TB MED 577

TECHNICAL BULLETIN

SANITARY CONTROL AND SURVEILLANCE OF FIELD WATER SUPPLIES

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HEADQUARTERS, DEPARTMENT OF THE ARMY

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TECHNICAL BULLETIN
MEDICAL 577*

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 15 December 2005

SANITARY CONTROL AND SURVEILLANCE OF FIELD WATER SUPPLIES

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*This bulletin supersedes TB MED 577, dated 9 November 2005.

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CHAPTER 1

INTRODUCTION

1-1. Purpose

a. This publication provides detailed technical guidance and recommendations for the sanitary control and surveillance of land-based field water support. The guidance and recommendations will help ensure field water supplies are potable in order to protect and enhance the health and performance of the warfighter.

b. This publication—

(1) Establishes field water quality standards.

(2) Describes the process for water potability certification.

(3) Describes water quality surveillance requirements.

(4) Defines preventive medicine (PVNTMED) roles and actions in field water support.

(5) Defines additional non-PVNTMED roles and actions related to the sanitary control and surveillance of field water support.

(6) Provides guidance on the management of wastes associated with the purification of field water.

(7) Provides guidance for maintaining water discipline.

1-2. References

Required and related publications and prescribed and referenced forms are listed in appendix A.

1-3. Explanation of abbreviations and terms

The glossary contains a list of abbreviations and terms used in this publication.

1-4. Applicability

This publication—

a. Applies to the Active Army, U.S. Army Reserve, and Army National Guard and addresses pertinent requirements identified in Joint Chiefs of Staff (JCS) Memorandum MCM–0006–02.

b. Applies to military and civilian personnel concerned with the location, purification, distribution, vulnerability, sanitary control, and surveillance of field water supplies, particularly those intended for consumptive and sanitation uses.

c. Applies to all phases of deployments and training exercises to ensure that water purified in the field for human consumption and other uses is of the best possible quality.

1-5. Technical assistance

Requests for technical assistance related to topics addressed in this technical bulletin (medical) (TB MED) should be forwarded through command channels. Table 1–1 lists multiservice organizations and laboratories that can provide additional technical support.

Table 1–1
Support labs and consultative resources

Consultative and laboratory services support	
USACHPPM-Main (Consultation) Water Supply Management Program Aberdeen Proving Ground (APG), MD 21010–5403 Defense Switched Network (DSN) (312) 584–3919; Commercial (410) 436–3919 http://chppm-www.apgea.army.mil/dehe/pgm31/ Deployment Health: DSN 584–6096 http://chppm-www.apgea.army.mil/desp/	USACHPPM-Europe CMR 402 APO AE 09180 011–49–6371–86–8084 DSN (314) 486–8084
USACHPPM-Main (Laboratory) Directorate of Laboratory Services APG, MD 21010–5403 DSN (312) 584–3919; Comm (410) 436–2306	USACHPPM-North Fort George Meade, MD 20755–5225 DSN (312) 923–6502; Comm (301) 677–6502
USACHPPM-West Fort Lewis, WA 98433–9500 DSN (312) 347–8447; Comm (253) 966–8447	USACHPPM-South Fort McPherson, GA 30330–5000 DSN (312) 588–3332; Comm (404) 464–3332
Air Force Detachment 3 Unit 5213 Kadena Air Base APO AP 96368–5213 DSN (315) 634–1769	Air Force Institute for Operational Health 2402 E Drive Brooks City-Base, TX 78235–5114 DSN (312) 240–3626; Comm (210) 536–3626
USACHPPM-Pacific Unit 45006, Camp Zama, Japan APO AP 96343–5006 DSN (315) 263–8597	Navy Environmental and Preventive Medicine Unit (NEPMU)–2 1887 Powhatan St, Norfolk, VA 23511–3394 DSN (312) 564–7671; Comm (757) 444–7671
NEPMU–6 Pearl Harbor, HI 96860 DSN (315) 473–0555; Comm (808) 473–0555 e-mail: PostOffice@nepmu6.med.navy.mil	NEPMU–5 3235 Albacore Alley San Diego, CA 92136–5199 DSN (312) 526; Comm (619) 556–7070 e-mail: nepmu5@nepmu5.med.navy.mil
Navy Environmental Health Center (NEHC) 620 John Paul Jones Cir, Ste 1100 Portsmouth, VA 23708–2103 DSN (312) 377–0700; Comm (757) 953–0700; After hours (757) 621–1967	NEPMU–7 PSC 825, Box 295, Sicily FPO AE 09627–2003 nepmu7@nepmu7.sicily.navy.mil DSN (314) 624–9252; Comm 011–39–095–86–9251
Intel consults/support	**Logistics**
Armed Forces Medical Intelligence Center (AFMIC) Tech support: DSN 343–2181; Comm (301) 619–2181 Policies or content: DSN 343–7574; Comm (301) 619–7574 http://mic.afmic.detrick.army.mil/ e-mail: support @ afmic.detrick.army.mil e-mail: afmicops@afmic.detrick.army.mil	U.S. Army Quartermaster Fort Lee, VA 23801 Operations, Petroleum and Water Dept. DSN (312) 687–2788; Comm (804) 734–2788 pwdweb@lee.army.mil http://www.quartermaster.army.mil/
Additional information sources	
U.S. Environmental Protection Agency (EPA)—Ground Water & Drinking Water http://www.epa.gov/safewater/	World Health Organization (WHO) http://www.who.int/water_sanitation_health/en/

