Waterworks Emergency Response Planning Standard

EPB 540

November 15, 2012

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1. Introduction

The purpose of this standard is to assist a drinking water management group in preparing a Waterworks Emergency Plan (WEP). The WEP deals specifically and solely with the waterworks but could be incorporated in a municipality's or another organization's larger emergency plan. Other styles and forms of emergency plans may be acceptable to or required by the Water Security Agency based on the local situation. Please contact your local Environment Officer for more information.

An emergency is an unforeseen or unplanned event that may degrade the quality or quantity of potable water supplies available to serve customers. A written emergency response plan for a waterworks allows operating personnel to respond efficiently, effectively and rapidly to an emergency situation. Water quality, system safety and system reliability are improved if a utility has a plan of action to respond to emergencies.

The WEP is an integral part of the comprehensive management plan of a waterworks including the source water, water treatment and distribution system. In the event of an emergency, the plan and associated measures will help to:

1. ensure the safety and reliability of the drinking water supply;
2. assist personnel to quickly determine and perform the proper remedial actions; and
3. reduce recovery times and costs following the emergency.

The preparation of an emergency plan assumes the existence of normal operations manuals; however, in many cases, these do not exist. Before preparing a WEP, normal operating manuals need to be prepared or obtained. The WEP shall cover the most probable emergency situations, including both routine problems (such as main breaks) and disasters (such as the occurrence of a tornado). The WEP needs to be easy to use and understand, outlining step-by-step procedures to follow in the event of a specific emergency. The preparation of the plan needs to involve significant input from operational personnel.

Emergency response planning generally involves three phases. The initial evaluation phase includes the definition of emergency types for a facility, risk evaluations and the development of a work plan for further emergency planning. The second phase involves the actual development of a formal plan based on the requirements identified in the initial phase. The third phase describes the measures, which are necessary to acquire competency in implementing the plan and ensuring its continued operation.

A Waterworks Emergency Planning Task Force (WEPTF) shall be identified in the initial stages of planning. It is this group's job to complete the emergency response planning process and to review the plan periodically to ensure the accuracy of the information contained within. In addition, the WEPTF shall review the WEP after an emergency situation to ensure that the actions plans were and still are appropriate. The task force needs to consist of technical employees of the water system, local health authorities, local Water Security Agency staff and official(s) of the consumers of the water.

One of the most important actions that can be taken by a water system is the mitigation of risks prior to an emergency. Mitigation actions cover a wide range of activities and can be as simple as installing locks on well lids or as complex as retrofitting an entire water system in order to minimize the probability of an emergency occurring or to minimize the effects of an emergency. During the planning process, many vulnerable components are identified and response plans are developed. Mitigation actions need to be taken, where possible, to minimize the effect of any disaster or emergency however this topic is not covered in detail in this document.

2. Phase I: Hazard and Risk Evaluations

Prior to the development of the actual Waterworks Emergency Plan, it is necessary as an initial step to identify the potential types of emergency situations, determine the associated hazards and evaluate the risks to the water system. A hazard is a source of potential damage associated with a disaster/emergency. Examples are found in Table 2-A.

This process will identify the range of potential causes and consequences of emergency situations and provide the framework for further development of an emergency response plan.

2.1. Step 1: Determine the Possible Disasters, Emergencies and Hazards

The types of emergency situations shall be determined so that appropriate response procedures are prepared. Generally, emergency situations may result from the occurrence of a fire, water contamination, equipment failures, process breakdown, natural phenomena or civil disturbance. All may have the potential to develop into an emergency situation or disaster. Help may be sought from your Environment Officer or an emergency planning expert.

The following are examples of possible situations:

- tornadoes
- flooding (danger to intake, higher turbidity, higher bacteria)
- fire (forest fire in water shed or firefighting with system water)
- other severe weather
- waterborne diseases
- construction or transportation accidents
- vandalism, riots and terrorism
- strikes
- loss of source
- water quality degradation
- treatment process malfunction (pump failure, power failure, lack of settling)
- contamination of source (ie. leakage of gas or other hazardous material into a water course)
- backflow conditions
- broken water main
- chlorine gas leaks
- other

After determining all the possible disasters that may occur and affect your water system, a hazard summary shall be completed. Table 2-A is an *example* of a hazard summary and can have elements added or removed as necessary. A hazard summary is a list of disasters and emergencies that may affect a water system, the hazards associated with them and the potential magnitude of the hazards. In addition, the situation shall be categorized into one of the following four categories: routine problem, minor emergency, major emergency, or disaster. A routine problem is one that can be handled by personnel and equipment currently on duty. A minor emergency can be handled by on duty staff but requires that additional staff be notified, given related work or work additional shifts. A major emergency requires personnel and equipment beyond the capabilities of those on duty. A disaster is an emergency where the problems are immediately beyond the capability of the staff of the waterworks and the repair costs and the time required will be extensive.

