of the drinking water system. Similarly, should people or buildings in the community become

contaminated as a result of a chemical, biological, or radiological (CBR) attack, spent wash water used in the decontamination process may find its way into the municipal wastewater collection and treatment system.

Wastewater systems are a major part of the infrastructure of this country.

2.4 Candidate Contaminants

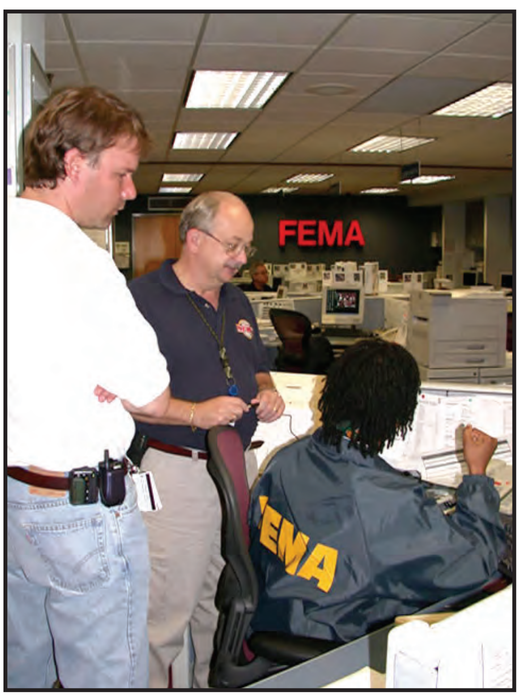
A candidate list of contaminants could include various flammable, explosive, infectious, toxic, and radioactive substances. If injected or released into a sanitary or storm water collection system, these contaminants could cause injury or death to the public or utility workers, damage to the wastewater infrastructure and nearby property within the community, damage to the biological components of the wastewater treatment process, and impacts on downstream water users if the contaminants managed to pass through the wastewater treatment plant.

To support emergency management of wastewater and drinking water contamination threats and incidents, EPA has developed a resource for contaminant-specific information for use by the drinking water and wastewater sectors. The Water Contaminant Information Tool (WCIT) is an Internet database that provides detailed information for potential contaminants on key factors such as contaminant toxicity and infectivity, chemical characteristics, clinical symptoms of exposure, drinking water and wastewater treatability, and decontamination approaches among others. Access to this database is available to utilities, regulators, health agencies, and others by registration with EPA. Information on registration procedures can be obtained at http://www.epa.gov/wcit.

3 Considerations in Responding to Contamination Threats

With the events of 9/11, continued threats against the homeland, and the realization that drinking water and wastewater systems could potentially become the targets of intentional contamination, questions have arisen concerning the role that utilities should play in responding to threats or actual incidents.

One question that could reasonably be raised by wastewater utilities is: **"I'm just a utility – why do I need to do anything at all?"**



Wastewater utilities play an essential role in the safe collection, treatment, and disposal of sanitary wastes, industrial wastes, and storm water. A growing number of utilities are also processing reclaimed water for use in irrigation, cooling, lake or stream augmentation, groundwater recharge, and other non-potable uses. These functions have obvious public health ramifications. Wastewater utilities take their public health responsibilities very seriously. Either accidental or intentional contamination of a wastewater system with flammable, toxic, infectious, or radioactive substances may pose a risk to the health of the community, utility employees, and the environment. Utilities may be subject to legal and regulatory requirements associated with the contamination. Utilities should consider an effective response to a contamination event as being part of their mission.

Presidential Policy Directive 8 is aimed at strengthening the security and resilience of the U.S. against threats that pose the greatest risk to the Nation (e.g., terrorism, catastrophic natural disasters). In the Directive, "response" refers to those capabilities that save lives, protect property and the environment, and meet basic human needs after an incident. The water sector plays an important role in response by providing safe drinking water and wastewater sanitation services.

A second potential question among utilities is: **"What should I be doing to protect against and respond to contamination threats?"**

Specific actions to protect against and respond to a contamination threat are warranted, due to the public health and public safety consequences of wastewater system contamination, and need to be conducted in accordance with applicable legal and regulatory requirements. The wastewater system should work with applicable local, state, and federal agencies and emergency officials to determine the appropriate actions. This document can help a wastewater utility evaluate issues involved in determining the appropriate actions and integrate the relevant information into documents such as utility Emergency Response Plans. Effective planning will assist the wastewater utility to conduct a careful evaluation of any threat and take appropriate response actions based on that evaluation.