1-6. Provisions
This publication is subject to four international agreements:

a. North Atlantic Treaty Organization (NATO) Standardization Agreement (STANAG) 2136.
b. STANAG 2885.
c. STANAG 2473.
d. Quadripartite (American-British-Canadian-Australian Armies) Standardization Agreement (QSTAG) 245.

When an amendment, revision, or cancellation of this publication is proposed that will affect or violate one or more of these agreements, the preparing activity will take proper action through international standardization channels.

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CHAPTER 2
ROLES AND PROCEDURES

2-1. Overview
This chapter describes the roles of PVNTMED and other units and personnel with respect to field drinking water, and the procedures they must follow to ensure the potability of drinking water provided for deployed forces. It also describes the employment and capabilities of PVNTMED personnel during military operations, and outlines specific tasks they must perform to successfully meet their field water mission responsibilities.

2-2. Background
a. Disease and nonbattle injury (DNBI). Military history has demonstrated that more soldiers become injured or ill from DNBI than from combat losses, and that these nonbattle losses play a significant role in the outcome of military operations. PVNTMED practices, when supported by command emphasis, are the most effective and least expensive means of reducing DNBI and maximizing the fighting strength.

b. Water support mission and DNBI. The water support mission is a key component of sustaining forces on the battlefield. The lack of adequate quantities of potable water can produce significant numbers of casualties far more quickly than the lack of food, rest, combat stress, or operational stress. Providing adequate quantities of potable water to deployed forces is critical to maintaining the health and readiness of those forces. If the water support mission is not properly executed, DNBI numbers will increase because of illness and performance degradation caused by either poor water quality or dehydration. Dehydration is one of the greatest nonbattle threats to combat force superiority. Physical work, environmental stress, clothing, and equipment all increase body water losses (BWL) and can lead to dehydration. Modest dehydration (less than 2 percent BWL) degrades physical and mental performance, while larger deficits can be catastrophic.

c. Force health protection (FHP). Recent FHP policies expand DNBI considerations to address additional causes of acute health effects as well as those that can cause delayed or long-term health consequences. Specifically, commanders are now required to ensure that all occupational and environmental health (OEH) hazards, including those that cause DNBI, are identified, assessed, and mitigated to the extent feasible using operational risk management (ORM) decision-making tools. PVNTMED personnel must advise and provide recommendations to commanders to help them evaluate the risks associated with the water support mission and make the best risk management decisions. PVNTMED personnel provide this support at all levels of command and through all phases of the operational cycle.

d. Water discipline. Commanders and leaders must make decisions that will affect DNBI using ORM. They are the most significant factors in the adequate hydration of their personnel and the prevention of dehydration casualties. They are the principal advocates of hydration discipline, ensuring that adequate supplies of potable water are available and consumed by their personnel.

2-3. Roles

The following roles support the sanitary control and surveillance of the field water supplies as part of the water support mission for deployed forces.

a. Commanders at all levels will—

(1) Plan for the sanitary control and surveillance of field water supplies in support of the operational mission.

(2) Protect water inventories from contamination.

(3) Maximize the use of type-classified tactical water treatment, storage, and distribution equipment.

(4) Use tactical water concepts for command post and other training exercises.

(5) Establish and enforce water use discipline.

(6) Ensure, when nonmilitary issue, commercial unit-level or individual water purifiers must be used for atypical missions or emergency water supplies, that such devices are as far as possible Army-approved and determined by the Army Surgeon General to meet Army field drinking water performance standards.

(7) Ensure that unit field sanitation teams (FSTs) are trained, equipped, and employed according to FM 4–25.12, to conduct routine inspections of unit water containers and trailers, daily checks of unit water supplies for chlorine residual, and, when necessary, disinfection (rechlorination) of unit water supplies.

(8) Inform, motivate, train, and equip subordinates, and work closely with PVNTMED personnel to minimize DNBI resulting from dehydration, drinking contaminated water, and poor personal and unit sanitation and hygiene practices.

