



# **Water Security Initiative: Guidance for Building Laboratory Capabilities to Respond to Drinking Water Contamination**

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## List of Acronyms

AA	Atomic Adsorption
AOAC	AOAC International (formerly the Association of Official Analytical Chemists)
APHL	Association of Public Health Laboratories
ASM	American Society for Microbiology
ASTM	ASTM International (formerly the American Society for Testing and Materials)
BMBL	<i>Biosafety in Microbiological and Biomedical Laboratories</i>
BOA	Basic Ordering Agreement
BSL	Biosafety Level
BT	Bioterrorism
CDC	Centers for Disease Control and Prevention
CETL	Compendium of Environmental Testing Laboratories
CFR	Code of Federal Regulations
CWA	Chemical Warfare Agent
CWS	Contamination Warning System
DHS	Department of Homeland Security
DOD	Department of Defense
ECD	Electron Capture Detector
ELISA	Enzyme-linked Immunosorbent Assay
EMSL	Environmental Monitoring Systems Laboratory
EPA	U.S. Environmental Protection Agency
ERLN	Environmental Response Laboratory Network
ETV	Environmental Technology Verification
EU	Environmental Unit
FDA	U.S. Food and Drug Administration
FERN	Food Emergency Response Network
GA	Tabun
GB	Sarin
GC	Gas Chromatograph or Gas Chromatography
GC-ECD	Gas Chromatography – Electron Capture Detector
GC-FID	Gas Chromatography – Flame Ionization Detector
GC-MS	Gas Chromatography – Mass Spectrometry
GD	Soman
GM	Geiger-Mueller
HHS	U.S. Department of Health and Human Services
HPGe	High-Purity Germanium
HPLC	High Performance Liquid Chromatography
Hach HST	Hach Homeland Security Technologies
ICLN	Integrated Consortium of Laboratory Networks
ICP-AES	Inductively Coupled Plasma – Atomic Emission Spectrometry
ICP-MS	Inductively Coupled Plasma – Mass Spectrometry
ICS	Incident Command System
IMS	Immunomagnetic Separation
LC	Liquid Chromatography
LC-MS-MS	Liquid Chromatography/Tandem Mass Spectrometry
LRN	Laboratory Response Network
LSE	Liquid-solid Extraction
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols
MCEARD	Microbiological and Chemical Exposure Assessment Research Division
MS	Mass Spectrometry
NAHLN	National Animal Health Laboratory Network



NAREL	National Air and Radiation Environmental Laboratory
NEMI	National Environmental Methods Index
NEMI-CBR	National Environmental Methods Index for Chemical, Biological, and Radiological Methods
NERL	National Exposure Research Laboratory
NHSRC	National Homeland Security Research Center
NIMS	National Incident Management System
NPDN	National Plant Diagnostic Network
OEM	Office of Emergency Management
OGWDW	Office of Ground Water and Drinking Water
ORCR	Office of Resource Conservation and Recovery
ORD	Office of Research and Development
OSC	On-Scene Coordinator
OW	Office of Water
PCB	Polychlorinated biphenyls
PCR	Polymerase Chain Reaction
PDA	Photodiode Array
RFQ	Request for Quote
RT-PCR	Reverse Transcription – Polymerase Chain Reaction
RT-qPCR	Real Time -quantitative Polymerase Chain Reaction
QA	Quality Assurance
QC	Quality Control
SAM	<i>Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events or Selected Analytical Methods for Environmental Remediation and Recovery</i> (for revisions after 2011)
SDWA	Safe Drinking Water Act
SM	Standard Methods for the Examination of Water and Wastewater
TETS	Tetramethylenedisulfotetramine
TTEP	Technology Testing and Evaluation Program
USDA	U.S. Department of Agriculture
UV	Ultraviolet
WARN	Water/Wastewater Agency Response Networks
WaterISAC	Water Information Sharing and Analysis Center
WCIT	Water Contaminant Information Tool
WLA	Water Laboratory Alliance
WLA-RP	Water Laboratory Alliance – Response Plan
WS	Water Security (initiative)

## Section 1.0: Introduction

The Water Security (WS) initiative was developed by the U.S. Environmental Protection Agency (EPA) in close partnership with drinking water utilities and other key stakeholders in response to Homeland Security Presidential Directive 9. The WS initiative provides the design basis of a multi-component contamination warning system (CWS) intended to provide timely detection and response to drinking water contamination incidents. More information about the WS initiative, including guidance based on lessons learned from pilot programs, is available on the following Web site:

<http://water.epa.gov/infrastructure/watersecurity/lawsregs/initiative.cfm>.

The primary goal of a utility's sampling and analysis program within a CWS is to ensure that analytical capabilities are ready and accessible for determination of a broad range of chemicals, radiochemicals, pathogens, and biotoxins in possible, credible, and confirmed contamination incidents. By identifying contaminants of concern, analytical methods, and laboratories in advance of a contamination incident, the utility will be able to: 1) practice methods and exercise laboratory partnerships, 2) establish baseline contaminant occurrence and method performance for water samples from the utility's distribution system, and 3) improve the efficiency of utility-led sampling and analysis by developing and practicing procedures specifically for response to possible water contamination.

This document is written for utilities developing a sampling and analysis program as part of a CWS, but may also be useful to utility partners such as public health, state, EPA regional, and commercial laboratories. Guidance is provided regarding identification of representative contaminants from contaminant classes of concern to drinking water security, analytical methods, and potential support laboratories for responding to water contamination. It is not the intention of this document to present information on methods typically performed in the field; however, some methods presented in this document may be field-deployable.

This document provides an overview of the role of sampling and analysis in a CWS, provides a framework for building laboratory capabilities for response to water contamination, presents contaminant classes of concern to water security, lists methods for a representative number of contaminants from those classes and provides information on the role of national laboratory networks in responding to drinking water contamination events. These topics are described in the following sections:

- **Section 2.0: Sampling and Analysis in a Contamination Warning System.** This section describes the role of sampling and analysis in a CWS with emphasis on the role of sampling and analysis in consequence management and planning.
- **Section 3.0: Building Laboratory Response Capabilities.** This section describes the process that a utility follows to build laboratory capabilities for incident response sampling and analysis.
- **Section 4.0: Analytical Approach.** This section describes contaminant classes of concern to water security around which utilities should build their capabilities and discusses various organizations' efforts to identify representative contaminants of concern to water security to promote the development of response capabilities.
- **Section 5.0: Methods for Contaminants of Concern to Water Security.** This section contains examples of representative contaminants from the contaminant classes of concern to water security and corresponding methods for detection and, in most cases, confirmation. The objective of this section is to be informational and to illustrate the use of available resources for identification of analytical methods.
- **Section 6.0: Building Laboratory Support Networks.** This section describes federal level emergency response laboratory networks and explains their role in responding to water system contamination incidents. This section also discusses important considerations for utilities when selecting laboratory partners and presents three examples of utility laboratory networks as designed for a CWS.

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- **Section 7.0: Reimbursement of Analytical Costs Incurred During Emergency Response.** This section describes the conditions that are necessary to receive federal reimbursement for costs associated with analysis of water samples in a water contamination emergency.
- **Section 8.0: References.** This section lists references cited in the document *Water Security Initiative: Guidance for Building Laboratory Capabilities to Respond to Drinking Water Contamination*.
- **Section 9.0: Summary of Resources.** This section lists resources for laboratory methods, field screening methods, and general laboratory guidance.

## Section 2.0: Sampling and Analysis in a Contamination Warning System

Sampling and analysis in a CWS is not performed at a frequency to provide early detection of contamination. The purpose of routine sampling and analysis is to establish baseline contaminant occurrence and method performance for water throughout the distribution system, and to maintain analyst proficiency and instrument capabilities for incident response. The most important role of sampling and analysis in a CWS is in consequence management where it is among the first utility-led responses to possible contamination. Sample collection and analysis in response to validated CWS component alerts is part of the credibility determination process in the consequence management process, and may involve specific analyses, based on information available from other CWS components or simultaneous analyses for a broad range of contaminants and contaminant classes to rule-out, or confirm, as many contaminants as possible in a short period of time.

By understanding the role of sampling and analysis throughout consequence management, utilities can better plan what analytical capabilities they will use, and when. For example, a utility may elect to use an in-house suite of methods providing broad contaminant coverage in the early phases of investigation when contamination has not been confirmed, but choose to use partner laboratories during the remediation and recovery phases of confirmed contamination when the sample load might exceed in-house capacity. Or a utility may choose to utilize a specific laboratory partner and method for confirmation of a suspected contaminant or for highly specialized analyses such as for chemical warfare agents (CWAs) or select pathogens. The remainder of this section briefly describes the role of sampling and analysis in consequence management during possible, credible, and confirmed contamination incidents.

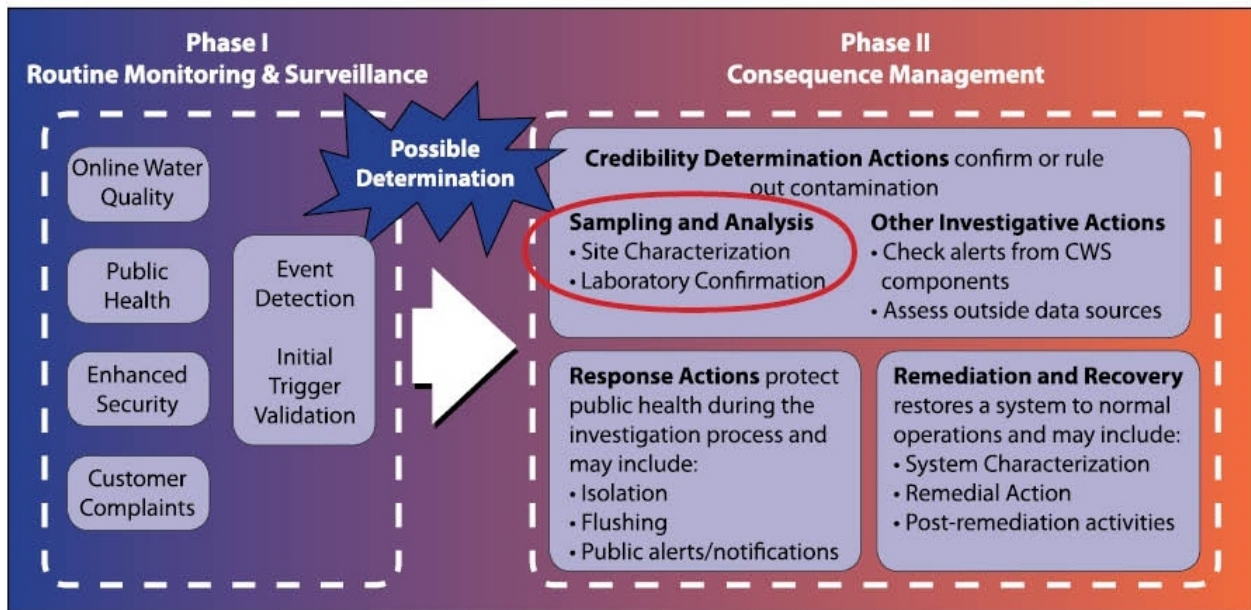


Figure 2-1. WS Initiative CWS System Architecture

Based on EPA’s WS initiative CWS system architecture (**Figure 2-1**), water contamination is characterized as *possible* if the cause of routine monitoring and surveillance component alert cannot be identified and/or determined to be benign. For example, if multiple customer complaints regarding illness and off-tasting, discolored water are verified to be real, but no known cause has yet to be found, then a *possible* contamination incident is in progress. Once a possible contamination incident has been identified, a utility’s consequence management plan is activated, which defines a process for establishing the credibility of the suspected incident, the response actions that the utility will take to minimize public

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health and economic consequences, and a strategy to ultimately restore the system to normal operations. Utilities need to consider in advance their desired response capabilities when a possible contamination incident has been identified since, at this stage of the investigation, the identity of the contaminant will likely be unknown.

In the context of the credibility determination process, water contamination is characterized as *credible* if information collected during the investigation of possible contamination corroborates information from the validated CWS alert even though the exact contaminant may not have been identified and/or quantified. Information collected from initial response actions (such as site characterization and laboratory analysis and/or additional information from monitoring and surveillance) will be considered before additional response actions are implemented. Information provided by other CWS components or evidence discovered during the investigation may help focus the analytical investigation to confirm a specific suspected contaminant. Water contamination is characterized as *analytically* confirmed when the analysis of water samples has provided conclusive evidence of the presence of a specific contaminant at a level that could cause public health risk.

Upon *confirmation* of water contamination, the utility will shift to remediation and recovery activities. The goal of this process is to return the water supply system to service as quickly as possible. During remediation, a utility's sampling and analysis program will likely provide support to determine the extent of contamination. This process would involve analysis of water samples for a known contaminant using select methods as recommended by EPA and multiple laboratories to meet the required analytical capacity. It will be critical in this stage to demonstrate that the contamination has been remediated and that the water is safe for essential services and consumption. Furthermore, analytical support may be needed during decontamination of utility infrastructure to confirm contaminant removal. Overall, sampling and analysis plays an instrumental role throughout the investigation of a possible contamination incident (i.e., the credibility determination process), and during remediation and recovery once water contamination has been confirmed.

Additional information on the possible, credible, and confirmed stages of a contamination incident can be found in EPA's *Water Security Initiative: Interim Guidance on Developing Consequence Management Plans for Drinking Water Utilities* (USEPA, 2008a).

## Section 3.0: Building Laboratory Response Capabilities

A laboratory support network is the foundation of an effective and sustainable sampling and analysis program for utilities with CWSs. The contaminants for which a utility builds capabilities, either in-house or through partnerships, for responding to *possible* contamination should represent a broad range of chemicals, radiochemicals, pathogens, and biotoxins; however, it is not expected that a utility’s laboratory or traditional laboratory partners will be able to perform analyses for all contaminants under all threat scenarios. To the extent possible, utilities should identify contaminants and scenarios for which they know they will require analytical support and identify appropriate laboratories and emergency response partners. For example, chemical warfare and bioterrorism agents require specialized methods and laboratories. Knowing this in advance provides the utility with the opportunity to identify those partner laboratories and determine how they would most efficiently access those laboratories in an emergency. Identifying these partners in advance also enables the utility to learn of any special sample collection, packaging and/or shipping requirements. There also may be scenarios under which the utility cannot provide analytical coverage (i.e., after normal business hours, vacations, holidays), or provide rapid turn-around of analytical results, or the utility laboratory may not be able to handle a large number of samples. Planning for a wide range of such scenarios is the key to building successful emergency response capabilities. **Figure 3-1** illustrates a general approach utilities can follow to build laboratory capabilities for response to contaminants of concern to water security.

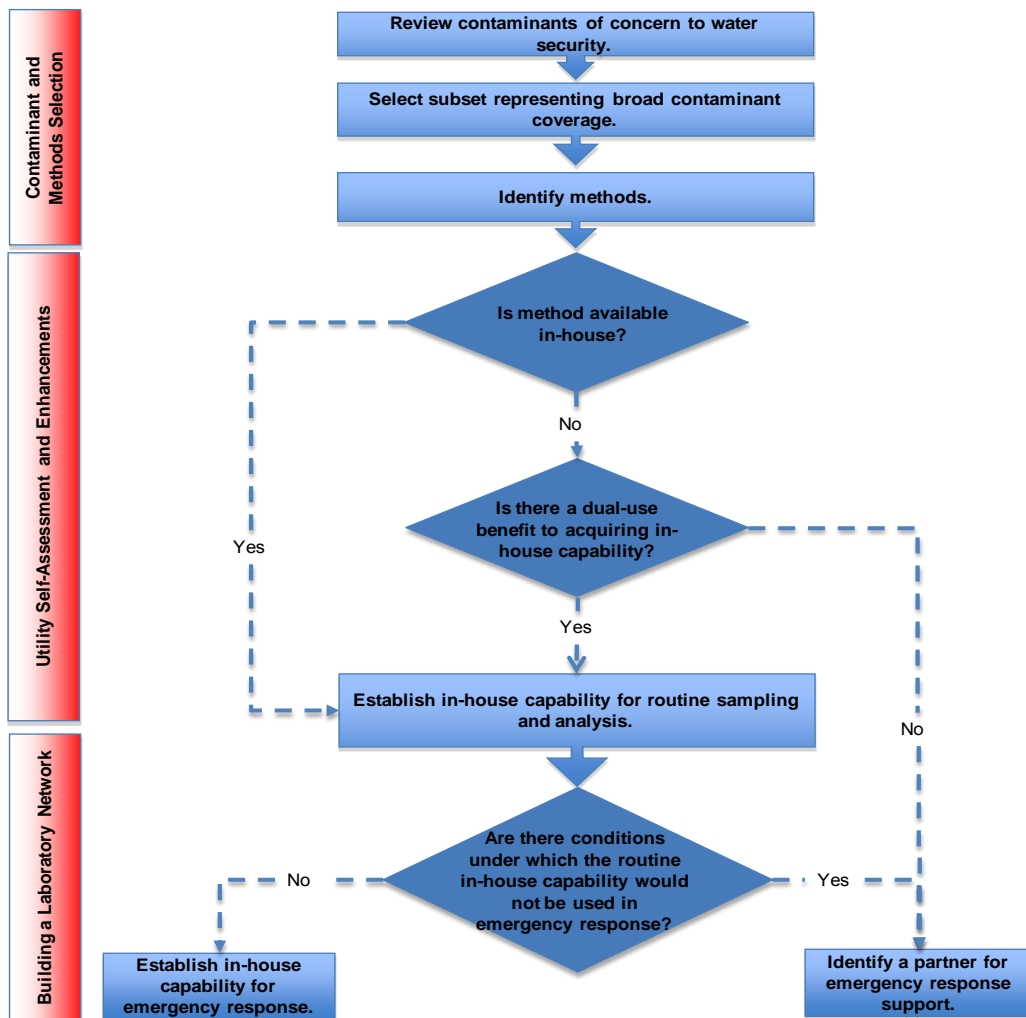


Figure 3-1. Process Flow for Building Laboratory Response Capabilities

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The first steps involve the identification of representative contaminants from a wide range of contaminant classes of concern to water security and corresponding analytical methods. Analytical method capabilities can then be built in-house or through partnerships. A utility would first assess their existing in-house and traditional drinking water partner capabilities to determine if they could be used to detect representative contaminants of concern during incident response sampling and analysis. If the utility does not have an existing capability, then adoption of new methods can be considered. If there are dual-use benefits to the utility in implementing new laboratory methods, then it may be advantageous to build that capability in-house for emergency response analysis. In other cases it may be preferable to identify an emergency response laboratory partner.

