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Chapter 5

Water Supply Ashore

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CHAPTER 5
WATER SUPPLY ASHORE

Section L GENERAL INFORMATION

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5-1. Purpose.

This chapter gives public health and preventive medicine information and guidance to Department of the Navy personnel concerned with the production and surveillance of potable water at fixed shore facilities and advanced bases. Department of the Navy personnel include military and civilian members of the Navy and Marine corps.

5-2. Background.

1. The Safe Drinking Water Act (SDWA) (Public Law 93-523) was signed into law on 16 December 1974. The SDWA and later amendments direct the U.S. Environmental Protection Agency (EPA) to develop National Primary Drinking Water Regulations (NPDWR) for all public water systems from a health standpoint. As a result of this legislation, primary enforcement authority (Primacy) is to be adopted by the individual states.

2. Under the SDWA, EPA has developed National Secondary Drinking Water Regulations (NSDWR) for all public systems. Contaminants covered by NSDWR may adversely affect the aesthetic quality of drinking water. The NSDWR are not federally enforceable, as are NPDWR; rather they are intended as guidelines for the states, but may be incorporated into state law and enforced by the respective state.

3. The NPDWR are published in Title 40, Code of Federal Regulations part 141(40 CFR 141); NSDWR are published as 40 CFR 143.

4. OPNAV Instruction 5090.1, Environmental and Natural Resources Protection Manual, published procedures and requirements of SDWA and 40 CFR 141 and 143 within the Department of the Navy.

5. MEDCOM Instruction 6240.1 Series, Standards for Potable Water, set drinking water standards in the naval establishment ashore and afloat as well as outside the Continental United States. The use of forms DD 686, Fluoride Bacteriological Examination of Water, and DD 710, Physical and Chemical Analysis of Water, was also directed.

5-3. Policy.

1. In states where primacy has been granted by EPA, Navy and Marine Corps installations, classified as suppliers of water must follow substantive and procedural requirements of NPDWR to conform with the SDWA as may be published by state regulatory authorities.

2. In states and territories not having primacy, Navy and Marine Corps installations classified as suppliers of water (owner or operator of a public water system) must follow the substantive and procedure requirements of NPDWR to conform with the SDWA as administrated by the applicable EPA regional office.

3. Navy and Marine Corps installations classified as suppliers of water located outside the continental limits of the United States (CONUS) shall comply with the substantive and procedural requirements of NPDWR to conform with the SDWA, or the host country whichever is more stringent. If compliance is inconsistent with international agreements, status of forces agreements, host country laws, or cannot be achieved for any reason, requests for deviation from CONUS drinking water standards must be submitted in writing to Chief, Bureau of Medicine and Surgery (B UMED), Washington, DC 20372-5120. This request must be forwarded via the cognizant Navy Environmental

and Preventive Medicine Unit (NAVENPVNT-MEDU and the Navy Environmental Health Center (NAVENVIRHLTHCEN).

4. The establishment of drinking water system standards and monitoring requirements aboard Navy ships, both USS and USNS is a responsibility of BUMED, and are published in Chapter 6, Water Supply Afloat, of this manual.

5. Field water supply standards and monitoring requirements are a responsibility of BUMED, and are published in Chapter 9 of this manual, titled "Preventive Medicine for Ground Forces."

6. When considered necessary, BUMED may publish additional standards of water quality and monitoring requirements for Navy drinking water systems, ashore and afloat.

5-4. Responsibilities.

1. NAVFACENGCOM Engineering Field Divisions (EFDs) are responsible for:

a. Giving technical and regulatory advice to major claimants and activities concerning actions necessary for compliance with SDWA, 40 CFR 141 and those states which have primacy.

b. Conducting periodic surveys of activity water systems and reporting technical and administrative deficiencies to activities via Utility Systems Assessments (USA).

c. Determining activity needs and helping activities with respect to training and certification of water treatment plant personnel.

d. Helping activities in the development of contracts and selection of laboratory services for potable water analyses.

e. At the request of activities, negotiating with state regulatory officials to ensure equitable and realistic terms for compliance between activities, state agencies, and EPA.

f. Serving as the focal point for liaison between activities, state agencies, and EPA.

g. Checking overall regulatory compliance for activities within respective geographic regions.

h. Timely review and action with respect to public notification during incidence of activity non-compliance as required by EPA and those states having primacy.

2. The Navy Energy and Environmental Support Activity (NEESA) is responsible for:

a. Updating, as needed, the standard operating procedure for potable water monitoring.

b. Keeping EFDs and activities informed of related legislative and regulatory changes via directives from NEESA, Point Hueneme, California.

c. Giving Navy-wide defense environmental status reports to NAVFAC, CNO, major claimants and DOD as needed.

d. Helping EFDs concerning the development of water conservation projects and water contingency planning criteria. See Appendix H, H-3.1.

3. Per OPNAV Instruction 5090.1, major claimants and activity Commanding Officers with public water system are responsible for:

a. Operating, and maintaining facilities to manufacture drinking water which meets applicable standards.

b. Sampling, conducting analysis, reporting to EPA or states, and keeping records per 40 CFR 141. Copies of all records or reports sent to EPA or states must be forwarded to the proper EFD.

c. Giving notification per 40 CFR 141 to the state, or EPA and to all persons served by a community water system, if there is any failure to follow applicable substantive and procedural regulations.

d. Ensuring that water treatment plant personnel are trained and certified as required by EPA or state regulations.

4. Public Works officers (USN) and Maintenance Officers (USMC) are responsible for:

a. Developing, in coordination with the, installation medical authority, (preventive medicine department), adequate water supply treatment techniques to ensure water supply that is free of disease-producing organisms, hazardous concentrations of toxic materials, and objectionable color, odor, and taste. As a minimum, ensure the water supply meets all applicable NPDWR and the state water quality standards.

b. Pursuing, in coordination with the installation medical authority (preventive medicine department), an aggressive program to identify, isolate, and correct potential sources of contamination to the distribution system.

c. Coordinating with federal, state, and local agencies to set up a meaningful exchange of information regarding local water resources, NPDWR and NSDWR.

d. Ensuring local water treatment personnel are trained to meet levels of proficiency consistent with the operator certification requirements applicable to their location.

e. Encouraging operating personnel to attend seminars, short courses, and other formal instruction to remain abreast of new developments in water treatment practices. -

f. Maintaining quality control data to ensure NPDWR or state requirements are followed.

g. Developing a program to correct system deficiencies, and upgrading equipment as needed.

h. Collecting and shipping water samples following NPDWR, and NSDWR.

i. Notifying the installation medical authority (preventive medicine department) upon discovery that a water main break or similar occurrence has taken place.

j. Ensuring that all new mains and extensions are flushed and disinfected before placing them into service.

5. Installation medical authority (preventive medicine department). The installation medical authority, aided by the environmental health officer and/or preventive medicine technicians, has an advisory role and recommends corrective measures when any phase of water sanitation is unsatisfactory. Normally, adequate water quality can be maintained through cooperation and communication with the public works or maintenance officer. To carry out this advisory role, a water surveillance program tailored to each individual water system is required. Appendix A is a model potable water monitoring program. The water surveillance program should include but is not limited to the following:

a. Maintaining liaison with federal, state, and local regulatory authorities regarding current drinking water regulations to ensure compliance.

b. Conducting periodic sanitary surveys to locate and identify possible health hazards in the potable water system.

c. Conducting tests for halogen residuals, bacteriological quality and other tests as needed to supplement sanitary surveys.

d. Maintaining, or having access to, a copy of the plumbing diagram of the potable water, fire fighting (if separate), and sanitary waste systems.

e. Maintaining records that reflect the chemical, radiological, and microbiological quality of the installation potable water supply system.

f. Monitoring and giving recommendations, when needed, regarding the disinfection of all new additions or repairs to water mains, wells, pumps, storage tanks, and other units of the water supply system.

g. Ensuring that all types of chemical additives to potable water supplies are approved by the supplier of water, the state, and the National Sanitation Foundation (NSF) and are used in proper concentrations.

Section II. IMPORTANCE OF POTABLE WATER

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5-5. General.

There are few environmental factors that affect the individual's well-being more than the availability of an adequate potable water supply. As water is a necessity to sustain life, a closely controlled and adequate potable water supply is mandatory.

5-6. Microbiological Considerations.

1. One of the greatest deficiencies of customary methods for evaluating the bacteriological quality of water is that results from tests are unknown until after the sampled water has entered the distribution system. Successful regulation of the microbiological quality of drinking water depends on the use of raw water supplies of relatively unchanging high quality. Localized contamination characteristics of leaking or broken water lines, back siphonage and cross connections are unlikely to be detected early enough to prevent exposure. Also, the low residual disinfectant maintained in the distribution system will almost certainly be overcome by such contamination. Despite the shortfalls of current microbiological monitoring techniques, it is essential that these methods continue to be used. The goals of microbiological monitoring are:

a. Provide an indicator of the effectiveness of disinfection.

b. Detect sanitary defects in the water distribution system.

2. In overseas areas, water continues to be a major consideration in the spread of disease. Special attention to water handling and treatment in these areas is needed to minimize the spread of such disease.

5-7. Physical-Chemical Considerations.

While the effects of microbiological contamination of potable water may manifest themselves in a period of days, a long-term relationship may appear when examining the effects of physical-chemical contaminants. Physical-chemical contaminants may be present in the water supply as a result of a variety of factors. Naturally occurring inorganic and organic contaminants are plentiful in the environment and are readily assimilated by water which acts as a solvent for many of them. Trace metals, other inorganic, and organics may also be assimilated by water as a result of the waste disposal and industrial actions of man. Recent trends lead one to believe that increasing concern will be generated by both the regulating agencies and the using public over the presence of both naturally occurring and man-made organics in drinking water.

5-8. Radiological Considerations

1. As with physical-chemical contaminants, minute traces of radioactivity are normally found in all drinking water. These levels vary considerably throughout the United States and the. world. The concentration and composition of these radioactive constituents depend principally on the radiochemical composition of the soil and rock strata through which the raw water has passed.

2. The long-term effects of radiological contaminants in drinking water continues to be examined. Radioactivity in water systems may be broadly categorized as either naturally occurring or man-made. Radium-226 is the most important of the naturally occurring radionuclides likely to occur in public water systems. Although radium may occasionally be found in surface water due to man's activities, it is usually found in ground water as the result of geological conditions. In contrast to radium, man-made radioactivity is widespread in surface water because of fallout from nuclear weapons testing. In some localities this radioactivity is increased by small releases from nuclear facilities (e.g., nuclear power plants, hospitals, and scientific and

industrial uses of radioactive materials). The residual radioactivity in surface waters from fallout due to atmospheric nuclear weapons testing is mainly strontium-90 and tritium.

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5-9. General.

1. Depending on local conditions, water supplies for installations may be obtained from any of a number of sources. Commonly used water sources include underground sources, such as springs or wells, and surface sources, such as rivers, streams or lakes. Most Navy or Marine Corps installations obtain their water supply from adjacent municipal facilities. Information concerning the development and maintenance of water sources can be found in Civil Engineering Water Supply Systems, Design Manual 5.7 (NAVFAC DM-5.7).

2. A properly conducted sanitary survey will furnish sufficient data to base the acceptance or rejection of the water as a present or potential source. This survey will be aided by chemical and bacteriological analyses, and a knowledge of the significance of the factors involved. Personnel, trained and competent in environmental engineering and the epidemiology of waterborne diseases, will conduct the sanitary survey. A sanitary survey of an existing supply will be conducted when considered essential for the maintenance of good sanitary quality. An annual sanitary survey is recommended. A sanitary survey of a new source may be made in conjunction with the collection of initial engineering data covering the development of the source.

3. Many installations have isolated water sources, such as wells and springs, for service of training areas. In many cases, these isolated water sources do not service residents and are not classified as public water systems. Water systems that meet these criteria will be classified as field sources. Sanitary control of field sources is addressed in Chapter 9 of this manual, “Preventive Medicine for Ground Forces.”

5-10. Selection of Water Source.

1. To ensure the selection of an adequate source, the average daily demand and the peak demand rate must be determined. The average daily demand may be estimated to meet continuing demands during periods when surface flows and ground water elevations are reduced. The peak demand rate, including fire protection usage, may be estimated to determine plumbing needs, pressure losses, and storage requirements in order to supply enough water to all parts of a distribution system during peak demand periods. Use of peak demand data will give the system enough contact time to ensure adequate disinfection under worst-case conditions.

2. Cost Estimate. Besides capacity, consideration till also be given to the proximity and quality of the source, the expected development costs, and life of the project. Annual operating expenses that include the cost of power and chemicals, as well as personnel salaries, will be considered over the expected life of the project to arrive at a sound final selection.

3. Public Water Systems. Where practical, approved public water systems will be considered for use. An evaluation of the municipality’s ability to produce enough potable water over an extended period of time will be carried out. The mission of the base or unit will be considered if the water supply depends on an outside source.

Also, the projected mobilization needs for water will be considered in evaluating a public water source. Public water systems may also be considered for their applicability as backup water systems. If two independent potable water supplies are to be interconnected, approval of the producers must be obtained. See NAVFAC DM-5.7 for more information.

5-11. Wells.

1. Ground water occurs in geologic formations called aquifers. Aquifers contain saturated permeable material which 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. Ground water, when available, is usually an excellent source of water supply. 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 more highly mineralized. At present, wells serve small to medium-size installations although a system of multiple wells may be used to develop a supply for large installation. Consult NAVFAC DM-5.7 on this subject. More information may be found in NAVFAC Guide Specification NFGS 02734, Rotary-Drilled Water Wells and AWWA A-100-66, American Water Works Association Standard for Deep Wells.