(9) Use appropriate ORM methods (see FM 100–14 and FM 3–100.12/MCRP 5–12.1C/ NTTP 5–03.5/AFTTP(I) 3–2.34) to integrate water supply-related health risk information into overall mission planning and execution.

(10) Ensure that all results from chemical and microbiological analyses of field water samples are documented and reported to the U.S. Army Center for Health Promotion and Preventive Medicine Deployment Data Archiving and Policy Integration (USACHPPM DDAPI) Program (see table 1–1 and para 6–5*d*(2)).

(11) Use risk communication techniques to disseminate water supply-related health risk information to unit personnel. Trained preventive medicine personnel can assist commanders with risk communication.

b. Unit and Theater/Command Surgeons will—

(1) Advise commanders and assist them with recognizing the importance of the sanitary control and surveillance of field water supplies in planning operational missions.

(2) Implement or oversee the implementation of PVNTMED procedures and instructions required for ensuring the security, adequacy, and quality of field water supplies.

(3) Provide medical oversight of field water supply operations for the prevention of waterborne diseases.

(4) Ensure that results of field water quality analyses which indicate the potential for immediate and acute health threats as well as those that may cause chronic or long-term health effects are documented and reported.

(5) Make recommendations to commanders for applying ORM principles to water supply decisions, including ORM-based responses to analytical results of water quality tests.

c. PVNTMED unit commanders and PVNTMED staff officers will—

(1) Advise commanders and combat service support (CSS) personnel in planning for the sanitary control and surveillance of the field water supplies.

(2) Implement PVNTMED procedures required for the sanitary control and surveillance of field potable water supplies.

(3) Provide PVNTMED oversight of field water supply operations for the prevention of waterborne illness and disease.

(4) Document and forward to USACHPPM for archiving the results of field water quality analyses that indicate the potential for immediate and acute health threats as well as those that may cause chronic or long-term health effects.

(5) As directed, assist commanders in applying ORM principles to water supply-related decisions.

d. PVNTMED noncommissioned officers (NCOs) will—

(1) Assist CSS personnel in water source selection by conducting water source reconnaissance surveys.

(2) Assist in certifying purified water as potable.

(3) Conduct sanitary surveys of potable water containers and water points.

(4) Inspect potable water treatment, storage, and distribution equipment.

(5) Test treated water to ensure water quality standards are met and chlorine residual is appropriate.

(6) Inspect field shower points and personnel decontamination stations.

(7) Train and evaluate unit FSTs and soldiers at all levels in proper field water surveillance and sanitation.

e. Unit FSTs will—

(1) Coordinate dining facility sanitation, field waste disposal, and personal hygiene inspections to prevent the spread of waterborne disease.

(2) Test unit water supplies for appropriate chlorine residuals when containers are filled, when water arrives in the unit area, and when directed to do so by medical or command personnel.

(3) Add chlorine to unit water supplies using approved methods when chlorine residuals are below required levels.

(4) Inspect water containers and trailers for cleanliness: quarterly in garrison, prior to deployment, and before filling at distribution points. Ensure containers are maintained in a clean and sanitary condition.

(5) Ensure unit has adequate stocks of iodine tablets, bulk chlorination equipment, and other supplies necessary for field water sanitation.

(6) Ensure water trailers and containers are protected from temperature extremes, when feasible, to keep drinking water as cool as possible for palatability.

(7) Train individual soldiers to perform sanitary control measures for field water supplies.

(8) Request PVNTMED assistance to correct or control field water problems that are beyond the capabilities of the unit FST.

f. Individual soldiers will—

(1) Fill canteens and personal hydration systems with Army-approved potable water at every opportunity.

(2) Use only approved methods of disinfection (according to FM 21–10) when treating raw water supplies for drinking.

(3) Avoid the transmission of disease by keeping personal water containers and unit water supplies clean and secure.

(4) Seek the support of unit FST or local PVNTMED personnel to assist in correcting or controlling problems related to drinking water that are beyond individual soldier capabilities.

2-4. Preventive medicine levels of field water support

a. PVNTMED services are described in terms of five levels of support with increasing capabilities at each higher level as illustrated in figure 2–1. Levels I through IV are normally available in the theater of operations (TO), while level V resides in the continental United States (CONUS) at USACHPPM, U.S. Army Medical Department Center and School, and major Army command (MACOM) surgeon’s office, and outside the CONUS (OCONUS) at combatant command, the component command surgeon’s office and USACHPPM subordinate commands in Japan (CHPPM–PAC) and Germany (CHPPM–EUR). In the TO, PVNTMED support is tailored and employed to enhance mission requirements, to counter the medical threat, and to provide PVNTMED support as far forward as the tactical situation permits within the health service support (HSS) system (see FM 4–02, chap 2). PVNTMED services are provided on an area support basis to afford the utmost benefit to the maximum number of personnel in the TO. The levels of PVNTMED support are more fully described in FM 4–02.17.