The remainder of this document expands on the topics of 1) selection of representative contaminants from contaminant classes of concern to water security, 2) selection of methods, and 3) building laboratory partnerships. The internal process of self-assessment of the utility's existing sampling and analysis program is not discussed in detail in this document although considerations for developing emergency response laboratory capabilities are discussed in Section 6.

## Section 4.0: Analytical Approach

### 4.1 Contaminants of Concern to Drinking Water Security

There are a large number of contaminants that could cause serious harm if introduced into a drinking water distribution system, whether intentionally or accidentally. In most instances, utilities are prepared to respond to regulated contaminants and may have even adopted more esoteric capabilities to address contaminants of local or regional concern. However, utilities may be less cognizant of, or prepared to respond to, contaminants of concern from a terrorist threat perspective.

Utilities designing a CWS or desiring to enhance their water security practices should consider non-traditional as well as traditional contaminants as the starting point for development of a sampling and analysis program for water security. Utilities should identify the in-house resources they currently have to respond to a broad range of contaminants, identify gaps and, either enhance their own in-house capabilities, or identify partner laboratories that can analyze samples in an emergency. This advance planning will enable utilities to practice emergency response procedures internally and with partners as well as help in the establishment of baseline contaminant occurrence and method performance for more meaningful interpretation of results during incident response sampling and analysis.

**Table 4-1** contains a representative number of contaminants from contaminant classes of concern that can serve as a basis for development of a sampling and analysis program for water security. The representative contaminants contained in Table 4-1 illustrate the full range of contaminant classes of concern. Representative contaminants within each contaminant class can be considered for building laboratory capabilities in-house or through laboratory partnerships. In Section 5 of this document, methods have been identified for a sub-set of the contaminants in Table 4-1 to illustrate how available resources can be used to identify methods for contaminants of concern to water security. Note that other sets of representative contaminants could form the basis for the design of a sampling and analysis program for water security, as long as it includes representative contaminants from all the contaminant classes of concern.



**Table 4-1. Representative Contaminants for Building a Sampling and Analysis Program for Drinking Water Security**

<b>PATHOGENS</b>		
<b>Bacteria</b>		
<i>Bacillus anthracis</i> <i>Brucella spp.</i> <i>Burkholderia spp.</i> <i>Clostridium perfringens</i>	<i>Escherichia coli</i> O157:H7 <i>Francisella tularensis</i> <i>Leptospira interrogans</i> <i>Listeria monocytogenes</i> <i>Salmonella Typhi</i>	<i>Shigella spp.</i> <i>Staphylococcus aureus</i> <i>Vibrio cholerae</i> O1 <i>Yersinia pestis</i>
<b>Viruses</b>		
Caliciviruses	Enteroviruses	
<b>Rickettsia</b>	<b>Protozoa</b>	
<i>Coxiella burnetii</i> <i>Chlamydophila psittaci</i>	<i>Cryptosporidium parvum</i>	
<b>BIOTOXINS</b>		
<b>Plant Toxins</b>	<b>Bacterial Toxins</b>	<b>Fungal Toxins</b>
Abrin Alpha amanitin Picrotoxin Ricin	Botulinum toxins	Aflatoxin T2 mycotoxin
	<b>Algal Toxins</b>	<b>Animal Toxins</b>
	Brevetoxins Microcystins Saxitoxin	Tetrodotoxin
<b>CHEMICALS</b>		
<b>Carbamate Pesticides</b>	<b>Herbicides</b>	<b>Mercury Compounds</b>
Aldicarb Carbofuran Methomyl Oxamyl	Paraquat	Mercuric chloride Methoxyethylmercuric acetate
	<b>Fluorinated Organic Compounds</b>	<b>Arsenic (III) Compounds</b>
	Sodium fluoroacetate	Sodium arsenite
<b>Organophosphate Pesticides</b>	<b>Chemical Warfare Agents</b>	<b>Heavy Metal Compounds</b>
Dichlorvos Dicrotophos Fenamiphos Mevinphos Phorate Tetraethyl pyrophosphate (TEPP)	Sarin (GB) Soman (GD) Tabun (GA) VX	Lead Thallium
	<b>Pharmaceuticals</b>	<b>Persistent Chlorinated Organics</b>
	Colchicine Digoxin Nicotine sulfate	Polychlorinated biphenyls (PCBs)
<b>Rodenticides</b>	<b>Cyanide Compounds</b>	<b>Petroleum Products</b>
Bromadiolone Crimidine Strychnine Tetramethylenedisulfotetramine (TETS)	Cyanide salts (sodium & potassium) Cyanogen chloride	Gasoline range organics Volatile organic compounds (VOCs) Diesel range organics
<b>RADIONUCLIDES</b>		
<b>Alpha Emitters</b>	<b>Beta Emitters</b>	<b>Beta + Gamma Emitters</b>
Americium-241 Uranium-238	Strontium-90 Technetium-99	Cesium-137 Cobalt-60 Iridium-192

EPA continues to identify, develop, and validate screening and confirmatory methods for non-traditional contaminants that are of concern to drinking water security. As these methods become available they will be posted by EPA in the latest revision of *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM)*<sup>1</sup>. Analytical methods which can be used to detect representative contaminants from the contaminant classes in Table 4-1 are discussed in Sections 5.3 through 5.6, although utilities may select different contaminants from the broad contaminant classes in Table 4.1 when designing their own sampling and analysis program.

<sup>1</sup> Beginning with SAM 2012, the title will be revised to *Selected Analytical Methods (SAM) for Environmental Remediation and Recovery*. Current and archived versions of SAM can be accessed at: <http://www.epa.gov/sam/>

## **4.2 Additional Research for Contaminants of Concern to Drinking Water Security**

Other federal agencies and organizations have identified contaminants of concern to water/wastewater security. The Water Research Foundation (formerly AwwaRF), and the Water Environment Research Foundation have identified chemicals, toxins, and biological contaminants that could be introduced intentionally into a drinking water distribution system using criteria similar to the EPA's. Many of the lethal contaminants identified are the same as those identified by the EPA; however, low-toxicity contaminants such as geosmin, ammonia, dimethylsulfide, naphthalene, and trimethylamine are also included (AwwaRF and Kiwa, N.V., 2006). The Water Environment Research Foundation supported a research effort to develop a prioritization framework for contaminants that may be intentionally or accidentally introduced into a wastewater collection and treatment system (WERF, 2010). The list of contaminants developed as a part of their research project included a total of 147 chemical, radiochemical, and biological threat agents, which were ranked in four categories including: 1) worker/public health exposure, 2) process upset to a wastewater system, 3) physical damage and destruction, and 4) how quickly they would be expected to pass through a wastewater system. Many of the contaminants are included in EPA's Water Contaminant Information Tool (WCIT).

And finally, commercial vendors of online water quality monitors have developed contaminant lists based on contaminant profiles generated by different contaminant classes (Kroll, 2008). Such contaminant lists may be useful to review when building laboratory capabilities to complement on-line water quality monitoring.

## Section 5.0: Selecting Methods to Build a Sampling and Analysis Program for Drinking Water Security

### 5.1 Method Resources

This section provides information on analytical methods for a representative sub-set of contaminants of concern to water security as described in Section 4. While any comprehensive or partial listing of potential threat agents provides a useful and informative reference, it is not feasible for a utility to build analytical capabilities for *all* potential threat agents, either in-house or through laboratory partnerships. Instead, utilities should identify a sub-set of contaminants from the contaminant classes of concern to water security from Table 4.1 and/or other contaminants of concern to water security that represent broad contaminant coverage and build analytical capabilities for those contaminants either in-house or through laboratory partnerships. Although not discussed in this document, field deployable methods can also be considered.

There are a number of resources that have been developed under homeland security directives to help utilities plan for and respond to water contamination incidents. A brief description of those resources applicable to identifying analytical methods is provided below:

- **Water Contaminant Information Tool (WCIT).** WCIT is a password-protected on-line database with information for 805 contaminants of concern that could pose a serious threat if introduced into drinking water and/or wastewater. More than 100 contaminants have full WCIT profiles (including analytical methods if available). More than 700 contaminants only have analytical methods, names and synonyms. This tool provides drinking water-specific data compiled in one convenient location that can be accessed for planning and response to drinking water contamination incidents. By accessing WCIT, users may also use the National Environmental Methods Index for Chemical, Biological, and Radiological Methods (NEMI-CBR), a web-based tool designed to assist users in searching and displaying methods be used in emergency use (<http://water.epa.gov/scitech/datait/databases/wcit/index.cfm/>).
- **Selected Analytical Methods (SAM) for Environmental Remediation and Recovery.** SAM is a collection of environmental methods intended to support environmental remediation efforts following a homeland security-related contamination event. SAM provides information regarding current analytical methods for possible use in detecting and quantifying target analytes in support of remediation activities. SAM addresses chemical, radiochemical and biological (pathogen and biotoxin) contaminants in a variety of environmental matrices, including drinking water (<http://www.epa.gov/sam/>).
- **Water Information Sharing and Analysis Center (WaterISAC).** WaterISAC is a highly secure subscription-based information service that maintains databases of chemical, biological, and radiochemical agents and provides access to sensitive information regarding physical, contamination, and cyber threats to the Water Sector (<https://portal.waterisac.org/web/>).
- **National Environmental Methods Index (NEMI).** NEMI is an on-line database of analytical methods for water and other environmental matrices developed jointly by EPA and the U.S. Geological Survey. NEMI allows users to search and compare the performance and relative cost of regulatory and non-regulatory environmental monitoring methods (<http://www.nemi.gov/>).

*Methods listed in SAM may not have been validated for the contaminant/matrix of interest. Users should verify the status of recommended methods for the contaminant of interest in the drinking water matrix.*

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- **Standard Methods for the Examination of Water and Wastewater (SM).** SM is a subscription-based compendium of chemical and microbiological methods for the analysis of water and wastewater published by the American Public Health Association, the American Water Works Association and the Water Environment Federation. Many Standard Methods are also approved for Safe Drinking Water Act (SDWA) regulatory compliance monitoring ([www.standardmethods.org](http://www.standardmethods.org)).
- **American Society for Testing and Materials (ASTM).** ASTM is a not-for-profit organization that develops and provides voluntary consensus standards, related technical information, and services having internationally recognized quality and applicability. ASTM publishes numerous test methods and standards pertaining to the analysis of water including chemical and microbiological methods. Of particular interest to water utilities and laboratories are the current (2011) ASTM Volumes 11.01 and 11.02 (Water I and Water II, respectively). These test methods can be obtained through subscription (<http://www.astm.org/>).

EPA offices and laboratories that develop and publish methods for contaminants of concern to water security, regulated contaminants, and emerging contaminants of concern are:

- Office of Water (OW), <http://water.epa.gov/>
- Office of Research and Development (ORD), <http://www.epa.gov/ord/>
- Office of Resource Conservation and Recovery (ORCR), <http://www.epa.gov/epawaste/hazard/testmethods/mice.htm>
- National Exposure Research Laboratory (NERL), <http://www.epa.gov/nerlcwww/ordmeth.htm>
- National Air and Radiation Environmental Laboratory (NAREL) <http://www.epa.gov/narel/>

The CDC also develops methods for their Laboratory Response Network (LRN) laboratories (<http://www.bt.cdc.gov/lrn/>). State LRN laboratories can coordinate for utilities' emergency analyses for select and some non-select pathogens and toxins.

Sections 5.3 – 5.6 present possible methods for detection of representative chemical, radiochemical, pathogen, and biotoxin contaminants of concern to water security. Most methods were identified using resources that have been described above; however, for uncommon drinking water contaminants, possible literature methods were identified. These methods can be adapted, validated, and used in the utility's or partner's laboratory until which time there is a validated consensus method available.

Literature methods mentioned in this document do not constitute an endorsement for use. Some are listed to highlight the fact that more advanced utilities and their laboratory partners are free to develop or evaluate literature methods for contaminants that are not regulated in drinking water or where there is no consensus method. Utilities should give advance consideration to the interpretation of results from such methods during consequence management of possible water contamination incidents.

## 5.2 Method Definitions

The following definitions are provided to clarify terms used in Tables 5-1 through 5-4. In most cases the terms are consistent with those used in SAM except for specific instances when it was believed greater clarification was necessary.

### **Chemical Contaminants**

- **Possible Method.** A written procedure for the detection and/or confirmation of a specific contaminant.
- **Determinative Technique.** An analytical instrument or technique used for qualitative and confirmatory determination of compounds or components in a sample. The determinative step is performed after any required sample preparation methods.
- **Recommended Confirmatory Method.** A written validated analytical method that provides qualitative and quantitative results for a specific contaminant using a determinative technique. Confirmatory methods produce quantitative contaminant data of known quality. For chemical contaminants the recommended confirmatory method is one for which there is published single or multi-laboratory data for the contaminant of interest in a drinking water matrix. For contaminants that are also regulated under the SDWA, the listed recommended confirmatory methods are those approved for regulatory compliance monitoring.

### **Radiochemical Contaminants**

- **Possible Method.** A written procedure for the detection and/or confirmation of a specific contaminant.
- **Determinative Technique.** An analytical instrument or technique used for qualitative and confirmatory determination of compounds or components in a sample. The determinative step is performed after any required sample preparation methods.
- **Recommended Confirmatory Method.** A method for measurement of the activity from a particular radioisotope per unit of mass, volume, or area sampled. Confirmatory methods produce quantitative contaminant data of known quality. For contaminants that are also regulated under the SDWA, the listed recommended confirmatory methods are those approved for regulatory compliance monitoring.

### **Pathogen and Biotxin Contaminants**

- **Screening Methodology.** An analytical methodology that may identify a contaminant, but does not provide a high level of confidence that a specific contaminant is present. The methodology may be offered by a number of vendors using their instrumentation, reagents, assays, etc. By their nature, screening methodologies are best used to inform the choice of subsequent analysis to confirm the presence or absence of a contaminant. Screening methodologies are typically used in situations that require a large number of samples to be processed. Screening (or presumptive) assays generally include real-time polymerase chain reaction (PCR) or immunoassays.
- **Confirmatory Methodology.** A methodology that confirms, with high confidence, the presence of a contaminant or suggests conclusively that it is absent. The methodology may be offered by a number of vendors using their instrumentation, reagents, assays, etc. Confirmatory methods are generally more time consuming and expensive when compared to screening methods. Confirmatory methods may include time-resolved fluorescence, molecular characterization, or culture-based methods with biochemical/serological confirmation.

Some small molecular weight biotoxins may be determined using a chemical methodology such as liquid chromatography-mass spectrometry and may more appropriately use the method definitions of the chemical contaminants. Other large molecular weight biotoxins may be more appropriately associated with pathogen methods for sample preparation and analyses.

### 5.3 Chemical Contaminants and Analytical Methods

The representative sub-set of chemical contaminants included in this section includes arsenic compounds, carbamate pesticides, CWA degradation products, cyanide compounds, fluorinated organic compounds, heavy metals, herbicides, mercury compounds, organophosphate pesticides, persistent chlorinated organics, petroleum products, pharmaceuticals, and rodenticides. **Table 5-1** includes example chemical contaminants in each of these categories, available methods, instrumentation, sources where additional method information can be located, and special considerations that utilities may find helpful in identifying analytical methods. It should be noted that the methods listed in this table are not intended to be a comprehensive listing of all potential methods but have been selected based on applicability to drinking water. Some of the chemical contaminants included in this table can be analyzed by commonly available drinking water methods routinely used for compliance monitoring. Instrumentation, methods, and standards for CWA degradation/hydrolysis products are commonly available so that a utility could screen samples for CWAs either in-house or through a partner laboratory and seek confirmation of the parent CWA if one of its degradation/hydrolysis products is detected.

