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SANITARY CONTROL AND SURVEILLANCE OF WATER SUPPLIES AT FIXED INSTALLATIONS

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*This bulletin supersedes TB MED 576, dated 15 March 1982.

CHAPTER 1

INTRODUCTION

1−1. Purpose

This technical bulletin, medical (TB MED) provides public health information and guidance regarding the production, distribution, and surveillance of potable water supplies at fixed installations according to the public health drinking water program functions outlined in Department of the Army Pamphlet (DA Pam) 40−11.

1−2. General

Surveillance and control of the potable water supply system at Army installations requires coordinated efforts and expertise from several organizations. The day-to-day operations and maintenance of water treatment, distribution, and storage systems, to include water sampling for regulatory compliance, are performed by the water supplier and system operator. This may include the installation Directorate/Department of Public Works (DPW), Facilities Engineering, neighboring community water utilities, or base operating contractors. General requirements for water supply treatment, distribution, management, and surveillance on the installation are specified in Army Regulation (AR) 420−1 and are further discussed in this bulletin. The installation public health (PH) authority conducts drinking water quality assurance monitoring to ensure the water supply remains safe for human consumption.

1−3. References

See appendix A.

1−4. Explanation of abbreviations and terms

See the glossary.

1−5. Responsibilities

a. The Chief of Engineers. The Chief of Engineers refers to the Chief of the U.S. Army Corps of Engineers (USACE). This individual/organization is responsible for the design and construction of facilities for utility services.

b. Installation Commander. The installation commander (IC), also referred to as the garrison commander, provides utility services in compliance with applicable standards, laws, and regulations. Utility service includes Army drinking water systems that are optimally operated and maintained, and capable of providing safe palatable drinking water. The DPW, applicable contractors, and the installation medical authority (IMA) assist commanders in ensuring that water systems are operated and maintained in a safe and sanitary manner to protect human health according to all applicable regulations. At some facilities, the IC is deemed the highest-ranking member of the installation staff, while the garrison commander manages the operations and all activities at the installation. For the purposes of this document, the two terms may be used interchangeably.

c. Director of Public Works. The Director of Public Works is the principal staff officer who reports to the IC, or appropriate commander, at installations in the continental United States (CONUS) and is responsible for all utility functions. At many Army installations, the water system is operated and maintained by an operating contractor who maintains a long-term lease to control the water system and appurtenances. The Director/operating contractor—

(1) Provides safe, efficient, reliable, and Life Cycle Cost (LCC)-effective utility services, including water supply services that provide for the health and well-being of the supported population and enable the installation to meet mission requirements.

(2) Coordinates with the IMA for utility service planning.

(3) Provides for the protection and security of utility systems.

(4) Conducts or contracts compliance monitoring of the water supply, as required by the State/local authority, and reports monitoring results to the regulatory authority.

At installations outside the continental United States (OCONUS), water system operations and maintenance may be controlled by the DPW, operating contractors, or the municipality providing water to the installation.

d. Installation Medical Authority and Installation Public Health Authority. The relational roles of the IMA and the installation PH authority are outlined in AR 40–5. The installation PH authority collaborates with the IMA to provide coordinated, efficient, and thorough delivery of PH services on the installation and within their defined area of responsibility (AOR) (refer to app B). Environmental health (EH) services such as drinking water and source water quality monitoring are functions of the installation PH authority and are provided according to the implementing instructions and guidance in DA Pam 40–11, as supplemented by this TB MED. Many installations may not possess an inherent PH Program or IMA. If not, the PH/IMA responsibilities must be assumed by the activities covering that AOR, as depicted in appendix B or as identified by the Defense Health Agency (DHA). Resources needed to perform the requisite duties at all facilities within the PH/IMA's designated AOR should be incorporated into annual requirements submitted to the U.S. Army Medical Command (MEDCOM)/DHA.

e. Installation Public Health Authority. The installation PH authority plays a critical role (as described in this document) for the installation's potable water supply by ensuring a safe product of consistently high quality is maintained. This responsibility requires a team of EH personnel who are knowledgeable in the operation, maintenance, and surveillance of a water supply system. The installation PH authority—

(1) Maintains sampling supplies and equipment to perform the following water quality tests and analysis:

(a) Free available chlorine (FAC) or combined available chlorine (CAC) residual.

(b) Total coliform and *Escherichia coli* (*E. coli*)/fecal coliform. The membrane filter technique or another U.S. Environmental Protection Agency (EPA)-approved alternative, such as Colilert® or Colisure®, is appropriate.

(c) Potential of hydrogen (pH).

(2) Establishes and maintains proper communication and coordination with the DPW or contractor personnel responsible for water purveyance to become familiar with the water supply and distribution system, remain informed when changes or disruptions occur, and exchange information related to drinking water quality as presented in this publication.

(3) Maintains medical oversight and provides technical assistance and support for the

Army's drinking water surveillance program at fixed Army installations that produce water, or purchases drinking water from a regulated supplier off post.

(4) Ensures drinking water sampling and analysis addresses all requirements identified within the state/Federal and Army drinking water regulations (or applicable OCONUS requirements), whichever maintains regulatory primacy or is more stringent.

(5) Advises the IMA and IC to ensure adequate monitoring is accomplished at all installations to ensure the safety and security of water supplies, even where the supply is not directly regulated by the state or Federal authority. For example, a noncommunity water supply at an installation containing only 200 personnel may fall below the criteria required for regulatory scrutiny. Where the water supply falls below the criteria for regulatory oversight, monitoring should be based on the results of initial water supply/source analyses.

(6) Incorporates "high-risk" areas of the distribution system, such as child development centers, schools, hospitals and clinics, and areas with low flow or stagnant waters, as part of the surveillance sampling plan.

(7) Consults with the appropriate regional Public Health Command (PHC) or the Defense Centers for Public Health–Aberdeen (DCPH-A) (formerly the U.S. Army Public Health Center (APHC)), as specified in DA Pam 40–11, when assistance is required for evaluation of water supply system operations, maintenance, or associated monitoring activities. The installation PH Program should first request assistance from the regional PHC. DCPH-A may be consulted if additional or broader-scale support is required.

(8) The PH authority is not generally responsible for compliance monitoring at Army installations. The installation PH authority routinely maintains a supplementary sampling role within CONUS and most other locations. Within Europe and potentially any other installation (as needed), the PH authority may maintain greater responsibility if their participation is approved by the regulatory authority and a memorandum of agreement (MOA) between the installation Command and the PH authority is signed. This MOA must specify all duties regarding sampling, analysis, reporting, and the compensation provided for such services. Analyses must be performed by an appropriately certified laboratory—either the PH laboratory or a contracted facility.

f. Installation Environmental Coordinator. The installation Environmental Coordinator (EC) is usually located within the Environmental Division of the installation. The EC has many roles in reviewing and approving environmental plans and remediation activities. Historically, the EC also serves as the representative of the IC in interactions with the regulatory authorities for issues addressing water supplies. In the past, it has been the EC's responsibility to ensure that compliance sampling and analysis are routinely conducted on the installation and that all requisite data have been submitted to the appropriate primacy regulatory authority (usually the state). Further, the EC serves as the single point of contact between the installation Command and the regulatory authorities, to ensure that a single, clear message is conveyed in both directions. Currently, privatization contracts may transfer some of this authority to the operating contractor.

g. Housing Services Office. Potable water delivered to privatized housing becomes a responsibility of the contracted housing partner once the water enters the privatized building. Residents should report concerns with water quality, plumbing and fixtures, or related issues inside privatized housing to the garrison Housing Services Office (HSO). The HSO is responsible for ensuring the privatized housing partner mitigates any validated drinking water issues within privatized buildings in accordance with contract requirements.

CHAPTER 2

DRINKING WATER SUPPLY SOURCES

2–1. Selection and protection of water sources

The selection and protection of all potential sources of supplied drinking water are critical. The installation PH authority should coordinate closely with the IC, DPW, Engineering, and water system authorities/contractors to define the mission priorities of the Command and ensure that safe water supplies are provided to support those missions. All such authorities must ensure that the total water needs, including average daily demand, peak demand, and firefighting demands, are met and that water quality remains high. Missions requiring a higher quality of water (exceeding normal, regulated parameters) and systems not receiving routine regulatory scrutiny require increased surveillance and assessment by the installation PH authority. Such systems might include those where specific potential contamination has been identified in the area (for example, leaking underground tanks) or where critical mission uses require a higher level of water quality. The concomitant actions and resources required to address these systems should be enforced for all systems, regardless of whether the primary operators/providers are Government- or contractor-based. Although the PH Program may play only a peripheral review role in the selection of water sources, it is important that the Program understands the sources of water available and the considerations involved in source selection and use. Assess the potential effects and risks associated with new sources combined with distribution system materials and mixture with other water sources used.

a. There are many factors to consider when a viable water source is selected, such as water quality, source volume, and consistent reliability for source output. Water sources must meet average daily water demands, peak daily demands, and firefighting demands.

(1) Apply caution when considering using water sources that exhibit changing water quality throughout the year. For example, stream water quality may change significantly subsequent to heavy rainfall, requiring changes in treatment processes and chemical addition to provide the requisite high-quality water.

(2) Avoid intermittent sources such as rivers, streams, or ponds that dry up or exhibit fluctuating water levels with changing weather conditions.

(3) Identify alternate water sources to assure adequate supplies under all circumstances. Wells may augment the total water supply or serve as a backup for installations that rely on a surface water source that fluctuates in volume during dry summer months. Additionally, installations may maintain emergency interconnections with local community water supply systems.

b. All water sources utilized and developed for an installation must be carefully protected. Most states, and many nations, have developed wellhead protection programs for groundwater supplies. Restrictions and guidelines for these programs are often determined locally.

(1) Guidance for development and implementation of a wellhead protection program is available through the U.S. Environmental Protection Agency (EPA). The following documents delineate the technical considerations for defining and protecting wellhead protection zones to minimize the potential for entraining harmful contaminants into these groundwater sources:

(a) *Handbook:* EPA/625/R-94-001.
(b) *Guidelines:* EPA 440/6-87-010.
(2) The key PH concern is identifying potential contamination activities and sites proximate to well drawdown zones and estimating the risk associated with these activities. The installation PH authority should work with installation DPW/Engineering/Master Planning/operating contractor authorities to perform an expanded Sanitary Survey and relative risk assessment approach to evaluate the potential threats posed to these groundwater resources.

c. Conduct a thorough assessment of potential contamination sources and associated risk for all water sources. Identify the potential contaminants associated with each source. Consider the following as potential contamination sources:

(1) Industrial and commercial activities.

(2) Surface runoff emanating from paved surfaces and agricultural activities. Contaminants may include oils, grease, and gasoline from vehicles; and pesticides and herbicides from residential and commercial weed and insect control.

(3) Surface water sources used for recreational boating activities or supporting transportation assets. The potential release of fuels and oils may adversely affect water quality and increase treatment needs.

(4) Surface water sources downstream from livestock holding areas and poultry farming operations, where fecal contamination, other bacteria, and viruses may be present.

(5) Groundwater sources in the vicinity of injection wells or fracking activities.

d. The installation PH authority must work closely with DPW/operating contractors, Engineering, Master Planning, and Command authorities to periodically review and evaluate potential water sources. Changes to the installation's missions and activities, as well as to water quality and availability, may require development or utilization of new or different water sources.

2–2. Regulated water systems

a. Regulated systems. The EPA and state regulatory authorities oversee operations and water quality for systems classified as public water systems. A public water system may emanate from groundwater wells or surface water sources and is broadly characterized as a system that provides water to a minimum of 25 people through at least 15 service connections or that regularly serves a daily average of at least 25 individuals for at least 60 days within a year. Public water systems are further divided into categories, as presented below, based on the number of people served, the number of service connections present, and the length of time each year that those individuals are served. The regulatory requirements vary for each, depending on the size and water source.

(1) Community water systems (CWSs) serve at least 25 persons on a year-round basis.

(2) Nontransient noncommunity (NTNC) water systems regularly supply water to at least 25 of the same people at least 6 months of the year. Examples include schools, factories, office buildings, and hospitals.

(3) Transient noncommunity (TNC) water systems operate for at least 60 days per year and serve 25 or more people who do not remain at a location for very long. Examples include gas stations and campgrounds.

b. Unregulated systems. Unregulated water supply systems are drinking water sources that do not meet the definition of a public water system. Examples of an unregulated system are individual wells or springs supplying multiple residences, isolated buildings, trailer parks, and training ranges.

(1) Unregulated systems are not part of the public water system and generally do not receive regulatory compliance scrutiny or control from any installation water authority or off-post local regulatory authorities. Examples of unregulated systems include—

(a) A water system that purchases water from a neighboring utility but is not required to conduct compliance sampling on its own.

(b) A consecutive water system (para 2–5).

(2) Installation DPW, Engineering, or operational contractors provide operational control of unregulated water systems, which includes disinfecting, monitoring, and maintaining the water quality of these systems. Activities include a review of all operational and compliance monitoring along with initial and periodic sanitary surveys.

(a) Water from newly established unregulated water systems is required to undergo total coliform sampling and analysis prior to consumption.

(b) The installation PH authority monitors water quality and potability of all unregulated water supplies. Monitoring activities include initial and periodic sanitary surveys.

(c) When a potential or known contamination threat is suspected, conduct sampling and analysis according to the *National Primary Drinking Water Regulations* (NPDWR) and/or applicable OCONUS Army regulations using the guidance presented in this TB MED and TB MED 577. The installation PH authority reviews all data and analytical results to ensure the potability of such water supplies.

2−3. Wells and groundwater

a. Aquifer development. Groundwater is water that originates underground and must be withdrawn for use by means of drilling and the development of wells. In the hydrologic cycle, water from precipitation or surface water bodies percolates through the soils until it reaches a semi-impermeable region below ground and collects there. These regions are known as aquifers. There may be multiple aquifers underground in an area, depending on the local geology and amount of water available. Aquifers may be relatively isolated in size or may extend for great distances. The total volumes available in any region can only be estimated, based on geological studies and the presence of wells already developed. Many aquifers provide sufficient saturated, permeable material to yield reliable quantities of water under hydrostatic or pressure gradient conditions for long-term use. Groundwater is often relatively clear and colorless due to the filtration of water through the soils; it is not readily impacted by surface weather or contamination. However, some naturally-occurring minerals, metals, or radiological sources may be deemed as contaminants and pose potential health threats. Further, the disposal of industrial/commercial contaminants onto surface and subsurface soils, and agricultural wastes and applications such as nitrites/nitrates, pesticides, and herbicides have adversely impacted some groundwater supplies. An evaluation of these contaminants should be conducted prior to development of a groundwater source as a potable water supply to discern if a water source should be used and/or what level of treatment may be required.

b. Well types. Wells are often classified according to their method of construction. The construction and development of water supply wells must follow state/local regulations. Descriptions of particular well types and design considerations are provided in Technical Manual (TM) 3-34.49 and Unified Facilities Criteria (UFC) 3-230-02 (2019).

(1) Dug wells. Dug wells are among the oldest methods recorded for obtaining subsurface water supplies. Soil was excavated by hand shovel to a level below the water table until the water inflow exceeded the digger's bailing rate. (NOTE: The water table is the shallowest subsurface water level encountered and is generally an unconfined aquifer under atmospheric pressure.) Dug wells were typically lined with stones, brick, tile, or other material to prevent collapse, and were covered with a cap of wood, stone, or concrete. Modern dug wells may be excavated with power equipment and lined with concrete tile. Dug wells are now uncommon due to their limited depth, potential for collapse, and the prevalence for surface contamination.

(2) Bored wells. Bored wells are drilled using an auger rotated either manually or by power. Displaced soils are carried to the surface by the auger as the soil is penetrated. The casing is frequently steel, plastic, or concrete. Bored wells generally range from 2 to 30 inches in diameter with a maximum depth of 1000 feet. Because of its proximity to the surface, this type of well displays a higher potential for contamination.

(3) Driven-point wells. Driven-point wells are constructed by driving assembled lengths of pipe into the ground with percussion equipment or by hand. These wells are often 2 inches or less in diameter and have a maximum depth of 50 feet. Driven-point wells are typically used to monitor water table aquifers or contaminated soils (using direct push technology, for example). This type of well is viable only in loose soils or in areas devoid of rock or consolidated geologic features. Because of their shallow depths and the need for loose, relatively permeable soils, driven-point wells pose a high risk for contamination from adjacent surface waters or contamination sources.

(4) Drilled wells. Drilled wells are the most common type used for supplying drinking water. Rotary drills and percussion tools are used to penetrate subsurface substrates, whether unconsolidated or solid materials. Solid casing is used to prevent collapse of the well and to prevent the introduction of fluids from other aquifers. Well screens are also placed at the depth(s) from which water will be withdrawn. The well should be permanently capped and the space around the casing must also be sealed at the surface with grout, concrete, or other material to prevent contamination of the well by water or materials entering from the surface downward around the outside of the casing.

c. Shallow groundwater. Shallow groundwater is groundwater under the direct influence of surface water (GWUDISW), such as a lake, pond, or river. The designation of a system as GWUDISW is often determined by the respective state regulatory agency maintaining primacy. Shallow groundwater wells, also called bank filtration, are often constructed in an array with intake piping extending horizontally around central, vertical withdrawal wells. Water from the surface water source is drawn through the shallow soils into the wells. This type of system is rare but can be found near historic facilities.

(1) Water quality of a shallow groundwater well may closely resemble the biological, physical, and chemical characteristics of surface water sources, depending on the depth of the

well arrays and proximity to the surface water source.

