



Manual of Naval Preventive Medicine

Chapter 5

WATER QUALITY FOR SHORE INSTALLATIONS

DISTRIBUTION STATEMENT "A"

This publication supersedes NAVMED P-5010-5 of 2008

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NAVMED P-5010-5

Chapter 5 Manual of Naval Preventive Medicine Water Quality for Shore Installations

1 Jul 2019

To: Holders of the Manual of Naval Preventive Medicine

1. Purpose. This revision provides general public health and preventive medicine guidance for Department of the Navy personnel concerned with the medical surveillance of public water systems at shore facilities.
2. Background. This manual is applicable to all Navy medical assets. All continental United States Navy and Marine Corps public water systems must comply with Federal law. For outside the continental United States locations, Navy and Marine Corps public drinking water systems must comply with final governing standards or Department of Defense Overseas Environmental Baseline Guidance Document as applicable and Commander, Navy Installations Command or Marine Corps Installations Command guidance.
3. Action. Replace entire Chapter 5 with this version.



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Acting

Releasability and distribution:

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CHAPTER 5 WATER QUALITY FOR SHORE INSTALLATIONS

SECTION I. GENERAL INFORMATION

5-1. Purpose

1. This chapter provides general public health and preventive medicine guidance for Department of the Navy (DON) personnel concerned with medical surveillance of public water systems (PWS) at shore facilities. This chapter also provides technical information on PWSs to help preventive medicine authorities to understand water treatment processes, distribution system components, and Federal and Navy regulations and requirements, and to properly address and manage public water quality issues and any public health risks related to public water supply. All PWSs must be properly operated and maintained to supply safe and aesthetically pleasant water and to comply with all Federal and State regulations as well as Department of Defense (DoD) and DON directives, policies, and standards.

2. DoD and DON policies and guidance, roles and responsibilities for safe and sanitary operation of PWSs that supply drinking water to consumers on DON installations are characterized in this section and detailed throughout this chapter. Navy medical personnel assigned to billets that include responsibilities for public health surveillance of drinking water quality play a critical role in preventing waterborne disease outbreaks and detecting water quality problems and public health risks, in order to protect the lives and health of water system consumers.

3. Sections II and III of this chapter provide an overview of drinking water fundamentals and compliance requirements set forth by regulatory agencies. Information provided in these sections is meant to provide necessary knowledge to the preventive medicine authorities for successful execution of drinking water surveillance responsibilities. Sections IV and V provide specific guidance to preventive medicine authorities on the implementation and execution of a public health drinking water surveillance program. Section VI provides information about the Navy's overseas drinking water program along with a description of unique aspects of Navy overseas drinking water programs. Extensive endnotes that provide supplemental information and sources to explore topics annotated with superscript numerals in greater detail are provided in Appendix A.

5-2. References. See Appendix B of this chapter.

5.3. Terms and Definitions, Acronyms, and Abbreviations. The glossary provided in Appendix C defines terms as they are used in this chapter. A list of acronyms and abbreviations used in this chapter is provided in Appendix D.

5-4. Background

1. The Safe Drinking Water Act (SDWA) was signed into law on 16 December 1974. The SDWA and subsequent amendments directed the U.S. Environmental Protection Agency (EPA) to develop Federally enforceable National Primary Drinking Water Regulations (NPDWR) (<https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations>) for a PWS. As a result of this legislation, primary enforcement authority (primacy) has been delegated to the individual states (except District of Columbia and Wyoming).

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2. Under the SDWA, EPA has developed National Secondary Drinking Water Regulations (NSDWR) (<https://www.epa.gov/dwregdev/drinking-water-regulations-and-contaminants#Secondary>) for all PWSs. NSDWR refer to contaminants that may affect the aesthetic quality of drinking water. Unlike the NPDWR, the NSDWR are not federally enforceable, but may be incorporated into State law and enforced by respective states.

5-5. Policy

1. It is DON policy that all Navy and Marine Corps PWSs be operated and maintained to comply with Federal and State laws and regulations as well as DoD and DON policies.

2. DoD Instruction 4715.06, Environmental Compliance in the United States, sets forth policy that all PWSs serving DoD installations in the United States must comply with the SDWA along with applicable EPA rules. Regulations for drinking water purchased or produced at Navy and Marine Corps installations outside the continental United States (OCONUS) are included in environmental documents published by DoD. These DoD regulations do not apply to contingency operational and training deployments off-base, U.S. naval vessels, and U.S. military aircraft.

3. This chapter defines safe drinking water and potable water as water that has been confirmed via testing to meet established health-based water quality standards and is fit for human consumption. Fit for human consumption is the term that is used by the U.S. Navy to indicate that the water is safe for drinking, cooking, bathing, showering, dishwashing, and maintaining oral hygiene. Thus, for the purposes of this chapter, potable water is safe drinking water that is fit for human consumption.

4. Environmental Final Governing Standards (FGS) for drinking water quality standards have been established for specific OCONUS DoD installations.

5. When Environmental FGS have not been established for OCONUS DoD installations, refer to the overseas environmental baseline guidance document for the drinking water quality standards.

6. References (a) and (b), set forth the policies and procedures for implementing the SDWA and the Federal drinking water regulations found in reference (c), parts 141-143. The NPDWR are published in reference (c), part 143. Reference (b) addresses in CONUS, OCONUS, and overseas policies and procedures for Marine Corps installations. Reference (b) is available at [https://www.marines.mil/Portals/59/MCO% 20P5090.2A% 20W% 20CH% 201-3.pdf](https://www.marines.mil/Portals/59/MCO%20P5090.2A%20W%20CH%201-3.pdf).

7. At Navy installations overseas (those that are not located in a U.S. territory or possession), overseas drinking water program standards and requirements are contained in references (d) through (f), addressed in section VI of this chapter.

8. Reference (g), provides guidance and assigns roles and responsibilities for medical personnel assigned to billets that involve public health surveillance of Navy and Marine Corps drinking water programs.

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5-6. Responsibilities

1. Commander, Navy Installations Command (CNIC). Serves as executive agent for drinking water quality matters for all Navy shore facilities and installations worldwide as described in reference (a).
2. Chief, Bureau of Medicine and Surgery (BUMED)
 - a. Provides consultative services to CNIC, Marine Corps Installations Command and Navy Facilities Engineering Command (NAVFAC) headquarters for drinking water quality exceedances and concerns, per references (a) and (g).
 - b. Formulates and disseminates Navy Medicine policy and guidance related to drinking water quality.
 - c. Provides medical representation at all overseas drinking water and Executive Water Quality Oversight Council meetings.
3. Commander, Navy and Marine Corps Public Health Center (NAVMCPUBHLHCEN)
 - a. Provides subject matter experts (SME), to include public health advice and consultation for water quality concerns, formal public health risk assessments and risk communication support to shore, afloat, and field commands as requested or required per reference (g).
 - b. Appoints SMEs to serve as the NAVMCPUBHLHCEN representatives to the CNIC Water Quality Oversight Council staff body.
 - c. Maintains and updates Navy Medicine policy and guidance related to drinking water quality as needed.
 - d. Ensures that the preventive medicine authority training course is in alignment with the guidance issued by Commander, Navy Medicine Education, Training and Logistics Command regarding curriculum management and development, including maintaining and updating the formal Catalog of Navy Training Courses (CANTRAC) annually.
 - e. Provides SME support as the public health lead on CNIC Water Quality Oversight Council sanitary surveys.
4. Navy Medicine East and West Preventive Medicine Authorities
 - a. Provides direct medical drinking water surveillance program oversight for all Navy and Marine Corps installations within their respective areas of responsibility (AOR) per reference (g).

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b. For locations within CNIC's overseas drinking water program, appoints in writing, preventive medicine representatives (i.e., environmental health officer (EHO), or preventive medicine officer) to serve as the preventive medicine authority on the applicable Navy regional Water Quality Boards (WQB) within their AOR.

c. Conducts audits and site assessments of medical treatment facilities within the respective AOR tri-annually for compliance with reference (g) and other drinking water program responsibilities.

d. Navy Medicine regional preventive medicine authorities advise all Navy regional preventive medicine authorities and installation preventive medicine authorities, and serve as liaison with BUMED, NAVMCPUBHLTHCEN, etc.

5. Navy Regional WQB Preventive Medicine Authority

a. Per reference (g), serves as the medical representative on the applicable regional WQBs.

b. Provides public health advice and consultation to the applicable Navy regional commanding officers (CO) on health aspects of drinking water quality.

c. Advises designated regional public works department, environmental, and command personnel on health aspects of a public health notice and assists with risk communication as needed.

d. For locations within CNIC's overseas drinking water program, participates in CNIC Water Quality Oversight Council sanitary surveys and quarterly regional conference calls within the designated Navy region.

e. Completes the Preventive Medicine Authority CANTRAC course and obtains/maintains a thorough knowledge of the drinking water program within 4 months of assignment.

6. NAVFAC. Per reference (a), NAVFAC supports CNIC on all aspects of drinking water system management, including, but not limited to: operation, maintenance, repair, compliance testing results from U.S. accredited and certified laboratories, and compliance with applicable drinking water standards.

7. Shore Installation COs

a. As described in reference (a), ensure the installation is in compliance with all Federal, State, and local regulations, Executive Orders, and Navy and Marine Corps policy pertaining to drinking water. This includes planning, programming, and budgeting resources to meet requirements. The installation CO is responsible for ensuring Consumer Confidence Reports (CCR) and public notifications are released and distributed when applicable.

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b. Per OPNAV N45 letter, N45 Ser/16U132466 of 14 Oct 16, Navy Policy Requirements for Drinking Water Exceedances (<https://www.med.navy.mil/sites/nmcphc/program-and-policy-support/water-sanitation-and-safety/Pages/default.aspx>), in lieu of an official change to reference (a) in its next revision, in the event of an exceedance of a drinking water maximum contaminant level (MCL), action level (AL), health advisory or other promulgated drinking water quality standard in the United States and overseas:

(1) Consult with the local preventive medicine authority regarding whether to provide alternate water supplies to all Navy consumers or a subset of Navy consumers.

(2) Consider input from state or local regulators (in the United States), the installation WQB (for overseas), the installation public works officer and the environmental and utilities staff prior to deciding to provide alternate water.

(3) If alternate water supply is required, request a formal public health risk assessment from the NAVMCPUBHLTHCEN to determine whether the installation water system(s) in exceedance may be used for other specific consumptive purposes.

(4) Continue to work with the preventive medicine authority, state and local regulators until the exceedance is resolved.

8. Installation Preventive Medicine Authority

a. Per reference (g), the preventive medicine authority has an advisory role and provides public health related consultant assistance as needed.

b. Provides preventive medicine oversight of medical surveillance aspects of the drinking water system such as liaison with public works (water purveyor), certified water laboratory, and local, State, and Federal regulatory authorities as applicable. The installation preventive medicine authority should develop a medical surveillance program for their AOR based on local considerations. A drinking water medical surveillance program standard operation procedures (SOP) template is provided in Appendix F of this chapter and is available for download from NAVMCPUBHLTHCEN at <http://www.med.navy.mil/sites/nmcphc/program-and-policy-support/water-sanitation-and-safety/Pages/default.aspx>.

c. Monitors local disease surveillance data at least 3 times a week for events that may indicate a drinking water quality issue.

d. Per OPNAV N45 letter, N45 Ser/16U132466 of 14 Oct 16, "Navy Policy Requirements for Drinking Water Exceedances," in lieu of an official change to reference (a) in its next revision, in the event of an exceedance of a drinking water MCL, AL, health advisory or other publicized drinking water quality standard in the United States and overseas:

(1) When notified of an exceedance by the installation CO or designated representative, immediately consults with the NAVMCPUBHLTHCEN.

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(2) As advised by NAVMCPUBHLTHCEN, provides recommendations to the installation CO on whether to provide alternate water supplies to all Navy consumers or a subset of Navy consumers.

(3) They may not override a regulatory requirement to provide alternate water, but may advise the installation CO to implement measures that are more protective than the regulatory requirements.

e. Provides assistance to Public Works as requested to ensure that all chemicals which are direct or indirect additives to drinking water supplies are National Sanitation Foundation (NSF)/American National Standards Institute (ANSI) Standard 60 certified, and that all materials and components used in the distribution system are NSF/ANSI Standard 61 certified.

f. The preventive medicine authority is appointed in writing by the installation CO to the installation WQB as applicable.

g. Completes the preventive medicine authority CANTRAC course within 4 months of assignment and maintains thorough knowledge of all applicable DoD and DON water system regulations, policies, and guidance.

h. Collects water samples for medical surveillance monitoring per an established sampling plan that ensures adequate representation of the overall distribution system and performs testing of the water samples for disinfectant residual, pH (potential of hydrogen), total coliform and Escherichia coli (E. coli).

i. Per BUMEDINST 6240.12, enters all drinking water program medical surveillance data in the Defense Occupational & Environmental Health Readiness System (DOEHRS) Industrial Health (IH) - Environmental Health (EH) module.

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SECTION II. WATER QUALITY COMPLIANCE

5-7. Water Sources

1. General

a. Drinking Water Sources. The water utility or public works department must identify the source of the public water supply. Drinking water comes from surface and ground water sources. Large-scale water supply systems tend to rely on surface water sources, while smaller water systems tend to use ground water. Slightly more than half of the population receives their drinking water from ground water sources, including the millions of Americans who use ground water as private drinking water wells.

b. Surface Water. Surface water is an open body of water. Surface water includes rivers, seas, oceans, lakes and reservoirs that receive water from precipitation, runoff from higher elevations, or recharge from ground water moving below the stream or lake bed. Compared to ground water, surface water is generally more vulnerable to microbial and chemical contamination through runoff from contaminated sources of mining, industrial, urban and agricultural areas.

c. Ground Water. Ground water can be drawn directly by tapping into springs or by pumping from wells that are drilled into aquifers. Ground water collects in geologic formations called aquifers. Aquifers contain saturated permeable material that yields water to wells and springs. An aquifer serves as a transmission conduit and storage reservoir that transports water under a hydraulic or pressure gradient from recharge areas to water-collecting areas. Water can be brought to the surface through natural springs or by pumping. Drinking water wells may be shallow (50 feet (ft.) or less) or deep (more than 1,000 ft.). The quantity and quality of water in an aquifer depend on the nature of the rock, sand, or soil in the aquifer from which the well withdraws water. Generally, ground water is considered to be free from pathogenic organisms. This is based on the assumption that soil acts as an effective treatment media removing harmful microorganisms. The “filtered” microorganisms subsequently find themselves unable to multiply and eventually die. When rain or snow falls onto the earth, a portion of the precipitation seeps into the ground to replenish ground water. Therefore, well construction and wellhead protection are critical for preventing a ground water source from becoming contaminated.

d. Ground Water under Direct Influence of Surface Water (GWUDISW). There are cases where surface water can influence ground water supplies, thus causing the ground water to become vulnerable to microbial contamination. The ground water is then considered to be under the direct influence of surface water. Each well source serving a PWS must be evaluated to determine whether or not the well is directly influenced by surface water, in which case the ground water is classified GWUDISW as stipulated per reference (c), part 141.2. If the source of a water system is determined to be GWUDISW, the system must comply with the same treatment and monitoring requirements as a surface water system.

e. Source Water Contamination and Protection. Contaminants can be introduced into ground water, rivers, lakes, and streams through infiltration and runoff from a variety of sources including

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septic tanks and cesspools, surface impoundments, lawn care, gardening and agricultural activities, landfills, underground storage tanks, abandoned and waste water effluent injection wells, spills, storm water runoff and systems, illegal dumping and highway de-icing. This introduction of pollutants directly relates to drinking water safety and public health.

2. Ground Water² (Wells and Springs)

a. General

(1) Ground water is usually an excellent water supply source. Such water can be expected to be clear, cool, colorless and quite uniform in character. It is generally of better microbiological quality and contains much less organic material than surface water, but may be highly mineralized. Section III, article 5-22 of this chapter provides a detailed overview of ground water rule requirements.

(2) Some ground water contains high levels of iron, manganese and hardness (i.e., mainly high levels of magnesium and calcium) that may alter aesthetical water quality (e.g., discoloration) and create problems in water system components (e.g., fixture staining or pipe/system scaling).

(3) Approximately 15 percent of the U.S. population relies on their own private drinking water supplies (i.e., not a PWS). These supplies are not subject to EPA regulations (i.e., NPDWR), although some State and local governments do set rules to protect users of these wells.

(4) Contaminants can be introduced into ground water through infiltration from a variety of surface sources or injection of contaminants through wells. Depending on the hydrogeological setting, contaminants may migrate and pollute ground water far away from the source. Wells that are improperly constructed or abandoned provide a direct conduit for surface contaminants to migrate to ground water. Therefore, proper siting (far from potential contamination sources) and construction of wells are essential to reduce the risk of ground water contamination.

b. Wells. Structures created by digging, boring or drilling to access ground water in underground aquifers. Ground water is normally drawn by pumping from aquifers. Wells generally serve small to medium-size installations, although a system of multiple wells may be used to develop a supply for a large installation. Some Navy installations or their satellite facilities depend primarily or partially on their own wells for water supplies.

(1) Types of Wells. Wells are classified according to the construction method, i.e., dug, bored, driven, drilled or jetted. Each type of well has distinguishing physical characteristics that are best used to satisfy a particular need. Unified Facilities Criteria (UFC) 3-230-02 describes particular well types and design considerations. Dug, driven, and bored type wells are susceptible to contamination and generally have poorer water quality than drilled wells.

(2) Sanitary Wellhead Protection. Proper sanitary measures must be taken to ensure ground water pumped from a well is safe for human consumption. Potential sources of contamination may exist above or below ground level. Where possible, wells will be located on

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ground that is higher than potential contamination sources. The area must be well drained to divert surface waters from the well and reduce the possibility of flooding. The following are guidelines for the sanitary protection of wells:

(a) The annular space outside the casing must be filled with water-tight cement grout per the EPA Manual of Individual and Non-Public Water Supply Systems or State regulations.

(b) For artesian aquifers, the casing must be sealed into the overlying impermeable formations to retain the artesian pressure.

(c) When a water-bearing formation containing poor quality water is penetrated, the formation must be sealed off to prevent the infiltration of water into the well and developed aquifer.

(d) Every well must be provided with an overlapping watertight cover at the top of the casing (sanitary seal), and a raised pipe sleeve to prevent contaminated water or harmful materials from entering the well.

(e) All abandoned wells must be plugged and properly sealed, as required by State, Federal or local authority, to prevent aquifer contamination and for safety reasons. Proper sealing of any abandoned well aims to restore the controlling geological conditions that existed before the well was constructed. If properly restored, an abandoned well will not create a physical or health hazard. American Water Works Association (AWWA) Standard A100 series provides further guidance on this subject.

(f) A well is most susceptible to contamination from the immediate surrounding area. Table 5-7-1 lists the suggested minimum distance a well must be located from sources³ of contamination. In some areas, soil and rock formations may require increased distance. Contact the primacy agency and local health departments for site specific regulations including various setback distances. Standard policy must include a sanitary survey conducted by qualified individuals prior to the construction or drilling of any new well with nearby potential contamination sources.

Table 5-7-1 - Minimum distance between wells or springs and various potential sources of contamination⁴	
Potential Contamination Source	Distance to Well or Spring (feet)
Sewer Line (watertight)	50
Septic Tank (watertight)	50
Petroleum Tanks	100
Liquid-Tight Pesticide and Fertilizer Storage and Handling	100
Disposal Field	100
Seepage Pit	150
Cesspool	150
Manure Stacks	250

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(3) Disinfection. Disinfection of all wells must be per UFC 3-230- 02, State requirements and AWWA Standard C654 latest edition.

(a) Well disinfection is required after construction, cleaning or removal of repair equipment. The PWS must document the following:

1. The procedure used for disinfection.
2. Calculations of the quantity of water in the well based on the depth of water and the diameter of the casing.
3. Pumping records showing the number of chlorine applications and pumping rounds and the quantity of chlorine solution used to obtain a distinct chlorine odor and a free available chlorine (FAC) measurement of 100 parts per million (ppm).
4. Use of an appropriate mixing method such as a clean hose that is raised and lowered to all depths within the well.
5. Use of a spray nozzle to disinfect the inside of the casing and the outside of the riser.

(b) Following disinfection, the well must stand for 24 hours and then be flushed by pumping to waste until the water is clear. The well must be pumped to waste until the chlorine drops to approximately 1 ppm FAC. The PWS must then collect at least two samples not less than 30 minutes apart for total coliform bacteriological analysis. Wells may be returned to service only when all test results show absence of total coliforms. If any test results detect total coliforms, the well disinfection process must be repeated. New wells should be tested for organic and inorganic chemical contaminants once disinfection is complete.

(c) Dug Wells. This type of well is used as a last resort and only in emergency situations because of high susceptibility to contamination. After the casing or lining is completed and prior to placing the cover over the well, the well must be disinfected through the following process:

1. Remove everything (e.g., tools, equipment and structures) that will not remain in the well.
2. Determine the quantity of water in the well and the amount of disinfecting solution needed.
3. Scrub the casing or lining wall with a stiff broom or brush and a 100 ppm chlorine solution.
4. Place the well cover in position and introduce the disinfecting solution through a clean hose that is raised and lowered to all depths of the well water.

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5. Wash the outside of the pump cylinder and piping as the unit is lowered into the well.

(d) After the pump is in place, pump the water until a distinct odor of chlorine is detected, at which point test the chlorine residual. When the FAC level reaches 100 ppm, allow the well to stand for 24 hours before pumping the well to waste until the chlorine residual is reduced to 1 ppm. When water sample test results show 1 ppm FAC, collect at least two samples not less than 30 minutes apart for total coliform bacteriological analysis. Return the well to service only when all test results show absence of total coliform bacteria. If any sample detects total coliform, repeat the well disinfection process. Test water quality in new wells for organic and inorganic chemical contaminants.

c. Springs

(1) Springs. Springs are formed at the intersection of an aquifer with the ground surface, or by leakage of an artesian aquifer through a fracture or solution zone.

(2) Spring Contamination and Source Protection. Contrary to popular belief, spring water is not always of good microbiological quality. Contamination concerns associated with a spring water source are usually higher than for a ground water source. Extreme caution must be exercised in the development of springs for potable water use. Generally, the same principles that apply to location, protection, development and operation of wells apply to springs. The factors presented in this chapter for well location must also be considered when conducting a sanitary inspection of a spring. When used as a water source, spring water is generally captured in a small catchment reservoir to enclose and intercept as much of the spring as possible.

(3) Collection System. A spring water collection system is similar to a ground water well and must be evaluated to determine whether it is influenced by surface water when serving as a public water supply. The vulnerability assessment and ensuing mandatory treatment and disinfection requirements of springs determined to be under the influence of surface water are comparable to those described in article 5-12.2. However, there are additional assessment criteria that apply to spring water sources:

(a) Presence of an impervious barrier over the collection pipes to keep rainwater runoff from contaminating the spring.

(b) Presence of a diversion ditch around the upper end of the spring area.

(4) Spring Disinfection. Spring encasements must be disinfected by scrubbing the inside of the encasement above the water line with a stiff brush or broom and 100 ppm chlorine solution. When the flow can be stopped or maintained within the encasement, determine the volume of water and add enough chlorine solution to obtain a 100 ppm FAC residual in the water. Let the spring stand 24 hours and discharge to waste until the FAC residual is approximately 1 ppm. Take samples and place in service as described for wells. When the spring flow cannot be stopped,

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continuously feed enough chlorine into the contained water in the spring encasement, near the inlet, to result in 100 ppm FAC in the outlet. This residual must be maintained for at least 24 hours.

d. Modification of Sources. Sources deemed under the influence of surface water may be altered in some cases to eliminate the surface water influence provided the primacy agency or the Water Quality Oversight Council for OCONUS PWS approves the modifications. Possible modifications include the following:

- (1) Trenching to divert surface runoff from springs.
- (2) Redeveloping springs to capture them below a confining layer.
- (3) Covering open spring collectors.
- (4) Reconstructing wells to install sanitary seals and screen them in a confined aquifer.
- (5) Repairing cracks or breaks in any type of source collector that allows the entry of surface water.
- (6) Discontinuing the use of infiltration laterals that intercept surface water.
- (7) If modification is not feasible, another alternative may be to develop a new well either deeper or at a different location. An extended period of monitoring should follow reconstruction (at least 2 years) to assess whether the influence of surface water has been eliminated.

3. Surface Water. It is generally obtained from rivers, streams, and lakes. The ease of physical and microbiological contamination of surface water requires consideration of additional factors, not usually associated with ground water sources, when selecting surface water sources. As a general rule, surface water should only be used when ground water sources are not economically justifiable or are of inadequate quality or quantity.

a. Source Selection. In examining surface waters for potential use as drinking water sources, several interrelated factors must be carefully considered. These include, but are not limited to, sources of pollution, hydrological studies, proposed intake location and water uses identified by responsible governmental agencies for the particular water source. Prior to making a final determination regarding the acceptability of the source, raw water quality should be examined and a treatment scheme proposed to ensure applicable regulations are followed and to provide the best possible water supply for the Navy and Marine Corps. Acute health effects from exposure to microbial pathogens (viruses, bacteria and protozoa) are documented and associated illness can range from mild to moderate cases lasting only a few days to severe infections lasting several weeks and possibly resulting in death for those with weakened immune systems.

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b. Treatment. As amended, the Surface Water Treatment Rule (SWTR) seeks to ensure that surface water is adequately treated to protect drinking water from microbial contaminants including viruses, *Legionella*, *Giardia lamblia*, and *Cryptosporidium*. Section III, article 5-21 of this chapter provides an overview of these regulations under the heading SWTR.

c. Recreational Use of Surface Sources. Surface waters that are used as a potable water source may have desirable recreational qualities, e.g., fishing, boating, picnicking and swimming. A surface water source must not be used for drinking water purposes if the water treatment plant does not include filtration or if sedimentation, resulting from storage in reservoirs followed by chlorination, is the only treatment provided. Care must be exercised in determining what types of recreational activities (swimming, boating, etc.) are suitable for these waters. Periodic sanitary surveys must be conducted to evaluate the impact of recreational uses on these water sources (e.g., potential for hydrocarbons and other toxic chemicals spills). See NAVMED P-5010-4 for recreational water sanitation requirements.

d. Surface Water Source Contamination. Compared to ground water, surface water sources are more vulnerable to contamination through both runoff and ground water infiltration from a variety of contamination sources. Runoff from surface areas in a watershed, either near a drinking water supply intake or in upstream tributaries, may contain contaminants, including human or animal wastes. In addition, contaminated ground water may recharge streams or lakes spreading the contamination to a surface water source.

4. Bottled Water

a. Bottled water is classified as a food product per federal law and DoD regulations. Reference (h), parts 129 and 165 provide the Food and Drug Administration rules for bottle water. Army Regulation 40-657/NAVSUP 4355.4H/MCO P10110.31 H, *Veterinary/Medical Food Safety, Quality Assurance, and Laboratory Service*, sets forth the DoD approval process for bottled water sources. Only DoD approved bottled water sources are acceptable for use.

b. Bottled water must only be acquired from U.S. Army Public Health Center approved sources. A list of approved sources can be found in the *Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement*⁷.

c. Bottled water must not be stored in direct sunlight. It should be stored in shaded, well-ventilated areas, and in boxes that keep the packages upright. Bottled water should be managed on a “first in – first out” basis. Improperly storing bottled water in sunlight may affect the water temperature, which in turn may support bacteria growth and impact taste. Field deployment settings require additional monthly microbiological testing of bottled water by the Preventive Medicine Authority, consistent with guidance contained in NAVMED P-5010-10.

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5-8. PWS Classification

1. PWS. The SDWA defines a PWS as a system for provision to the public of water for human consumption through pipes or other constructed conveyances that has at least 15 service connections or regularly serves an average of at least 25 individuals daily for at least 60 days out of the year. Such systems may be owned by homeowner associations, investor-owned water companies, local governments, or others. Water that does not come from a public water supply, and does not meet the definition of a public water supply is considered a private water supply and is not covered by SDWA rules. State or local health departments often have rules governing private water supplies.

2. PWS Classification. EPA classifies PWSs according to whether they serve the same customers year-round or on an occasional basis, and the source of their water.

a. Three types of PWSs according to whether they serve the same customers year-round or on an occasional basis

(1) Community Water System (CWS). A PWS that serves the same population year-round.

(2) Non-Transient Non-Community Water System (NTNCWS). A PWS that regularly serves at least 25 of the same people at least 6 months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals that have their own water systems.

(3) Transient Non-Community Water System (TNCWS). A PWS that does not regularly serve at least 25 of the same individuals over 6 months per year. Examples include a gas station or campground where people do not remain for long periods of time. The SDWA applies to these systems with different rigor, based on consumer exposure to potential contaminants. The TNCWS must comply only with regulations that govern contaminants (such as microbiology and nitrate/nitrite) creating acute health effects, but are not regulated for contaminants (such as organic carcinogens) that cause health effects associated with long-term exposure. The NTNCWS must comply with all regulations that apply to community water systems. As a general rule, if the Navy or Marine Corps owns and operates a water system that includes a housing area, the system is a CWS. However, some remote range and testing facilities may fall under NTNCWS.

b. PWS classification according to the source of water

(1) Surface Water System. A PWS using a surface water source.

(2) GWUDISW. GWUDISW includes any water beneath the surface of the ground with significant occurrence of insects or other macro-organisms, algae, or large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*; or significant and relatively rapid shifts in water characteristics, such as turbidity, temperature, conductivity or pH, that closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources per criteria established by the State. The Water Quality Oversight Council (or the primacy agency in the United States) determination of direct influence may be based on site-specific

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measurements of water quality and documentation of well construction characteristics and geology with field evaluation. Once the source water of a system is determined GWUDISW, the system is subject to the same treatment and monitoring requirements as surface water systems.

(3) Ground Water System. A PWS using a ground water source, provided that it does not combine all its ground water with surface water or GWDUISW prior to treatment.

c. Consecutive Water System. CONUS military installations generally obtain fit for human consumption water from a State-approved municipal PWS. References (a), section 21-5.5 and (b)⁸ define a consecutive water system as a water system that has no water production, treatment, or source facility of its own, and obtains all of its water from another water system. Consecutive water systems must perform sampling and testing to comply with applicable Regulatory authority. The NAVFAC User's Guide, UG-2034-ENV⁹ provides compliance guidance to consecutive systems.

(1) Reference (c), part 141.29, consecutive systems section, gives the primacy agency the option to consider a supplier and a consecutive system as a single system or separate systems for the purposes of monitoring under any of the drinking water regulations. CONUS military installations must consult with their primacy agency for status and compliance requirements.

(2) Per references (c), part 141.3 and (a), section 21-3.3, consecutive PWSs generally are not subject to requirements of the SDWA if they satisfy the following requirements:

(a) Consist of distribution and storage facilities only and provide no treatment.

(b) Obtain all drinking water from a regulated water supplier.

(c) Do not sell drinking water.

(d) Do not provide water to commercial carriers conveying passengers in interstate commerce.

(3) Per reference (a), section 21-3.4, Navy water systems including consecutive water systems are, at a minimum (emphasis added), required to comply with regulations pertaining to those contaminants that could be contributed by the consecutive PWS distribution system downstream of the point of connection to the regulated PWS. As specified in OPNAVINST 5090.1 section 8, regardless of variances and exemptions from regulatory monitoring (emphasis added), shore facilities that own and operate a consecutive water system must perform the following monitoring:

(a) Bacteriological

(b) Arsenic

(c) Asbestos

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- (d) Lead in priority areas
- (e) Lead and copper in water systems
- (f) Radionuclides
- (g) Unregulated Contaminants as applicable

(h) Requirements mandated by surface water treatment rules (SWTR), interim enhanced surface water treatment rule (IESWTR), long-term 1 enhanced surface water treatment rule (LT1ESWTR), long-term 2 enhanced surface water treatment rule (LT2ESWTR), and filter backwash recycling rule), as applicable.

- (i) Ground water rule requirements, as applicable

(j) Applicable Requirements mandated stage 1 and stage 2 disinfection and disinfectant byproduct rule (DBPR)

(4) Per MCO P5090.2A, Marine Corps consecutive PWSs will, at a minimum, accomplish the following monitoring, required regardless of variance or exemptions:

- (a) Bacteriological
- (b) Asbestos
- (c) Lead in priority areas
- (d) Lead and copper in water systems

(e) Regulatory requirements for arsenic, radionuclides, radon and unregulated contaminants are listed in chapter 16, section 16104, subparagraphs 2a(1) and 2a(2).

5-9. Water Distribution Systems¹⁰

1. General

a. Water distribution systems contain several components including pipes, valves, fittings, meters, hydrants, pumps, storage facilities, secondary treatment devices (e.g., booster disinfection system), and other appurtenances.

b. Awareness of the critical role that distribution systems play in ensuring the delivery of safe water has increased over the past several years. The distribution system is likely the weakest link in a PWS vulnerability assessment. Inadequate design, construction and management of a water distribution system contribute to a significant proportion of drinking water-borne disease. The second highest cause of yearly waterborne disease outbreaks in the United States is attributed to distribution system deficiencies rather than inadequate treatment.

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c. Proper operation and management of distribution systems are critical to maintaining the final barrier that protects drinking-water from contamination.

d. All materials used for potable water piping, valves, fittings, meters, hydrants, pumps, and other appurtenances and their design, installation, operation, and maintenance must be per NSF/ANSI Standard 61; applicable UFC standards including UFC 3-230-01¹¹, UFC 3-230-02¹², UFC 3-600-01¹³, and UFC 3-600-02¹⁴; and AWWA Standards (e.g., AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances). Likewise, all additives and chemicals used in drinking water treatment, to include corrosion and scale inhibitors, coagulants and flocculants, disinfection and oxidation chemicals, pH adjustment, softening, precipitation and sequestering chemicals, well drilling aids, and other specialty chemicals must comply with NSF/ANSI Standard 60.