Many of the methods listed in Table 5-1 are those recommended in SAM Version 6.0 for laboratories tasked with performing analyses on environmental samples in support of EPA restoration efforts following a homeland security incident (refer to the latest version of SAM for more up-to-date information), (USEPA, 2010a). In some cases SAM-referenced methods are the same methods that would be recommended to screen for or confirm contaminants in possible contamination incidents. Methods may require both sample preparation and analysis procedures, while others contain sample prep and analysis within one method. Other method sources include ASTM, Standard Methods, CDC, Food Emergency Response Network (FERN), etc., as well as the published literature. It is EPA's goal to develop single-laboratory validation data for contaminant/matrix combinations that may be lacking. As this is accomplished, updates should be available in the future at <http://www.epa.gov/nhsrc/pubs.html>. This EPA website also contains a feature that enables users to automatically be notified of developments on certain topics (<http://www.epa.gov/nhsrc/hm/distlist.html>).

Several of the methods described in Table 5-1 are mass spectrometry (MS) methods. These methods have the potential to tentatively identify compounds (e.g. through the use of a mass spectral library). Reporting of tentative identification is more important during incident response analysis than in routine compliance monitoring analysis, and the utility should modify standard procedures for incident response analysis to ensure the laboratory report stresses the tentative nature of the identification, along with any qualifying statements the laboratory can provide regarding the nature of the tentative identification. Tentative identification of unexpected compounds during incident response analysis may lead the utility to seek confirmation using either the same method via the use of appropriate standards or another confirmatory approach.

*Note: EPA has not evaluated literature or vendor methods contained in Table 5-1 and their mention does not constitute an endorsement or recommendation for use.*

*Confirmation of CWAs should be performed by an approved Environmental Response Laboratory Network (ERLN) laboratory or a qualified commercial laboratory. Screening for CWAs through analyses of CWA degradation/hydrolysis products, however, can be performed by utilities or commercial laboratories with appropriate instrumentation and standards.*

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**Table 5-1. Representative Chemicals and Methods**

Contaminant	Possible Methods	Instrumentation	Method Source <sup>(1)</sup>	Special Considerations	Recommended Confirmatory Method(s) <sup>(2)</sup>
<b>Arsenic (III) Compounds</b>					
Sodium arsenite (as total arsenic) <sup>(3)</sup>	EPA 200.5	ICP-AES	EPA NERL	<sup>(4)</sup>	EPA 200.5 EPA 200.8 EPA 200.9
	EPA 200.8	ICP-MS	EPA NERL	<sup>(4)</sup>	
	EPA 200.9	Atomic Adsorption (AA)- Graphite Furnace	EPA NERL	<sup>(4)</sup>	
	ASTM D2972 B	AA-Hydride	ASTM	<sup>(4)</sup>	
<b>Carbamate Pesticides</b>					
Aldicarb <sup>(3)</sup>	EPA 531.1 EPA 531.2	Liquid Chromatography (LC) – post column derivatization and fluorescence detection	EPA NERL EPA OW	<sup>(4)</sup>	EPA 531.1 EPA 531.2
	EPA 538	LC-MS-MS	EPA NERL	EPA 538 and ASTM D7645-10 contain data for drinking water, but are not approved for SDWA monitoring.	
	ASTM D7645-10		ASTM EPA Region 5		
Carbofuran <sup>(3)</sup> Oxamyl <sup>(3)</sup> Methomyl	EPA 531.1 EPA 531.2	LC – post column derivatization and fluorescence detection	EPA NERL EPA OW	<sup>(4)</sup>	EPA 531.1 EPA 531.2
	ASTM D7645-10	LC-MS-MS	ASTM EPA Region 5	<sup>(4)</sup>	
<b>CWA Degradation Products</b>					
<b>VX Degradation Products</b>					
Ethyl methylphosphonic acid	ASTM D7597-09	LC-MS-MS	ASTM EPA Region 5	Laboratories should evaluate the method for their drinking water matrix.	-
Methyl phosphonic acid					
<b>GA Degradation Product</b>					
Ethyl hydrogen dimethylamidophosphate	ASTM D7597-09	LC-MS-MS	ASTM EPA Region 5	Laboratories should evaluate the method for their drinking water matrix.	-
<b>GD Degradation Products</b>					
Pinacolyl methylphosphonic acid	ASTM D7597-09	LC-MS-MS	ASTM EPA Region 5	Laboratories should evaluate the method for their drinking water matrix.	-
Methyl phosphonic acid					

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Contaminant	Possible Methods	Instrumentation	Method Source <sup>(1)</sup>	Special Considerations	Recommended Confirmatory Method(s) <sup>(2)</sup>
<b>GB Degradation Products</b>					
Isopropyl methyl-phosphonic acid	ASTM D7597-09	LC-MS-MS	ASTM EPA Region 5	Laboratories should evaluate the method for their drinking water matrix.	-
Methyl phosphonic acid					
Diisopropyl methyl-phosphonate	EPA 538	LC-MS-MS	EPA NERL EPA OW	<sup>(4)</sup>	EPA 538
	ASTM D7597-09	LC-MS-MS	ASTM EPA Region 5	Laboratories should evaluate the method for their drinking water matrix.	
<b>Cyanide Compounds</b>					
Cyanide <sup>(3)</sup>	EPA 335.4 (total cyanide)	Distillation – Spectrophotometry (Automated)	EPA NERL	EPA 335.4 contains data for reagent water only, but is approved at 40 CFR 141 for drinking water monitoring.	EPA 335.4 ASTM 6888-04
	ASTM D6888-04 (free and available cyanide)	Flow injection analysis/gas diffusion with amperometric detection	ASTM	Laboratories should evaluate the method for their drinking water matrix.	
Cyanogen chloride	EPA 524.2	GC-MS	EPA NERL	Cyanogen chloride standards are not commercially available and must be synthesized. Possible methods can be used for screening in absence of standards.	-
	ASTM D4165-06	Ultraviolet (UV) spectrophotometry	ASTM		
<b>Fluorinated Organic Compounds</b>					
Fluoroacetate salts (analyzed as fluoroacetate ion)	Direct Determination of Fluoroacetate in Water by IC-MS (Dionex Application Note 276)	IC-MS	Dionex Corporation App Note No. 276 <sup>(3)</sup>	<sup>(4)</sup>	Dionex Application Note
<b>Heavy Metals</b>					
Lead <sup>(3)</sup>	EPA 200.5	ICP-AES	EPA NERL	<sup>(4)</sup>	EPA 200.5 EPA 200.8 EPA 200.9
	EPA 200.8	ICP-MS	EPA NERL	<sup>(4)</sup>	
	EPA 200.9	AA-Graphite Furnace	EPA NERL	<sup>(4)</sup>	
Thallium <sup>(3)</sup>	EPA 200.7	ICP-AES	EPA NERL	EPA 200.7 contains drinking water data, but is not approved at 40 CFR 141 for drinking water monitoring.	EPA 200.8 EPA 200.9
	EPA 200.8	ICP-MS	EPA NERL	<sup>(4)</sup>	
	EPA 200.9	AA-Platform	EPA NERL	<sup>(4)</sup>	
<b>Herbicides</b>					
Paraquat	EPA 549.2	LC-UV	EPA NERL	<sup>(4)</sup>	EPA 549.2



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Contaminant	Possible Methods	Instrumentation	Method Source <sup>(1)</sup>	Special Considerations	Recommended Confirmatory Method(s) <sup>(2)</sup>
<b>Mercury Compounds</b>					
Mercuric chloride (as total mercury) <sup>(3)</sup>	EPA 200.8	ICP-MS	EPA NERL	<sup>(4)</sup>	EPA 200.8 EPA 245.1 EPA 245.2
	EPA 245.1	CVAS (Manual)	EPA NERL	Method 245.1 contains data for river and natural waters only, but is approved at 40 CFR 141 for drinking water monitoring.	
Methoxyethylmercuric acetate (as total mercury) <sup>(3)</sup>	EPA 245.2	CVAS (Automated)	EPA NERL	Method 245.2 contains data for reagent and surface waters only, but is approved at 40 CFR 141 for drinking water monitoring.	
<b>Organophosphate Pesticides</b>					
Dichlorvos Mevinphos	EPA 525.2	Liquid Solid (Solid Phase) Extraction GC-MS	EPA NERL	<sup>(4)</sup>	EPA 525.2
	EPA 3535A [Sample Preparation] / EPA 8270D [Determinative]	Solid Phase Extraction GC-MS	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix.	
Dicrotophos	EPA 3535A [Sample Preparation] / EPA 8270D [Determinative]	Solid Phase Extraction GC-MS	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix.	EPA 538
	EPA 538	LC-MS-MS	EPA NERL	<sup>(4)</sup>	
Fenamiphos	EPA 525.2	Liquid Solid (Solid Phase) Extraction  GC-MS	EPA NERL	Fenamiphos is instable in aqueous matrices, and quantitative determination is questionable. Samples should be analyzed as soon as possible upon receipt.	EPA 538
	EPA 538 (as chlorination products, fenamiphos sulfone and fenamiphos sulfoxide)	LC-MS-MS	EPA NERL	<sup>(4)</sup>	
Phorate Tetraethyl pyrophosphate (TEPP)	EPA 8141B	GC-FPD or -NPD	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix.	-
	EPA 3535A [Sample Preparation] / EPA 8270D [Determinative]	Solid Phase Extraction GC-MS	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix.	

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Contaminant	Possible Methods	Instrumentation	Method Source <sup>(1)</sup>	Special Considerations	Recommended Confirmatory Method(s) <sup>(2)</sup>
<b>Persistent Chlorinated Organics</b>					
Polychlorinated biphenyls (PCBs) <sup>(3)</sup>	EPA 508.1 (as Aroclors)	GC-Electron Capture Detector (ECD)	EPA NERL EPA OW	EPA 508.1 contains data for reagent and synthetic surface water only, but is approved in 40 CFR 141 for drinking water monitoring. <sup>(4)</sup>	EPA 508.1 EPA 525.2 EPA 505
	EPA 525.2 (as Aroclors)	Liquid Solid (or Solid Phase) Extraction GC-MS			
	EPA 505 (as Aroclors)	GC-ECD			
<b>Petroleum Products</b>					
Volatile organic compounds indicative of gasoline (i.e., BTEX) <sup>(3)</sup>	EPA 524.3	GC-MS	EPA OGWDW	<sup>(4)</sup>	EPA 524.3 EPA 502.2
	EPA 502.2	GC-PID and ECD	EPA NERL EPA OW	Method 502.2 contains data for reagent water only, but is approved in 40 CFR 141 for drinking water monitoring.	
Diesel range organics	EPA 3520C/3535A [Sample Preparation] /	Continuous Liquid-Liquid or Solid Phase Extraction	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix.	-
	EPA 8015C [Determinative]	GC-FID			
Gasoline range organics Kerosene	EPA 5030C [Sample Preparation] / EPA 8015C [Determinative]	Purge-and-trap GC-FID	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix.	-
<b>Pharmaceuticals</b>					
Colchicine	LC-Tandem MS for the Determination of Colchicine in Postmortem Body Fluids	LC-MS-MS	J. of Analytical Technology, 2006, 30(8), 593-598.	Laboratories should evaluate the method for their drinking water matrix.	-
	Development and Validation of a Rapid Method for Direct Determination of Colchicine in Pharmaceuticals and Biological Fluids	LC-UV spectrophotometry	J. of Liquid Chromatography and Related Technologies, 2006, 29, 1-13.	Laboratories should evaluate the method for their drinking water matrix.	-
Digoxin	EPA 1694	LC-MS-MS	EPA OW	Laboratories should evaluate the method for their drinking water matrix.	-
Nicotine sulfate (as nicotine)	EPA 3535A [Sample Preparation] / EPA 8270D [Determinative] (as nicotine)	Solid Phase Extraction GC-MS	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix. Improved extraction of alkaline compounds, such as nicotine, may occur under basic conditions.	-

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Contaminant	Possible Methods	Instrumentation	Method Source <sup>(1)</sup>	Special Considerations	Recommended Confirmatory Method(s) <sup>(2)</sup>
<b>Rodenticides</b>					
Crimidine	Pesticide monitoring of drinking water with the help of solid-phase extraction and high-performance liquid chromatography	Solid Phase Extraction LC-Diode Array Detector	J. of Chromatography A, 1996, 737(1), 67-74.	Laboratories should evaluate the method for their drinking water matrix.	-
	Multiresidue Analysis of 95 Pesticides at Low Nanogram/ Liter Levels in Surface Waters Using Online Preconcentration and High Performance Liquid Chromatography/ Tandem Mass Spectrometry	LC-MS-MS	J. of AOAC International, 2010, 93(6), 1732-1747.	Laboratories should evaluate the method for their drinking water matrix.	
	Identification and Quantitation of Herbicides and Pesticides in Water by LC and Diode Array Detector	LC-Diode Array Detector	Varian/Agilent App. Note No. 9	Laboratories should evaluate the method for their drinking water matrix.	
Strychnine	EPA 3535A [Sample Preparation] / EPA 8270D [Determinative]	Solid Phase Extraction GC-MS	EPA ORCR	Laboratories should evaluate the method for their drinking water matrix. Improved extraction of alkaline compounds, such as strychnine, may occur under basic conditions.	-
TETS	Analysis of Tetramethylene Disulfotetramine in Foods Using Solid-Phase Microextraction– Gas Chromatography–Mass Spectrometry	Solid Phase Micro Extraction GC-MS	J. of Chromatography A, 2008, 1192(1), 36-40.	Laboratories should evaluate the method for their drinking water matrix.	-
	Quantitative Analysis of Tetramethylenedisulfotetramine (Tetramine) Spiked into Beverages by Liquid Chromatography-Tandem Mass Spectrometry with Validation by Gas Chromatography-Mass Spectrometry	LC-MS-MS and GC-MS	J. Agric. Food Chem., 2009, 57(10), 4058-4067.	Laboratories should evaluate the method for their drinking water matrix.	

<sup>(1)</sup> Method sources: ASTM – <http://www.astm.org/Standards/water-testing-standards.html>, EPA ORCR – <http://www.epa.gov/epawaste/hazard/testmethods/mice.htm>, EPA NERL (formerly EMSL) – <http://www.epa.gov/nerlcwww/ordmeth.htm>, EPA OW and EPA Office of Ground Water and Drinking Water (OGWDW) – [http://water.epa.gov/scitech/drinkingwater/labcert/analyticalmethods\\_ogwdw.cfm](http://water.epa.gov/scitech/drinkingwater/labcert/analyticalmethods_ogwdw.cfm), EPA Region 5 Laboratory – <http://www.epa.gov/aboutepa/r5lab.html>

<sup>(2)</sup> If a possible method has been validated for in the drinking water matrix, it is listed as a recommended confirmatory method.

<sup>(3)</sup> This analyte is regulated in drinking water at 40 CFR 141. The possible and recommended confirmatory methods listed for this analyte provide a representative sub-set of the methods that EPA has approved for use in monitoring drinking water for this analyte. Other approved methods listed for this analyte for SDWA compliance monitoring may also be used.

<sup>(4)</sup> If no special considerations are listed, then the method has been evaluated for the drinking water matrix.

## 5.4 Radiochemical Contaminants and Analytical Methods

Drinking water radiochemical contaminants include radionuclides emitting alpha (e.g., uranium-238), beta (e.g., strontium-90), and beta/gamma (e.g., cesium-137) radiation. During incident response there may be a need for both sample radiation screening methods (gross activity) and specific analytical methods for detecting, identifying, and quantifying radionuclides in water samples. For comprehensive preparedness planning, utilities should identify a laboratory partner that can analyze for alpha and beta emitters and develop procedures to collect samples and access the laboratory partner. The following information on laboratory-based screening and confirmatory methods may be especially useful to a utility's radiochemical laboratory partner; however, field-based radiological testing equipment can be easily adopted by a utility's field or laboratory personnel for screening of gamma and some beta emitters.

Alpha emitters are effectively shielded in containerized water samples even if present at concentrations harmful when ingested, as well as most beta emitters. Some high energy beta emitters are also gamma emitters, so it is possible to detect some beta emitters indirectly through detection of the gamma emission. An overview of radiological methods for detection of various radionuclides in water is provided in the document, *Inventory of Radiological Methodologies for Sites Contaminated with Radioactive Materials* (USEPA, 2006). This document provides an overview of field and laboratory screening methods (gross alpha, gross beta, and gamma analysis), routine methodologies for radionuclide quantification and discrimination (gross alpha and gross beta requiring chemical separation procedures, alpha spectrometry, and gamma spectrometry) and specialized methodologies that rely on isotope mass rather than radioactive particle emissions (mass spectrometry). For example, inductively coupled plasma – mass spectrometry (ICP-MS) is one specialized technique that may be used to detect and/or speciate some isotopes (e.g., iodine-129, uranium isotopes).