(2) According to the EPA and OCONUS guidelines, water supply systems utilizing GWUDISW are handled similarly to surface water. GWUDISW must meet the filtration and disinfection requirements presented under Subparts H and P of the NPDWR or chapter 3 of the Final Governing Standards (FGS), or the Overseas Environmental Baseline Guidance Document (OEBGD), DoD Manual 4715.05, 2020, for OCONUS operations.

2−4. Surface water

Surface water is water that lies on the Earth's surface and is exposed to the ambient atmosphere and environment. Streams, rivers, lakes, and ponds are all viable surface water sources. Accessing a surface water source and estimating available surface water volume are generally much easier and more straightforward than developing a groundwater source. However, because of its environmental exposure and contamination potential from naturally-occurring and manmade sources, surface water requires greater levels of water treatment and water quality scrutiny prior to human consumption.

a. Potential contamination. Surface water sources are susceptible to microbiological contamination from surrounding soils and animal wastes, to include a myriad of point source and nonpoint source contamination. Examples of contaminants include organic material emanating from decomposing/decaying biota; agricultural wastes (herbicides, pesticides, and fertilizers) washing in from adjacent fields, lawns, and ditches; heavy metals and petroleum product run-off from parking lots and roadways; and chemical and microbiological contamination derived from specific discharge points at residential, commercial, and industrial sources. The overall quality of a surface source, and the cost and effectiveness of available treatment technologies, will determine feasibility for using the source. An additional factor to consider involves the use of certain surface water sources for recreational activities. Apply caution when determining the types of recreational activities that may be allowed on potential surface water sources, and the proximity of those activities to the water treatment plant (influent) location. Generally, swimming and fishing have been allowed at specific locations, while power-boating has been limited due to the potential for fuel spillage or discharge. The installation PH authority and state authorities should characterize surface water sources carefully prior to considering them for development and use. Conduct a comprehensive sanitary survey to characterize the surface water source.

b. Springs. Springs are formed when a confined aquifer is intercepted by the ground surface or an artesian groundwater aquifer is introduced to the ground surface via a geologic fracture. A surface water body (small pond or lake) is often formed as a result. The quality of spring water is generally good. However, potential subsurface hydrological contamination may occur from local residential, agricultural, commercial, or industrial activities, which must be evaluated and characterized. Refer to state guidance regarding development and disinfection of springs.

2−5. Purchased and consecutive water systems

Installations may purchase their water supply from a public or private utility that supplies potable water to a neighboring community. The water purveyor is responsible for ensuring the water supply meets all Federal and state drinking water regulations up to the point of system interconnection with the installation. Water flow is usually metered at the interconnection point so the utility can accurately bill the installation for water usage. The purveyor sees the installation as an interconnected user of the water the purveyor produces. The installation assumes responsibility for water quality between the point of connection from the off-post purveyor and throughout the distribution network located on the installation. This responsibility is particularly important for installations that provide some measure of additional treatment, sell water to a tenant activity, or provide water to a neighboring community via water passing through its piping network or storage tanks (that is, a consecutive water system).

a. In some states or select situations, installation water treatment and distribution systems are fully regulated (similar to the off-post water purveyor) or only partially regulated. Partially regulated systems may require only monitoring and compliance for lead and copper or disinfectant byproducts (DBPs) while others may be required to comply with more extensive standards.

b. In many cases, the installation's water supply system is completely unregulated and free from external scrutiny. If the installation system is unregulated, the water system operator (DPW, Engineers, or contractor) monitors water quality and collaborates with the water purveyor as specified in paragraphs 6–3 and 6–8. The installation PH authority provides water quality assurance monitoring and assessment as specified in paragraph 6–4. In some cases, portions of the installation's water supply system are completely unregulated and free from external scrutiny due to the absence of a significant population served on a routine basis. Those portions of the water system may not be considered community water systems (CWS) and therefore are not addressed by the prevalent regulatory agencies.

c. Installation water supply systems that are unregulated are considered high-risk and may pose potential harm to consumers due to the lack of regulatory scrutiny, regular monitoring, and associated treatment. The installation may be compelled to monitor select water quality parameters that could change within the distribution system. Parameters may include monitoring for chlorine residual, coliform bacteria, lead, copper, and DBPs.

2–6. Bottled water

a. Commercial bottled water is commonly misconceived as being of higher quality than the potable water available from the installation's water supply system. When produced in the U.S., all water supplies used for human consumption must meet the same basic water quality standards according to the NPDWR. The aesthetic quality of bottled water, such as taste, odor, and appearance (clarity), will vary based on the water source, the treatment applied during processing, and other factors such as handling and packaging. Commercial bottled water is typically not packaged with a disinfection residual such as chlorine; a residual disinfectant may impart a slight taste or odor that can be detected by some consumers and found undesirable. The absence of a disinfectant residual makes the bottled water more susceptible to microbiological growth and potential illness. Quality standards for foreign manufactured bottled water may vary significantly from U.S. standards; therefore, commercial bottled water manufacturers that supply the Department of Defense (DoD) must be approved by Army Veterinary Services and listed in the *Worldwide Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement* to ensure essential quality standards are met.

(1) The U.S. Food and Drug Administration (FDA) sets regulations for bottled water produced, packaged, or sold in the U.S. These regulations address processing and bottling of water supplies, and the standards applicable to bottled water. The standards address bottling plant construction and design; sanitation of facilities and operations; and the equipment, procedures, processes, and controls used. The quality standards defined are, in most cases, identical to the maximum contaminant levels (MCLs) identified in the NPDWR for public drinking water systems.

(2) AR 40–657/NAVSUPINST 4355.4F/MCO P1011031G, *Veterinary/Medical Food Inspection and Laboratory Service,* addresses the inspection and certification of bottling facilities as approved providers of bottled drinking water. This regulation is the basis for the publication of directories of sanitarily approved sources for DoD procurement of food items. Military Standard (MIL-STD) 3006, *Sanitation Requirements for Food Establishments,* contains the inspection checklist and certification process for processing and bottling plants. Appendix K of MIL-STD 3006 specifically addresses bottled water and soft drink plants. The standards and inspection criteria are very similar to the FDA standards and apply to bottled water produced in CONUS and OCONUS for DoD procurement.

(3) The International Bottled Water Association (IBWA) is the trade association representing the bottled water industry. The Association's member companies produce and distribute 80 percent of the bottled water sold in the U.S. Membership includes U.S. and international bottlers, distributors, and suppliers. The *IBWA Model Code* is designed to be used as model regulation or legislation in states or municipalities and has been used as such in at least 15 states. The inspection and testing criteria, as well as contaminant limits, are similar to the FDA and DoD regulations and criteria. Since the IBWA Model Code is unenforceable, compliance by a bottler is voluntary unless a state or local governing body adopts the Code.

b. Commercial bottled water is not authorized for use as an installation's primary drinking water source. Further, this bottled water cannot be blended with the drinking water system, or used to augment it, to achieve compliance with MCLs.

(1) Bottled water may be used on a temporary basis or in emergency situations to avoid unreasonable risk to health (Part 141.101, Title 40 Code of Federal Regulations (40 CFR 141.101). The appropriate use of bottled water must be delineated in the water system emergency response plan (WSERP). The decision to institute the use of bottled water for temporary or emergency use should be made by the installation commander in consultation with the IMA and PH authority.

(2) Bottled water is not normally provided to installation personnel when complaints about perceived taste and odor of the supplied water are made unless the situation is investigated and a determination to use bottled water on a temporary or emergency basis is made by the IC.

CHAPTER 3

WATER TREATMENT TECHNOLOGIES

3−1. General

Water treatment operations involve many facets. Important factors to consider include the water source(s); the physical, chemical, radiological, and biological character and quality of the water available; projected use(s) of the water supply; and the types of consumers to be supplied (for example, sensitive subpopulations, children, pregnant women, healthcare operations). All surface or groundwater considered for use as a potable source must be characterized through sampling and comprehensive analyses to discern the type and extent of treatment required.

3−2. Basic treatment technologies

The types of water treatment applied depend on the character of the water source and the potential contaminants present. Generally, systems utilizing surface water sources require a greater degree of treatment and disinfection than systems supplied by groundwater sources. The following conventional treatment processes represent a typical flow of water through the treatment system.

a. Coagulation/flocculation. Many surface water sources contain particles of soils and sediments (possibly containing metals, minerals, or chemicals and inert materials), microbiological organisms, and organic materials from decaying vegetation. These materials contribute to the turbidity and color of the water supply and may also contribute to the overall microbiological and chemical contamination of the water. Coagulation is often applied as one of the initial treatment processes to aid in the removal of many of these materials. The water is destabilized by adding a positively charged coagulation chemical that causes the negatively charged particles to attach to the coagulant. Aluminum sulfate is the most common destabilizer used. A polymer is sometimes added to further enhance coagulation, depending on the character of the water. The coagulation process results in the formation of a "floc," which continues to grow as the other particles in the water supply come into contact with, and are enmeshed in, the formed floc. Coagulation and flocculation often occur in a single, continuous basin. The coagulation action occurs at the beginning of the basin, where the chemical is added and allowed to mix thoroughly with the water. Alternating baffles slow the water flow considerably throughout the majority of the basin. The reduced flow increases contact time with the coagulant, which allows formation of the floc particles and settling.

b. Sedimentation. Sedimentation may occur at the end of the coagulation/flocculation basin or in a separate basin. Treated water flows into the sedimentation area or basin where the water remains very quiescent. This allows the weight of the floc particles to settle out of the water column and fall to the bottom of the tank. A weir located at the water's surface at the effluent end of the basin precludes the majority of the floc particles from carrying over into subsequent processes. Troughs located at the bottom of the sedimentation basin collect the floc particles that have settled out. The settled particles are subsequently pumped to a sludge collection/handling process.

c. Filtration. The clean water effluent passing over the weirs at the exit of the sedimentation basins is introduced to the filters. Filtration removes dissolved and very small particles, including bacteria, viruses, and parasites.

(1) Most filtration systems allow water to flow by gravity through a basin filled with sand overlying an anthracite coal or gravel base. Multimedia filters containing an additional layer of charcoal, diatomaceous earth, or garnet may also be used to filter various particulate sizes.

(2) Pressure filters are typically employed for groundwater sources. Pumps, instead of gravity, push the groundwater directly from wells through the filter media without applying a coagulation or flocculation process.

(3) Filters must be backwashed periodically to remove materials trapped in the filter media and prepare them for reutilization. Backwash cycles are controlled by operations personnel and are often predicated on the pressure loss measured across the filter bed or the amount of time the filter has operated. For gravity filters, the backwash water flows up from the bottom to cleanse the media, which then settles back in the basins due to gravity. A similar process occurs within pressure filters, with the exception that the filter media will settle according to the specific gravity of the materials and be assisted by the pressure of influent water. The filtrate is washed out of the top of the basins, over a weir, and collected in the sludge collection/handling process.

d. Disinfection. Disinfection is a critical process employed for all installation water systems, as it provides the primary treatment barrier to deactivate pathogenic microorganisms such as parasites, bacteria, viruses, and cysts. Note that some OCONUS installations have received waivers to not add disinfectant. AR 420–1 mandates that ICs will provide facilities and capability to disinfect water supplies in accordance with this bulletin and UFC 3-230-02. (Disinfection efficacy is discussed further in paragraph 5–3*a*(3) of this bulletin.)

(1) Chlorine is the most common disinfectant used. It is injected as a gas or one of two salts in solution: sodium hypochlorite (NaOCl) or calcium hypochlorite ($Ca(OCl)_2$). Chlorine disinfection inactivates microorganisms at the point of injection and also provides a residual in the water supply to protect against the growth of microorganisms within the distribution system. Chloramine is an alternative disinfectant involving the injection of an ammonia solution subsequent to the chlorine. Chloramines provide a residual concentration in the system, as well, and reduces the potential for DBP formation when compared to disinfection solely by free chlorine. Other disinfectant alternatives include chlorine dioxide and ozone, both of which are generated onsite and injected under very controlled conditions. Chlorine dioxide is a very effective bacteriocidal and oxidizing agent that may produce a small residual within the water supply for continued disinfection. Considerable care and oversight are required when chlorine dioxide is used because potentially harmful disinfection byproducts (chlorite ions) may be formed. The disinfectant residual preferred by public health officials throughout the distribution system is the FAC concentration, as it is the most effective at deactivating microorganisms and retains the best residual throughout the water supply system. A CAC residual (0.2 milligrams per liter), which is present when chloramines are used, is effective but generally not as persistent as the FAC.

(2) The effectiveness of all chemical disinfectants depends on the—

(a) Dosage injected,

(b) pH (most effective between 7.4 and 7.8, approximately),

(c) Contact time (preferably a minimum of 30 minutes),
(d) Water temperature (cold temperatures can require higher doses of disinfectant),
(e) Turbidity and other interferences that reduce the efficiency of disinfectants (NSDWR standard of <0.3 Nephelometric Turbidity Units (NTUs), and
(f) Other disinfectant-demanding substances (for example, ammonia; organic materials that will be oxidized).

(3) Ultraviolet (UV) irradiation is an approved alternative disinfectant for water treatment in select applications. The UV rays produced by the light fixtures can penetrate only a limited depth of the water passing over the light source. Turbidity and light intensity potentially limit the efficacy of this technology, and operating it for long periods of time requires significant power requirements. Disinfection by UV irradiation does not provide a disinfectant residual in the distribution system. See the discussion below for disinfectant residual considerations.

(4) Many alternative disinfectants provide limited or no residual and must be combined with some form of chlorine disinfection to maintain a residual throughout the piping network. EPA and state requirements mandate that disinfection residuals be maintained throughout the distribution systems using surface water and/or groundwater under the influence of surface water sources. EPA requires the disinfection of groundwater systems if the system is susceptible to fecal contamination. The American Water Works Association (AWWA) suggests maintaining a measurable disinfectant residual throughout the distribution system to thwart microbial growth. A minimum chlorine residual of 0.2 milligrams per liter (mg/L) is the acceptable standard after all treatment at the point of entry to the distribution system has been completed, although many states simply require a measurable residual rather than a defined specific minimum value. A higher minimum residual may be required based on the size of the distribution system and/or the daily drinking water demand. NPDWR allows Heterotrophic Plate Count (HPC) test results less than 500 colony forming units/milliliter to be substituted for evidence of a disinfectant residual. This HPC substitution must be based on multiple HPC results for a specific segment of the distribution system.

(5) The use of disinfectants must be carefully controlled and monitored. The biocidal action that they provide must be balanced with the potential for the formation of harmful DBPs, discussed in paragraph 5–3*e*. Disinfectants should—

(a) Mix uniformly to provide intimate contact with potential microbial populations within the water supply and piping.

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

(c) Not be toxic to humans at the concentration levels present in the finished water.

(d) Have a residual action sufficient to protect the distribution system from microbiological growths and act as an indicator of recontamination after initial disinfection.

(e) Be readily measurable in water in the concentrations expected to be effective for disinfection. Light intensity and turbidity in the water can adversely affect the disinfection potential for UV, since the UV light must physically contact the bacteria and viruses in order to deactivate them.

(f) Destroy or deactivate virtually all microorganisms. (NOTE: It is generally accepted that for waterborne diseases, those caused by bacteria are the most susceptible to disinfection.

Conversely, certain pathogenic organisms such as the cysts of the protozoa *E. hystolytica*, *Giardia lamblia*, and *Cryptosporidium* are among the most resistant to disinfection.)

(g) Be practical to use and maintain.

(6) As stated above, a detectable chlorine residual (usually > 0.2 mg/L) should be present throughout the distribution system. The DPW/operating contractor can determine the optimal concentration that must be added at treatment locations (an estimated 2.0 mg/L) to achieve this goal. The addition of excess disinfectant concentrations should be avoided to minimize the potential for disinfectant byproduct (DBP) formation (see para 53e). Chlorine residual surveillance will be performed daily by operations personnel in association with bacteriological sampling to ensure appropriate treatment of the water supply. Similarly, chlorine residual monitoring must be performed at all critical locations within the system by PH authorities on a weekly basis to verify proper system operations.

e. Fluoridation.

(1) General. Many public or community water systems add fluoride to their water supply, often in the form of sodium fluoride (NaF) injected at the water treatment plant (WTP). The addition of fluoride is common in water systems where the natural fluoride concentration is insufficient to provide a barrier to the formation of dental caries in children. This practice is strongly advocated by the EPA, The Surgeon General (TSG) of the Army, and the Centers for Disease Control and Prevention (CDC). In some regions, where there is an elevated natural fluoride concentration, additional fluoride is not necessary and/or some fluoride must be removed from the water supply. Installations must forward requests for either fluoridation or defluoridation of water supplies through appropriate Command channels to TSG. OCONUS installations submit similar requests through the appropriate Command channels to the Theater Army Command Surgeon.

(2) Surveillance. The injection of fluoride solution in the water supply must be closely controlled and monitored. Excessive amounts of fluoride may produce objectionable dental fluorosis (mottling of tooth enamel). Fluorosis increases in severity as the fluoride concentration rises above the upper control limit. According to the NPDWR, the MCL for fluoride is 4.0 mg/L. The U.S. Department of Health and Human Services (DHHS) and the CDC have recommended an optimum fluoridation concentration of 0.7 mg/L in water supplies, regardless of ambient weather conditions where greater quantities of water may be consumed due to warmer temperatures and drier conditions. Higher concentrations of fluoride (for example, 5–10 mg/L or greater) can cause acute diarrhea and other adverse health conditions.

(a) The authorities responsible for water production (for example, DPW, contractors, and Engineers) must perform routine and frequent fluoride analyses at both the point of injection (at the WTP) and within the distribution system. Testing of treated water prior to distribution is accomplished daily or more frequently. (NOTE: Many WTPs utilize continuous, in-line monitors to record concentrations.) Sampling from representative points in the distribution system must also be performed at least weekly as a means of further evaluation of plant control effectiveness.