2. Types of Wells. Wells are classified according to the construction method, i.e., dug, bored, driven, drilled, and jetted. Each type of well has distinguishing physical characteristics which are best used to satisfiy a particular need. NAVFAC DM-5.7 gives descriptions of particular well types and design considerations.

3. Sanitary Protection. Proper sanitary measures must be taken to ensure the purity of the water whenever ground water is pumped from a well for human consumption. Potential sources of contamination may exist either above or below ground level. Where possible, wells will be located on ground that is higher than a potential source of contamination. The area will be well drained to divert surface waters from the well and reduce the possibility of flooding. Listed below are guidelines for the sanitary protection of wells:

a. The annular space outside the casing will be filled with water-tight cement grout per EPA *Manual of Individual Water Supply Systems.*

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 water of poor quality is penetrated, the formation must be sealed off to prevent the infiltration of water into the well and developed aquifer.

d. Every well will be provided with an overlapping watertight cover at the top of the casing, or a raised pipe sleeve to prevent contaminated water or other harmful materials from entering the well.

e. All abandoned wells must be plugged and properly sealed, as required by Federal, State, or local authority, to prevent contamination of the ground water formation and for safety reasons. The basic concept behind the proper sealing of any abandoned well is that of restoration, of the controlling geological conditions that existed before the well was drilled or constructed. If this restoration can be done, an abandoned well will not create a physical or health hazard. AWWA Standard A100-66 provides further guidance on this subject, Table 5-1 is the suggested minimum distance a well will be located from sources of contamination. In many areas, various soils and rock formations may require increased distance. State and local health departments may have requirements for various distances. A sanitary survey, conducted by qualified individuals, must be a matter of policy in the construction or drilling of any new well with nearby potential contamination sources. States and local health departments will be contacted in each area.

f. Disinfection.

(1) Drilled, jetted, bored, and driven wells must be disinfected after construction, cleaning, or the removal of equipment for repair. When the well equipment is ready for operation, the well will be flushed by pumping to waste until the water is clear. Calculate the quantity of water in the well based on the depth of water and the diameter of the casing. Introduce enough chorine solution to obtain 100 parts per million (ppm) through a clean hose that is raised and lowered to

TABLE 5-1.

Minimum distance between wells, springs, etc. and various potential sources of contamination

Potential Contamination Source	Well, spring,etc. (distance in feet)
Sewer Line	50
Septic Tank (Watertight)	50
Pit Privy	100
Disposal Field	150
Seepage pit	150
Cesspool	150

all depths of the well water. A spray nozzle will be used to disinfect the inside of the casing and the outside of the riser. Operate the pump until a distinct odor of chlorine can be detected. Check the free available chlorine (FAC). When 100 ppm FAC is obtained, allow the well to stand for 24 hours and then pump to waste until the chlorine drops to approximately 1 ppm FAC. Obtain water samples for bacteriological analysis and determine potability before putting the well in service.

(2) Dug Wells. After the casing/lining is completed and prior to placing the cover over the well, disinfection is accomplished by the following steps: Remove every-thing, (e.g., tools, equipment, and structures) that will not be part of the well. Determine the quantity of water in the well and the amount of disinfecting solution needed. Scrub the casing or lining wall with a stiff broom or brush and a 100 ppm chlorine solution. 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. Wash the outside of the pump . cylinder and piping as the unit is lowered into the well. After the pump is in place, pump the water until a distinct odor of chlorine is detected. Check the chlorine residual; when 100 ppm FAC is measured allow the well to stand for 24 hours. Pump the well until the chlorine residual is reduced to 1 ppm. Take samples for bacteriological analysis. When negative results are obtained, place the well in service.

5-12. **Springs.**

1. 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. Contrary to popular belief, spring water is not always of good microbiological quality. Extreme caution must be exercised in the development of springs. Generally, the same principles that apply to location, protection, development, and operation of wells apply to springs. The factors presented above for well location must also be considered when conducting a sanitary survey of a spring.

2. Protection. When used as a water source, spring water is usually captured in a small catchment reservoir to enclose and intercept as much of the spring as possible.

3. Spring Disinfection. Spring encasements will 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 the water 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 1.0 ppm. Take samples and place in service as described for wells. When the spring flow cannot be stopped, enough chlorine must be continuously fed into the contained water in the spring encasement, near the inlet, to result in 100 ppm FAC in the outlet. This residual will be maintained for at least 24 hours.

5-13 **Surface Water Source.**

1. Surface water supplies are obtained from rivers, streams, lakes, and ponds. Because of the ease of physical and microbiological contamination of surface water, additional factors not usually associated with ground water sources, must be considered when selecting surface water sources. As a general rule, surface water should be used only when ground water sources are not economically justifiable or are of an inadequate quality or quantity.

2. Source Selection. In examining surface waters for potential use as drinking water sources, care must be exercised. A number of interrelated factors need to be considered. These include, but are not limited to, sources of pollution, hydrological studies, proposed intake location, and water uses identified for the particular water source by responsible governmental agencies. Raw water

quality should be examined and a treatment scheme proposed to make sure applicable regulations are followed and to give the best possible water supply for Navy and Marine Corps use before a final determination regarding the acceptability of the source is made.

3. 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 bathing. A surface water source will not be used for recreational purposes if the water treatment plant does not include filtration and if sedimentation, resulting from storage in reservoirs followed by chlorination, is the only treatment provided. Care will be exercised in determining what types of recreational activities (swimming, boating, etc.) are suitable and may be authorized for these waters. Periodic sanitary surveys, will be used to evaluate the impact of recreational uses on these water sources.

5-14. Rainwater.

1. Rain, including snow and ice can be used as a source for potable water. In most climates it only augments the supplies from other sources.

2. Because of its softness (freedom from minerals), rainwater may be used for cooking, bathing, laundry, and in boilers. Due to the absence of minerals, rainwater lacks palatability and may contain dissolved gases, dust particles, and bacteria swept from the air. In some cases, rainwater may be an important source of fresh water, (e.g., small islands and isolated areas), where ground water is salty and surface water is inadequate. Under some conditions. where usage rates are small and precipitation heavy, rain may furnish an adequate source. In many places, rain can be used to supplement other sources. Rainwater, like any water source, must be properly treated, disinfected, and handled.

3. Rainwater is collected from impervious surfaces, (e.g., roofs, concrete pavement and aprons, paved catchment areas, and barren rocks). The volume obtained depends on the size of the catchment and the amount of rainfall. An estimate of the volume (in gallons) that may be collected from an impervious surface can be made by multiplying the total catchment volume, in square feet, by one half the rainfall in inches.

4. Rainwater may be stored either above or below ground in tanks *or* containers. Potable water tank coatings must be accepted by NSF Standard No. 61 or state regulations for contact with potable water. Storing rainwater in underground cisterns reduces evaporation, keeps the water cooler and more palatable. Storage tanks must be protected from contamination by polluted surface and ground water. Storage tanks must be covered and the vents or other openings screened to protect the water from dust, dirt, mosquito breeding and the entrance of vermin.

5. The surfaces from which rain is collected are subject to contamination by birds, animals, dust and, if at ground level, by human wastes. The first rain which falls during a storm flushes these substances from the surface and must be diverted to waste. Rainwater must be considered contaminated until treated similar to other surface water sources, (e.g., filtration, coagulation, chlorination). The treated water must conform with SDWA as published by EPA in 40 CFR 141.

5-15. Snow and Ice.

1. While almost any place in the Arctic will be near water in one form or another during the year, the provision of an adequate and safe water supply for more than 50 persons is likely to be a major problem. If possible, get water from running streams or lakes instead of melting ice or snow. The melting of ice or snow uses large quantities of fuel. In winter, surface water points may freeze to a depth of 6 to 8 feet. The water source must be deep enough to prevent freezing to the bottom. Freezing of the intake can be prevented by constructing a wooden box with insulating materials to cover the opening in the ice. The raw water pump, when used, may be protected by an insulated cover or an insulated box may be constructed. In some situations, a skid-mounted, heated shelter may be constructed over the water intake to house raw water pumps and settling tanks. This water can be loaded into ski-mounted water tankers and transported to the camp where it is treated. If the water is filtered, heated buildings will be needed in winter. Standard water treatment equipment will need special heating and insulating when used in below freezing weather. Normally, water hoses may be laid directly on the snow as long as water in them is circulating.

When the pumps are stopped, water in the hoses must be drained immediately to prevent freezing. All water lines will be pitched to allow for rapid draining when the pump stops. Adequate provisions must be made to prevent freezing of stored water. Small tanks or open basins must be located in heated shelters. Outside or elevated tanks must be properly insulated.

2. In winter, if water is not available, it will be necessary to obtain water by melting snow or ice. To save fuel, use ice or the most compact snow available. Ice is preferred to snow because it will yield more water for a given volume. About 1 cubic foot of water can be obtained from melting 5 cubic feet of snow. Freshly frozen sea ice is salty, but year old sea ice has the salt leached out. Freshly frozen ice must be tested for salt content because, in some areas, where tidal action and currents are small, there is a layer of fresh water ice lying on top of the new sea ice. In some cases, this layer of salt free ice may be 2 to 4 feet in depth. Old sea ice is rounded where broken and is Likely to be pitted and have pools on it. The submerged portion of old sea ice has a bluish appearance. Fresh sea ice has a milky appearance and is angular w-here broken. Small quantities of water may be obtained by melting snow or ice over a heat source. Store the snow or ice to be melted just outside the shelter and bring it inside as needed. If necessary, keep pots of snow or ice on the stove, when not cooking, to increase the water supply. Several models of ice and snow melters are available in the supply system. They are batch units into which ice or snow is manually loaded. Most units are portable, can be operated indoors or outdoors, and can be fueled with gasoline or diesel fuel.

3. In arctic areas during the summer, surface sources are obtained and treated the same as surface supplies in other geographic regions. The milky water of a glacial stream is not harmful. Sedimentation will settle out most of the color. In summer, a muskeg area can sometimes be used as a water source. Muskeg is a resilient soil covered with bog and has a high water table. Muskeg water can be collected by building ditches.

5-16. Sea Water.

1. The sea serves as the major source of drinking water for the fleet. Ashore, the sea may be used as a water source by processing it with reverse osmosis water purification units (ROWPUS) or stills.

2. Sea water contains up to 37,000 parts per million of dissolved salts which must be removed by distillation or reverse osmosis. Since coastal water may carry considerable organic material and turbidity or be polluted with oil or other waste, it may be desirable to settle sea water before processing. The natural filtration and diluting effect of ground water may be used by processing water from shallow wells located along the shore. Since the production of potable water from brackish or fresh water is more efficient, these sources will be used as soon as the military situation permits. Hot, arid climates contain few, if any, fresh water sources large enough to support major military operations,

5-17. Bottled Water.

Bottled water may be used on Navy and Marine Corps installations in the United States or overseas as a source of drinking water. Bottled water is derived from surface or subsurface water sources, depending on the bottler, and has been shown to be of variable quality. It is commonly contended that bottled water may be of better quality than locally available public water supplies. This may not be the case. Bottled water will be only as good as the source from which obtained and the quality of treatment received. Bottled water used at Navy and Marine Corps installations must meet all the requirements of the NPDWR for physical, chemical, bacteriological, and radiological parameters.

Section IV. WATER DISTRIBUTION SYSTEMS

	Article
General	5-18
Cross-Connections	5-19
Water Main Flushing and Disinfection	5-20
Pressure	5-21
Use of Non-potable Water	5-22

5-18. General.

The use of substandard facilities for water distribution will adversely affect the quality of the water being supplied even though the water leaving a treatment facility is of satisfactory chemical and microbiological quality. The safety and palatability of the water must not be impaired by defects in the system. The distribution system must not leak, and, when possible, its various mains and branches will not be submerged in surface water or ground water. Dead-end mains must be reduced to ensure effective circulation of the water. Water mains must be laid above the elevation of sanitary sewers and at least 10 feet horizontally from such sanitary sewers when they are parallel. Where a sanitary sewer crosses over a water supply, the sanitary sewer must be in pressure pipe or encased in concrete for 10 feet on both sides.

5-19. Cross-Connections.

1. Sanitary Standards. Interconnections between a potable water distribution system and a non-potable system must not be permitted. Each potable water distribution system must be periodically inspected to detect and remove all potential or existing cross-connections and to ensure that proper engineering measures, (e.g., air gaps and back-flow prevention devices) are in place and properly operating. Only through routine inspections can the control and elimination of hazards be achieved. EPA-570/9-89-007, Cross-connection Control Manual, gives excellent information on methods and devices for backflow prevention, testing procedures for backflow prevention, and administration of a cross-connection control program. NAVFACINST 11330.11 series contains a list of backflow prevention devices approved for use at Navy and Marine Corps shore installations, See Appendix B for definitions of terms used in this chapter.

5-20. Water Main Flushing and Disinfection.

1. Computation of Water Volume. Chlorine dosage needed to disinfect any unit depends on the contact time and the organic, chlorine-consuming material present. The volume of water in the unit to be disinfected must be computed before chlorine dosage can be estimated. Volumes of water contained in different sizes of pipe are listed in Table 5-2.

2. Water Main Flushing. Public works or maintenance personnel must make sure that all new or repaired mains and extensions are cleaned and flushed with potable water prior to disinfecting them and placing them into service. The purpose of this flushing is to clear all dirt, mud, and debris from the new or repaired mains. A velocity of at least 3 feet per second is needed for adequate flushing.