EPA also has developed guidance regarding screening water samples for gross radioactivity using a variety of common survey equipment. The *Radiological Laboratory Sample Screening Analysis Guide for Incidents of National Significance* (USEPA, 2009a) describes how to develop laboratory methods to perform gross radioactivity analysis for samples. It also discusses technical issues associated with screening measurements, provides the suggested methodologies to determine correction factors for these instruments, offers a consistent methodology for measuring sample gross activity concentrations, and provides guidance on the calibration of screening equipment commonly used by laboratories (available at: [www.epa.gov/narel](http://www.epa.gov/narel)).

*Portable radioactivity meters can be used for site safety screening and laboratory screening of samples for gamma and some beta emitting radiochemicals.*

For example, Geiger-Mueller (GM) detectors are sensitive to all gamma and beta particles with enough energy to pass through the sample and container walls but not to alpha particles or low-energy beta particles, so no assessment of alpha particle or low-energy beta particle contamination can be made. These measurements take no more than 5 to 10 seconds to complete per sample and the sample mass and integrity remain unchanged (this is a non-destructive, non-invasive test). Important aspects of the outcome of these measurements are that samples can be appropriately shielded and labeled for both radiation protection and prioritization purposes. EPA has recently published a field instrument guide providing information regarding the use of various instruments for detection of specific analytes in environmental matrices. This document is titled *Field Screening Equipment Information Document – Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events*, SAM, Revision 5.0 (USEPA, 2010b; <http://www.epa.gov/sam/samcomp.htm>), and may be useful in identifying common field instrumentation that can be used for laboratory screening as well as specific radiochemical analyses.

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Rapid methods for detection of some radionuclides (e.g., americium-241, plutonium-238 and plutonium-239/240, isotopic uranium, radiostrontium [strontium-90], and radium-226) in water have been developed specifically for incident response by EPA (*Rapid Radiochemical Methods for Selected Radionuclides in Water for Environmental Restoration Following Homeland Security Events*, [USEPA, 2010c]). These new methods have been single-laboratory validated and were developed to expedite the analytical turnaround time (8 to 38 hours) while providing quantitative results. It should be noted that these methods were not developed for compliance monitoring of drinking water samples and are not approved for regulatory monitoring.

*Utilities should determine if their emergency response partner for radiochemical analyses has knowledge of rapid methods. The utility should document the anticipated time-line for analysis of radiochemicals in water samples.*

Additional guidance for laboratories supporting incident response has been developed by EPA, *Radiological Laboratory Sample Analysis Guide for Incidents of National Significance - Radionuclides in Water* (USEPA, 2008b). This document is intended to assist those analytical laboratories that will be called upon to provide rapid support following a radiological or nuclear incident. Because EPA recognizes that, following an incident, there may not be sufficient time to coordinate and communicate complete data quality objectives, measurement quality objectives, and analytical priorities to the

laboratory, this document details protocols that will enable laboratories to proceed with a consistent approach to developing and reporting appropriate data suitable for the anticipated use. Many useful procedures in support of radiochemical sample screening can also be found in the *All Hazards Receipt Facility Screening Protocol* (USEPA, 2008c) document ([http://cfpub.epa.gov/si/si\\_public\\_record\\_report.cfm?address=nhsrc/&dirEntryId=199346](http://cfpub.epa.gov/si/si_public_record_report.cfm?address=nhsrc/&dirEntryId=199346)).

EPA's SAM is a valuable resource for identification of radiochemical methods that are applicable to the analysis of drinking water samples. SAM lists appropriate qualitative and confirmatory methods for specific radionuclides as well as methods for gross alpha/beta and gamma radioactivity determination and analyte/method combinations are conveniently tabulated in Appendix B (<http://www.epa.gov/sam/>). Included in SAM are current drinking water compliance monitoring methods that can also be used for analysis of radiochemical contaminants in possible contamination incidents, although these methods require more time than the recently developed rapid methods. In addition, EPA's Radiation Protection (<http://www.epa.gov/radiation/radionuclides/index.html>) and the *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP) (<http://www.epa.gov/radiation/marlap/manual.html>) websites also provide information pertaining to radionuclides of interest and selection of radiochemical methods.

**Table 5-2** provides possible drinking water methods that can be used for analysis of gross alpha, beta, and gamma radiation, as well as three representative radiochemical contaminants. Until the rapid radiochemical methods are more widely adopted, a utility may use regulatory compliance methods and laboratories. Utilities should discuss with their radiochemical laboratory partner in advance the need to have rapid turn-around results in possible contamination incidents so that appropriate protocols can be established.

**Table 5-2. Representative Radiochemicals and Methods**

Contaminant	Possible Methods	Instrumentation	Method Source <sup>(1)</sup>	Special Considerations	Recommended Confirmatory Method
<b>Alpha Emitters</b>					
Gross Alpha	EPA OO-02/900.0 [Confirmatory]	Alpha Beta scintillation scaler or gas-flow low-background proportional detector	EPA NERL	Total (gross) for alpha and beta emissions; does not distinguish isotopes.	EPA 900.0
Uranium-238	EPA 908.0 [Qualitative Determination]	Alpha scintillation counting or gas-flow proportional detector	EPA NERL	Qualitative determination; does not distinguish uranium isotopes.	EPA 200.8
	D3972-02 [Confirmatory]	Alpha spectrometry	ASTM	Isotopic confirmation	
	EPA 200.8 [Quantitative Determination]	ICP-MS	EPA NERL	May distinguish uranium isotopes. Measures total uranium; does not measure radioactivity.	
	Isotopic Uranium ( <sup>238</sup> U, <sup>235</sup> U, and <sup>234</sup> U) in Water: Rapid Method for High-Activity Samples [Confirmatory]	Extraction chromatography + alpha spectrometry	EPA NAREL	Isotopic confirmation; although the method can detect concentrations of <sup>238</sup> U, <sup>235</sup> U, and <sup>234</sup> U on the same order of magnitude as methods used for the SDWA, this method is not a substitute for SDWA-approved methods for isotopic uranium.	
<b>Beta Emitters</b>					
Gross Beta	Rapid sample screening [Qualitative Determination]	Open-end or pancake style GM detectors with ratemeter	EPA NAREL	Sample/container shielding of low energy beta emissions.	EPA 900.0
	EPA OO-02/900.0 [Confirmatory]	Alpha Beta scintillation scaler or gas-flow low-background proportional detector	EPA NERL	Total (gross) for alpha and beta emissions; does not distinguish isotopes.	
Strontium-90	SM 7500-Sr B [Confirmatory]	Beta counting by gas-flow or thin-window proportional detector	SM	Selective sample precipitation required.	7500-Sr B (SM)
<b>Beta + Gamma Emitters</b>					
Gross Gamma	Rapid sample screening [Qualitative Determination]	GM detector with ratemeter	EPA NAREL	Total (gross) for gamma and high energy beta emissions; does not distinguish isotopes.	EPA 901.1
	EPA 901.1 [Qualitative Determination and Confirmatory]	High purity germanium (HPGe) gamma spectrometry	EPA NERL	Total (gross) for gamma emissions; does not distinguish isotopes.	
Cesium-137	EPA 901.1 [Qualitative Determination and Confirmatory]	HPGe gamma spectrometry	EPA NERL	Qualitative determination can be performed by application of the method over a shorter count time than that used for confirmatory analysis.	

<sup>(1)</sup> Method information: ASTM – <http://www.astm.org/Standards/water-testing-standards.html> EPA NAREL – <http://www.epa.gov/narel/> EPA NERL (formerly EMSL) – <http://www.epa.gov/nerlcwww/ordmeth.htm>

## 5.5 Pathogen Contaminants and Analytical Methods

EPA has identified more than 15 pathogens including bacteria, viruses, and protozoa among the drinking water contaminants of concern. Some of these pathogens have been declared select agents by the U.S. Department of Health and Human Services (HHS) due to their potential to pose a severe threat to public health and safety and as such, their possession, use, or transfer is regulated. These safety and security concerns limit the availability of qualified laboratories and methods for select agent analyses. Further information on representative pathogens of concern (including select agents) and laboratory biosafety requirements can be found in *Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition* (USHHS, 2009).

Resources for identifying pathogen methods include *Standard Methods for the Evaluation of Water and Wastewater* (Eaton, et al., 2005), *USEPA Microbiology Methods* (USEPA, 2010d), and the *USEPA Manual of Methods for Virology* (USEPA, 2001). EPA's Microbiological and Chemical Exposure Assessment Research Division (MCEARD) website (<http://www.epa.gov/nerlcwww/microbes/epamicrobiology.html>) provides access to a number of drinking water methods that have been developed for microbial monitoring (bacteria, viruses, and protozoa). SAM and WCIT are additional resources for identifying appropriate laboratory methods for pathogens of concern. The U.S. Food and Drug Administration (FDA) supports FERN and the development of microbiological methods for food-borne pathogens (e.g., *Salmonella*, *E. coli* O157:H7, *Shigella*) that may be applicable to drinking water. However, reagents and methods for representative pathogens of concern developed for FERN and CDC's LRN are only available to qualified laboratories within each network. Additional information regarding FERN and the LRN may be found in Section 6.

If the selection of a method of analysis for a particular agent is made by a public health laboratory partner and not the utility, the utility and laboratory partner should discuss the level of confidence of the selected method. For example, many bacterial pathogens have established confirmatory culture-based methods as well as more rapid detection procedures (e.g., PCR or immunoassay) that can be used in tandem to rule-out or confirm a potential contaminant. In these cases, results from the more rapid method may be used by the utility to make consequence management decisions while awaiting the confirmatory results from culture-based methods. Conversely, most viral and protozoan pathogens are difficult to identify by culture or may require lengthy procedures (turn-around times on the order of weeks). For these reasons, the preferred methods for these pathogens are often immunoassay or PCR-based. It is important to note that pathogen viability or infectivity is not addressed by techniques that target agent-specific markers such as genomic or antigenic markers.

*As many pathogens are not routinely analyzed for in the drinking water matrix, utilities should verify that a planned emergency response laboratory partner has demonstrated capability and method performance in the drinking water matrix in advance of an emergency.*

PCR-based methods have been developed for the detection and identification of some representative pathogens of concern, including select agents, in drinking water. These methods include commercially available assay formats as well as some that are intended for specific applications and laboratories (e.g., LRN Bioterrorism [BT] Agent Screening Protocol). PCR technologies can potentially provide rapid and sensitive qualitative detection of target agents but due to the low infectious dose of many pathogens of concern coupled with small assay volumes typically used, large volume sample collection and sample concentration may be required to achieve detection levels below estimated lethal/infective dose ranges. PCR is often used for downstream analyses of culture isolates to verify or confirm pathogen identification



but this process may require lengthy enrichment or isolation procedures and may not support the need for rapid results.

Several commercial PCR formats, including field-deployable and laboratory-stationed platforms, have been tested for use in drinking water by EPA's Technology Testing and Evaluation Program (TTEP) and National Risk Management Research Laboratory's Environmental Technology Verification (ETV) Program, and all were found to have target detection capabilities above levels of concern (lethal/infective dose) and offer a limited number of pathogen-specific assays (USEPA, 2010e). Nonetheless, this technology holds great potential for rapid, high-throughput, and cost-effective detection of multiple

*EPA has developed a portable, ultrafiltration device for concentration of bacterial and viral agents in water so that large volume sample concentration can be performed in the field.*

<http://www.epa.gov/nhsrc/news/news081409.html>

pathogens when coupled to appropriate sample concentration and processing procedures (Francy, et al., 2009, Holowecky, P.M., et al., 2009 and Polaczyk, A.L., et al., 2008).

Immunoassays for representative pathogens of concern are not generally recommended for direct analysis of drinking water where contaminant levels are anticipated to be very low. However, concentration of drinking water (e.g., ultrafiltration) may increase the potential for target detection using immunoassay formats. An

overview of commercial immunochemical assays for pathogen detection is available (U.S. Department of Homeland Security, 2005, *Guide for the Selection of Biological Agent Detection Equipment for Emergency First Responders*) and EPA's ETV program has evaluated several commercial formats for use in drinking water (<http://www.epa.gov/etv/>). Both resources focus primarily on screening technologies that could provide rapid information during incident response. Antibody-based techniques (e.g., immunoassays, immunomagnetic separation, immuno-PCR) are frequently used in conjunction with other pathogen detection methods or following culture enrichment or sample concentration to facilitate target detection and/or identification. Many public health and diagnostic laboratories utilize immunoassays for various pathogens of clinical importance and these capabilities may provide support for identification or confirmation of some representative pathogens of concern but generally these methods require initial isolation (e.g., culture) or enrichment of the target agent.

Bacterial agents of concern to drinking water security include select agents and non-select agents. A few LRN laboratories provide support for the analysis of 5 bacterial select agents (bioterrorism threat agents) in drinking water samples and SAM Version 5.0 lists LRN Sentinel (or Level A) protocols (American Society for Microbiology [ASM]) or LRN comparable assays for culture-based and PCR/immunoassay analytical methods for these bacterial select agents. Analytical methods for representative bacterial agents of concern are generally more accessible than select agent methods and SAM, Revision 5.0 can be consulted for guidance in selecting appropriate drinking water methods (USEPA, 2009b) (consult the latest version of SAM for the most up-to-date information). Alternative methods for some representative pathogens of concern (e.g., PCR method for *Escherichia coli* O157:H7) may be commercially available and for agents not listed in SAM (e.g., *Clostridium perfringens*, *Escherichia coli*), additional resources should be consulted (e.g., SM). NHSRC recently completed single-laboratory verification of culture-based methods for *E. coli* O157:H7, *Vibrio cholerae* O1 and O139, *Salmonella* Typhi, and non-typhoidal *Salmonella* spp. and will initiate multi-laboratory validation of culture-based methods for *E. coli* O157:H7 and non-typhoidal *Salmonella*. These methods are available through the EPA's National Homeland Security Research Center (NHSRC) website (<http://www.epa.gov/nhsrc>). This website also contains a feature that enables users to automatically be notified of developments on certain topics (<http://www.epa.gov/nhsrc/htm/distlist.html>).

*Utilities should identify their LRN partner in the planning phases of building capabilities for select bioterrorism pathogens and toxins and make sure they understand how to access an LRN lab.*



Enteric viruses, including caliciviruses (noroviruses and sapoviruses) and enteroviruses (polioviruses, echoviruses, coxsakieviruses A and B, and non-polio enteroviruses) are not select agents but are considered contaminants of concern. Analytical methods for viruses include tissue culture-based (infectivity assays) methods, PCR-based methods, and Integrated cell culture (ICC)-PCR methods. Since

*Utilities should learn in advance of any special sample collection, packaging and shipping requirements from their LRN partner laboratory.*

some enteric viruses cannot be cultured, a PCR-based strategy may be helpful in screening samples for a viral contaminant. SAM, Revision 5.0 lists potential methods for enteroviruses but these methods have not been thoroughly evaluated for drinking water matrices (USEPA, 2009b). EPA Method 1615, which detects enterovirus and norovirus by culture and Real Time-quantitative PCR (RT-qPCR) has recently been developed and

evaluated by EPA and is available at (<http://www.epa.gov/nerlcwww/online.html#vis/>).

*Cryptosporidium* is a contaminant that is commonly monitored in source water using EPA Methods 1622 or 1623. Numerous laboratories conduct EPA Methods 1623 or 1622. Utilities that elect to use these methods for finished drinking water should ensure that appropriate matrix spikes are evaluated per method requirements. Additional methods for *Cryptosporidium parvum* include tissue culture and PCR, but may require additional evaluation for application to drinking water.

Rickettsial agents are considered contaminants of concern as well as select agents. It should be noted that some of these agents (e.g., *Coxiella burnetii*) are obligate intracellular bacteria and as such are listed in SAM as bacteria rather than rickettsial agents. Analytical methods for these agents include host cell culture, PCR, and immunoassay procedures.

Sample processing techniques (e.g., filter concentration) may impact pathogen viability and thus impose limitations on the use of culture-based methods. Also, drinking water, particularly when concentrated, may contain substances that interfere with PCR and immunoassay methods (Hill, V.R., et al., 2007). Guidelines for establishing PCR practices and method controls are available to assist laboratories in developing these capabilities (USEPA, 2004). Recovery criteria for ultrafiltration procedures have been developed by the EPA's NHSRC and the Water Laboratory Alliance (WLA) to help laboratories demonstrate and maintain proficiency.

**Table 5-3** provides a list of representative pathogens of concern to water security, possible methods, and special considerations that utilities may find helpful in identifying analytical methods and developing laboratory support networks. It should be noted that the methods listed in Table 5-3 are not intended to be a comprehensive listing of all potential methodologies but have been selected based on applicability to drinking water. Pathogens identified as select agents in Table 5-3 are included in the HHS/U.S. Department of Agriculture (USDA) select agent list and should be analyzed in accordance with appropriate regulatory compliance (42 Code of Federal Regulations [CFR] parts 72 and 73, and 9 CFR part 121) and safety and biosafety level (BSL) requirements (see CDC's BMBL, 5<sup>th</sup> Edition, <http://www.cdc.gov/biosafety/publications/bmb15/index.htm>). Additional information on the LRN, including laboratories capable of receiving and processing drinking water samples for specific pathogen analyses is available at: <http://www.bt.cdc.gov/lrn/>.