4 How to Prepare for a Contamination Threat or Incident

There are a number of steps that utilities can take to prepare for contamination threats. These include:

- **Use the WWRPTB to develop an updated Emergency Response Plan**

  Utilities are encouraged to use the recommendations presented in this document that are appropriate for their local needs. Utilities should feel free to 'cut and paste' protocols, forms, and other information from the Toolbox and customize them for their own response plan. Again, use of the Toolbox is not mandatory.

- **Conduct a Vulnerability Assessment (VA)**

  Under the Public Health and Bioterrorism Preparedness and Response Act of 2002, drinking water utilities serving more than 3,300 persons were required to conduct a formal Vulnerability Assessment. While wastewater utilities were not mandated to conduct VAs, a wastewater system can gain an enhanced perspective on their risks and susceptibilities from this type of effort. A VA can be used to define risks from both intentional and accidental contamination events as well as from natural disasters, accidents, and other intentional acts (e.g., physical attacks, cyber attacks, and intentional release of harmful treatment chemicals such as gaseous chlorine).

  EPA and several wastewater industry organizations have produced vulnerability assessment and consequence analysis tools to assist wastewater systems in conducting their assessments. These tools can be accessed from EPA's Water Security website at http://www.epa.gov/watersecurity.

- **Know your wastewater system**

  A detailed knowledge of the hydraulic and chemical characteristics of the wastewater collection and treatment system will assist utility officials in determining the credibility of suspicions that a contamination event has actually occurred. It will also help utility personnel predict which portions of the wastewater system may be compromised by an event.

  EPA has made available, free of charge, a security hydraulic model (SewerNet) that wastewater utilities can use to predict the transport and fate of contaminants in a wastewater collection system.

- **Include intentional and accidental contamination scenarios in your utility's Emergency Response Plan**

  Even if the risk of a contamination event is not deemed to be particularly high when a utility conducted its VA, the potential consequences of such an incident may be serious enough to warrant contingency planning.

- **Develop utility specific Response Guidelines for intentional contamination**

  Response Guidelines are condensed field guides for responding to specific emergencies. They should be action oriented, easy to use in the field under emergency conditions, and contain all the necessary forms and information. They are composed of written procedures, report forms, templates, and checklists, examples of which can be found in Modules 2 thru 6 of the WWRPTB.

- **Establish a structure for incident command**

  Ideally this structure should be based on the **Incident Command System** (ICS) and the **National Incident Management System** (NIMS). ICS is the system that has been adopted throughout the United States to manage emergencies ranging from natural disasters to terrorist events. NIMS is a nationwide template that enables all government and non-government organizations to work together during an incident requiring the use of ICS. If the ICS structure is already being used as the model for emergency management at the utility level, it will be much easier to coordinate the utility's response with the efforts of outside agencies should a situation expand in

  complexity. Utility personnel can access free, online ICS/NIMS training courses through FEMA at http://training.fema.gov/is/crslist.asp. Also, EPA provides on-line and in-person ICS training targeted to water and wastewater utilities at http://water.epa.gov/infrastructure/watersecurity/emerplan/index.cfm.

- **Develop an information management strategy**

  During a threatened or actual incident, information will be received from multiple sources including those performing site characterization, law enforcement agencies, and health officials. The effectiveness of incident response will be determined, in large part, by how effectively this volume of information is collected, analyzed, and disseminated within the utility, and between the utility and other responding agencies.