(b) The installation PH authority is encouraged to test for fluoride at random sampling points throughout the distribution system, concurrent with microbiological sampling. All fluoride sampling and analysis are conducted in accordance with methodologies required by the NPDWR. Consultation with drinking water subject matter experts at the DCPH-A is recommended to obtain the proper assessment procedures required for new water sources.

3−3. Alternative treatment technologies for unique purposes

A number of alternative treatment technologies are frequently employed in water supply systems to address specific problematic issues or conditions prevalent in some water sources. These technologies may augment the conventional processes identified in paragraph 3–2 and often involve somewhat greater expense and operator training to perform as designed. Examples of technologies that are frequently observed at Army and DoD installations include, but are not limited to the following:

a. Corrosion control. Many water sources are somewhat corrosive/aggressive to the metals used in the construction of treatment plants and water distribution systems. While corrosion may appear innocuous at first, causing minor pitting of the metal surfaces, it may cause significant water system failures through piping breaks or leaks, resulting in costly repairs and water outages. Primary factors affecting the corrosive nature of a water source are the pH, alkalinity, type of materials used for piping, and the age of the system. Corrosion is most prevalent when the pH of the water falls below the neutral range (pH of 7), making the water acidic. The addition of calcium carbonate along with other natural chemicals increases the total alkalinity of the water supply, which tends to buffer the pH and corrosive nature of water on metal piping and joints. Since the late 1980s, a major concern for water purveyors, regulators, and PH authorities has been the effect of corrosion on piping, fixtures, and the solder used in joints, which may release lead and copper into the drinking water. The practice of corrosion control is intended to establish a protective scale between the water and the materials that may leach into solution. Lead, in particular, poses a major health concern to children exposed to it at a young age, as it delays their physical and mental development. Corrosion control is often provided through the injection of a lime, soda ash, or caustic soda solution, which raises the pH slightly and adds ions to the solution. This promotes the development of scale on the pipes and joints, creating a protective barrier against corrosion. Orthophosphate or polyphosphate mixtures are sometimes injected for this purpose.

(1) To provide optimal levels within the system, all chemical additions must be closely monitored and scrutinized by operations personnel.

(2) Although recent amendments to the SDWA have banned the use of lead-based materials (pipes, solders, and so forth) in potable water systems, these materials remain prevalent throughout many older water supply systems. Corrosion control is a recommended remedial measure for systems where lead or copper has been observed in water sampling.

b. Ion exchange. Ion exchange is often used to provide extra purification of water entering dialysis treatment units in healthcare operations. The basic principle of this treatment process is providing a containerized filtration medium composed of specific, benign ions (such as sodium or potassium) to replace unwanted or potentially harmful ions in the water supply. The potentially harmful ions may include excessive calcium or magnesium, either of which serves as a water softener or causes scale growth; or toxic materials such as nitrite, lead, mercury, or arsenic. As the water flows through the filter medium, the ions are dissociated and replaced by the preferential ions held within the medium. The filter media must be replaced to continue functional use when pressure loss is recorded through the filter bed or a breakthrough of ions is detected in the process effluent, and when the frequency for filter replacement, as specified by the manufacturer, has been reached.

c. Activated carbon. The presence of organic chemical compounds in water supplies has posed a formidable threat for many decades. Organic compounds are often soluble in water and may be present due to human actions, such as spills or releases, or the degradation of natural vegetation. These compounds are not readily destabilized or filtered out of solution. Organic compounds that have few carbon atoms and a relatively low molecular weight (such as 1,1,1-trichloroethane and tetrachloroethylene) are considered to be volatile organic compounds (VOCs) (see para 3–3*d*). Through adsorption, activated carbon can effectively remove VOCs and more complex organic chemicals (containing many carbon atoms with higher molecular weights, such as semi-volatile organic compounds (SVOCs) and pesticides/herbicides) from water. An activated carbon material is often used in WTPs in one of two forms: powdered activated carbon (PAC) or granular activated carbon (GAC).

(1) PAC may be injected into the water stream at any location but is often added near the source, prior to chemical addition and coagulation at the beginning of the water treatment process. The PAC absorbs many of the natural organics entering the WTP intake and may settle out in the sedimentation or filtration processes.

(2) GAC granules are slightly larger than PAC particles. The open spaces between the granules serve as activation sites to adsorb all organic compounds present. GAC is generally contained in a separate basin and must be periodically replaced with a fresh medium. Water treatment plant operators monitor the GAC media for pressure loss or breakthrough of organic contamination as indicators that the bed has become exhausted and must be replaced. Operational run time may also be used to establish an appropriate frequency for replacing the GAC medium. This is often applied after sufficient operational analysis is conducted to determine the timeframe in which the organic compounds are safely removed from the volume of water supplied.

(3) Used GAC media are typically discarded as hazardous waste. Larger companies may possess ovens to burn off the accumulated organics and recharge the GAC for resale. This process is difficult and costly and can be accomplished only on a large scale.

d. Air-stripping. VOCs readily volatilize when exposed to air and may be removed from water using an air-stripping tower. Air-stripping towers are designed as large cylinders that are filled to capacity with small plastic shapes. The contaminated water is introduced at the top of the cylinder and flows by gravity to the base, where it is collected and moved to the next treatment process. The organics that are volatilized (stripped) from the water flow upward with the airflow. The original design of these towers allowed the airflow to exhaust to the ambient atmosphere. Subsequent concerns regarding potential air pollution (transferring the contamination from water to air) caused regulators to require activated carbon filters to collect the organics prior to discharge.

(1) Location of the air-stripping tower within the WTP is important with respect to other treatment processes. For example, removal processes for materials such as iron and manganese must be located ahead of these towers. If water containing these minerals is allowed to enter an air-stripping tower, the iron and manganese will change state and oxidize. This causes the minerals to come out of solution and precipitate within the tower. These red and black mineral

particles will foul the tower, adversely affecting its operational efficiency.

(2) Air-stripping treatment technology is no longer commonly applied since activated carbon is required for the tower effluent. Many WTPs employ large-scale GAC filters when VOCs are present in the water supply.

e. Ultra- and nanofiltration. These filtration processes are used to "polish" the treated water supply, removing suspended and dissolved materials as well as microorganisms. Both processes utilize polymer-based or metallic (for example, aluminum) membranes with chemically etched-out pores. The primary difference between these technologies is the size of the particles allowed to pass through the filter. Membranes may also be coated with materials that will aid in the preferential absorption/removal of designated materials. The amount of pressure needed to push the water supply through the medium depends on the type of material comprising the membrane and the size of the materials to be removed from the water.

(1) Ultrafiltration may function at normal water system pressures (50–70 pounds per square inch (psi)) or slightly above. The pore size is generally 0.01–0.10 micrometers (µm), which equals 10–100 nanometers (nm) in diameter. This process may be used in place of the conventional treatment processes (coagulation, flocculation, sedimentation, and sand filtration) for "clean" water sources. Ultrafiltration consistently achieves NPDWR standards and is advantageous in these cases because no chemical addition is necessary, and the footprint of the WTP is considerably smaller. Ultrafiltration is often used as a pre-filtration/polishing process prior to reverse osmosis (RO) to provide protection for the sensitive RO membranes.

(2) Nanofiltration use has become more prevalent in water supplies exhibiting low total dissolved solids (TDS), or to further remove DBP precursors. The membrane pore size ranges from 1–10 nm in diameter (equivalent to approximately 10 times smaller than ultrafiltration), which typically requires pressurizing or pumping the water into the filtration chambers.

(3) The use of these technologies will likely become more prevalent as concerns for the removal of dissolved minerals, soluble organics, and microorganisms increases, and as the use of brackish or potentially contaminated water becomes unavoidable to meet the water supply demand.

(4) Application of these technologies may increase operational costs associated with increased power requirements, operator training, and the periodic replacement of filter media.

f. Reverse osmosis/desalination. Many regions, both within the U.S. and globally, are experiencing prolonged drought conditions, with a lack of viable surface or groundwater available to meet the potable water needs for growing populations. This is particularly evident near coastal areas. In some areas, "fresh" surface and groundwater sources are now experiencing salt- or brackish water intrusion and can no longer be adequately treated using conventional treatment processes alone. Specialized treatment technologies, such as flash distillation, electrodialysis reversal, membrane distillation, or mechanical vapor compression, must be used to remove significant dissolved mineral and salt concentrations to make these waters available for potable use. RO is a commonly used technology in the U.S. and throughout Europe.

(1) RO uses an interwoven semipermeable membrane with increased surface area and pressure to remove problematic ions, molecules, and particles from solution. Pressure is applied to the influent side of the membrane. Under normal circumstances, ions and molecules will flow from the most concentrated side of a membrane to the side possessing a lesser concentration,

until both sides achieve equilibrium. However, in an RO system, the pressurization forces the purified water through the membrane, and the ions and molecules (that is, the solute) are rejected by the very small pores and collect on the membrane surface.

(2) The primary difference between RO and the conventional filter technologies previously described is that the latter exclude particles due to straining, or size exclusion, alone. RO incorporates the process of diffusion, which makes the process dependent on pressure, the flow rate, and other factors. As a result, RO has been used very effectively to produce potable water from seawater, brackish water, and many recycled water sources.

(3) RO is often used in conjunction with ultrafiltration vessels. Ultrafiltration is applied prior to the RO process to remove particles larger than approximately 10 nm. Disinfection occurs after the RO process to deactivate any microorganisms passing through the membranes.

(4) Major disadvantages of RO processing are the significant power demands created by the need for continuous pressurization/pumping, and the cost of replacing membranes. The small pore size of the membranes will cause them to clog quickly unless larger particles are removed prior to RO. Although these membranes are becoming more readily available, they are expensive to develop and replace.

(5) Used RO membranes should be replaced when the available effluent flow diminishes to a pre-determined level. The membrane manufacturer can assist in determining the appropriate replacement target level.

g. Manganese greensand. The staining of fixtures and laundry by "rust" and black marks caused by the water supply is not harmful but has proven bothersome to consumers, suggesting that their water supply is not clean. Consumers often complain of foul tastes in conjunction with discoloration. Staining has also been an issue for supported Army/DoD industrial operations that require a "clean" water supply. Manganese greensand filtration is a treatment technology developed in the 1950s and is still used to address this issue. Minerals such as iron and manganese could precipitate out when exposed to air in stripping towers, potentially fouling the intended treatment process. A similar action occurs in sand filtration, thus impeding the efficiency of this technology. Manganese greensand treatment involves the use of a naturally-mined glauconite greensand material, which is subsequently coated with a manganese oxide solution. This filter medium is usually placed in a container within the water supply near the beginning of the water treatment process; water flows through the filter medium by gravity. The greensand medium is most effective when the total iron and manganese concentrations are less than 15 mg/L, and it will remove hydrogen sulfide concentrations up to approximately 5 mg/L. The medium should be backwashed when the pressure differential between influent and effluent drops below manufacturer-specified limits, and it can be recharged by adding a potassium permanganate solution. The backwash water can be safely discharged to the sanitary sewer or septic system. The medium usually lasts 4–8 years before requiring replacement, depending on the concentrations evident and the operational conditions. (Consult with the manufacturers for appropriate replacement frequencies.)

h. Point of entry/point of use devices. Point of entry/point of use (POE/POU) water treatment devices are installed to treat water entering a building or to treat a specific faucet within a building. These devices help to improve the aesthetic quality of the water supply, impacting taste, odor, or color concerns. POE/POU filters have been used to remove nitrates to protect young children and have also been used to remove microorganisms, including *Legionella*, to protect high-risk patients in hospital settings.

(1) The use of POE/POU devices may be considered a temporary means to protect consumers from potential chemical or biological exposures within the water supply system. This application requires close analytical scrutiny (that is, constant sampling and analysis to discern potential breakthrough of contaminants within the devices), which would be very time-consuming and cost-ineffective.

(2) POE/POU devices are often designed to provide the filtration of water through a paper-based filter, followed by a finer membrane material, and possibly a small carbon filter. Some of these devices are falsely marketed as providing RO treatment of the water through the membrane element. RO cannot be achieved at the system pressures prevalent within a household or installation water supply system. True RO requires significantly elevated pressures to segregate the minerals/chemicals in solution and push the clean water through the membranes. The actual type of filtration achieved by POE/POU devices is a form of microfiltration or ultrafiltration that traps small particles and minerals. The carbon filters provide absorption of organic materials, which helps to improve the palatability of the water supply for some consumers.

(3) Employment of these devices requires implementation of a routine and enduring maintenance program. Recurring replacement of filter units/cartridges is required to avoid breakthrough and the potential exposure of high concentrations of mineral and chemical contaminants.

(4) POE/POU treatment should not be relied upon to achieve compliance with an MCL. However, amendments to the SDWA allow the use of POE/POU devices for removal of some contaminants, as well as lead and copper, in small water systems.

CHAPTER 4

WATER STORAGE AND DISTRIBUTION SYSTEMS

4−1. General

The distribution and storage of potable water supplies must receive sufficient attention when the quality and availability of water to consumers and activities on Army installations are considered. Many of these critical infrastructure networks are aging and have been serviced or repaired with materials of vastly different composition. The importance and condition of these materials and structures are often overlooked when resources for preventive maintenance and system replacement are considered. These materials/structures are assumed to function indefinitely—until a disruption, such as a water main break or another structural or operational failure, occurs. Routine diligence regarding the operation, maintenance, and monitoring of such systems must be a high priority among DPW/operating contractors and the installation PH authority, and the need to support such efforts must receive Command support to continue the Army mission uninterrupted.

a. Operational coordination. The intentional or unintentional introduction of materials into water storage and distribution systems can adversely affect drinking water quality. The DPW/operating contractor or Engineering groups maintain primary responsibility for the operation and maintenance of these systems and perform the requisite regulatory and quality monitoring as presented in chapter 6. Close interaction between the installation PH authority and DPW/operating contractor or Engineering personnel is required to ensure that water quality remains sufficient to protect the health of all consumers.

b. Installation maps. Army regulations require that installations maintain comprehensive and updated maps of the potable water supply system. Maps serve as a critical tool in planning and performing routine preventive maintenance activities (for example, flushing programs, cross connection control, valve maintenance programs, and maintenance of pressure zones). Maps are also used for delineation of system monitoring programs and to define areas of concern during emergency operations such as fire response and natural or manmade disaster situations. Current maps should be made available to all activities performing maintenance or monitoring within the distribution system. Ideally, the installation PH authority should maintain a digital or printed copy of water distribution system maps to demarcate sampling locations and potential areas of concern within the system. Examples include child care centers, healthcare facilities, and areas of low use or where positive microbiological or low disinfection residual results have been identified. Maps must include the version number or date to ensure that everyone involved is referring to the most current representation.

4−2. Water storage

Storage tanks comprise an important part of water supply systems, but their maintenance, security, and water quality are often overlooked. Storage tanks serve to provide equal pressurization of the water reaching consumers throughout the day, particularly during periods of peak usage, and to augment available supplies for fire suppression and during emergency periods of low flow. Open tanks or reservoirs are often used for raw water storage; closed storage tanks are generally reserved for treated potable water supplies. Potable water can be stored in elevated steel tanks and ground-level or underground concrete or steel structures. To ensure optimal water quality is maintained, all tanks should remain closed and sealed from easy access by animals, people, or the debris caused by weather events.

a. Operations. Potable water storage tanks must be constructed and operated as integral parts of the water system. The tanks remain interconnected to the water distribution system, releasing water as demanded during periods of peak flow or emergencies, and refilling during periods when normal water flow through the distribution piping can readily meet the demand (for example, overnight). This continued cycle keeps the water in the tanks fresh and well-mixed, enables maintenance of an effective disinfectant residual, and minimizes the potential for microbiological growth within the tanks. Many installations control and/or check the levels of water within the tanks via an electronic monitoring system, such as Supervisory Control and Data Acquisition (SCADA). Computerized systems help to control the water flow from the distribution piping network into the storage tanks and to determine when the tank is full. Such a system is often connected to electronic pressure gauges, which are correlated to level indicators within the tanks. The appropriate tank levels are often manually adjusted for each tank. This type of system may also allow water to re-enter the distribution system if the demand requires additional water, or the system pressure drops to a pre-designated level. Water system pressures often range between 30 psi and 80 psi, depending on system configuration and size. Several Army installations continue to utilize antiquated systems where the storage tanks fill and discharge manually, or remain full until operators physically adjust the valves to discharge the stored water. These types of systems must be upgraded to afford automatic control of the altitude valves and improve water availability and quality for consumers and industrial operations. Water must not be allowed to sit and become stagnant.

b. Maintenance. The installation PH authority should monitor certain security or maintenance practices performed by the DPW/operating contractors to ensure protection of the potable water supply system.

(1) Cathodic protection [from corrosion] is usually standard for elevated or ground-level steel storage tanks. It is a process attached to the tank that reduces overall galvanic wear of the structure (occurring when two dissimilar types of metal are interconnected without suitable protection), impacting the life of the component, and makes it easier to maintain an appropriate disinfection residual and high water quality. Approved coatings applied to the interior surfaces of the tanks may be used to serve the same purpose (per the American National Standards Institute (ANSI)/American Water Works Association (AWWA) or similar OCONUS standards).