3. Disinfection of New, Repaired, or Accidently Polluted Water Mains.

a. When the number of gallons of water the component or system contains or will contain has been determined, the correct dosage of calcium hypochlorite (65-70 percent available chlorine) or sodium hypochlorite (5-10 percent available chlorine) may be found by referring to the “Chlorine Dosage Calculator” in Chapter 6, Water Supply Afloat, of this manual. This calculator gives the approximate dosage of chemicals needed for the desired disinfecting FAC residual. These residuals must be checked with the DPD calorimetric procedure.

b. When portable gas chlorinators are used to disinfect mains, tanks or other units, the operator's instruction manual must be consulted. The desired disinfecting residuals must be checked with the DPD calorimetric procedure.

c. Residuals and specified contact times listed in Table 5-3, are acceptable for disinfecting water mains, tanks and other appurtenances providing they are first cleaned, and flushed, as above, with potable water.

TABLE 5-2.
Volume of Water in Different Sizes of Pipe

Pipe Diameter (Inches)	Gallons Per Foot of Pipe.
2	0.16
2 ½	0.26
3	0.37
3 ½	0.50
4	0.66
6	1.50
8	2.62
10	4.10
12	5.90
14	8.04
16	10.50

(a) D^2 x .041 = gallons per foot of pipe or foot depth in a round tank. D = diameter of pipe or round tank in inches.

(b) One cubic foot of water = 7.48 U.S. gallons.

(c) One U.S. gallon = 8.34 pounds.

(d) One U.S. gallon. 3,785 ml.

TABLE 5-3.
Water Main Disinfecting Procedures

Initial FAC PPM	Contact Time Required	FAC PPM After Contact Time
50 PPM	24 hours	25 PPM
500 PPM	30 minutes	500 PPM
100 PPM	4 hours	50 PPM

d. Swabbing Repair Pipe Lengths and Fittings. Besides the flushing and disinfecting procedures described above, the interior of all repair pipe lengths and fittings w-ill be swabbed with 5 percent chlorine solution (50,000 PPM) before installing. After the repairs are completed, the repaired section must be flushed and disinfected as discussed above. The purpose of swabbing is to make sure that the residue in the joints and fittings is oxidized.

e. Post Disinfection Flushing and Microbiological Analysis. Regardless of the method used to disinfect new or repaired mains, the high concentration chlorine solutions must be flushed from the line after disinfection is complete. Samples must, then be collected downflow from the affected pipe length, or on both sides of the length if the direction of flow is variable or unknown. These samples must be checked for microbiological contamination to make sure that disinfection has been adequate. Once it has been shown that disinfection has been adequate (based upon appropriate microbiological test results), the new or repaired main can be returned to service.

5-21. **Pressure.**

1. Water distribution systems will be designed to provide an acceptable operating pressure in distribution mains, building service connections, and within buildings. Areas on high ground or with high pressure needs will have a separate high service system for maintaining pressures by pumping, backed by elevated storage, where possible.

2. No main in a distribution system will be less than 6 inches in diameter. Sizes 4 inches and smaller are to be used only upon approval of NAVFAC Headquarters. Within these constraints select the smallest pipe satisfying the following conditions:

a. Supports not less than 20 pounds per square inch residual pressure at all hydrants.

b. Supports residual pressure meeting the needs of automatic fire extinguishing systems while giving 50 percent of the average domestic and industrial flows, and the fire flow.

c. For pressure needs for graving docks see NAVFAC DM-29, Drydocking Facilities.

d. For pressure needs for berthing piers and wharves see NAVFAC DM-25, Waterfront Operational Facilities.

5-22. **Use of Non-potable Water.**

1. Non-potable distribution systems must be designed to prevent interconnection (e.g., by use of incompatible coupling devices) with a potable system. Also, the marking “NON-POTABLE” must be stenciled on the non-potable distribution system to identify it from the potable system. On shore stations, color-coding of pipes will be used to distinguish potable from non-potable systems.

Section V. POTABLE WATER STORAGE

	Article
General	5-23
Maintenance	5-24
Sanitary Standards for Water Storage	5-25
Disinfection of Water Storage Tanks	5-26

5-23. General.

Potable water distribution reservoirs are necessary for fire fighting, to satisfy peak demands, to support uniform water pressure, to meet industrial needs, and to avoid continuous pumping. Storage tanks permit the operation of pumps during periods of low electrical use rates. The location of water storage tanks close to the source of supply will allow the use of the most economical pipe sizes and pumping capacities; NAVFAC DM-5.7 gives detailed information on selection of storage tanks for use on Navy and Marine Corps installations.

5-24. Maintenance.

1. Inspection, maintenance, and repair of storage tanks is essential to the efficient operation of a distribution system. Corrosion and scaling in storage tanks may adversely affect the quality of the stored water, and ultimately result in their structural failure. All tank coatings, including sealing compounds and other materials, must be accepted by NSF Standard No. 61 or the state having primacy, for contact with and in potable water. AWWA standards D102-78 and D101-53 contain more information on inspection, painting, and repairing of tanks, standpipes, and reservoirs.

TABLE 5-4
Color coding for shore-to-ship water connections.

a. Potable Water	Blue, Dark
b. Water Provided for Fire Protection	Red
c. Chilled Water	Striped Blue/White
d. Oily Waste-Water	Striped Yellow/Black.
e. Sewer	Gold

Non-potable systems must be physically separated from all potable water distribution systems. Whenever possible, precautions will be implemented (i.e., removal of control valves, etc.) so that only authorized personnel can operate the non-potable system.

2. Non-potable fresh or salt water supplies must be used for fire protection, flushing, and industrial uses only when the potable supply is insufficient for all requirements.

3. The use of non-potable water for personal hygiene (e.g., laundering, showering, and bathing) is prohibited for Navy and Marine Corps installations.

5-25. Sanitary Standards for Water Storage.

1. When potable water tanks are below ground level:

a. The overflows, (e.g., manhole covers, vents) must be located with their tops 6 inches above grade.

b. The bottom of the tank will be higher than the water table or flood water design for a minimum depth of 8 feet.

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 which is higher than any sewers or sewage disposal systems.

e. Sewers or sewage disposal systems must be located at least 50 feet from water storage tanks.

2. All Potable Water Tanks.

a. Potable water storage tanks must be covered to prevent contamination by dust, rain, insects, animals, birds, and to discourage algae growth.

b. All vents and overflows must be screened with 20-mesh bronze insect screens. The vents must be rain proofed by using gooseneck or vent caps.

c. The construction and location of manholes must minimize the possibility of contamination. Manholes (roof hatch) will be designed with a coaming or curb 2 to 6 inches high around the opening. The manhole covers will overlap this coaming by at least 2 inches. Except when in actual use, manhole covers will be locked.

d. Overflow and drain pipes must not be directly connected to sewers.

3. Safety Precautions, All Tanks.

a. Precautions must be taken before entering the storage tank to prevent accidents due to oxygen deficient atmospheres or harmful concentration of toxic or explosive gases or vapors. The NAVSEA Gas Free Engineering Manual (NAVSEA S6470-AA-SAF-010) or other local instructions must be consulted for correct entry procedures. The local safety and health officer or an industrial hygienist (available at Naval hospitals, clinics commands and NAVENPVNTMEDUs) will be contacted for safety information on working in tanks and other confined spaces. The industrial hygienist or safety officer can outline entry procedures, specify respirators, and recommend other safety equipment necessary for tank

Water, like many other natural resources, is procured as a raw material, manufactured into a commodity suitable for use and distributed for

(confined space) entry and work.

b. Ladders, with approved safety cages will be used on all standpipes and elevated storage tanks.

c. Install a wire fence and locked gate around storage tanks prevent unauthorized entrance.

5-26. Disinfection of Water Storage Tanks.

1 . Potable water tanks must be disinfected before new, rehabilitated, or repaired tanks are put into service or when entered for inspection or any other reason. Tanks will also be disinfected when bacteriological evidence shows that the tank has become contaminated.

2. Disinfecting procedures may be one of the techniques described in Article 5-20 or a method which uses spraying or swabbing the walls and surfaces with a 500 PPM FAC solution. This concentration gives almost immediate disinfection. After complete application, all surfaces must be flushed with potable water. This operation must be coordinated with facility medical personnel and entry and work must follow 5-25.3.a. above.

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Section VI. WATER TREATMENT

Article

General 5-27
Disinfection 5-28
Fluoridation 5-29
Corrosion Control 5-30

5-27. General.

Water, like many other natural resources, is procured as a raw material, manufactured into a commodity suitable for use and distributed for consumption. A safe and dependable water supply greatly enhances the physical and mental well-being of the individual. Each water source will be evaluated individually to determine the type and degree of treatment needed. Disinfection is a must for all water used for drinking. Disinfection alone may suffice for a deep well, where sedimentation, coagulation, flocculation, filtration, and disinfection are usually needed for most surface sources. It is the responsibility of the installation commander to make sure that the water supply is safe and palatible. The commander must also make sure that, as a minimum, the water supply meets or exceeds all applicable NPDWR and state water quality standards as required by OPNAVINST 5090.1. NAVFAC DM-5.7 gives further information on the specifics of various treatment methods.

5-28. Disinfection.

1. Potable water sources are disinfected because no other treatment process, or combination of processes, will reliably remove all disease-producing organisms from water. All acceptable methods of disinfection satisfy the following criteria. The disinfectant must:

a. Mix uniformly to provide intimate contact with microbial populations potentially present.

b. Have a wide range of effectiveness to account for the expected changes in the conditions of treatment or in the characteristics of the water being treated.

c. Not be toxic to burn-ans at the concentration levels present in the finished water.

d. Have enough residual to protect the distribution system from microbial growth and act as an indicator of recontamination after initial disinfection.

e. Be readily measured in water in the concentrations expected to be effective for disinfection.

f. Destroy virtually all disease-producing microorganisms.

g. Be practical to use and store.

2. Chlorination.

a. Under normal operating conditions, chlorination is the most widely used procedure for the routine disinfection of water. The efficiency of chlorine is affected by the following variables:

TABLE 5-5.

Chlorine-pH Relationship 100 Percent Bacteria Kill in 60 Minutes (At 72° F)

Combined Chlorine

pH	PPM
6.5	0.3
7.0	0.6
7.7	0.9
8.0	1.0
8.5	1.2
9.5	1.5
10.5	1.8

(1) The types and concentrations of the chlorine forms present.

(2) The pH of the water. At pH 6.5 and a temperature of 70° F (22° C), 0.3 ppm of combined residual causes a 100 percent bacterial kill in 60 minutes. With the same temperature and time, at pH 7.0 the combined residual must be increased to 0.6 ppm, to accomplish the same degree of bacterial kill. Data for this pH-chlorine residual relationship are presented in Table 5-5.

(3) The type and density of organisms (virus, bacteria, protozoa, helminth, or others). Of all the waterborne diseases, those caused by bacteria are the most easily prevented by chlorine disinfection. At the other extreme, certain pathogenic organisms such as the cysts of the protozoa *E. histolytica and Giardia lamblia* are the most resistant. Therefore, two parallel recommendations for chlorine residuals are often made. The lower one for bactericidal purposes and the higher one for cysticidal purposes. Available information suggests that cysticidal residuals are also viracidal. Figure 5-Cl, (Appendix C), presents data on the bactericidal and cysticidal effectiveness of free available chlorine (FAC) and combined chlorine residuals at various pH and temperature levels. Bactericidal levels are routinely used for all water supplies at Navy and Marine Corps installations in the United States since waterborne bacteria are likely to be the most prevalent organisms. Cysticidal levels will be used whenever epidemiological evidence shows the presence of nonbacterial waterborne diseases such as amebiasis, viral hepatitis A, or giardiasis.

(4) The contact time of the organisms with the chlorine.

(5) The temperature of the water. At lower temperatures, bacterial kill tends to be slower and higher residuals are needed. The effect of low temperatures is greater with combined chlorine than with free available chlorine.

(6) The concentration of substances exerting other demands on the chlorine. During disinfection, chlorine demand can be exerted by chemical compounds including those containing ammonia and the whole spectrum of organics. Many of these compounds are not effectively removed in conventional water treatment processes.

(7) Mixing of chlorine and chlorine demanding substances. The agent must be well dispersed and homogeneously mixed to assure that the contact time for disinfection is applied throughout the water supply.