Table 2-A – Example Emergency Hazard Summary[1]

Type of Emergency or Disaster	Associated Hazards	Estimated Probability[2]	Category of Emergency
Tornados	High winds	Low	Disaster
Floods	Inundate facilities, disrupt power and transportation and communications, contaminate water supplies	Medium	Minor emergency to disaster
Forest fire	Fire	Medium	Minor emergency to disaster
Blizzard	High winds, high snowfall	Medium	Routine to disaster
Extreme Heat	Heat	Medium	Routine to major emergency
Wind	High winds	Low	Routine to major emergency
Lightning	Fires, electric shock	Medium	Routine to major emergency
Waterborne diseases	Widespread sickness	Low	Major emergency
Water Quality Degradation	Various	Medium	Routine to major emergency
Broken water main	Contamination	High	Routine to major emergency
Treatment process breakdown	Various	High	Routine to major emergency

1. This table is for illustration purposes only and the data contained within may not be assumed to be correct for every situation.
2. The estimated probability could change over time such as risk of blizzards is high in the winter and non-existent in the summer. The value for this column needs to be achieved by asking oneself, " Over the average year, what is the chance that this type event will happen with enough severity to cause an emergency?"

2.2. Step 2: Identify the Separate Components of the Total Water System

This step involves completing a vulnerability assessment. A comprehensive review and evaluation of all aspects of the operation is necessary to identify all potential events or conditions that could lead to personnel loss, property loss, environmental loss or water contamination.

Key elements of the total system shall be listed and described as components under the following general headings: (1) administration and operations, (2) source water, (3) transmission system, (4) treatment facilities, (5) storage, (6) distribution system, (7) electric power, (8) transportation, and (9) communications, (10) consumers. See Appendix A for a list of suggested major components.

System components need to be described in as much detail as possible. System maps or, where possible, geographical information system (GIS) files shall be included and a description of the system needs to be written.

2.3. Step 3: Estimate the Potential Effects of Probable Hazards

To complete this step, the effects of the emergencies and their associated hazards are evaluated for each component of the total system. This can be accomplished using a form like Table 2-B.

Natural disasters can create many conditions for contaminated water to enter distribution systems. Ground movement caused by frost heave will cause pipes and storage facilities to fail. Floodwaters can wash away soil, which supports pipelines, causing them to break. Floodwaters may be contaminated with untreated sewage and other contaminants. Tornadoes, ice storms and windstorms can also cause damage to distribution systems when the ground is disrupted due to fallen trees and utility poles.

Emergencies such as a treatment process failures or backflow conditions generally have less of an effect on physical components than natural disasters such as tornadoes but process failures may have consequences just as large or larger for the consumers of your water; i.e. a failed process may allow a pathogen into the drinking water system.

Table 2-B - Emergency Effects Matrix

System components - likely damage, loss or shortage due to hazards	Tornado	Floods	Forest Fire	Other Severe Weather	Waterborne Disease	Hazardous Material	Structure Fire	Construction Accidents	Transportation Accidents	Vandal, Riots, Terrorism	Strike	Loss of Source	Water Quality	Contamination of Source	BackFlow Conditions	Broken Water Main	Chlorine Gas Leaks	Spill of Chlorinated Water	Treatment Breakdown	Other
(1) Administration and operations																				
personnel																				
facilities and equipment (buildings and computers)																				
records																				
emergency Plan																				
(2) Source water																				
watersheds and surface water sources																				
reservoirs and dams																				
groundwater sources																				
wells and galleries																				
(3) Transmission system																				
intake structures																				
aqueducts																				
pump stations																				
pipelines, valves, and other appurtenances																				
(4) Treatment facilities																				
facility Structures (buildings, basins and tanks)																				
controls (manual and computer)																				
equipment (feeder, pumps and piping)																				
chemicals																				
(5) Storage																				
tanks																				
valves																				
piping																				
(6) Distribution system																				

System components - likely damage, loss or shortage due to hazards	Tornado	Floods	Forest Fire	Other Severe Weather	Waterborne Disease	Hazardous Material	Structure Fire	Construction Accidents	Transportation Accidents	Vandal, Riots, Terrorism	Strike	Loss of source	Water Quality Degradation	Contamination of Source	BackFlow Conditions	Broken Water Main	Chlorine Gas Leaks	Spill of Chlorinated water	Treatment break down	Other
pipelines, valves, and other appurtenances																				
pump or pressure reducing stations																				
materials (extra pipe, valves, hydrants, etc.)																				
(7) Electric power																				
substations																				
transmission lines																				
transformers																				
standby generators																				
(8) Transportation																				
vehicles (including construction equipment)																				
maintenance facilities																				
supplies, spare parts and fuel																				
roadway infrastructure																				
(9) Communications																				
telephone																				
radio																				
telemetry																				
mass media outlets (such as newspaper, radio and television)																				
(10) Consumers																				
increased risk of chronic sickness																				
increased risk of acute sickness																				
aesthetically less pleasing																				

Place an ‘X’ where the system component is affected by the emergency.