(2) Security of the altitude and flow valves, as well as entry hatches, is essential to prevent unauthorized access, which could easily disrupt water system operations for significant portions of the installation. These valves were traditionally located inside a maintenance pit covered by steel plates and placed underground at the base of, or adjacent to, the tanks. Security can be readily accomplished by locking the steel plates to prevent unauthorized access. Similarly, general access to storage tanks can be minimized by placing appropriate security fencing with a padlocked gate around the base of these structures. Key control would limit access to authorized personnel only. Additionally, access into these areas should be very limited by not allowing antennas to be attached to the upper reaches of the elevated tanks, or the area within the

fence to be used for general storage (for example, light standards, equipment, or scrap materials). Allowing these practices increases the number of personnel who have access, thus creating a greater opportunity for gates and access points to be left open. Other security measures include retracting (or folding) and locking the ladders that provide access to the elevated levels of tanks. Proper mesh screening (per the UFC) must be used to cover all vents and overflow pipes to minimize access by birds and other animals.

(3) Routine/visual inspection of storage tanks may be accomplished on a weekly basis, during routine activities on the installation. Comprehensive inspection, involving physical inspection and cleaning of the tank interior, should be accomplished every 3–5 years (per UFC and AWWA guidance) to ensure water quality and tank integrity. Before the facilities are placed back into service, the water should be tested to ensure that no coliform bacteria are present. Water should be sampled and assessed, per applicable ANSI/AWWA, or similar OCONUS, guidelines.

(4) The installation PH authority should be aware of these issues and report security and accessibility concerns and unidentified personnel or materials around the tanks when conducting their routine water quality monitoring activities. PM personnel should notify the DPW and/or operating contractor of reportable observations.

4–3. Water distribution systems

The piping networks that comprise potable water distribution systems are very complex. They consist of many different types and sizes of piping within each network and display a wide variety of configurations and maintenance requirements. The following summary identifies key concerns and requirements for the installation PH authority to consider when a water quality sampling and assessment plan is designed, as specified in paragraph 6–4.

a. Distribution design. Historically, it was not uncommon to over-design many aspects of an installation's infrastructure in anticipation of meeting expected installation expansion needs. As a result, many potable water distribution systems on Army installations are oversized, with dead-end mains designed to reach all structures on the periphery of the installation. These design features proved useful for installations operating at full operational demand and to meet fire-flow requirements but become problematic during periods of reduced operations/capacity. The presence of oversized piping creates a potential for low-flow or stagnant areas, which could facilitate unwanted microbiological growths within the water system. The transfer of Army industrial operations to commercial or contracted facilities located off post, and the relocation of military organizations to other installations due to base realignment and closure activities, are examples of contributing factors that have caused a significant decrease in water demand on an installation. The oversized water mains tend to cause pooling of water within the network, which facilitates a dissipation of disinfectant residual and an increase in microbiological growth. Piping replacement has occurred at few installations, usually in response to widespread main breakage or disruption caused by corrosion, contamination, or longstanding, significant water quality issues. Dead-ends frequently found in piping systems also tend to minimize the flow of water through the system. This stagnancy reduces the disinfectant residual and promotes microbiological growth. In an effort to eliminate dead-ends and increase water circulation, many installations have installed additional piping to connect dead-ends with other mains. Replacing distribution system piping can be costly and is uncommon. Such conditions must be addressed in sampling and analysis plans developed by the installation PH and DPW/operating contractor authorities. Potentially problematic zones of distribution systems may require more frequent flushing by the DPW/operating contractor, with coordination with the PH authority to provide concomitant bacteriological monitoring.

b. Network vigilance. The water distribution system is one of the systems that is most susceptible to compromise. Constant vigilance and a consistent preventive maintenance program are requisite to retain the integrity of the distribution network. Frequently, the water quality and availability issues experienced at Army installations are functions of problems experienced within the distribution system network. These may include disruptions caused by water main breakage or leakage, flow constraint due to corrosion or buildup of materials within the piping, presence of metals or microbiological aftergrowths from within the network, or contamination introduced (accidentally or intentionally) via improper or unprotected interconnection (backsiphonage or cross connection). Close communication between the installation PH authority and DPW/operating contractor is necessary to ensure PH representatives understand "normal" system operations and maintenance. Establishing a close relationship enables the installation PH authority to help recognize and react to changing water quality conditions within the system, and to assist when problems arise.

4–4. Preventive maintenance programs

Preventive maintenance is key to the optimal performance of a water supply system and the delivery of a high-quality product to consumers. This section highlights key preventive maintenance activities that should be included as part of the overall water supply preventive maintenance program. The installation PH authority uses this information when collaborating with the DPW/operating contractor regarding issues related to designing systems, interpreting sampling data, and developing assessment programs.

a. Flushing program. Water main flushing achieved by flowing water from a fire hydrant positioned on the potable water mains is a critical element of distribution system preventive maintenance. Spot flushing of several/individual hydrants may be useful when sediment or debris is cleaned from a main or water line repaired after an isolated leak. The lines should be disinfected, flushed, and sampled for coliform bacteria prior to being placed back into service. Spot flushing also proves useful for increasing water flow through areas possessing dead-end or stagnant zones within the distribution system. A comprehensive main flushing program, where all hydrants are opened sequentially to clear the distribution piping network of sediment and debris, must be achieved on an annual basis. The goal is to remove all debris and tubercules built up within the pipes. Major nodes in the distribution network, such as the treatment plant, storage tanks, and major main interconnections, serve as the flushing start point. The flushing occurs sequentially, hydrant by hydrant, to logical end-points in the system, or circles back to the starting point (in "perfectly" looped systems).

(1) Hydrants are opened one at a time from the starting point and allowed to flow until equilibrium is achieved, that is, the operator is assured that water from the main is flowing and any debris in the lines is cleaned out. Often, this action requires water to flow at about 2.5 feet per second (fps) for several minutes, or possibly flushing 2–3 times the volume of water

contained in the last segment to ensure that debris is removed. The flushed hydrant is closed after the next hydrant in sequence is opened. Multiple hydrants may be flushed simultaneously in this manner if sufficient personnel are available and assigned to this task. Further, flow valves within the system may be operated to increase flow within the segment of piping being flushed. A minimum system pressure of 20 psi must be maintained throughout the flushing program.

(2) Water flowing from the flushed hydrants should possess a disinfectant residual greater than 0.2 mg/L, which should be verified by DPW/operating contractor.

(3) Successful flushing programs require significant planning to create minimal disruption to normal operations. Therefore, a flushing plan should be developed where flushing is often conducted during the overnight hours.

(a) Advance notification of service disruption is required for all households and administrative and industrial operations supported by the distribution system.

(b) Care must be taken to avoid flooding yards and roads during flushing.

(c) Coordination among water personnel and traffic management, police, and roads and grounds authorities is required when a flushing event is scheduled. Special arrangements or postponements may be necessary if the scheduled outage poses a threat to personnel, property, or operations.

(4) Flushing of the entire distribution system should be accomplished at least annually. More frequent flushing may be required for individual portions of the distribution system exhibiting dead-ends, routine absence of disinfection residual, or stagnant water within the piping network. The installation PH authority should be aware of the programmed schedule and should discuss the status of the program with the DPW/operating contractor. This information is helpful for preparing responses to consumer complaints and developing sampling and analysis programs to monitor the safety and potability of the water supply.

(5) Routine fire hydrant flushing conducted periodically by the fire department does not accomplish the benefits of a comprehensive, sequential flushing program.

b. Valve maintenance program. The DPW/operating contractor should conduct recurring valve inspection and maintenance. The distribution system contains a large number of butterfly and gate valves that are used to manage directional flow and closure of piping segments flowing to downstream areas. During emergency situations, control of water flow is particularly important in cutting off portions affected by water main breakage or leakage, providing greater flow to specific areas for fire suppression, limiting the dissemination of potential contamination introduced into the system, or restricting water dissemination points for consumer distribution subsequent to a disaster. Distribution system valves are located underground and are accessed by a special, long-handled wrench. Since they are not visible from the surface, it is critically important to maintain updated, detailed water distribution system maps to define the location of all system valves. Water system maintenance personnel should fully exercise all valves within the system annually and should immediately repair or replace each valve that does not function optimally. Valves left unexercised for extended periods of time, or exposed to significant corrosion, may freeze in an open or closed position and may not respond to the turning of the wrench. Maintenance records should include dates of inspection and the number of turns needed, and in which direction, to close each valve. Historically, valve exercise and maintenance programs have been one of the preventive maintenance programs readily cut when funding problems arise. The potential costs attributed to faulty valves, particularly in an emergency, may far exceed the cost of administering a valve maintenance program. It is critical to maintain control over water flow within the piping network and to have the capability to isolate portions of the water supply system.

c. Cross connection control program. Cross connection control is essential to protect the potable water supply from direct interconnections with nonpotable piping networks and the potential backsiphonage or backflow of contaminants within the distribution system. An initial thorough cross-connection survey should be undertaken to ensure that all potential cross connections or backsiphonage locations have been identified and addressed. Cross-connection prevention is achieved by applying air gaps or installing various control devices between key connections in the water distribution system. Color-coding or marking nonpotable water lines also aids in cross-connection control by distinguishing between piping networks for nonpotable water and water lines for potable water.

(1) Configuring an air gap between a potable supply outlet, such as a faucet, hose, or pipe, and a nonpotable system inlet, such as a sewage drain, eliminates the possibility of an interconnection between these systems.

(2) Cross-connection control devices are applied to potential sites of interconnection and range from small hose bibs that fit on outside faucets to large, complex, reduced pressure zone (RPZ) devices that provide extra protection as the water passes through major interconnections.

(3) An installation cross-connection program requires certified individuals to inspect, maintain, and repair/replace cross-connection devices.

(4) Initially, a comprehensive cross-connection control survey should be accomplished to determine the potential for cross connections and/or backflow in existing buildings and equipment. Ensure that the appropriate backflow prevention devices are implemented at each site where needed. Subsequently, device inspection and maintenance should be conducted annually (or per manufacturer's specifications) by certified personnel to prevent device failure and the potential for a contamination event to occur. (The required inspection frequency may be more often for OCONUS.) Documentation of maintenance activities is very important and should include the locations of each device, the types of devices installed, the dates of annual inspection and maintenance, notes of conditions and/or of actions taken, and the identity of the individual performing the inspection/maintenance. Identified failures, particularly those of RPZ devices, must receive immediate attention. For industrial operations involving critical contaminants (for example, plating shops), the potable water system should be shut down until the faulty device is repaired or replaced.

d. Hydrant access control program. Implementing hydrant access control as part of the maintenance program has become more important in recent years due to the increased threats of intentional contamination to a public water system. Fire hydrants are readily accessible throughout the installation and are easily opened to accommodate emergency response by the fire department. This accessibility makes fire hydrants susceptible targets of misuse, including intentional contamination. Frequently, installation personnel and contractors requiring temporary access to water will tap into a fire hydrant to support activities such as cleaning equipment, applying pesticide, or spraying herbicides and other lawn chemicals. Inappropriate handling of chemicals during these activities may inadvertently contaminate the potable water supply through backsiphonage. Recommended hydrant access control initiatives include, but are not limited to, the following:

(1) Instituting a hydrant locking system to secure hydrants from unauthorized use. Such a locking system requires specialized equipment and instruction provided to vetted users only.

(2) Providing cross-connection control training to individuals who require access to the water supply via hydrants while working on the installation (for example, Government workers, contractors, and public utility authorities).

(3) Maintaining RPZ backflow prevention devices, which are temporarily assigned to the unit or contractor requiring water access. After abbreviated training and demonstration of how to use the device properly, the device must be installed at each site where hydrants are accessed and water is withdrawn from the potable supply system. All points where the water system will be accessed must be reported to the DPW prior to interconnection.

(4) Implementing a reporting process to track incidents of uncoordinated hydrant use. Installation personnel responsible for water system operations and security should report instances of uncoordinated hydrant use, particularly if a backflow prevention device is not being used where it should. Reporting should involve the military police or Provost Marshal, DPW/operating contractor, fire department, and the installation PH authority. Effective programs have punished violators by denying further access to the installation or use of the water system, severely limiting their ability to work on the installation.

e. Corrosion control program. Corrosion of metal piping presents a significant problem within the distribution system. Corrosion occurs as a function of piping materials, the age of piping, the pH and mineral content of the water supply, the use and effectiveness of applied corrosion control measures/chemicals, and the retention time of water within the piping network.

(1) There are a wide variety of approved piping materials, including ductile iron, galvanized steel, asbestos-cement/transite, and several types of plastic, copper, and brass. Aged water distribution systems typically found on Army installations may contain a number of different types of interconnected materials, some of which are more durable than others for the conditions present.

(2) External corrosion occurs under two distinct conditions. The first involves highly acidic or basic soils that diminish the integrity of the outer surface of a pipe. Soil conditions must be monitored, and associated corrosion can be corrected only by replacing the piping with a more resistant material. The second condition is galvanic corrosion, which occurs when two dissimilar types of metal piping are interconnected without suitable protection. Galvanic corrosion is common and is corrected (or prevented) by applying dielectric unions at these connection points.

(3) Internal piping corrosion is typically the most common and is often a function of the pH, chemical character, and flow or stagnation of the water supply. This type of corrosion may cause piping walls and joints to deteriorate. As the integrity of the system weakens, breaks may occur when the system is subjected to stress or to changes in temperature or pressure. Corrosion can also lead to the development of tubercules and debris within the pipes, particularly in areas where there is low flow. Low flow areas serve as traps for contaminants and breeding grounds for microbial aftergrowths.

(4) The installation PH authority should maintain situational awareness regarding corrosion control, as consumer water quality complaints are often attributed to corrosion issues.

Understanding the condition of all installation piping networks plays a key role in the development of the public health monitoring plan.

f. Disinfection program. The presence of certain microbes in the water distribution system automatically renders the water supply nonpotable and will trigger a “boil water” notice. A contamination event may require the temporary use of alternate water supplies, or, in extreme/prolonged contamination cases, may cause installations to cease operations and close. Proper management of a disinfection program coupled with the other preventive maintenance programs discussed in this section assures the potability of the drinking water system. Refer to paragraph 3–2*d* for disinfection methods. Although several materials provide effective disinfection of water, only chlorine and chloramine produce a residual throughout the distribution system.

(1) Chloramine, which does not have the same potency or lasting power of chlorine, breaks down more readily with retention time.

(2) Chlorine can remain in solution for an extended period of time and is the preferred treatment for disinfecting drinking water. FAC residual will reduce when exposed to microbes, heat, or corrosion tubercules and debris, and after extended retention times in the piping system.

(3) The installation PH authority and DPW/operating contractor will monitor FAC concentrations (or CAC concentrations if chloramines are used) throughout the distribution system to discern the movement of fresh water (absence of stagnant water) within the system and to ensure that microbiological regrowth within the piping system, or some other compromise, has not occurred.

(4) In-line rechlorination points—often using hypochlorite solutions—may be installed to augment the disinfection residual by injecting additional chlorine solution within the system. This technology is typically applied in supply systems where microbial regrowths have been identified. Water system operators should not rely solely on in-line rechlorination technology to address residual maintenance problems. The presence of bacterial regrowths may indicate other problematic issues within the water treatment, storage, or distribution system, such as compromised piping, ineffective treatment processes, stagnant water zones, or a buildup of tuberculation within the piping. Additionally, other requirements, such as increased operational oversight and control by the DPW/operating contractor and the possible formation of DBPs, must also be considered before rechlorination points are installed.

(5) The DPW/operating contractor and the installation PH authority should assess water quality trends closely over time and review the current status of operations and maintenance to discern the best actions to take for long-term microbial control.

(6) Coordinate with the installation PH authority (or Environmental Health representative) prior to placing a system back into operation following a service disruption.

CHAPTER 5

WATER QUALITY STANDARDS

5−1. General
Water that is accessible and safe to consume is necessary to sustain life. Extensive scientific, engineering, and administrative efforts have been expended to develop the technology and standards to ensure that a relatively consistent and safe drinking water supply is available to all consumers. Providing safe drinking water can be challenging, considering the disparate availability, origin, and quality of natural water sources available, as evidenced by the fact that contaminated water results in approximately half a million deaths per year worldwide.

5−2. Health-based drinking water standards
a. Congress enacted the Safe Drinking Water Act (SDWA) (Public Law (PL) 93-523) on 16 December 1974; it provides the health-based standards that all potable water suppliers within the U.S. must meet (at a minimum). The SDWA is codified in Part 141−149, Title 40 CFR(40 CFR 141–149). The SDWA and subsequent amendments direct the EPA to develop primary drinking water regulations for all public water systems. These regulations comprise the NPDWR. The drinking water standards presented in the NPDWR are shown as MCLs, which are based on the protection of human health. These primary standards are continuously revised and improved to protect the health and welfare of all consumers. The current NPDWR standards, which define the potability of a water supply, are delineated in the most recent revision of 40 CFR 141.

b. The EPA also established the National Secondary Drinking Water Regulations (NSDWR). These standards are based on potential adverse effects on the aesthetic quality or economic operation of drinking water systems and are not Federally enforceable.

c. All regulated drinking water systems in the U.S. must meet or exceed the NPDWR health-based standards (AR 200–1). The tenets of the SDWA allow the states to assume primacy (primary enforcement authority) for the enforcement of potable water regulations and standards, assuming that their requirements are at least as stringent as the Federal standards. Primacy for potable water has been assumed by almost all individual states within the U.S. State standards may encompass additional requirements but must include the NPDWR standards, at a minimum. State standards may be more stringent.

d. Army installations in OCONUS locations supply potable water in accordance with the requirements and quality standards published in the FGS developed and approved by the designated DoD Lead Environmental Component and the respective host nation. The FGS are based on a combination of the standards placed in the Overseas Environmental Baseline Guidance Document (OEBGD), the NPDWR, and other standards utilized by the host nation. The more stringent requirements are typically placed into the FGS. In the absence of a country-specific FGS, the OEBGD would apply.