(8) Appendix D discusses the safe operation of chlorination facilities,

b. Chlorine Residual. A measurable chlorine residual (FAC or combined) must be maintained in all parts of the potable water distribution system under constant circulation. This applies to Navy and Marine Corps owned and operated. supplies from ground and surface sources. This does not apply to water supplied directly to installations, leased buildings, or like facilities by a satisfactory public water supply distribution system, or from a supplier of bottled water that has been approved by the State or host nation health authority. If water supplied to an installation from an approved outside source does not have a measurable chlorine residual (FAC or combined), then this should be considered in the microbiological monitoring program of the installation medical authority. Coordination between the supplier, the public works or maintenance officer and the preventive medicine department is essential in this situation. Installation of a chlorination system for the supplied water (dechlorination) must be considered if an unhealthful situation exists. Not all disinfectants or chemicals added to purchased water will be compatible with chemicals used by the supplier. For example, the addition of chlorine (sufficient to produce FAC) to water disinfected with combined chlorine (chloramine), which delays formation of trihalomethanes (THM), may result in a product which exceeds the maximum contaminant level (MCL) for THM. Hence, the supplier and state or EPA authorities must approve chemicals added to purchased water. Dechlorination (or other chemical addition) of purchased water could make the installation commander a new supplier of water responsible for all requirements of the SDWA implemented by NPDWR. Final interpretation of whether or not an installation is classified as a supplier of water rests with the state regulatory authorities (if primacy has been granted) or with regional EPA officials (if in a nonprimacy state).

c. Chlorination in the Event of System Problems. Water from systems where sanitary, physical, or operating defects or other special hazards are known to exist, or where microbiological examinations show that satisfactory quality cannot be obtained without dechlorination, must be chlorinated to bactericidal levels shown in Table 5-6.

d. Health Effects of Chlorination. Concern has been generated over the health effects of chlorinated organics. Specifically, trihalomethanes (THMs) were placed into the maximum contaminant levels (MCLs) of NPDWR. THMs are commonly found in chlorinated drinking water, particularly in drinking waters obtained from surface water sources. THMs are formed by the reaction of naturally occurring organic substances with chlorine during drinking water treatment and distribution. Chlorination methods used by the installation may have a dramatic affect on the resultant level of THMs. As a minimum, installations obtaining their raw water from surface sources and practicing pre- and postchlorination must practice chlorination optimization. Prechlorination dosages must be reduced to the lowest level consistent, with the maintenance of a trace chlorine residual through the treatment system before postchlorination. Postchlorination will then be used to achieve needed chlorine residuals for the distribution system. Use of this technique allows for the most effective use of chlorine consistent with minimizing THM formation. Potable water trans-

TABLE 5-6

Minimum Free and Combined Bactericidal Chlorine Residual Recommended in the Event of Water System Problems

pH value	Minimum concentration of free chlorine residual after 10 minutes. ppm (mg/L)	Minimum concentration of combined chlorine residual after 60 minutes ppm (mg/L)
6.0	0.2	1.0
7.0	0.2	1.5
8.0	0.4	1.8
9.0	0.8	Not applicable
10.0	0.8	Not applicable

ferred from shore to ship will normally contain at least 0.2 ppm FAC; still, ships may be supplied with water disinfected with chloramine. In this case, the area NAVENPVNTMEDU may be contacted for instructions on testing, treatment and surveillance procedures.

e. Determination of Chlorine Residuals. Both FAC and combined chlorine residuals are applicable at facilities located in the United States and overseas. Residual FAC will be found by using the diethyl-p-phenylene, diamine (DPD) method or other EPA approved method that measures specifically for FAC. Combined chlorine residuals can be found by tests that give the total chlorine present from which the free component can be subtracted.

f. Chlorination Methods.

(1) Marginal Chlorination. In marginal chlorination, the initial chlorine demand has been satisfied but some oxidizable substances remain.

(2) Superchlorination-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.

(3) 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 present.

(4) Chloramines (Combined Chlorine and Ammonia). Depending on the population served, EPA has established the maximum contaminant limit (MCL) for trihalomethanes at 0.10 mg/1. Some raw water sources contain naturally Occurring organic substances (precursors) which react with chlorine to form THM. When chloramines, rather than free available chlorine, are used to disinfect water containing precursors, the formation of THM may be delayed until the water is used. When compared to free available chlorine, the disinfection capabilities of chloramines are less effective. A longer contact time is needed to obtain complete disinfection. Specific chloramine disinfection techniques, (e.g., ratio of ammonia and chlorine, point in treatment where chlorine is added, and point where ammonia is added) are designed for the water being treated. All proposed treatment processes, to remove THM, must be approved by the state or EPA regional office.

g. Surveillance. Water plant personnel must ensure that proper chlorine levels are maintained by regular and frequent chlorine analyses, both at the point of application and at various points in the water distribution system. Testing of treated water for chlorine residual before distribution must be accomplished at least daily, more often if the character and variability of the water supply dictates, and at least daily at various points in the water distribution system. Also, the installation medical authority must test for chlorine residuals when microbiological surveillance samples are taken (see Appendix A).

3. Other Methods. Methods of disinfection other than chlorination are being used throughout the world. Requests for the Navy and Marine Corps to use a method of disinfection other than chlorination must be forwarded to BUMED Code 03B4 via the area Navy Environmental and Preventive Medicine Unit (NAVE NPVNTMEDU). See Appendix E.

5-29. Fluoridation.

Fluorides are a small but important element in the human diet. Part of the concentration may be obtained in food, but the greatest portion will come from the potable water supply. Application of fluoride to water supplies, is recommended when the natural fluoride content of the water supply is below levels necessary for prevention of dental caries in children. The maximum contaminant fluoride level is established by the NPDWR (See Appendix F). If levels exceed NPDWR in a public water systems, control methods must be installed. Although fluorides, when taken internally in recommended concentrations, are beneficial in the prevention of dental caries, excessive amounts may produce objectionable dental fluorosis (mottling of tooth enamel). The fluorosis increases in severity as fluoride concentration rises above the NSDWR maximum contaminant level.

5-30. Corrosion Control.

1. Corrosion is a phenomenon associated with a metal and the water within a water distribution system. Corrosion in water distribution systems can be described as a two-phase process. In the first phase, the metal dissolves in the water. in the second phase, the oxide of the dissolved metal deposits itself at the corrosion site. For a metal to corrode, thus reverting to its native stable state as an oxide, is a natural tendency. Because of the differences in mineral and gas content of water supplies, some waters promote the solution of metal more rapidly than others. Some water may help to develop a mineral or oxide layer that protects against continued corrosion. Waters that generally let corrosion take place are called corrosive *waters;* and waters in which the metal does not corrode are called *non-corrosive* or *protective.* 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. Simplified indexes have been developed for determining the relative corrosiveness of the water which take into account pH, temperature, alkalinity, hardness and total dissolved solids of the water.

2. Corrosion results from the flow of electric current between two electrodes (anode and cathode) on the metal surface. These areas may be microscopic and in close proximity causing general, uniform corrosion and often red *water*, or, they may be large and somewhat remote from one another causing pitting, with or without tuberculation (small knobby prominences). Electrode areas may be induced by various conditions. Some due to the characteristics of the metal and some to the character of the water at the boundary surface.

3. A number of installations practice chemical corrosion control to increase the longevity of the distribution system. protective measures that may be necessary to control corrosion include the use of different alloys in pipe manufacture, the use of protective coatings in new main installation, and in-place coating/lining after main cleaning. Chemical control is a supplement to protective control; not a substitute for it. Chemical control cannot be expected to overcome improper flow conditions, poor design, defective materials, and faulty coatings. Polyphosphates and silicates are routinely used for chemical corrosion control. Polyphosphates have been reported to be effective in reducing corrosion by domestic waters; but, a case-by-case evaluation must be made as to the potential for effectiveness. Polyphosphates may also result in substantial phosphorus loadings in receiving wastewater treatment facilities. silicates are popular for chemical corrosion control in waters of low hardness or alkalinity.

4. Further Information. Consult AWWA Standard No. 10008 for a more detailed discussion of corrosion control.

Section VII. WATER QUALITY STANDARDS

	Article
General	5-31
Treated Water Standards.	5-32

5-31. General.

The suitability of water for any given use is determined by its quality in terms of its physical, chemical, radiological, and microbiological constituents. For water to be acceptable for human consumption it must be palatable, and, more importantly, free of any constituents that would cause adverse physiological effects. Also, it must not be destructive to the materials used in its transportation and storage. Potable water must also be suitable for the ancillary uses associated with human habitation, (i.e., personal hygiene, laundering of clothes, and dishwashing). The purpose of setting drinking water quality standards is to give a basis for the selection or rejection of a water supply intended for human consumption. It should be emphasized that the standards are maximum values and every reasonable attempt must be made to obtain water of a better quality. Interpretation of water quality data must be made only by a qualified sanitary engineer, environmental health officer, or medical officer.

5-32. Treated Water Standards.

1. General. Water made available for human consumption must be of the highest quality. Quality standards for treated water reflect the maximum values of various constituents that may be present in drinking water. Quality standards are presented in Appendix F.

2. Physical Quality. The principal physical characteristics of' water are color, odor, and turbidity. Temperature may also be considered a physical quality. The basis for physical quality standards is primarily related to consumer acceptance of the water. Waters having physical characteristics exceeding the limits in Appendix F will not, as a general rule, be used for drinking. When water of a lesser physical quality is used due to local conditions, concurrence must be obtained from the installation medical authority. Note: If water quality does not meet the standards of NPDWR (Appendix F), coordination with regulatory authorities is also needed.

3. Chemical Quality. The chemical quality of water is determined by all the chemical constituents present and any interactions between these constituents. The chemical quality of water may be described in terms of inclusive characteristics (e.g., total hardness, alkalinity, pH) or it may be described in terms of a particular cation or anion (e.g., arsenic, barium, or calcium).

a. Basis. Chemical water quality standards have been set up based on the following criteria the physiological impact and attendant effect the water will have on humans; and the consumer response to the palatability or useability of the water. The effect of a particular chemical constituent or of an inclusive characteristic of chemical quality will determine whether a mandatory limit or desirable limit is set for that chemical. Chemical constituents having deleterious physiological effects must have a mandatory limit that can not be exceeded under any circumstances. Other constituents, such as iron and manganese, have no significant adverse physiological effect, but may restrict the uses of the water for laundering of clothes. These constituents normally have a desirable limit that will not be exceeded unless a water supply of better quality is not available. Appendix F lists the chemical water quality standards for potable water.

b. Pesticides. Pesticide chemicals are toxic and must be properly stored, handled, and used to achieve the desired results without creation of unwanted toxic hazards and environmental contamination. Their persistence in the environment makes it necessary that limits be placed on the concentrations of these pesticides in drinking water. Reference limits are provided in Appendix F.

4. Microbiological Quality.

a. The microbiological quality of drinking water indicates its potential for transmitting waterborne diseases. These diseases may be caused by viruses, bacteria, protozoa, or by higher organisms. Microbiological examinations will reveal the quality of the raw water source and is an aid in deciding the treatment needed. These examinations are essential to keeping the water quality within established potability standards. The direct measurement, of pathogenic organisms in a water sample is extremely difficult. The density of these organisms is usually very low, even in a badly polluted water supply, and the analytical techniques used in their identification are complex. For these reasons, indicator organisms are used to show the presence of fecal contamination in a water supply. The most common organisms used as indicators of possible contamination are bacteria of the coliform group such as *Escherichiu coli, Klebsiella pneumoniae,* and *Enterobacter aerogenes.* These organisms occur in large quantities in the intestines of warm-blooded animals and are used as presumptive evidence of fecal contamination of water. Their occurrence, particularly in low densities, does not always mean that human fecal contamination has occurred. But, the presence of any coliform organism in treated drinking water is a sign of either inadequate treatment or the introduction of undesirable materials to the water after treatment.

b. Microbiological examinations of potable waters are usually conducted to show either the presence or absence of the coliform group. 40 CFR 141, refers to the membrane filter (MF) Technique and the Multiple Tube Fermentation (MTF) Technique. In addition EPA has recently approved two additional tests, the Autoanalysis Coilert Test, henceforth called the Minimal Media ONPG-MUG (MMO-MUG) Test, and the Presence-Absence (P-A) Coliform Test as approved methods for satisfying the NPDWR.

(1) Membrane Filter Technique. Because of its relative simplicity, the membrane filter technique has gained wide acceptance throughout the military as the preferred technique for identifying coliform organisms in drinking water. The membrane filter technique, as described in the current edition of *Standard Methods for the Examination of Water and Wastewater*, must be used except when the facility is located in a state which has been granted primacy and that state mandates the multiple tube fermentation technique. A step-by-step description is included in Chapter 6 of this manual.

(2) Multiple Tube Fermentation Technique. This method can be found in a current edition of *Standard Methods of Examination of Water and Wastewater.* This test can be used when high amounts of suspended solids in the sample limit the use of the membrane falter technique.

(3) MMO-MUG Test. The MMO-MUG Test is based on the ability of coliform bacteria to produce the enzyme beta-galatosidase which hydrolzes o-nitrophehyl-betad-glactopyranoside (ONPG) present in the chemically defined medium to form a yellow color. The formulation of the test medium poorly supports the growth of non-coliform microorganisms, the target coliform microorganisms produce the yellow color within 24 hours.

(4) Presence-Absence (P-A) Coliform Test. The P-A Test is described in *Standard Methods for the Examination of Water and Wastewater.* It is a simple modification of the multiple-tube procedure. Simplification is accomplished by the use of one large test portion (100 ml) in a single test tube.

(5) Standard Plate Count. Although the standard plate count is not directed by the EPA NPDWR, its use may be needed in conjunction with modification of the turbidity limit. This test gives the number of bacteria that can grow under the conditions of the test. It has varying significance for finished water, particularly if the plating is not completed within 6 hours after collection of the sample. The testis valuable in finding the microbiological efficiency of the various units in a water treatment process. Excessively high counts may indicate serious contamination in the system and warrant further investigation.

c. Other Microbiological Tests. Other methods exist to more specifically identify the origin of bacteriological contamination. Fecal coliform and fecal strep techniques are two commonly used methods. Specific testing procedures, such as these, are recommended for drinking water when more generalized testing yields positive results. Fecal coliform bacterial testing may be determined by using either the multiple tube or the membrane filter procedure. The membrane filter technique has been shown to have 93 percent accuracy for differentiating between coliforms from warm-blooded animals and coliforms from other sources. Fecal streptococcal group organisms can also be identified by using either membrane filter or multiple tube methods. The normal habitat of fecal streptococci is the intestines of man and animals, making these organisms one indicator of fecal pollution. Because of organism survival characteristics, other fecal indicators (fecal coliforms and total coliforms) must be used concurrently. Further discussion on the microbiology of drinking water and testing methods can be found in *Drinking Water and Health and Standard Methods for the Examination of Water and Wastewater*. Consultation on this subject can be obtained by contacting the area Navy Environmental and Preventive Unit (NAVENPVNTMEDU).