2.4. Step 4: Establish Performance Goals.

A water system is considered an essential service, as it is necessary for the safety and health of the population it serves. A utility needs to develop specific goals and acceptable levels of service under disaster, emergency and recovery conditions. Some examples of performance goals and acceptable levels of performance are:

- high-quality water – supply consumers with sufficient quantities of safe and acceptable water.
- fire suppression – supply enough water for fire suppression and make such water available as soon as possible after an emergency.
- public health needs – supply the following needs with potable water in the allowable time span after an emergency. Please note that the following are a guide only.
    - hospital – continuous
    - emergency shelters – immediately
    - kidney dialysis – 24 hours
    - waste disposal – 72 hours
- commercial and business uses – supply businesses relying on water as soon as possible.

2.5. Step 5: Work Plan for Further Emergency Planning

Steps one through four shall provide planners with a complete list of all potential emergency hazards, risks and consequences. A working plan for the development of the actual emergency response plan shall then be devised using the data and analysis completed during the hazard definition and risk evaluation effort. The components of a Waterworks Emergency Plan are dealt with in Phase 2.

3. Phase 2: Emergency Response Plan Development

This section of the guide outlines the typical Waterworks Emergency Plan (WEP), general content, format, requirements and considerations.

In order to meet the needs of a specific water supplier and the requirements of *The Environmental Management and Protection Act, 2010* all WEP's shall be clear, concise and easy to use. The WEP needs to be indexed for ready reference. Diagrams, check lists and charts may be used to show the organization, summarize the duties and responsibilities, illustrate the alarm or response initiation procedures and to show how the organization will respond during both normal and off-duty hours. Plans are used infrequently and details are hard to remember; therefore a well-organized simple plan is usually the most effective.

Section 1 Table of Contents

The first page of the document shall include a list of all elements of the WEP.

Section 2 Introduction and Policy Statement

The introductory section of the WEP shall set the terms of reference (what the plan specifically addresses) and scope (the extent of these considerations) for the document. In addition, the performance goals and acceptable levels of performance shall be laid out.

Section 3 Telephone/Contact Lists

This section of the emergency plan shall include a current and complete list of all employees, people, organizations or other necessary contacts including their alternates and their 24-hour contact telephone numbers. The responsibility for revising the list and distributing it shall be assigned to one person. This section of the plan shall also include a list of off-site emergency organizations available to provide assistance together with a summary of their capabilities and limitations.

The list shall include contact information for WEPTF members, priority customers (child care facilities, senior citizen homes, bakeries, water companies, breweries, organizations for the immuno-suppressed, etc.) and Water Quality Crisis Management Center members (explained later).

Section 4 Organization & Responsibilities

A description of the facility's organizational structure is necessary in order to define personnel functions and responsibilities in the event of an emergency incident. Organization and reporting structure charts may be useful in this application.

The Waterworks Emergency Planning Task Force (WEPTF) shall identify a Waterworks Emergency Command Center. The Command Center needs to be equipped with communications equipment, infrastructure system maps, records and other emergency equipment. In addition to the Command Center, the WEPTF may wish to establish a Water Quality Crisis Management Cell (CMC), whose members may be the same or differ from the WEPTF members. During an emergency, personnel in the Water Quality Crisis Management Cell need to report to the command center. Some of the members of the CMC have authority positions that are designated by the Waterworks Emergency Planning Task Force. All authority positions may be designated to one person (as may occur in a small community) or to different people. However, each member of the CMC does not require an Authority position. In general, the Water Quality Crisis Management Cell is responsible for making decisions during a crisis and for the reporting of the incident when complete. Members of the WEPTF, municipal authorities, waterworks employees and government representatives all shall be considered for membership in the CMC.

Types of Authority positions could include:

1) Water Quality Crisis Coordinator:
   This individual coordinates all emergency actions, personnel and equipment. This position classifies all emergencies and disasters, determines whether a trigger event (defined later in the explanation of Section 6) has been met, sets into motion the technical action plans and contacts the crisis management team. The Water Quality Crisis Coordinator is usually the manager of the waterworks (or equivalent) or town administrator.

2) Public Relations Coordinators (2):
   There needs to be two spokesperson authority positions, one for technical matters and the other to represent the municipality or corporation. Both these authority positions may be assigned to one person or to two separate people. All the infrastructural facilities including support staff and hotline facilities need to be made available to CMC and the Public Relations Coordinator(s). The spokesperson(s) must have experience and knowledge of the local water system and strong management capabilities. All media enquiries and public enquiries need to be directed to CMC. The CMC shall be informed about the ongoing activities about the situation and the updated activities need to be made available to the public through the Public Relations Coordinator. One possible technical spokesperson is the waterworks manager or operator. The municipal spokesperson is typically the mayor or administrator.

3) Crew Foreman:
   This person would coordinate, supervise and schedule personnel, equipment and materials to facilitate the repair or replacement of critical drinking water facilities, which have been prioritized by the CMC and Water Quality Crisis Coordinator.

Classification of the Emergency or Disaster

The classification of the emergency or disaster will be the decision of the Water Quality Crisis Coordinator and it will be communicated to other personnel of the water system. Every emergency/incident is classified into one of four categories.

Level 1: Normal (routine) incident – Personnel and equipment currently on duty can handle the problem. There will be no effect on subsequent shifts or future operations. The CMC is not activated.