5−3. Categories of standards
The NPDWR is organized into general categories of potential contaminants, which are discussed in the following paragraphs. Information regarding specific contaminants is provided in APHC

Technical Guide (TG) 179 and may also be obtained from the EPA or the toxicity profiles developed and published by the Agency for Toxic Substances and Disease Registry (ATSDR) (http://www.atsdr.cdc.gov/toxprofiles/index.asp), which is part of the DHHS.

a. Microbiological considerations.

(1) The control of microorganisms is essential for ensuring a safe drinking water supply. Water containing pathogens such as bacteria, viruses, and protozoa is responsible for many waterborne illnesses that have impacted significant populations throughout history. Some outbreaks of diseases such as typhoid, cholera, dysentery, and giardiasis have altered the course of history. Many water-related diseases involve water supplies that have been contaminated by fecal material originating from the intestinal tracts of warm-blooded animals. Disruption of the water distribution system can also introduce microbiological contaminants. For example, breaks in the piping network may introduce harmful microbes from surrounding soils. By shielding these microbes from residual disinfectants, the corrosion and scaling within the distribution system provide a medium for bacteria, cysts, and viruses to attach and proliferate within the water supply. Over time, these microbes may slough off, become entrained in the water flow, and reach consumers in potentially significant concentrations. Various modes of filtration and disinfection have proven effective in minimizing consumer exposure to pathogenic organisms in water.

(2) Comprehensive testing to identify all pathogenic organisms in the water supply is not recommended because it is both difficult and resource intensive. Indicator organisms are used to show possible contamination, which then determines if additional microbial analysis is needed. Fecal-specific indicator bacteria such as total coliforms and *E. coli* are commonly used as parameters to depict the need for further or more specific evaluation. The EPA, through the Total Coliform Rule (TCR), has established monitoring requirements for total coliforms and an MCL for *E. coli* in water supply systems. Detection of coliform bacteria in drinking water requires additional testing for *E. coli*.

(3) Reported outbreaks of waterborne disease involving protozoa, viruses, and the breakdown of water treatment processes resulted in the EPA establishing the Long-Term 1 and Long-Term 2 Enhanced Surface Water Treatment Rules. The Rules provide stringent filtration and disinfection requirements for surface water and GWUDISW supplies. Treatment system processes must now achieve at least 99.9 percent (3-log) removal and/or inactivation of *Giardia lamblia* cysts, at least 99 percent (2-log) removal of *Cryptosporidium*, and at least 99.99 percent (4-log) removal/inactivation of viruses in addition to the coliform bacteria.

b. Chemicals.

(1) Inorganic and organic materials emanate from natural and manmade sources and are prevalent in all water sources. Metals and inorganic materials often result from the natural environment in which they originate, whether the source is surface water or groundwater. The leaching of such materials depends on local geology and soil characteristics, corrosiveness of the natural water, flow characteristics, and materials within the water source itself. As identified, potential contaminants may be introduced due to industrial or agricultural activities, or through the inherent growth of populations and commercial operations. Piping materials and sealants also present a potential chemical contamination source. Aggressive or stagnant water in the piping network may cause certain metals to leach out of the confining structures, such as pipes and

tanks, and solubilize into the water supply. Lead has posed a particular threat due to its historical use in distribution system and building plumbing over the years. Additionally, some inorganic and organic-based chemicals are intentionally injected into the water supply for treatment or conditioning to enhance water quality characteristics. For example, chemical addition may enhance coagulation, settling, and filtration; pH adjustment is accomplished using chemical compounds; and fluoridation and disinfection involve adding a variety of chemicals to the system. Careful evaluation of the chemicals found in the water supply, and the use and source of each chemical, are essential during PH surveillance of the drinking water supply. Specific chemical and physical treatment processes are available to remove or minimize exposure to such chemical contaminants effectively.

(2) The presence of organic chemicals in drinking water supplies and their uncertain impacts upon consumers have been a longstanding concern. Drinking water regulators initially addressed pesticides and herbicides used for agricultural applications based on their potential to be entrained in adjacent surface water and groundwater resources. Concerns have since expanded to encompass VOCs, SVOCs (which are more complex, high molecular weight materials), toxic industrial chemicals (TICs), and a broader spectrum of synthetic organic materials. These widely used chemical compounds have been identified in small and large water supply systems worldwide. Many of these compounds have the potential to cause adverse effects with long-term exposure, and some of them are known to be carcinogenic, mutagenic, or teratogenic. The EPA has established low-level standards for many of these chemicals, and several physical and chemical treatment processes have proven effective at minimizing or removing them from water supplies. The presence of these chemicals, however, often remains unknown or intermittent. Unless the chemicals are specifically investigated, treatment processes may prove only partially effective or practical from a cost perspective, depending upon the type of chemical(s) present and the relative number of consumers affected. This circumstance highlights the importance of evaluating alternative water sources, if available.

c. Physical parameters.

(1) Turbidity and pH are two physical characteristics of a water supply that play a critical role in determining water quality. Depending on its source, turbidity, which is caused by inorganic materials, can be relatively innocuous to the health and welfare of consumers. The primary threat from turbidity is the potential for microbiological, organic chemical, or radiological materials to attach to the inorganic matter and pass through the treatment and distribution system for direct delivery to consumers. The particles causing turbidity act as a shield to prevent removal or inactivation of the microbiological, organic chemical, or radiological particles when disinfectants or oxidants are applied during water treatment. In most cases, inorganic materials will coalesce and be removed from the water stream during treatment processes via sedimentation and/or filtration. The detection of elevated turbidity levels generally results in the initiation of emergency response treatment actions. For example, the AWWA recommends that detection of a turbidity greater than 1 NTU should identify a need to flush the distribution system and search for areas of pipe corrosion that must be controlled. Actions may include issuance of a consumer "boil water" order, or requirements to utilize an alternative water supply.

(2) The pH of drinking water is a secondary water quality parameter since it presents a minimal direct health impact upon consumers. Its importance stems from the unique role it plays relative to distribution system maintenance and treatment. The pH, measured on a scale of 1–14, indicates the concentration of the hydrogen ion available within a water supply. The lower end of the scale represents a stronger acidic character, which is corrosive and may degrade the physical integrity of piping, joints, and fixtures. The upper end of the scale reflects stronger base materials, which may cause blockages due to scaling. A pH level of 7 indicates a neutral water supply. The ideal pH range for a potable water supply is 6.5–8.5. These levels reflect a relatively neutral water supply, posing no threat to consumers, and are in the range at which most of the desired chemical reactions in water treatment are optimal.

d. Radiological materials.

(1) Minute traces of radioactivity have been identified in many drinking water supplies around the world. The relative concentration and composition of these radioactive constituents, called radionuclides, depend principally on the radiochemical composition of the soil and rock strata through which the water has passed to the groundwater and surface water sources. Radioactive materials in drinking water may emanate from either naturally-occurring or manmade sources. Radium-226 is the most important of the naturally-occurring radionuclides likely to be identified in public water systems. While it may be present in surface water due to man's activities, radium-226 is usually found in groundwater as a result of geological conditions; it is not subject to external input or contaminant control mechanisms. Conversely, beta/photon emitters are most often present in surface water sources due to man's activities (for example, released from nuclear facilities, commercial nuclear power plants, hospitals, and scientific/industrial users of radioactive materials).

(2) The long-term effect of radionuclides in drinking water has not been examined extensively. Radionuclides emit ionizing radiation that can be harmful to living cells and may cause cancer in humans. The three types of high-energy waves that can be released from radionuclides are alpha, beta, and gamma radiation. To protect public health, the EPA has established monitoring requirements and separate MCLs for four groups of radiation in drinking water, based on the type of radiation emitted: combined radium-226/228, gross alpha particle, uranium, and beta/photon emitters. Uranium is also regulated because of its potential toxic effects as a heavy metal on the human kidney.

e. Disinfection byproducts.

(1) Nearly all water treatment operations apply a disinfection process. Many disinfectants introduced in a gas or liquid form are often strong oxidants. Strong oxidants may change the configuration of natural organic materials in the source water, react with them, or create potentially problematic byproduct materials during the reaction process. Because many of these byproducts are undesirable or pose potential health risks, it is critical that water treatment operations balance the deactivation and removal of microbial pathogens while preventing or minimizing the formation of DBPs.

(2) As part of the SDWA, the EPA developed several special rules to address the target residuals of disinfectants and MCLs, and MCL goals (MCLGs) for DBPs allowed in the water supply. Table 5–1 displays the regulated DBPs and the target concentrations for drinking water disinfectant residuals. The sampling requirements can be complicated, as they are based on

running averages obtained at specific problem locations within the distribution systems. These requirements are delineated in the Phase 1 and 2 DBP rules. Clarification of the requirements is provided in APHC TG 179.

Table 5–1
Summary of disinfectant and disinfection byproduct rules

Disinfectant Residual	**MRDLG (mg/L)**	**MRDL (mg/L)**	**Compliance Based On:**
Chlorine	4 (as Cl_2)	4 (as Cl_2)	See TG 179
Chloramine	4 (as Cl_2)	4 (as Cl_2)	See TG 179
Chlorine Dioxide	0.8 (as ClO_2)	0.8 (as ClO_2)	Daily samples
Disinfection Byproducts	**MCLG (mg/L)**	**MCL (mg/L)**	**Compliance Based On:**
Total Trihalomethanes (TTHMs)[1] – Chloroform – Bromodichloromethane –Dibromochloromethane – Bromoform	NA NA 0 0.06 0	0.080	Locational Running Annual Average (LRAA)
Haloacetic Acids, five (HAA5)[2] – Dichloroacetic Acid – Trichloroacetic Acid	NA 0 0.3	0.060	Locational Running Annual Average (LRAA)
Chlorite	0.8	1.0	See TG 179
Bromate	0	0.010	Annual Average

Legend:
MCL=maximum contaminant level
MCLG= maximum contaminant level goal
MRDL= maximum residual disinfectant level
MRDLG= maximum residual disinfectant level goal
NA= not applicable because there are specific MCLs for TTHMs and HAAs
Notes:
[1] Total Trihalomethanes is the sum of the concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.
[2] HAA5 is the sum of the concentrations of mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids.
[3] State or host nation rules may apply if more stringent.

5−4. Secondary standard parameters

The standards comprising the NSDWR are not enforceable unless they are incorporated into state drinking water regulations. The secondary drinking water standards address contaminants that affect the aesthetics or palatability of the water supplies consumed. Secondary parameters such as color, taste, and odor may not pose a direct or immediate adverse health impact, but they do influence the consumer's desire to use and consume the water. This is particularly important under circumstances where the health and welfare of consumers are affected by their ability to remain hydrated. Some of these parameters also have an adverse impact on the condition of distribution and storage systems, ultimately affecting maintenance and operational costs. OCONUS, the FGS apply to the countries where these standards have been developed. Where the FGS is not applicable, the standards presented in the Overseas Environmental Baseline Guidance Document should be used. Refer to 40 CFR 143 for the Secondary Drinking Water Standards, secondary maximum contaminant levels (SMCLs), and impacts associated with each material.

5−5. Enforcement of drinking water standards

The NPDWR are enforceable within CONUS, while the NSDWR are desired goals to be achieved. However, most states have assumed primacy over the establishment and enforcement of state-based drinking water standards. State-based standards must be at least as stringent as the Federal standards but may be more inclusive or stringent if supported and codified. Many states have incorporated some or all of the Federal secondary standards into their state drinking water standards. State regulatory agencies possess direct authority over water suppliers (including military installations) with oversight from the EPA. Many facilities OCONUS receive water supplies from local purveyors. Local/regional water standards would apply to these water supplies, but the FGS or OEBGD standard applies to potable water within the Army installation boundary.

5−6. Contaminants of emerging concern

In addition to the materials promulgated in Federal and state regulations as required drinking water standards, a number of potential contaminants that have not been formally included in these regulations may pose a threat to human health and welfare. These materials are generally not included as part of the enforceable regulatory standards because of low prevalence across the state or country, or because there is insufficient information available to develop a viable standard. The following resources identify contaminants of emerging concern and provide guidance for public health authorities. These resources do not offer official standards that are enforceable by a regulatory authority.

a. The EPA Office of Water has published health advisories (HAs) to address potential contaminants, which may pose a threat within a broad spectrum of potable water systems. The HAs address physical, chemical, and bacteriological contaminants and were developed to assist local public health and water system officials when dealing with episodic drinking water contamination problems and contamination by unregulated materials. Establishment of an HA is based on two criteria: there is evidence that the material has the potential to cause adverse health effects, and the contaminants are known to occur or might reasonably be expected to occur in drinking water supplies. Health advisories provide a synopsis of the potential adverse health impacts of ingesting these materials through drinking water, and present available analytical methodologies and effective treatment technologies to remove or inactivate the materials. Whenever toxicological data exist, criteria are developed for exposure durations of 1-day, 10-day, and lifetime exposure periods. Several EPA expert panels critically review these documents prior to publication.

b. Per- and polyfluoroalkyl substances (PFAS) have been used since the 1940s in products worldwide to provide stain-resistant, waterproof, and non-stick properties. PFAS are also present in some formulations of aqueous film forming foams that have been used by military and civilian fire fighters. The EPA has evaluated the widespread presence and health impacts of PFAS for several years. In May 2016, the EPA established a drinking water lifetime health advisory (LHA) level for two PFAS chemicals: perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). In addition, various states are proposing or have set their own health-related advisories and/or standards for PFOS/PFOA and other PFAS chemicals in drinking water. The DoD addresses new PFAS standards and/or advisories when appropriate and applicable. As of 2022, the EPA has moved forward to implement the national primary drinking water regulation development process for PFOS/PFOA. In 2016, the DoD and Army initiated a program for monitoring PFAS in their drinking water systems. The program was updated in 2017 and 2020 and affects all installation drinking water systems, regardless of population served or type of supplier (that is, privatized, DoD-owned, or purchased from a local commercial or municipal system). Installation drinking water program managers should contact the Major Command Headquarters for the latest PFAS monitoring guidance.

c. The ATSDR is responsible for developing and publishing Toxicological Profiles for potential contaminants that may pose health threats to humans via any exposure pathway. These profiles provide a synopsis of all studies, which indicate potential adverse human impacts. The profiles also present observed health impacts, the test animals on which these impacts were observed, and the levels of exposure at which the impacts occurred. The ATSDR does not extrapolate these findings to assign action levels or standards for human exposures.

d. Military Exposure Guidelines (MEGs) are presented in APHC TG 230. The TG provides health risk-based criteria for a number of military-unique materials that may be encountered by Service members during deployments (in both CONUS and OCONUS locations). The TG also provides insight into the health impacts of certain contaminants/materials that are not addressed in other documents. The MEGs represent relatively short-term exposure periods and target a healthy, young population; therefore, care must be applied when attempting to use these data for assessing exposures at fixed installations. The MEGs represent 7-day, 14-day, and 1-year periods of exposure from consuming this water. The 7-day and 14-day levels presume an ingestion rate of 5 L/d for temperate environments and 15 L/d for dry/arid environments; whereas, the long-term exposure level (1 year) is based on a 5 L/d ingestion rate. Direct application of the MEGs to populations at most fixed installations is rare and would require a specific risk assessment.

CHAPTER 6

WATER SURVEILLANCE

6−1. General

There are three levels of surveillance applied to a drinking water supply system: regulatory compliance monitoring, operational quality monitoring, and public health quality assurance monitoring. The regulatory authority conducts compliance surveillance to ensure NPDWR or applicable OEBGD/FGS standards are met. The installation's drinking water operations personnel monitor conditions daily to control chemical addition and water quality. The quality assurance monitoring conducted by the installation PH authority is an added measure to assure the safety of the water supply. (PH monitoring must adhere to MEDCOM OPORD 21-57, which helps to define the current role of the PH authority.) The overlap created by these surveillance activities ensures that the necessary data are acquired and are seen by all requisite personnel. Collaboration and communication amongst these drinking water program stakeholders are essential when water surveillance is conducted. Sampling depicted in this text will be collected from sites within the distribution system as identified in the approved installation sampling plan. One possible exception may involve installations that procure water from another PWS system. Under these circumstances, it may be advantageous to collect and analyze a sample at the point(s) of interconnection, as well. This would allow installation authorities to discern if any potential materials/contaminants identified were attributed to the source water supply received. If such were deemed to form or develop within the installation distribution or delivery network, the installation should institute measures to address potential risks or concerns.

6–2. Regulatory compliance monitoring

The installation EC is typically responsible for interacting with the Federal, state, and local regulatory authorities and serves as the IC representative. Designation of a single individual or office as a point of contact (POC) allows the installation to speak with "one voice," which facilitates the clarity of information coordinated and eliminates the potential for issues or data to be miscommunicated. The EC ensures that the collection, analysis, and submission of samples comply with pertinent drinking water standards and regulations. The EC may contract with a local, certified laboratory to collect and analyze the samples required by the regulatory authorities.

a. Sampling occurs at a frequency dictated by the regulators, often on a monthly basis. Sampling status is often based on the characterization of the water supply as a public water supply, CWS, TNC water system or NTNC water system, the type of water source, and the potential presence of contaminants found. These definitions, along with the MCLs, are provided in 40 CFR 141 and the appropriate FGS. Monitoring frequencies are identified by the regulators, depending on the status of the various water supplies. Army installations must comply with these standards and regulations.

b. Each installation that produces water must comply with state and Federal regulations by sampling the water systems at required locations and analyzing them for a series of specified parameters, which will indicate the overall quality and safety of the water supply. Similarly, OCONUS installations adhere to the requirements defined in the appropriate FGS or OEBGD. For CONUS installations, sampling results are submitted to the primacy regulatory authority for review on a monthly basis. OCONUS sampling results should be submitted to the respective Medical Readiness Command (MRC) or the Theatre Surgeon, as required, for review and concurrence.

c. Sampling analysis data should be discussed with the water purveyors and the installation PH authority to ensure that no operational or monitoring changes are needed. Data are submitted to Federal, state, or local regulatory authorities, as required.

d. When operational data or special sampling and analysis is required (for example, lead tracing in water, or remediation of DBPs), the EC remains the sole intermediary with the regulatory authorities and maintains constant communication with the DPW/operating contractor.

e. The designated EC works closely with the DPW or water contractor and the installation PH authority to obtain and understand all available data. The EC should provide copies of the data transmitted, as well as guidance and concerns received from the regulatory authorities, to each group on the installation that holds responsibility for some aspect of the water supply system.