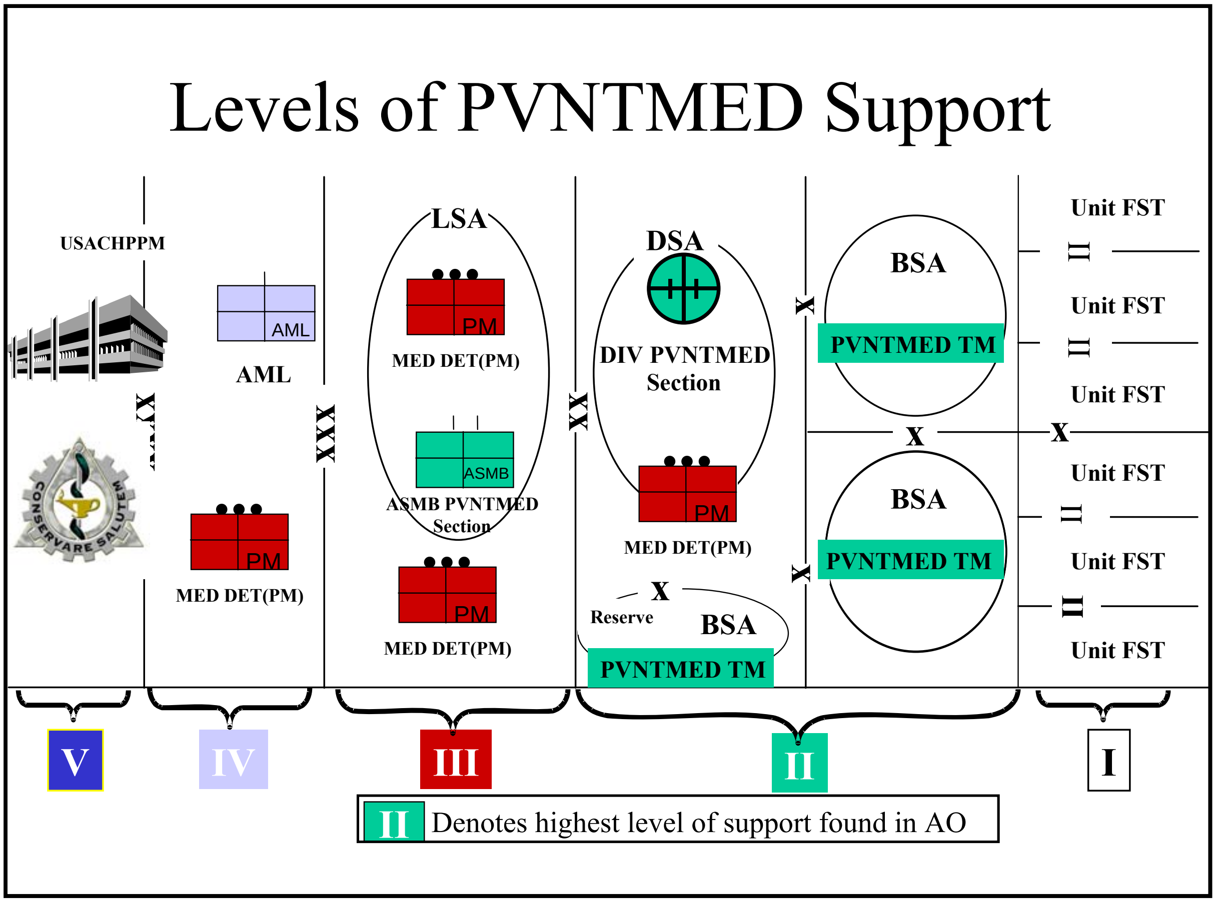
b. Table 2–1 describes the five levels of PVNTMED support to field water operations. Levels II and III can each fulfill the roles and perform the tasks of the levels below them.

2-5. Preventive medicine support to the field water mission through the operational cycle

This section lists and describes typical tasks that PVNTMED personnel will perform to fulfill their field water mission responsibilities during all phases of a deployment cycle.

a. Predeployment. PVNTMED personnel will work with logistics and operations planners to plan and prepare for deployment. For PVNTMED personnel, predeployment planning includes determining detailed support requirements and providing the preventive medicine estimate (PME) based on medical and nonmedical intelligence. Predeployment preparation includes assisting in intelligence preparation of the battlespace and conducting strategic-level coordination. Some of the water-related predeployment tasks that PVNTMED personnel should perform include the following (see chap 4 for more detailed guidance):

(1) Assist in estimating consumption requirements based on the location/climate, and the anticipated level, duration, and frequency of operational activities (see chap 3).