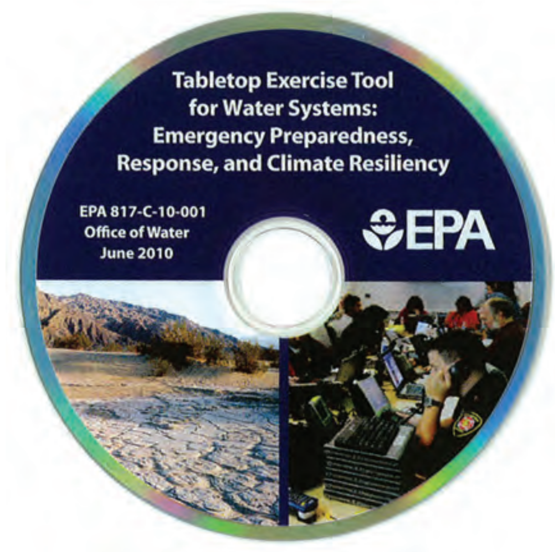
- **Establish a communication and notification strategy**

  This includes timely and accurate notifications of personnel within the wastewater utility, the public, and other organizations such as emergency responders, regulators, health officials, neighboring wastewater utilities, and downstream drinking water plants in accordance with all regulations and requirements.

- **Conduct training**

  A well-written Emergency Response Plan may not be effectively executed if key players are not familiar with their roles and how they are expected to coordinate with other responders (e.g., law enforcement, fire department, and health department). Training should begin with classroom instruction on utility Emergency Response Plans, guidance such as the WWRPTB, and the ICS. It should then progress to tabletop exercises and finally to field exercises so that the utility and outside response agencies can practice their interaction with each other.

  EPA's *Tabletop Exercise Tool for Water Systems: Emergency Preparedness, Response, and Climate Resiliency* (EPA-817-C-10-001, June 2010) allows utilities to conduct their own customized incident response training. The Tool can be obtained from the following website: www.epa.gov/watersecurity.



- **Enhance physical security of the wastewater system**

  While physical protection systems alone cannot guarantee security, enhancement of physical barriers through such measures as fences, intrusion detection systems, and closed-circuit TV surveillance is an important first step in improving the overall security of a wastewater system.

  The Water Infrastructure Security Enhancements (WISE) program has produced a guidance document to assist wastewater utilities in improving their physical security. The document is entitled *Guidelines for the Physical Security of Wastewater/Stormwater Utilities* (December 2006) and is available at: http://www.cdph.ca.gov/certlic/drinkingwater/Documents/Security/WISE-Phase3WastewaterStormwaterUtilityGuidelines.pdf

- **Establish a baseline monitoring program**

  The ability to detect significant excursions from the normal chemical characteristics of wastewater within the collection system and through the various stages of treatment is an important means of determining whether a contamination event has actually occurred. Evaluating the significance of water quality excursions requires comparison with established baseline wastewater chemical data. For example, what is the usual pH range for a utility's wastewater? What are the typical concentrations of various organic compounds in the wastewater (e.g., toluene or benzene)?

- **Use and understand on-line monitoring**

  While current online monitoring capabilities are limited, the technology is improving. Online monitoring of water quality is a means for detecting accidental and intentional contamination events. The resources to purchase, operate, and maintain monitoring systems will be enhanced if the monitoring can be used not only to bolster security, but also to provide multiple benefits such as improving the utility's process control and regulatory compliance.

- **Participate in Mutual Aid Programs**

  Drinking water and wastewater utilities, in conjunction with EPA, state regulatory agencies, and water industry organizations, have developed mutual aid and assistance agreements for almost all 50 states. This initiative, Water and Wastewater Agency Response Networks (WARNs), involves wastewater and drinking water utilities within a state signing a mutual aid agreement pledging to support other utilities during emergencies. Support can involve the sharing of personnel, equipment, and supplies. Additional information on the WARN initiative, including specific information about wastewater utilities in WARN, is available at http://water.epa.gov/infrastructure/watersecurity/index.cfm.

5 Summary

A number of wastewater system contamination events have occurred in this country and elsewhere. Most of these have been accidental but some have occurred intentionally. Several of these have resulted in loss of life, injuries, and significant damage to both wastewater infrastructure as well as private property. These incidents underscore the vulnerability of wastewater systems to accidental or intentional contamination. They also illustrate the potential risk to public safety, public health, private property, and the wastewater infrastructure, as well as the large amounts of time and money needed to repair the damage. Wastewater utilities have a responsibility to prepare for and respond to contamination threats. A number of practical suggestions have been offered in this module for steps that wastewater systems can take to improve their ability to manage contamination incidents. Again, these are only general suggestions that may be tailored to the needs and resources of individual utilities consistent with any applicable laws and regulations.

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