6–3. Operational quality monitoring

Continuous, daily assessment is required for all aspects of the potable water supply system operation and maintenance activities. The DPW/operating contractor/water purveyor monitors specific physical and chemical parameters to ensure optimization of treatment, storage, and distribution operations. Samples are collected from the WTP to monitor proper operation of equipment, treatment processes, and chemical addition. Sampling and analysis may be performed by the operations personnel themselves and/or through the employment of in-line monitoring technology, with results stored in a database, connected to the SCADA system. For example, pH and alkalinity are monitored to ensure that water conditions are satisfactory for effective floc formation, settling, and filtration. FAC is monitored to facilitate bactericidal capability throughout the distribution system, and fluoride concentration is monitored for the prevention of dental caries among consumers. These parameters are tested throughout each shift to ensure the integrity of the water supply is not compromised. The DPW/operating contractor also collects samples for analyses to assess potential problems incurred or remediation measures undertaken within the water supply system in situations involving, but not limited to, water main breaks, a threat of contamination, or physical damage/replacement of any aspect of the water system. Operations personnel may collect samples for analysis or rely on in-line telemetry monitoring systems that store results in a database.

6–4. Public health quality assurance monitoring

a. Quality assurance monitoring assesses the potability of the drinking water supply and involves routine sampling and analysis by the installation PH authority for the following parameters: coliform bacteria, FAC residual, and pH. A detailed sampling and monitoring plan that specifies the sites and frequency of all PH authority monitoring must be documented and reviewed periodically (for example, annually) to ensure that it is current. Sampling is conducted monthly; the numbers of samples and sampling locations are based on population size, as indicated in table 6–1, and high-priority populations, as specified in paragraph 1–5*e*(6). Samples are not collected from hot water faucets, mixing faucets, leaking faucets, drinking water fountains, or dead-end locations. The sampling and monitoring plans, and all data compiled, will be retained and available for review in the Defense Occupational and Environmental Health Readiness System (DOEHRS).

(1) The ability to identify the chlorine residual concentration rapidly is most critical to discern the potential for bacteriological growth in the water supply system. This action can also provide important information regarding the movement or flow of water in the piping and storage network, which can also impact the potential for microbial growth.

(2) The installation PH authority may use operational monitoring data from the water system operators at remote installations within the AOR to characterize risk, as confirmed by the PH authority and IMA.

(3) Sampling and analysis for bacteriological contamination are required, especially for systems exhibiting low or absent chlorine disinfectant residual and very low water movement typically attributed to stagnant water or dead ends in piping.

(4) Quality assurance monitoring should be conducted based on the risk characterization of the water supply system or those systems routinely scrutinized by state or local regulatory authorities. Operational surveillance data generated by the installation's water system authorities can be used for this risk analysis. Some installations, however, fall below the requirements for regulatory scrutiny due to the size of the population served, the size of the distribution system, or the source of the water supply used. Therefore, the installation PH authority may collect and analyze a minimum of 2 bacteriological samples per month for facilities serving less than 200 persons, or a minimum of 5 bacteriological samples per month for facilities serving 200–750 persons. The samples are collected from predetermined, representative points within the water distribution system at each installation or military site within the AOR. This action provides minimum statistical assurance that potentially problematic or high-risk areas within the distribution system are assessed. Further assurance of representative coverage may be attained by defining two sets of sampling locations and rotating the collection groupings every other month.

b. Regular interface between the installation PH authority and the water purveyors (whether the installation DPW, operating contractor, or an external provider of water) is essential to maintain awareness of operational or water quality issues impacting the water supply system. Such issues may include a degradation of the source water, dysfunction of the WTP, disruption of the integrity of the distribution or storage systems, or the accidental or intentional introduction of possible contamination to the water supply.

(1) To judge the drinking water quality adequately, the installation PH authority conducts routine reviews of all compiled operational and compliance data. Data from quality assurance monitoring and other surveillance activities conducted by the installation PH authority augment the operational and compliance data to provide a clear and consistent view of water quality and the status of the entire supply system.

(2) The installation PH authority must establish itself as an active stakeholder in water supply system operations and assessment by initiating an open and consistent relationship with the water purveyors. The DPW/operating contractor and Engineering authorities seldom seek PH

input; therefore, the installation PH authority must initiate and maintain this interface (further described in para 6–8*b*). A formal meeting of water system stakeholders should occur at least quarterly for the exchange of operational and compliance data, discussions of water system concerns, proposed changes to system operations, and upcoming monitoring to be undertaken. This information is used to identify appropriate sampling locations within the water supply system and may further identify needed adjustments for bacteriological monitoring locations to address areas susceptible to stagnant flow conditions, structural compromise, or consumer complaints.

(3) Implementing regular communications facilitates the coordinating activities necessary between the water purveyors and installation PH authority during water system emergencies such as a water main break or contamination event.

(4) The installation PH authority provides assistance to the IC and DPW/operating contractor to ensure a public notification plan exists for each water system within the installation PH authority's AOR for consumer notification when there is degradation of the water supply system or prescribed water quality standards. Notifications provide instructions for consumers to treat water from their current source or identify a safe, interim potable water source. The installation PH authority coordinates with the DPW/operating contractor to subsequently notify the IC and IMA when such restrictions may be lifted and the water is safe for consumption.

6−5. Bacteriological testing

Bacteriological quality of the water supply is a critical factor in determining water potability because the presence of harmful bacteria can cause acute health impacts to the consumer. Bacteriological testing of a fixed installation water supply system generally falls into two categories: compliance monitoring on behalf of the installation, and supplemental monitoring for quality assurance.

a. Bacteriological analyses for regulatory compliance must be conducted by a state-certified laboratory (or an appropriately accredited laboratory for OCONUS installations), which is usually coordinated by the DPW/operating contractor. Regulatory compliance monitoring for bacteriological quality may be provided by the installation PH authority, according to AR 40–5, on a reimbursable basis, under the following conditions:

(1) The installation PH authority laboratory must obtain and maintain EPA or state certification to perform compliance-based sampling and analysis for total and fecal coliform testing. This certification is particularly important for OCONUS PH Programs, as it minimizes data conflicts between the laboratory and the DPW/operating contractors.

(2) The PH laboratory must possess the manpower, materials, and capacity to analyze the required monthly water samples, including repeat and confirmation samples.

(3) A formal MOA between the DPW/operating contractor and the installation PH authority is required, stipulating the details of the agreement (for example, timing and locations of sampling, and modes and timeliness of reporting), and the funding source.

(4) The DPW/operating contractor may request supplemental bacteriological monitoring from the installation PH authority to clarify the status of water quality in the supply system, provide oversight of water systems that receive insufficient regulatory scrutiny, or to monitor

maintenance of the water distribution system. Use of a certified laboratory is not required for supplemental monitoring activities.

b. Compliance monitoring for bacteriological water quality is based on the size of the population served; larger populations require a higher number of total coliform samples to be tested each month. In situations where an external purveyor supplies drinking water, that purveyor may collect all monthly compliance samples from distribution system locations "outside the gate." Army installations may receive no regular sampling or scrutiny regarding the quality of the water supply. This is often the case for smaller, remote sites within the PH authority's AOR. In these situations, it is critical for the installation PH authority to provide comprehensive quality assurance sampling and assessment to adequately judge the water quality on the installation and other sites within the AOR. Such assessment is particularly important considering the age and condition of most piping systems at military installations. Table 6–1 specifies the minimum number of samples that should be collected and analyzed each month based on the average daytime population serviced by the water distribution system on post. The number of samples delineated provides a statistical representation of the system; whereas, a single sample or two would not adequately depict the quality of water within the piping network. Installations comprised of only a building or two may, indeed, be adequately characterized by only 2 samples per month, as shown in table 6–1. Additional sampling may be required depending on the configuration of the system (for example, dead-ends, high usage in specific areas, schools, or child development centers). The number of bacteriological samples identified in table 6–1 for smaller installations may be greater than the numbers identified in the NPDWR. This table represents the number of quality assurance samples to be performed by the PH authority and provides sufficient confidence in the data for an IMA to certify use of this water supply. The numbers in table 6–1 are necessary to adequately characterize the water quality in aging water supply systems containing multiple low-flow, stagnant water, and dead-end zones, which are prevalent at many installations. Note that some installations within a defined AOR may require travel to collect required surveillance samples. Note that the number of samples identified in table 6–1 is the minimum number that should be collected and analyzed each month. The PH Program may analyze a greater number of samples to ensure water quality. Ideally, the number of samples collected and analyzed would be distributed evenly during the month (for example, 2 samples/week for each week of the month). However, it is recognized that distance and logistics may preclude the possibility of weekly site visits. When this limitation occurs, all coliform samples may be collected and field parameters tested during 1 week within a month. In some OCONUS locations, PH authorities using certified laboratories conduct drinking water compliance sampling/analysis. The adequacy of those programs should be verified by a lab certification officer, or equivalent, and should be reviewed during higher-level PH SAVs and OIPs. Where this alternate surveillance process is implemented, additional QA sampling is not necessary.

Table 6–1
Number of bacteriological samples required monthly per installation population

Daytime Population	Minimum Number of Samples
<750	5
750–1500	6
1501–3000	7
3001–5000	8
>5000	>8, follow table in 40 CFR 141.21 for the population served

c. The EPA has determined that the total coliform test is the standard for evaluating the bacteriological quality of drinking water supplies throughout the U.S. Both the Army and the DoD have adopted this approach and standard for U.S. Forces worldwide. This test is based on the premise that total coliform bacteria are typically present in contaminated water at higher levels than other pathogenic organisms. Testing for total coliform bacteria using one of several test methods is easier and more cost-effective to accomplish than testing for low levels of pathogenic bacteria, which requires more complex procedures and additional time.

(1) Total coliform bacteria have the ability to ferment lactose with gas and acid productions at 35 degrees Celsius (ºC). The lactose-fermenting characteristic has been the basis for historical testing procedures. The bacteria genera *Escherichia, Klebsiella, Enterobacter*, and *Citrobacter* are generally considered to comprise the total coliform group. The majority of species from these groups are found in the environment in soils or untreated source waters such as rivers and lakes. Treatment techniques to produce potable water are generally effective in removing the coliform species of bacteria as well as the pathogenic microbes that may be present in untreated water. Therefore, detecting total coliform bacteria in drinking water supplies is usually an indication that an event leading to contamination of the supply has occurred. Potential problems include water line breaks or inflow, cross connection between potable and nonpotable water supplies, a drop in water pressure resulting in backsiphonage from a contaminated or untreated source, or an intentional contamination.

(2) Fecal coliform bacteria is a subgroup of the total coliforms that inhabit the digestive tracts of warm-blooded animals. Certain species of *Escherichia* and *Klebsiella* bacteria are commonly found in this category and may cause acute illness to consumers. These bacteria have the ability to grow at higher temperatures than other coliform bacteria. The testing procedures utilized to discern the presence of fecal coliform bacteria use a temperature of 44.5 °C, as per 40 CFR 141–143, and an additional 24 hours may be required to identify this presence accurately. The detection of fecal coliform in drinking water is concerning because it indicates that animal or human fecal material may have contaminated the water supply.

(3) The TCR and the newer Revised TCR require that a drinking water sample that has tested positive for total coliform bacteria must be further tested for either the fecal coliform group or specifically for the bacterial species *Escherichia coli* (*E. coli*). The purpose of this additional testing is to provide critical information regarding the public health significance of the coliform presence. *E. coli* is the predominant indicator species comprising the fecal coliform group; some estimates show that 92 percent of fecal coliforms identified are *E. coli*. The EPA

and PH authorities at all levels, in general, place far more emphasis on the detection of *E. coli* as the basic indicator of fecal contamination.

(a) A positive total coliform test result requires collection and coliform analysis of a repeat sample taken from the same location in addition to one sample taken upstream and one sample taken downstream. Collect the upstream and downstream samples from a location that is within five service connections from the location of the positive sample point.

(b) Report the samples presenting positive for total coliform, and subsequent *E. coli* (or fecal coliform) results, to the IMA and DPW/operating contractor, and consult them regarding further testing and reporting to off-post regulatory authorities.

d. EPA-approved methods for total coliform testing include the multiple-tube fermentation (MTF) test, the membrane filter (MF) test, and the enzyme substrate test. The original MTF test required fermentation for approximately 48 hours to obtain results. Subsequently, the improved MF test proved easier and required incubation for only about 24 hours. Since the early 2000s, the enzyme substrate test has proven to be the method of choice, as it is much easier to perform and provides reliable results within 24 hours. All of these procedures are considered viable, and they are certified for use by the EPA and state regulatory authorities. The enzyme substrate test, for example, Colilert and Colisure, is the most efficient method, and the testing components are readily available through the DoD/Army supply system. Additionally, the enzyme substrate test requires less equipment and less hands-on manipulation of the sample. Results are easy to interpret, and results can be obtained quicker as compared to either the MTF or MF procedure. For OCONUS facilities, bacteriological compliance monitoring may be conducted by local accredited laboratories using approved country-specific methods.

e. HPC analysis is an additional bacteriological monitoring capability that should be maintained by the installation PH authority. The HPC analysis is the preferred method for testing ice machine samples. Instead of isolating total coliform, the analysis provides an indication of the total microbial load. An elevated HPC signifies a possible breakdown in sanitary controls, which should trigger an investigation to resolve the causative factors. HPC analysis is generally used to assess commercial bottled water, ice machine sanitation, and recreational waters. Guidance is provided in TB MED 531 for ice machine quality assurance monitoring and in TB MED 575 for recreational water facilities.

f. Bacteriological water sampling and assessment are required prior to placing a drinking water system back into service following a service line disruption, repair, or other breach that may have introduced contaminants. Sampling provides a measure of assurance that the piping network has been “cleaned” by means of flushing of dirt and debris, and disinfected to neutralize potentially debilitating bacteria introduced into the water supply. After a water main break is repaired by either the DPW/operating contractor or an external contractor, the water system must be thoroughly flushed, disinfected, sampled, and analyzed to show sequential days of negative sample results. The installation PH authority provides direct sampling support to the DPW/operating contractor and/or Engineers when equipment or materials within the water supply system need repair or replacement. At OCONUS installations, the local contractors performing such repair work must follow the country-specific regulations/standards addressing flushing and disinfection of mains prior to placing them back into service.

6−6. Sanitary surveys
A sanitary survey is a valuable tool that allows the installation PH authority to observe water supply system operations, maintenance, and equipment to facilitate the provision of a reliable and safe water supply for all consumers. The sanitary survey encompasses the review of water sources, treatment capabilities, water storage and distribution, and plumbing activities with the goal of ensuring proper design and operations, detecting and eliminating potential sources of contamination, and the assurance of proper monitoring and reporting. Sanitary surveys are performed locally by the PH authority at two distinct levels: a comprehensive survey conducted every 3 years, and an annual review. For OCONUS installations, the OEBGD and FGS call for systems utilizing groundwater sources to receive a sanitary survey every 5 years. Systems serviced by surface water or GWUDISW should be assessed every 3 years.

a. The comprehensive sanitary survey is conducted by a public health engineer or scientist who possesses in-depth knowledge and understanding of water system operations. The goal of the comprehensive survey is to provide a detailed, technical assessment of each Army water system on a scheduled basis. The installation PH authority may require consultative assistance through the PHC or the DCPH-A to conduct a comprehensive survey. Installation PH personnel should accompany and receive onsite training and clarification of issues from the PH engineers or scientists conducting these assessments.

b. The annual sanitary survey review is generally conducted by installation PH authority personnel. Each water supply system at installations within the installation PH authority's AOR undergoes this review.

(1) Annual surveys are conducted to discern any potential changes, concerns, and conditions associated with the drinking water supply systems. The results of the survey assist in the determination of high-risk systems requiring increased PH and installation scrutiny and resources. The installation PH authority may seek approval from the IC and the IMA to reduce the requirement for annual sanitary surveys at low-risk installations where water systems are well maintained. The frequency may be extended to every 2 or 3 years and should include appropriate documentation containing the rationale and the approval authority's signature.

(2) Development of a new sanitary survey report is not required when the annual survey is conducted; use the most recent comprehensive survey report as a guide. Focus on and document any observed changes to the water system. These may include issues involving physical structure or configuration, treatment processes, chemical addition, storage tank operation, distribution system maintenance, main breaks or leakage, changes in water monitoring or quality, and other changes or issues that impact the drinking water supply system.

(3) Findings from the annual surveys should be communicated to the DPW/operating contractor and Engineering authorities during the periodic stakeholder meeting as specified in paragraph 6–8*b*.