LEGEND:

USACHPPM: United States Army Center for Health Promotion and Preventive Medicine
AML: area medical laboratory
PM/PVNTMED: preventive medicine
LSA: logistics support area
DSA: division support area
ASMB: area support medical battalion
MED DET: medical detachment
BSA: brigade support area
TM: team

Figure 2–1. Levels of PVNTMED support

Table 2–1
Levels of PVNTMED support to field water operations

Level	Description	Roles	Tasks
I	Unit FST	Assess local unit treated water supplies.	Inspect water containers and trailers; test unit water supplies for chlorine and add additional chlorine when needed; report problems and concerns to unit commander and supporting PVNTMED section (Level II).
II	PVNTMED sections of divisions, separate brigades, armored cavalry regiments, and area support medical battalions	Identify/assess medical threats; oversight monitoring of potable water supplies; train FSTs; provide commanders with recommendations to minimize adverse health effects arising from water-related risks.	Identify and coordinate with logistical elements for needed PVNTMED materials; use field test kits to screen water supplies and certify them as potable; conduct sanitary surveys and perform additional sampling; coordinate with Levels III–V to characterize risks associated with identified water contaminants; recommend ORM strategy and courses of action (COAs) to command elements to minimize health risks.
III	Medical detachments (PM)	Augment and support FST and Levels I and II PVNTMED personnel and provide unique capabilities.	Collect and analyze samples; conduct epidemiological investigations; provide technical consultation.
IV	Area Medical Laboratory (AML) PVNTMED support (normally allocated based on the anticipated medical threat); other military units/organizations for specific technical support	Augment and support PVNTMED Levels II & III, and provide unique capabilities.	Provide more advanced laboratory analytical support and technical consultative services.
V	USACHPPM – resource for technical information, sampling assistance, and laboratory support	Maintain all deployment-related environmental (including drinking water) data; augment and support PVNTMED Levels II–IV and provide unique capabilities.	Archive exposure data and provide more advanced laboratory analytical support and technical consultative services regarding health risks and preventive measures.

(2) Obtain and deliver medical threat information including medical intelligence reports, medical threat products, and briefings (FM 4–02.17, para 4–5a). This includes the use of medical and nonmedical intelligence information to evaluate potential threats to field water supplies such as industrial contamination or endemic diseases (see chap 4).

(3) Assist in identifying and assessing potential field water sources including assessing the quantity, quality, potential health risks, and anticipated treatment and disinfection requirements for all potential and proposed water sources.

(4) Conduct preliminary field water system vulnerability assessments (FWSVAs).

(5) Assist in training unit FSTs in unit-level field water mission tasks.

(6) Assist in determining the equipment that will be needed to conduct surveillance of field water supplies.

(7) Assist in performing predeployment PVNTMED equipment checks for PVNTMED units and unit FSTs.

b. During deployment. PVNTMED personnel will perform surveys, inspections, and evaluations, and will collect samples and perform sample analysis. They will also provide real-time recommendations and assistance to commanders and FST personnel with regard to source selection and treatment, field water testing, water supply inspection and certification, and operational risk assessment and exposure documentation. Typical deployment-phase tasks include—

(1) Using field observations and equipment to perform water source reconnaissance and to screen potential raw water sources based on reverse osmosis (RO)-based water purification system (WPS) (or other available treatment system) capabilities, to identify and assess health hazards, and to support documentation requirements for environmental baseline surveys (EBSs) (see chap 5).

(2) Ensuring that proper treatment and disinfection procedures are followed (see chap 9).

(3) Certifying that water purified at field water purification points is potable based on comparing the results of basic testing to the Tri-Service Field Water Standards (TSFWS) (see chap 5).

(4) Initiating advanced water surveillance monitoring (AWSM) by collecting treated water samples, properly labeling and documenting them, sending them to rear-area laboratories for advanced water testing (AWT), then reviewing and taking appropriate actions based on the results of the analyses (see chap 6).

(5) Conducting field inspections to ensure all potable water supply systems and associated equipment are properly maintained and monitored (see chap 8).

(6) Evaluating AWT analytical results using appropriate military exposure guidelines (MEGs) and take any required actions using ORM methods (see chap 7).

(7) Ensuring that all field water supply-related analytical data, risk assessments, and corrective actions are documented and provided to the USACHPPM DDAPI Program (see chap 6).

(8) Performing FWSVAs.

(9) Assisting commanders with the assessment, oversight, and sustainment training of unit FSTs.