Level 2: Minor emergency – Personnel and equipment currently on duty can handle the emergency, but requires that additional staff be notified, given related work tasks, or work additional shifts. The CMC is activated and the Waterworks Emergency Command Center is staffed.

Level 3: Major emergency – The problems are beyond the capabilities of the drinking water system staff and equipment. Requires personnel work extra shifts and they may need the assistance of outside help. The CMC is activated and the Waterworks Emergency Command Center is staffed.

Level 4: Disaster – Problems are clearly and immediately beyond the capability of the drinking water system. The costs will be great and the repair time will exceed one week. The assistance of outside personnel and equipment will be required. The CMC is activated and the Waterworks Emergency Command Center is staffed.

Section 5 Notification and Communication

The purpose of this section is to identify a process for system personnel to notify system users about an emergency and for system users to notify system personnel about an emergency.

System personnel shall develop a plan that describes how to react to a system emergency. Proper reaction includes a two-way communication of information. System personnel need to be able to notify system users and develop a plan of action to solve any emergency problems that may arise.

In general, a waterworks incident needs to follow these steps:

1. the waterworks owner/operator(s) monitor the distribution system and treatment plant for trigger events (as defined in section 6). The local Health District monitors the public for a public health trigger;
2. all incidents are reported to the Water Quality Crisis Coordinator;
3. the Water Quality Crisis Coordinator evaluates the event, determines if a trigger has been met and classifies all events even those without a technical action plan (TAP) (see section 6).
4. The Water Quality Crisis Coordinator activates the Water Quality Crisis Management Cell (CMC), if called for;
5. The CMC directs the implementation of the TAP and recommends further actions, if required. This may require the notification of the Emergency Measures Organization for the municipality or corporation;
6. The CMC utilizes the Communication Plan to advise the public.
7. When the emergency is over, CMC is deactivated; and
8. The Water Quality Crisis Coordinator prepares a report on the incident and presents it to the Waterworks Emergency Planning Task Force for evaluation.

There shall be a plan to guide and control the quick and accurate dissemination of information in the event of an emergency related to drinking water. Under the direction of the CMC and the Water Quality Crisis Coordinator, the Public Relations Coordinator(s) provides accurate information to the media, stakeholders and the public in the event of a water system emergency.

A communications plan shall be developed by the WEPTF in preparation for a possible emergency. The primary function of the communications plan is to notify residents and users of the emergency and what is being done to deal with it.

The communications plan shall consist of standard official statements to be used by the Public Relations Coordinator(s) and released as written communications. Also emergency “hotline” plans, web site update plans (if applicable) and information materials need to be included.

System personnel will typically inform system users using one or more of the following methods:

- phone
- phone tree
- flyer
- personal contact
- media release
- door to door or
- other

System users need to also be given the names and phone numbers of the system personnel to contact in case of an emergency. Typically, billing or newsletters are used to provide this information.

Media Communications

Local media can also be used to carry warnings to the public if the problem is serious enough. Make sure you contact your local radio, television and newspapers when completing your Emergency response plan in order to ensure that if you ever do have to call, they’ll know who you are and cooperate to ensure that their readers or listeners are informed. Media contact information needs to be included and contain phone numbers, addresses and names. When contacting the media, be prepared to answer questions and give statements that may be broadcast.

Official Statements

The statements listed below shall be included in your Waterworks contingency and usually will not be found in your Corporate/Municipal Emergency Plan.

- Emergency Boil Water Order Has Been Issued
- Emergency Boil Water Order Has Been Rescinded
- Precautionary Drinking Water Advisory Has Been Issued
- Precautionary Drinking Water Advisory Has Been Rescinded
- Refute a False Water Contamination Report

Signs

All example signs (Precautionary Drinking Water Advisory & Emergency Boil Water Order) are available from the Water Security Agencies document entitled “Bacteriological Follow-up Standard for Waterworks, November 1, 2012, EPB 505”.

Section 6 Technical Action Plans
The Technical Action Plan (TAP) is a listing of the primary measures to be employed to control or combat an emergency incident. A TAP shall specify actions to take for each particular type of emergency or disaster listed and described in Phase I.

Trigger events shall be identified for each emergency. A trigger event is a definable event, which causes a TAP to be activated when it occurs. These trigger events will determine what type of emergency (routine, minor, major) or disaster each situation is and the steps to follow. In some cases, emergencies are related to a regulatory issue. The trigger event for these problems does not need to be the levels laid out in regulation. It may be better to set a level somewhat more conservative as a trigger event so compliance with legislation is always achieved. For example, a waterworks may wish to take action when chlorine levels drop to 0.7 mg/l total chlorine or 0.5 mg/l free chlorine rather than the regulatory minimum of 0.5 mg/l total chlorine and 0.1 mg/l free chlorine.

Operators of a small water system need only to list those actions, which they must carry out immediately to deal with the specific emergency situation. Longer-term solutions to correct the situation can be developed with the assistance of the Water Security Agency and other experts after the initial actions have taken place.

Initially, the Water Quality Crisis Coordinator begins the remedial actions. After the Water Quality Crisis Management Cell is activated, its members direct the action taken and ensures that the TAP is followed.