5. Radiological Quality.

a. Radioactive elements can appear in water supplies as a result of naturally occurring contamination. Radioactive elements can also enter water from indiscriminate disposal of hospital or industrial radionuclides as well as a result of leakage from reactors.

b. Radiological Standards. Radiological water quality standards are based on the premise that radiation has an adverse physiological effect on humans and any unnecessary exposure must be avoided. The physiological effects that are associated with overexposure to radiation demands the rejection of any treated water containing excess quantities of radionuclides. Proper treatment methods will provide drinking water of desired radiological quality in most cases. The NPDWR standards for radionuclide are summarized in Appendix F.

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Section VIII. WATER QUALITY SURVEILLANCE

Article

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5-33 OBJECTIVES

The objectives of water quality surveillance are to make sure that the quality of drinking water on Navy and Marine Corps installations meets the minimum health standards of NPDWR and any additional standards mandated by BUMED, to assure that the distribution system is protected from undue corrosion or scaling and that economically thorough treatment is carried out by the treatment plant. These objectives are met by a program of water quality monitoring under the direction of NAVFACENGCOM in coordination with BUMED. Consult Appendix F for treated water quality standards.

5-34. Surveillance Sampling.

1. Treated Water at Navy and Marine Corps Owned and Operated Facilities. Surveillance sampling to meet the goals of the preceding paragraph must be carried out on treated waters supplied by the installation at Navy and Marine Corps owned or operated facilities. Treated water is defined to include any treatment of raw surface or ground water sources and may include dechlorination or fluoridation of purchased water. Also, Navy and Marine Corps installations which sell or give treated water to non-department of the Navy military authorities or to civilian communities are considered suppliers of water and must perform surveillance monitoring services, for the areas covered by their treated waters, following the NPDWR and NSDWR, as applicable. A “supplier of water” owns or operates a public water system. Compliance with state drinking water regulations or NPDWR requires surveillance monitoring. Drinking water must be analyzed at laboratories certified by state regulatory agencies (in states having primacy) or by the Regional EPA office (in states not having primacy).

a. Surveillance Responsibility. The installation commanding officer is responsible for sampling, conducting analyses, reporting to EPA or states and keeping records per the NPDWR. The public works or maintenance department is normally assigned responsibility for collecting samples and doing laboratory analyses, The installation medical authority (preventive medicine department) must work closely with the certified laboratory, the water supplier, and the federal, state, or local regulatory authority. The medical authority will review results of the analyses and make recommendations to assure compliance with NPDWR and NSDWR. All water analyses must be conducted by an EPA or state certified military or civilian laboratory. NAVFACENGCOM helps activities in the development of contracts and selection of laboratory services for potable water analyses.

b. Physical, Inorganic, Organic and Radiological Surveillance.

(1) Surface Water Sources. Analyses for the inorganic chemicals specified in the NPDWR must be conducted at yearly intervals for community water systems. Analyses for the specified organic chemicals, excluding trihalomethanes, must be at a frequency specified by the state but never less often than 3 year intervals for community water systems. Trihalomethanes must be monitored quarterly as directed by the states having primacy or EPA. For community water systems, analyses for radiological activity must be conducted at least once every 4 years. Initial radiological analysis must be conducted on either the analyses of an annual composite of four consecutive quarterly samples or the average of the analyses of four samples obtained at quarterly intervals. Once an acceptable data base is available, the state may modify the sampling scheme. Likewise, where there is reason for concern, the state may decrease monitoring intervals. Water must be analyzed for man-made radioactivity in those systems serving over 100,000 persons or those systems specified by the state. Few, if any Navy or Marine Corps systems will be affected by this portion of the NPDWR; but, guidance and sampling mandates of the various states must be followed. Turbidity analysis must be conducted at least once daily for both community and noncommunity systems using the Nephelometric Method on a sample collected at an entry point into the distribution system (refer to the current edition of *Standard Methods for the Examination of Water and Wastewater.* Turbidity analysis is the public works or maintenance officer's responsibility. Nitrate analysis is the only inorganic analysis directed for noncommunity systems; but, additional analyses may be specified by the state. Organic and radiological analyses are not directed for noncommunity systems.

(2) Ground Water Sources. Community water systems using only ground water sources must have the inorganic analyses conducted at least every third year per the NPDWR. Organic analyses must be conducted as specified by the state. Analyses for natural radioactive substances must be as specified for surface water sources. Analyses of ground water sources for man-made radioactive substances must be as specified by the state. Turbidity need not be monitored for ground water sources. Nitrate analyses for ground water supplied noncommunity systems must be conducted as specified by the state.

c. Microbiological Surveillance. For community water systems, the, number of samples collected from the installation distribution systems will be no less than that required by the NPDWR for the population served. For noncommunity water systems, at least one microbiological sample per month must be collected unless increased by a state mandate.

d. Supporting Laboratories. Analyses of samples from public water systems in the U.S. must be conducted by laboratories certified by EPA or the state. Measurements for turbidity and free chlorine residual may be conducted by anyone acceptable to the state. Technical help for radionuclide analyses may be obtained from the USAF Occupational and Environmental Health Laboratory, Brooks Air Force Base, Texas and the U.S. Army Environmental Hygiene, Agency, Aberdeen Proving Grounds, Maryland. This service may be used only if state certified laboratories are not available. Approval to use these laboratories must be obtained from NAVFACENGCOM, Code 1122 via the cognizant EFD.

2. Treated Water at Navy and Marine Corps Owned and Contractor Operated Facilities.

a. Surveillance Responsibility. The installation commanding officer is responsible for surveillance monitoring (see Appendix (G). Actual collection and submission of samples is normally assigned to the public works or maintenance officer. The Medical Department, (preventive medicine department) will routinely review surveillance monitoring results to see that all NPDWR or corresponding state drinking water regulation mandates are met. In cases where the contractor must accomplish NPDWR or corresponding state drinking water regulations, the installation medical authority (preventive medicine department) must institute a parallel surveillance program to include the following:

(1) Verify that a potable water quality survey is done every 3 years.

(2) Conduct medical bacteriological surveillance of the distribution system per Appendix A, Section A-7.

(3) Conduct monthly reviews of drinking water records.

(4) Make sure that the sampling and preservation procedures, discussed in Article 5-38, are followed when samples are taken for medical surveillance testing.

3. Purchased Water.

a. NPDWR and NSDWR Application. The NPDWR and NSDWR will apply to Navy and Marine Corps purchased water if:

(1) The system has collection and treatment facilities.

(2) The purchased water is obtained from a water system to which NPDWR and NSDWR do not apply.

(3) Water is sold for potable use.

(4) The purchased water is supplemented with water from Navy or Marine Corps sources.

(5) Additional treatment, (e.g., rechlorination, fluoridation, or addition of chemicals for corrosion control) is conducted.

(6) Note: Final interpretation of whether or not an installation is classified as a "supplier of water" rests with the state (for states that have assumed primacy) or EPA region (for states that have not assumed primacy). If final determination is made that an installation which purchases its potable water is a "supplier of water," then that installation must comply with the requirements of NPDWR and NSDWR. Suppliers of water are required by the NPDWR and NSDWR to conduct physical, inorganic, organic, radiological, and microbiological monitoring of the water system.

b. Surveillance Responsibility. The installation medical authority must coordinate with the supplier of water to see that the requirements of NPDWR and NSDWR are being fulfilled. Independent analyses are not needed for physical, chemical, and radiological contaminants if the installation medical authority (preventive medicine department) is satisfied that the federal, state and local mandates are being fulfilled. The installation medical authority will conduct bacteriological surveillance of the purchased water in accordance with Appendix I.

4. Bottled Water. Bottled water is a type of purchased water. Bottled water must comply with the requirements of NPDWR and NSDWR for physical, chemical, bacteriological, and radiological contaminants. The installation medical authority is responsible for verifying the quality of this supply source and must approve, from a medical perspective, the purchase of a bottled water for distribution on an installation. A program of microbiological monitoring of bottled drinking water must be instituted if this source is used.

5-35. **Surveillance Sampling Overseas.**

All Navy and Marine Corps installations located outside CONUS must maintain the same drinking water standards as prescribed for CONUS installations. Any requests for deviation from CONUS drinking water standards must be submitted in writing to BUMED via the area NAVENPVNTMEDU and The Navy Environmental Health Center (NAVENVIRHLTHCEN).

5-36. **Military-Unique Chemicals and Other Potentially Hazardous Materials.**

The area NAVENPVNTMEDU must be consulted immediately upon suspicion of contamination of a water source by military-unique chemicals or other potentially hazardous materials. The NAVENPVNTMEDU can arrange analysis from laboratories capable of performing the necessary tests.

5-37. **Operational Surveillance.**

Besides the surveillance sampling program previously mentioned, water treatment personnel will collect additional samples to provide quality control for any treatment processes that are used. Examples of this type of analyses are: coagulant demand, turbidity, color, odor, chlorine residual, fluoride, iron, manganese, pH, temperature, hardness, total alkalinity, and total dissolved solids. The latter five analyses are needed for the determination of the Langlier Index (See Appendix H, H- 8.10.) which is used as an indicator of corrosive properties of treated water. Operational sampling will be done as often as necessary to assure the maintenance of effective treatment control and to reduce the cost of treatment.

5-38. **Procedures for Sampling and Preservation**

1. Physical, Inorganic, Organic and Radiological Surveillance. For those installations having public water systems, sampling and sample preservation guidelines are contained in NPDWR and NSDWR, or corresponding state drinking water regulations. Installations not having public water systems must contact the supporting laboratory or activity to verify laboratory capability, appropriateness of the analytical request, sampling techniques, and sample preservation guidelines.

2. Microbiological Surveillance. Sampling and preservation guidelines for installations not having public water systems must be identical to those stated in NPDWR and NSDWR, or corresponding state regulations. As a general guide, Appendix I presents the sampling techniques to be used in determining the microbiological quality of water. Samples collected for microbiological analysis must be examined as soon as possible after collection. Ideally, samples will not be held for more than 6 hours between collection and analysis. The exception to this rule is for samples mailed from distant installations. These samples may be held for Up to 30 hours. Samples must be shipped in ice. This is important because of the extensive changes that take place in the bacterial flora even though the samples are stored at temperatures as low as 4° C.

3. Sampling Location Plan. A map of the installation water distribution system, showing all sampling points, must be kept by the installation medical authority. Only those samples of water distributed for drinking and culinary purposes will be used in the evaluation of potability. Sampling points, such as dining facilities, hospitals, barracks, and residential and administrative areas will be chosen to be representative of principal use. Hot water faucets, mixing faucets fixtures that are leaking, drinking fountains, fire hydrants, or outlets connected to dead end sections of the distribution system will be spot checked, but need not be the subject of routine monitoring. On those installations where more than one independent distribution system is in use, each system must be considered as separate and distinct for the purpose of calculating the number and frequency of samples to be drawn.

4. Analytical Methodology.

a. Physical, Inorganic, Organic and Radiological Surveillance. The NPDWR, NSDWR, and corresponding state drinking water regulations contain analytical methods for surveillance of public water systems. For other types of surveillance, the current edition of *Standard Methods For The Examination of Water and Wastewater* will be used.

b. Microbiological Surveillance. For those installations having public water systems, approved analytical methods are contained in NPDWR or corresponding state drinking water regulations. The MF, the MTF, the MMO-MUG and then P-A tests are approved methods. The standard sample for the examination of finished water is 100 ml. The MF, because of ease, maybe used by Navy and Marine Corps facilities unless the facilities are located in states which require another approved total coliform test. The standard sample using the MF technique is 100 ml. This 100 ml sample may be distributed among multiple membranes if necessary. For other types of surveillance, not governed by drinking water regulations, the MF technique can be used.

5-39. **Reporting and Record Keeping.**

The NPDWR directs operators of public water systems to give to the regulatory agency chemical and microbiological results within 40 days following the analyses. Records of microbiological analysis must be kept for 5 years, and chemical analysis records must be kept for 10 years. Other information on sample collection and laboratory analyses must also be kept. Consult the NPDWR, subpart D, or corresponding state regulations for complete reporting and record keeping details.

5-40. **Remedial Action.**

1. Suspected Bacteriologic Contamination. Appendix J presents information as to the type of action to be taken when bacteriological contamination is suspected. The important fact to remember is not to unduly alarm the consumer. Overreaction on the part of responsible personnel results in increasing the magnitude of the suspected problem, often to an extent entirely out of proportion to the seriousness of the problem. If coliform positive samples are found and the required follow-up samples are also positive, then consultation is recommended with the area NAVENPVNTMEDU. Specialized testing, to indicate the source of contamination, maybe called for.

2. Noncompliance with NPDWR. (NSDWR for Fluoride)

a. If a particular sampling point has been confirmed to be in noncompliance with the standards listed in Appendix F, the installation commander will:

(1) Give notification, per NPDWR, to the state or EPA and to all persons served by the community water system. DD Form 1535, request/approval for Authority to Advertise, will be completed and sent along with a copy of the proposed notification, to the NAVFACENGCOM, Engineering Field Division (EFD), Environmental Branch, for approval before the publication of the notice of non-compliance.

(2) Provide alternative drinking water until the supply is again known to be safe.

b. For those installations operating public water systems, there is a public notification requirement under NPDWR when Maximum Contaminant Levels (MCLs) are exceeded. Public notification is called for when applicable testing procedures are not followed; schedules of a variance or an exemption are not followed; when a variance or an exception is granted; and when monitoring is not done. Public notification is explained in detail in NPDWR, subpart D, or corresponding state drinking water regulations.

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Section IX. CONTINGENCY PLANNING

Article

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5-41. General.