(10) Conducting water sampling and analysis, and provide ORM assessment and recommendations in response to water supply incidents such as environmental spills and suspected tampering.

(11) Advising the commander concerning drinking water quality issues and the use of risk communication techniques to inform unit personnel (see chap 7).

c. Postdeployment. Typical postdeployment tasks that PVNTMED personnel will perform with respect to the field water support mission include—

(1) Ensuring that all field water quality analytical results, with appropriate context information, risk assessments, and corrective actions are forwarded through command channels to the USACHPPM DDAPI Program for archiving.

(2) Providing guidance on field water site/area restoration, including the removal and disposal of waste (see chap 11 and FM 4–02.17).

CHAPTER 3

INTRODUCTION TO FIELD DRINKING WATER

3-1. General

a. Overview. This chapter defines basic field water terms and concepts, describes field water sources, gives water consumption guidelines for promoting good water discipline, and provides guidance for the use of nonpotable water for purposes other than drinking.

b. Background. Water is a required commodity for numerous activities in deployed environments. The most important of these is personal consumption. Water intended for drinking must be readily available and consumed in adequate quantities to prevent dehydration. Drinking water must be potable or it may have adverse health effects on those who consume it. It must also be palatable so personnel will be willing to drink it in adequate quantities, and not choose to drink from unapproved sources that may taste better but may cause illness because of chemical or microbiological contamination. Commanders must have confidence in Army-supplied drinking water. They must advocate and implement established field water doctrine to prevent their personnel from consuming water that could cause disease or illness.

3-2. Field water terms and concepts

The following field water definitions and concepts apply to the discussions presented throughout this bulletin.

a. Potable water. Potable water for field operations is water that is safe to drink, insofar as it will not be an impediment to mission execution. It does not contain chemical, microbiological, radiological, or other contaminants in concentrations that will make personnel who drink it sick in the short term. The Army generally requires water in the field to be treated (purified) and disinfected before it is considered potable. PVNTMED personnel certify that drinking water produced in the field is potable by ensuring that it meets the TSFWS listed in table B–1. Drinking water produced at bulk water treatment locations in the field must also contain a disinfectant residual (usually chlorine) when it is issued to personnel.

b. Nonpotable water. Nonpotable water is water that has not been determined to be safe for human consumption. Any water in the field, whether raw or treated, that has not been approved for consumption by the theater/command surgeon's representative (normally a PVNTMED specialist) is considered nonpotable. PVNTMED or using-unit personnel will identify nonpotable water sources (such as taps or spigots) with signs that read "NONPOTABLE WATER. DO NOT DRINK."

c. Palatable water. Palatable water is water that is pleasing to the senses. It looks, tastes, and smells good and is neither too hot nor too cold. Palatability is usually quantified in terms of temperature, color, taste, and odor, and acceptable levels for these parameters are also included in the TSFWS.

d. Water treatment/water purification. Water treatment/purification is the combination of one or more processes employed to improve the quality of water. Treatment involves removing suspended and dissolved contaminants and killing or inactivating microorganisms, usually with the goal of making the water potable and palatable. Typical water treatment processes include but are not limited to screening, aeration, chemical addition, coagulation, flocculation, sedimentation, filtration, RO, ion exchange, sorption processes, and disinfection.

e. Disinfection. Disinfection is a water treatment process in which pathogenic (disease producing) organisms are destroyed or otherwise inactivated (see para 9–6 for a detailed discussion of disinfection). Common methods of disinfecting drinking water include boiling, ultraviolet (UV) radiation, and various procedures using chlorine, chlorine dioxide, iodine, or ozone. The preferred field method of water disinfection in the Army is chlorination which can be accomplished using chlorine gas or chlorine compounds such as calcium hypochlorite (granular) and sodium hypochlorite (liquid bleach).

f. Fixed facility water supplies. Fixed facility water supplies consist of permanent water sources, treatment, disinfection, storage, and distribution systems that provide water to a fixed or "brick and mortar" installation. They are characterized by permanent structures, unit operations equipment, and distribution systems of buried water mains, laterals, and connections to building systems.

g. Semifixed field water supplies. A semifixed field water supply employs part or all of a non-U.S. fixed facility water treatment system to provide drinking water for deployed personnel. In the field, water drawn from semifixed supplies is treated the same way as water drawn from raw water sources. It needs to be evaluated for quality and will likely need to receive treatment just as water from any other raw water source in the field prior to being certified potable. Quartermaster units determine treatment requirements and treat the water, after which PVNTMED personnel must certify that the treated water is potable before it is used for drinking water. On rare occasions, at commanders' discretion, a semifixed water supply that is tested by PVNTMED personnel and meets the TSFWS may be certified potable requiring no additional treatment prior to consumption. However, those occasions are the exception rather than the rule.