Section 7 Appendices
The purpose of this section is to serve as a repository for detailed reference material that may be used for training or needed during an emergency. Material generated in Phase 1 and 3 shall be included here. Plot plans, maps, process diagrams, flow charts, Material Safety Data Sheets (MSDS) for all chemicals and equipment lists shall be included in this section. In addition, potential effects charts and lists of system components shall be included here.

Other possible appendices to a Waterworks Emergency Plan may be found in Appendix C: Example Appendices of a Waterworks Emergency Plan.

4. Phase 3: Employee Training and Plan Review

Competency in responding to emergency incidents requires that each person must completely understand his or her role and responsibilities. Training is necessary to ensure the best possible response capability. Provision of training is a part of a complete emergency planning and implementation effort. Emergency response training needs to be in addition to operator certification.

Training is generally provided:

- for new employees during their introductory period;
- for transferred or promoted employees;
- when new equipment or materials are introduced which affect the response in an emergency;
- when emergency procedures are revised; and
- at least annually.

Testing of the plan needs to be performed periodically so all individuals involved are aware of their duties.

The plan shall be reviewed annually by the WEPTF to ensure that it is still valid.

References

American Water Works Association. *Emergency Planning for Water Utilities Manual of Water Supply Practices M19*. 4th ed. Denver: American Water Works Association, 2001.

American Water Works Association. *Workshop S6 The How, Where and Why of Applying HACCP to Water, Workshop Manual.* American Water Works Association, 2002.

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Environmental Protection Agency. *Guidance for Water Utility Response, Recovery & Remediation Actions for Man-Made and/or Technological Emergencies.* Office of Water, 2002.

Dyches, Kim. *Drinking Water System Emergency Response Guidebook.* Utah: Division of Drinking Water, 2001.

American Water Works Association. *AWWA Standard for Disinfecting Water Mains C651-99*. Denver: American Water Works Association, 2000.

Alberta Agriculture, Food & Rural Development. *Shock Chlorination and Control of Iron Bacteria.* Available on-line: http://www.agric.gov.ab.ca/agdex/700/16d12.html#shock.

Appendix A - Major system components

1. Administration and operations
    - personnel
    - facilities and equipment (buildings and computers)
    - records
    - emergency plan
2. Source water
    - watersheds and surface water sources
    - reservoirs and dams
    - groundwater sources
    - wells and galleries
3. Transmission system
    - intake structures
    - aqueducts
    - pump stations
    - pipelines, valves and other appurtenances
4. Treatment facilities
    - facility Structures (buildings, basins, and tanks)
    - controls (manual and computer)
    - equipment (feeder, pumps, and piping)
    - chemicals
5. Storage
    - tanks
    - valves
    - piping
6. Distribution system
    - pipelines, valves and other appurtenances
    - pump or pressure reducing stations
    - materials (extra pipe, valves, hydrants, etc.)
7. Electric power
    - substations
    - transmission lines
    - transformers
    - standby generators
8. Transportation
    - vehicles (including construction equipment)
    - maintenance facilities
    - supplies, spare parts, and fuel
    - roadway infrastructure
9. Communications
    - telephone
    - radio
    - telemetry
    - mass media outlets (such as newspaper, radio and television)
10. Consumers
    - increased risk of acute sickness
    - increased risk of chronic sickness
    - aesthetically less pleasing

Appendix B - Checklist for Emergency Plan Preparation

1.0 Pre-WEP planning

- ❑ standard operating manuals

2.0 Phase 1 Documentation

- ❑ emergency effects matrix
- ❑ system description
- ❑ 2.0 Emergency Phone Contact List Including
- ❑ personnel
- ❑ government Agencies
- ❑ repair Services
- ❑ priority Customers
- ❑ utilities
- ❑ miscellaneous

3.0 Organizational Responsibilities

- ❑ Waterworks Emergency Planning Task Force Members
- ❑ Crisis Management Cell members and their positions
- ❑ organizational chart
- ❑ typical emergency response steps

4.0 Notification and Communication

- ❑ notification of customers procedures
- ❑ customer notification of waterworks personnel procedures
- ❑ media contact information
- ❑ standard statements
- ❑ example signs and documents

5.0 Technical Action Plans

- ❑ possible emergency situations
- ❑ trigger events
- ❑ actions
- ❑ contacts

6.0 Map of System Showing

- ❑ mains
- ❑ critical control points
- ❑ schools, day cares centres, hospitals, long-term care facilities
- ❑ other

7.0 Electrical Schematics

- ❑ generators
- ❑ other

8.0 General Procedures

- ❑ generator start-up
- ❑ power source change over
- ❑ disinfectant operation
- ❑ disinfectant procedures for well and distribution system

9.0 Training Procedures

- ❑ training manuals

Appendix C: Example Appendices of Waterworks Emergency Plan
Example Appendix – Emergency Effects Matrix