2. Water Quality Problems in the Distribution System

a. **Problem Areas.** The design, operation, and maintenance of distribution systems have traditionally focused on public safety requirements and hydraulic objectives (involving flow and pressure), some of which may adversely affect water quality. The distribution system for any installation may contain problem areas that can accelerate water quality deterioration:

- (1) Dead-ends where the water remains stagnant for extended periods of time.
- (2) Tanks that are hydraulically locked out of the system (i.e., due to water pressure constraints, tanks that are not routinely emptied and filled).
- (3) Tanks that are not turning over due to minimal demands within the proximity (i.e., lengthy water detention time due to tank size relative to water demand).
- (4) Oversized pipes where higher demands existed in the past or as a result of a change in flow patterns.
- (5) Artificial dead-ends created by closed valves that should be open.
- (6) Areas within the system that still contain unlined cast iron pipe.
- (7) Areas within the system where it is difficult to maintain a disinfectant residual or that are prone to coliforms or high concentrations of bacterial organisms as measured by heterotrophic plate count (HPC).

b. **Typical Water Quality Problems.** Increased detention time (water age¹⁵) is a major factor in water quality deterioration within the distribution system. The typical problems encountered within water distribution systems include the following:

- (1) Loss of disinfectant residual within the distribution system.
- (2) Bacterial regrowth¹⁶ (biofilm).

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- (3) Growth of nitrifying bacteria¹⁷ in chloramine treated water.
- (4) Excessive levels of Trihalomethanes (THM) or other disinfection byproducts (DBP).
- (5) Leaching or contamination of chemical and biological contaminants from corrosion, other structural integrity problems in piping, and other distribution system components.
- (6) Discolored water.
- (7) Taste and odor problems.
- (8) Excessive disinfectant residuals (i.e., greater than the Maximum Residual Disinfectant Level (MRDL) from excessive disinfectant boosting or disinfectant dosage for piping and storage disinfection.
- (9) For water systems using or receiving chloramine disinfected water, excess free ammonia in the water being delivered to the distribution system.

c. Hazardous Events Causing Water Contamination or Water Quality Deterioration. Within distribution system, the hazardous events, incidents or situations shown in table 5-9-1 can lead to water contamination or water quality deterioration by affecting the physical, hydraulic, or water quality integrity of the distribution system and the quality of the water. Table 5-9-1 also includes main cause(s) and preventive and corrective measures of each hazardous event within distribution system:

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Table 5-9-1		
Distribution System Hazardous Events and their Main Causes and Preventive and Corrective Measures		
Hazardous Event	Main Cause	Preventive and Corrective Measure
System Operation and Design Deficiencies – Repair, Replacement, Materials Deficiencies		
Microbial or chemical contamination during construction of new water mains, water meters, pumps, valves or hydrant insertions.	Improper sanitary procedures and verification during construction or repair	<ul style="list-style-type: none"> • Develop and follow proper SOPs for sanitary practices (storage, transport and installation repair), disinfection, flushing and water quality testing before, during and after main commissioning or repair • Proper field verification and audits • Follow construction standards, specification and installation procedures
Contamination during water main repair.		
Contamination or leaching from chemicals (e.g., heavy metals and organic chemicals) in materials used in construction and maintenance of pipes, fittings and tanks (e.g. copper, iron, lead, plasticizers, bituminous or cement linings, solders and coating materials) ¹⁹	Use of unapproved or non-standard materials (e.g., NSF 61 approved materials). Degradation of old metal and non-metal piping materials, non-metallic pipes and joints, coatings and lining materials.	<ul style="list-style-type: none"> • Use of NSF approved materials meeting AWWA standards • Proper material selection, design and installation based on finished water quality • Prompt piping and other appurtenance repair or replacement including lead service line replacements
The use of inappropriate materials, including use of metallic products (dissimilar metal) that are incompatible with existing materials in the system, causing corrosion (galvanic corrosion)	Not following installation or material specification, standards or manufacture's instructions	

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Table 5-9-1		
Distribution System Hazardous Events and their Main Causes and Preventive and Corrective Measures		
Hazardous Event	Main Cause	Preventive and Corrective Measure
System Operation and Design Deficiencies - Piping and Appurtenances Corrosion Deficiencies		
<p>Toxic metal or chemical release and water discoloration from internal corrosion of distribution piping and appurtenances</p> <hr/> <p>Contamination from leaky water mains and joints due to pipe corrosion or structural integrity degradation²⁰ specifically in areas of low pressure or intermittent water supply.</p>	<ul style="list-style-type: none"> • Internal corrosion of pipes and appurtenances • Aged components (structural integrity degradation) 	<ul style="list-style-type: none"> • Corrosion control additives. • Water main condition and criticality assessment and inspection programs to prioritize replacement program • Repair or replacement pipe, fittings and other appurtenances. • Use of NSF approved materials meeting AWWA standards • Leak detection program • Maintain positive pressure and continuous supply
System Operation and Design Deficiencies - High Water Retention (Water Age) and Other Operational Deficiencies		
<p>Accumulation of biofilms, sediments and particles in water mains – taste and odor problems.</p>	<p>High water retention (water age), low flow velocity, internal corrosion, low chlorine residual.</p>	<ul style="list-style-type: none"> • Maintain proper chlorine residuals or chlorine boosting as necessary • Develop and practice comprehensive flushing program and spot flushing SOP. • Design standard to decrease Water Retention (age) and achieve self- cleaning pipe velocity <ul style="list-style-type: none"> - Minimize dead-ends - Limit the excessive size or capacity of piping and storage • Corrosion control
<p>Resuspension of biofilms, sediments, scales – taste and odor problems.</p>	<p>Sudden high flow velocity or flow reversal</p>	<ul style="list-style-type: none"> • Minimize sudden changes of flow and hydraulic transient (water hammer) by proper operation of pumps and valves • Develop and follow SOPs for operation of valves after repairs

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Table 5-9-1 Distribution System Hazardous Events and their Main Causes and Preventive and Corrective Measures		
Hazardous Event	Main Cause	Preventive and Corrective Measure
Elevated DBPs	High water retention (water age) and high DBP precursors (e.g., high organic matter content)	<ul style="list-style-type: none"> • Reduce DBP precursors (e.g., dissolved organic matter) from source water through additional treatment. • Reduce disinfectant dosage or change disinfectant injection point. • Reduce water retention (age) (e.g., eliminate dead-ends, increase turnover through storage tanks during periods of low flow by dropping high water levels, taking tanks out of service during low flows)
No or low Chlorine residual	High water retention (water age) or low chlorine addition or boosting	<ul style="list-style-type: none"> • Reduce water retention (age) (e.g., eliminate dead-ends, increase turnover through storage tanks during periods of low flow by dropping high water levels, taking tanks out of service during low flows) • Increase chlorine dosage or boosting
Excessive chlorine above MRDL	Excessive chlorine addition or boosting	Decrease chlorine dosage or boosting
Cross-Connection and Backflow Prevention Deficiencies		
Chemical or biological contamination by backflow from residential, industrial or commercial customers due to lack of prevention device or failure of device; likelihood increased during low pressure events in water supply network	Cross-connection and lack of proper back flow prevention	<ul style="list-style-type: none"> • Develop and practice comprehensive cross-connection control and backflow prevention programs including cross-connection control/backflow prevention survey, inspection, installation, repair and replacement of appropriate backflow prevention devices. • Maintain positive pressure, provide continuous supply • Maintain proper chlorine residuals or chlorine boosting as necessary
Accidental cross-connection between drinking-water and non-drinking water assets during construction or maintenance, including opening a normally shut valve to allow recharging after repairs and failing to close after completion		

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Table 5-9-1		
Distribution System Hazardous Events and their Main Causes and Preventive and Corrective Measures		
Hazardous Event	Main Cause	Preventive and Corrective Measure
Storage Facility Deficiencies²¹		
Contamination from Storage Tank Structural, Sanitary, Security Deficiencies (intrusions of dusts, sediments, ground water, animals, and insects) <ul style="list-style-type: none"> • Roofs or hatches • Overflow pipes and inlet control valves from upstream sources • Air vents • Unsealed joints and cracks • Unauthorized access including vandalism and sabotage 	Storage tank structural, construction or design, or security deficiencies.	<ul style="list-style-type: none"> • Reservoir inspection and maintenance program • Proper installation, repair or replacement of tank components with structural, sanitary, and security deficiencies. • Disinfect tank after repairs • Maintain proper chlorine residuals in the tank or chlorine boosting in the tank as necessary • Meet proper design and construction standards
Water quality deterioration in water storage <ul style="list-style-type: none"> • Low residual chlorine • Sediment accumulation and biofilm growth in the bottom of the tank • pH increase in concrete tank • internal corrosion of steel storage tanks 	High water retention (age) Low chlorine dosage or boosting Lack of corrosion control Aggressive water	<ul style="list-style-type: none"> • Reduce water retention (age) (e.g., increase turnover through storage tanks during periods of low flow by dropping high water levels, taking tanks out of service during low flows) • Maintain proper chlorine residuals in the tank or chlorine boosting in the tank as necessary • Reservoir inspection and maintenance program including proper internal coating, lining, or painting

3. Distribution System Management and Water Quality Control Measures. For proper management and operation of distribution systems, there may be a need to go beyond the minimum requirements to ensure the delivery of a safe and acceptable drinking water supply. Water systems need to focus on water quality control within the distribution systems to minimize degradation. Available tools are as follows:

a. An initial distribution system survey. The purpose of an initial distribution system survey is to identify all potential problem areas within the system, including dead-ends, oversized pipes, of this survey can be used to develop a comprehensive plan to correct deficiencies within the system to improve overall water quality control closed valves, storage tanks that are hydraulically locked out or not turning over, etc. The results of this survey can be used to develop a comprehensive plan to correct deficiencies within the system to improve overall water quality control.

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b. Operational Monitoring of Water Quality and Physical Operational Parameters

(1) Appropriate operational monitoring is an important factor for timely indications of the performance of current system operation and any operational deficiencies, as well as for allowing timely corrective actions or control measures. Operational monitoring includes water quality (e.g., disinfectant residual, HPC, and pH) and other physical operational parameters (e.g., pressure, flow, tank level). Such operational water quality and physical operational parameter monitoring within the distribution system is usually based on simple tests that can easily be measured, monitored, and assessed such as chlorine residual, pH, turbidity, pressure, and flow rate.

(2) Operational monitoring should be performed at a frequency that enables timely intervention before control of water quality is lost and unsafe water is delivered to consumers. In many cases, parameters are monitored online. A supervisory control and data acquisition (SCADA) system that communicates directly with these on-line monitoring devices provides distribution system managers with real-time opportunities to implement operational controls. Monitoring devices can be set to trigger alarms at alert levels that are within critical compliance limits, but allow timely interventions to bring the system back into the desired operating range. Infrastructure inspections coupled with timely data on turbidity and chlorine residuals provide rapid feedback on the effectiveness of system operation.

(3) The quality of water in a distribution system can best be evaluated through regular water quality monitoring and sampling. Proper water quality monitoring can often highlight problems in water furnished by suppliers, as well as distribution system deficiencies, before compliance problems arise. Appropriate operational water quality parameters must be monitored for control measures for any water quality deficiencies or for operation parameters indicating out of target range.

(a) Operational Water Quality Parameters

1. Disinfectant Residual:

a. As the final barrier of protecting water quality prior to customer delivery, maintaining proper disinfectant residual throughout the distribution system is one of the most important water quality control measures.

b. Proper operational disinfectant residual monitoring within a distribution system normally requires daily sampling from several locations throughout the distribution system including a location representing maximum residence time in the distribution system.

c. On-line real-time disinfectant residual monitors can often be used in different locations, including the location within distribution system where disinfectant boosting is implemented, to measure free chlorine, chloramines or oxidation–reduction potential. The on-line monitoring technologies employ polarographic, voltammetric, or colorimetric methods that can influence the device sensitivity, calibration, and interference from other water quality parameters. On-line disinfectant residual monitoring equipment requires periodic verification and regular calibration. Therefore, during an inspection of a water system it is critical to verify evidence showing that the devices are maintained and calibrated as required by the manufacturer.

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d. The disinfectant residual concentrations at the customer's tap should be within the target operational range set up for the system considering both operational criteria and aesthetic water quality, but must be below the MRDL (e.g., 4.0 milligrams per liter [mg/L] for chlorine). Chlorine doses should be managed to achieve effective disinfection while minimizing the formation of DBPs.

e. HPC measurement provides an indicator of biological activity and a surrogate for disinfectant residual presence.

2. Temperature:

a. Water temperature influences a range of important water quality parameters affecting disinfection efficiency, disinfectant residual decay, biological activity, and corrosion.

b. It is generally recommended that temperature be measured during disinfectant residual monitoring.

c. Chlorine efficacy generally increases at higher temperature, but chlorine decay rate increases as well.

3. pH

a. Water pH is a master variable in chemical and biological reactions that affect water quality parameters, including disinfection efficiency, biological activity and corrosion.

b. A wide variety of portable or on-line pH electrodes and meters are available. Measurements are reliable only with proper and frequent maintenance and calibration of the pH electrode and meters.

c. An optimal pH range for drinking water distribution system is normally 6.5 – 8.

d. Drinking water pH can increase through distribution systems due to leaching of lime from concrete storage reservoirs and cement-lined pipes, with the amount of increase proportional to the detention time of the water within the distribution network

e. Chlorine efficacy increases at lower pH and decreases significantly with increasing pH. Chlorine is ineffective at pH 10 and above.

f. It is generally recommended that pH be measured during disinfectant residual monitoring.

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4. HPC²²

a. HPC refers to culture-based tests that are intended to recover a wide range of heterotrophic microorganisms (including bacteria, yeast and molds) that require organic carbon for growth.

b. HPC is often used in distribution system operations as an indicator of system performance and may forewarn of potential system problems, including a loss of disinfection efficacy, intrusion of contaminants into drinking water, or growth of biofilms that could support the presence of pathogens.

c. HPC testing results greater than given value (e.g., greater than 500) may trigger a corrective action, such as comprehensive unidirectional flushing of the system, spot flushing of the affected area, increasing the chlorine dose at the water treatment plant, or chlorine boosting/re-chlorination of the affected area.

5. Other Water Quality Parameters. The following water quality parameters are also measured as operational water quality parameters:

a. Conductivity and Total Dissolved Solids. Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Conductivity is measured in micro-siemens per centimeter ($\mu\text{S}/\text{cm}$). Conductivity can be used as an efficient parameter to check increase of dissolved metals and other charged contaminants from corrosion or other contamination sources. Conductivity can be easily measured in the field, and the meter generally provides a very quick and reliable and measurement.

b. Turbidity. Turbidity is a measure of water clarity. It is used to quantify how much the material suspended in water decreases the passage of light through the water (i.e., cloudiness of water). Suspended sediments and corrosion products such as iron and manganese can cause elevated turbidities. There are many different models of benchtop, portable or on-line real-time turbidity meters available. However, turbidity probes that are more sensitive in detecting low ranges (i.e., <1 nephelometric turbidity units) are preferred for use in the finished water distribution system.

(b) Operational Physical Parameters

1. Pressure

a. Maintaining positive pressure throughout the distribution system is essential in preventing contamination from entering the water distribution system.

b. The positive pressure in the water main may drop from time-to-time by accident or under control by the water utility during construction, renovation, or repair work. It is

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at this controlled time when flow is stopped, water in the main is drained away and the main is cut open that potential ingress of contamination can occur. Therefore, it is critical to properly design, plan, and manage these pressure drops during construction or repair works to prevent the introduction of microbial and chemical hazards.

c. Daily or weekly pressure measurements from several locations throughout the distribution system may be necessary to verify positive pressure throughout the distribution system.

d. For locations of concern, operational monitoring of transient pressure changes using high-speed electronic pressure data loggers is generally recommended. High-speed devices (sampling up to 20 times per second) are necessary because distribution system pressure transients may last for only a few seconds and be missed by conventional pressure monitoring. Pressure detection units are programmable and can be set to trigger alarms at specific thresholds.

2. Flow

a. Flows can be influenced by pumping regimes, storage tank operations, and manipulations of hydrants or blow-off valves.

b. Monitoring of flows using in-line meters is typically conducted at sub-district boundaries to provide comparisons with customer meter data and so allow measurement of leakage rates.

c. A distribution system hydraulic model can use flow data to generate detailed descriptions of distribution system water velocities and flow reversals.

3. Storage Tank Level

a. Continuous monitoring of water level in the tanks within the distribution system is important to water system operators for providing a reliable and continuous water supply to customers without service interruption.

b. There are many different types of tank level sensors including Hydrostatic type, ultrasonic type, magnetic type, and float type.

c. Pressure transmitters are the most common type of level sensor used with SCADA systems for distribution system storage tanks.

c. Compliance Water Quality Parameters from Distribution System Locations

(1) Compliance monitoring (from the distribution system) involves testing the water supplied and distributed to consumers to determine compliance with applicable water quality standards (i.e., MCL). Compliance monitoring must meet both regulatory monitoring frequencies and water quality standards. Relative to operational monitoring, mandated regulatory compliance monitoring generally involves different parameters monitored at lower frequencies.

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(2) Parameters monitored from distribution system locations include microbiological parameters such as total coliform, E. coli, and health-related chemicals such as lead, copper, and DBPs. Section III, articles 5-14 through 5-25 of this chapter includes detailed information regarding NPDWR standards and MCLs for the compliance monitoring parameters. The following parameters must be monitored from distribution system locations for compliance monitoring:

(a) Coliform

1. Total coliform
2. Fecal coliforms

(b) Lead and copper

(c) Disinfectants and disinfection byproducts

1. Disinfectant residual
 - a. Free and total chlorine (for chlorine system)
 - b. Total chlorine (for chloramine system)
 - c. Chlorine dioxide (for chlorine dioxide system)
2. Disinfection Byproducts
 - a. Trihalomethanes (TTHM)
 - b. Five Haloacetic Acids (HAA5)
 - c. Bromate (for system using ozone for disinfection or oxidation)
 - d. Chlorite (for system using chlorine dioxide for disinfection or oxidation)²³

d. Maintaining Disinfectant Residuals

(1) Maintaining disinfectant residuals throughout the distribution is used as a barrier against intrusion of bacterial and viral pathogens into distribution systems and as a mechanism to reduce the formation of biofilms and the growth and persistence of free-living pathogens.

(2) Disinfectant residuals should be detectable (preferably ≥ 0.2 mg/L), but must be below the MRDL (e.g., 4.0 mg/L for chlorine and chloramine, and 0.8 mg/L for chlorine dioxide) throughout the distribution system including the location representing maximum residence time in the distribution system.

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(3) In some cases, secondary booster chlorination stations located within distribution systems are used to maintain proper disinfectant residuals throughout the distribution system. Where distribution systems include long pipelines and extended residence times, chloramination has been used to improve persistence.

(4) Sudden drop(s) of disinfectant residual(s) may indicate contamination event(s) within the distribution system.

(5) Proper operational monitoring of disinfectant residuals throughout the distribution system is essential in distribution operation for timely control and adjustment of disinfectant dosage (at the water treatment plant or disinfectant boosting station within the distribution system) to maintain a disinfectant level within the target range throughout the distribution system. Disinfectant residuals at the point of entry into the distribution system (i.e., at the interconnection with the municipal system or the discharge from the treatment plant) must be at least 0.2 mg/L.

e. Maintaining Positive Pressure

(1) Water distribution systems must be designed to provide an acceptable operating pressure. Areas on high ground or with high pressure demand must have a separate high service system for maintaining pressure by pumping, backed by elevated storage, whenever possible. No water main in a Navy or Marine Corps distribution system should be less than 6 inches in diameter (to provide minimum firefighting flows) without approval of NAVFAC Headquarters.

(2) Maintaining a positive pressure at all locations within the distribution system is a critical daily operational requirement for a potable water system. Failure to maintain positive pressure could result in backflow at cross-connections and the contamination of drinking water from leaking pipes, submerged air or vacuum relief valves or faulty check valves. Preventive Medicine Authority should be notified in the case of loss of pressure. Reduced pressure can occur if the flow velocity increases significantly because of a large water main break, pump failure, peak demand, flushing maintenance, etc. Table 5-9-2 provides recommended pressure requirements for water distribution systems.

Table 5-9-2 - Recommended Pressure Requirements		
Requirement	Value (psi)	Sources
Minimum Pressure	35 psi	All points within distribution system
	20 psi	All ground level points (with fire hydrant in use)
Desired Maximum	100 psi	All points within distribution system
Fire Flow Maintenance	20 psi	All points within distribution system
Ideal Range	50-75 psi	Residences
	35-60 psi	All points within distribution system

(3) Excessively high pressures can have a detrimental effect on water heaters, washing machines, and dishwashers. Pressure reducing valves should be installed in areas with pressures greater than 75-100 psi.

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f. Documentation and evaluation of customer complaints. Documentation and evaluation of customer complaints is a valuable tool that can be used to solve problems as they arise.

(1) The Public Works Department (PWD) is responsible for receiving and logging customer complaints and documentation of resulting investigation (if applicable) and corrective action taken to resolve the cause of the water quality problem.

(2) Because some customer complaints may be received by Preventive Medicine Authorities, they should also implement a system for receiving and logging complaints and forwarding them to the PWD for the appropriate corrective action. Preventive Medicine Authorities should maintain contact with the PWD and verify that the situation leading to each customer complaint is properly resolved.

g. Cross-Connection Control and Backflow Prevention²⁴

(1) Cross-connection. Cross-connection refers to any actual or potential connection between the public water supply and a source of contamination or pollution (e.g., interconnections between a potable water distribution system and a non-potable water distribution system).

(2) Backflow. Backflow refers to the flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source or sources other than its intended source. There are two types of backflow: back pressure and back siphonage:

(a) Back pressure. Back pressure refers to backflow that occurs when the pressure in an unprotected downstream piping system exceeds the pressure in the supply piping.

(b) Back siphonage. Back siphonage refers to backflow resulting from negative pressures in the pipes of a water supply distribution system.

(3) Implementation of a Cross-Connection Control and Backflow Prevention Program²⁵.

(a) The possibility of backflow due to improper piping configuration or layout within facilities is especially significant because such cross-connections may easily result in the contamination of the drinking water system. These situations may result in the drinking water system becoming a vehicle for transmission of pathogenic organisms, toxic materials, or other hazardous substances that can adversely affect public health and welfare. The only protection against such occurrences is the elimination of cross-connections or the protection of the drinking water system by proper application of approved backflow prevention devices or installation of an appropriate air gap.

(b) The University of Southern California Foundation for Cross-Connection Control and Hydraulic Research maintains a list of “lead-free” compliant parts on its Web site: <https://fccchr.usc.edu/leadfree.html>.

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(c) An implemented cross-connection control and backflow prevention program is essential to prevent degradation of water quality. A cross-connection control and backflow prevention program generally involves authority for establishment of a program; technical provisions relating to eliminating backflow and cross-connections; and provisions for deficiencies, recordkeeping and violations, reporting and public notification, and education. A cross-connection control and backflow prevention program is, in general, a continuing effort to locate and correct all existing or potential cross-connection hazards and to discourage their creation typically through the following measures:

1. Comprehensive cross-connection survey of installation drinking water system by qualified personnel and contractor to determine possible or actual cross-connection, degree of hazard, location, and adequacy of existing backflow prevention devices, and the need for installation of additional backflow prevention devices.
2. All backflow prevention devices must be tested and the certification of the backflow prevention devices must be accomplished by certified testers at the frequencies required or recommended by the primacy agency and Navy standard (see table 5-9-3).

Table 5-9-3	
Backflow Prevention Device Maximum Certification Interval	
(UG-2029-ENV)	
Class of Health Hazard	Maximum Certification Interval
Low	12 Months
High	6 Months

3. In addition to comprehensive cross-connection survey and periodic testing of backflow prevention devices, each potable water distribution system should be routinely inspected by experienced water system operators or qualified PWS personnel to identify any potential or existing cross-connections and any deficiencies of backflow prevention devices. All backflow prevention devices should be properly maintained by experienced water system operators or qualified PWD personnel. Each backflow preventer device should have an asset and inspection tag. An effective cross-connection program must also include routine and regular surveillance by qualified PWD personnel.

4. All potential or existing cross-connections must be eliminated or isolated by installing proper backflow prevention devices to prevent the possibility of backflow into the drinking water system. The installation must comply with criteria set forth by Federal, State, and local codes or regulations, the manufacturer's recommendations, and relevant references from AWWA/Foundation for Cross-Connection Control and Hydraulic Research.

a. Backflow prevention devices must be approved by the appropriate State or local authority and listed by the University of Southern California, Foundation for Cross Connection Control and Hydraulic Research.

b. If a backflow prevention device is found defective, it must be promptly repaired or replaced to provide proper backflow protection.

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c. Following installation, repair, or replacement, all backflow prevention devices must be certified as satisfying acceptable performance.

d. Any new construction must be provided with proper backflow prevention through coordination with applicable authority.

h. Water Main Disinfection for Water Main Installation, Repair, and Replacement

(1) General

(a) Installation and repair of water mains provides the potential for direct contamination of the distribution system. Following proper sanitary procedures before, during, and after water main installation, repair, and replacement is essential to preventing contamination of potable water.

(b) Disinfection of all potable water lines (mains) must be per AWWA Standard C651, UFC 3-230-01, and State requirements.

(c) Proper inspection of pipes, material integrity, and sanitary practices in pipe and material storage and handling is important to prevent contamination of materials and supply water.

(d) Chlorine used for disinfection must be NSF 60 approved and the pipe and other materials used for main installation or repair must be NSF 61 approved.

(e) Basic Disinfection Procedure for New Water Mains:

1. Material Inspection and Sanitary Measures. Properly inspected all materials used for main installation for their integrity. Follow proper sanitary measures to prevent contaminants from entering into new mains during storage, construction, or repair.

2. Preliminary Flush. Preliminary filling and flushing may be required before the main is chlorinated to eliminate air pockets and remove particulates.

3. Pressure Testing. Perform hydrostatic pressure tests for the water main to ensure the main meets the allowable leakage rate.

4. Chlorination. Disinfect the water main using the tablet, continuous, slug, or spray method as applicable to satisfy minimum required contact time chlorine residual concentration.

5. Final Flush. Flush heavily chlorinated water from the main until chlorine residuals are restored to normal levels maintained in the distribution system.

6. Bacteriological Testing. Collect and analyze bacteriological samples to confirm the effectiveness of the disinfection procedure using EPA-approved methods and a State-certified or Navy-approved laboratory.

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7. Final Connection for Supply. Apply proper sanitary practices and conditions during final connection of the newly disinfected water main to the active distribution system.

(f) If a contractor is used for main installation, repair, or replacement, PWD and the Preventive Medicine Authority must ensure the following:

1. Proper Contract. PWD must ensure the contract includes all proper main disinfection procedures including final flushing and bacteriological testing, as applicable, before putting the line into service.

2. Proper Field Inspection and Surveillance. PWD must ensure that the contractor follows the proper sanitary practices and disinfection procedures before, during, and after main installation, repair, or replacement through field inspection and verification. It is advisable that PWD or Preventive Medicine verify proper main disinfection through its own surveillance bacteriological testing.

3. Record Keeping and Verification. PWD must receive any records and documents related to water main disinfection including the documents showing bacteriological testing results. PWD must review all applicable documents including the bacteriological testing to verify the main is properly disinfected before returning the main to the service.

(1) Disinfecting New Water Mains

(a) Methods of Chlorination for Water Main Disinfection. Disinfecting water mains must be conducted following one of four methods: tablet, continuous feed, slug, and spray methods described in AWWA Standard C651. Table 5-9-4 summarizes initial chlorine dose and minimum contact time and chlorine residual concentration for each method used for water main disinfection.

Table 5-9-4			
Chlorination Methods for Water Main Disinfection			
Chlorination Methods	Initial Chlorine Dose (mg/l)	Minimum Contact Time (hours)	Minimum Chlorine Residual Concentration (mg/l)
Tablet Method	25	24	0.2 mg/L after 24-hour contact time
Continuous Feed Method	25	24	10 mg/L after 24-hour contact time
Slug Method	100 (up to 300 mg/L for emergency use)	3 (15 minutes with 300 mg/L chlorine for emergency use)	50 mg/L
Spray Method	200 (10,000 [1%] for emergency use)	-	-

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1. Tablet Method

- a. Follow procedures per AWWA C652.
- b. Place calcium hypochlorite granules or tablets in the water main during installation and then fill the main with potable water to create a chlorine solution.
- c. Initial chlorine dose of 25 mg/L and a minimum contact time of 24 hours (with minimum 0.2 mg/L of residual free chlorine after the 24-hour contact time).
- d. This method may be used only if the pipes and appurtenances are kept clean and dry during construction.
- e. This procedure must not be used on solvent-welded plastic or on screwed-joint steel pipe because of the danger of fire or explosion from the reaction of the joint compounds with the calcium hypochlorite.
- f. The use of the tablet method precludes preliminary flushing.

2. Continuous Feed Method

- a. The method is suitable for general application and is generally recommended for new water main installation.
- b. Follow procedures per AWWA C652. Completely fill the main with potable water to eliminate air pockets, then flush the completed main to remove particulates and refill the main with potable water that has been chlorinated to 25 mg/L.
- c. A velocity of at least 3.0 ft. per second (0.91 m/sec) is needed for adequate preliminary flushing. Note: preliminary flushing is not a substitute for preventive measures during construction. Certain contaminants, such as caked deposits, resist flushing at any feasible velocity, and pigging of the main, or other acceptable method, may be required.
- d. Add chlorine to the line to bring the residual up to 25 ppm. After the entire main is filled with chlorinated water of 25 mg/L, retain the chlorinated water in the main for at least 24 hours; at the end of 24 hours, check the chlorine residual to ensure a minimum of 10 ppm. If the chlorine residual is at least 10 ppm after 24 hours, begin the final flushing and bacteriological sampling phases. If the residual is less than 10 ppm, re-chlorinate the line. Table 5-9-5 presents the amount of chlorine required for each 100 ft. (30.5 m) of pipe for various pipe diameters and stock chlorine concentrations.

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Table 5-9-5									
Drinking Water Piping Disinfection									
Pipe Diameter (inches)	Sodium Hypochlorite Solution required (gallons) per 100 feet (30.5 m) of pipe								
	Dose of 25 mg/L					Dose of 100 mg/L		Dose of 300 mg/L	
	1%	5%	10%	12.5%	15%	5%	12.5%	5%	12.5
2	0.041	0.0082	0.0041	0.0033	0.0027	0.033	0.013	0.098	0.039
4	0.16	0.033	0.016	0.013	0.011	0.13	0.052	0.40	0.16
6	0.36	0.073	0.037	0.029	0.024	0.30	0.12	0.88	0.35
8	0.65	0.13	0.065	0.052	0.044	0.53	0.21	1.6	0.63
10	1.02	0.20	0.10	0.082	0.068	0.83	0.33	2.4	0.98
12	1.44	0.29	0.15	0.12	0.098	1.2	0.47	3.5	1.4

3. Slug Method

- a. Three-hour exposure of not less than 50 mg/L.
- b. Follow procedures per AWWA C652.
- c. Fill the main to eliminate air pockets, flush the main to remove particulates, then slowly flow through the main a slug of water dosed with chlorine to a concentration of 100 mg/L.
- d. A velocity of at least 3.0 ft. per second (0.91 m/sec) is needed for adequate preliminary flushing.
- e. Water entering the new main must receive a dose of chlorine fed at a constant rate such that the water will have not less than 100 mg/L free chlorine. The slow rate of flow ensures that all parts of the main and its appurtenances will be exposed to the highly chlorinated water for a period of not less than 3 hours. The chlorine concentration measured in the slug must not be less than 50 mg/L. Table 2-3-5 presents the amount of chlorine required for each 100 ft. (30.5 m) of pipe for various pipe diameters and stock chlorine concentrations.
- f. Suitable for use in large-diameter mains where the volume of water makes the continuous-feed method impractical and difficult to achieve for short attachments. This method is generally recommended for emergency water main disinfection for long, large diameter mains.
- g. The slug method is often used for emergency repaired main disinfection. The chlorine dose may be increased to as much as 300 mg/L and the contact time reduced to as little as 15 minutes. After chlorination and repair, perform scour flushing at 3.0 ft. per second (0.91 m/sec) or greater for a minimum of three pipe volumes and continue until discolored water is not observed and the chlorine residual is restored to the levels maintained in the distribution system by the water utility.

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h. This method reduces the volume of heavily chlorinated water to be flushed to waste.

4. Spray Method

a. Suitable for use in large-diameter transmission lines where spray equipment can be used to disinfect all surfaces of the pipe.

b. Follow procedures per AWWA C652 section 4.3.2 (disinfection of water storage facilities).

c. Spray a 200 mg/L free chlorine solution on all surfaces for a 30-minute contact time.

d. This method reduces the volume of heavily chlorinated water to be flushed to waste.

(b) Final Flushing of Main after Disinfection

1. After the applicable minimum retention period of main disinfection, water mains must be adequately flushed before returning to service to prevent corrosion damage to the pipe lining or the pipe itself, and to eliminate highly chlorinated water from the main until chlorine residual measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system.

2. As the chlorinated discharge may damage the environment, a neutralizing chemical (dechlorinating agents) must be applied to the water prior to wasting to thoroughly neutralize the residual chlorine following AWWA C655. Federal, State, local, or other applicable authorities must be contacted as necessary to determine special provisions for the disposal of heavily chlorinated water.