h. Field water supplies. Field water supplies are generally portable and temporary. They include individual emergency, unit, and centralized water source, treatment, disinfection, storage, and distribution systems. Their purpose is to provide potable, palatable water to maintain the combat effectiveness and health of military personnel and civilians.

i. Individual/emergency water supplies. In cases where unit-level or larger water supply systems are not accessible, personnel may be required to find their own sources of raw water and treat them using personal treatment devices and/or disinfectants. Personal water treatment devices have capabilities and limitations that personnel must be aware of to ensure that the devices operate correctly and to reduce the risk of illness from device failure. See paragraph 9–4 and section III of chapter 9 for detailed guidance on individual/emergency water supply treatment and disinfection.

3-3. Field water sources

Raw water may be obtained from various sources in the field including surface water (rivers, streams, ponds, lakes, rain, ice, snow, seas, and oceans), ground water (wells or springs), and in some cases, from municipal water treatment systems located in the deployment area. Water from all raw water sources is considered nonpotable until it is treated and certified to meet the

TSFWS, regardless of how clean the water may appear. Raw or inadequately treated water may contain unseen toxic chemicals or microorganisms that can cause illness and waterborne diseases such as cholera, viral hepatitis, gastroenteritis, giardiasis, and cryptosporidiosis. In many modern military operations, locally procured bottled water may also be available. Several factors need to be considered when evaluating the acceptability of water sources and comparing these different water sources for drinking water production. Chapter 5 presents guidance on water source selection.

a. Surface water. Surface water sources that the Army's RO-based WPSs can treat include rivers, streams, lakes, ponds, seas, and oceans. These sources are usually more readily available than other sources, and are generally capable of supplying adequate quantities of water for all purposes. However, such sources likely contain infectious microorganisms and may be contaminated with chemicals or radioactive substances. A few common sources of those kinds of contaminants include urban and agricultural runoff, industrial waste discharges, landfill leachates, septic tanks, and raw and treated sewage outfalls. When drawing water from a surface water source, the intakes should be screened and carefully positioned in the body of water to avoid areas of likely contamination. Three actions will help minimize the concentrations of contaminants drawn into surface water intakes:

(1) Avoid placing the intakes directly downstream from known sources of contamination.

(2) Place the intakes away from the shore to a position where the water appears less contaminated.

(3) Suspend the intakes between the surface and the bottom of the source to avoid collecting either settled or floating materials.

The quality of surface water sources should be reevaluated after rain storms to ensure they are still treatable because of the potential for increased contamination from runoff and resuspension of settled contaminants due to increased water flow in the source.

b. Ground water. Ground water comes primarily from various kinds of wells and springs. Microbiological contamination is less likely to be found in ground water than in surface water, but the quantity of water available from an undeveloped ground-water source may be difficult to determine, and possibility of chemical contamination of ground water from nearby, distant, and long-gone agricultural and industrial operations must be carefully considered. Accessible ground-water sources in the field include existing wells and springs, and wells constructed by military engineers. Latrines, septic tanks, and maintenance areas should be positioned at least 100 yards (yd) away from any ground-water sources used to produce drinking water, and oriented so that any drainage from these facilities flows away from the sources to prevent their contamination.

c. Semifixed/host-nation water systems. Partially or completely intact municipal water systems are sometimes available for use as water sources during deployments. In this TB MED, such systems are referred to as semifixed or host nation water supplies. Despite the ease of access and possible presumption that the water in these systems has been treated and is potable, the water in them is by Army doctrine considered nonpotable until PVNTMED personnel have inspected the systems, tested the water, and approved it for use. While these types of water sources may be appealing, the local water treatment methods may be less than adequate, inconsistent, and unreliable, and the water may become contaminated after it is treated through broken water lines or cross-connections in the storage and distribution systems that are not readily visible. Even if the local population appears healthy, they may have developed immunities to microbiological contaminants and tolerances for chemical impurities in their water through long periods of exposure. The same contaminants could cause severe adverse health effects in unacclimatized deployed personnel and reduce unit readiness. The water may also have contaminants that have the potential to increase long-term health risks to deployed personnel. Further, in areas of civil unrest, the threat of intentional contamination of the local drinking water system by disgruntled local nationals or terrorist groups must be considered.

d. Bottled water. Bottled water is water that is sealed in bottles, packages, or other containers by commercial (nonmilitary) interests for human consumption. It may or may not have been treated prior to bottling. Bottled water provided for Army personnel and operations is classified as a food item (beverage, nonalcoholic) in Army Regulation (AR) 40–657/ NAVSUPINST 4355.4H/MCO P10110.31H. In consonance with that AR, bottled water must be obtained from military-approved sources only. The U.S. Army Veterinary Command (VETCOM) approves commercial sources of bottled water for military use in CONUS and OCONUS. They inspect bottling facilities to ensure compliance with acceptable sanitation standards. A list of military-approved sources worldwide is published by VETCOM at http://vets.amedd.army.mil/vetcom/directory.htm. Appendix C contains useful information concerning the use of bottled water during deployments.