*Note: EPA has not evaluated literature or vendor methods contained in Table 5-3 and their mention does not constitute an endorsement or recommendation for use.*

**Table 5-3. Representative Pathogens and Methods**

Contaminant	Screening Methodology (presumptive)	Screening Method Source <sup>(1)</sup>	Confirmatory Methodology (viability/other)	Confirmatory Method Source	Special Considerations
<b>Bacteria</b>					
<i>Bacillus anthracis</i>	Immunoassay (commercial formats)	EPA (TTEP and ETV reports)	Culture (rule-out or refer for confirmation)	Public Health Reports, 1977, 92(2): 176–186.	Select Agent/BSL-3  Sample concentration
	PCR (commercial formats)				
	R.A.P.I.D. <sup>®</sup> / PathAlert <sup>™</sup>	Detecting Biological Contaminants in Water, Using Rapid PCR Technologies ( <a href="http://www.epa.gov/nhsrc/news/news070808a.html">http://www.epa.gov/nhsrc/news/news070808a.html</a> )			
	Real-time PCR (LRN protocols <sup>2</sup> )	LRN	Culture/confirmation (LRN protocols)	Not publicly available <sup>2</sup>	
			PCR/Viability	Development and Verification of Rapid Viability Polymerase Chain Reaction (RV-PCR) Protocols for <i>Bacillus anthracis</i> – For application to air filters, water and surface samples (EPA/600/R-10/156).	
<i>Burkholderia</i> spp.	PCR (commercial formats)	EPA (TTEP and ETV reports)	Culture (rule-out or refer for confirmation)	ASM Sentinel Laboratory Guidelines for Suspected Agents of Bioterrorism: <i>Burkholderia mallei</i> and <i>Burkholderia pseudomallei</i> .	Select Agent/BSL-3  Sample concentration
	Real-time PCR (LRN protocols <sup>2</sup> )	LRN	Culture/confirmation (LRN protocols)	Not publicly available <sup>2</sup>	
<i>Clostridium perfringens</i>	Not Available	Not available	Membrane filtration/culture/ verification	Membrane Filtration Method for <i>C. perfringens</i> (EPA/600/R-95/178).	BSL-2 Anaerobic spore former
<i>Escherichia coli</i> O157:H7	Immunoassay (commercial formats)	EPA (TTEP and ETV reports)	Broth culture/ selective isolation/ biochemical and serological confirmation  Broth culture/ immunomagnetic separation (IMS)/ selective media/ biochemical and serological confirmation  Real-time PCR verification of culture isolates	SM <sup>3</sup> 9260 F: Pathogenic <i>Escherichia coli</i> .  Standard Analytical Protocol for <i>Escherichia coli</i> O157:H7 in Water (EPA/600/R-10/056).  Applied and Environmental Microbiology, 2003, 69(10): 6327–6333.	BSL-2  Concentrated samples may be acceptable

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Contaminant	Screening Methodology (presumptive)	Screening Method Source <sup>(1)</sup>	Confirmatory Methodology (viability/other)	Confirmatory Method Source	Special Considerations
<i>Escherichia coli</i> O157:H7	PCR (commercial formats)	EPA (TTEP and ETV reports)	PCR/Viability	Environ. Sci. Technol., 2011, 45(6): 2250–2256.	
	TaqMan® <i>E. coli</i> O157:H7 Detection System/ R.A.P.I.D.®	Detecting Biological Contaminants in Water, Using Rapid PCR Technologies ( <a href="http://www.epa.gov/nhsrc/news/news070808a.html">http://www.epa.gov/nhsrc/news/news070808a.html</a> , <a href="http://www.epa.gov/nhsrc/tte_rapidpcr.html">http://www.epa.gov/nhsrc/tte_rapidpcr.html</a> )			
<i>Francisella tularensis</i>	Immunoassay (commercial formats) PCR (commercial formats)	EPA (TTEP and ETV reports)	Culture (rule-out or refer for confirmation)	CDC, ASM, Association of Public Health Laboratories (APHL) Basic Protocols for Level A Laboratories for the Presumptive Identification of <i>Francisella tularensis</i> .	Select Agent/BSL-3
	R.A.P.I.D.® / PathAlert™	Detecting Biological Contaminants in Water, Using Rapid PCR Technologies ( <a href="http://www.epa.gov/nhsrc/news/news070808a.html">http://www.epa.gov/nhsrc/news/news070808a.html</a> , <a href="http://www.epa.gov/nhsrc/tte_rapidpcr.html">http://www.epa.gov/nhsrc/tte_rapidpcr.html</a> )			
<i>Francisella tularensis</i>	Real-time PCR (LRN protocols <sup>1</sup> )	LRN	Culture/confirmation (LRN protocols)	Not publicly available <sup>2</sup>	Select Agent/BSL-3  Sample concentration
<i>Salmonella</i> Typhi	PCR (commercial formats); Requires culture enrichment	Vendor	Broth culture/ selective isolation/ biochemical and serological confirmation	SM <sup>3</sup> 9260 B: General Qualitative Isolation and Identification Procedures for <i>Salmonella</i> .  Standard Analytical Protocol for <i>Salmonella</i> Typhi in Drinking Water (EPA 600/R-10/133).	BSL-2  Concentrated samples may be acceptable
<i>Vibrio cholera</i> O1	PCR (commercial formats);  Requires culture enrichment	Vendor	Broth culture/ selective isolation/ biochemical and serological confirmation	SM <sup>3</sup> 9260 H: <i>Vibrio cholerae</i>  Standard Analytical Protocol for <i>Vibrio cholerae</i> O1 and O139 in Drinking Water and Surface Water (EPA 600/R-10/139).	BSL-2  Concentrated samples may be acceptable
<i>Yersinia pestis</i>	Immunoassay (commercial formats)  PCR (commercial formats)	EPA (TTEP and ETV reports)	Culture (rule-out or refer for confirmation)	ASM Sentinel Laboratory Guidelines for Suspected Agents of Bioterrorism: <i>Yersinia pestis</i> .	Select Agent/BSL-3

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Contaminant	Screening Methodology (presumptive)	Screening Method Source <sup>(1)</sup>	Confirmatory Methodology (viability/other)	Confirmatory Method Source	Special Considerations
<i>Yersinia pestis</i>	R.A.P.I.D. <sup>®</sup> /PathAlert™	Detecting Biological Contaminants in Water, Using Rapid PCR Technologies ( <a href="http://www.epa.gov/nhsrc/news/news070808a.html">http://www.epa.gov/nhsrc/news/news070808a.html</a> , <a href="http://www.epa.gov/nhsrc/tte_rapidpcr.html">http://www.epa.gov/nhsrc/tte_rapidpcr.html</a> )			
<i>Yersinia pestis</i>	Real-time PCR (LRN protocols <sup>2</sup> )	LRN	Culture/confirmation (LRN protocols)	Not publicly available <sup>2</sup>	Select Agent/BSL-3 Sample concentration
<b>Protozoa</b>					
<i>Cryptosporidium parvum</i>	Not available	Not available	IMS/ Fluorescent antibody/ Microscopy (Not suitable for viability determination)  Tissue culture (Viability determination)  Real-time PCR (Not suitable for viability determination)	EPA Method 1622: <i>Cryptosporidium</i> in Water by Filtration/IMS/FA and EPA Method 1623: <i>Cryptosporidium</i> and <i>Giardia</i> in Water by Filtration/IMS/FA.  Applied and Environmental Microbiology, 1999, 65(9): 3936–3941.  Applied and Environmental Microbiology, 2007, 73(13): 4218–4225.	BSL-2 Sample concentration
<b>Rickettsia</b>					
<i>Coxiella burnetii</i>	Not available	Not available	Culture/confirmation (LRN protocols)	Not publicly available <sup>2</sup>	Select Agent/BSL-3 Propagation in tissue culture
<b>Viruses</b>					
Caliciviruses (Noroviruses)	Real-time PCR (commercial formats)	Vendor	Real-time PCR (Not suitable for viability determination)	Journal of Clinical Microbiology, 2004, 42(10): 4679–4685.	BSL-2 Sample concentration Non-culturable virus
Enterovirus	Real-time PCR (commercial formats)	Vendor	Real-time PCR (Not suitable for viability determination)	Applied and Environmental Microbiology, 2003, 69(6): 3158–3164.	BSL-2 Sample concentration

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<b>Contaminant</b>	<b>Screening Methodology (presumptive)</b>	<b>Screening Method Source <sup>(1)</sup></b>	<b>Confirmatory Methodology (viability/other)</b>	<b>Confirmatory Method Source</b>	<b>Special Considerations</b>
Enterovirus and norovirus	RT-qPCR or cell culture	EPA NERL	Cell culture RT-qPCR (Not suitable for viability determination)	EPA Method 1615: Measurement of Enterovirus and Norovirus in Water by Culture and RT-qPCR	BSL-2  Sample concentration

<sup>(1)</sup> Screening method information: EPA TTEP – <http://www.epa.gov/nhsrc/pubs.html>  
 EPA ETV – <http://www.epa.gov/etv/publications.html>  
 LRN – <http://www.bt.cdc.gov/lrn/>

<sup>(2)</sup> CDC/LRN protocols and reagents are restricted to LRN laboratories

<sup>(3)</sup> Standard Methods for the Examination of Water and Wastewater

## 5.6 Biotxin Contaminants and Analytical Methods

Drinking water contaminants of concern to water security include biotoxins from plant, bacterial, algal, fungal, and animal sources; some of these contaminants are also included among HHS and USDA select agents and toxins. Methodologies for biotoxins include a variety of approaches designed to address specific properties and more than one of these may be required to identify and evaluate the health threat

*Confirmation of many low molecular weight biotoxins can be performed using liquid chromatography mass spectrometry (LC-MS) and commercially available standards. Such methods could be easily adopted by utilities with this instrumentation.*

of a biotoxin during incident response. For example, botulinum neurotoxins can be rapidly detected and identified using immunologic or instrumental techniques but a bioassay (e.g., mouse bioassay) is required to confirm toxicity. In contrast, many of the smaller non-protein biotoxins can be detected and identified using immunologic and/or instrumental techniques that determine intact compound structure and toxicity or biological activity, since these are generally assumed to be based on structural integrity.

Immunoassays for many biotoxins are available through commercial sources but these might only provide presumptive results. Analytical support for some biotoxins (e.g., ricin, botulinum toxins) may be available through LRN, FERN, and some commercial laboratories. In general, support for biological activity determinations or bioassays (e.g., mouse bioassays) will require coordination with laboratories that routinely conduct these analyses (e.g., public health, LRN, FERN, CDC, specialized commercial laboratories).

Analytical methods (presumptive, confirmatory, and biological activity) for biotoxins are summarized in SAM but it should be noted that most of these methods have not been evaluated for use with drinking water matrices. EPA is collaborating with other agencies to develop and validate methods for biotoxins, and these new methods will be listed in future revisions of SAM.

There are a variety of commercially available immunoassays that can provide rapid screening capability for some important biotoxins, particularly ricin and botulinum toxins. In addition, some general toxicity test systems are responsive to biotoxins (e.g., ricin and botulinum toxins) but do not identify the agent responsible for the toxic response. EPA has evaluated some of these commercial technologies (immunoassays and general toxicity tests) in drinking water and test results are available through EPA's TTEP website (<http://www.epa.gov/nhsrc/ttep.html>) and ETV Program (<http://www.epa.gov/nrmrl/std/etv/verifiedtechnologies.html>).

**Table 5-4** provides a representative list of biotoxins, available methods, and special considerations that utilities may find helpful in identifying analytical methods and developing laboratory support networks. Further information on these methods can be found in SAM. Biological activity assays (e.g., mouse bioassay) are not listed in Table 5-4 but may be required to demonstrate toxicity.

*Note: EPA has not evaluated literature or vendor methods listed in Table 5-4 and their mention does not constitute an endorsement or recommendation for use.*

**Table 5-4. Representative Biotoxins and Methods**

Contaminant	Presumptive Method	Presumptive Method Source <sup>(1)</sup>	Confirmatory Method	Confirmatory Method Source	Special Considerations
<b>Algal Toxins</b>					
Brevetoxins	Immunoassay (Enzyme-linked Immunosorbent Assay [ELISA])	Environmental Health Perspectives. 2002. 110(2): 179–185.	Chromatography-tandem mass spectrometry (HPLC-MS-MS)	Toxicol., 2004, 43(4): 455–465.	Requires standards
Microcystins	Immunoassay (ELISA)	Journal of AOAC International. 2001. 84(4): 1035–1044.	HPLC-photodiode array (PDA) detector	Analyst, 1994, 119(7): 1525–1530.	Consider LC-MS
Saxitoxin	Immunoassay (competitive ELISA)	SAM (Revision 6.0) (Commercial Kit)	Chromatography – fluorescence detector HPLC-FL (post column derivatization)	Journal of AOAC International, 1995, 78: 528–532.	Select agent/toxin status (HHS) Consider LC-MS
<b>Animal Toxins</b>					
Tetrodotoxin	Immunoassay (competitive ELISA)	Journal of Clinical Laboratory Analysis. 1992. 6: 65–72.	HPLC-MS and HPLC-MS-MS	Analytical Biochemistry, 2001, 290: 10-17.	Select agent/toxin status (HHS)
<b>Bacterial Toxins</b>					
Botulinum toxins	Immunoassay (multiple formats)	SAM (Revision 6.0) EPA (TTEP and ETV reports)	Immunoassay (ELISA)	FDA, Bacteriological Analytical Manual Online, January 2001, Chapter 17, <i>Clostridium botulinum</i> .	Select agent/toxin status(HHS/USDA); Commercial immunoassays available; Consider LC-MS
<b>Fungal Toxins</b>					
Aflatoxin	Antibody capture followed by HPLC (fluorescence detection)	AOAC Official Method 991.31.	Antibody capture followed by HPLC (fluorescence detection)	AOAC Official Method 991.31.	Consider LC-MS
T2 mycotoxin	Immunoassay (ELISA)	Journal of Food Protection. 2005. 68(6): 1294–1301.	LC-MS (HPLC- time-of-flight mass spectrometry)	Rapid Communications in Mass Spectrometry, 2006, 20(9): 1422–1428.	Select agent/toxin status (HHS/USDA); Consider LC-MS
<b>Plant Toxins</b>					
Abrin	Immunoassay (ELISA and electrochemiluminescence detection)	Journal of Food Protection. 2008. 71(9): 1868–1874.	Ribosome inactivation ( <i>in vitro</i> assay)	Adapted from Pharmacology & Toxicology, 2001, 88(5): 255–260.	Select agent/toxin status (HHS)
Alpha amanitin	Immunoassay (ELISA)	Journal of Food Protection. 2005. 68(6): 1294–1301.	HPLC with amperometric detection	Journal of Chromatography B, 1991, 563(2): 299–311.	Consider LC-MS
Ricin	Immunoassay (multiple formats)	SAM (Revision 6.0) EPA (TTEP and ETV reports)	Immunoassay (ELISA and electrochemiluminescence detection)	Journal of AOAC International, 2008, 91(2): 376–382.	Select agent/toxin status (HHS); Commercial immunoassays available; Consider LC-MS (ricinine biomarker)

<sup>(1)</sup> Presumptive method information: EPA TTEP – <http://www.epa.gov/nhsr/pubs.html>, EPA ETV – <http://www.epa.gov/etv/publications.html>



## Section 6.0: Building Laboratory Support Networks

### 6.1 Developing External Laboratory Support

In-house laboratory analytical capabilities can often be a utility's "front-line" for confirming or ruling out a broad range of contaminants in the absence of specific information to direct the analytical approach in possible contamination incidents. Expanding the utility's laboratory network can support a utility throughout the credibility determination process, confirmation, remediation and recovery.

Potential laboratory partners should be consulted during the design phase of the utility's sampling and analysis program for emergency response to ensure that analytical capability and procedures for emergency access and rapid turn-around are adequately addressed. Laboratory partners should also be involved to ensure that critical proficiencies (sample collection, packaging, transport, chain-of-custody, Quality Assurance (QA)/Quality Control (QC), analyses, and results reporting procedures) for emergency response preparedness are established and maintained.

When reviewing existing in-house and existing partner capabilities, utilities should consider the following:

- Can existing in-house analytical methods be used to screen for, or confirm, contaminants of concern to water security?
- Will the utility be required to report results from baseline monitoring (any new monitoring efforts to establish baseline contaminant occurrence in the distribution system) to the state's primacy agency if regulatory compliance monitoring methods are used for non-regulated contaminants of concern to water security?
- Could new analytical methods be implemented by the utility using existing in-house equipment/instrumentation and personnel to target contaminants of concern to water security?
- Are there scenarios under which a method or existing staff would not be available or used during incident response?
- If new instrumentation or equipment is acquired for emergency response sampling and analysis, is it sustainable and/or does it have dual-uses?