6−7. Compliance and operational data review
The installation PH authority conducts a monthly environmental health review and medical assessment of all regulatory compliance and operational monitoring data representing the potable water supplies at all installations within their AOR. The available information for each installation should allow an assessment of the potability of the water supplies and identify trends

in water quality changes as well as issues that must be addressed (for example, rising levels of lead or copper may impact sensitive sub-populations). Larger installations where water is treated and supplied may have a substantial database that can be reviewed to support such assessments; whereas, small or remote installations may possess very limited data for this purpose.

a. Compliance analytical results are generally compiled and submitted to the regulatory authorities by the installation DPW/operating contractor, Engineers, or EC on a monthly basis. Copies of all results, along with daily, operational monitoring logs/records as specified in paragraph 6–3 (for example, pH, turbidity, fluoride concentration, and disinfectant/chlorine residual) should be submitted to the installation PH authority each month.

b. Installations that purchase water from an external provider (for example, local county, municipality, or privately-owned operation) may not be required to perform a comprehensive analysis of their water system, as the installations are considered individual consumers of the purveyor's larger water supply system. In these cases, any sampling undertaken by the DPW or operating contractors responsible for water distribution, along with other monthly monitoring required by the installation PH authority, should be compiled in a file to represent each month of operation/consumption. Assistance for conducting detailed water quality analyses may be available through the PHC. The installation PH Program must archive all water quality data for the water supplies in DOEHRS.

6−8. Water purveyor collaboration

a. The safety and reliability of the water supply requires collaboration among the installation's water purveyor (Government- or contractor-operated), the EC, and the installation PH authority. The purveyor understands and implements the operational and maintenance aspects of the system and is often responsible for operational monitoring. The EC generally compiles the compliance data and interacts with the state/Federal regulatory authorities. The EC disseminates the data submitted for compliance and receives guidance from the regulators regarding the status of the water system and the need for increased supply system scrutiny or monitoring. The installation PH authority performs sampling and assessment of data and conditions, which determine the potability and safety of the water supply, particularly in the absence of direct regulatory scrutiny. Because each of these authorities controls somewhat different aspects of the same critical infrastructure system, it is essential that these personnel meet routinely to address water system status, recommended actions to optimize water quality and operations, and to integrate efforts to produce a consistently high-quality product to all consumers and activities.

b. Representatives of each major stakeholder with responsibility for the water supply system should meet on a quarterly basis (every 3 months). These stakeholders include the DPW, operational contractors (where applicable), EC (usually from the Environmental Division), installation PH authority, plumbing shop, and fire department (identified in Chapter 8 of DA Pam 40–11). The goals of these meetings are to—

(1) Discuss the status of operations and maintenance of the water system;
(2) Discuss water quality issues and concerns, including trends observed;
(3) Clarify potential system vulnerabilities for service disruption and mitigation measures;
(4) Describe actions and responsibilities for any leakage or piping breaks identified;

(5) Share operational and compliance data compiled and/or reported to regulators;
(6) Discuss pressure and flow information observed in dead-end and low-use portions of the distribution system;
(7) Identify alternative supply use (for example, external interconnections and water quality or bottled water);
(8) Discuss projected changes to system sampling, operations, or changes in structures or missions supported;
(9) Determine how to support identified mission essential vulnerability activities;
(10) Identify sampling locations and frequencies; and
(11) Discuss consumer complaints received.

6−9. Water system vulnerability assessments
The water supply system is a critical infrastructure that affects all consumers at installations: residents, employees, industrial operations, commercial activities, and other utilities (for example, heating and cooling systems). A disruption of the water system may adversely impact installation mission support functions and operations.

a. AR 420–21, AR 525–13, and DA Pam 40–11 require installations to conduct utility vulnerability analyses and to prepare remedial action plans to ensure mission support in the event of disruption to major utility systems (see para 6–10). Section 1433 of the Safe Drinking Water Act specifies that—

> "The vulnerability assessment shall include, but not be limited to, a review of pipes and constructed conveyances, physical barriers, water collection, pretreatment, treatment, storage and distribution facilities, electronic computer or other automated systems which are utilized by the public water system, the use, storage, or handling of various chemicals, and the operation and maintenance of such systems."

b. The DoD and the U.S. Army have established standards requiring a comprehensive water system vulnerability assessment (WSVA) at all military installations. A comprehensive WSVA is conducted every 3 years; a review of the water system vulnerabilities is conducted annually and is used to update the WSVA between comprehensive surveys. This frequency may be reduced to every 5 years (as determined by the regional PHC, Medical Readiness Command (MRC), and installation authorities) for installations that pose little threat or are overseen by other regulatory authorities. The installation PH authority must continue to perform an annual sanitary survey review at each installation within its AOR at a minimum.

(1) WSVAs are scheduled at the request of the U.S. Army Installation Management Command (IMCOM) and the U.S. Army Materiel Command (AMC).

(2) WSVAs are conducted concurrent with the Higher Headquarters Assessments performed by the Major Command or its contractors, unless otherwise directed.

(3) Security classification of WSVA documents is specified in APHC TG 374.

c. The original focus of the WSVA addressed the prevention of acts of intentional contamination or system disruption, from a security perspective, and their impacts upon the water system as a whole. Following recent changes to the WSVA, it now focuses on the potential for disruption or contamination from an "All-Hazards" perspective. An All-Hazards approach encompasses human or intentional disruptions of water service, disruptions caused by natural or weather events, and the degradation of water system elements due to age, corrosion, and operation and maintenance issues.

(1) Comprehensive WSVAs include an adequacy assessment of water system regulatory and operational monitoring.

(2) The WSVA reports findings and potential vulnerabilities to water system operations and considers the potential adverse impacts to the overall mission(s) of the installation and to Army readiness.

d. The installation Antiterrorism Officer (ATO) is responsible for ensuring an annual assessment of the water supply system is conducted and the most recent WSVA is revised accordingly.

(1) AR 525–13 states that TSG will provide WSVA support for the ICs. Assessments are typically performed by the PHCs, with oversight and coordination performed by the DCPH-A.

(2) A group of water supply stakeholders, as identified in paragraph 6–8*b*, including water purveyors and installation master planners, as applicable, should participate in the annual review.

(3) Substantive or operational changes are reflected in WSVA updates submitted to the ATO/Command. Required upgrades to the critical infrastructure are accomplished as needed.

6–10. Water system emergency response plan

AR 525–13 requires an annual review and updating, as appropriate, of the installation's water system emergency response plan (WSERP). This document, along with APHC TG 297 and DA Pam 40–11, defines the required actions and POC information to address any possible disruption of the water supply system. Included are the locations of equipment for repairing compromised treatment or distribution operations, POCs for water sampling and analyses, designated installation PH authority and state/local regulatory authorities authorized to approve the use/consumption of water supplies, interim actions during a water emergency, availability of alternative water supplies, and other essential emergency response guidance. All water supply assets should be encompassed in the installation Mission Essential Vulnerable Asset (MEVA) listing to ensure that proper support is received during emergency operations and that mission-critical assets on the installations remain functional.

a. The installation PH authority assists the DPW/operating contractor/Engineering/water system authorities in developing and periodically updating the WSERP.

b. The WSERP is developed during periods of normal operation and should not be postponed or ignored until an emergency situation arises.

c. The WSERP is a critical reference document when a WSVA is conducted.

6–11. American Water Infrastructure Act support

In 2018, Congress passed America's Water Infrastructure Act (AWIA), which requires all CWSs serving greater than 3,300 persons to certify the "Risk and Resilience" assessments of their water resources and infrastructure. The dates of implementation are based on categories of populations served, but all such systems must be in compliance during 2021. The AWIA requires all CWSs serving more than 3,300 persons to provide a comprehensive risk evaluation every 5 years. This evaluation mirrors the WSVAs that are conducted at Army installations but includes requirements for the installation Operations and Maintenance (O&M)/water purveyor to provide appropriate proof of certification to the EPA indicating a risk evaluation was completed and reflecting any substantial risks noted. All water systems that have been assigned a Public Water System Identification (PWSID) number in the Safe Drinking Water Information System must comply with the certification requirements imposed by the AWIA. Currently, the EPA has addressed water systems within the U.S. and associated territories. Therefore, the requirements of AWIA do not apply to OCONUS installations.

a. An Emergency Response Plan must be developed within 6 months after a Risk and Resilience assessment is performed.

b. A letter certifying completion of these actions must be sent to the EPA Administrator. Assessment documents and a copy of the WSERP are not forwarded to the EPA Administrator.

c. Guidelines for conducting a Risk and Resilience assessment, along with a certification letter template, are available from the EPA. The actions required by the AWIA are very similar to the guidelines and procedures delineated in paragraphs 6–9 and 6–10 of this bulletin for WSAVs and WSERPs, which can be used to certify the risk process.

(1) The IMCOM G-4 has identified that the O&M authorities within the respective installation DPWs are responsible for developing the certification letters and submitting them to the EPA Administrator. The O&M authorities should ensure the IC continues to communicate with the EPA Administrator with "one voice" so the Command does not miss any required deadlines or receive misinterpreted information. The O&M authority must interact closely with the water purveyors, Emergency Management Office, ATO, installation PH authority, and Command staff to accurately relay what was found, actions that will be taken to address potential water supply system risks, and implementation of actions for emergency situations.

(2) Additional guidance provided by the DCPH-A or PHC should be utilized to fulfill the resilience requirement. Supporting documents may be provided by the DCPH-A/PHC on a reimbursable basis, upon request, or by a certified contractor hired by the installation.

6−12. Consumer complaints

Establishment of a consumer complaint program provides an additional avenue for evaluating the integrity of the water supply system and addressing potential maintenance needs.

a. Development of the program should involve the installation PH authority and the water system purveyors (DPW/operating contractor). This action would include identifying a designated telephone line that is answered directly or collects messages that are reviewed regularly and forwarded to the appropriate workers on call.

(1) During normal working hours, the phone line may feed directly into the DPW/operating contractor/Engineering office, where the message is documented, POC information is recorded, and the problem/inquiry is passed to the appropriate personnel.

(2) Messaging systems should be established to receive complaints/concerns after normal duty hours.

(3) Consumers should receive a telephonic response from the responding personnel within 2 hours of placing the original call. Upon clarification of the problem/inquiry, an estimated response time should be provided to the complainant. Action may be delayed until the

next working day, depending on the priority placed on the situation. Calls involving water pressure, flow, equipment, and water availability may be addressed and prioritized by the purveyors.

(4) Questions regarding the safety of the water supply (particularly for sensitive subpopulations) may be addressed initially by an installation PH authority representative.

(a) Many issues, such as the impacts of materials causing tastes, colors, or smells, may be coordinated amongst the stakeholders on call prior to responding. The complaint/inquiry received and the associated conversation/clarification should be forwarded to the maintenance supervisor for action/response at that time. If the incident requires immediate assessment or mitigation (for example, breakage of a water line), the appropriate personnel and equipment should be coordinated as soon as possible.

(b) Consumers may report concerns regarding water quality due to discoloration (for example, “dirty” or “rusty” water). Such fears may be allayed by identifying the water sampling and quality reports compiled to meet regulatory or oversight standards. In most situations involving the aesthetics (color, odor), the water supply remains safe even while not appearing very palatable.

b. All actions must be recorded and stored in a proper maintenance file held by the responsible organization. Consumer complaint data should be submitted monthly to the installation PH authority for review and should be made part of the annual water system review submitted to the ATO/IC and coordinated with the installation Public Affairs Office. During these reviews, the locations and types of incidents reported should be noted to discern any trends regarding the degradation of water quality and/or equipment in specific areas of the installation water supply system.

c. According to the NPDWR, every CWS must provide a Consumer Confidence Report (CCR) to its customers annually. This report delineates the potential risks associated with contaminants or issues experienced within the drinking water system within that year, and the remedial actions undertaken to remedy those risks. It also provides basic educational information regarding possible contaminants, as well as phone numbers for sources of further information. For OCONUS facilities, CCRs are mandated within the OEGBD and will likely be included in subsequent FGS updates (https://www.denix.osd.mil/international/policy/oebgd/).

APPENDIX A

REFERENCES

Section I
Required Publications
This section contains no entries.

Section II
Related Publications
A related publication is a source of additional information. The user does not have to read it to understand this publication. Unless otherwise noted, AWWA manuals are available at https://www.awwa.org/; DoD publications are available at https://esd.whs.mil/; EPA and FR publications are available at https://www.federalregister.gov/.

Agency for Toxic Substances and Disease Registry (ATSDR)
(Available at https://www.atsdr.cdc.gov/toxprofiles/index.html.)

AR 40–1
Composition, Mission, and Functions of the Army Medical Department

AR 40–5
Army Public Health Program

AR 40–657
Veterinary/Medical Food Safety, Quality Assurance, and Laboratory Service

AR 200-1
Environmental Protection and Enhancement

AR 420–1
Army Facilities Management

AR 420–41
Acquisition and Sale of Utilities Services

AR 525–13
Antiterrorism

AWWA Manual M14
Backflow Prevention and Cross Connection Control: Recommended Practices, Fourth Ed.

AWWA Manual M21
Groundwater, Fourth Ed.

AWWA Manual M36
Water Audits and Loss Control Programs, Fourth Ed.

AWWA Manual M42
Steel Water Storage Tanks, Revised Edition

AWWA Manual M44
Distribution Valves: Selection, Installation, Field Testing, and Maintenance, Third Ed.

AWWA Standard C651−14
Disinfecting Water Mains

AWWA Water Quality & Treatment Handbook
Handbook of Community Water Supplies, Sixth Ed.

DA Pam 40–11
Army Public Health Program

DoDD 4715.1E
Environment, Safety, and Occupational Health (ESOH)

DoDD 6200.04
Force Health Protection

DoDI O-2000.16 Volume 1
DoD Antiterrorism Program Implementation: DoD Antiterrorism Standards

DoDM 4715.05 Volume 3
Overseas Environmental Baseline Guidance Document: Water

Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources. (Malcolm Pirnie, Inc. and HDR Engineering, Inc. 1989)
EPA Office of Drinking Water (Available at https://nepis.epa.gov/.)

Drinking Water Regulations and Health (Pontius, F.W. ed. 2003)
John Wiley & Sons, New York (Available at https://www.wiley.com/en-us.)

Environmental Systems Engineering (Rich, L.G. 1973)
McGraw-Hill, New York (Available at https://www.mheducation.com/.)

Environmental Engineering and Sanitation 4th ed. (Salvato, J.A. 1992)
John Wiley & Sons, New York (Available at https://www.wiley.com/en-us.)

EPA Distribution System Issue Paper
Finished Water Storage Facilities

EPA 430/9-74-007
Microorganism Removal for Small Water Systems

EPA 440/6-87-010
Delineation of Wellhead Protection Areas

EPA/625/R-94-001
Ground Water and Wellhead Protection

EPA 815-R-14-006
Revised Total Coliform Rule: Assessments and Corrective Actions Guidance Manual

EPA 816-R-03-002
Cross Connection Control Manual

EPA 822-S-12-001
Drinking Water Standards and Health Advisories

PL 93–523
The Safe Drinking Water Act of 1974 (Available at https://www.congress.gov/.)

PL 107–188
Safe Drinking Water Act Amendments of 2002 (Available at https://www.congress.gov/.)

PL 115–270
America's Water Infrastructure Act of 2018: Drinking Water Provisions (Available at https://www.congress.gov/.)

TB MED 531
Facility Sanitation Controls and Inspections

TB MED 575
Recreational Water Facilities

TB MED 577
Sanitary Control and Surveillance of Field Water Supplies

TM 3–34.49
Water-Well Drilling Operations

TM 5–803–1
Installation Master Planning

TM 5–813–1
Water Supply: Sources and General Considerations

TM 5–813–3
Water Supply, Water Treatment

TM 5–813–4
Water Supply, Water Storage

TM 5–813–5
Water Supply, Water Distribution

TM 5–813–8
Water Desalination

TM 5–813–9
Water Supply: Pumping Stations

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Emergency Response Planning for Military Water Systems (Available at https://phc.amedd.army.mil/Pages/default.aspx.)

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Water System Vulnerability Assessments (Available at https://phc.amedd.army.mil/Pages/default.aspx.)

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21 CFR Part 165.110
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40 CFR Part 141
National Primary Drinking Water Regulations (Available at https://www.govinfo.gov/.)

40 CFR Part 143
National Secondary Drinking Water Regulations (Available at https://www.govinfo.gov/.)

56 FR 26460
Drinking Water; Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper

63 FR 69390
National Primary Drinking Water Regulations: Disinfectants and Disinfection Byproducts

65 FR 1950
National Primary Drinking Water Regulations for Lead and Copper

67 FR 1812
National Primary Drinking Water Regulations: Long Term 1 Enhanced Surface Water Treatment Rule

71 FR 388
National Primary Drinking Water Regulations: Stage 2 Disinfectants and Disinfection Byproducts Rule

71 FR 654
National Primary Drinking Water Regulations: Long Term 2 Enhanced Surface Water Treatment Rule

77 FR 26072
Revisions to the Unregulated Contaminant Monitoring Regulation

71 FR 65574
National Primary Drinking Water Regulations: Ground Water Rule for Public Water Systems

Section III
Prescribed Forms
This section contains no entries.

Section IV
Referenced Forms
This section contains no entries.

APPENDIX B

AREAS OF RESPONSIBILITY

B–1. General

The PH Program and IMA have responsibility not only for the installation at which they are physically located but also for the activities and installations covering a somewhat broader area. The MEDCOM has identified these AORs in MEDCOM Regulation 40–21, *Regional Health Commands and Health Service Areas* (14 October 2016). The listing of Health Service Areas (HSAs) has been augmented to include the current listing of Areas of Responsibility for the Army within Europe (as identified by PHC-E). This appendix will be updated/replaced as the Defense Health Agency refines its Market Structure approach to encompass PH and EH responsibilities. This appendix assists PH Program and IMA personnel in understanding the scope of their responsibilities regarding the oversight of water supply systems at Army installations. The HSA's responsibility may also include certain designated semi-active or inactive Federal sites and state-operated sites used for annual training of the Reserve Components. Authorities within the Medical Readiness Commands and/or MEDCOM can assist the PH Program and IMA personnel in further defining these areas. The listing below is presented by the HSA of each PH Program/IMA.