System components - likely damage, loss or shortage due to hazards	Tornado	Floods	Forest Fire	Other Severe Weather	Waterborne Disease	Hazardous Material	Structure Fire	Construction Accidents	Transportation Accidents	Vandal, Riots, Terrorism	Strike	Loss of Source	Water Quality Degradation	Contamination of Source	BackFlow Conditions	Broken Water Main	Chlorine Gas Leaks	Spill of Chlorinated Water	Treatment Breakdown	Other
(1) Administration and operations																	X	X		
personnel				X	X			X	X	X	X		X							
facilities and equipment (buildings and computers)	X	X	X				X			X	X	X								
records	X	X	X				X			X	X									
emergency plan	X	X																		
(2) Source water																				
watersheds and surface water sources		X	X		X	X				X		X	X	X				X		
reservoirs and dams	X	X			X	X				X	X	X	X	X				X		
groundwater sources		X			X	X						X	X	X	X			X		
wells and galleries	X	X		X	X	X				X		X	X	X	X					
(3) Transmission system																				
intake structures	X	X		X					X	X										
aqueducts								X	X											
pump stations	X	X	X	X			X	X	X	X	X									
pipelines, valves and other appurtenances				X				X		X		X	X	X	X	X			X	
(4) Treatment facilities																				
facility Structures (buildings, basins and tanks)	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	
controls (manual and computer)	X	X	X	X			X	X	X	X	X									
equipment (feeder, pumps and piping)	X	X	X				X	X	X	X	X	X	X	X	X		X		X	
chemicals	X	X	X				X										X			
(5) Storage																				
tanks	X		X	X	X	X	X		X			X	X		X		X		X	
valves				X					X								X			
piping				X													X			
(6) Distribution system																				
pipelines, valves, and other appurtenances				X	X	X	X	X				X	X		X	X			X	
pump or pressure reducing stations	X	X	X	X			X	X	X				X							
materials (extra pipe, valves, hydrants, etc.)		X	X														X			

(7) Electric power																				
substations	X	X	X	X			X	X	X	X										
transmission lines	X	X	X	X			X	X	X	X										
transformers	X	X	X	X			X	X	X	X							X			
standby generators		X					X			X							X			
(8) Transportation																				
vehicles (including construction equipment)	X	X	X	X				X	X		X									
maintenance facilities	X	X	X	X			X		X	X	X									
supplies, spare parts and fuel		X	X				X			X							X			
roadway infrastructure		X		X				X	X	X										
(9) Communications																				
telephone	X	X	X	X			X	X	X	X										
radio										X										
telemetry	X	X	X							X										
mass media outlets (such as newspaper, radio and television)	X	X	X							X	X									
(10) Consumers																				
increased risk of chronic sickness					X	X				X		X	X	X	X	X	X		X	
increased risk of acute sickness		X			X	X				X	X	X	X	X	X	X	X		X	
aesthetically less pleasing		X			x	X				X	X	X	X	X	X	X			X	

Table C. 1- Emergency Effect Matrix

Example Appendix – Emergency Disinfection of the Distribution System

Disinfection methods for water mains
Disinfection is performed in accordance with AWWA Standard C651. Three forms of chlorine may be used for disinfection including liquid chlorine, liquid sodium hypochlorite and calcium hypochlorite, which is available in granular form or tablets. Three disinfection methods are included in the standard, as summarized in the below table. The utility may select the most appropriate method for each specific application.

Disinfection Methods for Water Mains					
Disinfection Method	**Chlorine Dose**	**Contact Time**	**Application**	**Advantages**	**Disadvantages**
Tablet	25 mg/L	24 to 48 hours	Mains up to 24 inches. Not to be used on solvent-welded plastic or screwed joint steel pipe.	Requires no special equipment.	No preliminary flushing. Main kept clean & dry during construction. Chlorine conc. not uniform. Tablets may dissolve slowly under stagnant conditions.
Continuous Feed	10 mg/L free chlorine residual after contact time	24 hours	General	Uniform chlorine concentration.	
Slug	50 - 100 mg/L	3 hours	Large diameter mains, long mains.	Reduced volume of heavily chlorinated water to be disposed.	

Source: AWWA (1992)

Disinfection does not occur until the chlorine demands are met. Chlorine demand is caused by the pipe's interior surface, pipe joint lubricant, rust from connected mains, construction dirt and the water used to fill the main.

The use of too much chlorine can be a problem. Not only may the taste and odor be unacceptable, but the production of trihalomethanes such as chloroform and chlorate from calcium hypochlorite makes the disinfected water unusable in the distribution system.

Example Appendix – Disinfection of Wells

Shock Chlorination Procedure for Drilled Wells

A modified procedure is also provided for large diameter wells.
Caution: If your well is low yielding or tends to pump any silt or sand, you must be very careful using the following procedure because over pumping may damage the well. When pumping out the chlorinated solution, monitor the water discharge for sediment.

Follow these steps to shock chlorinate your well.
Step 1 Store sufficient water to meet needs for 8 to 48 hours.