The management and operation of a water supply, treatment, and distribution system are complex tasks directed towards guaranteeing a continuous supply" of high quality water for domestic and industrial use. This chapter is concerned with highlighting the need for contingency planning that can aid an installation in maintaining an uninterrupted water supply during natural and man-made disasters.

5-42. Points to Consider.

When making contingency plans, coordination between the public works or maintenance officer and the installation medical authority is essential. Specific responsibility must be defined for each organization. other factors to be considered include:

1. Create a priority of service listing for major areas and users on the installation.

2. Locate major valves and backflow prevention devices for isolating damaged areas to prevent the spread of contamination.

3. Find alternate water storage, purification, and power generation equipment, (e.g., use of swimming pool treatment facilities, use of field water treatment equipment from the Marine Corps or construction battalions, Army and Air Force active and reserve components).

4. Setup procedures to elevate disinfectant (chlorine) residual levels to give added disinfectant capability.

5. Setup procedures for notification of installation residents and work force of emergency potable water considerations.

6.1 through 5 above are not intended to be all inclusive. These paragraphs show potential areas that need further analysis on a case-by-case basis.

5-43. **Additional Information.**

For help in developing contingency plans to cope with an emergency or disaster, consult the AWWA Manual M19 and NEESA 1-38, Water Management Contingency Planning Criteria.

5-44. References Appendix H is a list of reference materials used in the preparation of this chapter.

5-43. **Additional Information.**

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APPENDIX A

MODEL POTABLE WATER MONITORING PROGRAM FOR THE INSTALLATION MEDICAL AUTHORITY

A-1. Coordinate liaison with applicable federal, state, and local regulatory agencies for information and guidance with the medical monitoring program. The area NAVENPVNTMEDU can be a source of guidance on this subject.

A-2. Write a SOP detailing the potable water monitoring program to be followed by your branch or activity.

A-3. Keep a updated list of all water sources including the type, location quality, and quantity of each. Maintain information on the treatment provided to each water source.

A-4. Keep a current set of plans of the water distribution system.

A-5. Keep records of surveys, analyses, actions and other information pertinent to the sanitary surveillance of the potable water system.

A-6. Keep copies of all regulatory agency and Navy/Marine Corps water regulations, instructions, and orders.

A-7. Collect samples for bacteriological analyses as directed, (e.g., after system or main disinfection, consumer complaints, special samples for studies in connection with positive EPA or state samples, monthly spot checks from points representative of major sections of the distribution system, etc.).

A-8. Do chlorine residual tests to investigate water problems (e.g., taste and odor, consumer complaints, and with each above bacteriological analyses).

A-9. Review the results of all EPA or state potable water analyses done at certified water laboratories and local analyses performed in A-7 and A-8 above.

A-10. Inspect the water source, treatment plant (when located on the installation), and the storage and distribution systems at least quarterly.

A-Il. Approve or ensure that all chemical additions and concentrations to potable water supplies are as listed in NSF Standard No. 60. Also, make sure that water tank coatings, water hoses, and other materials used in, or in contact with, potable water are listed in applicable NSF Standards.

A-12. Where applicable, inspect the water treatment plant laboratory and review analytical procedures to assure compliance with Standard Methods quarterly.

A-13. Set up a program to inspect for and do away with cross-connections.

A-14. Coordinate with the facilities public works or maintenance officer to:

1. Give feedback on inspections and analyses.
2. Make sure that medical department (preventive medicine department) personnel are told of distribution system breakage, modification, flushing, shutdown, or when component or main disinfection occurs.
3. Insure that adequate chlorine residuals are maintained in all portions of the distribution system under constant circulation.
4. Develop contingency plans for natural or manmade disasters.

A-15. Pursue an aggressive continuing education program in health related potable water training.

A-16. Give applicable command environmental health guidance found in OPNAV, NAVFAC, and BUMED instructions, appropriate state drinking water regulations, 40 CFR, and this publication.

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APPENDIX B
DEFINITIONS

B-1. AIRGAP A physical separation sufficient to prevent backflow between the free-flowing discharge end of the potable water system and any other system. An airgap is physically defined as a distance equal to twice the diameter but never less than one (1) inch.

B-2. AQUIFER A permeable, water-bearing geologic formation.

B-3. BACKFLOW The flow of water or other liquids, mixtures, or substances into the distribution pipes of a potable system of water from any source or sources other than its intended source. Backsiphonage is one type of backflow.

B4. BACKFLOW PREVENTER A device or means designed to prevent backflow or backsiphonage. Most commonly categorized as air gap, reduced pressure principle device, double check valve assembly, pressure vacuum breaker, atmosphere vacuum breaker, hose bib vacuum breaker, residential dual check, double check with intermediate atmosphere vent, and barometric loop.

B-5. BACKSIPHONAGE Backflow resulting from negative pressures in the distribution pipes of a potable water system.

B-6. BREAK-POINT CHLORINATION The application of chlorine to produce a residual of free available chlorine with little or no combined chlorine present.

B-7. CHECK VALVE A self-closing device which is designed to allow the flow of fluids in one direction and to close if there is a reversal of flow.

B-8. COMBINED AVAILABLE CHLORINE The chlorine products formed by the reaction of equilibrium products of ammonia with the equilibrium products of chlorine to form chloramines. Combined available chlorine has significantly less disinfecting power.

B-9. COMMUNITY WATER SYSTEM A public water system that serves at least 15 service connections used by year-round residents or regularly serves at least 25 year-round residents.

B-10. CONTAMINANT A substance that will impair the quality of the water to a degree that it creates a serious health hazard to the public leading to poisoning or the spread of disease.

B-1l. CROSSOVER POINT Any point or points where a potable water main makes contact or crosses over or under a non-potable liquid conduit (sewer, nonpotable water supply).

B-12. CROSS-CONNECTION Any actual or potential connection between the public water supply and a source of contamination or pollution.

B-13. DISINFECTION The act of inactivating the larger portion of microorganisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

B-14. EPA The United States Environmental Protection Agency.

B-15. FIELD WATER SUPPLY SYSTEM That assemblage of collection, purification, storage, transportation, and distribution equipment and personnel to provide potable water to field units in training and actual deployment environments.

B-16. FINISHED WATER Treated Water.

B-17. FIXED INSTALLATION An installation that, through extended use, has gained those structures and facilities not initially found or intended for use at a "temporary" facility, (e.g., paved roads, fixed electrical distribution systems, fixed water treatment facilities, and underground distribution lines).

B-18. FLOOD-LEVEL RIM The edge of the receptacle from which water overflows.

B-19. FREE AVAILABLE CHLORINE Chlorine available (after chlorine demand has been satisfied) in the. forms of hypochlorous acid and hypochlorite ions.

B-20. HEALTH HAZARDS Any condition, including any device or water treatment practice, that may create an adverse effect on a person's well-being.

B-21. INSTALLATION MEDICAL AUTHORITY In medical commands, the Commanding Officers and Officers in Charge; in other than naval medical commands, the medical officer or medical department representative; and in the Marine Corps, the installation surgeon.

B-22. MARGINAL CHLORINATION Application of chlorine to produce the desired total chlorine residual without reference to the amounts of free or combined chlorine present.

B-23. MAXIMUM CONTAMINANT LEVEL The maximum permissible level of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system except for turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Substances added to the water under circumstances controlled by the user, are excluded ii-em this definition.

B-24. MEDICAL BACTERIOLOGICAL SAMPLING Independent bacteriological sampling, conducted by the medical department, of the water distribution system to augment sampling required by NPDWR.

B-25. MUST Indicates a requirement that is necessary or essential to meet current accepted standards of protection of federal rules and regulations.

B-26. NONCOMMUNITY WATER SYSTEM A public water system that is not a community water system.

B-27. 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.

B-28. PALATABLE WATER Water that is pleasing to the taste and is significantly free from color, turbidity, and odor. Does not imply potability.

B-29. POTABLE WATER Water that has been examined and treated to meet appropriate standards and declared fit for domestic consumption by responsible installation medical authorities.

B-30. PRIMACY Primary enforcement authority. A state government has primary enforcement authority under the Safe Drinking Water Act. primacy is delegated to the state by the EPA Administrator. Before assuming primacy, the state shall establish drinking water regulations no less stringent than the present NPDWR.

B-31. PUBLIC WATER SYSTEM A system for the provision to the public of piped water for human consumption. A system that has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year. This term includes:

1. Any collection, treatment, storage, or distribution facility under the control of the operator of such systems and used primarily in connection with such system.

2. Any collection or pretreatment storage facilities not under such control that are used primarily in connection with such system. A public water system is either a "community water system" or a "noncommunity water system."

B-32. 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 a natural or impounded body of water, such as a stream, lake, pond, or a ground water aquifer.

B-33. 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.

B-34. SANITARY DEFECTS Conditions that may cause the contamination of a 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.

B-35. SANITARY SURVEY An on site review of the water source, facilities, equipment, operation, and maintenance of a public water system for evaluating adequacy of such source, facilities, equipment, operation, and maintenance for producing and distributing safe drinking water.

B-36. SHOULD Indicates an advisory recommendation that is to be applied when practicable.

B-37. SPRING A spring is a concentrated discharge of ground water appearing at the ground surface.

B-38. STANDARD SAMPLE The aliquot (100 ml) of finished drinking water that is examined for the presence of coliform bacteria.

B-39. SUPERCHLORINATION The application of chlorine in dosages far in excess of the chlorine demand for disinfection.

B-40. SUPPLIER OF WATER Any person

who owns or operates a public water system.

B-41. TOTAL AVAILABLE CHLORINE The sum of the chlorine forms present as free available chlorine and combined available chlorine.

B-42. TREATED WATER Water that has undergone processing such as sedimentation, filtration, softening, disinfection, etc., and is ready for consumption. Included is purchased potable water that is retreated (chlorinated, fluoridated, etc.).

B-43. TRIHALOMETHANES (THM) A class of organic compounds, commonly found in chlorinated or brominated drinking waters. THM are formed by the reaction of naturally occurring organic substances (commonly called precursors) with chlorine or bromine during water treatment operations and distribution. The four organic halogen compounds that make up total trihalomethanes are: Trichloromethane (chloroform), bromodichloromethane, dibromochloromethane and tribromomethane (bromoform).

B-44. WATER QUALITY The chemical, physical, radiological, and microbiological characteristics of water with respect to its suitability for a particular purpose.

B45. VACUUM BREAKER, NONPRESSURE TYPE A device or means to prevent backflow designed not to be subjected to static line pressure.

B-46. VACUUM BREAKER, PRESSURE TYPE A device or means to prevent backflow designed to operate under conditions of static line pressure.

who owns or operates a public water system.

B-41. TOTAL AVAILABLE CHLORINE The sum of the chlorine forms present as free available chlorine and combined available chlorine.

B-42. TREATED WATER Water that has undergone processing such as sedimentation, filtration, softening, disinfection, etc., and is ready for consumption. Included is purchased potable water that is retreated (chlorinated, fluoridated, etc.).

B-43. TRIHALOMETHANES (THM) A class of organic compounds, commonly found in chlorinated or brominated drinking waters. THM are formed by the reaction of naturally occurring organic substances (commonly called precursors) with chlorine or bromine during water treatment operations and distribution. The four organic halogen compounds that make up total trihalomethanes are: Trichloromethane (chloroform), bromodichloromethane, dibromochloromethane and tribromomethane (bromoform).