(c) Bacteriological Testing

1. Immediately following disinfecting and flushing, water samples should be collected and sent to a State-certified (or Navy-approved) laboratory for coliform analysis.

2. For new mains, sets of samples must be collected every 1,200 ft. (370 m) of the new water main, plus one set from the end of the line and at least one from each branch greater than one pipe length. Although HPCs are not required, should local regulations require samples, then the Preventive Medicine Authorities should review results for potential health impacts.

3. For repaired mains that were maintained under pressurized conditions at all times, disinfection and testing may not be required. For repaired mains that were depressurized or wholly or partially dewatered, one set of samples may be required; depending upon the sanitary conditions, the line may be reactivated prior to the completion of bacteriological testing. Samples

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must be collected downstream of the repair site and at intervals of approximately 200 ft. (61 m) within the length of pipe that was shut down. If direction of flow is not known, samples must be collected on either side of the repair site. Unless absolutely necessary, the repaired water main should not be returned to service until the results of the bacteriological samples are known (usually 24 hours after the sample is taken). If the water service must be resumed before that time, verify in writing, that correct disinfection and flushing procedures were followed. The laboratory must contact sampling personnel immediately upon knowledge of a positive result.

4. For new mains, there are two options for the bacteriological testing for total coliform analysis:

a. Option 1: The first sample set should be collected immediately after the installation and a second sample must follow a minimum of 16 hours later. Both sets of samples must pass for the main to be approved for release.

b. Option 2: Allow the main to sit for a minimum of 16 hours without any water use. Then using the sampling site procedures outlined and without flushing the main, collect two sets of samples a minimum of 15 minutes apart while the sampling taps are left running. Both sets of samples must pass for the main to be approved for release.

5. It is also recommended that samples be tested for chlorine residual, pH, alkalinity, conductivity, and turbidity.

6. If either the first or second bacteriological sample is positive, immediately notify the public works officer (PWO), Preventive Medicine Authority and any other designated individual in order to coordinate corrective action. The designated individuals will direct all actions until two consecutive negative samples are achieved.

7. If the initial disinfection fails to produce satisfactory bacteriological results, or if other results indicate unacceptable water quality, the main may be reflushed and resampled. If check samples fail to produce acceptable results, the main must be rechlorinated by the continuous-feed or slug methods until satisfactory results are obtained. If sample results show HPC greater than 500 colony forming unit (cfu)/mL, flushing should resume and new sets of HPC and coliform samples be collected until no coliform are present and the HPC is less than 500 cfu/mL.

8. When bacteriological sample results will not be known within 24 hours of the repair or samples cannot be delivered to a certified laboratory, ensure the flushing and disinfection procedures above have been followed. Bacteriological samples must be collected the first normal work day and immediately delivered to a certified laboratory.

(d) Final Connection of the Newly Disinfected Main

1. The new pipe, fittings and valve(s) required for the connection may be spray disinfected or swabbed with a minimum 1 percent chlorine solution just prior to installation, if the total length of the connection from the end of the new main to the existing main is less than or equal to 20 ft. (6 m).

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2. The pipe required for the connection must be set up aboveground, disinfected, and bacteriological samples taken, as described in section V of this chapter, if the total length of the connection from the end of a new main to the existing main is greater than 20 ft. (6 m). After satisfactory bacteriological sample results have been received for the pre-disinfected pipe, the pipe can be used in connecting the new main to the active distribution system. Between the time the satisfactory bacteriological sample results are received and the time the connection piping is installed, the ends of the piping must be sealed with plastic wraps, watertight plugs or caps.

(e) Other Considerations for Main Disinfection

1. When chlorinating, the system not affected by the repair or the new installation must be isolated from the work to ensure that the part of the system still being used by customers does not become contaminated or subject to super-chlorinated water (which can cause extreme illness).

2. All necessary valves must be closed and holding. Isolate only the affected piping portion of the distribution system to minimize system disruption and maximize chlorination efficacy.

3. It is preferable to add the chlorine to the line before the line is closed. When this is not possible, a temporary tap must be installed in the line to add the chlorine, and then plugged after the chemical has been added. Temporary taps can also be installed to flush a line and must be plugged when flushing and sampling is complete. This is done when a convenient flushing location (e.g., hydrant, faucet, etc.) is not readily available.

4. When dirt or debris must be flushed from a line before chlorination can begin, potable water must be used. Depending on the size of the line, use a garden hose or hydrant hose connected to a potable water source (not a part of the repair or installation area) to clear the line(s).

5. When portable gas chlorinators are used to disinfect mains, tanks or other units, consult the operator's instruction manual to check for the desired disinfecting residuals.

(2) Disinfection of Existing Pipe Repair

(a) General

1. Properly follow SOP per AWWA Standard C651 for water main repair to prevent contaminants from entering the existing pipe during the repair.

2. Maintain positive pressure in the leaking pipe until the repair site on the pipe is fully exposed.

3. Properly dewater the trench.

4. Maintain all pipe materials used in the repair in a clean and sanitary condition.

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5. Properly disinfect the following items by spraying or swabbing with a minimum 1 percent chlorine solution:

- a. Exposed portions of existing pipe interior surfaces.
- b. Pipe, fittings, clamps used in the repair.
- c. Handheld materials and tools used to make the repair.

6. The affected portions of main must be properly flushed at 3.0 ft. per second (0.91 m/sec) or greater for a minimum of three pipe volumes prior to returning into service.

(b) Controlled pipe repair without opening the existing pipe (no interior surface exposure to the environment).

1. When making a repair (not replacement, e.g., installing a utility clamp) of existing water lines that do not come in contact with either the ground or internal flooring, flushing (to obtain three volumes of water turnover) may be sufficient without chlorination. However, the interior of all pipes and fittings (particularly couplings and sleeves) used to make a repair or connections must be thoroughly swabbed or sprayed with a 10,000 ppm (1 percent) chlorine solution.

2. The repair site should be properly exposed and the trench should be adequately dewatered to clean and disinfect the exposed portion of existing pipe as necessary by spraying or swabbing with a minimum 1 percent chlorine solution.

3. The water main may be returned to service after flushing at 3.0 ft. per second (0.91 m/sec) or greater to obtain three volumes of water turnover and ensuring that the flushed water is visually clear.

4. No bacteriological testing is necessary. Continued flushing and monitoring of chlorine residual is recommended until chlorine residuals are restored to normal distribution system levels.

(c) Controlled pipe repair with interior surface exposure to the environment (opening the existing pipe). In addition to the previous procedures, these additional procedures must be followed:

1. Inspect and clean the existing pipe with the help of flushing water into the trench, where possible, until the flush water runs visually clear.

2. Disinfect any accessible upstream and downstream interior of the existing pipe by swabbing or spraying with a minimum 1 percent chlorine solution.

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3. If the repair requires a full pipe section replacement, inspect, clean, and disinfect the new pipe from both ends by swabbing with a minimum 1 percent chlorine solution.

4. The water main may be returned to service after flushing to scour the pipe and obtain three volumes of water turnover, making sure that the flushed water runs visually clear with a typical system chlorine residual.

5. Bacteriological samples must be collected, but the pipeline may be returned to service prior to obtaining analysis results.

(d) Uncontrolled pipe break with a likelihood of water contamination or loss of sanitary conditions during repair.

1. Examples include:

a. Muddy trench water flowing into the broken pipe and a leaking sewer pipe in the trench.

b. Catastrophic pipe failure where pipe is open and there is a likelihood that contamination was drawn into the active system.

c. A controlled repair situation turns into a situation in which the internal pipe and water have become contaminated.

2. Where practical, disinfect water mains using one of four methods following the AWWA C651.

a. The line or services must be reliably isolated or shut down to prevent exposure of customers to high concentrations of chlorine.

b. After chlorination and repair, perform scour flushing at 3.0 ft. per second (0.91 m/sec) or greater for a minimum of three pipe volumes and continue until discharge water is clear and the chlorine residual is restored to normal distribution system levels.

c. Prior to returning the pipe to service, verify the efficacy of the disinfection procedure by testing for the absence of coliform bacteria.

d. If allowed by local regulations, the pipeline may be returned to limited service prior to obtaining bacteriological results with proper notification of the affected customers.

i. Leakage Management²⁷. Water loss from distribution system leaks results not only in wasted resources and revenues, but also increased risks of contamination. Furthermore, some States have regulatory policies that set acceptable losses from PWS distribution systems at a maximum of between 10 and 15 percent of the water produced by the PWS. The following management techniques help to minimize water leaks from the distribution system:

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(1) Metering. Accurate metering is crucial in leakage management. Metering establishes production and customer use volumes, and provides historic demand and consumption data useful not only for water auditing, but for planning future needs. Meters should be properly installed, maintained, and calibrated according to manufacturers' instructions. AWWA's manual M6, Water Meters-Selection, Installation, Testing, and Maintenance, provides detailed descriptions of meter calibration testing and maintenance programs.

(2) Water Audit. The water audit is an assessment of the distribution, metering, and accounting operations of the water utility, and uses accounting principles to determine how much water is being lost and where. AWWA recommends that the water utility compile an annual water audit as a standard business practice.

(3) Leak Detection and Locating. Identifying and repairing system leaks is important in conserving supplied water and reducing risks of contamination. Detecting and identifying system leaks, however, can be challenging. Some leaks in the distribution system can be identified during operating personnel's routine field inspections. However, not all leaks are visible, and targeted leak detection efforts are needed to detect hidden leaks in the water distribution system. The following are three major water loss leak detection categories: (1) leak detection through appearance, (2) leak quantification through flow monitoring, and (3) locating hidden leaks with leak detection equipment (acoustic, thermal, electromagnetic, tracer, etc.). There are several different types of leak detection equipment using different operating principles. Levels of skill and experience required to operate with accuracy vary based on the different types of leak detection equipment used.

(4) Pipe Repair and Replacement. Once a leak is located it should be repaired properly and immediately. Properly repairing a leak quickly and securely generally requires trained crews, adequate tools, and appropriate materials. Completing repairs in a timely manner can save labor and resources as well as reducing customer complaints. Some repair techniques include wrapping or using repair clamps. Replacement can be done by installing new pipe in an excavated trench or by use of a trenchless method, such as slip lining or pipe bursting, where a new pipe of the same size or larger is pulled through the existing pipe with special equipment.

(5) Other Preventive Measures

(a) Proper selection of pipe material based on design standards, and installation of new distribution components.

(b) Proper corrosion control measures to minimize pipe corrosion and leakage.

(c) Maintenance and operation measures such as system flushing, valve exercising, meter assessment testing and replacement programs, system modeling, and pressure management all contribute to improved efficiency, reduction in water losses, and often cost savings.

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j. Water Retention (Age) Reduction. High water retention is a major factor in deteriorating water quality²⁸ (e.g., residual chlorine decay, DBP formation, biofilm growth, sediment deposition, taste and odor problems) in the distribution system. Therefore, distribution system water quality can be improved by decreasing water retention through the following operational means or system modifications:

(1) Prevent water stagnation and stratification in storage tanks

(a) Maximize turnover volume (e.g., turnover of at least one-third of the water in the tanks daily).

(b) Achieve proper mixing of water and eliminate short circuiting in the tank.

1. Install a mixer or turbulent inlet jet nozzles in the water tank for proper water mixing.

2. Separate inlet and outlet pipes.

(2) Distribution system modification

(a) Eliminate unnecessary storage and dead-ends where possible. Reduce dead-end mains to ensure effective circulation of the water.

(b) Properly size distribution system pipes.

(c) Employ computer modeling of the system, if possible, to provide a tool for better operational control and planning.

k. Booster Chlorination²⁹. Booster chlorination in the distribution system provides the means for primary systems to meet their microorganism inactivation goals without dosing to meet residual requirements, and offers consecutive systems a treatment option to consider in optimizing their distribution systems. Lowering the dose in the primary treatment system and re-chlorinating in the distribution system decreases overall DBP concentrations. The American Water Works Association Research Foundation (AWWARF) report, *Maintaining Distribution System Residual Through Booster Chlorination*, provides detailed information on the benefits of booster chlorination as well as guidance and technical assistance on system design and implementation. To optimize booster chlorination, systems should consider performing a hydraulic study. Familiarity of the system is vital in order to assess areas of greatest concern, retention times, demand, flow, optimization of disinfectant, and most beneficial points of application. However, booster chlorination is considered additional treatment and the addition may change the facility's classification with the primacy agency.

l. Other Management and Control Measures

(1) Periodic and routine finished water tank inspection, maintenance, and cleaning³⁰ (refer to article 5-10).

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- (2) Proper operation of valves (open and close) and pumps (start and stop) to limit hydraulic transient (water hammer).
- (3) Proper operation of valves to eliminate dead-ends in the distribution system.
- (4) Precursor removal (e.g., removal of total dissolved carbon and bromide from source water) and water retention reduction to control DBPs (e.g., TTHM) in distribution system.
- (5) Proper water tight construction of meter/valve vaults throughout the distribution system and installation of proper protective measures (e.g., sump pumps) to prevent flooding or submergence in ground water.
- (6) When possible, prevent distribution system mains and branches from becoming submerged in surface or ground water.
- (7) Lay water mains above the elevation of sanitary sewers and at least 10 ft. horizontally from such sanitary sewers when they are parallel, or as required by local or State standards. Where a sanitary sewer crosses over a water supply pipe, both the water main and the sewer must be constructed of ferrous materials with joints equivalent to water main standards for a distance of 10 ft. on each side of the crossing. A section of water main pipe must be centered at the point of crossing. Local standards may require additional separation materials.

4. Fire Hydrants³¹

a. General

- (1) Navy water systems are required to comply with the requirements of UFC 3- 600-01, paragraph entitled “Hydrants.” UFC 3-600-01 Change 3. 1 March 2013. *Fire Protection Engineering for Facilities*.
- (2) Fire hydrants must be Underwriters Laboratories listed, Factory Mutual Global approved, or listed or classified by a Nationally Recognized Testing Laboratory and must have two 2-1/2-inch (65 mm) hose outlets and one 4-1/2-inch (115mm) suction connection with national standard fire hose threads per National Fire Protection Association (NFPA) 1963, Fire Hose Connections.
- (3) Wet-barrel or California-type hydrants are preferable in areas with no danger of freezing.
- (4) Dry barrel or traffic-type hydrants must be used in areas where there is a danger of freezing. Hydrants must be above ground type.
- (5) Local municipal departments using non-standard connections must make and supply adapters to engine companies that respond to DoD installation fires. On DoD installations serviced only by local fire departments, hydrant hose threads must meet local requirements. See AWWA Manual M17, *Installation, Field Testing, and Maintenance of Fire Hydrants* and AWWA Manual M31, *Distribution Systems Requirements* for additional information.

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(a) Note 1: Overseas bases with current below grade hydrants per local national policy are acceptable.

(b) Note 2: For Navy projects, a 4-inch (100 mm) suction connection must be provided for facilities that have existing fire hydrants with 4-inch (100 mm) suction connection.

b. Hydrant Color Coding

(1) Hydrant barrels must be color coded to prevent cross-connection. Established color code standards include red for non-potable water, yellow for potable water, and purple for reclaimed/reuse water.

(2) All hydrants must also be marked based on the fire flow capacity. In the absence of an installation established marking standard, the hydrant bonnet must be painted per NFPA 291, *Fire Flow and Marking of Hydrants*.

(a) Hydrant bonnet and caps color based on fire flow capacity

1. Red: 500 gpm or less
2. Orange: 500 - 1000 gpm
3. Green: 1000 - 1500 gpm
4. Light Blue: 1500 gpm or more

(b) Exception: Hydrants at DoD facilities serviced only by local municipal fire departments must comply with the requirements of the local municipality.

(c) The blow-off hydrants must be a different color than fire hydrants and prominently marked as blow-off hydrants.

c. Installation Requirements

(1) Hydrants must be installed adjacent to paved areas, accessible to fire department apparatus.

(2) Hydrants must not be closer than 3 ft. (1 m) nor farther than 7 ft. (2.1 m) from the roadway shoulder or curb line.

(3) Hydrants must be installed with not less than a 6-inch (150 mm) connection to the supply main, and valved at the connection.

(4) Barrels must be long enough to permit at least 18-inch (450 mm) clearance between the center of the 4-1/2-inch (115 mm) suction connection and grade.

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- (5) The ground must be graded so that any surface drainage is away from the hydrant.
 - (6) Hydrant installation must be per NFPA 24, except as modified by the UFC.
 - (7) Suction connection must be perpendicular to the street to allow straight-lined connection to the pumper.
 - (8) At airfields, the tops of the hydrants should be installed no more than 24 inches (610 mm) above the level of the adjacent airfield pavement, but in no case may the tops of the hydrants be higher than 30 inches (760 mm) above the airfield pavement.
- d. Spacing Requirements. A sufficient number of hydrants must be provided to meet fire flow demand without taking more than 1,250 gpm (4,740 L/min) from any single hydrant. Hydrants must also be spaced per the following requirements:
- (1) All parts of the building exterior must be within 350 ft. (106 m) of a hydrant with consideration given to accessibility and obstructions. Hydrants must be located with consideration to emergency vehicle access.
 - (2) At least one hydrant must be located within 150 ft. (45 m) of the fire department connection.
 - (3) Hydrants protecting warehouses must be spaced a maximum of 300 ft. (91 m) apart.
 - (4) Hydrants protecting aircraft hangars must be located at 300 ft. (91 m) maximum intervals, and there must be at least one hydrant at each corner of the hangar.
 - (5) Hydrants protecting petroleum, oil, and lubricant storage and distribution facilities must be spaced at 300 ft. (91 m) maximum intervals. A minimum of two hydrants must be provided and hydrants must be located to allow protected exposures to be reached by hose lays not exceeding 300 ft. (91 m) in length.
 - (6) Hydrants protecting aircraft parking and servicing aprons must be spaced at 300 ft. (91 m) maximum intervals along one side.
 - (7) Hydrants protecting exterior storage must be spaced at 300 ft. (91 m) maximum intervals around the perimeter.
 - (8) Hydrant spacing must not exceed 600 ft. (182 m) for family housing developments without sprinkler protection. Hydrant spacing must not exceed 1,000 ft. (305 m) for family housing developments with sprinkler protection.
- e. Hydrant Protection. Hydrants located adjacent to parking areas or other vehicle traffic areas, must be protected by bollards. The bollards must not be located directly in front of an outlet and must allow clearance to remove the hydrant caps and attach hoses.

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f. Testing Hydrant Flow and Pressure. Fire hydrants must be tested according to AWWA M17 at the frequency required by UFC 3-230-02 Table 26.

5. Use of Non-Potable or Not Fit for Human Consumption Water

a. Non-potable (i.e., not fit for human consumption) distribution systems must be designed to prevent interconnection (e.g., by employing incompatible coupling devices) with the fit for human consumption water system. The marking “NON-POTABLE” or “NOT FIT FOR HUMAN CONSUMPTION” must be stenciled on the not fit for human consumption distribution system. On shore stations, color-coding of pipe connections (risers) and valves must be used to distinguish fit for human consumption from non-fit for human consumption systems.

b. Not fit for human consumption water distribution systems must be physically separated from all fit for human consumption water distribution systems. Only authorized personnel may operate the non-fit for human consumption water distribution system.

c. Not fit for human consumption fresh or salt water is used for fire protection, flushing, and industrial uses only when the potable water supply is insufficient for all requirements. Table 5-9-6, which comes from DoD UFC 4-150-02, provides the approved color codes for water connections.

Table 5-9-6 Color Coding for Ship-to-Shore Utility Connections	
Shore Service	Color (Fed. Std. 595B)
Potable (Fit for Human Consumption) Water	Blue, dark
Non-Fit for Human Consumption Water (Fire Main)	Red
Chilled Water	Striped Blue and White
Oily Waste-Water	Striped Yellow and Black
Sewer (Collection Holding and Transfer)	Gold

d. The use of water that is not fit for human consumption for bathing and laundering is prohibited for Navy and Marine Corps installations and vessels. After consultation with the Preventive Medicine Authority and other resources, the installation or vessel CO may authorize restrictions on water use, such as a “boil water” notice, “do not drink” notice or “do not use” notice, along with identification of options for a short-term alternate supply of fit for human consumption water. For more information, refer to article 5-30 in section V of this chapter.

6. Water Hauling

a. It may be necessary for a PWS to have bulk water hauled in during an emergency situation such as a water shortage or a water quality problem. If it becomes necessary to haul finished water from a water treatment facility, via any means of transportation (e.g., tanker trucks, water barges) to another point outside the distribution system, reference (h), part 129.40, CNIC Memorandum 5090, Ser N4/17U009 dated 26 January 2017 (Hauling Drinking Water) and applicable local health department regulations address sanitation requirements.

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b. Per reference (h), part 129.40, all water contact equipment must be suitable for its intended use, including tanks, surfaces, hoses, pumps, valves, fittings and lubricants. All such equipment must be constructed of non-toxic, non-absorbent NSF/ANSI 61 listed material which can be adequately cleaned and sanitized. All equipment must be constructed so as to allow inspection and adequate sanitation of water contact surfaces.

c. Tanks used to transport finished water must be labeled “POTABLE WATER ONLY” on both sides of the tank in letters at least 4 inches in height.

d. The local Preventive Medicine Authority must observe operations at both the fill and distribution points at least monthly. Additionally, they must sample each labeled potable water container to test its contents for FAC, enteric bacteria, E. coli and pH at least monthly. Additional information can be found in section IV of this chapter.

e. Water hauling operations must be conducted in a safe, sanitary manner, similar to that of the water treatment and distribution system. Water haulers are required to ensure that their containers, hoses, fittings and other related equipment are protected from the introduction of contaminants at all times, whether the container is full or empty.

(1) Personnel handling bulk water delivery equipment should conduct and maintain good hygiene practices to prevent contamination of the bulk water.

(2) Bulk water should not be stored in a bulk water transport tank for more than 3 days.

(3) Any water tank used for bulk water hauling should be used exclusively for hauling bulk water only. When prior use of a container is unknown or if it has been used for hauling a material other than potable water, the tank may be rejected for use as a bulk water hauling container.

(4) The World Health Organization provides guidance for cleaning and disinfecting water storage tanks and tankers. This technical guidance document can be obtained at:
http://www.who.int/water_sanitation_health/hygiene/envsan/cleaningtanks.pdf?ua=1

f. It is important to note that bulk water hauling may be acceptable as a temporary solution to a water emergency or shortage. Should bulk water hauling be the only solution, it is important that the Preventive Medicine Authority liaison with public works, contracting officials, base environmental, public affairs, and the NAVMEDPUBHLTHCEN to ensure potential public health concerns are addressed.

5-10. Water Storage

1. General

a. Fit for human consumption water storage tanks are necessary for firefighting, to satisfy peak demands, to support uniform water pressure, to meet industrial demands, to provide emergency water reserve, and to avoid continuous pumping. UFC 3-230-01 addresses drinking

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water storage requirements, site considerations, tank types, tank material and construction at U.S. Navy installations. UFC 3-600-01 addresses fire demands. The minimum volume of water storage required is the sum of 50 percent of the average total daily domestic requirements, plus any industrial demand that cannot be reduced during a fire period, plus the required fire demand.

b. Many installations have oversized fit for human consumption water storage tanks that exceed their routine capacity requirements. This results in low turnover of the stored water, which may lead to water quality complaints or problems. Many tanks are kept full in an effort to better prepare for emergency conditions. Thus, water in storage tanks may be subject to prolonged detention times also referred to as hydraulic residence time contributing to water quality deterioration. Typical problems with stored water include:

- (1) Loss of disinfectant residual.
- (2) Bacterial growth (biofilm) and elevated HPC.
- (3) Nitrification in systems that use chloramines.
- (4) DBP formation.
- (5) Accumulation of debris and sediment.
- (6) Degradation of tank coatings, materials, and plumbing.
- (7) Lack of corrosion control, which prematurely ages steel tanks.

(8) Water tank openings such as vents, hatches, elevation gauges, and overflows provide access for contaminants from dirt, birds, and other animals to enter the water.

2. Maintenance. Ensure fit for human consumption water storage tanks are inspected and maintained as specified in UFC 3-230-02.

a. Corrosion and scaling in storage tanks may adversely affect the water. All tank coatings (paint), including sealing compounds and other materials, must be certified to NSF/ANSI Standard 61.

b. Turnover or flushing of the stored water is necessary to minimize detrimental effects on water quality due to long detention times. Turnover is defined as discharging the entire volume of the tank, and turnover rate is the average time in hours or days required for a complete turnover. Increasing water turnover frequency is beneficial in maintaining or restoring disinfectant residual within storage tanks. Typically, the turnover rate is on the order of once every 3, 5, or 7 days (depending on ambient temperature and stored water quality). Recommendations in NAVFAC User's Guide (UG) – 2077-ENV to improve the conditions of finished water storage facilities focus on reducing detention time by considering the following options:

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(1) Mix the storage facility by:

- (a) Increasing inlet momentum
- (b) Changing inlet configuration
- (c) Installing mixing devices
- (d) Increasing fill-time

(2) Utilize tank turnover by:

- (a) Increasing water level fluctuation
- (b) Increasing draw-downs between fill and draw cycles
- (c) Converting tank to plug flow reactor

(3) Take excess storage facilities off-line after considering the impact on available water for user-demand and emergency response.

3. Water Storage Sanitary Standards. Water storage can consist of raw or finished water storage:

a. **Raw Water Storage**. Storing water for as little as a few hours will sediment the large, dense particles, such as inorganic sands and silts, large microbes, and any other microbes associated with larger, denser particles. Longer settling times, such as overnight or for 1-2 days, will remove larger microbes, parasites, algae, and the larger clay particles. Most viruses and bacteria and fine clay particles are too small to settle out by simple gravity sedimentation. The World Health Organization guidance recommends rigorous physical or chemical cleaning of raw water collection tanks and cisterns to avoid the microbial colonization of surfaces and the resulting accumulation of biofilms. The Preventive Medicine Authority should provide surveillance of compliance sampling for raw water storage, if applicable.

b. **Finished Water Storage Sanitary Standards**

(1) **Below Ground Fit for Human Consumption Water Tanks**

(a) If the bottom of a storage reservoir must be below the normal ground surface, at least 50 percent of the water depth must be above grade. The top of a partially buried storage structure must not be less than 2 ft. above normal ground surface. Clear wells and certain reservoirs may be exempted from this requirement when the design provides adequate protection from contamination.

(b) The overflows (e.g., manhole covers and vents), must be located at least 2 ft. above the 100-year flood stage. In addition, the overflow pipe discharge point must be at least twice the diameter of the discharge pipe above grade to maintain the required air gap.

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- (c) The ground around the tank must be sloped away from the tank to provide drainage.
- (d) The tanks must be located at a level higher than any sewers or sewage systems.
- (e) Sewers or sewage disposal systems must be located at least 50 ft. from water storage tanks.

(2) Ground and Elevated Fit for Human Consumption Water Tanks

(a) Fit for human consumption water storage tanks must be covered with suitable watertight roofs to prevent contamination by dust, rain, insects, animals and birds, and to discourage algae growth.

(b) The lowest elevation of the floor and sump floor of ground level reservoirs must be placed above the 100-year flood elevation or the highest flood of record, whichever is higher, and at least 2 ft. above the ground water table as recommended in the *Ten State Standards* (2012).

(c) Finished water storage structures must be vented. The overflow pipe must not be considered a vent. Open construction between the sidewall and roof is not permissible. All vents and overflows must be screened with 24-mesh (non-corrodible) insect screens. The vents must be rain-proofed by using goosenecks or vent caps. The screen must be installed within the overflow pipe at a location least susceptible to damage by vandalism.

(d) Overflow pipe must discharge by gravity with a free fall at a location where the discharge can be observed, does not cause erosion of the reservoir abutment, and is not directly connected to sewers or storm drains. The overflow pipe must be of sufficient diameter to permit waste of water in excess of the filling rate.

(e) Drainpipes must not be directly connected to sewers or storm drains. The design should allow for draining the storage facility for maintenance without causing loss of pressure in the distribution system.

(f) Ladders with approved safety cages must be used on all standpipes and elevated storage tanks. Access to ladders must be locked and secured. Elevated tanks with riser pipes over 8 inches in diameter must have protective bars over the riser openings inside the tank. Railings or handholds must be provided on elevated tanks where persons must transfer from the access tube to the water compartment.

(g) Install a wire fence and locked gate around storage tanks to prevent unauthorized entrance. Provide locks on access manholes to prevent vandalism and sabotage.

(h) Water storage tanks should be designed to facilitate turnover and minimize stagnation by providing separate inlet and outlet pipes.

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4. Disinfection of Water Storage Tanks. Fit for human consumption water tanks should be disinfected as described in the current AWWA Standard C652, *Disinfection of Water Storage Facilities* and UFC 3-230-02, *Operation and Maintenance: Water Supply Systems*.

a. Two or more successive sets of samples, taken at 24-hour intervals, must demonstrate satisfactory microbiology levels prior to placing the facility into operation.

b. Disposal of heavily chlorinated water from the tank disinfection process must be per the requirements of the State regulatory agency.

c. The disinfection procedure specified in AWWA Standard C652 *Chlorination Method 3*, which allows use of the highly chlorinated water held in the storage tank for disinfection purposes, is not recommended. The chlorinated water may contain various DBPs (including regulated DBPs), which should be kept out of the distribution system. If this procedure must be used, the initial heavily chlorinated water must be properly disposed.

5-11. Water Treatment³²

1. General. Water suppliers use a variety of treatment processes to remove contaminants from drinking water. The types of treatment depend on the system size, source water type (i.e., surface water or ground water), and source water quality. Large water systems generally rely on surface water sources and small water systems generally rely on ground water sources. Surface water systems generally require more treatment than ground water systems. A typical water treatment plant has a combination of processes to treat the contaminants in the source water used by the facility. For installations with water treatment plants, the Preventive Medicine Authority must contact the certified water plant operator to obtain a general understanding of the plant operation. All additives and chemicals used in drinking water treatment, to include corrosion and scale inhibitors, coagulants and flocculants, disinfection and oxidation chemicals, pH adjustment, softening, precipitation and sequestering chemicals, well drilling aids, and other specialty chemicals must comply with NSF/ANSI Standard 60. All materials used for potable water piping, valves, fittings, meters, hydrants, pumps, and other appurtenances and their design, installation, operation, and maintenance must be per NSF/ANSI Standard 61.

a. Surface water systems (systems using surface water sources). Surface water sources contain relatively high-suspended solids and, therefore, treatment generally requires suspended solid removal processes such as flocculation, sedimentation, and filtration. Some treatment processes may also include ion exchange, reverse osmosis (RO), adsorption (e.g., granular activated carbon (GAC) filter), and other processes for further contaminant removal.

b. Ground water systems (systems using ground water sources). Treatment processes for ground water sources vary depending on source quality. Ground water commonly has high hardness (i.e., high calcium and magnesium), iron and manganese levels; therefore, ground water treatment systems often include processes for iron and manganese removal (e.g., oxidation and filtration) and hardness removal (e.g., cation exchange, membrane filtration) in addition to disinfection. Some ground water treatment processes may also include adsorption (e.g., GAC filter, aeration, membrane) and other processes for further contaminant removal.

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2. Conventional Treatment Processes. Conventional treatment includes two processes:

a. **Flocculation and Sedimentation**. Flocculation refers to processes that combine small colloidal particles into larger particles, which settle out of the water as sediment. Alum and iron salts or synthetic organic polymers (alone, or in combination with metal salts) are generally used to promote coagulation. Settling or sedimentation is a gravity process that removes flocculated particles from the water.

b. **Filtration**³³. Single and multi-media filters are used to remove remaining particles from the water supply. Particles removed include clays, silts, natural organic matter, precipitants from other treatment processes, iron and manganese salts, and microorganisms. Filtration clarifies water and enhances the disinfection efficiency.

(1) **Conventional Filtration**³⁴. Conventional filtration treatment means a series of processes including coagulation, flocculation, sedimentation, and filtration resulting in substantial particulate removal.

(2) **Direct Filtration**. Direct filtration means a series of processes including coagulation and filtration, but excluding sedimentation, resulting in substantial particulate removal.

(3) **Diatomaceous earth filtration**³⁵. Diatomaceous earth filtration means a process resulting in substantial particulate removal in which (1) a pre-coat cake of diatomaceous earth filter media is deposited on a support membrane (septum), and (2) while the water is filtered by passing through the cake on the septum, additional filter media known as body feed is continuously added to the feed water to maintain the permeability of the filter cake.

(4) **Slow Sand Filtration**³⁶. The rarely used method (high footprint) slow sand filtration refers to a process involving passage of raw water through a bed of sand at low velocity (generally less than 1.3 ft./h [0.4 m/h]) resulting in substantial particulate removal by physical and biological mechanisms. No chemicals are added to aid the filtration process.

3. Unconventional Treatment Processes

a. **Membrane Filtration**³⁷. Membrane filtration utilizes a thin layer of membrane capable of separating substances through application of a driving force (typically pressure by pumping). Pressure driven membrane filtration technologies include microfiltration, ultrafiltration (UF), nanofiltration (NF) and RO. Microfiltration and ultrafiltration are called low-pressure membrane filtration technologies and require relatively lower pressure compared to high-pressure membrane filtration technologies such as NF and RO.

(1) **Low-Pressure Membrane Filtration**³⁸. Low-pressure membrane filtration processes (microfiltration and UF) are applied for particle and microbial contaminant removal as stand-alone treatment or as pretreatment of other advanced membrane filtration processes such as NF and RO filtration.