Step 2 Pump the recommended amount of water (see Table 1, Amount of Chlorine Required to Obtain a Chlorine Concentration of 1000 PPM) into clean storage. A clean galvanized stock tank or pickup truck box lined with a 4 mil thick plastic sheet is suitable. The recommended amount of water to use is twice the volume of water present in the well casing. To measure how much water is in the casing, subtract the non-pumping water level from the total depth of the well. See the example below.

Metric Example

The drilling record indicates the casing is 61 meters in length and the non-pumping ("static") water level is 30.5 meters ft. The length of casing that is holding water in it is 30.5 m. (61-30.5). If your casing is 150 mm. in diameter you need to pump 35.3 litres of water for every meter of water in the casing, into your storage container. Since you have 30.5 m. of water in the casing, you will pump 35.3 L./m. x 30.5 m. = 1077 litres. of water into storage.
Using Table 1, calculate how much water you need to pump into clean storage.
Casing diameter_________ needs_________L/m. x __________ m. = __________ L.

Table 1 Amount of Chlorine Required to Obtain a Chlorine Concentration of 1000 PPM-Metric

Casing diameter	Volume of water needed per 1 meter of water	5 ¼% domestic chlorine bleach - litres needed per 1 meter of water	12% industrial sodium hypochlorite - litres needed per 1 meter of water	70% high test hypochlorite - dry weight[1] per 1 meter of water
mm	(L)	(L)	(L)	(g)
100	15.7	0.30	0.13	102.0
150	35.3	0.67	0.29	229.5
200	62.8	1.2	0.52	408.0
600	565.4	10.8	4.7	3672.4
900	1272.3	24.2	10.6	8262.9

Imperial Example

The drilling record indicates the casing is 200 ft. in length and the non-pumping ("static") water level is 100 ft. The length of casing that is holding water in it is 100 ft. (200-100). If your casing is 6 in. in diameter you need to pump 2.4 gal. of water for every foot of water in the casing, into your storage container. Since you have 100 ft. of water in the casing, you will pump 2.4 gal./ft. x 100 ft. = 240 gal. of water into storage.
Using Table 2, calculate how much water you need to pump into clean storage.
Casing diameter_________ needs_________gal./ft. x __________ ft. = __________ gal.

Table 2 Amount of Chlorine Required to Obtain a Chlorine Concentration of 1000 PPM-Imperial

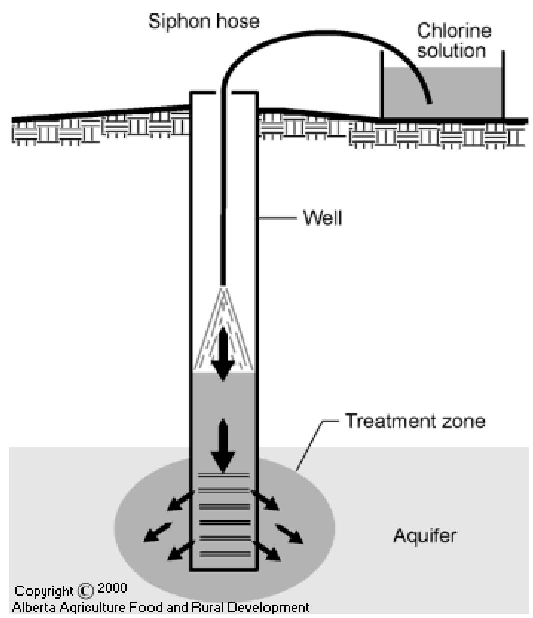
Casing Diameter	Volume of water needed per 1 foot of water	5 ¼% domestic chlorine bleach - litres needed per 1 foot of water	12% industrial sodium hypochlorite - litres needed per 1 foot of water	70% high test hypochlorite - dry weight[1] per 1 foot or water
(in)	(gal Canadian)	(gal)	(gal)	(oz)
4	1.1	0.02	0.01	0.25
6	2.4	0.05	0.02	0.56
8	4.3	0.08	0.04	1.0
24	39.1	0.74	0.33	9.0
36	87.9	1.7	0.73	20.1

[1] Since a dry chemical is being used, it needs to be mixed with water to form a chlorine solution before placing it in the well.

12% industrial sodium hypochlorite and 70% high test hypochlorite are available from:

- Water treatment suppliers
- Drilling contractor (s)
- Swimming pool maintenance suppliers
- Dairy equipment suppliers
- Some hardware stores.

Figure 1 Siphoning Chlorine Solution



Caution: Chlorine is corrosive and can even be deadly. If your well is located in a pit, you must make sure there is proper ventilation during the chlorination procedure. Well pits are no longer legal to construct. Use a drilling contractor who has the proper equipment and experience to do the job safely.

Step 3 Calculate the amount of chlorine that is required, as shown in Table 1 and Table 2. Mix the chlorine with the previously measured water to obtain a 1000 ppm chlorine solution.

Calculating Amount of Chlorine Metric Example

If your casing is 150 mm. and you are using 12% industrial sodium hypochlorite, you will require .29 litres per m of water in the casing. If you have 30.5 m. of water in the casing, you will use 0.29 litres x 30.5 m. = 8.85 litres of 12% chlorine.
Using Table 1, calculate the amount of chlorine you will need for your well.
Casing diameter_______ Chlorine strength_______
Gallons needed per 1 m. of water______ x _______ m. of water in casing = ______ litres of chlorine.