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APPENDIX C
PRINCIPAL WATERBORNE DISEASES OF CONCERN WITHIN CONUS

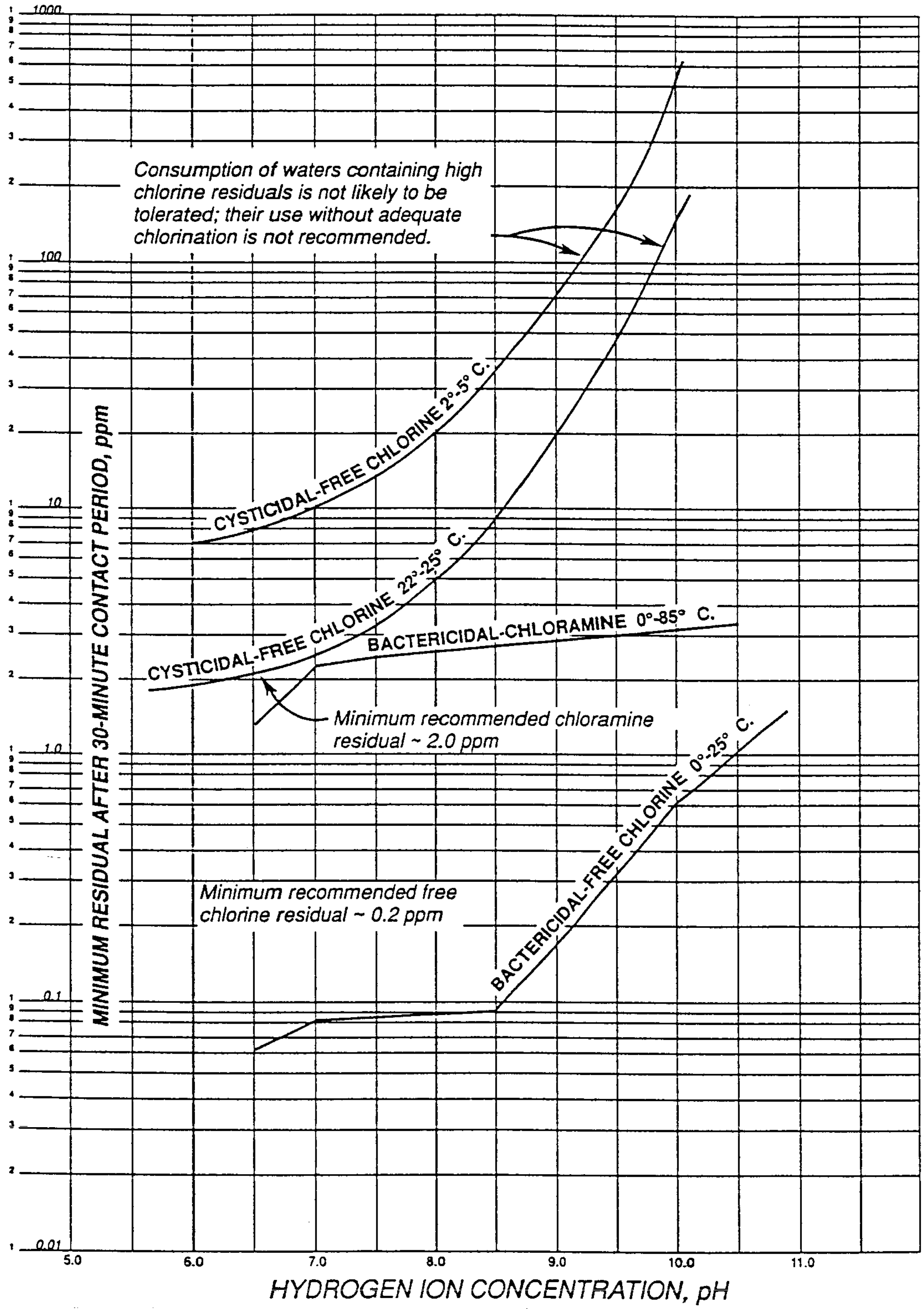
C-1. The principal diseases contracted by man from ingesting contaminated water are gastroenteritis, (both viral and bacterial), giardiasis and other protozoal diseases, typhoid fever, salmonellosis, shigellosis, and viral hepatitis. Also, the larvae of certain schistosomes of birds and mammals can penetrate human skin and cause a dermatitis upon exposure to raw water in the Great Lakes of North America. These schistosomes do not mature in man; the resulting dermatitis is sometime known as “swimmer’s itch.”

C-2. The transmission of these diseases is not limited only to water. With the exception of the bird or mammal schistosome, they all enter man by the fecal-oral route. The impact of waterborne disease may be catastrophic since a single contaminated water supply may affect an entire population rather than isolated individuals. The incidence of waterborne outbreaks is on the increase, possibly due to accident, negligence, or a drastic change in conditions at an existing treatment plant.

C-3. Figure 5-C 1 shows a single line for bactericidal chlorine residuals over the temperature range 0°—2° C. The same is true for bactericidal chloramine residuals. Also shown are curves for cysticidal residual for free chlorine for the low and normal temperature ranges.

C-4. NAVMED P-5010-6, Water Supply Afloat, discusses disinfection of water manufactured on Navy ships both on the open sea and from areas where amebiasis or hepatitis is endemic. NAVMED P-5010-9 discusses water supply procedures for field units of the Navy and Marine Corps. *Control of Communicable Diseases in Man,* NAVMED P-5038, published by the American Public Health Association discusses the infectious agents, reservoirs, incubation periods, and methods of control for waterborne diseases found both in CONUS and in overseas areas.

FIGURE 5-C1 — Minimum 30 minutes free chlorine and chloramine residuals for naturally clear or filtered water



APPENDIX D
SAFE OPERATION OF CHLORINATION FACILITIES

D-1. Chlorine storage and use areas must be isolated from other work areas and kept in a dry condition. All chlorine cylinders must be secured to prevent rolling or falling. Empty containers will be segregated from full containers and tagged. Cylinders must not be stored near heat sources, or areas of elevated temperature. Storage will be above ground in a well-ventilated area separated from other occupied areas by a gas tight partition. “

D-2. The room must be continuously ventilated at a rate of one air change every 2 minutes through exhaust grilles located not more than 6 inches above the floor level and make up air vents located high on the opposite wall. The ventilated air must be exhausted to the outdoors and not into interior areas. All doors must be hinged to open outward and at least one door will have a viewport to let operators look into the room before entering. Written operating instructions developed by the local safety officer, must be posted near the chlorination facility. Operating switches for lights and ventilation fan must be located exterior to and adjacent to the chlorine room access door.

D-3. A warning sign, similar to the following, must be affixed in a readily visible location at or near entrances to the chlorination room:

CAUTION
CHLORINE HAZARD AREA
UNAUTHORIZED PERSONS KEEP OUT
CAUSES BURNS, SEVERE EYE HAZARD
MAY BE FATAL IF INHALED
IN CASE OF EMERGENCY CALL
(Fire Department #)
DO NOT ENTER SPACE

D-4. Where chlorine gas is used, one of the most important items of safety equipment is a fail-safe type chlorine leak detector. The leak detector must sound an alarm at an atmosphere chlorine concentration of 1 ppm ($3mg/m^3$). The chlorine detector will be calibrated and maintained per the manufacturer’s instructions. Written records of calibration and maintenance will be kept on file.

D-5. Personal Protection Equipment.

1. Employees will be provided with and required to use impervious clothing, gloves, face shields (eight inch minimum), and other protective clothing necessary to prevent any possibility of skin contact with liquid chlorine.

2. Where there is any possibility of exposure of an employee’s body to liquid chlorine, facilities for quick drenching of the body will be provided within the immediate work area for emergency use.

3. Non-impervious clothing which becomes contaminated with chlorine will be removed immediately and not reworn until the chlorine is removed from the clothing.

4. Employees will be provided with and required to use splash-proof safety goggles where there is any possibility of liquid chlorine contacting the eyes.

5. Where there is any possibility that employees’ eyes may be exposed to liquid chlorine, an eye wash fountain will be provided within the immediate work area for emergency use.

D-6. In the event of a chlorine leak or spill employees must immediately evacuate the area and notify the fire department or rescue unit. Fire department and rescue personnel will be qualified to contain chlorine leaks or spills and are under a respiratory protection program which includes regular training in respirator selection, maintenance, inspection, cleaning, and evaluation.

D-7. Leak repairs must be made by personnel trained in the use of and equipped with a self-contained breathing apparatus (SCBA). It is recommended that SCBA equipment (two sets) be kept at a central location (i.e., fire station) so that they can be used throughout the installation whenever the need arises. SCBA equipment must be maintained per the respirator program. See OPNAVINST 5100.23 series.

D-8. The base safety officer or a qualified dustrial hygienist (located at Naval hospitals, clinics commands and NAVE NPVNTMEDUS) will be consulted about the safe operation of chlorimation facilities.

APPENDIX E
NAVY ENVIRONMENTAL AND PREVENTIVE MEDICINE UNITS

UNIT	GEOGRAPHICAL AREA OF ASSIGNMENT
Navy Environmental and Preventive Medicine Unit No. 2 Norfolk, Virginia 23511-6288 Commercial: (804) 444-7671 AUTOVON:564-7671	20° W longitude West to 100° W longitude, including Iceland
Navy Environmental and Preventive Medicine Unit No. 5 Naval Station, Box 143 San Diego, California 92136-5143 Commercial: (619) 556-7070 AUTOVON: 526-7070	100° W longitude West to 150° W longitude, including all of Alaska
Navy Environmental and Preventive Medicine Unit No. 6 Pearl Harbor, Hawaii 96860-5040 (Mail address: Box 112, Fleet Post Office San Francisco 96610 Commercial: (808) 471-9505 AUTOVON: 430-0111 ask for 471-9505	150º W longitude West to 70° E longitude, except Alaska
U.S. Navy Environmental and Preventive Medicine Unit No. 7 Naples, Italy (Mail address Fleet Post Office New York 09521 Commercial: 9-011-39-81-724-4468/4469 AUTOVON: 450-3219	70° E longitude West to 20° W longitude, except Iceland

APPENDIX F
TREATED WATER QUALITY
STANDARDS

Section 1. NATIONAL PRIMARY DRINKING WATER REGULATIONS (NPDWR)

F-1. Contaminant Levels for Inorganic Chemicals

Contaminant	MCLG mg/L[1]	MCL mg/L	AL mg/L[2]
Asbestos	7 million fibers/L longer than 10 micrometers	7 million fibers/L longer than 10 micrometers	
Arsenic		0.05	
Barium	2	2	
Cadmium	0.005	0.005	
Chromium	0.1	0.1	
Copper	1.3		1.3 [3]
Lead	o		0.015[4]
Mercury	0.002	0.002	
Nitrate (as N)	10	10	
Nitrite (as N)	1	1 '	
Total Nitrate and Nitrite (as N)	10	10	
Selenium	0.05	0.05	
Fluoride	4	4	

1 Maximum Contaminant Level Goal (MCLG). The maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur, and which allows an adequate margin of safety. Maximum contaminant level goals are nonenforceable health goals.

2 Action Level (AL). Concentration of lead or copper in water that determine, in some cases, whether a water system must install corrosion control treatment, monitor source water, replace lead service lines, and undertake a public education program.

3 The copper action level is exceeded if the concentration of copper in more than 10 percent of tap water samples properly collected during any monitoring period is greater than 1.3 mg/L (i.e., if the "90th percentile" copper level is greater than 1.3 mg/L).

4 The lead action level is exceeded if the concentration of lead in more than 10 percent of tap water samples properly collected during any monitoring period is greater than 0.015 mg/L (i.e., if the "90th percentile" lead level is greater than 0.015 mg/L).

F-4. Turbidity. The MCL for turbidity is applicable to both community water systems and noncommunity water systems using surface water sources in whole or in part. The MCL for turbidity in drinking water measured at a representative entry point(s) to the distribution system is:

1. One turbidity unit for monthly average (5 turbidity units monthly may apply at State option).

2. Five turbidity units (maximum) average for two consecutive days.

3. The requirements in this section apply to unfiltered systems until 30 December 1991, unless the State has determined prior to that date, in writing, that filtration is required. These requirements apply to filtered systems until 29 June 1993. The requirements apply to unfiltered systems that the State has determined, in writing, must install filtration until 29 June 1993 or until filtration is installed whichever is later. After the above dates, consult the latest edition of 40 CFR 141.

F-5. Coliform Bacteria

1. The MCL for coliform bacteria (also called total coliforms) is based on the presence or absence of coliforms in a sample rather than on an estimate of coliform density.

a. The MCL for systems analyzing at least 40 samples each month is: No more than 5 percent of the monthly samples may be total coliform positive.

b. The MCL for systems analyzing fewer than 40 samples/month is: No more than 1 sample per month may be total coliform positive.

2. A public water system must demonstrate compliance with the MCL for total coliforms each month it is required to monitor.

3. MCL violations must be reported to the State no later than the end of the next business day after the system learns of the violation.

4. Monitoring Requirements for Total Coliforms:

a. Each public water system must sample according to a written sample siting plan. Plans are subject to State review and revision. The State must establish a process which ensures the adequacy of the sample siting plan for each system.

b. A system must collect a set of repeat samples for each total coliform-positive routine sample and have it analyzed for total coliforms. At least one repeat sample must be from the same tap as the original total Coliform-positive sample; other repeat samples must be collected from within five service connections of the original total coliform-positive sample. At least one must be upstream and another downstream. The system must collect all repeat samples within 24 hours of being notified of the original result, except where the State waives this requirement on a case-by-case basis. If a total coliform-positive sample is at the end of the distribution system, or one service connection away from the end of the distribution system, the State may waive the requirement to collect at least one repeat sample upstream of the original sampling site.

c. If total coliforms are detected in any repeat sample, the system must collect another set of repeat samples, as before, unless the MCL has been violated and the system has notified the State (in which case the State may reduce or eliminate the requirement to take the remaining samples).

d. If a system has only one service connection, the State has the discretion to allow the system to collect the required set of samples at the same tap over a four-day period or to collect a larger volume repeat sample(s) (e.g., a single 400ml sample).

e. If a system which collects fewer than five samples/month detects total coliforms in any routine or repeat sample (and the sample is not invalidated by the State), it must collect a set of five routine samples the next month the system provides water to the public, except that the State may waive this requirement if (1) it performs a site visit to evaluate the contamination problem, or *(2)* it has determined why the sample was total coliform-positive and (a) this finding is documented in writing along with what action the system has taken or will take to correct this problem before the end of the next month the system serves water to the public, (b) this document is signed by the supervisor of the State official who makes the findings, (c) the documentation is made available to EPA and the public and (d) in certain cases (described in this rule), the system collects at least one additional sample.

f. Unfiltered surface water systems and systems using unfiltered ground water under the direct influence of surface water must analyze one coliform sample each day the turbidity of the source exceeds one NTU (this sample counts toward the system's minimum monitoring requirements) .

g. Monthly monitoring requirements are based on population served. Tables 5-F1 and 5-F2 summarize the routine and repeat sampling requirements for total coliforms.

TABLE 5-F1
Total Coliform Sampling Requirements
According to Population Served

Population Served			Minimum Number of Routine Samples per Month
25	to	1,000	1 *
1,001	to	2,500	2
2,501	to	3,300	3
3,301	to	4,100	4
4,101	to	4,900	5
4,901	to	5,800	6
5,801	to	6,700	7
6,701	to	7,600	8
7,601	to	8,500	9
8,501	to	12,900	10
12,901	to	17,200	15
17,201	to	21,500	20
21,501	to	25,000	24
25,001	to	33,000	30
33,001	to	41,000	40
41,001	to	50,000	50 **

*** For non-community water systems see NPDWR.**
**** For community water systems serving greater than 50,000 see NPDWR.**

5. Invalidation of Total Coliform Positive Samples

a. Each total coliform-positive sample counts in compliance calculations, unless

b. a turbid culture in the absence of an acid reaction using the P-A;

c. or confluent growth or colony number that is "too numerous to count" using the MF, the sample is invalid (unless total coliforms are determined, in which case, the sample is valid) and the system must, within 24 hours of being notified of the results, collect another sample from the same location as the original sample and have it analyzed for total coliforms. In such case, EPA recommends using media less prone to interference from heterotrophic bacteria for analyzing the replacement sample. The State may waive the 24-hour time limit on a case-by-case basis.