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(a) Microfiltration. Membrane pore size generally ranges from 0.03 to 10 microns and the system is generally driven with a pressure of 15 to 60 psi. The process is primarily applied for particulate and microbial removal.

(b) Ultrafiltration. Membrane pore size generally ranges 0.002 to 0.1 microns and the system is generally driven with a pressure of 30 to 100 psi. The process is primarily applied for finer particulate and microbial removal, but may be also used for removal of some organic materials.

(2) High-Pressure Membrane Filtration. High-pressure membrane filtration processes include NF and RO. RO and NF are proven, widely utilized treatment technologies for desalination of seawater and brackish water.

(a) NF. Membrane nominal pore size is approximately 0.001 microns and the system is generally operated with a pressure of 90 to 150 psi. In addition to microbial removal, NF removes most organic molecules (including disinfection byproduct precursors and a range of salts). Unlike RO, NF is not a complete barrier to dissolved salts) including divalent ions (i.e., removal of hardness and alkalinity).

(b) RO is a process for the removal of dissolved ions. Pressure is used to force water through a semi-permeable membrane, which allows passage of water, but excludes dissolved minerals. It is necessary to establish and adhere to strict feed water quality guidelines and pretreatment requirements to optimize water treatment performance and mitigate common problems associated with RO. These problems include scaling, fouling, and degradation of RO membranes. In addition, demineralized water, while not a health risk, tends to be corrosive to plumbing fixtures and distribution system components. Facilities where RO is used for drinking water production are urged to evaluate and implement the appropriate corrosion control measures. Facilities that blend RO produced water with raw or partially treated water must consider the effects on finished water quality particularly microbial quality and corrosion.

(3) Membrane Integrity Test. Membrane integrity testing is a means of assessing whether a membrane system is completely intact or has been compromised. Proper membrane integrity testing can verify effectiveness against contaminants by detecting membrane leaks or breaches. Specifically, in order to receive bacteriological parameter removal credit for a membrane filtration process, a system must conduct proper membrane integrity tests according to the procedure and frequency required in LT2ESWTR. There are two general types of integrity testing methods: direct and indirect integrity.

(a) Direct integrity testing methods detect membrane integrity breaches through a physical test applied to a membrane unit. Common direct integrity testing methods include pressure hold (decay), diffusive air flow, sonic sensing analysis, and bubble point.

(b) Indirect integrity testing methods continuously monitor filtrate water quality parameters or components (e.g., turbidity monitoring or particle counting and monitoring) as a surrogate measure of EPA-approved direct membrane integrity tests.

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b. Ion Exchange. Ion exchange processes are used to remove inorganic constituents if they cannot be adequately removed by filtration or sedimentation. Ion exchange is primarily used to treat hard water (i.e., removing calcium and magnesium ions). It can also be used to remove other dissolved ionic species including arsenic, chromium, excess fluoride, nitrates, radium, and uranium. Ion exchange processes use a solid phase of naturally occurring materials (zeolites) or a synthetic resin as the exchange medium consisting of a mobile ion attached to an immobile functional acid or base group. The mobile ions (normally sodium ion for cation exchange and chloride ion for anion exchange) are exchanged with target ions having a stronger affinity to the immobile functional group (e.g., calcium ion in inlet water replaces sodium ion attached to medium).

c. Adsorption. Organic contaminants, color, taste, and odor-causing compounds can be removed with GAC or powdered activated carbon, which sticks to the surface of these compounds. GAC is generally more effective than powdered activated carbon in removing these contaminants.

d. Other Treatment Processes:

(1) Lime Softening³⁹. Addition of lime removes hardness through calcium carbonate precipitation caused by the pH increase. Water hardness⁴⁰ is mainly caused by calcium and magnesium ions in water.

(2) Oxidation and Filtration. Are the most common processes used for iron and manganese treatment⁴¹. High iron and manganese in water can cause various problems including water discoloration; rusty/brown stains on plumbing fixtures, fabrics, and dishes; and iron deposits on tanks, water heaters, and pipelines. The oxidant (e.g., chlorine, ozone, oxygen, or potassium permanganate) chemically oxidizes the iron or manganese to form precipitate particles that are later removed by filtration.

(3) Air Stripping (also called aeration). Normally used to remove volatile contaminants (e.g., volatile organic compounds [VOC] and radon). Several different types of air stripping processes (e.g., packed tower aeration, diffused aeration, multiple tray aeration, and mechanical aeration) are commonly used to volatilize contaminants and release them directly to atmosphere.

(4) Electrodialysis and Electrodialysis Reversal systems use an ion exchange membrane to separate ionic contaminants. The process uses an electric voltage applied across alternating anion and cation exchange membranes. The systems are used for desalination and effective in removal of contaminants of concern such as uranium, arsenic, nitrate, perchlorate, and aesthetic contaminants such as hardness. However, Electrodialysis and Electrodialysis Reversal systems require advanced operation and maintenance skills and their costs are relatively high compared to conventional systems.

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4. Disinfection (Chlorine-based Chemicals, Ozonation, and Ultraviolet (UV) Light)

a. General

(1) Water is disinfected before it enters the distribution system to kill pathogenic microbes. Chlorine, chloramines, or chlorine dioxide are commonly used because they are very effective disinfectants and residual concentrations can be maintained to guard against biological contamination in the water distribution system. Water plant personnel must use regular and frequent field testing, both at the point of application and various points in the distribution system, to ensure the system maintains sufficient chlorine-based disinfectants levels.

(2) Ozone is a powerful disinfectant, but it is not effective in controlling biological contaminants in the distribution pipes because it leaves no disinfectant residual. Ozonation should therefore be followed by a secondary disinfectant that provides a residual in the distribution system. Details on water disinfection requirements including concentration time as requirements may be found in reference (c), part 141.

(3) UV⁴² disinfection uses radiation emitted from UV lamps to inactivate microorganisms. UV radiation is a physical disinfectant that leaves no residual. Therefore, UV disinfection must be followed by a chemical disinfectant (e.g., chlorination) to provide a disinfectant residual in the distribution system. UV disinfection is very effective for inactivating *Cryptosporidium* and *Giardia* at low doses, but is much less effective against viruses. Therefore, UV disinfection is often used as an additional disinfection for *Cryptosporidium* and *Giardia* inactivation at the end of the treatment process.

(4) DBPs form when chemical disinfectants react with organic matter in treated drinking water. NPDWR sets forth MCLs for specific DBPs. Long-term exposure to some DBPs may increase the risk of cancer or other adverse health effects.

b. Disinfection Requirements

(1) Disinfection Requirements for Non-Filtering Systems

(a) A PWS using a surface water source may avoid filtration only if the system meets all the filtration avoidance criteria specified in the Surface Water Rule (see subpart H of reference (c), part 141.71).

(b) Public water systems that do not provide filtration and use a surface water or GWUDISW source must provide disinfection sufficient to ensure at least 99.9 percent (3 log) inactivation of *Giardia lamblia* cysts and 99.99 percent (4 log) inactivation of viruses every day the system serves water to the public. The EPA Surface Water Treatment Rules provide information on imparting sufficient disinfection to achieve the target inactivation rates.

(c) The disinfectant system must either have redundant components, including an auxiliary power supply with an automatic start-up and alarm to ensure that disinfectant application

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is maintained continuously while water is being delivered to the distribution system, or an automatic shut-off of water delivery whenever there is less than 0.2 ppm of residual FAC disinfectant concentration in the water.

(d) The residual disinfectant concentration entering the distribution system cannot be less than 0.2 ppm for more than 4 hours.

(e) The residual disinfectant concentration in the distribution system, measured as total chlorine, combined chlorine or chlorine dioxide, cannot be undetectable in more than 5 percent of the samples each month for any 2 consecutive months that the system serves water to the public. See reference (c) part 141.72(4)(i) for an exception when, approved by the authority, HPC may be used rather than a detectable disinfectant residual for purposes of determining compliance with this requirement.

(f) In addition to required inactivation of *Giardia lamblia* cysts and viruses, LT2ESWTR (reference (c), part 141.712) requires up to 99.9 percent (3 log) inactivation of *Cryptosporidium* (depending on source water cryptosporidium concentration).

1. LT2ESWTR requires unfiltered systems to use chlorine dioxide, ozone, or UV to meet the *Cryptosporidium* inactivation requirements.

2. LT2ESWTR requires at least two disinfectants for unfiltered surface water systems, at least one of which is effective against *Cryptosporidium*.

(2) Disinfection Requirements for Filtering Systems

(a) Filtered water systems, including surface water or GWUDISW systems, will provide a combination of disinfection and filtration that achieves a total of 99.9 percent (3 log) removal or inactivation of *Giardia lamblia* cysts and 99.99 percent (4 log) removal or inactivation of viruses.

(b) Water plant operators must monitor the turbidity of filtered water at least once every 4 hours. The turbidity of filtered water will not exceed 0.3 nephelometric turbidity units (NTU), or 1 NTU for slow sand and diatomaceous earth filters, in 95 percent of the analyses in a month, with a maximum of 5 NTU. Elevated turbidity signifies a breakdown in treatment processes and indicates that the water is not being adequately disinfected.

(c) Disinfection concentration must be sufficient to provide the remaining log-removal of *Giardia lamblia* cysts and viruses not obtained through filtration.

(d) Disinfection residual maintenance and monitoring requirements are the same as those for unfiltered systems.

(e) Water supplied to an installation from an approved PWS should have a measurable chlorine-based disinfectant residual (FAC, total chlorine, chloramines, or chlorine dioxide). When the disinfectant residual is insufficient, additional disinfection treatment is required.

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(f) In addition to required inactivation of *Giardia lamblia* cysts and viruses, LT2ESWTR requires up to 99.9 percent (3 log) inactivation of *Cryptosporidium* (depending on source water cryptosporidium concentration [i.e., bin classification]).

(3) Potable water systems should be rechlorinated where sanitary, physical, or operating defects or other special hazards are known to exist, or where microbiological examinations show that satisfactory water quality cannot be obtained. Rechlorination should be at a level sufficient to produce a FAC residual of 0.2 ppm after 60 minutes of contact time, typically prior to the first customer at the point of entry (POE) to the distribution system.

(4) There is a general public concern over the health effects of chlorinated organics. As a result, SDWA now regulates THMs and NPDWR lists MCLs for these compounds. THMs are commonly found in chlorinated drinking water, particularly in drinking water obtained from surface sources. THMs form when chlorine reacts with naturally occurring organic substances during drinking water treatment and distribution.

(5) Only chlorine-based chemicals provide measurable residual in the distribution system. FAC and chloramines disinfection processes are found at almost all Naval facilities. Measurement of FAC or chloramines can be determined by using any EPA State-approved method.

c. Chlorination

(1) Type of Chlorine

(a) Chlorine Gas (Cl_2). Chlorine gas is greenish yellow in color and heavier than air. It is highly toxic and very hazardous to humans if inhaled. It is generally marketed in 150-pound cylinders or one ton containers under pressure with nearly 100 percent chlorine.

(b) Sodium Hypochlorite (NaOCl). Sodium hypochlorite is a chlorine-containing liquid compound commonly known as bleach. Sodium hypochlorite used in water systems generally contains 12-15 percent chlorine and is a light yellow liquid. It has a relatively short shelf life and an increase in byproducts is noted as it decays⁴³.

(c) Calcium Hypochlorite ($\text{Ca}(\text{OCl})_2$). Calcium hypochlorite is chlorine-containing solid compound and is marketed as powder, granules, pellets, or tablets as a water disinfectant. Calcium hypochlorite is relatively stable and has greater available chlorine (generally 65-70 percent chlorine) than sodium hypochlorite.

(2) Disinfection Efficiency. Chlorination is the most widely used procedure for the routine disinfection of water. The efficiency of chlorine is affected by the following variables:

(a) Chlorine Concentration. Chlorine residual concentration is one of the most important variables that water system operators can adjust to enhance microbial inactivation. A higher chlorine residual reflects better disinfection. However, high chlorine residual (less than 2 mg/L generally recommended) can cause taste and odor problems, and chlorine residual must not be greater than the 4 mg/L MRDL.

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(b) Chlorine Contact Time. Chlorine contact time refers to the length of time water is exposed to chlorine disinfection. Longer chlorine contact times produce higher disinfection efficiency. Chlorine contact time in a water system (i.e., for use in CT calculation) generally refers to the time in minutes that it takes for water to move from the point of disinfectant application to the first customer (with consideration of baffling factor).

(c) Water pH. Within the normal water system operational pH range (i.e., 6.5-8.5), chlorine disinfection efficiency is higher at a lower pH. At a temperature of 72° F (22°C), 0.3 ppm of chlorine in a water system with pH 6.5 achieves a 100 percent bacterial kill in 60 minutes. With the same temperature and time, at pH 7.0 the chlorine residual must be increased to 0.6 ppm to achieve the same percent of bacterial kill. Table 5-11-1 presents data for this pH-chlorine residual relationship. If the system uses chlorine, the pH of the disinfected water must be measured at least once per day at each chlorine residual concentration sampling point.

Table 5-11-1			
Chlorine-pH Relationship for 100 Percent Bacterial Kill in 60 Minutes (at 72°F)			
Water pH	Chlorine (ppm)	Water pH	Chlorine (ppm)
6.5	0.3	8.5	1.2
7.0	0.6	9.5	1.5
7.7	0.9	10.5	1.8

(d) Water Temperature. Chlorine disinfection efficiency, as well as chlorine residual decay, increases with temperature.

(e) Type and Density of Organisms. Chlorine disinfection efficiency varies with the type and density of organisms (virus, bacteria, protozoa, etc.). Of all the waterborne diseases, chlorine disinfection is most effective in preventing those caused by bacteria. At the other extreme, certain pathogenic organisms such as the cysts of the protozoa *E. histolytica*, *Giardia lamblia* and the oocysts of *Cryptosporidium parvum* are resistant to chlorine.

(f) CT Values. CT (mg/L*minutes) is defined as the product of C, residual disinfectant concentration in mg/L (determined before or at the first customer), and T, corresponding ‘disinfectant contact time’ in minutes. CT is a measure of disinfection process effectiveness at a certain pH and temperature, and is used to determine the degree of inactivation (i.e., percent of microorganisms inactivated through disinfection process) of each microorganism (*cryptosporidium*, *Giardia* and viruses) based on EPA CT tables.

(3) Chlorination Methods

(a) Marginal Chlorination. In marginal chlorination, the initial chlorine demand has been satisfied, but some oxidizable substances remain. The oxidizable substances may be detected by the DBP method as combined chlorine residual. However, the portion of the combined chlorine residual represented by these substances is not a disinfectant.

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(b) Super Chlorination-Dechlorination. This procedure involves the application of chlorine in greater concentrations than are needed to afford acceptable bactericidal efficiency. This practice gives control over taste and odor producing substances as well as control of bacteria. Surplus chlorine is removed by dechlorination with sulfur dioxide, aeration, or activated carbon before the water enters the distribution system. If dechlorination is used, care must be exercised to ensure adequate chlorine residual is present in the water in the distribution system.

(c) Break-Point Chlorination. In break-point chlorination, enough chlorine is applied to produce a chlorine residual composed of predominantly FAC with little or no combined chlorine.

d. Chloramines (Combined Chlorine and Ammonia). Chloramines are created by the addition of ammonia to water that contains free chlorine.

(1) Conversion to chloramines benefits. Chloramines have been successfully used throughout the U.S. as a secondary disinfectant, and are widely accepted as an alternative disinfectant that can be used to comply with increasingly stringent drinking water regulations. The use of chloramines as a secondary disinfectant can reduce disinfection byproduct levels, provide a lasting disinfectant residual in the distribution system, control coliforms per primacy agency and Federal regulations, and reduce the chlorine taste in the water.

(2) Conversion to chloramine drawbacks

(a) Potential growth of nitrifying bacteria.

(b) Adverse taste and odors that can result from blending water that contains chloramines with water that contains free chlorine.

(c) Potential adverse impacts on kidney dialysis patients and tropical fish. This is especially true for at-home dialysis patients. Clinics, hospitals, and dialysis centers must be informed prior to conversion to chloramination (especially for systems that seasonally use chloramination). The water system must provide these medical facilities time to contact their at-home patients. The system must obtain a list of at-home patients to ensure that they have been contacted and made aware of the risks of chloraminated water on their health.

(3) Conversion to Chloramine specific requirements. Effective use of chloramines requires establishing a program that takes advantage of the benefits of chloramines while minimizing the associated drawbacks.

(a) The primary supplier should select the point of ammonia addition downstream of the primary disinfection point (addition of free chlorine, chlorine dioxide, or ozone) to minimize the amount of free ammonia leaving the treatment plant and entering the distribution system.

(b) The installation should maintain an adequate chloramine residual within the distribution system. Considering chloramines are weaker disinfectants than free chlorine, maintaining a total chlorine residual of 2 mg/L is recommended.

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(c) A distribution system code of practice should be implemented to provide positive control and feedback on water quality within the distribution system.

(d) The water supplier should develop a public notification information program to avoid potential adverse effects on special water users such as kidney dialysis patients, tropical fish, etc.

e. UV Disinfection. PWSs often include UV disinfection to receive credit for inactivation of *Cryptosporidium* and *Giardia*. Table 5-11-2 presents the required UV dose values for microbial inactivation credits (see reference (c), part 141.720(d)). The UV dose depends on the intensity (in milliwatts [mW]/cm²) * time (seconds [sec]) or (IT). IT is expressed in mWsec/cm² or millijoules per square centimeter (mJ/cm²). The IT is similar to the CT concept for chlorine disinfection; the higher the light intensity or exposure time, the more effective the disinfection process. UV light is measured by UV sensors. The delivered UV dose depends on the flow rate and the UV transmittance.

Table 5-11-2								
UV Dose Requirements for Inactivation of <i>Cryptosporidium</i>, <i>Giardia</i> and Viruses (mJ/cm²)								
Target Pathogens	Log Inactivation (wavelength of 254 nm)							
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Cryptosporidium	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3.0	5.2	7.7	11	15	22
Virus	39	58	79	100	121	143	163	186

(1) A PWS using UV disinfection must monitor their UV reactors to demonstrate that UV reactors are operating within the range of conditions validated for the required UV dose.

(2) At a minimum, a PWS using UV disinfection must monitor the following parameters from each UV reactor:

- (a) UV intensity as measured by a properly calibrated UV sensor.
- (b) Lamp status.
- (c) Flow rate.
- (d) UV absorbance as applicable.

(3) The NSF/ANSI 55 standard, for UV light disinfection water treatment systems (class A), sets a minimum dose of 38 /cm² or mJ/cm².

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5. Fluoridation

a. When optimum amounts of fluorides are not naturally present in drinking water, the application of fluoride to water supplies is a current and long standing public health recommendation to prevent dental caries. Drinking water fluoridation is not regulated, but it is endorsed by EPA and Centers for Disease Control and Prevention (CDC), which has determined that the “optimal” range of fluoride in water lies between 0.7-1.2 mg/L (ppm), depending on the mean daily air temperature of a geographic area. The MCL for fluoride in drinking water is 4 ppm due to evidence that in extreme cases, exposure to drinking water fluoride levels over 4 ppm for many years may result in skeletal fluorosis, a serious bone disorder. A secondary standard of 2 ppm has been established because some children exposed to fluoride levels greater than 2 ppm may develop dental fluorosis, an unsightly cosmetic discoloring or mottling of the enamel, visible by chalky white specks and lines or pitted and brown-stained enamel on permanent, adult teeth.

b. Not applicable to overseas installations as per the Overseas Environmental Baseline Guidance Document and Office of the Secretary of Defense Memo of 18 March 2013.

6. Corrosion Control⁴⁴. Corrosion is a phenomenon associated with a metal and the water within a distribution system. Physical factors that affect corrosion and corrosion control are temperature, velocity of water moving over the metal, changes in direction and velocity of flow, and contact with a second metal or nonmetal. Water pH may also be a significant corrosion factor. Installations that are considering converting from free chlorine to chloramines for residual disinfection or whose primary supplier is considering such a change should be aware that chloramines have been implicated in recent occurrences of high lead levels. In addition, there is evidence that changes in treatment chemicals, such as converting from the use of aluminum sulfate to a polyaluminum chloride as a coagulant for surface water treatment, may alter the chloride to sulfate ratio sufficiently to increase the rate of corrosion with respect to lead.

7. Point of Use (POU) and POE Treatment

a. EPA has approved centrally managed POU and POE treatment devices as a means to achieve compliance with MCLs. POU devices treat only the water intended for direct consumption at a single tap, while POE devices are typically installed to treat all water prior to entering a building or dwelling.

b. POU and POE treatment strategies may be useful for selected PWSs as an interim measure or, when constructing, upgrading, or expanding a central water treatment plant is not a viable option. States that have Primacy (i.e., regulatory oversight authority for the SDWA) may have restrictions regarding use of these treatment strategies. Therefore, any POU/POE treatment compliance strategies must be co-coordinated with all applicable approval authorities, both military and civilian.

c. POU treatment units must not be used to achieve compliance with an MCL or treatment technique for a microbial contaminant or an indicator of a microbial contaminant. However, POE devices may be used to achieve compliance with an MCL for a microbial contaminant or an indicator of a microbial contaminant.

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d. POU and POE units must be owned, controlled and maintained by the PWS or by a contractor hired by the PWS to ensure proper operation and maintenance of devices, and compliance with the MCLs. Important considerations are correct installation, maintenance and sampling of the water treatment device. To satisfy baseline data requirements, an initial water sample analysis must be carried out to verify the POU or POE device is working as designed. The system owner retains final responsibility for the quality and quantity of the water provided to the service community and must closely monitor all contractors. The applicable authorities must approve periodic sampling plans for compliance monitoring.

e. Manufacturers and companies that make or market water vending machines for the purpose of treatment or reduction of health or aesthetic contaminants must provide documentation that all treatment (wetted) components of the water vending machine have been certified by the manufacturer via the applicable NSF/ANSI Standard using an established third party accredited laboratory.

f. POU and POE units must have mechanical warnings to automatically notify customers of operational problems.

g. Only NSF/ANSI third party certified POU and POE treatment devices must be used as part of a compliance strategy if a standard exists for that type of treatment device. Table 5-11-3 lists NSF/ANSI Drinking Water Treatment Related Standards.

Table 5-11-3
NSF/ANSI Drinking Water Treatment Related Industry Standards
42: Drinking Water Treatment Units – Aesthetic Effects
44: Cation Exchange Water Softeners
53: Drinking Water Treatment Units – Health Effects
55: Ultraviolet Microbiological Water Treatment Systems*
58: Reverse Osmosis Drinking Water Treatment Systems
60: Drinking Water Treatment Chemicals – Health Effects
61: Drinking Water System Components – Health Effects
62: Drinking Water Distillation Systems

*The SWSA prohibits use of POU devices for microbiological contaminant water quality compliance. Therefore, although POU UV devices may be certified under NSF/ANSI Standard 55, they must not be considered when identifying potential compliance technologies for SDWA.

5-12. Water Quality

1. Water Quality Overview

a. General

(1) All drinking water sources may contain naturally occurring impurities or contaminants. Water easily dissolves many materials upon contact. Removing all impurities or contaminants is

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extremely expensive and in most cases, provides no additional health benefits. A few of the naturally occurring substances may actually improve the taste of drinking water and have nutritional value at low levels.

(2) Population growth and development of natural areas contribute to growing numbers of contamination threats to drinking water. Suburban sprawl has encroached upon watersheds, bringing with it potentially hazardous materials. Instances of serious drinking water contamination occur infrequently, and typically not at levels posing acute health concern. Nonetheless, the threats are real and the potential for such events is increasing. Drinking water safety cannot be taken for granted and ongoing surveillance of water treatment is critical to maintain public health.

(3) Each PWS must establish adequate infrastructure; proper system management, operation and maintenance; appropriate system and water quality monitoring; effective planning; and independent surveillance.

b. Microbiological Considerations in Water Quality

(1) Microbiological contaminants can enter water supplies as a result of human and animal activity. Animal waste from feedlots, pastures, lawns, etc., may be discharged to receiving waters that ultimately flow to water bodies used as a drinking water source. Human waste can contaminate water supplies through non-point sources such as septic tank systems or point sources such as a sewer plant discharges. Floods and storm water runoff are also non-point sources of microbial contamination. Coliform bacteria from human and animal wastes may be found in drinking water if the water is not properly treated and disinfected. Coliform bacteria are used as the indicator organism for microbiological water quality. Their presence indicates that harmful organisms may also be in the water or the disinfection treatment system is not working properly.

(2) Localized outbreaks of waterborne disease demonstrate the potential for health problems from drinking water. Many of these outbreaks have been linked to contamination by bacteria or viruses, probably from human or animal waste. Some of these pathogens are not readily identified through routine water quality testing. The first indication of a drinking water contamination issue may be an unexplained local increase in gastrointestinal illnesses. For this reason, a robust disease surveillance program is a vital aspect of the installation Preventive Medicine Authority's overall drinking water surveillance program. Disease and syndromic surveillance is discussed further in article 5-27.3 in section IV of this chapter.

(3) Certain pathogens, such as *Cryptosporidium*, may pass through water treatment filtration and disinfection processes in sufficient numbers to cause health problems. These pathogens may also enter ground water through a direct hydraulic connection to a nearby surface water supply or runoff. *Cryptosporidium* is a protozoan that causes the gastrointestinal disease cryptosporidiosis. The most serious, and sometimes deadly, consequences of cryptosporidiosis appear among sensitive members of the population, such as individuals with immune system deficiencies.

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(4) Microbial contamination of the water in the distribution system can occur through loss of disinfectant (e.g., chlorine) residual, the air-water interface in storage tanks, water piping breaks and repairs, construction, and cross-connections. Loss of sufficient disinfectant residual within a distribution system may result from numerous factors including long detention time in storage tanks, oversized transmission lines, dead-ends, and closed valves that can create artificial dead-ends. In addition, the accumulation of organic and inorganic matter such as sediments, debris, corrosion byproducts, and biofilm can contribute to the loss of disinfectant residual. Loose or missing screens on storage tanks or reservoir vents can provide the opportunity for birds and other animals to enter storage tanks or reservoirs and contaminate the water.

(5) Bacteria and other microorganisms in a potable water distribution system are associated with biofilm that attaches to surfaces within the distribution system. Biofilms are an accumulation of microorganisms' extra cellular material and debris attached to the interior walls of distribution system pipes, tanks, and reservoirs. Biofilm organisms do not usually pose a direct health risk. However, biofilm can be responsible for microbiological water quality violations such as growth of total coliform bacteria. Biofilm can also harbor pathogens such as *Legionella*. Repeated positive total coliform tests may indicate a biofilm problem exists. *Klebsiella* bacteria, which are members of the total coliform group, are ubiquitous in the environment, and originate from a wide variety of both animal and plant sources. Their presence is often responsible for total coliform positive tests, but does not necessarily imply an acute health risk exists. However, presence of *E. coli* violates the SDWA regulations and indicates the need for an assessment of the system. For additional information on *E. coli* violations, refer to the EPA Revised Total Coliform Rule and public notification requirements for Tier 1 and Tier 2 Revised Total Coliform Rule violations.

(6) Several factors may encourage biofilm growth in a distribution system. Examples are temperature, hydraulic effects (flow velocities), nutrient availability (e.g., carbon, phosphorus, and nitrogen), loss of disinfectant residual, corrosion, and sediments. An early warning indicator of biofilm growth in the distribution system is the HPC in a water sample. Water utilities use these laboratory test results to monitor biofilm growth in the distribution systems and trigger flushing response.

c. Physical Considerations in Water Quality. Physical characteristics of water such as clarity, taste, odor, temperature, and turbidity will impact palatability. NPDWR only regulates turbidity.

(1) Water turbidity is cloudiness caused by suspended material consisting of clay, silt, finely divided organic material, and plankton. Turbidity is measured in NTUs. When turbidity exceeds five NTUs, suspended material is visible in a glass of water and objectionable for aesthetic reasons. Turbidity is regulated because it can harbor bacteria and exert a high demand on chlorine. Optimal water treatment plant operating conditions produce turbidity levels between 0.05-0.3 NTU in finished water.

(2) Color quality problems in water may be attributed to dissolve organic matter (amber), iron (red) or manganese (black).

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(3) Ideal water temperature range for palatability is between 50-60 °F (10-15 °C). Water that is too hot will be unpalatable and personnel may refuse to drink it unless it is cooled.

(4) Odor in drinking water may be caused by a number of factors such as algal growth or hydrogen sulfide (rotten egg smell).

(5) Drinking water taste may be impaired by dissolved minerals, which are characteristic of the local geology. Water quality problems including hard water, salty or brackish taste, and musty or earthy smell are not likely to cause adverse health problems, but will negatively impact the taste and smell of water, thus impacting palatability.

d. Chemical Considerations in Water Quality. The chemical makeup of drinking water supplies is a result of natural (e.g., local geology) and man-made activities. Reference (c), part 140-143, sets forth the National Drinking Water Quality Standards establishing MCLs for regulated chemicals.

(1) Primary Drinking Water Standards establish legally enforceable MCLs for numerous contaminants that may be found in drinking water. Adverse health effects have been observed when various chemical contaminants exceed established safe levels.

(a) Nitrate (MCL 10 mg/L) and nitrite (MCL 1 mg/L) inorganic contaminants, if present in drinking water above their individual MCLs or combined 10 ppm MCL may cause methemoglobinemia in infants less than 6 months of age. This serious condition, commonly referred to as “blue baby syndrome,” may be life threatening without prompt medical attention.

(b) Other inorganic contaminants (e.g., copper, lead, arsenic, cadmium, mercury, and recently added thallium) present in drinking water at levels above their respective MCLs can cause serious health problems ranging from hair and fingernail loss and skin lesions to kidney, intestinal, or liver problems.

(c) Exposure to organic contaminants (discharges from industrial factories, runoff from pesticide use) above the MCL can cause a myriad of ailments ranging from liver and kidney problems to reproductive difficulties and increased risk of cancer.

(2) Secondary Drinking Water Standards refer to non-enforceable guidelines for contaminants that may cause cosmetic (e.g., tooth discoloration) or aesthetic (e.g., taste and odor) effects from drinking water. Examples of secondary contaminants deemed to cause benign health effects in subgroups within the general population include the following:

(a) Sulfate. Health concerns regarding sulfate in drinking water have been raised due to reports that ingestion of water containing sulfate levels above 500 mg/l may cause diarrhea. Diarrhea can have serious effects on infants and babies using feed bottles prepared by tap water high in sulfate content.

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(b) Sodium. The EPA Office of Water has issued a drinking water advisory to provide guidance to communities that may be exposed to drinking water containing sodium chloride or other sodium salts. The advisory does not recommend a reference dose because data for quantifying risks are limited. Rather, it provides guidance on concentrations at which problems with taste would likely occur. The Advisory recommends reducing sodium concentrations to levels between 30 to 60 mg/L for aesthetic effects (i.e., taste). An EPA guidance level of 20 mg/L for sodium in drinking water was developed for those individuals restricted to a total sodium intake of 500 mg/day (e.g., elderly with high blood pressure or other ailments); this level should not be extrapolated to the general population.

(c) Radiological Considerations. Most drinking water sources have very low levels of radioactive contaminants (radionuclides), which are not considered a public health risk. Of the small percentage of drinking water systems with radioactive contaminant levels high enough to cause concern, most of the radioactivity is naturally occurring in certain rock types. Radionuclides found naturally in rock emit “ionizing radiation” as they radioactively decay. Aquifers in such rock will absorb the radiation. Long-term exposure to radionuclides in drinking water may cause cancer. Aerosolizing and inhalation is a potential pathway for human exposure when excessive radiation contamination (radon) is in water. Additionally, ingestion of Uranium decay products through drinking water can cause toxic effects to the kidney.

2. Water Quality Monitoring. Drinking water systems must conduct water quality monitoring to verify supplied water safety and comply with all applicable Federal (NPDWR), State, and Navy standards. Water quality monitoring includes compliance, operational and medical surveillance monitoring, each of which have a specific monitoring purpose and function.

a. Compliance Water Quality Monitoring

(1) General

(a) Compliance water quality monitoring refers to the water quality monitoring activities required to comply with all applicable Federal (i.e., reference (c), part 141), State, host nation, and Navy regulations and standards. Compliance monitoring must meet both regulatory monitoring frequencies and water quality standards.

(b) Regulatory mandated compliance monitoring involves different parameters, generally monitored at lower frequencies, than operational monitoring.

(c) Proper record-keeping, reporting to primacy agency, public notification, and performing corrective measures or treatment techniques must accompany compliance water quality monitoring.

(d) Analytical methods used for compliance water quality monitoring must be EPA approved and analysis for each water quality parameter must be conducted by properly accredited or State-certified (or Navy-approved as applicable) laboratories.

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(2) Source Water Compliance Monitoring

(a) Surface Water Rules require *E. coli* and *Cryptosporidium* monitoring from source water for surface water systems as applicable.

(b) Total organic carbon (TOC) (as DBP precursor) monitoring of source water for surface water systems is required as applicable.

(3) Finished Water Compliance Monitoring Parameters (sampled at each entry point to the distribution system)

(a) Inorganics including heavy metals, asbestos, cyanide, fluoride, and nitrate/nitrite

(b) Disinfectant residual

(c) Synthetic organic compounds (SOC) including VOCs and pesticides

(d) Radionuclides

(4) Compliance Monitoring Parameters from Treatment Process. Turbidity monitoring is required from individual or combined filter effluent for filtration systems using surface water sources. TOC monitoring from the combined filter effluent may be also required as applicable.