Utilities should consider the following when developing laboratory support networks:

- Experience of a laboratory using the method for the analyte in a drinking water matrix
- Proximity of laboratories can impact time to results due to sample shipping requirements
- Laboratory qualifications/certifications to conduct specific analyses
- Analytical turn-around time during emergency response
- Sample load capacity
- Existing and up-to-date accreditations or certifications
- QA program that encompasses method/analyte/matrix of interest
- How the laboratory will be paid (e.g., contracts, agreements, purchase orders) in an emergency
- Sample requirements (e.g., volumes, preservatives, packaging, shipping, sample information, chain of custody procedures) specified by individual support laboratories
- QC requirements for emergency response samples
- Adequacy of data review and reporting procedures
- Ability and willingness to analyze samples containing "unknown" contaminants
- Laboratory emergency readiness (e.g., available personnel, reagents and hours of operation)



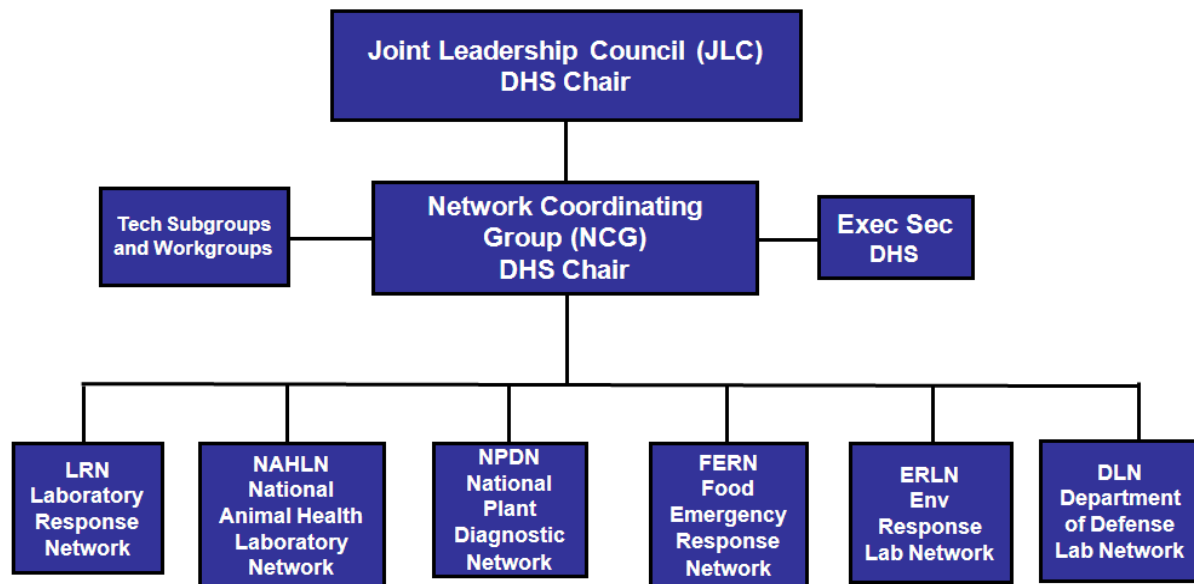
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Sections 6.1.1 – 6.1.5 of this document describe the EPA’s Environmental Response Laboratory Network (ERLN) and resources developed by EPA through the WLA for utilities during the process of building a laboratory network to support sample analyses during incident response. A utility can use these resources to plan for expanded analytical capabilities through the development of relationships and contractual agreements with external support laboratories. Furthermore, suggestions are provided regarding the various types of support laboratories that utilities may contact to ensure coverage of chemical, radiochemical, and biological contaminants for which external analytical support would be needed.

### 6.1.1 Overview of the Environmental Response Laboratory Network

The ERLN is an EPA administered network of laboratories of known quality. These pre-approved laboratories can provide analytical support to address responses to acts of terrorism, natural disasters, or other catastrophic events which may result in large numbers of environmental samples. The ERLN addresses environmental samples potentially contaminated with chemicals (including CWAs), radiochemical agents, and biological agents (including select agents).

The primary mission of the ERLN is to provide decision-makers with reliable, high quality analytical data in support of remediation and recovery activities. The ERLN is one of the member networks of the federal Integrated Consortium of Laboratory Networks (ICLN) (**Figure 6-1**).



**Figure 6-1. Integrated Consortium of Laboratory Networks**

ICLN members have established relationships with other federal laboratory networks to address human health, food safety, crops, and animal health. Unlike the other networks, the ERLN is comprised of public and private sector laboratories. The WLA is the water matrix component of the ERLN and has a specific emphasis on water contamination.

The ICLN was established by a Memorandum of Agreement in June 2005 to create a structure for an integrated and coordinated response to and consequence management of nationally significant incidents requiring laboratory response capabilities. The ICLN provides the mechanism by which laboratory networks can share information, optimize, and coordinate resources and conduct strategic planning. The Department of Homeland Security (DHS) chairs the Joint Leadership Council and the Network Coordinating Group of the ICLN. In addition to the DHS, the other nine participating federal agencies are: USDA, Department of Commerce, Department of Defense (DOD), Department of Energy, HHS, Department of Interior, Department of Justice, Department of State, and EPA.

The participating laboratory networks, as shown in Figure 6-1, include the following:

- LRN managed by CDC, under the HHS for clinical sample analysis
- National Animal Health Laboratory Network (NAHLN) under the USDA for food and animal analyses
- National Plant Diagnostic Network (NPDN) also under the USDA for crop and plant sample analysis
- FERN managed by FDA, under the USDA, for analysis of the human food supply
- ERLN managed by EPA for environmental analyses including soil, air, water, and surface samples
- Defense Laboratory Network (DLN) within the DOD for analyses of environmental and clinical samples for bioterrorism agents

### 6.1.2 Overview of the WLA

The WLA provides the Water Sector with an integrated nationwide network of laboratories with the capabilities and capacity to analyze water samples in the event of natural, intentional, or unintentional water contamination involving chemical, biological, or radiochemical contaminants. The WLA relies on the ERLN for CWA and radiochemical capabilities and, in turn, the ERLN relies on the WLA for its water response capability. Further information about the WLA, in addition to training opportunities and tools can be found at <http://water.epa.gov/infrastructure/watersecurity/secres/wla.cfm>.

### 6.1.3 Benefits of the ERLN/WLA to Utilities

Utilities can benefit from the ERLN/WLA in a number of ways. In the event that a utility experiences a confirmed contamination incident or is unable to process routine regulatory samples due to natural disasters, such as earthquakes or hurricanes, WLA member laboratories can be identified and solicited for support. In addition to supporting expansion of utility capabilities in a contamination incident, the WLA provides access to validated analytical methods for unregulated contaminants of concern to water security, the opportunity to participate in emergency response exercises, and water security-related training opportunities.

*WLA membership offers networking opportunities and training to utilities covering a wide variety of topics related to laboratory operations during emergencies.*

When accessing WLA member laboratories, utilities are assured that the laboratories have complied with various useful measures related to laboratory quality, capability, capacity, and data management and reporting, including:

- Drinking water certification or quality system consistent with International Organization for Standardization 17025
- Sample management system
- Facilities to handle and secure samples
- Data management and exchange procedures
- Accurate inclusion of capability information into the Compendium of Environmental Testing Laboratories (CETL or Lab Compendium)

Utilities are strongly encouraged to develop and utilize intrastate mutual aid and assistance agreements, sometimes known as Water/Wastewater Agency Response Networks (WARNs), which include a laboratory component. WARNs can help to reduce the typical response gap between local and statewide agreements, as they do not require emergency declaration prior to activation. The mission of WARNs is to provide expedited access to specialized resources needed for response and recovery. WARNs provide both public and private utilities with emergency assistance through sharing of equipment, personnel, and other resources required for responding to any crisis. An overview of the goals of WARN can be found in

the document *Mutual Aid and Assistance: Utilities Helping Utilities* (USEPA, 2007, [http://www.epa.gov/flowoftheriver/pdf/fs\\_watersecurity\\_warn.pdf](http://www.epa.gov/flowoftheriver/pdf/fs_watersecurity_warn.pdf)).

Aside from the benefits of ERLN/WLA services, utilities can benefit further if their laboratory becomes an ERLN/WLA member. This includes access to standards, specialized training, and reimbursement for analytical services provided during a declared emergency. Further information on the benefits of becoming an ERLN/WLA member can be found at <http://www.epa.gov/oamsrpod/ersc/ERLN2/index.htm>.

#### **6.1.4 Coordinating External Laboratory Support**

Utilities should inventory in-house laboratory capability and capacity prior to a possible contamination incident in order to identify analytical gaps. Once completed, the utility can begin to develop a network of support laboratories that could be accessed during incident response, depending on the specific expanded analytical needs that have been identified. There are several ways that utilities can identify external laboratories to provide analytical support:

- The utility should consult with their state environmental or public health laboratories, primacy agencies, and local commercial laboratories to become familiar with their analytical capabilities
- Utilities should become familiar with EPA regional laboratory capabilities even though access, if needed, will likely occur by request from a state agency
- For all external laboratories that a utility anticipates would be utilized during the early phases of incident response, a contractual agreement or memorandum of understanding is recommended to formalize sample analysis requirements (e.g., results turn-around time, analytical costs, etc.)

A utility can consider participation in local emergency preparedness exercises, or joining an existing mutual aid laboratory network as a way to build relationships and to increase familiarity with laboratory support mechanisms. The Compendium of Environmental Testing Laboratories (CETL, or Lab Compendium) is a secure, web-based tool that provides users with laboratory information such as emergency contacts, analytical capabilities, matrices of specialization, and capacity (available through the WLA Web site: <http://water.epa.gov/infrastructure/watersecurity/secres/wla.cfm>). A caveat to using the compendium is that the information provided is voluntary and may or may not be up to date; however, users can be assured that ERLN member laboratories have updated their information within the previous six months.

**Table 6-1** presents the types of laboratories that would generally be able to provide analytical support for the indicated contaminant class. Due to the fact that analytical capabilities vary widely among state, public health, commercial, and EPA regional laboratories, it is important that utilities consult directly with potential support laboratories to determine the specific capabilities that are available at each. A utility should identify and communicate with laboratories for analysis of representative contaminants from the contaminant classes of concern in advance of needed service to ensure timely analytical support during an emergency. This may also include establishing how the utility will procure the services.

**Table 6-1. Typical Support Laboratories for Chemicals, Radiochemicals, Pathogens, and Biotoxins**

Contaminant Type	Support Laboratories
Chemicals (except CWAs)	<ul style="list-style-type: none"> <li>• Utility</li> <li>• State environmental and public health laboratories</li> <li>• Commercial laboratories</li> <li>• EPA regional laboratories</li> </ul>
Chemical Warfare Agents <sup>1</sup>	<ul style="list-style-type: none"> <li>• ERLN CWA laboratories                             <ul style="list-style-type: none"> <li>○ Must be arranged by the state through an EPA regional laboratory or the EPA Headquarters Office of Emergency Management (OEM)</li> </ul> </li> </ul>
Chemical Warfare Agent Degradation Products <sup>2</sup>	<ul style="list-style-type: none"> <li>• Utility</li> <li>• Commercial laboratories</li> </ul>
Radiochemicals	State, EPA regional and commercial laboratories
Biological Agents (non-select agents)	<ul style="list-style-type: none"> <li>• Utility</li> <li>• State environmental and public health laboratories</li> <li>• Commercial laboratories</li> <li>• EPA regional laboratories</li> </ul>
Biological Agents <sup>1</sup> (select agents)	State public health laboratories (CDC LRN)

<sup>1</sup> Confirmatory laboratory support for CWAs and select agents will normally occur through the Incident Command System (ICS) to a federal lead agency.

<sup>2</sup> During the early phases of incident response, methods for CWA degradation products could be implemented first (at a capable support laboratory) unless there is compelling evidence that dictates the need for confirmation of a suspected CWA.

Utilities may access ERLN/WLA member laboratories regardless of whether they are a member, however, how utilities access laboratory resources will depend on the credibility of the event. Following the National Incident Management System (NIMS), local events should be addressed with local resources until overwhelmed. Utilities may access laboratory support directly, including ERLN/WLA laboratories, at their own expense at any time during smaller incidents. To access ERLN/WLA laboratories during significant events, the following conditions should apply:

- When local resources are overwhelmed, and state or federal assistance is required
- The utility will normally request assistance through the local emergency management coordination structures
- During significant events, such as terrorism or natural disasters, access to laboratory support will normally be through the established ICS structures
- The ICS Environmental Unit (EU) supports obtaining and managing analytical services
- EU personnel will have access to ERLN/WLA laboratory assets and other federal laboratory assets through the Unified Command under NIMS

The WLA Response Plan (WLA-RP) provides processes and procedures to provide coordinated analytical response to water contamination events

([http://water.epa.gov/infrastructure/watersecurity/wla/upload/WLAResponsPlan\\_November2010.pdf](http://water.epa.gov/infrastructure/watersecurity/wla/upload/WLAResponsPlan_November2010.pdf).)

The WLA-RP can be used for incidents ranging from small local events to large, multi-regional events and provides a good reference document for utilities in managing the analytical needs of a contamination event. The Plan was developed with the national input of laboratories, utilities, and emergency response personnel, and has been extensively tested in table top and full scale exercises.

The WLA-RP covers a wide variety of subjects and includes helpful checklists which guide the user during an incident. The Plan covers the following topics, among others:

- Laboratory roles and responsibilities
- Laboratory coordination

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- Integration of the ICS with WLA-RP processes and procedures
- Communication and logistics
- Sample brokerage, tracking, and transport
- Sample analyses – field screening, rapid, and confirmatory
- QA/QC
- Data review and validation
- Data reporting and data storage
- Reimbursement

### 6.1.5 Example Utility Laboratory Networks

As discussed in this guidance, it is recommended that utilities design a sampling and analysis program to achieve broad contaminant coverage from the full range of contaminant classes described in Section 4. The manner in which a utility achieves broad contaminant coverage will vary; some utilities may need to establish partnerships with external partners to build analytical capabilities for contaminants of concern, whereas other utilities may have extensive existing capabilities which would allow them to conduct analyses in-house for a large sub-set of contaminants of concern to drinking water security as well as contaminants of local/regional concern. **Tables 6-2, 6-3 and 6-4** contain examples of selected contaminants and how three differently qualified utilities may choose to build capabilities for a wide range of contaminants of concern. The blue shading in Tables 6-3 and 6-4 denotes the differences between capabilities (for utilities 2 and 3) when compared to utility 1 (Table 6-2) and shows that there are many ways of accomplishing the desired objective of broad contaminant coverage.

The conditions for use (routine and/or incident response) of the described method are listed to illustrate how a laboratory may choose to use the method: routinely to establish baseline contaminant occurrence and method performance or only during incident response. Methods only used during incident response may be for contaminants requiring external emergency response partners or for contaminants where historical data indicates no baseline occurrence.

**Utility 1:** This water utility achieved broad contaminant coverage through a combination of existing in-house capabilities as well as through partnerships with various external laboratories. Prior to implementing a CWS, the utility had laboratory capabilities primarily for compliance monitoring; total coliforms and regulated chemicals. To increase their in-house laboratory capabilities, the utility decided to expand analyte screening to include organophosphate pesticides using Method 525.2.

The utility had an existing partnership established with the state Department of Health to provide analysis of compliance monitoring samples for radiochemicals, as well as one commercial laboratory for metals and carbamate pesticide analyses. The utility further supplemented their overall incident response preparedness by establishing a protocol for accessing the state LRN laboratory for select agents and toxins, as well as an EPA regional laboratory for coverage of CWAs. To identify these partner laboratories, the utility accessed EPA's Lab Compendium through the ERLN or WLA Web site. In addition to expanding contaminant coverage, the utility established procedures for sampling, packaging and rapid delivery of samples to partner laboratories in the event of an emergency.

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**Table 6-2. Example Utility Capabilities and Laboratory Network (Utility 1)**

Laboratory	Method	Contaminants	Contaminant Class	Conditions
In-house	EPA 524.3: Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry	Volatiles indicative of gasoline	Petroleum Products	Routine and incident response
	EPA 525.2: Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry	Dichlorvos, Mevinphos, Fenamiphos, PCBs (as Aroclors), and MS Screening	Organophosphate Pesticides and Persistent Chlorinated Organics	Routine and incident response
	ASTM D6888-04	Free Cyanide	Cyanide Compounds	Routine and incident response
State LRN Laboratory	LRN Sample Concentration and BT-Agent Screening Protocol	Select agents: pathogens and toxins	Plant Toxins, Viruses, Bacteria	Incident response
State Department of Health	EPA OO-02 / 900.0 Gross Alpha and Gross Beta Radioactivity in Drinking Water	Gross Alpha and Gross Beta Activity	Radionuclides	Routine and incident response
	EPA 901.1: Gamma Spectrometry	Radionuclide Screen and Gross Gamma Activity	Radionuclides	Routine and incident response
Commercial Environmental Laboratory	EPA 200.8: Determination of Trace Elements in Waters by Inductively Coupled Plasma - Mass Spectrometry	Arsenic, Mercury, and Metals Screening	Arsenic and Mercury Compounds, Heavy Metals	Routine and incident response
	EPA 531.1: Measurement of N-Methylcarbamoyloximes and N-Methylcarbamates in Water by Direct Aqueous Injection High Performance Liquid Chromatography with Post Column Derivatization	Aldicarb, Carbofuran, Oxamyl, and other regulated EPA 531.1 analytes	Carbamate Pesticides	Routine and incident response
	EPA 549.2: Diquat and Paraquat in Drinking Water by LSE and HPLC-UV	Paraquat	Herbicides	Routine and incident response
	Quantitation of Fluoroacetic Acid and Fluoroacetamide with Mass Spectrometric Detection (in-house method based on Dionex Application Note 276)	Sodium fluoroacetate	Fluorinated Organic Compounds	Routine and incident response
ERLN CWA Laboratory	ERLN CWA Laboratory Methods	GB, GD, GA, and VX	CWAs	Incident response



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**Utility 2:** Prior to implementing a CWS, utility #2 had a variety of in-house laboratory capabilities in place for regulatory compliance monitoring. Many of these capabilities were leveraged for the sampling and analysis program for water security. The utility broadened contaminant coverage through laboratory partnerships. The utility established a protocol for accessing the state LRN laboratory to provide coverage for select pathogens and toxins, and identified an EPA regional laboratory (ERLN Laboratory) to provide for confirmation of CWAs. The utility also identified a new commercial laboratory partner through use of EPA’s Lab Compendium and established a contract for non-select pathogen agent sample analyses (*Salmonella* Typhi and *V. cholera* O1). *Note:* asterisks in the table which precede method names indicate unique capabilities for utility 2 in comparison to utility 1.