10. Analytical Methodology

a. Total coliform analyses are to be conducted using the 10 tube MTF, the MF, The P-A or the MMO-MUG test. A system may also use the 5 tube MTF technique (using 20 ml sample portions) of a single culture bottle containing the MTF medium, as long as a 100 ml sample is used in the analysis.

b. A 100 ml standard sample volume must be used in analyzing for total coliforms, regardless of the analytical , method used.

c. Fecal coliform analysis must be conducted using methods described in 40 CFR 141.21 and *Standard Methods.*

d. *E. coli* analysis must be conducted using methods described in the *Federal Register* of 8 Jan 91 (56 FR 642) and/or *Standard Methods.*

F-6. The MCL for radiological contaminants are: *

Gross alpha particle activity including radium 226 but excluding radon and uranium. . . .	15 pCi/L
Combined radium-226 and radium-228	5 pCi/L
Tritium.	20,000 pCi/L
Strontium-90	8 pCi/L

*Screening indicators have been established for radiological contaminants. Gross alpha present at less than or equal to 5 pCi/L, as an indicator, eliminates the need to analyze for radium 226 and 228. Gross beta present at less than or equal to 8 pCi./L, as an indicator, eliminates the need to analyze for tritium and strontium-90.

F-7. Sodium and Corrosivity

No MCLs have been published; however, monitoring is required. See Appendix G.

Section II. NATIONAL SECONDARY DRINKING WATER REGULATIONS (NSDWR)

F-8. The secondary MCLs are as follows:

Contaminant	Level
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 color units
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2.0 mg/L
Foaming agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5 to 8.5
Silver	0.1 mg/L
Sulfate	250 mg/L
Total Dissolved Solids (TDS)	500 mg/L
Zinc	5 mg/L

Note: The contaminants covered by this regulation are those that may adversely affect the aesthetic quality of the drinking water. These secondary levels represent reasonable goals for drinking water quality, but are not federally enforceable. The individual States may establish higher, lower or no levels for these contaminants. All Navy and Marine Corps facilities must provide drinking water of the highest quality in consonance with the NSDWR as well as the federally enforceable NPDWR.

APPENDIX G
NPDWR SURVEILLANCE REQUIREMENTS

System	Source	Test	Sampling interval
Community water	Surface water	Inorgmics	annually
		Organics	every 3 years
		Radiochemicals	every 4 years
		Turbidity	daily
		Coliform bacteria	monthly*
		Trihalomethanes	quarterly**
		Nitrates	annually
		Sodium	annually
		Corrosivity	biannually
	Ground water	Inorganic	every 3 years
		Organics	State option
		Radiochemicals	every 4 years
		Turbidity	State option
		Coliform bacteria	monthly*
		Trihalomethanes	quarterly**
		Nitrates	every 3 years
		Sodium	every 3 years
		Corrosivity	annually
Noncommunity water	Surface water	Inorganic	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	daily
		Coliform bacteria	quarterly
		Nitrates	State option
	Ground water	Inorganic	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	State option
		Coliform bacteria	one per quarter
		Nitrates	State option

*Number of samples dependent on number of people served bysystem.

**For systems serving greater than 10,000 population. For those systems serving populations less than 10,000 monitoring is at state discretion.

APPENDIX G
NPDWR SURVEILLANCE REQUIREMENTS

System	Source	Test	Sampling interval
Community water	Surface water	Inorgmics	annually
		Organics	every 3 years
		Radiochemicals	every 4 years
		Turbidity	daily
		Coliform bacteria	monthly*
		Trihalomethanes	quarterly**
		Nitrates	annually
		Sodium	annually
		Corrosivity	biannually
	Ground water	Inorganic	every 3 years
		Organics	State option
		Radiochemicals	every 4 years
		Turbidity	State option
		Coliform bacteria	monthly*
		Trihalomethanes	quarterly**
		Nitrates	every 3 years
		Sodium	every 3 years
		Corrosivity	annually
Noncommunity water	Surface water	Inorganic	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	daily
		Coliform bacteria	quarterly
		Nitrates	State option
	Ground water	Inorganic	State option
		Organics	State option
		Radiochemicals	State option
		Turbidity	State option
		Coliform bacteria	one per quarter
		Nitrates	State option

*Number of samples dependent on number of people served bysystem.
**For systems serving greater than 10,000 population. For those systems serving populations less than 10,000 monitoring is at state discretion.

APPENDIX H
REFERENCES

H-1. **NAVY Instructions**

1. OPNAVINST 5090.1, Environmental and Natural Resources Protection Manual.

2. OPNAVINST 5100.23 Series, Navy Occupational Safety and Health (NAVOSH) Program.

3. NAVFACINST 11330.11. Backflow rreventers, Reduced Pressure Principle Type.

4. NAVSUPINST 5100.24 Series, Calcium Hypochlorite.

5. NAVMEDCOM 6240.1 Series, Standards for Potable Water.

H-2. **NAVAL FACILITIES ENGINEERING COMMAND MANUALS**

1. NAVFAC DM-5.7, Water Supply Systems.

2. NAVFAC MO-210, Operation and Maintenance of Water Supply Systems.

H-3. **NAVAL ENERGY AND ENVIRON-**

MENTAL SUPPORT ACTIVITY

1. NEESA 1-038 Water Management Contingency Planning.

H-4. **NAVAL SEA SYSTEMS COMMAND MANUAL**

1. NAVSEA S6470-AA-SAF-010, Gas Free Engineering.

H-5. DEPARTMENT OF THE ARMY PUBLICATIONS

1. TB MED 576, Sanitary Control and Surveillance of Water Supplies at Fixed Installations.

2. TM5-700, Field Water Supply.

H-6. **PUBLIC LAW** Public Law 93-523, Safe Drinking Water Act.

H-7. **CODE OF FEDERAL REGULATIONS**

1. Title 29, Code of Federal Regulations (CFR), Part 1910 OSHA Safety and Health Standards.

2. Title 40, Code of Federal Regulations (CFR), Part 141, National Primary Drinking Water Regulations, as amended.

3. Title 40, Code of Federal Regulations (CFR), Part 143, National Secondary Drinking Water Regulations.

H-8. **MISCELLANEOUS**

1. U.S. Environmental Protection Agency, Water Supply Division. *Cross-Connection Control Manual,* EPA-570/9-89-007.

2. U.S. Environmental Protection Agency, Municipal Environmental Research Laboratory, *Treatment Techniques for Controlling Trihalomethanes* in *Drinking Water,* EPA-600/2-81-156.

3. American Water Works Association, *Emergency Planning for Water Utility Management,* AWWA manual M19.

4. American Water Works Association, *Standardfor Deep Wells* AWWA No. A100-66.

5. American Water Works Association, *Standard for Disinfection Water Mains.* AWWA No. C-601-68.

6. American Water Works Association, *Standard for Inspecting and Repairing Steel Water Tanks, Stand Pipes, Reservoirs, and Elevated Tanks, for Water Storage,* AWWA D101-53 (R1979).

7. American National Standards Institute (ANSI) Z117.1-1977, *American Safety Requirements for Working in Tanks and other Confined Spaces.*

8. National Academy of Sciences, *D-inking Water and Health,* Volumes 1 (1977),2 (1980) National Academy of Sciences, 201 Constitution Avenue, Washington, DC.

9. Ehlers, V., and E. Steel, *Municipal and Rural Sanitation,* 6th edition, McGraw-Hill Book Company, Incorporated, 1965.

10. Salvato, J.A., *Environmental Engineering and Sanitation,* 3rd edition, John Wiley and Sons, 1982.

11. Freedman, B., *Sanitarian's Handbook, Theory and Administrative Practice for Environmental Health,* 4th edition, Peerless Publishing Company, 1977.

12. White, G. C., *Handbook of Chlorination,* 2nd edition, Van Nostrand Reinhold Company, 1986.

13. APHA-AWWA-WPCF, *Standard Methods for the Examination of Water and Wastewater,* 16th edition, American Public Health Association.

14. U.S. Environmental Protection Agency Manual EPA-430/9-74-007, *The Manual of Individual Water Supply Systems.*

15. U.S. Environmental Protection Agency Manual, EPA-670/9-75-006, *Handbook for Evaluating Water Bacteriological Laborites.*

16. DHHS (NIOSH) Publication No. 81-123, NIOSH-OSHA *Occupational Health Guidelines for Chemical Hazards.*

APPENDIX I
MICROBIOLOGICAL SAMPLING TECHNIQUE FOR DRINKING

Sample Size: For most purposes, a 100 to 120 ml sample will suffice. Prior coordination with the testing agency is recommended.

Type Container: A sterile, clean container with a screw cap will be used in microbiological sampling. EPA approved water sampling bags containing sodium thiosulfate may also be used.

PROCEDURE

I-1. Open the cold water tap and allow the water to flow freely for several minutes to ensure drawing water directly from the mains. Determine the chlorine residual and pH, and record the value.

Note: Samples must not be collected from faucets with aerators, swivel or add-on devices unless these devices are removed before running the water in this step.

I-2. Reduce the flow to produce a small stream of water. Carefully remove the cap or stopper of the sample bottle by grasping the outside of the cap. Do not touch any surfaces which the sample will contact. Hold the cap in the hand. Fill the bottle to within one-half inch of the bottom of the neck and replace the cap.

I-3. Complete, the information required on DD Form 686 (Fluoride Bacteriological Examination of Water) identifying the sample as to exact source, time of collection, chlorine residual, special circumstances if any, and the address to which the report will be forwarded. Identify the sample bottle and the data card by the same number.

I-4. Sodium thiosulfate should be added to the sample container before collection of the sample. This chemical stops the bactericidal action of the chlorine residual present in the drinking water sample. Consult the current edition of *Standard Methods for the Examination of Water* and *Wastewater* for preparation of this chemical. DO NOT RINSE OR FLUSH THE SAMPLES CONTAINER PRIOR TO COLLECTING THE SAMPLES AS THE SODIUM THIOSULFATE WILL BE WASHED OUT!

I-5. In the case of individual potable water samples sent to the laboratory by courier, the elapsed time between collection and examination will not exceed 6 hours. (The exception to this 6-hour rule is for samples mailed from distant installations; these samples may be held for up to 30 hours.) Samples will be refrigerated to 4° C during shipment. The time and temperature of storage of all samples will be recorded and must be considered in the interpretation of data.

I-6. Flaming water taps before collecting potable water samples is not necessary if reasonable care is exercised in the choice of sampling tap (clean, free of attachments, and in good repair) and if the water is allowed to flow at a uniform rate before sampling. Alterations in the valve setting to change the flow rate during collection could affect the sample quality. Superficially passing a flame from a match or an alcohol-soaked cotton applicator over the tap a few times may have a psychological effect on observers, but it will not have a lethal effect on attached bacteria. The application of intense heat may damage the valve-washer seating or create a fire hazard to combustible materials next to the tap. If successive samples from the same tap continue to show coliforms, the tap maybe disinfected with a hypochlorite solution to reduce external contamination as the source of these organisms.

APPENDIX J
REMEDIAL ACTIONS TO BE TAKEN IN EVENT CONTAMINATED WATER SAMPLES ARE FOUND

Conditions	Possible Cause	Recommendations
1. No known sanitary defects, health hazards, or incidents of a gastrointestinal disease.	The contaminated samples might indicate a localised situation within the piping of the building where the sample was collected, or a faulty sampling technique.	a. Collect repeat samples promptly. b. Expedite shipment of samples so that a prompt report may be obtained from the laboratory. c. Make an immediate investigation to determine if any unusual conditions have occurred, such as repairs to the water mains, faucets, or piping within the building, or in the vicinity of the sampling point. d. Test for chlorine at various outlets to ensure the proper dosage. e. If the foregoing investigation shows the need, flush the portion of the system by opening outlets, until a proper chlorine residual is recorded; carry out localised chlorination if needed. f. Resample following paragraph 5-20.3.e. g. If examination shows that conditions defined in paragraph 2 below exist, then the remedial actions recommended in that paragraph must be followed.
2. occurrence of a major disaster, such as the inundation of the source, breakdown in treatment plant units, gross contamination of the system through a cress-connection, failure of an underwater crossing, damage from an earthquake, etc.	Self evident.	a. Immediate rejection of water supply system and institution of an emergency treatment program. Treat all drinking water and water used for culinary purposes. b. After the necessary repairs have been completed, super-chlorinate and flush the entire system. c. Collect samples from representative points throughout the system until negative microbiological results are obtained on at least two consecutive sets of standard samples collected on different days. d. Remove restrictions on the use of water.
3. Occurrence of an outbreak of one of the so-called waterborne diseases.	Contamination of the water system at the source, in reservoirs, treatment plant facilities, or distribution system and not generally obvious at the onset of the outbreak.	a. Carry out recommendations under Condition 1 with special emphasis on the investigation of the source, reservoirs, treatment processes, and distribution system. b. Increase the chlorine dosage and residual in the system. c If the conditions contributing to the contamination are found to be serious, such as a direct contamination with sewage, reject the supply and institute emergency treatment until the condition is corrected.