(5) Compliance Monitoring Parameters from Distributed Water (i.e., sampled at distribution system locations). Coliforms, lead and copper, lead in priority areas, disinfectant, and DBPs must be monitored from distribution system locations.

b. Operational Water Quality Monitoring. Operational water quality monitoring refers to water quality monitoring activities (sampling and measurements) through grab sampling and on-line monitoring to assess whether the control measures in a drinking-water system are operating properly.

(1) General

(a) Operational monitoring is the conduct of measurements (and evaluation of the measurements) to assess whether the control measures in a drinking-water system are operating properly. Operational monitoring parameters generally include quickly-measurable water quality and physical parameters (such as pH, turbidity, temperature, oxidation-reduction potential [ORP] and disinfectant residual). Operational non-water quality parameters (such as system water pressure, water storage tank level, water flow rate, and chemical dosage rate) must also be appropriately monitored throughout the water system for proper operation and timely corrective measures/maintenance of water systems.

(b) Operational monitoring parameters should reflect the effectiveness of each control measure, provide a timely indication of performance, be readily measured and provide the opportunity for an appropriate operational response.

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(c) The time required to monitor operational water quality parameter should generally be short enough to allow operational adjustments to be made prior to supply.

(d) Operational water quality parameters can be monitored continuously through on-line monitoring equipment as well as periodically (e.g., hourly or daily) through grab-sampling and laboratory desktop or portable handheld water quality monitoring equipment.

(e) Water system operators should record all measured operational parameters properly in daily worksheets and logs, and keep the records readily accessible to operators if needed for future reference.

(f) Operational adjustment and control or corrective measures in response to data from operational water quality monitoring must be properly implemented in a time frame adequate to maintain performance and water safety. Operational limits should be defined for each parameter. If monitoring shows that an operational limit or range has been exceeded, predetermined corrective actions must be applied. Immediate notification to the appropriate, primacy agency, health authority, and the public may be required if timely control measures cannot be implemented or safe water supply confirmed.

(2) Operational Water Quality Parameters and Typical Monitoring Locations

(a) Disinfectant Residual Concentration – application point, entry point to each filter and entry point to distribution system.

(b) pH – Source water (entry point to treatment system), each acid or base application (pH adjustment) point, entry point to each filter, individual filter effluent, combined filter effluent, finished water (entry point to distribution system) and distribution system locations.

(c) Turbidity – Source water (entry point to treatment system), entry to point to each filter, individual filter effluent, combined filter effluent, finished water (entry point to distribution system) and distribution system locations.

(d) Conductivity or Total Dissolved Solids – Source water (entry point to treatment system), entry to point to each filter, individual filter effluent, combined filter effluent, finished water (entry point to distribution system), and distribution system locations.

(e) Alkalinity and Hardness – Source water (entry point to treatment system), entry point to coagulation, combined filter effluent, finished water (entry point to distribution system) and distribution system locations.

(f) TOC – Source water (entry point to treatment system), combined filter effluent, entry point to distribution system and distribution system locations.

(g) Temperature – Source water (entry point to treatment system), entry point to distribution system and distribution system locations.

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(h) Streaming Current – Right after the rapid mixing stage of coagulation (Streaming current meter monitors coagulated particle stability for feedback control of coagulant dosage through measuring the charge that exists on small, suspended particles in water).

(i) Silt Density Index – Source water (silt density index provides a measure of the fouling potential of water in RO systems).

(3) Non-Water Quality Operational Parameters and Typical Monitoring Locations

(a) System Pressure – Source water inlet point, entry point to each filter, each filter effluent, each filter backwash flow, each (membrane) filter concentrate flow, point of entry to distribution system and distribution system locations.

(b) Water Storage Tank Level – All water storage tanks including clear well, finished, and source water storage tanks.

(c) Flow Rate and Total Flow – Source water intake, source water inlet, inlet, outlet, concentrate, and bypass to each treatment process, finished water, entry point to distribution system and each consumer building entry point.

(d) Chemical storage tank level or daily usage.

(e) Disinfection contact time.

c. Medical Surveillance Water Quality Monitoring. Medical surveillance water quality monitoring refers to water quality monitoring samples collected by the Preventive Medicine Authority per reference (g) and section IV of this chapter.

5-13. Contingency and Vulnerability Planning

1. General

a. The management and operation of a PWS is a complex task with the objective of providing a continuous, high quality and safe source of water supply during natural or manmade disasters. Water suppliers must be able to ensure that adequate supplies of water are delivered to satisfy consumer demand at sufficient pressure and palatability and, most importantly, that the water is safe for human consumption. Drinking water supply systems, especially treatment and distribution or storage facilities, may present targets of opportunity for physical destruction, intentional contamination, or cyber-attack by adversaries. Preventive medicine personnel have a keen interest in medical surveillance of the water system because history has shown that contaminated water can be a significant vehicle for spread of infectious diseases and other waterborne agents. Preventive medicine personnel play a critical role in an emergency response action for any water contamination event. To this end, Preventive medicine personnel may be consulted in regard to the ongoing development, review, and implementation of a contingency plan regarding preparedness and response for water contamination issues.

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b. SECNAVINST 3300.2 series implements the Navy's antiterrorism program. Water vulnerability assessment is one element of the antiterrorism program. The antiterrorism officer coordinates efforts of a multi-disciplinary team including representatives from facilities (Public Works), Preventive Medicine Authority, security, and other key installation personnel. The team also plays an important role in developing an installation vulnerability assessment and contingency plan (emergency response). Generally, installations utilize water from either ground or surface water sources (or a combination of both). Some locations control the source of their water, while others purchase their supply from another entity. Some installations have their water source located within the military geographical boundaries, while others do not. The installation must consider all of these factors when developing an installation contingency and vulnerability plan.

c. The Navy developed Technical Memorandum TM-2401-ENV to assess drinking water contaminant monitoring technologies and strategies that can be used as an early warning system to enhance facility drinking water system security and improve water supply and distribution operations. The EPA has developed Water Quality Surveillance and Response Systems that apply to drinking water distribution systems. It provides basic information about the design and objectives of a surveillance and response system, and describes how these systems can provide a framework for detecting and responding to water quality incidents occurring in a drinking water distribution system at <http://www2.epa.gov/waterqualitysurveillance>.

d. A PWO who determines that a contamination threat is credible must consult with the primacy agency to determine if public notification is required. Credible drinking water contamination threats require a Tier 1 public notice.

2. Points to Consider

a. Physical destruction, biological and chemical contamination, and cyber-attack are examples of violations that could affect the operation of the PWS. A water vulnerability assessment is one aspect of the antiterrorism program. Public works is generally responsible for oversight of the water vulnerability assessment. While this assessment is not a responsibility of the local Preventive Medicine Authority, he or she should contact the water purveyor to become familiar with the contents of this report. In the event of an emergency, the Preventive Medicine Authority will no doubt have a response role. Some of the basic preparedness planning factors are listed as follows:

(1) Current listing of telephone numbers for all key personnel, including an emergency notification recall.

(2) Plans and procedures for emergency response.

(3) A current water systems facilities map with directional flow, including major valves and backflow prevention devices for isolating damaged or contaminated areas.

(4) Listing of certified laboratories with analytical capabilities. Specialized analyses considerations may be warranted.

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(5) Alternative emergency water approaches (e.g., boiling, bottled water, temporary treatment equipment, and hauled-in supplies).

(6) Review of vulnerability of water system points for security intervention considerations.

(7) Education efforts to impress waterworks personnel to report any observed abnormal conditions.

(8) Consideration of enhanced monitoring by waterworks personnel during periods of increased threats. Measurements of routine parameters such as pH, turbidity, conductivity, and chlorine residual should be expanded (location, frequency). Loss of water pressure may heighten concerns for contamination through cross-connections.

(9) Consideration for prioritizing water distribution system areas for maintaining water supply and pressure.

(10) Protection of any automated equipment and system SCADA from cyber-attack.

b. The effectiveness of an emergency response is directly proportional to the care with which the contingency plan has been prepared. However, as with any contingency plan, action responses may change due to changes and additional insults to the potable water system.

(1) The EPA has developed ten "rip and run" style incident action checklists to help with emergency preparedness, response and recovery activities following weather or natural disaster related incidents. The checklists can be accessed at the following link <http://www2.epa.gov/waterutilityresponse/access-incident-action-checklists-water-utilities>.

(2) The Water Contaminant Information Tool (WCIT) is a secure, on-line database that provides information on chemical, biological, and radiological contaminants of concern for water security. For a description of WCIT, access the following link <http://water.epa.gov/scitech/datait/databases/wcit/index.cfm#five>.

(3) Access to this password-protected tool 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.

(4) To apply for access to the WCIT database, visit <https://cdx.epa.gov/>.

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SECTION III. WATER QUALITY COMPLIANCE

5-14. General

1. The objective of water quality compliance monitoring is to verify that drinking water quality on all Navy and Marine Corps installations meets the minimum health standards of State regulations and federal NPDWR. This objective is met through a program of water quality monitoring and testing by certified laboratories. For overseas installations, refer to the FGS or Overseas Environmental Baseline Guidance Document for applicable drinking water quality standards. The EPA NPDWR do not apply to shipboard or RO water production unit field product water. For shipboard water quality standards, refer to NAVMED P-5010-6. For field water quality standards, refer to the DoD Tri-Service standards listed in NAVMED P-5010-10. The electronic code of federal regulations (e-CFR) for Title 40, Part 141, and the NPDWR can be viewed at <http://www.ecfr.gov/cgi-bin/text-idx?SID=f0c0d8616c1fbfc5f8934428dd67ef68&mc=true&node=pt40.23.141&rgn=div5>. To review the latest MCLs for the Primary and Secondary Drinking Water Standards, refer to <https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations>.

2. **Water Quality Standard Compliance.** Federal Drinking Water Quality Standards for the SDWA are found in reference (c), part 141. Regulatory compliance may be achieved in one of two ways: applying a required treatment technique to control or remove regulated contaminants, or providing water meeting all drinking water MCLs, ALs (in the case of lead and copper), and Secondary MCLs when required by the primacy agency. Before establishing an MCL, the EPA considers the best available technologies for removing the contaminant, analytical technologies for monitoring the contaminant, and the cost of both. A balance is made between the cost to the consumer and the reduction of the risk to consumer health. This cost-benefit analysis attempts to achieve a risk to human health that is no greater than one in a million (e.g., the added threat of the contaminant at that level would cause no more than one extra cancer or adverse health effect per million people, each drinking two liters of water per day during a 70-year lifetime). Exceeding the AL for lead or copper requires a water system to take action to reduce the leaching problem within the system and to educate and protect the consumer from exposure to lead and copper from drinking water. The EPA establishes each MCL upon the contaminant's maximum contaminant level goal (MCLG), which is the level of a contaminant in drinking water at which no known or anticipated adverse health effects are expected to occur. The MCLGs are not federally enforceable, but are a more desirable limit.

3. **Compliance Monitoring.** Naval installations operating water systems must comply with all applicable Federal, State and local safe drinking water regulations, executive orders, and DON policy. The water supplier (PWS) must monitor drinking water quality by using certified laboratories to ensure all applicable MCLs are met. EPA established a Standardized Monitoring Framework to reduce the variability and complexity of drinking water monitoring requirements. The framework synchronizes the monitoring schedule for source-related contaminants associated with chronic health effects (e.g., VOCs, pesticides, herbicides, radionuclides, and inorganics other than nitrate/nitrite). Violations of MCLs require the water purveyor to provide public notification as applicable.

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4. Analytical Requirements. State-certified laboratories must conduct all drinking water analyses for SDWA (EPA) compliance monitoring. All certified laboratories must conduct analyses using EPA-approved test methodologies, and follow water control requirements for testing all water samples as set forth in reference (c), parts 141 and 143.

5-15. Revised Total Coliform Rule

1. The Revised Total Coliform Rule went into effect on 1 April 2016, superseding the [reference (c), part 141.21] coliform sampling requirements of the Total Coliform Rule. The provisions of the Revised Total Coliform Rule are contained in the new [reference (c), part 141 subpart Y]. All Navy systems are required to conduct bacteriological sampling per the requirements of the Revised Total Coliform Rule [reference (c), part 141.851]. Bacteriological samples are analyzed for the presence of total coliform bacteria.

a. Sample siting plans under the Revised Total Coliform Rule must continue to be representative of the water throughout the distribution system. Under the Revised Total Coliform Rule, the system has the flexibility to propose repeat sample locations that best verify and determine the extent of potential contamination of the distribution system, rather than having to sample within five connections upstream and downstream of the total coliform-positive sample location. In lieu of proposing new repeat sample locations, the system may stay with the default used under the 1989 Total Coliform Rule.

b. Table 5-15-1 is an abbreviated version of the table provided in reference (c), part 141.857 that established the minimum routine total coliform monitoring requirements for PWSs that serve more than 1,000 people. Note: This table applies to compliance monitoring. For Public Health Surveillance monitoring, see Table 5-27-1.

Table 5-15-1	
Public Water System Total Coliform Routine Monitoring Frequencies	
Population	Minimum Samples Per Month
1,001-2,500	2
2,501-3,300	3
3,301-4,100	4
4,101-4,900	5
4,901-5,800	6
5,801-6,700	7
6,701-7,600	8
7,601-8,500	9
8,501-12,900	10
12,901-17,200	15
17,201-21,500	20
21,501-25,000	25
25,001-33,000	30
33,001-41,000	40
41,001-50,000	50

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c. The Revised Total Coliform Rule eliminates the MCLG and the MCL for total coliforms, and replaces them with an E. coli MCL and treatment technique triggers and assessment requirements for protection against fecal contamination. The presence of total coliforms is viewed as an indicator of a potential pathway of contamination into the distributions system. As described in reference (c), part 141.859(a)(1) and (2), if the specified treatment technique trigger is exceeded, the water system is required to conduct an assessment (level 1 or level 2, described in reference (c), part 141.859(b)(3) and (4)) and implement corrective actions as needed. For each level 1 and level 2 assessment, water systems will submit a completed assessment form to the State within 30 days after learning a trigger has been exceeded. Level 2 assessments must be completed by the State or by a party approved by the State as soon as practical after any trigger in reference (c), part 141-859(a)(2) is exceeded.

5-16. Inorganic Compounds. Compounds lacking carbon atoms, such as metals, nitrates and asbestos, are considered inorganic compounds. These contaminants are naturally occurring in some water, but can also be introduced to water through farming, chemical manufacturing, and other human activities. The EPA has established MCLs for 15 inorganic contaminants (reference (c), part 141.62). Table 5-16-1 presents MCLs for inorganic chemicals in drinking water.

Table 5-16-1	
Inorganic Contaminants Maximum Contaminant Levels	
Contaminant	Maximum Contaminant Level (mg/L)
Antimony	0.006
Arsenic	0.010
Asbestos	7 million fibers per liter (longer than 10 micrometers)
Barium	2
Beryllium	0.004
Cadmium	0.005
Chromium	0.1
Cyanide (as free cyanide)	0.2
Fluoride	4.0
Mercury	0.002
Nitrate as nitrogen	10
Nitrite as nitrogen	1
Nitrate+Nitrite	10
Selenium	0.05
Thallium	0.002

5-17. Lead and Copper Rule (LCR), Lead Contamination Control and SDWA Amendment 2011 Act

1. LCR General

a. The LCR was finalized in June 1991 with corrections and revisions in July 1991, June 1992, June 1994, January 2000, and October 2007. It is published in reference (c), part 141, subpart I.

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b. Public water systems must sample for lead and copper in conformance with the LCR requirements (reference (c), parts 141.80 through 141.91). The purpose of the LCR is to protect public health by minimizing lead and copper levels in drinking water. Lead and copper are primarily introduced to drinking water through corrosion of plumbing materials containing lead and copper. Almost all lead and copper concentrations in water systems result from leaching of the metals from water service lines and internal plumbing materials rather than contaminated source water. Corrosive water allows leaching of lead and copper from the distribution system. The rule requires monitoring for lead and copper at the consumer's water tap (sink taps, not drinking fountains).

c. The LCR provisions include the following:

(1) Lead and copper monitoring (from various distribution system locations)

(2) Further water quality parameter monitoring and control measures based on lead and copper monitoring results (if more than 10 percent of tap water samples exceed the AL, water systems must take additional steps):

(a) Water quality parameter (WQP) monitoring

(b) Corrosion control treatment

(c) Source water monitoring and treatment

(d) Lead service line replacement

(3) Reporting (consumer notice of lead tap results and information in CCR of lead in drinking water) and recordkeeping.

2. Lead and Copper AL

a. The LCR establishes lead and copper ALs, rather than MCLs, of 1.3 mg/L for copper and 0.015 mg/L for lead. If more than 10 percent of first draw tap water samples exceed the AL, the LCR mandates treatment techniques. While an AL exceedance does not constitute a violation, it does trigger mandated actions.

b. First draw samples (water standing in the tap for at least 6 hours) are collected by catching the first water (one-liter) that comes from the tap and not allowing any flushing or wasting of the water. ALs are not exceeded if 90 percent of the first draw samples fall below 0.015 mg/L for lead and 1.3 mg/L or for copper. Sampling sites may not include faucets that have POU or POE approved treatment devices designed to remove inorganic contaminants.

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3. Lead and Copper Monitoring, Treatment, Reporting, and Public Education Requirements⁴⁵

a. Monitoring Frequency and Number of Samples. Initial monitoring for the LCR occurs for two consecutive 6-month monitoring periods, although small and medium systems that exceed the ALs during the first 6-month monitoring period need not sample for a second 6-month monitoring event. Schedules for continued monitoring depend upon the results of the first two monitoring periods. The LCR requires water systems to monitor lead and copper content at the consumer’s taps within homes and work places. The number of samples required is determined by the system population served. Table 5-17-1 provides sampling protocol.

Table 5-17-1		
Number of Lead and Copper Samples Required		
Population Served	Standard Number of Samples	Reduced Number of Samples
>100,000	100	50
10,001 to 100,000	60	30
3,301 to 10,000	40	20
501 to 3,300	20	10
101 to 501	10	5
≤100	5	5

b. Sample Locations. The location of samples must be chosen according to specific criteria as defined by the rule. The EPA has set a priority tier classification system to include sample sites that have the highest probability of corrosion as monitoring sites for lead and copper. Targeted locations are divided into Tiers 1, 2, and 3. Tier 1 sites have the highest probability of corrosion, decreasing to Tier 2, and then Tier 3. If no “Tier” sites are available, “Other” sampling sites can be selected. See Table 5-17-2 for each Tier definition. Water systems unable to get all required samples from Tier 1 sites must have the sample site plan approved by the primacy agency.

Table 5-17-2	
Tier Definitions	
Tier	Sites Include
Tier 1	Single family structures* that 1. Contain copper pipes with lead solder installed after 1982 or lead pipes 2. Contain lead pipe or are served by a lead service line
Tier 2 **	Buildings or multi-family structures that Contain copper pipes with lead solder installed after 1982, but before the effective date of the State lead ban Contain lead pipe or are served by a lead service line
Tier 3	Single family structures* that contain copper pipes with lead solder installed before 1983.
Other	Other representative structures with other plumbing material.
* For community water systems whose area served consists of more than 20 percent multi-family residences, these structures may be included in the sampling pool.	
** NTNCWS will consider Tier 2 as Tier 1 for the sampling pool. Tier 3 then becomes Tier 2.	

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c. Lead and Copper Monitoring in Navy Consecutive PWS Family Housing. Reference (a), chapter 21, subparagraph 21-3.4(c)(3), requires Navy consecutive PWSs that serve family housing and are not included in the primary system sampling pool (at the time the primary system performed Lead and Copper Rule monitoring) for lead and copper to sample for lead and copper. Installations must ensure the number and location of samples are sufficient to be representative of the system and in conformance with LCR procedures. This requirement can be waived if Navy installations operating consecutive PWSs document that their water supplier passed its LCR monitoring, and that the water being supplied to them is noncorrosive. A formal waiver does not need to be submitted, but documentation must be maintained in drinking water program records.

d. WQP Monitoring⁴⁶. Additional monitoring for distributed water quality characteristics (pH, alkalinity, orthophosphate, silica, calcium, conductivity, and temperature) must be conducted by all large systems. Small and medium systems must monitor water quality parameters when the ALs for lead and copper are exceeded. See Table 5-17-3 for the number of water quality characteristic samples required. Monitoring is required at two locations: (1) representative taps throughout the distribution system, and (2) entry points to the distribution system. All large water systems and those small and medium-size water systems that exceed the lead or copper AL must collect two tap samples for each applicable water quality constituent during each 6-month monitoring period. In addition, one sample must be collected for each applicable water quality constituent at each entry point to the distribution system every 2 weeks. After installing optimal corrosion-control treatment, systems must continue to collect two samples from each specified sampling site every 6 months and one sample for each applicable water quality constituent at each entry point to the distribution system every 2 weeks. All water systems that maintain State-specified water quality for optimal corrosion control for two consecutive 6-month monitoring periods may reduce the number of tap samples collected during each 6-month monitoring period. Systems that maintain State-specified levels of water quality for optimal corrosion control for 3 consecutive years may reduce the number of tap samples collected and the frequency at which the tap samples are collected to once a year.

(1) Per reference (c), part 141.82, each CWS serving a population of less than 50,000 is mandated to perform corrosion control and WQP monitoring only if it exceeds lead or copper ALs.

(2) The WQP monitoring is used to determine the corrosivity of the water and determine the type of corrosion control that should be implemented. The primary mechanism for mitigating lead and copper levels is corrosion control.

(3) WQP samples include analysis for

- (a) pH
- (b) Alkalinity
- (c) Calcium

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- (d) Conductivity
 - (e) Water temperature
 - (f) Orthophosphate, if an inhibitor containing phosphate is used
 - (g) Silica, if an inhibitor containing silica is used
- (4) WQP samples are collected at two separate locations
- (a) Points of entry to the distribution system (water treatment plant)
 - (b) Representative taps throughout the distribution system (*approved coliform sampling sites may be used*).

Table 5-17-3		
Number of Water Quality Samples Required		
Population Served	Standard Number of Samples	Reduced Number of Samples
≥ 100,000	25	10
10,001 to 100,000	10	7
3,301 to 10,000	3	3
501 to 3,300	2	2
101 to 501	1	1
≤ 100	1	1

e. Treatment Techniques. Systems that exceed the lead or copper AL in either of the initial 6-month monitoring periods must begin corrosion control treatment. Guidance for corrosion control studies may be found in the EPA manual, *Lead and Copper Rule Guidance Manual Volume II: Corrosion Control Treatment*.

f. Reporting Requirements. Up to five basic elements may have to be reported to the primacy agency under the Lead and Copper Rule: tap water sampling results for lead, copper, and water quality parameters; source water monitoring results; treatment technique application results (corrosion control, source water treatment and lead service line replacement); public education program demonstration; and results of any additional lead and copper or water quality samples taken by the system. Monitoring must be reported within the first 10 days of the end of the monitoring period.

g. Public Education Programs. The public education program is essential not only to remain in compliance with the LCR, but to protect the health of the consumers. The rule details very specific required text and content for a public education program. See reference (c), part 141, subpart I.

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4. Lead in Priority Areas. Although similar, these ‘Lead in Priority Areas’ monitoring requirements are separate from the LCR requirements.

a. Per references (a) and (b), all Navy and Marine Corps installations must sample, test and maintain records for all “priority areas” drinking water coolers and outlets to determine the presence of lead. Navy (Ser N45/14U132588) and Marine Corps policies (Ser 5090/G-F of 24 February 2014) provide program information including rationale and sampling protocols. These policies identify priority areas as:

(1) Primary and Secondary Schools

(2) Child Development Centers

(3) Youth Centers

b. These policies do not extend to on or off-base residences (e.g., child development homes or family child care homes) used for child care purposes under Navy's Child Development Home Program, or schools that are not owned or managed by DoD.

c. Sampling and Testing. All Navy installations are directed to implement a three-step program for sampling and testing drinking water in priority areas:

(1) Step 1: All Navy installations must perform sampling and testing at all of the following water outlets in priority areas to establish a baseline:

(a) Drinking fountains, both bubbler and water cooler style, indoor and outdoor (e.g., playgrounds, sports fields, etc.)

(b) Kitchen sinks

(c) Home economic rooms sinks

(d) Teacher's lounge sinks

(e) Nurse's office sinks

(f) Classroom sinks

(g) Bathroom faucets

(h) Utility sinks, hose attachments, and outdoor outlets if used to fill water jugs (e.g., for sports team practice)

(i) Any sink known to be or visibly used for consumption (e.g., coffee maker)

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(2) Step 2. Sampling and testing water outlets in newly constructed or modified priority areas. The environmental office must query each priority area annually to determine if any plumbing or treatment modifications have been made and if sampling needs to be conducted. This step also includes initial baseline testing of all outlets identified in Step 1 in newly constructed or modified priority areas prior to occupancy; however, if the installation can document that all plumbing materials conform to section 1417 of reference (c), then the requirement to test new construction is waived.

(3) Step 3. Periodic re-testing and sampling of all outlets in Step 1. Periodic testing must be accomplished every 5 years from the established baseline or per State requirements if more frequent.

d. Lead Screening Level and Control Action. If initial screening results exceed EPA's recommended lead screening level of 20 parts per billion (ppb), installations must:

(1) Immediately take the outlet temporarily out of service or select an interim remedy as outlined in the EPA guidance document⁴⁸.

(2) Use full protocol sampling on affected outlets (EPA's Two-Step Sampling Process identified in the EPA guidance document).

(3) If full protocol sampling continues to exceed 20 ppb, installations must institute permanent corrective actions per the EPA guidance document.

(4) Record Keeping and Public Notification. A copy of all test results must be made available to the local preventive medicine service, medical treatment facility, all schools, child development centers, Navy operated 24/7 group homes, and youth centers where testing was conducted. At a minimum, of testing results must be made available to the parents or legal guardians of children attending the schools, child development centers, Navy operated 24/7 group homes, and youth centers. Direct notification of results must be conducted for any lead detection greater than 20 ppb during a sampling event.

(5) Notification requirements and procedures must be coordinated with Public Affairs staff, the local Navy preventive medicine service or medical treatment facility and the legal department, and must be conducted per any other installation, regional, or command guidance if applicable. All records of sampling and testing of drinking water in priority areas must be retained for 12 years.

5. SDWA Amendment 2011. The Reduction of Lead in Drinking Water Act was passed on 4 January 2011 and went into effect on 4 January 2014. This Act amended section 1417 of the SDWA making it unlawful to introduce into commerce certain items that are not lead-free. "Lead-free" was re-defined as not more than a weighted average of 0.25 percent lead when used with respect to the wetted surface of pipes, pipe fittings, plumbing fittings and fixtures conveying potable water for human consumption⁴⁹. The Act includes exemptions for non-potable water used plumbing parts.

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6. Other Considerations for Lead and Copper

a. In general, POU and POE devices (e.g., activated carbon filters, sand filters, and cartridges or micro-filters) will not reduce lead and copper. In addition, it should be noted that the LCR does not allow sampling from sinks where POU or POE devices have been installed.

b. RO and distillation can reduce the concentration of lead and copper in the water entering the unit, but these treatment processes produce highly aggressive water that, by itself, can leach lead from downstream plumbing fixtures.

5-18. Synthetic Organic Compounds

1. Carbon-based compounds, such as industrial solvents and pesticides generally enter water sources through farm cropland or discharge from factories. The EPA has set legal limits on 54 organic contaminants that are to be reported (reference (c), part 141.61). PWSs are required to conduct sampling for VOCs and SOCs. Table 5-18-1 lists the MCLs for organic compounds.

Table 5-18-1	
Maximum Contaminant Levels for Organic Compounds	
Contaminant	Maximum contaminant level (mg/L)
Volatile Organic Compounds	
Vinyl chloride	0.002
Benzene	0.005
Carbon tetrachloride	0.005
1,2-Dichloroethane	0.005
Trichloroethylene	0.005
Para-Dichlorobenzene	0.075
1,1-Dichloroethylene	0.007
1,1,1-Trichloroethane	0.2
Cis-1,2-Dichloroethylene	0.07
1,2-Dichloropropane	0.005
Ethylbenzene	0.7
Monochlorobenzene	0.1
o-Dichlorobenzene	0.6
Styrene	0.1
Tetrachloroethylene	0.005
Toluene	1
Trans-1,2-Dichloroethylene	0.1
Xylenes (total)	10
Dichloromethane	0.005
1,2,4-Trichlorobenzene	0.07
1,1,2-Trichloroethane	0.005

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Table 5-18-1	
Maximum Contaminant Levels for Organic Compounds	
Contaminant	Maximum contaminant level (mg/L)
Synthetic Organic Compounds	
Alachlor	0.002
Atrazine	0.003
Carbofuran	0.04
Chlordane	0.002
Dibromochloropropane	0.0002
2,4-D	0.07
Ethylene dibromide	0.00005
Haptachlor	0.0004
Heptachlor eposide	0.0002
Lindane	0.0002
Methoxychlor	0.04
Polychlorinated biphenyls	0.0005
Pentachlorophenol	0.001
Toxaphene	0.003
2,4,5-TP	0.05
Benzo(a)pyrene	0.0002
Dalapon	0.2
Di(2-ethylhexyl) adipate	0.4
Di(2-ethylhexyl) phthalate	0.006
Dinoseb	0.007
Diquat	0.02
Endothall	0.1
Endrin	0.002
Glyphosate	0.7
Hexachlorobenzene	0.001
Hexachlorocyclopentadiene	0.05
Oxamyl (vydate)	0.2
Picloram	0.5
Simazine	0.004
2,3,7,8-TCDD (dioxin)	3x10 ⁻⁸

5-19. Disinfectants, Disinfection Byproducts⁵⁰

1. Community and NTNCWS that add chemical disinfectant to their water are required to monitor distribution system residual to determine compliance with the MRDLs per reference (c), parts 141.131-133 stipulating:

a. Analytical requirements in (reference (c), part 141.131(c)). This section of the CFR lists approved methods for chlorine residual monitoring. The rule allows systems to use N, N- diethyl-p-phenylenediamine (DPD) kits, among other methods, for measuring these residuals. Only a party approved by EPA or the State may measure the residual disinfectant concentration for compliance.

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b. Monitoring requirements in (reference (c), 141.132(c) (1)). Systems must measure the residual disinfectant concentration at the same time and location as total coliforms are sampled as specified in §141.21. Refer to Total Coliform Monitoring Plan for sample points where residual disinfectant should be measured⁵¹.

c. Compliance requirements in (reference (c), 141.133(c) (1)). Systems must determine MRDL compliance using a running annual average, computed quarterly, of monthly averages of residual disinfectant samples collected for compliance. If the running annual average exceeds the MRDL, the system is in violation of the MRDL and must report to the State and notify the public. The MRDL for chlorine is 4.0 mg/L (reference (c), 141.65).

d. Control of disinfectant residuals (reference (c), 141.130 (d)). Notwithstanding the MRDLs in §141.65, systems may increase residual disinfectant levels of chlorine in the distribution system to a level and for a time necessary to protect public health, to address specific microbiological contamination problems caused by circumstances such as, but not limited to, distribution line breaks, storm run-off events, source water contamination events or cross-connections.

2. PWSs, including consecutive systems, adding a chemical disinfectant to their water are required to comply with the requirements of reference (c), 141, subparts U (Stage 2 Initial Distribution System Evaluation) and V (DBPR).

3. Per the SDWA 1996 amendments, EPA developed the Stage 1 DBPR (December 1998) to mitigate health risks caused by disinfectants and DBPs in drinking water. The Stage 2 DBPR (January 2006) builds upon Stage 1 DBPR to address higher risk PWSs for protection measures beyond those required by Stage 1 DBPR.

4. The MCLs for Total TTHM and HAA5 are the same for the Stage 1 and Stage 2 DBPR. However, the method of calculating Stage 2 DBPR compliance differs from the Stage 1 method. Stage 2 DBPR compliance is based on locational running annual averages of TTHM and HAA5 concentrations as determined through a monitoring plan developed for the system (reference (c), 141.622). Compliance is based on meeting the MCL at each monitoring location, instead of using the system-wide running annual average that was previously required under the Stage 1 DBPR. Monitoring for Stage 2 DBPR compliance is conducted at State approved sites for the regulated constituents listed in Table 5-19-1.

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Table 5-19-1 Disinfection Byproducts MCLs	
Regulated Contaminants	MCL (mg/L)
TTHM	0.080 locational running annual
Chloroform	
Bromodichloromethane	
Dibromochloromethane	
Bromoform	
HAA5	0.060 locational running annual
Monochloroacetic acid	
Dichloroacetic acid	
Trichloroacetic acid	
Bromoacetic acid	
Dibromoacetic acid	

* MCL from a particular FGS (e.g., FGS Italy) may be more stringent.

5. Other regulated DBPs include bromate, a byproduct of ozone treatment or old hypochlorite solution, and chlorite, a byproduct created when ClO₂ is used as a disinfectant.

Table 5-19-2 Regulatory Levels for Bromate and Chlorite			
Contaminant	MCLG (mg/L)	MCL (mg/L)²	Potential Health Effects from Long-Term Exposure Above the MCL
Bromate	zero	0.010	Increased risk of cancer
Chlorite	0.8	1.0	Anemia; nervous system effects in infants and young children

6. MCL compliance is based on the locational running annual averages of the last 4 calendar quarters. Table 5-19-3 presents an overview of DBPR requirements.