B–2. Medical Readiness Command, East

a. *Fort Moore Health Service Area*
(1) Fort Moore, Georgia
(2) Anniston Army Depot (AD), Alabama
(3) Fort McClellan, Alabama

b. *Fort Liberty Health Service Area*
(1) Fort Liberty, North Carolina
(2) Camp Mackall, North Carolina

(3) Marine Ocean Terminal Sunny Point, North Carolina

c. *Fort Campbell Health Services Area*

(1) Fort Campbell, Kentucky
(2) Milan Army Ammunition Plant (AAP), Tennessee
(3) Holston AAP, Tennessee

d. *Fort Drum Health Services Area*

(1) Fort Drum, New York
(2) Camp Edwards, Massachusetts
(3) Fort Devens, Massachusetts
(4) Camp Johnson, Vermont

e. *Fort Eustis Health Services Area*

(1) Fort Eustis, Virginia
(2) Fort Story, Virginia
(3) Camp Dawson, West Virginia

f. *Fort Gordon Health Services Area*

(1) Fort Gordon, Georgia
(2) Miami (U.S. Southern Command), Florida
(3) Camp Frank D. Merrill, Georgia
(4) Fort McPherson, Georgia
(5) Camp Shelby, Mississippi
(6) Fort Buchanan, Puerto Rico

g. *Fort Jackson Health Services Area*

(1) Fort Jackson, South Carolina
(2) McCrady Training Center, South Carolina

h. *Fort Knox Health Services Area*

(1) Fort Knox, Kentucky
(2) Rock Island Arsenal, Illinois
(3) Camp Atterbury, Indiana
(4) Fort Benjamin Harrison, Indiana
(5) Blue Grass AD, Kentucky
(6) Camp Grayling, Michigan
(7) Detroit Arsenal, Michigan
(8) Camp Perry, Ohio
(9) Fort McCoy, Wisconsin
(10) Camp Williams, Wisconsin
(11) Ravenna AAP, Indiana
(12) Badger AAP, Wisconsin
(13) Lima Army Tank Plant, Ohio

i. *Fort Gregg-Adams Health Services Area*

(1) Fort Gregg-Adams, Virginia
(2) Fort Barfoot, Virginia
(3) National Ground Intelligence Center, Virginia
(4) Radford AAP, Virginia

(5) Fort A.P. Hill, Virginia

j. Fort Meade Health Services Area

(1) Fort Meade, Maryland
(2) Fort McNair, Virginia
(3) Aberdeen Proving Ground, Maryland
(4) Fort Detrick, Maryland
(5) Carlisle Barracks, Pennsylvania
(6) Fort Indiantown Gap, Pennsylvania
(7) Letterkenny AD, Pennsylvania
(8) New Cumberland AD, Pennsylvania
(9) Scranton AD, Pennsylvania
(10) Fort Myer-Henderson Hall, Virginia
(11) Adelphi, Maryland

k. Fort Novosel Health Services Area

(1) Fort Novosel, Alabama
(2) Mississippi Ordnance Plant, Mississippi

l. Fort Stewart Health Services Area

(1) Fort Stewart, Georgia
(2) Camp Blanding, Florida
(3) Hunter Army Airfield, Georgia
(4) Shades of Green, Florida

m. Redstone Arsenal Health Services Area – Redstone Arsenal, Alabama

n. West Point Health Services Area

(1) West Point, New York
(2) Natick Laboratories, Massachusetts
(3) Fort Dix, New Jersey
(4) Picatinny Arsenal, New Jersey

B–3. Medical Readiness Command, West

a. Fort Bliss Health Services Area

(1) Fort Bliss, Texas
(2) White Sands Missile Range, New Mexico
(3) Los Alamos Demolition Range, New Mexico
(4) Camp Cody, New Mexico

b. Fort Carson Health Services Area

(1) Fort Carson, Colorado
(2) Chemical Depot, Colorado
(3) Fort William Henry Harrison, Montana
(4) Dugway Proving Ground, Utah

(5) Tooele AD, Utah
(6) Fort Douglas, Utah

c. Fort Cavazos Health Services Area

(1) Fort Cavazos, Texas
(2) Camp Bowie, Texas
(3) Camp Wolters, Texas
(4) Red River AD, Texas

d. Fort Huachuca Health Services Area
(1) Fort Huachuca, Arizona
(2) Yuma Proving Ground, Arizona
(3) Camp Navajo, Arizona

e. Fort Irwin Health Services Area
(1) Fort Irwin, California
(2) Hawthorne Army Ammunition Depot, Nevada
(3) Camp Haan, California

f. Fort Leavenworth Health Services Area
(1) Fort Leavenworth, Kansas
(2) Lake City AAP, Kansas

g. Fort Leonard Wood Health Services Area
(1) Fort Leonard Wood, Missouri
(2) Camp Dodge, Iowa
(3) Fort Des Moines, Iowa
(4) Iowa AAP, Iowa
(5) Camp Clark, Missouri
(6) Camp Ripley, Minnesota
(7) Fort Snelling, Minnesota
(8) Twin Cities AAP, Minnesota

h. Fort Johnson Health Services Area
(1) Fort Johnson, Louisiana
(2) Camp Beauregard, Louisiana

i. Fort Riley Health Services Area
(1) Fort Riley, Kansas
(2) Kansas Regional Training Institute, Kansas
(3) Camp Ashland, Nebraska
(4) Camp Grafton, North Dakota

j. Fort Sam Houston Health Services Area
(1) Fort Sam Houston, Texas
(2) Camp Bullis, Texas
(3) Camp Mabry, Texas
(4) Camp Swift, Texas
(5) Camp Stanley, Texas
(6) Corpus Christi AD, Texas
(7) Martindale Army Airfield, Texas

k. Fort Sill Health Services Area
(1) Fort Sill, Oklahoma
(2) Fort Chaffee, Arkansas

(3) Pine Bluff Arsenal, Arkansas
(4) McAlester AAP, Oklahoma

B–4. Medical Readiness Command, Pacific

a. Fort Wainwright Health Services Area
(1) Fort Wainwright, Alaska
(2) Fort Greely, Alaska
(3) Fort Richardson, Alaska

b. Japan Health Services Area
(1) Camp Zama, Japan
(2) Sagami AD, Japan
(3) All Japan

c. South Korea Health Services Area – All

d. Fort Lewis Health Services Area
(1) Fort Lewis, Washington
(2) Camp Beale, California
(3) Camp Cooke, California
(4) Camp Roberts, California
(5) Camp San Luis Obispo, California
(6) Fort Hunter Liggett, California
(7) Los Alamitos Joint Forces Training Base, California
(8) Marine Ocean Terminal, Concord, California
(9) Camp Parks, California
(10) Presidio of Monterey, California
(11) Sharpe AD, California
(12) Stockton AD, California
(13) Tracy AD, California
(14) Sierra AD, California
(15) Umatilla Chemical Depot, Oregon
(16) Yakima Training Center, Washington
(17) B.T. Collins Reserve Center, California

e. Tripler Health Services Area
(1) Tripler Army Medical Center, Hawaii
(2) Fort Shafter, Hawaii
(3) Fort DeRussy, Hawaii
(4) Kunia Field Station, Hawaii
(5) Pohakuloa Training Area, Hawaii
(6) Schofield Barracks, Hawaii
(7) Wheeler Army Airfield, Hawaii
(8) Guam
(9) Kwajalein Atoll, Republic of the Marshall Islands

B–5. Medical Readiness Command, Europe

a. Bavaria Health Services Area

(1) U.S. Army Garrison (USAG) Ansbach
(a) Barton Barracks, Ansbach, Germany
(b) Bleidorn Family Housing, Ansbach, Germany
(c) Katterbach Kaserne, Ansbach, Germany
(d) Oberdachstetten Training Area, Illesheim, Germany
(e) Shipton Kaserne, Ansbach, Germany
(f) Storck Barracks, Illesheim, Germany
(g) Urlas Family Housing, Ansbach, Germany
(2) USAG Bavaria
(a) Ammunition Storage Point 2, Germany
(b) Artillery Kaserne, Garmisch, Germany
(c) East Camp Grafenwoehr, Germany
(d) Fitzthum Village, Germany
(e) Freihoelser Training Area, Germany
(f) Grafenwoehr Training Area, Germany
(g) Hohenfels Training Area, Germany
(h) Munich Villa, Munich, Germany
(i) NATO School, Oberammergau, Germany
(j) Netzaberg Village, Germany
(k) Sheridan Kaserne, Garmisch, Germany
(l) South Camp Vilseck, Germany
(3) USAG Stuttgart
(a) Echterdingen Army Airfield, Germany
(b) Kelley Barracks, Stuttgart, Germany
(c) Kornwestheim Golf Course, Germany
(d) Panzer Kaserne, Böblingen, Germany
(e) Patch Barracks, Stuttgart, Germany
(f) Robinson Barracks, Stuttgart, Germany
(4) Mihail Kogălniceanu (MK), Romania
(5) Novo Selo Training Area (NSTA), Bulgaria

b. Landstuhl Health Services Area

(1) USAG Rheinland-Pfalz
(a) Baumholder Military Community, Germany
(b) Coleman Barracks, Mannheim, Germany
(c) Daenner Kaserne, Kaiserslautern, Germany
(d) Germersheim Army Depot, Germany
(e) Gruenstadt Activity, Germany
(f) Kaiserslautern Army Depot, Kaiserslautern, Germany
(g) Kleber Kaserne, Kaiserslautern, Germany
(h) Landstuhl Regional Medical Center, Germany
(i) Miesau Ammunition Depot, Germany

(j) Panzer Kaserne, Kaiserslautern, Germany
(k) Pulaski Barracks, Kaiserslautern, Germany
(l) Rhine Ordnance Barracks, Kaiserslautern, Germany
(m) Sembach Kaserne, Germany
(2) USAG Wiesbaden
(a) Amelia Earhart Hotel, Wiesbaden, Germany
(b) Aukamm Family Housing, Wiesbaden, Germany
(c) Clay Kaserne, Wiesbaden, Germany
(d) Crestview Family Housing, Wiesbaden, Germany
(e) Darmstadt Training Center, Darmstadt, Germany
(f) Egelsbach Transmitter Site, Germany
(g) Hainerberg Family Housing, Wiesbaden, Germany
(h) Mainz Kastel, Mainz, Germany
(i) McCully Support Center, Wackernheim Germany
(j) Rheinblick Recreation Annex, Wiesbaden, Germany

c. Supreme Headquarters Allied Powers Europe (SHAPE) Health Services Area – USAG Benelux

(1) Army Materiel Command (AMC), Dülmen, Germany
(2) AMC Eygelshoven, Netherlands,
(3) AMC Zutendaal, Belgium
(4) Brussels Garrison Headquarters, Belgium
(5) Château Gendebien, Belgium
(6) Chievres Air Base, Belgium
(7) Headquarters, 950th Transportation Company, Bremerhaven, Germany
(8) Joint Forces Headquarters, Brunssum, Netherlands
(9) SHAPE Headquarters, Belgium

d. Vicenza Health Services Area

(1) USAG Italy
(a) Camp Darby, Livorno, Italy
(b) Camp Ederle, Vicenza, Italy
(c) Caserma Del Din, Italy
(d) Lerino, Italy
(e) Livorno Supply and Maintenance Activity, Italy
(f) Longare Communication Site, Italy
(g) Pisa Ammunition Storage Area, Italy
(h) Torri Di Quartesolo, Italy
(i) Vicenza Basic Load Storage Area, Italy
(j) Vicenza Family Housing, Italy
(2) USAG Poland
(a) Boleslawiec
(b) Drawsko Pomorskie Training Area (DPTA)
(c) Karliki
(d) Lublinec, Zagam

(e) Powidz/Camp Kosciuszko
(f) Shwierzyna
(g) Swietoszow
(h) Toron
(i) Trzebien

GLOSSARY

Section I
Abbreviations

AMC
U.S. Army Materiel Command

AOR
area of responsibility

APHC
U.S. Army Public Health Center

AR
Army Regulation

ATO
Antiterrorism Officer

ATSDR
Agency for Toxic Substances and Disease Registry

AWIA
America's Water Infrastructure Act

AWWA
American Water Works Association

˚C
degrees Celsius

CAC
combined available chlorine residual

$Ca(OCl)_2$

calcium hypochlorite solution

CDC
Centers for Disease Control and Prevention

CFR
Code of Federal Regulations

Cl_2
chlorine gas

ClO_2
chlorine dioxide

CONUS
Continental United States

CWS
community water system

DA
Department of the Army

DA PAM
Department of the Army Pamphlet

DBP
disinfection byproduct

DCPH-A
Defense Centers for Public Health–Aberdeen

DHHS
U.S. Department of Health and Human Services

DoD
Department of Defense

DoDD
Department of Defense Directive

DoDI
Department of Defense Instruction

DOEHRS
Defense Occupational and Environmental Health Readiness System

DPW
Directorate/Department of Public Works

EC
Environmental Coordinator

EH
environmental health

EHE/EHED
DCPH-A or PHC Environmental Health Engineering Division

EPA
U.S. Environmental Protection Agency

ESEO
Environmental Science/Engineering Officer

FAC
free available chlorine

FDA
U.S. Food and Drug Administration

FGS
Final Governing Standards

fps
feet per second

FR
Federal Register

FY
fiscal year

GAC
granular activated carbon

GWUDISW
groundwater under the direct influence of surface water

HA
Health Advisory

HPC
heterotrophic plate count

HSO
Housing Services Office

IBWA
International Bottled Water Association

IC
Installation Commander

IMA
Installation Medical Authority

IMCOM
U.S. Army Installation Management Command

LCC
life-cycle cost

LHA
Lifetime health advisory

LRAA
locational running annual average

MCL
maximum contaminant level

MCLG
maximum contaminant level goal

MEDCOM
U.S. Army Medical Command

µg/L
micrograms per liter (equivalent to parts per billion)

mg/L
milligrams per liter (equivalent to parts per million)

MIL-STD
Military Standard

MOA
Memorandum of agreement

MRC
Medical Readiness Command

MRDL
maximum residual disinfectant level

MRDLG
maximum residual disinfectant level goal

MTF
multiple-tube fermentation

NaF
sodium fluoride

NaOCl
sodium hypochlorite solution

nm
nanometer

NPDWR
National Primary Drinking Water Regulations

NSDWR
National Secondary Drinking Water Regulations

NTNC
Nontransient Non-Community Water System

NTU
Nepholometric Turbidity Unit

OCONUS
outside the Continental United States

OEBGD
Overseas Environmental Baseline Guidance Document

PAC
powdered activated carbon

pCi/L
picocuries per liter

PFAS
Per- and polyfluoroalkyl substance(s)

PFOA
Perfluorooctanoic acid

PFOS
Perfluorooctane sulfonate

pH
potential of hydrogen

PH
Public health

PHC
Public Health Command

POC
point of contact

POE
point of entry

POU
point of use

ppm
parts per million

psi
pounds per square inch

RO
reverse osmosis

RPZ
reduced pressure zone backflow prevention device

SCADA
Supervisory Control and Data Acquisition system

SDWA
Safe Drinking Water Act

SMCL
secondary maximum contaminant level

SVOC
semivolatile organic compound

TB MED
Technical Bulletin, Medical

TCR
Total Coliform Rule

TDS
total dissolved solids

TG
Technical Guide

TIC
toxic industrial chemical

TM
U.S. Army Technical Manual

TNC
Transient non-community water system

TSG
The Surgeon General (U.S. Army)

UFC
Unified Facilities Criteria

µg/L
micrograms per liter (equivalent to parts per billion)

U.S.
United States

UV
Ultraviolet

VOC
volatile organic compound

WSERP
water system emergency response plan

WSVA
water system vulnerability assessment

WTP
water treatment plant

Section II
Terms

There are no entries for this section.

SUMMARY of CHANGE

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

This major revision, dated 10 October 2023—

- o Depicts microbiological sampling and analyses required of Public Health authorities to ensure coverage of all installations (paras 1–5, 6–5, and throughout document).
- o Provides specific direction for monitoring of privatized housing (para 1–5).
- o Introduces and discusses privatized water systems at Army installations (paras 1–5, 2–1, and throughout document).
- o Presents delineation of alternative water treatment technologies to educate and update Public Health personnel (para 3–3).
- o Identifies monitoring and inspection requirements for water storage tanks (para 4–2).
- o Focuses on distribution system maintenance programs as necessary to maintain critical infrastructure (para 4–4).
- o Provides limits associated with federal standards developed for disinfectants and disinfectant byproducts (para 5–3).
- o Addresses potential contaminants of emerging concern (para 5–6).
- o Defines requirements for compliance monitoring, operational monitoring, and Public Health quality assurance monitoring (paras 6–2, 6–3, and 6–4).
- o Describes Public Health monitoring, data review, and reporting requirements (para 6–4 and throughout document).
- o Emphasizes consistent communication and coordination between installation Public Health and Department of Public Works/operating contractor authorities to ensure efficient and effective surveillance of drinking water systems (para 6–8 and throughout document).
- o Introduces resources and resilience assessment of water supplies, in accordance with the American Water Infrastructure Act (para 6–11), as well as other updated federal standards (throughout document).
- o Emphasizes Public Health/Environmental Health roles and responsibilities to ensure coverage of all Army installations/garrisons (throughout document); defines Public Health Areas of Responsibility (appendix B).
- o Incorporates current Department of the Army Pamphlet 40–11 and Unified Facilities Criteria requirements (throughout document).