**Table 6-3. Example Utility Capabilities and Laboratory Network (Utility 2)**

Laboratory	Method	Contaminants	Contaminant Class	Conditions
In-house	EPA 524.3 Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry	Volatiles indicative of gasoline	Petroleum Products	Routine and incident response
	EPA 525.2 Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry	Dichlorvos, Fenamiphos, Mevinphos, PCBs (as Aroclors), and MS Screening	Organophosphate Pesticides and Persistent Chlorinated Organics	Routine and incident response
	ASTM D6888-04	Free Cyanide	Cyanide Compounds	Routine and incident response
	LRN Sample Concentration for BT Agent Screening Protocol	Select agents: pathogens and toxins	Plant Toxins, Viruses, Bacteria	Routine only
	*EPA 200.8 Determination of Trace Elements in Waters by Inductively Coupled Plasma - Mass Spectrometry	Arsenic, Mercury, and Metals Screening	Arsenic and Mercury Compounds, Heavy Metals	Routine and incident response
	*Quantitation of Fluoroacetic Acid and Fluoroacetamide with Mass Spectrometric Detection (Dionex Application Note 276)	Sodium fluoroacetate	Fluorinated Organic Compounds	Routine and incident response
State LRN Laboratory	LRN BT-Agent Screening Protocol	Select agents: pathogens and toxins	Plant Toxins, Viruses, Bacteria	Routine and incident response
State Department of Health	EPA OO-02 / 900.0 Gross Alpha and Gross Beta Radioactivity in Drinking Water	Gross Alpha and Gross Beta Activity	Alpha and Beta Emitters	Routine and incident response
	EPA 901.1 Gamma Spectrometry	Radionuclide Screen and Gross Gamma Activity	Gamma Emitters	Routine and incident response
Commercial Environmental Laboratory 1	EPA 531.1 Measurement of N-Methylcarbamoyloximes and N-Methylcarbamates in Water by Direct Aqueous Injection High Performance Liquid Chromatography with Post Column Derivatization	Aldicarb, Carbofuran, Oxamyl, and other regulated EPA 531.1 contaminants	Carbamate Pesticides	Routine and incident response
	EPA 549.2 Diquat and Paraquat in Drinking Water by LSE and HPLC-UV	Paraquat	Herbicides	Routine and incident response
Commercial Environmental Laboratory 2	<ul style="list-style-type: none"> <li>– *PCR (commercial formats), requires culture enrichment [Screening]</li> <li>– *Broth culture/selective isolation/biochemical and serological confirmation [Confirmatory]</li> </ul>	Non-select agents	Bacteria	Routine and incident response
ERLN CWA Laboratory	ERLN CWA Laboratory Methods	GB, GD, GA, and VX	CWAs	Incident response

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**Utility #3:** This water utility is well equipped and staffed, with strong capabilities and experience in analyses of many contaminants of concern to water security. To enhance in-house laboratory capabilities for a CWS, the utility implemented several new methods to provide contaminant coverage for organophosphate pesticides (dicotophos and fenamiphos) and non-select agents pathogens. The utility determined that procuring an LC-MS system would provide a long-term benefit as it could be used for analyses of endocrine disruptors and be used to screen for biotoxins and some pharmaceuticals. The utility purchased a Geiger counter for laboratory screening of beta and gross gamma activity prior to emergency response sample analyses. The laboratory established a protocol for accessing the state LRN laboratory for select pathogens and toxin analyses, and formed a partnership with an EPA regional laboratory (ERLN member) for CWA confirmatory analyses. *Note:* asterisks in the table which precede method names indicate unique capabilities for utility 3 in comparison to utility 1.

**Table 6-4. Example Utility Capabilities and Laboratory Network (Utility 3)**

Laboratory	Method	Contaminants	Contaminant Class	Conditions
In-house	EPA 524.3: Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry	Volatiles indicative of gasoline	Petroleum Products	Routine and incident response
	EPA 525.2: Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry	Dichlorvos, Fenamiphos, Mevinphos, PCBs (as Aroclors), and MS Screening	Organophosphate Pesticides and Persistent Chlorinated Organics	Routine and incident response
	*EPA 538: Determination of Selected Organic Contaminants in Drinking Water by Direct Aqueous Injection-Liquid Chromatography/Tandem Mass Spectrometry	Dicotophos and Fenamiphos	Organophosphate Pesticides	Routine and incident response
	ASTM D6888-04	Free Cyanide	Cyanide Compounds	Routine and incident response
	*EPA 200.8: Determination of Trace Elements in Waters by Inductively Coupled Plasma - Mass Spectrometry	Arsenic, Mercury, and Metals Screening	Arsenic and Mercury Compounds, Heavy Metals	Routine and incident response
	*EPA 531.1: Measurement of N-Methylcarbamoyloximes and N-Methylcarbamates in Water by Direct Aqueous Injection High Performance Liquid Chromatography with Post Column Derivatization	Aldicarb, Carbofuran, Oxamyl, and other regulated EPA 531.1 contaminants	Carbamate Pesticides	Routine and incident response
	*Quantitation of Fluoroacetic Acid and Fluoroacetamide with Mass Spectrometric Detection (in-house method based on Dionex Application Note 276)	Sodium fluoroacetate	Fluorinated Organic Compounds	Routine and incident response
	*EPA 549.2: Diquat and Paraquat in Drinking Water by LSE and HPLC-UV	Paraquat	Herbicides	Routine and incident response
	*In-house Method - High Performance Liquid Chromatography – Mass Spectrometry	Pharmaceuticals and Endocrine Disruptors	Pharmaceuticals Colchicine, Crimidine	Routine and incident response
	*Rapid Sample Screening (qualitative determination)	Gross Beta and Gross Gamma Activity	Beta and Gamma Emitters	Routine and incident response



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Laboratory	Method	Contaminants	Contaminant Class	Conditions
In-house	*EPA OO-02 / 900.0 Gross Alpha and Gross Beta Radioactivity in Drinking Water	Gross Alpha and Gross Beta Activity	Alpha and Beta Emitters	Routine and incident response
	*EPA 901.1 Gamma Spectrometry	Radionuclide Screen and Gross Gamma Activity	Gamma Emitters	Routine and incident response
	*ASTM Method D7597-09: Standard Test Method for Determination of Diisopropyl Methylphosphonate, Ethyl Hydrogen Dimethylamido-phosphate, Ethyl Methylphosphonic Acid, Isopropyl Methylphosphonic Acid, Methylphosphonic Acid and Pinacolyl Methylphosphonic Acid in Water by Liquid Chromatography/ Tandem Mass Spectrometry	Degradation Products of GB, GD, GA, and VX	CWA Degradation Products	Routine and incident response
	<ul style="list-style-type: none"> <li>- *PCR (commercial formats), requires culture enrichment [Screening]</li> <li>- *RT-PCR</li> <li>- *Broth culture/selective isolation/biochemical and serological confirmation [Confirmatory]</li> </ul>	Non-select agents	Bacteria and Enteric Viruses	Routine and incident response
State LRN Laboratory	LRN Sample Concentration and BT-Agent Screening Protocol	Select agents: pathogens and toxins	Plant Toxins, Viruses, Bacteria	Incident response
EPA Regional Laboratory (ERLN CWA laboratory)	ERLN CWA Laboratory Methods	GB, GD, GA, and VX	CWAs	Incident response

**Note:** *The above examples are for illustrative purposes only. Individual utilities may select different contaminants, methods, and laboratories to achieve the goal of broad coverage for representative contaminants of concern to drinking water security.*

## Section 7.0: Reimbursement of Analytical Costs Incurred During Emergency Response

Utilities may be eligible for reimbursement of analytical costs incurred by support laboratories during emergency response through local, state, or federal mechanisms. To be eligible for federal reimbursement, the expenses incurred by the utility would have to be covered under a formal declaration of a national emergency. State procedures may vary. Utilities are encouraged to prepare for possible reimbursements by doing the following:

- Establish pre-incident emergency procurement procedures to acquire supplies and services
- Join a mutual aid and assistance program
- Review insurance policies for coverage and limits
- Develop pre-incident accounting, documentation, and personnel policies for emergencies (as appropriate)
- Explore the web-based tool called Federal Funding for Utilities - Water/Wastewater- in National Disasters (Fed FUNDS) where you can obtain information tailored to the water sector on applicable federal disaster funds, documentation templates, lessons learned, successful funding applications from utilities, and access to funding mentors. See the following <http://water.epa.gov/infrastructure/watersecurity/emerplan/index.cfm>
- Become familiar with reimbursement eligibility, mechanisms, and resources and how they differ at the local, state, and federal level. See Reimbursement Tips for Emergency Laboratory Support- (USEPA, 2009c) for additional information: ([http://water.epa.gov/infrastructure/watersecurity/wla/upload/2009\\_8\\_14\\_watersecurity\\_pubs\\_fs\\_watersecurity\\_reimbursementtips\\_laboratory.pdf](http://water.epa.gov/infrastructure/watersecurity/wla/upload/2009_8_14_watersecurity_pubs_fs_watersecurity_reimbursementtips_laboratory.pdf))

The reimbursement process can be complicated and dependent on many factors. If a contamination incident is not an act of terrorism or a nationally significant event (e.g., natural disaster or unintentional contamination incident), federal funding may not be available for reimbursement. Each state also has its own rules for reimbursement, and utilities are encouraged to develop a good understanding of state mechanisms prior to an event.

In order to facilitate reimbursement following an incident, the utility should do the following during the event:

- Coordinate efforts with emergency management agencies at the local, state, and federal level
- Document emergency work prior to any federal declarations of disaster
- Document labor costs, equipment usage, material purchases, and validate/store all records

*If an incident is elevated to the level of a federal response, ERLN member laboratories are eligible for reimbursement of analytical costs through a Basic Ordering Agreement (BOA).*

When performing eligible analyses, members of the ERLN/WLA are compensated by EPA with federal funding through Basic Ordering Agreements (BOAs) that are established when they become network members. This is one of the benefits of membership mentioned above because a BOA is not a contract, but a written instrument of understanding negotiated between EPA and a contractor (state, local, municipal, or commercial laboratory). There are, however, important details about BOAs that non-member laboratories would not necessarily know but should be familiar with, in case they require services from member laboratories. Only authorized requestors identified in the BOA can order services from an

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ERLN/WLA laboratory under the BOA. Typically, authorized requestors are EPA's On-Scene Coordinators (OSC) from a regional office. Therefore, a utility may not utilize a federal BOA directly with another ERLN/WLA laboratory. However, if the analytical support is for a utility under an appropriate situation (i.e., formal declaration of national emergency) EPA may pay the support laboratory through a BOA.

A BOA contains the following:

- Terms and clauses applying to future purchase orders between the parties during its term;
- Description, as specific as practicable, of supplies or services to be provided; and
- Methods for pricing, issuing, and delivering future purchase orders under the BOA.

Work is ordered from a BOA holder either directly from the laboratory (sole source) or on a competitive basis. Sole-source purchase orders may be issued during national emergencies or other EPA defined specific incidents (defined case by case). At all other times, EPA will generate a Request for Quote (RFQ). Both the RFQ and the Purchase Order will detail the level of effort required for a particular service and will include specific information including the following, among others:

- Specific site or incident
- Description of services (how many samples, what type)
- Analytical method
- Reporting
- QA/QC procedures
- Payment terms

EPA OSCs may also request ERLN/WLA laboratories to follow ERLN requirements as established in the BOAs, and may purchase services directly using government-issued credit cards (up to certain dollar limit). The EPA headquarters WLA personnel may facilitate use of ERLN commercial laboratories by water utilities during incident response through coordination using an EPA regional laboratory, OSC, or ERLN BOA Project Officer. Utilities can also obtain services from ERLN/WLA laboratories outside the BOA at their own expense.

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## Section 9.0: Summary of Resources

Section 9 provides a summary of relevant resources that may be useful when implementing sampling and analysis as part of a CWS at a utility. The following includes information on contaminant resources, method resources, laboratory networks, and laboratory guidance, as referenced in this document.

### 9.1 Contaminant Resources

Contaminant resources provide specific information on regulated and non-regulated contaminants of interest, as discussed in Section 4.

#### **Hach Homeland Security Technologies (Hach HST)**

<http://www.hachhst.com/>

This company manufactured advanced analytical water quality testing systems for over than 65 years for nearly all sectors of water treatment and distribution. As part of their development of an event detection system based on profiles of various contaminant classes, Hach HST has generated a commercial list of contaminants of concern.

#### **Water Contaminant Information Tool (WCIT)**

<http://water.epa.gov/scitech/datait/databases/wcit/index.cfm>

This tool is a secure, on-line database that provides information on chemical, biological, and radiological contaminants of concern for water security. Access is password-protected and will be granted to select personnel from drinking water and wastewater utilities; State Primacy (primary enforcement) Agencies; federal officials (including government laboratory personnel); public health agencies; and water associations.

#### **Water Environment Resource Foundation**

<http://www.werf.org>

This organization provides information on numerous aspects of wastewater and storm water issues, including water quality monitoring via laboratory analysis. Specifically for contaminants, this organization provides an extensive list of publications for sampling, measurement, and analysis.

### 9.2 Methods Resources

The following resources provide information on general, chemical, biological, and radiological methods to detect regulated and non-regulated contaminants of interest, as discussed in Section 4. Field screening method resources are also included.

#### 9.2.1 General Method Resources

#### **U.S. Environmental Protection Agency. *Sampling Guidance for Unknown Contaminants in Drinking Water* (2008) EPA-817-R-08-003**

[http://www.epa.gov/safewater/watersecurity/pubs/guide\\_watersecurity\\_samplingforunknown.pdf](http://www.epa.gov/safewater/watersecurity/pubs/guide_watersecurity_samplingforunknown.pdf)

This document provides comprehensive guidance that integrates recommendations for pathogen, toxin, chemical, and radiochemical sample collection, preservation, and transport procedures to support multiple analytical approaches for the detection and identification of potential contaminants in drinking water. The guidance is intended to support sampling for routine and baseline monitoring to determine background concentrations of naturally occurring pathogens, sampling in response to a triggered event, and sampling in support of remediation or decontamination efforts.

**American Public Health Association, American Water Works Association, and Water Environment Federation. *Standard Methods for the Examination of Water and Wastewater Website***

<http://www.standardmethods.org/>

A comprehensive resource covering a variety of techniques developed by a number of water quality researchers who have been members of the Standard Methods Committee (SMC). This committee, consisting of over 500 people, is charged with the review and approval of methods to be included in Standard Methods for the Examination of Water and Wastewater. In addition, committee members serve on Joint Task Groups (JTGs) that are charged with the review, revision, and approval of specific methods.

**ASTM International (formerly the American Society for Testing and Materials)**

<http://www.astm.org/>

This organization has 30,000 members which contribute to over 12,000 standards as well as test methods, specifications, guides, and practices that support industries and governments worldwide.

**National Environmental Methods Index (NEMI) and National Environmental Methods Index for Chemical, Biological, and Radiological Methods (NEMI-CBR)**

<https://www.nemi.gov/apex/f?p=237:1:3957726782660559>

This index of water quality methods is maintained by numerous water quality experts from federal, state, and local agencies; municipalities; industry; and private organizations. NEMI provides a searchable database of numerous methods. The index provides mainly analytical laboratory method summaries, although some field sampling summaries are also available. NEMI is meant to provide guidance on the implementation of water monitoring strategies.

**U.S. Environmental Protection Agency - Forum on Environmental Measurements: Improving the Quality of Agency Methods**

[http://www.epa.gov/fem/agency\\_methods.htm](http://www.epa.gov/fem/agency_methods.htm)

The purpose of the Forum on Environmental Measurements (FEM) is to improve the quality of EPA methods. FEM aims to develop guidelines for minimum levels of method validation and peer review before materials are issued by EPA. It is comprised of two action teams which act to identify and correct concerns with current EPA issued methods, as well as address the importance of adequate validation across all EPA issued methods.