Table 5-19-3 Overview of Stage 2 Disinfectants and Disinfection Byproducts Rule	
Coverage	All CWS that Add Disinfectant Other Than UV
TTHM and HAA5 MCL Compliance	MCL compliance is calculated using the locational running annual averages for each monitoring location in the distribution system
Regulated Contaminant and disinfectants	TTHM Five HAA5
Disinfectants	Chlorine, chloramine, chlorine dioxide
Operational Evaluation	If an operational evaluation level (OEL) is exceeded, systems must evaluate practices and identify DBP mitigation actions

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7. EPA has set the enforceable MRDLs for disinfectants shown in Table 5-19-4.

Table 5-19-4 MRDL of Each Disinfectant	
Disinfectant	MRDL
Chloramine	4.0 mg/L as an annual average
Chlorine	4.0 mg/L as an annual average
Chlorine Dioxide	0.8 mg/L

5-20. Radionuclides Contaminants⁵²

1. All community water systems must conduct radionuclide contaminants sampling per reference (c), 141.26.
2. Table 5-20-1 lists the MCLs for radionuclides contaminants.

Table 5-20-1 Radionuclides Maximum Contaminant Levels	
Contaminant	MCL (mg/L)
Gross Alpha Radioactivity	15 pCi/L
Gross Beta Radioactivity	4 mrem
Combined Radium 226 +228	5 pCi/L
Uranium	30 µg/L

5-21. SWTR

1. General

a. Aims to improve public health protection through the control of microbial contaminants, particularly viruses, *Giardia lamblia* and *Cryptosporidium*.

b. Applies to all PWSs using surface water or GWUDISW, otherwise known as “Subpart H systems.”

c. Requires all Subpart H systems to disinfect.

d. Requires Subpart H systems to filter unless specific filter avoidance criteria are met.

e. Requires unfiltered systems to perform surface water monitoring and meet site-specific conditions for controls of microbial parameters.

f. Includes the following regulations:

- (1) SWTR ⁵³ 1989- reference (c), 141.70-141.75

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(2) IESWTR⁵⁴ () 1998- reference (c), 141.170-141.175

(3) Long-Term 1 Enhanced Surface Water Treatment Rule⁵⁵ (LT1ESWTR) 2002 - reference (c), 141.500-141.571

(4) Long-Term 2 Enhanced Surface Water Treatment Rule⁵⁶ (LT2ESWTR) 2006 - reference (c), 141.700-141.722

2. Requirements. The IESWTR, LT1ESWTR, and LT2ESWTR build on the existing requirements established in the original SWTR. These requirements differ for filtered and unfiltered systems:

a. Unfiltered Systems Requirements include the following:

(1) Regulated pathogen removal/inactivation of viruses, *Giardia lamblia* and *Cryptosporidium*.

(2) Treatment Requirements (mandated disinfectant residual at the POE (> 0.2 mg/L) and detectable in the distribution system).

(3) The LT2ESWTR requires that systems use a minimum of two disinfectants (one disinfectant must be effective against protozoa) to meet the *Cryptosporidium*, *Giardia lamblia*, and virus inactivation requirements.

(4) Source Water Monitoring Requirements. LT2ESWTR requires monitoring of *Cryptosporidium* to calculate the arithmetic mean of sample concentrations and determine additional treatment requirements.

(5) Avoidance criteria.

(6) Disinfection profiling and benchmarking. Systems must profile inactivation levels and generate benchmark, as applicable.

(7) Sanitary Surveys (CWS every 3 years, Non-Community Water System [NCWS] every 5 years) as mandated under IESWTR.

(8) Finished reservoir or water storage facilities. All new facilities must be covered (regulated under IESWTR and LT1ESWTR). Uncovered finished water facilities must be covered or discharge treated as required under LT2IESWTR.

(9) Operated by a qualified personnel as required by the state.

b. Systems Using Conventional or Direct Filtration Requirements. These systems are subject to the same requirements as unfiltered systems except for filtration avoidance criteria. The following requirements apply to filtered systems under SWTR, IESWTR and LT1ESWTR:

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(1) Regulated pathogen removal/inactivation of viruses, *Giardia lamblia* and *Cryptosporidium*.

(2) Treatment Requirements (mandated disinfectant residual at the POE (> 0.2 mg/L) and detectable in the distribution system).

(3) The LT2ESWTR requires that systems use a minimum of two disinfectants to meet the *Cryptosporidium*, *Giardia lamblia* and virus inactivation requirements.

(4) Source Water Monitoring Requirements. LT2ESWTR requires monitoring of *Cryptosporidium* to calculate arithmetic mean of sample concentrations and determine additional treatment requirements.

(5) Disinfection Profiling and Benchmarking. Systems must profile inactivation levels and generate benchmark, if required.

(6) Turbidity Performance Standards for:

(a) Combined filter effluent

(b) Individual filter effluent

(7) Sanitary Surveys (CWS every 3 years, NCWS every 5 years) as mandated under IESWTR.

(8) Finished Reservoir or Water Storage Facilities. All new facilities must be covered (regulated under IESWTR and LT1ESWTR). Uncovered finished water facilities must be covered or discharge treated as required under LT2IESWTR.

(9) Operated by a qualified personnel as required by the State.

c. Systems Using Slow Sand, Diatomaceous Earth, or Alternative Filtration⁵⁷ include the following:

(1) Regulated pathogen removal or inactivation of viruses, *Giardia lamblia* and *Cryptosporidium*.

(2) Treatment Requirements (mandated disinfectant residual at the POE (> 0.2 mg/L) and detectable in the distribution system).

(3) The LT2ESWTR requires that systems use a minimum of two disinfectants to meet the *Cryptosporidium*, *Giardia lamblia* and virus inactivation requirements.

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(4) Source Water Monitoring Requirements. LT2ESWTR requires monitoring of *Cryptosporidium* to calculate arithmetic mean of sample concentrations and determine additional treatment requirements.

(5) Disinfection Profiling and Benchmarking. Systems must profile inactivation levels and generate benchmark, if required.

(6) Turbidity Performance Standards for the following:

(a) Combined filter effluent – Slow Sand and Diatomaceous Earth

(b) Combined filter effluent – Alternative Filtration

(7) Sanitary Surveys (CWS every 3 years, NCWS every 5 years) as mandated under IESWTR.

(8) Finished reservoir or water storage facilities. All new facilities must be covered (regulated under IESWTR and LT1ESWTR). Uncovered finished water facilities must be covered or discharge treated water as required under LT2IESWTR.

(9) Operated by qualified personnel as required by the State.

5-22. Ground Water Rule⁵⁸. PWSs that use ground water began to comply with the Ground Water Rule on 1 December 2009. The Ground Water Rule applies to all PWSs that use ground water, including consecutive systems. It does not apply to PWSs that combine all of their ground water with surface water or with GWUDISW prior to surface water treatment.

1. The rule requires PWSs to conduct triggered source water monitoring (collecting a raw water sample from each ground water source in use at the time a routine total coliform-positive was collected). Ground water systems, that provide 4-log (99.99 percent) removal or inactivation of viruses, do not need to conduct triggered source water monitoring. However, PWSs that do provide 4-log treatment are required to conduct compliance monitoring.

2. The most common treatment is inactivation through disinfection. Typical disinfection using chlorination with contact time is considered to provide 4-log inactivation. Log credits given through removal may involve a treatment process such as conventional treatment with lime softening or other treatment units such as NF by a membrane filter.

3. A system that does not provide 4-log (99.99 percent) removal or inactivation of viruses, will trigger source water monitoring. The system must sample raw source water within 24 hours of notification that a distribution total coliform bacteriological sample is positive.

4. A PWS can apply for 4-log treatment removal or inactivation of viruses at any time, but will be required to complete triggered source water monitoring until approval of 4-log treatment for viruses is received.

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5. Once 4-log removal or inactivation of virus approval is received, compliance monitoring will be required. Under compliance monitoring, a system must measure the minimum disinfectant residual concentrations at or before the first customer. If the population served is less than or equal to 3,300, measurements are required daily. If the population served is greater than 3,300, measurements must be conducted continuously. Disinfectant residual concentrations are reported in the monthly operating report, along with documentation on flow rates, temperature, pH, clear well levels and other parameters necessary to determine compliance with the Ground Water Rule.

5-23. Consumer Confidence Reporting

1. General

a. NPDWR requires community water systems to deliver annual drinking water quality reports called “Consumer Confidence Reports” (CCR) to their customers pursuant to [reference (c), §§141.151-141.155: Subpart O]. The CCR summarizes information regarding sources used (e.g., aquifers), any detected contaminants, compliance and educational information.

b. The reports are due to customers by July 1st of each year. Some States require NCWS to distribute CCRs to their served population.

c. At a minimum, every CCR must include eight elements:

(1) Water system information (name and phone number of a contact person; information on public participation opportunities)

(2) Source(s) of water

(3) Definitions

(4) Detected contaminant table

(5) Information on monitoring for *Cryptosporidium*, radon and other contaminants

(6) Compliance with NPDWR (for example, explanation of violations, potential health effects, and corrective actions; special notices for Ground Water Rule and Revised Total Coliform Rule)

(7) If applicable, variances or exemptions (for example, under certain conditions the state or EPA may have granted permission not to meet an MCL or a treatment technique)

(8) Required additional information (such as, explanation of contaminants in drinking water and bottled water; information to vulnerable populations about *Cryptosporidium*; statements on nitrate, lead and arsenic.)

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2. CCR Compliance⁵⁹

a. Compliance tools including best management practices, and guidance for complying with CCR Rule are available at the following EPA link: <http://www2.epa.gov/ccr/how-water-systems-comply-ccr-requirements>.

b. CCR changes that went into effect following the implementation date of the Revised Total Coliform Rule (1 April 2016) can be viewed in tabular format by accessing the following link: <http://www2.epa.gov/ccr/converting-laboratory-units-consumer-confidence-report-units>.

c. CCR changes as of 1 April 2016 are summarized as follows:

(1) CWS must report:

(a) Until 31 March 2016. Total coliform, fecal coliform and E. coli: number or percentage of positive results.

(b) Starting 1 April 2016:

1. E. coli: number of positive results.

2. Level 1 or Level 2 assessment language.

3. Total coliform, fecal coliform and E. coli: number or percentage of positive results.

(2) CCR elements depend on the following case or violation:

(a) Case 1: for systems required to comply with L1 and L2 assessment (not due to an E. coli MCL violation) requirements.

(b) Case 2: for systems required to comply with the L2 assessment requirement due to an E. coli MCL violation.

(c) Case 3: for systems that detected E. coli and have violated the E. coli MCL.

(d) Case 4: for systems that detected E. coli, but did not violate the E. coli MCL5-16 Public Notice.

5-24. Public Notification⁶⁰

1. The purpose of the public notification rule (reference (c), 141, subpart Q: reference (c), 141.201 – 141.211) is to ensure that consumers are informed of water quality issues and how to protect themselves from potential risks. Public water systems must notify their customers when:

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a. They violate EPA or State drinking water regulations (including monitoring requirements),
or

b. They provide drinking water that may pose a risk to consumer's health.

2. To assist in developing public notifications, EPA issued the Revised Public Notification Handbook in 2010. The handbook is designed to meet the needs of PWSs of all sizes, including suggestions and instructions targeted to very small community systems (systems serving 500 people or fewer). It provides instructions and includes templates that can be used for various types of public notices. Additional detailed information is available at:
<https://www.epa.gov/dwreginfo/public-notification-rule>.

3. Per reference (a), upon discovering an exceedance of a drinking water MCL, AL, Health Advisory or other publicized drinking water quality standard in the United States and overseas, or a drinking water issue that has the potential to threaten public health, the installation must determine the proper response to the exceedance, to include public notification. The installation CO is required to consult with the local Preventive Medicine Authority, who will immediately consult with the NAVMCPUBHLHCEN. The Preventive Medicine Authority, under the direction of the regional Preventive Medicine Authority, NAVMCPUBHLHCEN and Occupational Health and Safety (BUMED-M44) will provide public health advice and consultation in the preparation of a draft public notification and the decision to provide alternate water supplies. Article 5-31 in section V of this chapter provides additional information on public notification.

5-25. SWDA Amendments of 1996

1. The Safe Drinking Water Act Amendments of 1996 (PL 104-182) include, among other things; new prevention approaches, improved consumer information, the regulatory program, and funding for States and local water systems.

2. The greatest impact of the first portion of the Safe Drinking Water Act Amendments of 1996 on existing and new Navy and Marine Corps CWSs is the requirement for CCRs. Navy and Marine Corps owned CWSs must report annually to their consumers the number and types of contaminants in their drinking water, as well as other vital public health water quality information. EPA developed a computerized fill-in-the-blank template for water systems to use if they are unable or do not choose to develop their own CCR format. The report must include the following:

a. The source of the water purveyed.

b. A brief and plainly-worded definition of the terms maximum contaminant level goal, maximum contaminant level, variances, and exemptions.

c. If any regulated contaminant is detected in the water purveyed by the community water system, a statement setting forth: the MCLG; the MCL and the level of such contaminant in the water system. For any regulated contaminant for which there has been an MCL violation during the year covered by the report, the CCR must also include a brief statement in plain language regarding the health concerns created by the exceedance.

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- d. Information on compliance with NPDWR and, if the system is operating under a variance or exemption, the basis on which the variance or exemption was granted.

- e. Information on the levels of unregulated contaminants for which monitoring is required including *Cryptosporidium* and radon where the primacy agency determines they may be found.

- f. A statement that the presence of contaminants in drinking water does not necessarily indicate that the drinking water poses a health risk, and that more information about contaminants and potential health effects can be obtained by calling the safe drinking water hotline.

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SECTION IV. PUBLIC HEALTH SURVEILLANCE OF DRINKING WATER QUALITY

5-26. General

1. Navy Medical Department personnel who are assigned to billets that include responsibilities for public health surveillance of drinking water quality at Navy and Marine Corps installations will establish and maintain a drinking water surveillance program per reference (g) and this chapter. Regional and installation level Preventive Medicine Authorities are appointed in writing by the appropriate Navy Medical Department Authority.

2. A template is provided on the NAVMCPUBHLHCEN Web site <http://www.med.navy.mil/sites/nmcphc/program-and-policy-support/water-sanitation-and-safety/Pages/default.aspx> to be used as a guide for the Preventive Medicine Authority for establishing a water surveillance program. It is not intended to be an exact fit for every installation water system. The Preventive Medicine Authority should review the entire template and tailor applicable sections to their regional or local circumstances, adding or omitting content as required.

3. Public health surveillance is the systematic and continuous collection, analysis, and interpretation of data, closely integrated with the timely and coherent dissemination of the results and assessment to those who have the right to know so that action can be taken.

4. The objective of public health surveillance of drinking water quality is to ensure that current installation drinking water quality programs adequately protect the health of all water system consumers and provide early identification of water quality issues that could result in illness or a disease outbreak. Public health surveillance of drinking water quality provides checks and balances to the installation water quality compliance program. It is for surveillance only and not intended to replace compliance monitoring that is required by Federal and State regulations, which is the responsibility of PWD.

5. Regional and installation level Preventive Medicine Authorities provide public health advice and consultation to the applicable Navy regional, and installation COs or Marine Corps installation commanders on health aspects of drinking water quality, and assist in proper risk communication for public notifications when necessary. In consultation with NAVMCPUBHLHCEN, they will advise installation COs on implementation of alternate water supplies in the event of an exceedance of a drinking water MCL, AL, health advisory, or other publicized drinking water quality standard in the United States or overseas.

5-27. Public Health Surveillance of Drinking Water Quality

1. Preventive Medicine Authorities must conduct monthly public health surveillance of drinking water quality.

a. Monthly surveillance will consist of the following program elements:

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(1) Surveillance Water Sample Collection and Testing. The Preventive Medicine Authority will collect water samples per an established sampling plan that ensures adequate representation of the overall water distribution system. The sampling plan should include a sample collected at either the installation water treatment plant or the main line entering installation (for municipality purchased water) and the most distal point in the water distribution system. This information should be readily available from the installation public works office. An example of a public health surveillance sampling plan is available as part of the SOP template referred to in article 5-26.2. In some locations, public health surveillance water sampling may be conducted in conjunction with the water purveyor’s compliance sample collection.

(a) The number and location of selected sampling sites are based on the population served by the system, and function of the building, with priority on health, safety, and mission. Table 5-27-1 provides minimal routine monitoring frequencies, based on population being served by the drinking water system.

(b) The minimum Preventive Medicine Authority routine surveillance monitoring frequency provided in the table 5-27-1 is designed to systematically include enough samples collected from more locations of concern on base selected in terms of a public health perspective such as child development and youth centers, galleys and food service establishments, in addition to the representative (geographically-distributed) samples through the distribution system. Therefore, the recommended minimum Preventive Medicine Authority routine surveillance frequency is more stringent than SDWA required minimum total coliform monitoring (i.e., compliance monitoring) frequency (refer to table 5-15-1) for small to medium population brackets.

Table 5-27-1	
Preventive Medicine Authority Water Surveillance Program Routine Monitoring Frequencies	
Population	Minimum Samples Per Month
500 or less	5
501-5,000	10
5,001-10000	15
10,001-greater	20

(c) Monthly public health surveillance samples will be tested for free available chlorine (FAC), pH, total coliform, and E. coli using procedures as outlined in local public health SOPs.

1. The preventive medicine water laboratory will utilize EPA-approved chlorine residual method 4500-Cl G (DPD Colorimetric Method 8021, Low Range) and microbiological standard method 9223B (Enzyme Substrate Coliform Test [Presence/Absence]).

2. All instruments, equipment, test kits, reagents, parts and equipment replacements must meet EPA accreditation specifications. Non-EPA accredited equipment, while cheaper, are not appropriate for drinking water surveillance. Preventive medicine water laboratory instruments and equipment includes:

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a. pH meter capable of measuring pH range from 0 to 14.00 with high resolution and accuracy of 0.01 pH and temperature range from -5° to 90° C (23° to 193° F).

b. Chlorine meter

c. Incubator

d. Long wavelength ultraviolet light

3. Equipment and instruments must be kept clean and in good working order and maintained and calibrated per the manufacturer's directions. Evidence of calibration must be maintained by the Preventive Medicine Authority.

(2) Disease and Syndromic Surveillance Monitoring. Localized outbreaks of waterborne disease have been linked to water contamination by bacteria or viruses. Some of these pathogens are not readily identified through routine water quality testing. The first indication of a drinking water contamination issue may be an unexplained local increase in gastrointestinal illnesses. For this reason, a robust disease surveillance program is a vital aspect of the installation Preventive Medicine Authority's overall drinking water surveillance program. The Preventive Medicine Authority should monitor disease surveillance data at least 3 times a week for events that may indicate a drinking water quality issue. This surveillance should include:

(a) Review of reportable medical events for diseases such as legionellosis, Shiga-toxin producing *E. coli*, giardiasis, norovirus, and cryptosporidiosis. All of these cases should be investigated to identify the potential source of exposure. Even a single disease report could be important as other illnesses may be going undiagnosed or unreported.

(b) Review syndromic surveillance trends for unexplained increases in gastrointestinal illnesses. If preliminary investigations lead to drinking water as a potential source of exposure, a case control questionnaire can help provide more definitive information.

(c) If drinking water is identified as a potential source of exposure, the Preventive Medicine Authority should contact the Navy Medicine regional Preventive Medicine Authority and NAVMCPUBHLHCEN for investigation support.

(3) Advise CO, Installation Public Works. Establish and maintain open lines of communication with the water purveyor/Public Works to provide advice and potential public health implications during routine and emergency situations.

(4) Installation WQB. Provide medical advice and consultation to the installation WQB as applicable for public health concerns, water quality exceedances, and program oversight.

(5) Emergency Points of Contact. Maintain a current list of key installation drinking water emergency points of contact, including after-hours contact information.

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(6) Review Compliance Monitoring Results. Regularly review and provide public health comments as necessary for the installation's compliance monitoring results.

(7) Drinking Water Regulations. Maintain copies of all regulatory agency and Navy and Marine Corps water regulations, instructions and orders.

(8) Public Notifications and Reporting. Verify that Public Works is conducting compliance monitoring using certified laboratories and issuing Consumer Confidence Reports & Public Notifications when required.

(9) Joint Annual Tour. When the water source, treatment plant, storage and distribution system are located on the installation, coordinate and conduct joint annual surveys with Public Works. Utilize the Defense Occupational & Environmental Health Readiness System (DOEHRS) Water Treatment System Inspection Form to document observations. The form is available and can be downloaded from the NAVMCPUBHLTHCEN Web site http://www.med.navy.mil/sites/nmcphc/program-and-policy-support/Pages/DOEHR_IH-EH.aspx.

(10) NSF/ANSI Standards 60 and 61 Compliance. Provide assistance to Public Works as requested to ensure that all chemicals which are direct or indirect additives to drinking water supplies, and all components (piping, valves, fittings, meters, hydrants, pumps and other appurtenances and their design, installation, operation and maintenance) are per NSF/ANSI Standards Numbers 60 and 61, which are available at <http://www.nsf.org/services/by-industry/water-wastewater/water-treatment-chemicals/nsf-ansi-standard-60>, and <http://www.nsf.org/services/by-industry/water-wastewater/municipal-water-treatment/nsf-ansi-standard-61>.

(11) Cross Connection Control Program. Verify that Public Works has established a cross-connection control program.

(12) Training of Water System Personnel. Verify that Public Works has a continuing education/training program for all personnel working with the potable water system.

(13) Water Vulnerability Assessment. Verify that the installation has completed a water vulnerability assessment/emergency response plan and be familiar with the plan.

2. If containerized drinking water delivery is being utilized, the Preventive Medicine Authority is responsible for ensuring that any potable water tanks or trailers used to haul finished water comply with the requirements in reference (h), part 129.40, CNIC Memorandum 5090, Ser N4/17U009 dated 26 January 2017 (Hauling Drinking Water) and applicable State or local health department regulations, and that the water in the container retains adequate disinfectant residual levels and is free of coliform bacteria.

a. The Preventive Medicine Authority will observe operations at both fill and distribution points at least monthly while hauled water is being utilized. Additionally, they must sample each labeled container and test the water for FAC, enteric bacteria, E. coli and pH at least monthly.

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b. Utilize the DOEHRS NAVMED 6240/12, Water Container Inspection Survey form to document observations from each inspection conducted. The form is available and can be downloaded from the NAVMCPUBHLTHCEN Web site:

(http://www.med.navy.mil/sites/nmcphc/program-and-policy-support/Pages/DOEHR_IH-EH.aspx).

c. For additional information on hauled water, refer to article 5-9.11 in section II of this chapter.

5-28. Reporting of Surveillance Monitoring Results. The Preventive Medicine Authority will report any bacteriological detection, lack of FAC or pH below 6.8 or above 8.2 immediately to Public Works following the local chain of command. The fixture from which the positive sample was obtained should immediately be secured by Public Works and resampled. Coordinate resampling with Public Works. Coordinate all follow-up actions if required through the Navy Medicine regional Preventive Medicine Authority and NAVMCPUBHLTHCEN as applicable.

5-29. Records

1. A record of all water quality surveillance results will be maintained locally by the Preventive Medicine Authority. The following minimum information is required:

- a. Sample number
- b. Date & time sample collected
- c. Installation (if installation has multiple sites)
- d. Fixture location
- e. Collected by
- f. Sample tested by
- g. Results, coliform, FAC, pH
- h. Date and time read
- i. Read by
- j. Comments

2. Per BUMEDINST 6240.12, all water surveillance samples and results will be entered in the DOEHRS-IH EH Module within 15 calendar days of obtaining test results. Entry of water testing data in the DOEHRS-IH EH Module will be utilized in lieu of a separate electronic water sampling log.

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3. The Preventive Medicine Authority will maintain records as follows:
 - a. Actions Taken to Correct Violations – 3 years after acting upon the violation
 - b. Review of Public Notices
 - c. Plans of Action & Milestones (POA&M)

4. Subject to a more stringent federal, state or local record-keeping requirement, Navy installations will maintain records as follows:
 - a. Bacteriological Testing Results – 5 years
 - b. Chemical Testing Results – 10 years
 - c. Lead and Copper Testing Results – 12 years
 - d. Actions Taken to Correct Violations – 3 years after acting upon the violation
 - e. Sanitary Survey Reports – 10 years
 - f. Variance or Exemption Records – 5 years following the expiration of the variance or exemption
 - g. Water Treatment Plant and Distribution System Operating Records – 5 years
 - h. Cross-Connection Inspection Records – 5 years
 - i. Consumer Confidence Reports – 5 years

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SECTION V. PUBLIC HEALTH RESPONSE

5-30. Public Health Response

1. Public health response actions should be defined during the planning process. The plan should identify the agency or organization that is responsible for carrying out the action(s) as well as the circumstances under which the actions are to be taken. Potential restrictions on water use that might be achieved through public notification include issuing a “boil water” notice, “do not drink” notice (no consumption), and “do not use” notice. An extremely important element of public health response is the identification of options and plans for a short-term alternate supply of drinking water if the public is notified not to drink or use the water. These options should be identified in the drinking water utility’s emergency response plan.

2. Per reference (a), upon discovering an exceedance of a drinking water MCL, AL, health advisory or other publicized drinking water quality standard in the United States and overseas, or a drinking water issue that has the potential to threaten public health, the installation must determine the proper response to the exceedance, to include public notification. The installation CO is required to consult with the local Preventive Medicine Authority, who will immediately consult with the NAVMCPUBHLTHCEN. The Preventive Medicine Authority, under the direction of the regional Preventive Medicine Authority, NAVMCPUBHLTHCEN and BUMED-M44 will provide public health advice and consultation in the preparation of a draft public notification and the decision to provide alternate water supplies.

a. The Preventive Medicine Authority will serve an important role in the response to and recovery from situations involving drinking water quality issues. The Preventive Medicine Authority will be the agent through which BUMED will fulfill its responsibility to provide public health advice and consultation to the installation CO, thereby enabling the CO to execute his or her responsibility of protecting the health of installation water system consumers.

b. The Preventive Medicine Authority may be tasked with gathering of data from disparate sources in the local area that will constitute essential elements of the investigation of the cause of the problem, development of interim measures to provide fit for human consumption water to the population at risk, the course of action to correct the underlying cause of the problem, and proper notification of the population at risk. The regional Preventive Medicine Authority, NAVMCPUBHLTHCEN and BUMED will assimilate all available, relevant information, which may include certified laboratory test results, water treatment facility records, and corrective actions taken as they develop public health recommendations to be provided to the installation CO via the Preventive Medicine Authority.

c. Although the Preventive Medicine Authority serves as the installation CO’s on-site public health advisor in matters pertaining to drinking water quality, he or she will not respond to questions from media sources unless specifically authorized to do so and briefed accordingly. All requests for information pertaining to drinking water quality by news media must be referred to the installation’s designated public affairs office.

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5-31. Public Notification

1. The Public Notification Rule is part of the SDWA. The rule ensures that consumers will know if there is a problem with their drinking water. The delivery timeframe of the public notification depends on what tier a violation or situation falls into. Each tier has different required methods to deliver the notice depending on water system type. The three types of public notice are:

a. Tier 1 Public Notice. Immediate notice; within 24 hours. Issued for violations, exceedances, situations, or failures that may pose an acute risk to human health (e.g., violation of the MCL for nitrate, nitrite, or total nitrate and nitrite; E. coli in the source water, MCL exceedance in the distribution system, or failure to test for E. coli when any repeat sample tests positive for coliform).

b. Tier 2 Public Notice. Notice as soon as practical, but within 30 Days of the violation. Issued for violations of a non-acute MCL, treatment technique requirement, except where Tier 1 notice is required (above).

c. Tier 3 Public Notice. Notice as soon as practical; but within a year of the violation for violations that do not pose an immediate risk to human health, including failure to develop a monitoring plan unless primacy agency elevates to Tier 2. The following page assists purveyors in communicating important water system information to non-English speaking populations. <http://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/DrinkingWaterEmergencies/PublicNotification/TranslationsforPublicNotification>.

2. For any water quality exceedance that requires a public notification, the draft public notification should be reviewed by the Preventive Medicine Authority for the following 10 EPA requirements. An example of what a public notification looks like is available at:

https://www.epa.gov/sites/production/files/2015-10/documents/publicnotification_figure.pdf.

- a. Description of the violation.
- b. When the violation occurred.
- c. Potential adverse health effects.
- d. Population at risk.
- e. Whether alternative water supplies should be used.
- f. Actions consumers should take.
- g. What is being done to correct the violation.
- h. When it is expected to return to compliance.

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- i. Where to find additional information.
 - j. Standard language throughout the document.
3. Figure 5-31-1 provides an overview of the decision process for recommending use of alternative water supplies and issuing a public notification.

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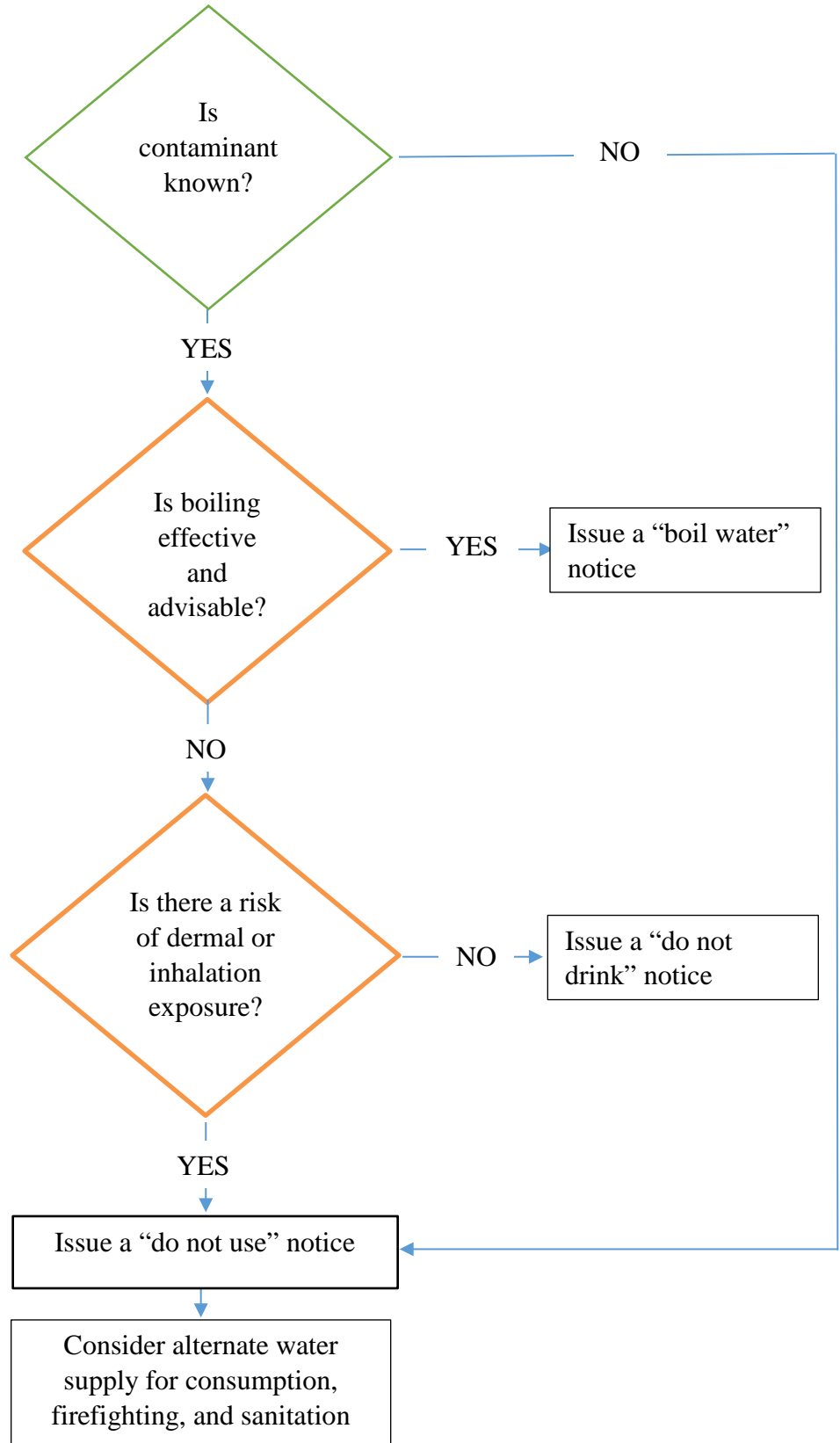


Figure 5-31-1 Decision Process for Public Notification

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5-32. Public Health Risk Assessment

1. The purpose of a public health risk assessment is to determine whether a drinking water system is supplying water that acceptable or unacceptable for use by water system consumers, considering all exposure pathways (i.e. ingestion, dermal, and inhalation).
2. The public health risk assessment is a scientifically defensible process conducted by a multidisciplinary team of SMEs at NAVMCPUBHLHCEN. It uses a weight of evidence approach and typically includes hazard identification and characterization, a toxicity assessment, exposure assessment, and risk characterization.
3. At locations within CNIC's overseas drinking water program, a determination of fit for human consumption or not fit for human consumption must include consultation with the Preventive Medicine Authority. The Preventive Medicine Authority must consult with NAVMCPUBHLHCEN and inform the regional Preventive Medicine Authority prior to advising the installation CO. Situations where the Preventive Medicine Authority would consult with NAVMCPUBHLHCEN may include but are not limited to, contamination of the overseas drinking water system by unregulated substances (i.e., no MCL established), or where the installation CO has determined the drinking water is not fit for human consumption and requests an evaluation for other consumptive uses (i.e. cooking, oral hygiene, dishwashing, bathing, showering, and hand-washing). Preventive Medicine Authorities are not authorized to perform a public health risk assessment on their own; they must consult with NAVMCPUBHLHCEN for all public health risk assessments.
4. The Preventive Medicine Authority may be tasked with gathering of data from disparate sources in the local area that will constitute essential elements of the public health risk assessment process. The regional Preventive Medicine Authority, NAVMCPUBHLHCEN and BUMED will assimilate all available, relevant information, which may include certified laboratory test results from compliance monitoring, water treatment facility records, and corrective actions taken as they develop the public health risk assessments to be provided to the installation CO via the Preventive Medicine Authority.
5. A public health risk assessment may not be required in every instance of an installation public notification of a drinking water violation. Refer to public notification procedures in article 5-24 of this chapter. Public health risk assessments should be infrequent events that serve as an interim assessment, not intended to delay or defer maintenance or repair to overseas drinking water systems that are necessary for compliance with applicable regulations and delivery of fit for human consumption water to consumers.