Calculating Amount of Chlorine Imperial Example

If your casing is 6 in. and you are using 12% industrial sodium hypochlorite, you will require .02 gal per ft. of water in the casing. If you have 100 ft. of water in the casing, you will use 0.02 gal x 100 ft. = 2.0 gal of 12% chlorine.

Using Table 2, calculate the amount of chlorine you will need for your well.

Casing diameter_______ Chlorine strength_______
Gallons needed per 1 ft. of water______ x _______ ft. of water in casing = ______ gal of chlorine.

Step 4 Siphon this solution into the well (see Figure 1, Siphoning Chlorine Solution).

Step 5 Leave the chlorine solution in the well and distribution system for 8 to 48 hours. The longer the contact time, the better the results.

Step 6 Open an outside tap and allow the water to run until the chlorine odor is greatly reduced. Make sure to direct the water away from sensitive plants or landscaping.

Step 7 Flush the chlorine solution from the well and piping.

If you have an old well that has not been routinely chlorinated, consider hiring a drilling contractor to thoroughly clean the well prior to chlorinating. Any floating debris needs to be removed from the well and the casing scrubbed or hosed to disturb the sludge buildup.

Modified Procedure for Large Diameter Wells
Due to the large volume of water in many bored wells the above procedure can be impractical. A more practical way to shock chlorinate a bored well is to mix the recommended amount of chlorine right in the well. The chlorinated water is used to force some of the chlorine solution into the formation around the well. Follow these steps to shock chlorinate a large diameter bored well.

Step 1 Pump 200 gal. (1000 L) of water into a clean storage tank at the well head.

Step 2 Mix 20 L of 5 1/4% domestic chlorine bleach (or 8 L of 12% bleach or 1.4 kg of 70% calcium hypochlorite) into the 200 gal. of stored water. This mixture will be used later in Step 4.

Step 3 Using Table 2 (or Table 1 for metric calculations) calculate the amount of chlorine you require per foot of water in the casing and add directly into the well. (Note that the 70% hypochlorite powder needs to be dissolved in water to form a solution before placing in the well.)

Step 4 Siphon the 200 gal. bleach and water solution prepared in Steps 1 and 2 into the well.

Step 5 Complete the procedure as described in Steps 5 to 7 for drilled wells.

Parts of this section are reprinted from *Shock Chlorination and Control of Iron Bacteria* and are available on-line at http://www.agric.gov.ab.ca/agdex/700/16d12.html#shock with the permission of Alberta Agriculture, Food & Rural Development.

Example Appendix – Alternate Source of Water

Alternate water supply
Besides boiling the water during an emergency situation, people need to be informed about alternatives such as water bottlers and household filters, which they can use if necessary. This will lessen the problems of the people, if they don't want to boil the water. The municipal authorities need to keep a list of agencies.

Emergency water source

During an emergency situation, if the outbreak persists for a long period, boiling the water or looking for bottled water may frustrate people. It may become necessary to create a central water supply area from where people can get clean safe water. People may find it more convenient to haul treated water home from a central supply area rather than boiling large quantities for drinking and food preparation. There are also small package treatment plants that could be used during such situations. Another option for a central supply is to haul treated water from a nearby community. Cash flow has to be available to meet the situation so funds need to be reserved. A list of bottled water distributors shall be included.

Example Appendix - Customer Complaint Tracking Form

Water Quality Complaint and Inquiry Form

Date: Day: _______________ Month: ______________ Yr: ____________ Time: ____________
Caller: Name:__________________________ Phone (H): _______________ (W): ___________
Address: ____
Complaint (tastes, odour, sediment, colour): _____________________________________
____
____
____
____

Questions:

1. When did this problem begin (date): ____
2. Does it involve: hot water line:__________ cold water line: _________ both: __________
3. Water foam? yes: _______ no: ________
4. Water softener, in-line filter, dishwasher connection: on this line? yes: ______ no: ________
5. Occurring right now? yes: _____ no: ______ If no, when did it stop: ___________________
   When does it occur? ____
   ____
6. Do your neighbours have the same problem? yes: _____ no: _____ n/a: _____
7. Smells/tastes like chlorine/swimming pool/Javex? yes: _____ no: _____
8. If cloudy, ask them to put it in a clear glass and see if it clears from the bottom up? yes: ____ no: ____ n/a: _____
9. If rotten egg/septic/fishy, ask them to take water from another sink to see if smell still occurs? yes: _____ no: _____ n/a: _____
10. If salty, ask them to rinse their mouth and re-taste to see if still occurs? yes: _____ no: _____ n/a: _____
11. Noticed any construction or street work in your area recently? no: ____ yes: _____ if yes, when: _____________________
12. Has there been any plumbing work done in your house recently? no: _____ yes: _____ If yes, describe:____
    ____
    ____

Sampling and Testing

Faucet Location	Location	Chlorine (mg/L)		Turbidity (NTU)	Aesthetics/Description	Lab Number	Lab Results
		Free	Total				