**U.S. Environmental Protection Agency. *Sample Collection Information Document: Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM) - Revision 5.0 (2010)* EPA 600-R-09-074**

<http://www.epa.gov/nhsrc/pubs/600r09074.pdf>

A companion document to SAM provides information regarding collection of samples for analysis by the methods listed in SAM. This document is intended to provide information regarding sample containers, preservation, size, packaging, and sources for additional information supporting collection of samples to be analyzed using the methods listed in SAM Revision 5.0.

**U.S. Environmental Protection Agency. *Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM) website***

<http://www.epa.gov/sam/index.htm> and <http://www.epa.gov/sam/archive.htm>

The information on this website includes selected methods for use by multiple laboratories when detecting and measuring chemical, radiochemical, pathogen, and biotoxin contaminants during remediation following a homeland security-related contamination incident. The methods are intended for use in evaluating the nature and extent of contamination and assess decontamination efficacy.

### **9.2.2 Biological and Chemical Method Resources**

**U.S. Centers for Disease Control and Prevention. *Biosafety in Microbiological and Biomedical Laboratories (BMBL), 5th Edition (2009) CDC-21-1112***

<http://www.cdc.gov/biosafety/publications/bmb15/index.htm>

Addresses the fundamentals of containment including the microbiological practices, safety equipment, and facility safeguards that protect laboratory workers, the environment, and the public from exposure to infectious microorganisms that are handled and stored in the laboratory.

**U.S. Environmental Protection Agency. *Microbiology Methods and USEPA Methods for Virology website***

<http://www.epa.gov/nerlcwww/microbes/epamicrobiology.html>

This site provides access to microbiology related information that has been developed or managed by the Agency. EPA methods related to bacteria, viruses and protozoans can be found, in addition to links to drinking water health documents and training modules.

**U.S. Environmental Protection Agency. National Exposure Research Laboratory (NERL) - Microbiological and Chemical Exposure Assessment Research Division (MCEARD)**

<http://www.epa.gov/nerlcwww/microbiology.html>

Research performed by NERL provides information on environmental pathways through which contaminants of public health concern are transported to populations at risk. Analytical quantitative methods are developed to accurately and specifically measure human risk factors associated with inhalation, ingestion, and dermal pathways. Surveys and monitoring studies are carried out to determine the levels of hazardous chemicals and microbials in environmental matrices, and human populations are studied to determine significant exposure pathways, the levels of exposure and the sources of exposure factors. State-of-the-art analytical methods are used to measure organic and inorganic chemicals. Genomic and immuno-based methods, as well as traditional cultural methods, are used to measure hazardous bacteria, viruses, fungi and protozoa.

**U.S. Environmental Protection Agency. *Quality Assurance/Quality Control Guidance for Laboratories Performing PCR Analyses on Environmental Samples (2004) EPA 815-B-04-001***

[http://www.epa.gov/nerlcwww/documents/qa\\_qc\\_pcr10\\_04.pdf](http://www.epa.gov/nerlcwww/documents/qa_qc_pcr10_04.pdf)

Provides general guidance for development of laboratory- and method-specific QA/QC procedures for PCR analysis of environmental samples, including QA/QC of reagents, kits, primer sets, and enzymes; method development and assessment; quality control samples for methods using PCR; and data recording, record keeping, and evaluation.

### **9.2.3 Radiological Method Resources**

**U.S. Environmental Protection Agency. *Multi-Agency Radiological Laboratory Analytical Protocols Manual (2004) NUREG-1576, EPA 402-B-04-001A, NTIS PB2004-105421***

<http://www.epa.gov/radiation/marlap/manual.html>

Developed by a number of government agencies, this manual provides a consistent approach to producing radioanalytical data for a program's data requirements, as well as guidance for the planning, implementation, and assessment phases of laboratory analysis projects.

**U.S. Environmental Protection Agency. *Radiological Laboratory Sample Analysis Guide for Incidents of National Significance - Radionuclides in Water (2008) EPA 402-R-07-007***

<http://nepis.epa.gov/Adobe/PDF/60000LAW.PDF>

Guidance on the analysis of water samples that may have been contaminated as the result of a radiological or nuclear event, such as a radiological dispersion device (RDD), improvised nuclear device (IND), or an intentional release of radioactive materials into a drinking water supply. In the event of a major incident that releases radioactive materials into the environment, EPA will turn to selected radioanalytical

laboratories to support its response and recovery activities. In order to expedite sample analyses and data feedback, the laboratories will need guidance on EPA's expectations.

**U.S. Environmental Protection Agency. *Rapid Radiochemical Methods for Selected Radionuclides in Water for Environmental Restoration Following Homeland Security Events (2010)* EPA 402-R-10-001**

[http://www.epa.gov/narel/reports/Rapid\\_Radiochemical\\_Methods\\_In\\_Water\\_with\\_cover\\_06-24-10.pdf](http://www.epa.gov/narel/reports/Rapid_Radiochemical_Methods_In_Water_with_cover_06-24-10.pdf)

Provides rapid radioanalytical methods for selected radionuclides in an aqueous matrix, as developed to expedite the analytical turnaround time necessary to prioritize sample processing.

### 9.2.4 Field Screening Resources

**U.S. Environmental Protection Agency. *Field Screening Equipment Information Document: Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (2010)* EPA 600-R-10-091**

[http://www.epa.gov/sam/Field\\_Screening\\_Equipment\\_Guide.pdf](http://www.epa.gov/sam/Field_Screening_Equipment_Guide.pdf)

This document provides information regarding the capabilities of field equipment currently being used or considered by OSCs for detecting chemical and radiochemical analytes listed in SAM.

**U.S. Department of Homeland Security *Guide for the Selection of Biological Agent Detection Equipment for Emergency First Responders Vols. 1 & 2 (2005)* NIJ Guide 101-04**

[https://www.rkb.us/contentdetail.cfm?content\\_id=97649](https://www.rkb.us/contentdetail.cfm?content_id=97649)

This guides focus on chemical and biological equipment in areas of detection, personal protection, decontamination, and communication. The document focuses specifically on biological agent (BA) detection equipment and was developed to assist the first responder community in the evaluation and purchase of BA detection equipment. It serves as the follow-on document to *An Introduction to Biological Agent Detection Equipment for Emergency First Responders* (NIJ Guide 101-00) published in December 2001.

**U.S. Department of Homeland Security and U.S. Environmental Protection Agency *All Hazards Receipt Facility Screening Protocol (2008)* DHS/S&T 08-0001; EPA 600-R-08-105**

[http://cfpub.epa.gov/si/si\\_public\\_record\\_report.cfm?address=nhsrc/&dirEntryId=199346](http://cfpub.epa.gov/si/si_public_record_report.cfm?address=nhsrc/&dirEntryId=199346)

The protocol described in this document represents the result of a multi-agency effort to develop, construct, and implement All Hazards Receipt Facilities (AHRFs) for screening samples of unknown and potentially hazardous character prior to laboratory receipt and analysis. The effort was initiated in response to requests from state and federal agencies, particularly public health and environmental laboratories, to help protect laboratory facilities and staff.

## 9.3 Laboratory Networks

The following resources include information on laboratory networks that utilities may enlist for certain analytical functions, as described in Section 5.

**Association of Public Health Laboratories**

<http://www.aphl.org/Pages/default.aspx>

This national nonprofit organization represents governmental laboratories that monitor and detect public health threats. It provides a forum for information exchange between public health laboratories and federal agencies as well as for training, education, and research.

**Centers for Disease Control and Prevention (CDC) Laboratory Response Network (LRN)**

<http://www.bt.cdc.gov/lrn/>

This LRN is charged with the task of maintaining an integrated network of state and local public health, federal, military, and international laboratories that can respond to bioterrorism, chemical terrorism and other public health emergencies. There are 150 biological and 46 chemical laboratory members.

**Food Emergency Response Network (FERN)**

<http://www.fernlab.org/>

This organization integrates the nation's food-testing laboratories at the local, state, and federal levels into a network that is able to respond to emergencies involving biological, chemical, or radiological contamination of food. The FERN structure is organized to ensure federal and state inter-agency participation and cooperation in the formation, development, and operation of the network.

**Integrated Consortium of Laboratory Networks**

<http://www.icln.org/>

This organization is a partnership between ten federal government agencies. The goal of the effort is to create the basis for a system of laboratory networks capable of integrated and coordinated response to and consequence management of acts of terrorism and other major incidents requiring laboratory response capabilities.

**International Organization for Standardization**

<http://www.iso.org/iso/home.html>

This organization is a network of the national standards institutes, both public and private, that form the world's largest developer and publisher of International Standards.

**National Animal Health Laboratory Network**

[http://www.aphis.usda.gov/animal\\_health/nahln/](http://www.aphis.usda.gov/animal_health/nahln/)

This network is part of a nationwide strategy to coordinate the work of federal agencies and laboratories managed by state governments and universities providing animal disease surveillance and testing services when a large-scale animal-disease outbreak occurs; tracking its progress and performing diagnostic tests.

**National Plant Diagnostic Network**

<http://www.npdn.org/>

This organization provides a nationwide network of public agricultural institutions with a system to quickly detect high consequence pests and pathogens that have been introduced into agricultural and natural ecosystems and report them to appropriate responders and decision makers. NPDN has invested in plant diagnostic laboratory infrastructure and training, developed an extensive network of first detectors through education and outreach, and enhanced communication among agencies and stakeholders.

**U.S. Environmental Protection Agency - Environmental Response Laboratory Network (ELRN)**

<http://www.epa.gov/oemerln1/>

ELRN is EPA's national network of laboratories that can be accessed as needed to support large scale environmental responses; solely dedicated to the testing of environmental samples. Participation in the ERLN is based on a laboratory's ability to meet the ERLN's core quality requirements, which streamline the network and allow for consistent analytical capabilities, capacities, and quality data that are managed in a systemic, coordinated manner.

**U.S. Environmental Protection Agency - Water Laboratory Alliance**

<http://water.epa.gov/infrastructure/watersecurity/secres/wla.cfm>

EPA's WLA provides the drinking water sector with an integrated nationwide network of laboratories with the analytical capability and capacity to respond to intentional and unintentional drinking water contamination events involving chemical, biological, and radiochemical contaminants.

**U.S. Environmental Protection Agency. *Water Laboratory Alliance –Response Plan (2010)* EPA 817-R-10-002**

[http://water.epa.gov/infrastructure/watersecurity/wla/upload/WLAResponsPlan\\_November2010.pdf](http://water.epa.gov/infrastructure/watersecurity/wla/upload/WLAResponsPlan_November2010.pdf)

This document provides processes and procedures for coordinated laboratory response to water contamination incidents that may require additional analytical support and a broader response than a typical laboratory can provide. The WLA-RP is designed to work within existing ICS structures and procedures.

**U.S. Environmental Protection Agency. *Water Sector Mutual Aid and Assistance: Utilities Helping Utilities (2007)* EPA 817-F-07-015**

[http://www.epa.gov/flowoftheriver/pdf/fs\\_watersecurity\\_warn.pdf](http://www.epa.gov/flowoftheriver/pdf/fs_watersecurity_warn.pdf)

Utilities can leverage laboratory support through intrastate mutual aid and assistance agreements, sometimes known as WARNs. WARNs provide both public and private utilities with emergency assistance through sharing of equipment, personnel, and other resources required for responding to any crisis.

## **9.4 Laboratory Guidance**

The following resources can be leveraged for general laboratory guidance, and are referenced throughout this document.

**American Society for Microbiology**

<http://www.asm.org/>

This organization has 43,000 members and is home to multiple journals, educational opportunities, and publication of texts in the field.

**AOAC International (formerly the Association of Official Analytical Chemists)**

<http://www.aoac.org/>

This organization assists in the development and use of validated analytical methods and laboratory quality assurance programs and services. AOAC is a primary resource for knowledge exchange and laboratory information.

**U.S. Department of Health and Human Services**

<http://www.hhs.gov/>

This organization is the United States government's principal agency for protecting the health of all Americans. In the context of this document, HHS has declared certain pathogens as select agents as safety and security concerns limit the availability of qualified laboratories and methods for select agent analyses.

**U.S. Environmental Protection Agency - Environmental Technology Verification (ETV) Program**

<http://www.epa.gov/etv/>

EPA's ETV program verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. ETV accelerates the entrance of new environmental technologies into domestic and international marketplaces. Verified technologies are included for all environmental media: air, water, and land.

**U.S. Environmental Protection Agency - National Air and Radiation Environmental Laboratory (NAREL)**

<http://www.epa.gov/narel/>

EPA's NAREL provides services to a wide range of clients, including other EPA offices and federal and state agencies. NAREL's mission is a commitment to developing and applying the most advanced methods for measuring environmental radioactivity and evaluating its risk to the public.



**U.S. Environmental Protection Agency - National Exposure Research Laboratory (NERL)**

<http://www.epa.gov/nerl/>

EPA's Drinking Water Research is directed to achieve three long term goals: (1) provide scientific support for EPA's implementation and reevaluation of existing regulations; (2) provide a scientific foundation for decisions on emerging and currently unregulated contaminants; and (3) provide data, tools and technologies to protect source waters and distribution systems.

**U.S. Environmental Protection Agency - National Homeland Security Research Center (NHSRC)**

<http://www.epa.gov/nhsrc/>

EPA's NHSRC assists with improving water security through detection of water contamination events caused by CBR agents, minimizing exposure and damage to infrastructure from contamination events, treating water and decontaminate water infrastructure, and assessing and communicating risks.

**U.S. Environmental Protection Agency - Office of Ground Water and Drinking Water (OGWDW)**

<http://water.epa.gov/drink>

EPA's OGWDW, together with states, tribes, and many partners, will protect public health by ensuring safe drinking water and protecting ground water. This is accomplished using the following principles: prevention as an effective approach; risk-based priority setting for new and existing regulations, based on sound science, quality data in reliable databases, and quality methods and standards; partnership and involvement of public and private organizations, citizens, and communities; flexibility and effectiveness in implementation while maintaining a national public health baseline; accountability of all parties through public participation and accessible information; and results documented and presented clearly.

**U.S. Environmental Protection Agency - Office of Research and Development (ORD)**

<http://www.epa.gov/ord/>

EPA's ORD uses scientific study to protect the quality and sustainability of water resources, ensure that treatment facilities are capable of controlling waterborne contaminants, understand and manage health risks associated with public water supplies, prevent and mitigate impacts of water distribution and storage systems on drinking water quality, and improve infrastructure reliability and sustainability.

**U.S. Environmental Protection Agency - Office of Water (OW)**

<http://water.epa.gov/>

EPA's OW provides oversight for the quality of drinking water, ground water, watersheds, and aquatic habitats. In addition, OW provides guidance to regional, state, and local governments in terms of specifying methods, data collection, and other outreach activities related to water quality. It includes the OGWDW, Office of Science and Technology, Office of Wastewater Management, and Office of Wetlands, Oceans and Watersheds.

**U.S. Environmental Protection Agency - Technology Testing and Evaluation Program (TTEP)**

<http://www.epa.gov/nhsrc/ttep.html>

EPA's Homeland Security Research Program has developed TTEP to conduct third-party performance evaluations of commercially available homeland security related technologies. TTEP tests technologies that are readily available to facility or building managers, responders, or those responsible for site decontamination.

**U.S. Environmental Protection Agency - Water Security Division (WSD)**

<http://water.epa.gov/infrastructure/watersecurity/>

EPA's Water Sector Security Mission is to provide national leadership in developing and promoting security programs that enhance the sector's ability to prevent, detect, respond to, and recover from all-hazards. This site provides resources for water utilities, state and local governments, public health

Guidance for Building Laboratory Capabilities to Respond to Drinking Water Contamination officials, emergency responders and planners, assistance and training providers, environmental professionals, researchers and engineers, law enforcement, and others.

**U.S. Environmental Protection Agency, Water Security Initiative**

<http://water.epa.gov/infrastructure/watersecurity/lawsregs/initiative.cfm>

EPA’s Water Security (WS) initiative is a program that addresses the risk of intentional contamination of drinking water distribution systems. EPA established this initiative in response to Homeland Security Presidential Directive 9, under which the Agency must “develop robust, comprehensive, and fully coordinated surveillance and monitoring systems, including international information, for...water quality that provides early detection and awareness of disease, pest, or poisonous agents.”

**Water Information Sharing and Analysis Center (WaterISAC) Portal**

<https://portal.waterisac.org/web/>

This organization’s mission is to keep drinking water and wastewater utility managers informed about potential risks to the nation's water infrastructure from contamination, terrorism and cyber threats. The mission has been expanded to help utilities respond to and recover from all hazards.

**Water Research Foundation**

<http://www.waterrf.org>

This organization forms a partnership with over 900 utilities, 40 consulting companies, manufacturers, and regulators that help advance research in treatment, distribution, resources, monitoring and analysis, management, and health effects issues with drinking water.