5-33. Risk Communication. In addition to the required content described in the Public Notification Rule, the following recommendations for effective notifications should be considered when preparing a public notification.

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1. Assume that consumers only read the top half of the notice (or what can be read in ten seconds). The most important information, especially instructions to protect consumers' health, should be placed on the top half of the notice in large print. Smaller print is appropriate for less critical elements.
2. Try to limit the wordiness of the notice. A question and answer format is easy to read and guides readers to the information that is likely to concern them. Bullets and bold text are also effective.
3. Highlight the name of the water utility, especially where people in the area are served by more than one water system. The water utility may also want to prepare a map showing the area served, especially if it extends beyond the installation boundaries or city limits.
4. Notifications should address the needs of special populations, including but not limited to people with disabilities (i.e. sight, hearing impairment, etc.), non-english speaking residents, individuals who cannot read or with limited literacy, etc.
5. For additional information and assistance with risk communication, contact NAVMCPUBHLTHCEN. NAVMCPUBHLTHCEN is the recognized center of excellence for risk communication, providing worldwide risk communication support. NAVMCPUBHLTHCEN is uniquely staffed with risk communicators with backgrounds in chemistry, biology, industrial hygiene, public health, and engineering who work side-by-side with other health professionals. Risk communication guidance is also available at <https://www.med.navy.mil/sites/nmcphc/environmental-programs/Pages/Risk-Communication-and-Media.aspx>.

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SECTION VI. NAVY DRINKING WATER QUALITY PROGRAM OUTSIDE OF THE
U.S., ITS TERRITORIES, AND POSSESSIONS

5-34. The Navy Overseas Drinking Water Program and its Applicability

1. The Navy overseas drinking water program and its requirements apply to U.S. Navy installations and installation properties Outside Continental United States (OCONUS), its territories, and possessions. These installations and their properties are also termed “Overseas Installations,” and commonly known as OCONUS. These include installations under the command of Naval Sea Systems Command (NAVSEA). Overseas installations may be located on a variety of properties, which can include ceded, leased, government, nongovernment and non-contiguous installation properties, or properties provided by other type of instrumentalities.
2. Overseas installations or facilities where the U.S. Navy regulates and controls drinking water criterion, instrumentality or operation must fall under the Navy overseas drinking water program requirements.
3. The Navy overseas drinking water program does not apply to contingency locations and associated operations and deployments, including cases of hostilities; contingency operations in hazardous areas; peacekeeping missions; or relief operations, including U.S. forces operating as part of a multinational force not under full U.S. control (e.g., North Atlantic Treaty Organization installations).

5-35. Applicability of Navy Overseas Drinking Water Standards, Policies, and Requirements

1. Overseas installations must comply with the following overarching standards in managing and operating their overseas drinking water systems:
 - a. DoD Instruction 4715.05 (Environmental Compliance at installations outside the United States) requires overseas drinking water systems to comply with one of the following:
 - (1) Country-specific FGS.
 - (2) The Overseas Environmental Baseline Guidance Document for host countries where FGS have not been established (DoD Instruction 4715.05-G).
 - b. Chapter 3 of each country-specific Environmental FGS and the Overseas Environmental Baseline Guidance Document includes the requirements for DoD overseas drinking water systems.
 - (1) The requirements include the health-based MCLs, water quality monitoring requirements, and water system operation and management criteria.
 - (2) Drinking water systems at U.S. Navy overseas installations are subject to requirements derived from a comparison of U.S. and host nation standards, and are required to use the more protective of the two. These standards are written in host nation-specific FGSs, which serve as the primary DoD requirements for water quality and system management.

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2. Reference (a) provides guidance on a variety of environmental issues, including drinking water:

a. Chapter 7 contains provisions for sampling and laboratory testing applicable to the collection and use of environmental data supporting all environmental regulations including drinking water programs.

b. Reference (a), chapter 34, provides environmental guidance for OCONUS Navy installations, including the following:

(1) Develop a Water System Vulnerability Assessment and emergency response plan update for internal use only.

(2) Develop Consumer Confidence Reports (CCR) for all Navy installations including outlying facilities and leased government properties (including Navy housing), and provide a copy of CCRs to the public and the regional WQB.

(3) Provide public notification reports as applicable.

3. CNIC issued three instructions to ensure that overseas drinking water systems provide drinking water that meets or exceeds U.S. water quality standards: references (d) and (e). Overseas drinking water systems must comply with these CNIC instructions in addition to FGS and the Overseas Environmental Baseline Guidance Document and other applicable requirements such as international agreements, in-theater commander directives, and DoD and Service policies. CNIC also issued several memoranda on other drinking water-related issues.

a. CNICINST 5090.1, U.S. Drinking Water Quality Standards for U.S. Navy installations Overseas

(1) Adopted many subparts of NPDWR including requirements that are not covered by country-specific Environmental FGSs and the Overseas Environmental Baseline Guidance Document.

(2) Purchased water must be subject to the same monitoring requirements as DoD-produced water, and should comply with the monitoring requirements as stated in this instruction.

(3) The Water Quality Oversight Council should be consulted for relevant compliance dates.

b. Reference (e) establishes Navy criteria for overseas drinking water sanitary surveys and follow-on certificates to operate (CTO). It also establishes an overseas Operator in Responsible Charge and Assistant Operator in Responsible Charge operator training and certification program and overseas requirements.

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(1) The main purpose of the CTO program is to ensure the Navy has implemented an oversight program overseas that results in drinking water system operations that meet or exceed water quality standards in the U.S.

(2) The CTO process includes Sanitary Surveys (SS) under the direction of the Water Quality Oversight Council, development of POA&M, corrective action implementation, issuance of CTO, and continued Navy drinking water system water quality tracking and evaluation efforts to ensure applicable drinking water quality standards are met.

(3) The Water Quality Oversight Council will recommend a CTO level based on its review of results of the sanitary survey and POA&M for each overseas drinking water system, along with water quality compliance monitoring results, water operator and training certification, and documented correction actions to address the POA&M. The final CTO will be issued by the regional commander.

c. Reference (f), establishes the overall requirements, organization, and roles and responsibilities for the Navy overseas drinking water program.

(1) Provides criteria and requirements to establish and implement the Navy overseas drinking water program ashore.

(2) Describes authorities and responsibilities.

(3) Defines Navy overseas drinking water program management, oversight and chain of command, and describes authorities and responsibilities.

d. Memorandum for Navy Overseas installation WQB and regional WQB – Navy Overseas Containerized Drinking Water Policy, Ser N4/15U3097, May 8, 2015

(1) Provides guidance on how to manage alternate delivery method of drinking water at overseas drinking water systems to comply with water quality requirements and deliver fit for human consumption water through containerized methods.

(2) Provides SOP for providing fit for human consumption containerized water delivery and dispenser servicing.

4. Other applicable supporting instructions, manuals, and criteria. The following Navy instructions, manuals, and DoD Unified Facilities Criteria (UFC) also provide guidance applicable to overseas drinking water systems:

a. Reference (g), Department of the Navy Medical Drinking Water Standards

b. NAVMED P-5010, Manual of Naval Preventive Medicine, (this document)

c. UFC 3-230-01 Water Storage, Distribution, and Transmission

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- d. UFC 3-230-02 Operations and Maintenance: Water Supply Systems
- e. UFC 3-230-03 Water Treatment

5-36. Navy Overseas Drinking Water Program Management and Oversight

1. Overseas Drinking Water Program Authorities:

a. CNIC serves as executive agent for drinking water quality matters for all Navy overseas installations. Primary enforcement authority or “primacy” rests with CNIC headquarters.

b. Water Quality Oversight Council provides overall management and oversight for the overseas drinking water program, evaluates system performance, and recommends CTO for each system. The Water Quality Oversight Council is the overall governing body and reports on a regular basis to the executive agent. The Water Quality Oversight Council is permanently chaired by the CNIC N4, Director of Facilities and Environmental. Standing members include representatives from CNIC and NAVFAC Headquarters Environmental and Facilities/Public Works, BUMED headquarters, Navy and Marine Corps Public Health Center, NAVFAC Atlantic and Pacific, and NAVFAC Engineering and Expeditionary Warfare Center. The Water Quality Oversight Council convenes on a regular basis, determines overarching policies, makes associated decisions and actions, and reports to the Navy executive agent for overseas drinking water ashore.

c. Navy regional WQBs. Each Navy region overseas or with overseas installations must establish regional WQBs. The regional WQB must be chaired by the regional commander (not a designee). Standing members include the Region N4 and N45, representatives from the region N45/Environmental Office, NAVFAC Facilities Engineering Command Public Works Utilities, Navy Region Preventive Medicine Authority, Region Public Affairs Office, and Region Counsel. Other ad hoc members must be added as needed. The regional WQB oversees installation programs and ensures compliance and consistency, but does not have program primacy. The regional WQB reports to the Water Quality Oversight Council for all drinking water matters.

d. Installation WQBs. Overseas installations must establish installation WQBs. Standing members are the Public Works Officer, representatives from the installation Public Works Environmental and Utilities, a representative from the local Preventive Medicine Authority, and the installation Public Affairs Office. Other ad hoc members must be added as needed. The installation WQB must be chaired by the installation CO, not a designee. The installation WQB manages the installation drinking water matters.

e. The Navy Operator Certification Authority Board is established to ensure that Navy overseas drinking water program policies are sufficiently equivalent to U.S. requirements and that Navy overseas operators are complying with the policies. The Navy Operator Certification Authority Board is comprised of five members, of which one acts as Chairperson. Members are nominated by CNIC region N4s and are selected by a panel chaired by the Water Quality Oversight Council Chair.

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f. The Water Quality Oversight Council Laboratory Authority ensures that overseas laboratory quality assurance requirements are sufficiently equivalent to U.S. requirements such that overseas installations are assured they are complying with the water quality requirements. The Water Quality Oversight Council Laboratory Authority is comprised of five or more members from CNIC, NAVFAC, BUMED, and NAVSEA's Navy Laboratory Quality Assurance Office. Members are nominated by their respective Commands and designated by the Water Quality Oversight Council Chair.

g. BUMED provides the following consultative services to CNIC for drinking water quality:

- (1) Risk assessment and risk communication.
- (2) Review of drinking water sampling and compliance data.
- (3) Public health assistance on preparation of CCRs and PNs.
- (4) Health related recommendations when water does not meet U.S. water quality standards.
- (5) Determination of implementation of alternative water supplies for drinking water system issues or discrepancies, and coordination of corrective action with the Executive Agent and NAVFAC.

2. Overseas Drinking Water Program Reporting Hierarchy

a. While the Navy chain of command remains applicable, installation WQBs, regional WQBs, and the Water Quality Oversight Council rely on reporting of critical information in a timely manner.

b. The installation WQB reports critical and routine information to the regional WQB. In similar fashion, the regional WQB reports to the Water Quality Oversight Council, and the Water Quality Oversight Council reports to the EA.

c. Conversely, the Water Quality Oversight Council ensures effective, efficient communication to the regional WQBs, and the regional WQBs ensure effective, efficient communication to the installation WQBs.

d. The Navy Operator Certification Authority and Laboratory Authorities ensure frequent, effective reporting and communications to the Water Quality Oversight Council Chair.

5-37. Other Unique Aspects of Navy Overseas Drinking Water Programs

1. Navy overseas drinking water systems must fully comply with the most stringent FGS and Overseas Environmental Baseline Guidance Document requirements applicable to each system. Additionally, overseas drinking water systems maintained by the Navy must comply with CNIC requirements.

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2. Many Navy overseas drinking water systems are operated by base operation and support (BOS) contractors to the U.S. Navy, and therefore, operational activities of those overseas drinking water systems are often bound to the water system BOS contracts. Services and activities required to meet all overseas drinking water standards and policies must be properly included in the BOS contract. Preventive Medicine Authorities may be called upon to provide public health advice in the process of reviewing a BOS contract as a member of an installation WQB or regional WQB. The BOS contract must be revised as necessary to amend identified contract deficiencies.
3. Many Navy overseas installations have no control over water sources and watershed areas. Therefore, implementing source water/watershed protection programs required by standards applicable to overseas drinking water systems may not be feasible. Those overseas installations must submit a request on a case by case basis to receive a Water Quality Oversight Council waiver from the relevant regulations for those areas not under the installation's control. The overseas installation must consult with the Water Quality Oversight Council for alternative plans to meet the goals of the regulations. The installation may need to install treatment and conduct monitoring within areas under the installation's control that meet the intent of the regulations (e.g., through strict raw water quality monitoring or additional treatment processes to achieve the required contaminant removal).
4. Many Navy overseas drinking water systems receive source (raw) water or drinking water from host nation water purveyors (e.g., local municipalities or private water companies). Maintaining good relationships and communication channels with the host nation water purveyors is very important in managing overseas drinking water systems properly in terms of prompt corrective actions and risk management during water system emergencies.

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APPENDIX A
ENDNOTES

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<http://water.epa.gov/infrastructure/drinkingwater/sourcewater/protection/upload/swpguidance.pdf>
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45. When developing LCR sampling plans, ensure that they comply with EPA’s October 20, 2006, *Memorandum: Management of Aerators during Collection of Tap Samples to Comply with the Lead and Copper Rule and Modify Sampling Instruction Form Issued to Residents Accordingly*. This memorandum clarifies that water systems should not instruct customers to remove or clean aerators prior to or during the collection of tap samples for lead. Aerators are part of some faucet assemblies and are used to introduce air into the water flow. Although not intended to remove inorganic contaminants, screens that are part of the aerator may trap particulate matter or debris within the faucet. Removal and cleaning of the aerator is advisable on a regular basis. However, if customers are only encouraged to remove and clean aerators prior to drawing a sample to test for lead, the water system could fail to identify a typically available contribution of lead from the tap, and thus, fail to take additional actions needed to reduce exposure to lead in drinking water. A copy of this memorandum is available at <http://www.epa.gov/safewater/lcrmr/compliancehelp.html>.
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APPENDIX C
TERMS AND DEFINITIONS

1. Action Level. A specified concentration of a contaminant in water at or above which a certain action-e.g., further treatment and monitoring—must be taken to comply with a drinking water regulation. (Segen’s Medical Dictionary, (2011). Retrieved April 26, 2018 from <https://medical-dictionary.thefreedictionary.com/action+level>.
2. Acute Health Effect. An immediate (i.e., within hours or days) adverse health effect that may result from exposure to certain drinking water contaminants (e.g., pathogens).
3. Airgap. A physical separation sufficient to prevent backflow between the free-flowing discharge end of a potable water system outlet and any other system. An air gap is physically defined as a distance equal to twice the diameter of the outlet, but never less than 1 inch.
4. Aquifer. A permeable, water-bearing geologic formation.
5. Backflow. The flow of non-potable water or other liquids, mixtures, or substances into the potable water supply system. Back-siphonage and back-pressure are the two types of backflow.
6. Backflow Prevention Device. A device or means designed to prevent backflow or back-siphonage. Most commonly categorized as air gap, reduced pressure principle device, double check valve assembly, pressure vacuum breaker, atmosphere vacuum breaker, residential dual check, double check with intermediate atmosphere vent, or barometric loop. An air gap is the preferred method for backflow prevention, but not always practical.
7. Back-siphonage. Backflow resulting from negative pressure in the distribution pipes of a potable water system.
8. Colony Forming Unit. A unit used to estimate the number of viable bacterial or fungal cells in a sample. For convenience, the results are given as cfu/mL [colony-forming units per milliliter]. This is generally used as a unit for HPC analytical results.
9. Check Valve. A self-closing device that is designed to allow the flow of fluids in one direction and to close if there is a reversal of flow.
10. Chloramine. An alternative means of disinfection often used to try to reduce disinfection byproducts formation. The equilibrium products of ammonia react with the equilibrium products of chlorine to form chloramines. Combined available chlorine (chloramine) has significantly less disinfecting power than chlorine.
11. Chronic Health Effect. The possible result of exposure over many years to a drinking water contaminant at levels above its MCL.
12. Coliform. A group of related bacteria whose presence in drinking water may indicate contamination by disease-causing micro-organisms or environmental contaminants.

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13. Community Water System. A PWS that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.
14. Compliance Monitoring. (1) Drinking water analysis by a State-accredited laboratory using EPA-approved methodology. (2) The act of meeting all state and federal drinking water regulations.
15. Contaminant. Anything found in water (including microorganisms, minerals, chemicals, radionuclides, etc.) that may be harmful to human health.
16. Continental United States. Indicates locations (military installations) within the continental United States.
17. Crossover Point. Any point or points where a potable water main makes contact with or crosses over or under a non-potable liquid conduit (sewer, non-potable water supply, etc.).
18. Cross-Connection. Any actual or potential connection between the public water supply and a source of contamination or pollution.
19. Cryptosporidium. A microbe commonly found in lakes and rivers that is highly resistant to disinfection. *Cryptosporidium* has caused several large outbreaks of gastrointestinal illness, with symptoms that include diarrhea, nausea and stomach cramps. People with severely weakened immune systems are likely to have more severe and more persistent symptoms than healthy individuals.
20. Concentration Time. The product of disinfectant concentration (C) (measured in mg/L) and contact time (T) (measured in minutes) using a particular disinfectant to achieve a certain degree of *Cryptosporidium*, *Giardia* or virus reduction. EPA specifies CT values for each disinfectant at defined pH levels and temperatures; for many disinfectants, microbial inactivation is both pH and temperature dependent. CT units are measured in mg-min/L.
21. Disinfectant. A chemical (commonly chlorine, chloramines or ozone) or physical process (e.g., UV light) that kills microorganisms such as bacteria, viruses, and protozoa.
22. Disinfection Byproduct. Chemicals that form when disinfectants (such as chlorine) react with plant matter and other naturally occurring materials in water. These byproducts may pose chronic health risks in drinking water.
23. Disinfection. A process that inactivates pathogenic organisms in water with chemical oxidants or equivalent agents.
24. Free Available Chlorine. Chlorine available in the forms of hypochlorous acid and hypochlorite ions after chlorine demand has been satisfied.
25. Fit For Human Consumption. This is the term that is used by the U.S. Navy to indicate that the water is safe for drinking, cooking, bathing, showering, dishwashing, and maintaining oral hygiene.

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26. Field Water Supply System. A system of collection, purification, storage, transportation, distribution equipment and personnel to provide drinking water to field units in training or in actual deployment environments. RO water production units are used for treating water for deployed units. Field Water Systems are not subject to requirements of the SDWA or EPA regulations. Tri-Service Drinking Water Quality Standards have been established for DoD field water sources.
27. Filtration. A process for removing particulate matter from water by passage through porous media.
28. Gastroenteritis. A general category of gastrointestinal illness that may result from drinking water contaminated with pathogenic viruses, bacteria, or protozoa. Symptoms include diarrhea, cramps, fatigue, nausea, and vomiting.
29. Giardia Lamblia. A microorganism frequently found in rivers and lakes, which, if not treated for properly, may cause diarrhea, fatigue, and cramps after ingested.
30. Ground Water Under The Direct Influence of Surface Water. Any water beneath the surface of the ground with: (1) significant occurrences of insects, microorganisms, algae or large diameter pathogens such as *Giardia lamblia*, or (2) significant and relatively rapid shifts in water characteristics, such as turbidity, temperature, conductivity or pH, that closely correlate to climatological or surface water conditions. Direct influence must be determined for individual sources per criteria established by the primacy agency. The primacy agency determination of direct influence may be based on site-specific measurements of water quality, and documentation of well construction characteristics and geology with field evaluation.
31. Health Hazard. Any condition, including any device or water treatment practice that may create an adverse effect on a person's health and well-being.
32. Inorganic Chemicals. Mineral-based compounds such as metals, nitrates and asbestos. These contaminants are naturally-occurring in some water, but can also enter the water stream through farming, chemical manufacturing, and other human activities.
33. Ion Exchange. A process whereby a positively or negatively charged ion exchanges itself with a similarly charged contaminant ion in the drinking water. This method is used to treat hardness, inorganic chemicals, and radionuclides.
34. Legionnaire's Disease. A type of pneumonia that results when aerosols containing *Legionella* bacteria are inhaled by susceptible persons. Aerosols may come from showers, hot water taps, whirlpools, and heat rejection equipment such as cooling towers and air conditioners. *Legionella* do not cause infection through water ingestion.
35. Marginal Chlorination. Application of chlorine to produce the desired total chlorine residual without reference to the amounts of free or combined chlorine present.
36. Maximum Contaminant Level. The maximum permissible level of a contaminant in water that is delivered to any user of a PWS. MCLs are legally enforceable standards. For deployment settings, defer to the DoD Tri-Service Drinking Water Standards.

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37. Maximum Contaminant Level Goal. The maximum level of a contaminant in drinking water at which no known or anticipated adverse human health effect would occur, and which allows an adequate margin of safety. MCLGs are not legally enforceable, but are health goals.
38. Medical Bacteriological Sampling/Surveillance. Bacteriological testing by the preventive medicine authority when warranted. It is not intended to meet SDWA compliance monitoring requirements.
39. National Primary Drinking Water Regulations. Legally enforceable standards that apply to PWSs. These standards protect drinking water quality by limiting the levels of specific contaminants that are known or anticipated to occur in public water supplies and can adversely affect public health.
40. National Secondary Drinking Water Regulations. Non-enforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration) or aesthetic effects (such as taste, odor or color) of drinking water.
41. Non-Community Water System. A PWS that is not a community water system. These can be either transient non-community water systems or non-community water system.
42. Non-Potable Water. Water that has not been examined, properly treated or approved by proper authorities as being safe for domestic consumption. All waters are considered non-potable until declared potable by the regulatory authority.
43. Non-Transient Non-Community Water System. A PWS that regularly serves at least 25 of the same persons over 6 months per year, but not year round. Some examples are schools, factories, office buildings, and hospitals with their own water systems.
44. Outside the Continental United States. Refers to locations (military installations) outside the continental United States but within a U.S. territory or possession.
45. Organic Chemicals. Carbon-based chemicals, such as solvents and pesticides that can enter a water source through runoff from croplands or discharge from factories.
46. Overseas. Refers to a location (military installation) that is not located in a U.S. territory or possession.
47. Palatable Water. Water that is pleasing to the taste and is largely free from color, turbidity, and odor. Palatability does not imply that the water is safe to drink and vice versa.
48. Pathogens. Disease-causing organisms, such as some bacteria, viruses, or protozoa.
49. Perchlorate. A contaminant that exists in the environment as a part of other chemical compounds such as ammonium, potassium or sodium perchlorate. The concerns surrounding perchlorate contamination involve its ability to affect the thyroid gland, which can affect metabolism, growth, and development.

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50. Point of Entry Treatment. Treatment device or technology intended to treat all water entering a residence or building.
51. Point of Use Treatment. Treatment device or technology intended to treat water at a single tap.
52. Potable Water. Water that has been treated and confirmed via testing to meet established water quality standards and declared fit for human consumption. Fit for human consumption is the term that is used by the U.S. Navy to indicate that the water is safe for drinking, cooking, bathing, showering, dishwashing, and maintaining oral hygiene.
53. Preventive Medicine Authority. The medical department representative(s) responsible for public health (preventive medicine). This will be the senior environmental health officer or preventive medicine technician for the area of responsibility. In their absence, Army veterinary technicians, independent duty corpsmen, senior general duty corpsmen, or medical officers may be designated.
54. Primacy. Primary enforcement authority for the drinking water program. Under the SDWA, States, U.S. territories, and Native American Tribes that meet certain requirements (including setting regulations that are at least as stringent as EPA's) may apply for, and receive, primary enforcement authority.
55. Public Water System. A system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least 60 days out of the year. The term PWS includes (1) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system; and (2) any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. A PWS is either a "community water system" or a "non-community water system."
56. Radionuclide. An unstable form of a chemical element that radioactively decays, resulting in the emission of nuclear radiation. Prolonged exposure to radionuclides increases risk of cancer.
57. Raw Water. (1) Untreated water, usually the water entering the first treatment unit of a water treatment plant; (2) Water used as a source of water supply taken from an impounded body of water, such as a stream, lake, or pond, or a well.
58. Reduced Pressure Principle Backflow Preventer. An assembly of differential valves and check valves including an automatically opened spillage port to the atmosphere designed to prevent backflow.
59. Reverse Osmosis. A pressure-driven treatment process using a specially prepared membrane that permits the flow of water through the membrane, but acts as a selective barrier to contaminants.

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60. Sanitary Defects. Conditions that may cause the contamination of water supply during or after treatment. These include connections to unsafe water supplies, raw water bypasses in treatment plants, plumbing fixtures improperly designed and installed, and leaking water and sewer pipes in the same trench.
61. Sanitary Survey. An on-site engineering review of the water source, facilities, equipment, operation and maintenance of a PWS for the purpose of evaluating the adequacy of such elements for producing and distributing safe drinking water.
62. Seimens. The SI derived unit of electric conductance is the seimens, which was previously referred to by the term mho. That term came from spelling ohm backwards, since a seimens (or mho) is equal to inverse ohm. Measuring the conductivity of a water sample is a common method used to determine the level of metals and other charged contaminants dissolved in the water (total dissolved solids).
63. Spring. A spring is a concentrated discharge of ground water appearing at the ground surface.
64. Supplier of Water. Any person who owns or operates a PWS.
65. Total Available Chlorine. The sum of the chlorine forms present as free available chlorine and combined available chlorine.
66. Total Trihalomethanes. The sum of the concentration in milligrams per liter of the trihalomethane compounds (trichloromethane [chloroform], dibromochloromethane, bromodichloromethane, and tribromomethane [bromoform]) rounded to two significant figures.
67. Transient, Non-Community Water System. A PWS that provides water in a place, such as a gas station or campground, where people do not remain for long periods of time. These systems do not have to test or treat their water for contaminants that pose long-term health risks, because fewer than 25 of the same people drink the water over a long period. They still must test their water for microbes and several chemicals posing short term health risks.
68. Treated Water. Water that has undergone processing (such as sedimentation, filtration, softening, disinfection, etc.) and is ready for consumption. This includes purchased potable water that is retreated (chlorinated, fluoridated, etc.).
69. Treatment Technique. A required process intended to reduce the level of a contaminant in drinking water.
70. Turbidity. The cloudy appearance of water caused by the presence of tiny particles. High levels of turbidity may interfere with proper water treatment and monitoring.
71. Vacuum Breaker, Non-Pressure Type. A device or means to prevent backflow designed not to be subjected to static line pressure.
72. Vacuum Breaker, Pressure Type. A device or means to prevent backflow designed to operate under conditions of static line pressure.

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73. Violation. A failure to meet any state, Federal, or DoD drinking water regulation.
74. Vulnerability Assessment. A systematic evaluation of a potable water system by Public Works, anti-terrorism officer, and other installation parties, to determine if the potable water system is vulnerable to natural or man-made disasters, or adversaries' activities. This includes a list of recommendations to eliminate or decrease any vulnerability to the system from these threats.
75. Water Quality. The chemical, physical, radiological, and microbiological characteristics of water with respect to its suitability for a particular purpose.

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APPENDIX D
ACRONYMS AND ABBREVIATIONS

ANSI	American National Standards Institute
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
B/C	Bag or Cartridge (filtration)
BOS	Base Operation and Support
BUMED	Bureau of Medicine and Surgery
CCR	Consumer Confidence Report (required annually)
CDC	Centers for Disease Control and Prevention
CNIC	Commander, Navy Installations Command
CNO	Chief of Naval Operations
CO	Commanding Officer
CONUS	Continental United States
CT	The product of disinfectant concentration (C) (measured in mg/L) and contact time (T) (measured in minutes), CT units are measured in mg-min/L
CTO	Certificate to Operate
CWS	Community Water System (a PWS that serves the same population year- round)
DBPR	Disinfection and Disinfectant Byproduct Rule
DoD	Department of Defense
DON	Department of the Navy
EA	Executive Agent
EHO	Environmental Health Officer
EPA	U.S. Environmental Protection Agency
FAC	Free Available Chlorine
GAC	Granular Activated Carbon
HAA5	Sum of Five Haloacetic Acids
HPC	Heterotrophic Plate Count
HVAC	Heating, Ventilating, and Air Conditioning
IESWTR	Interim Enhanced Surface Water Treatment Rule
IT	UV Intensity in mW/cm ² multiplied by time in seconds, used to calculate a UV dose
LT1ESWTR	Long-Term 1 Interim Enhanced Surface Water Treatment Rule
LT2ESWTR	Long-Term 2 Interim Enhanced Surface Water Treatment Rule
µg/L	microgram per liter (part per billion/ppb)
mg/L	Milligram per liter (part per million/ppm)
mHPC	Membrane Heterotrophic Plate Count
mJ	Millijoule
MRDL	Maximum Residual Disinfectant Level
mW	Milliwatts
NAVFAC	Naval Facilities Engineering Command
NAVMED	Navy Medicine

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NAVSEA	Naval Sea Systems Command
NESC	National Environmental Services Center
NF	Nanofiltration
NFPA	National Fire Protection Association
NRC	National Research Council
NSF	National Sanitation Foundation International
NTU	Nephelometric turbidity units
NWRI	National Water Research Institute
OCONUS	Outside the Continental United States (overseas)
OEBGD	Overseas Environmental Baseline Guidance Document
OEL	Operational evaluation level
OPNAV	Office of the Chief of Naval Operations
ORP	Oxidation-Reduction Potential
PH	Potential of Hydrogen
PMT	Preventive Medicine Technician
POA&M	Plan of Action and Milestones
PP	Pour Plate
ppm	Parts Per Million
PT	Proficiency Testing
PWO	Public Works Officer
PWD	Public Works Department
QA	Quality Assurance
QC	Quality Control
R2A	Reasoner's 2A (agar)
RCP	Risk Communication Plan
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
Sec	Seconds
SOFA	Status of Forces Agreement
SOC	Synthetic Organic Compounds
SOP	Standard Operating Procedure
SP	Spread Plate
SWTR	Surface Water Treatment Rule
THM	Trihalomethanes
TOC	Total Organic Carbon
UF	Ultrafiltration
UFC	Unified Facilities Criteria
UV	Ultraviolet
VOC	Volatile organic compound
WCIT	Water Contaminant Information Tool
WQP	Water Quality Parameter

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APPENDIX E
CONTACT INFORMATION FOR PREVENTIVE MEDICINE ASSISTANCE

PREVENTIVE MEDICINE AUTHORITY ASSISTANCE

Navy Medicine East
Regional Preventive Medicine Authority
620 John Paul Jones Circle
Bldg. 3, Suite 1400
Portsmouth, VA 23708-2103
Commercial: (757) 953-0432
DSN: 377-0432

Navy Medicine West
Regional Preventive Medicine Authority
4170 Norman Road, Suite 5
San Diego, CA 92136
Commercial: (619) 767-6780
DSN: 577-6780

Navy and Marine Corps Public Health Center
Preventive Medicine Directorate, Program and Policy Support Department – Environmental
Health, Senior Sanitarian
620 John Paul Jones Circle
Portsmouth, VA 23708-2103
Commercial: (757) 953-0700
DSN: 377-0700
www.med.navy.mil/sites/nmcphc/Pages/Home.aspx

Bureau of Medicine and Surgery (BUMED-M44)
Environmental Health Policy Manager
Environmental Health Officer
7700 Arlington Blvd
Falls Church, VA 22042-5122
Commercial: (703) 681-9329
DSN: 761-9329

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**APPENDIX F
MODEL POTABLE WATER SURVEILLANCE PROGRAM
SAMPLE ONLY**

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Section 7 Electronic Surveillance

Defense Occupational Environmental Health Readiness System-IH-EH

APPENDIX A Points of Contact List

APPENDIX B Sampling Map

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References:

- (a) EPA Drinking Water Contaminants – Standards and Regulations
- (b) (Host Nation) Environmental Governing Standards (if applicable)
- (c) Standard Methods for Examination of Water and Wastewater, 22nd Edition, 2012
- (d) OPNAV M-5090.1
- (e) MCO P5090.2A
- (f) CNICISNT 5090.1
- (g) CNICINST 5090.2
- (h) CNIC 5090.3
- (i) BUMEDINST 6420.10C
- (j) BUMED 6200.14D
- (k) NAVMED P-5010 Chapter 4 Recreational Water Facilities
- (l) NAVMED P-5010 Chapter 5 Water Quality for Shore Installations
- (m) NAVSEA T0300-AZ-PRO-010, Navy Environmental Compliance Sampling and Field Testing Procedures Manual
- (n) BUMED Sanitary Survey Checklist, Navy Installation Overseas Drinking Water Programs Ashore
- (o) CNIC 5090 Ser N4/17U082, Interim Guidance for Sampling and Testing for Lead in Drinking Water in Priority Areas, June 2017
- (p) Memorandum for Navy Overseas Installation Water Quality Board and regional Water Quality Board, 5200 Ser N4/13U84375 02 August 2013
- (q) EPA Revised Public Notification Handbook, 2nd Revision. EPA 816-R-09-013, March 2010
- (r) Safe Drinking Water Act (SDWA)
- (s) 40 CFR 141
- (t) Installation Water Vulnerability Assessment

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Note: THIS TEMPLATE MAY CONTAIN INFORMATION THAT IS APPLICABLE TO A SPECIFIC NAVY REGION OR BASE. IT IS PROVIDED FOR ILLUSTRATION PURPOSES. EACH PREVENTIVE MEDICINE AUTHORITY SHOULD TAILOR THIS TEMPLATE TO THEIR SPECIFIC LOCATION.

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SECTION 1. DRINKING WATER PROGRAM

1. Introduction. This SOP outlines the responsibilities for the Preventive Medicine Drinking Water Program. This SOP is per the agreement between [Navy Region], US Naval Hospital [Location/Country], and Navy Facilities Engineering Command (NAVFAC) [Region], and Public Works Department (PWD).
2. Preventive Medicine Authority's Mission. Implement BUMED's Drinking Water Surveillance Program for Shore Commands. Reference (c) provides policy for drinking water surveillance and testing on Navy and Marine Corps bases. Reference (i) describes the medical role in providing assistance and expertise for overseas drinking water concerns and ensures that NAVFAC reports compliance sampling data to medical for review. CNIC provides overall awareness and understanding of overseas drinking water program within Navy installations.

SECTION 2. ROLES AND RESPONSIBILITIES

1. Installation Preventive Medicine Authority

a. Program coordinator for the installation overseas drinking water program. Must be appointed in writing by installation commanding officer (CO) and maintain letter in program SOP binder. Manage all requirements set forth in instructions pertaining to Department of the Navy overseas drinking water program, references (a) through (t). Provide medical advice and consultation to installation Water Control Board and to the installation CO.

b. Preventive medicine authority. The role of preventive medicine authority may be filled by an environmental health officer, preventive medicine technician, environmental health technician or an appropriately trained civilian and master labor contractor. Appointment letter from the installation CO is required that designates the environmental health officer [rank, name] as installation Water Quality Board (WQB) preventive medicine authority.

c. Responsibilities. Outlined in references (f) through (i) and (p).

(1) Develop and maintain a written public health drinking water surveillance plan as set forth in references (b) through (l). Details for surveillance plan are in Section 4.

(2) Coordinate in collaboration with NAVFAC on the collection and testing of samples per references (a) through (c). The preventive medicine division's water program is operated in addition to the NAVFAC testing program for increased quality assurance.

(3) Participate in all installation WQB meetings as the installation medical representative.

(4) Provide public health consultation to the installation CO and PWD on health aspects of drinking water quality and assist with proper risk communication for public notifications as set forth in references (a) through (l).

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(5) Advise installation CO when water consumption may present health risks, to include recommending alternate water sources that are fit for human consumption when indicated. Consult Navy and Marine Corps Public Health Center (NAVMCPUBHLTCEN) for assistance to include advice on when to request a formal public health risk assessment.

(6) If treated water fails to meet water quality standards, then public notification actions described in reference (i) must be followed. When acute health effects exist with water quality, the installation WQB must notify the installation CO immediately. If the installation CO decides the water is or is not fit for human consumption, an alternate water source must be provided. preventive medicine authority must provide public health advice and consultation to the installation CO and installation WQB regarding water quality violations.

(7) Regularly review and provide public health comments as needed for:

- (a) Consumer confidence reports (CCR) (annual)
- (b) [Navy Region] Sampling SOP (annual)
- (c) [Navy Region] Bacteria Monitoring Plan (annual)
- (d) [Navy Region] Bacteria monitoring results (monthly)
- (e) [Navy Region] Organic/inorganic/lead in priority areas monitoring results (monthly)
- (f) [Navy Region] Systems Inventory (once per tour, or if systems change)
- (g) [Navy Region] Emergency Contingency Plan (annual)
- (h) [Navy Region] Drinking Water Master Plan (once per tour)
- (i) Installation WQB meetings with read-ahead (Quarterly Attendance)

d. Provide public health comments, which requires access to view all-important PWD and NAVFAC documents, test results, sample/distribution plans, and past surveys. All are located on the CNIC Environmental Portal. The Preventive Medicine Authority should have access to this portal and review documents regularly. Access can be obtained by contacting NAFVAC Environmental and PWD Environmental. Points of contact (POC) are listed below in Appendix A. The preventive medicine authority should consult or update key members often.

e. Report installation overseas drinking water concerns and all compliance sampling exceedances to regional preventive medicine authority immediately for awareness and guidance.

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2. Regional Preventive Medicine Authority

a. Responsibilities. Outlined in references (f) through (i) and (n). In addition to all responsibilities of the installation Preventive Medicine Authority at [Navy region], regional Preventive Medicine Authority has responsibility to ensure each installation Preventive Medicine Authority is supported and complies with their respective installation responsibilities.

b. Program coordinator for Navy region [location]. Provide oversight for each installation within designated regional Preventive Medicine Authority area of responsibility.

c. Installations under regional preventive medicine authority. [See following examples]

(1) Location 1

(2) Location 2

d. Provide medical advice and consultation to regional WQB and each installation WQB via the installation preventive medicine authority on public health concerns, sampling exceedances, and program oversight.

e. Participate in all regional WQB meetings as the regional medical representative.

(1) Provide public health consultation to the Commander Navy Region [location] and Navy facilities [region] on health aspects of drinking water quality and assist in proper risk communication for public notifications as set forth in references (a) through (l).

(2) Advise region commander when water consumption may present health risks, to include recommending alternate fit for human consumption water sources when indicated. Consult NAVMCPUBHLTHCEN for assistance to include advice on when to request a formal public health risk assessment.

f. Regularly review and provide public health comments as needed for:

(1) Review all Consumer Confidence Reports (CCRs) for region installations (annually)

(2) Review all Preventive Medicine Department (PMD) installation surveillance sampling plans (annual)

(3) Provide Tri-Annual review of installation programs and installation preventive medicine authority engagement

(4) Receive regular updates from each installation Preventive Medicine Authority on program status and surveillance and compliance monitoring results)

(5) Review installations most recent Sanitary Survey (once per tour, and once prior to next survey)

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(6) Provide technical assistance and Temporary Additional Duty (TAD) (if needed) prior to installation Sanitary Surveys to review the installation Preventive Medicine Authority's program prior to BUMED inspector.

3. PWD/NAVFAC. PWD's Environmental Department is responsible for implementing the [host Nation], Environmental Protection Agency (EPA), Office of the Chief of Naval Operations (OPNAV), and Commander, Navy Installations Command requirements at [location] and other locations within [Navy Region]. *All compliance monitoring for drinking water analysis for National Primary Drinking Water Regulations must be conducted by an EPA certified laboratory or equivalent* [emphasis added]. Overseas drinking water program compliance sampling is performed by installation PWD and testing is performed by an EPA certified (or equivalent) laboratory. PWD is required to report all compliance monitoring results to installation Preventive Medicine Authority. **PWD is responsible for requesting, drafting, and releasing public notices after installation WQB subject matter expert review.**

4. Operator in Responsible Charge. Installation operator responsible for drinking water system process. Per references (f) through (h), training certification for both distribution and treatment processes is required. Installation Preventive Medicine Authority should maintain training on file for ORS, and Alternate ORS of the water distribution system. NAVFAC headquarters is responsible for ORS and other operator training. Training is documented on the Environmental Portal Web. POC is [Name].

5. Installation CO. The installation CO is ultimately responsible for all overseas drinking water compliance. Only the installation CO can declare drinking water fit for human consumption. The installation CO is the head of the installation WQB.

6. Installation WQB

a. Responsibilities. Board of subject matter experts (SME) and program managers within the overseas drinking water program. The installation WQB meets officially on a quarterly basis to review major projects and overseas drinking water program status. Also meets as needed for distribution system concerns, outages, breaks, or compliance testing exceedances.

b. Members. All members are expected to attend meetings or send a knowledgeable substitute if unavailable. Installation preventive medicine authority substitute is [rank, name].

(1) Installation CO

(2) PWO

(3) Public Affairs Officer

(4) NAVFAC

(5) Installation preventive medicine authority

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- (6) Judge Advocate General office
- (7) Chief staff officer
- (8) Other members as the installation CO designates

7. Regional WQB

a. Responsibilities. Board of SMEs and program managers within the overseas drinking water from Navy Region [Location]. Regional WQB CO is [Name]. Regional WQB consists of two separate chains of command.

(1) Commander, Navy [forces, region, or installation], which includes the following installations:

- (a) Location 1
- (b) Location 2

(2) Commander, Navy [forces, region, or installation], which includes the following installations:

- (a) Location 1
- (b) Location 2

(3) Commander, Navy [forces, region, or installation], which includes:

- (a) Location 1
- (b) Location 2

b. Regional WQB meets officially on a quarterly basis for each chain of command to review major projects and overseas drinking water program status.

c. Members. All members are expected to attend meetings or send a knowledgeable substitute if unavailable. Regional preventive medicine authority substitute is [rank, name].

- (1) Attendee 1
- (2) Attendee 2

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8. Water Quality Oversight Council. Per references (g) and (h), Water Quality Oversight Council is responsible for monitoring future changes to U.S. drinking water standards applicable to Navy personnel at installations in the United States and applying them to Navy installations overseas. Navy's Overseas Water Quality Oversight Council will monitor future changes to U.S. drinking water standards and communicate to overseas Navy installations if future gaps are identified. Regional preventive medicine authority consults with BUMED and NAVMCPUBHLHCEN medical representatives on all medical matters affecting regional WQB or installation WQB matters.

SECTION 3. DRINKING WATER SOURCES

1. Summary of Distribution System. [Insert description of system here]
2. Summary of Storage System. [Insert description of storage system here]

SECTION 4. SAMPLING PLAN

1. Sampling Overview. Per references (g) through (j), [Navy region or base] is responsible for compliance sampling via PDW. Per reference (k) and (m), preventive medicine provides surveillance sampling as a form of “checks and balances” for the drinking water distribution system.
2. Surveillance with [Navy Region or Base] PWD Staff. Drinking water sample tests will be performed with the installation PWD sampling team once per quarter. The expectation will be to sample the same sites that PWD samples for the day, and observe the sampling methods of their trained sampling staff. POC to arrange joint sampling is [name] (PWD). [name] or a PMT should attend. EHO should attend at least annually with the PMT.
3. Preventive Medicine Sampling Guidance
 - a. Purpose. The purpose for PMD surveillance is to ensure current installation procedures adequately protect the health of [Navy region or base] water consumers. It also provides “checks and balances” to the installation compliance program. The sample plan for PMD represents a list of sample sites that were designated to be the best overall representation of the water distribution system. Locations can be changed as needed by the installation preventive medicine authority.
 - b. Preventive Medicine Sampling. Treated drinking water is sampled and tested for free available chlorine, pH, temperature, total coliforms, and E. coli using Presence/Absence procedure.
 - c. Samples are chosen due to their representation of the overall distribution system. The installation Preventive Medicine Authority should use the following to determine best locations:
 - (1) Variety of distribution areas on map
 - (2) Variety of distribution site types (near storage tanks, vs near distribution lines)

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- (3) Densely populated (high use) areas
- (4) Sites at beginning and end of system lines
- (5) History of exceedances
- (6) Accessibility for testing
- (7) Highly susceptible populations (i.e., child development center, schools, etc.)

The following is the excel version of the sample site locations and their sample frequency.
[EXAMPLE ONLY]

Water and Ice Sampling Points							
DATE	TYPE	BLDG#	FACILITY NAME	SAMPLING POINT	FREQ	COMMENTS	SAMPLER
05/12/2018	WATER	1400	USNH GALLEY	3-COMP SINK	M		HM3 SAILOR
05/14/2018	ICE	1752	CO LOUNGE	KITCHEN SINK	Q		HM3 SHIPMATE
05/14/2018	WATER	1455	WAREHOUSE	HAND SINK MEN'S RESTROOM	M		HM3 SHIPMATE
05/25/2018	WATER	1499	CPO CLUB	KITCHEN HANDSINK	M		HM3 SAILOR

d. Sample Collection

(1) Select water taps supplying cold water from a service main. Don't take sample from a drinking fountain, a drink machine (filters attached) with a water feed line or from a water tap with aftermarket attachments on them. Examples are aerator screens, hoses, filters or backflow prevention devices as dirt and bacteria can accumulate on the tap. **If you suspect a possible contamination, re-take the sample.** When collecting water samples:

- (a) Wear Gloves
- (b) Remove any attachments from the faucet
- (c) Allow water to flow for 5 to 6 minutes before sampling
- (d) Do not rinse or overfill Whirl-Pak® sample bags
- (e) Always collect cold water; never sample hot water
- (f) Do not touch the inside of the Whirl-Pak® sample bag

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(2) If possible, avoid the following sites for total coliform sampling:

- (a) Outdoor faucets
- (b) Faucets connected to cisterns, softeners, pumps, pressure tanks or hot water heaters
- (c) New plumbing and fixtures or those recently repaired
- (d) Threaded taps
- (e) Swing spouts
- (f) Faucets positioned close to sink or ground
- (g) Leaky faucets

e. Inorganic Testing

(1) Measure pH. [Depending on the type of meter being used] Fill 10 mL flask and place analyzer into flask. Press center “read” button and wait until numbers stop changing. Record pH and temperature readings. pH readings should be between 6.5 and 8.5. Results will be included in the monthly water quality report.

(2) Measure chlorine. Keep sample container closed until collection begins. Follow manufacturer suggested procedure. Avoid contact with inside of vials. Rinse sample vials a few times and fill to the white line. Place onto the digital reader. Replace cap before pressing “read” button. Record chlorine reading. Chlorine readings should be between 0.2 and 4.0 mg/L. Results will be included in the monthly water quality report.

Note: Refer to Hach® Pocket Colorimeter™ Instruction Manual for specific details on measuring free available chlorine (FAC).

f. Organic Testing

(1) Total and Fecal Coliform. Samples must be collected in a pre-sterilized 120-mL glass or plastic bottle or a pre-sterilized Whirl-Pak® bag. If the water being sampled is chlorinated, 0.008 percent sodium thiosulfate should be added to the container. Typically, the Whirl-Pak® bags are used to collect ice samples for coliform testing, while the pre-sterilized 120 mL glass or plastic bottles are used to collect water samples. Whirl-Pak® bags do not contain sodium thiosulfate, and it is not necessary to add it to the bags prior to collecting samples. Sodium thiosulfate will be added to the 120 mL Idexx test vessel prior to transferring the contents of the Whirl-Pak® bags as described in subparagraph (2)(b) of this appendix.

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(2) Using waterproof ink, fill out the container label with sample identification, sample location, sampler's initials, and date and time of collection.

(3) Wear gloves when collecting samples. Do not rinse the sample containers. The bottles are sterile so care must be taken not to contaminate the bottle or cap. Once the distribution line is flushed and the flow reduced, quickly open the bottle (but do not set the cap down), hold the cap by its outside edges only, and fill the sample bottle to just above the 100 mL line leaving a one inch headspace. Cap the bottle immediately and place it into a cooler with ice for delivery to the laboratory.

(4) If using a Whirl-Pak[®] bag, fill it to the marked fill line, pull the wire tabs and whirl the bag three times for a tight seal. Place the sealed sample bags into a cooler with ice for delivery to the laboratory.

(a) Be aware of any odor or physical characteristics (e.g., particulate, color) of the water and record notes.

(b) Once all samples have been collected, turn off the water and replace any removed parts (i.e., screen, aerator, strainer or hose).

(5) Test for Total Coliform

(a) Once back in the laboratory, log in all samples making sure you provide details of the exact sample location and time. If Colilert[®] reagent powder has been refrigerated, allow snap packs to come to room temperature but not exposed to ambient light.

(b) Pour water samples/melted ice in Whirl-Pak[®] bags directly into sterile 120 mL Idexx test vessel containing dechlorinating agent (sodium thiosulfate). Do not rinse bottle. Fill up to the 100 mL. Record sample identification information like name of sampler, date and time of sampling on the vessel. Tap the Colilert[®] snap pack to ensure all of the powder is at the bottom of the pack. Do not touch the opening as you will contaminate the Colilert[®]. If this happens, throw away the pack and start over.

Note: Be aware that Colilert[®] is expensive so take care during sampling process to not contaminate sample.

(c) Add the Colilert[®] Reagent to the water sample making sure not to touch the top of container opening. Aseptically replace the cap on the test vessel. Gently shake the container until the reagent powder is dissolved. If a transient blue color appears, the sample has an excessive amount of chlorine. Discard and retest from the same site.

(d) Place sample in the incubator for 24 hours at 35 degrees Celsius (95 degrees F) plus or minus 0.5 degrees C for 24 hrs.

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(e) At 24 hours, compare the water sample color to the Idexx Colilert® Color Comparator. If no yellow is observed, the test is negative for total coliform. Check the vessel for fluorescence by placing a long-wavelength ultraviolet light within 5 inches of the sample in a dark environment. A fluorescent sample indicates *shigella*-type organisms.

(f) If the color is yellow, equal to or greater than the comparator, the sample is positive for the presence of coliforms. If the color is not uniform, mix by inversion and re-check.

(g) If the sample is accidentally incubated over 28 hours, the following rules apply: a “no yellow color” is a valid negative test. If a yellow color appears, the sample must be discarded and retested.

(6) Test E. coli Fluorescence

(a) If yellow is observed while recording total coliform results, check the sample for fluorescence by placing the long-wavelength UV light next to the incubator 3-5 inches in front of the sampling vessel.

Caution: Ensure UV light faces away from recorder’s eyes. Although short wave (254-nm) UV light is known to be more dangerous than long wave (365-nm), both types of UV light can damage eyes and skin and are potentially are carcinogenic. Protect eyes by wearing safety glasses or goggles with solid sidepieces when using UV lights. Shut off the device when not in use.

(b) If fluorescence is greater than or equal to fluorescence of the comparator, the sample is positive for E. coli.

(7) Collection and testing of ice

(a) Ice intended for consumption is capable of transmitting pathogenic bacteria and must be manufactured and handled in a strictly sanitary manner.

(b) Collection

1. Large Ice Bins. Using facility ice scooper, collect ice from three different locations inside the storage bin. Place ice into Whirl-Pak® sample collection bag without touching inside of the bag.

2. Small Ice Bins. Using facility ice scooper, collect ice from one or two different locations inside the storage bin. PMT or EHO may determine which is more appropriate. Place ice into Whirl-Pak® sample collection bag without touching inside of the bag.

3. Soda Machines. Place open Whirl-Pak® sample collection bag under ice dispenser chute and allow ice to fall into bag. Do not let ice touch the outside of the bag.

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(c) Sample management

1. Place Whirl-Pak[®] sample collection bags into the laboratory sink in the sample tray (to avoid contamination of sink or bags).

2. Allow time for ice to melt. Although melted ice does not need to be at room temperature, it should be fully melted before testing.

3. Transfer the melted ice to a sampling vessel until the 100 mL mark is reached. Once melted, ice testing procedure is the same as drinking water.

4. Laboratory Equipment and Instrumentation Analysis Guidance

a. There is no requirement for the Preventive Medicine Water Laboratory to be certified by the EPA since PMD does not provide compliance sampling for [Navy Region]. Since the Preventive Medicine laboratory is not EPA accredited/certified, all testing is categorized as “other water types for non-compliance purposes” (Standard Methods 9060 B. 1d, Holding Time and Temperature).

Note: No samples from Preventive Medicine can be used for compliance data for any reason or any amount of time on behalf of [Navy Region] compliance requests.

b. The Preventive Medicine Water Laboratory uses EPA-approved chlorine residual method 4500-Cl G (DPD Colorimetric Method 8021, Low Range) and microbiological standard method 9223B (Enzyme Substrate Coliform Test [Presence/Absence]). All parts and equipment replacements must meet EPA accreditation specifications. Non-EPA accredited equipment, while cheaper, are NOT appropriate for drinking water surveillance.

c. Calibration and Maintenance. Maintain and calibrate laboratory equipment and instruments per manufacturer directions.

(1) pH meter. Use a meter capable of measuring pH range from 0 to 14.00, with high resolution and accuracy of 0.01 pH and temperature range from -5° to 90° C (23° to 193° F).

(2) Chlorine Meter. EPA recommends Hach[®] Pocket Colorimeter[™] #5870000.

(3) Incubator. Check and record temperature twice daily (morning and afternoon) on the shelves in use. Place incubator in an area where room temperature is maintained between 16 and 27 degrees C (60 to 80 degrees F).

Note: If incubator fails to maintain proper temperature, contact EHO immediately for action. The incubator must not be used if it cannot maintain proper temperature for samples.

(4) Long-Wavelength Ultraviolet Light. Disconnect light monthly and clean bulbs with a soft cloth moistened with ethanol. Protect eyes by wearing safety glasses or goggles with solid side pieces. Shut off the device when not in use.

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SECTION 5. NOTIFICATIONS

1. Preventive Medicine Surveillance Sampling Exceedance

a. Rule out the possibility of technical error or cross contamination.

b. Resample potable water sites within 24 hours.

(1) Performance of confirmation tests for positive total coliforms is mandatory.

(2) Ensure re-sampling one site above and below the water sample point.

c. If repeat sample is unsatisfactory, contact PWD to flush the line. Resample when this is completed. The EHO should notify base leaders if waterborne contamination or illness is suspected. However, positive results reported to PWD should be vetted and resampled via PWD sampling team prior to any additional action or notification since compliance sampling is required before notification and base action takes place.

d. Unsatisfactory Ice Results. Contact the supervisor of the food facility making sure you record your point of contact's full name and title, date, and time. Your recommendation to the person in charge will be to empty, clean and sanitize ice making/dispensing unit per manufacturer's recommendations. Resample when sanitizing is complete. Facilities are encouraged to clean the ice machine within two working days. Facility must call PMD when this is completed. The facility's inspector must diligently follow-up to ensure this is done and the ice machine is retested as soon as possible. The ice machine cannot be put back into service until retested and found to be negative for bacteria.

2. Installation PWD Compliance Sampling Exceedance

a. Per references (g) through (j), the installation Preventive Medicine Authority provides public health advice and consultation on health effects of exceedances from drinking water compliance testing.

b. All drinking water violations must be reported immediately to preventive medicine authority. This requires the Preventive Medicine Authority to work regularly and closely with the installation PWD to ensure open communication between PWD and PMD teams before any exceedance is reported. Since PWD provides compliance sampling, all positive samples reported from PWD must be acted upon promptly.

3. Public Notification

a. All exceedances that require a public notification should be reviewed by the Preventive Medicine Authority for the following 10 EPA requirements:

(1) Description of the violation

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- (2) When the violation occurred
- (3) Potential adverse health effects
- (4) Population at risk
- (5) Whether alternative water supplies should be used
- (6) Actions consumers should take, including when to seek medical help. Must include medical POC information (typically a designated clinic or provider for certain circumstances)
- (7) What is being done to correct the violation
- (8) When it is expected to return to compliance
- (9) Where to find additional information
- (10) Standard language throughout document

b. **Notification Timeline.** Exceedances within the drinking water distribution are categorized into 3 tiers that determine notification timeline requirements. Tier 1 exceedances must be reported within 24 hours. Tier 2 exceedances must be reported within 30 days, and Tier 3 exceedances must be reported within 1 year (usually in conjunction with the Consumer Confidence Report). Verify PWD categorized the tiered notice correctly. Details can be found in reference (s).

c. **Risk Communication.** Ensure medical information is clear, jargon free, and appropriate for the context of the health effects expected for an exceedance. If an exceedance is low enough that it does not reach the “health threshold” for a chemical, ensure the notification is clear. NAVMCPUBHLTHCEN offers a risk communication course that provides guidance for PMTs and EHOs. This course is a preventive medicine authority requirement per reference (p).

d. **Acute vs Chronic Contaminants.** Drinking water contaminants can enter the body through ingestion, dermal absorption, or inhalation. Consult the Centers for Disease Control and Prevention’s (CDC) Toxicology index to determine possible exposure categories. The installation Preventive Medicine Authority should recommend alternate water source when acute health hazards exist or if water is determined to be not fit for human consumption. Installation preventive medicine authority MUST contact NAVMCPUBHLTHCEN before making recommendations.

4. Public Health Risk Assessments

a. Public health risk assessment is a scientifically defensible process conducted by a multidisciplinary team of SMEs at NAVMCPUBHLTHCEN. It uses a weight of evidence approach and typically includes hazard identification and characterization, toxicity assessment, exposure assessment and risk characterization. Human consumption or not fit for human consumption must include consultation with the Preventive Medicine Authority. When this

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consultation warrants a public health risk assessment, the Preventive Medicine Authority must consult with NAVMCPUBHLTHCEN and inform the regional Preventive Medicine Authority prior to advising the installation CO. Situations where the Preventive Medicine Authority would consult with NAVMCPUBHLTHCEN may include but are not limited to, contamination of the overseas drinking water system by unregulated substances (i.e., no MCL established), or where the installation CO has determined the drinking water is not fit for human consumption and requests an evaluation for other consumptive uses (i.e., cooking, oral hygiene, dishwashing, bathing, showering, and hand-washing).

c. A Public Health Risk Assessment may not be required in every instance of an installation public notification of a drinking water violation. Refer to public notification procedures in reference (1).

Note: Public Health Risk Assessments should be infrequent and are interim assessments not intended to delay or defer maintenance or repair to overseas drinking water systems for purposes of compliance with applicable regulations and delivering water that is fit for human consumption.

SECTION 6. DRINKING WATER OUTAGES

1. Emergency Management Plan. [Navy region or base] water systems are potentially vulnerable to damage caused by [earthquake hurricanes, typhoons, flooding, hazardous materials leaks, spills, etc.]. The following is a summary of the [Navy region or base] emergency contingency plan (ECP), located [location specific information] at [Navy region or base] Environmental Portal.

a. Responsibilities

(1) PWD has the in-house capability to repair damages to the water system and has an inventory of water system components.

(2) NAVFAC PWD provides integral support to the overall [Navy region or base] emergency management program.

(3) Preventive Medicine Authority provides health information if water should be secured due to unsafe contamination or distribution issues. Preventive Medicine Authority may consult with NAVMCPUBHLTHCEN on recommended guidance for [Navy region or base]. Preventive Medicine Authority medical guidance may include:

(a) Boil water notice

(b) Do not consume hygiene use is safe

(c) Secure completely; do not use; not fit for human consumption

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- b. Alternate Sources. [List approved alternate drinking water sources]

Note: A close working relationship between the PWO and Preventive Medicine Authority is critical to ensure rapid notification in emergencies.

- 2. Water Line Breaks. [Describe local plans and procedures for water line breaks]
- 3. Not Fit For Human Consumption. Only the installation CO may declare [Navy region or base] drinking water system not fit for human consumption. The installation CO should convene SMEs from the installation WQB, including Preventive Medicine Authority to review the circumstances and discuss courses of action. If a system outage or break occurs that requires declaration of water not fit for human consumption, the installation CO and PWO will request the installation WQB to either meet formally, or discuss via e-mail. Preventive Medicine Authority roles include evaluation of current water in the distribution system (or site of concern) to determine what, if any, health concerns are present. The Preventive Medicine Authority will consult with NAVMCPUBHLTHCEN on recommended guidance for [Navy region or base]. Preventive Medicine Authority medical guidance may include:
 - a. Boil Water Notice
 - b. Do not consume hygiene use is safe
 - c. Secure completely; do not use; not fit for human consumption

SECTION 7. ELECTRONIC SURVEILLANCE

- 1. Defense Occupational & Environmental Health Readiness System (DOEHRS-IH-EH)
 - a. Purpose. The purpose of the DOEHRS IH-EH module integration into the drinking water program is to provide a system where water samples can be recorded into the electronic database and be used for electronic surveillance and data tracking for local commands, regions, and NAVMCPUBHLTHCEN. It allows long-term documentation for trends and issues that would typically be lost as annual hard copy records are destroyed.
 - b. Action. The following is step by step guidance on access to DOEHRS IH-EH and inputting a water sample.
 - (1) Log into DOEHRS (check URL: and program office are correct).
 - (2) Under Environmental Health menu, select “Location”
 - (3) The Locations – Search page is visible
 - (4) Using the “Browse by Location Tree” link select the appropriate location
 - (5) Using Environmental Health menu – expand location using the + icon

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- (6) Expand samples folder using the + icon
- (7) Expand water folder using the + icon, Select “Treated Water Kit”
- (8) Add a sample by using the + icon or “Other Actions” drop down
- (9) Complete administrative data, complete grey box area of field data
- (10) Click “SAVE”

Note: Remember to click save upon completion to record the sample into DOEHRs IH-EH.

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**SAMPLE
APPENDIX A
POINT OF CONTACT LIST**

<u>Location/Name</u>	<u>Contact Number</u>
[Rank, Name] [Navy region or base] Overseas Drinking Water Preventive Medicine Authority Title E-mail address	DSN Cell phone number
[Rank, Name] Director for Public Health USNH [location] E-mail address	DSN Cell phone number
[Rank, Title, Name] [Navy region or base] Environmental Director E-mail address	DSN
[Name] [Navy region or base] PDW Drinking Water Program Manager E-mail address	DSN
[Name] NAVFAC [region and location] Public Works E-mail address	DSN
[Name] NAVFAC [region] Regional Drinking Water Compliance Program Manager E-mail address	DSN
[Rank, Name] Commanding Officer, NAVFAC [Region] Regional Engineer E-mail address	DSN
[Rank, Name] Navy Marine Corps Public Health Center Environmental Health Programs E-mail address	DSN

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Location/Name Contact Number

[Name]
Navy Medicine [Region]
Regional Preventive Medicine Authority Office
E-mail address

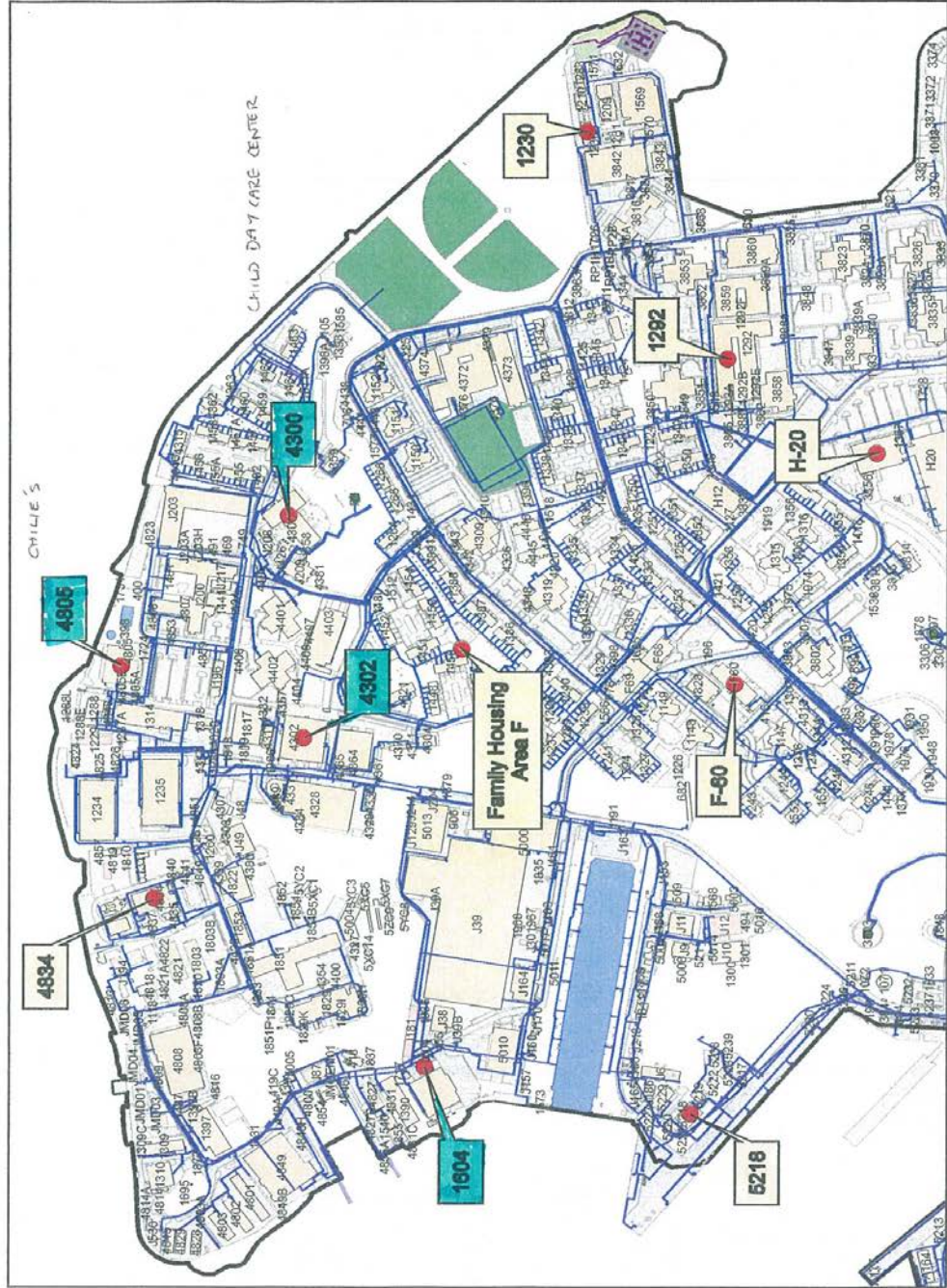
[Rank, Name] Office
BUMED Environmental Health Officer
E-mail address

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SAMPLE APPENDIX B
SAMPLING MAPS

CFAY Bacteriological Monitoring Plan

Figure B-1: Routine Bacteriological Sampling Locations, Yokosuka Main Base (North)



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