e. Packaged water. Packaged water is potable drinking water that is produced and packaged in sealed containers by military water treatment personnel in the field. It may be issued to deployed units and personnel in plastic bags or bottles. The requirements for treatment, disinfection, and PVNTMED monitoring associated with field water supplies also apply to packaged water operations. See appendix C for additional information.

3-4. Field water discipline

To complete their missions, deployed personnel must drink sufficient quantities of potable water to maintain adequate physical and mental health. The daily water requirements for personnel in the field depend on a number of factors including the weather, geographical area, the tactical situation, and the operational tempo. General consumption requirements for various environmental and military work conditions are estimated to be between 5 and 15 liters per day (L/d). It is important to determine and adhere to the appropriate consumption rates, spreading consumption throughout the work day, because medical casualties can result from both insufficient water intake, or dehydration, and too much water intake which results in overhydration.

a. Dehydration. The healthy human body loses water through urination, breathing, and sweating. Dehydration can occur quickly not only in extremely hot climates, but in cold and mountainous environments as well. To meet their bodies' needs, personnel must sometimes drink water even when they are not thirsty. An active individual subjected to high heat stress may lose more than a liter of water per hour through sweating. Water and salts/electrolytes (primarily sodium and potassium) that are lost through perspiration are essential to proper muscle function; they must be replaced to ensure mission effectiveness. Wearing mission-oriented protective posture (MOPP) gear aggravates heat stress, and additional factors must be considered for fluid intake requirements under such conditions. Sustained dehydration is very serious and can result in heat stress, deterioration of performance, and, if left untreated, death.

b. Overhydration. This condition, also known as “water toxicity” or “hyponatremia,” can cause electrolyte imbalances in the body, and can also result in serious illness and death. Irreparable harm can also be done when a dehydrated person’s abnormal electrolyte levels are corrected either too quickly or too slowly. Adequately controlled water consumption is paramount, and excessive water consumption must be avoided.

c. Water replacement. The preferred method of water replacement is to drink small volumes of water throughout the work period. During periods of moderate activity with moderate environmental conditions prevailing, the individual water requirement is 0.5 quart (qt) or more per hour and is best taken as a cup or so at 20- to 30-minute (min) intervals. As activities or conditions become more severe, the command must take action to ensure that individual water intake is increased accordingly. Table 3–1 in TB MED 507/AFPAM 48–152 (I) provides fluid replacement and work/rest guidelines for warm weather training conditions. Table 3–3 in TB MED 507/AFPAM 48–152 (I) provides guidelines for continuous work duration and fluid replacement during warm weather training conditions. Individual water needs may vary by up to ¼ qt per hour. Hourly fluid intake should not exceed 1.5 qt, and daily fluid intake should not exceed 12 qt. Unit commanders will provide the required amount of safe drinking water. When sufficient quantities do not exist, work/rest cycles must be modified to prevent dehydration.

3-5. Uses for potable and nonpotable water

In situations where the potable water supply is insufficient to meet all water requirements, nonpotable water may be used for purposes other than drinking. Table 3–1 lists activities that require potable water and those that can be performed adequately using water of lesser quality. Note that brackish and sea water should be used only as last resorts, since their high salt content can cause corrosion of mechanical and electrical components, as well as have adverse effects on other materials.

Table 3–1
Acceptable uses for different quality water

Water quality	Acceptable activities
Potable water	a. Drinking water b. Dining facility operations such as food washing c. Brushing teeth d. Medical treatment e. Ice production for food preservation and cooling f. Water hose and pipeline testing and flushing g. Photo-processing (for quality control, not health reasons—separate standards apply)
Disinfected fresh water (nonpotable)	a. Centralized hygiene such as field showers b. Decontamination of personnel c. Retrograde cargo washing d. Heat casualty body cooling e. Graves registration personnel sanitation f. Well development
Fresh water (nonpotable)	a. Vehicle coolant b. Aircraft washing c. Pest control d. Field laundry e. Concrete construction f. Well drilling
Brackish and seawater[1]	a. Vehicle washing b. Electrical grounding c. Fire fighting d. Chemical, biological, radiological, nuclear, and explosives (CBRNE) decontamination of material

Note:
[1]Brackish and seawater are minimally acceptable and may lead to significant corrosion if used; therefore, fresh water should be used if at all possible. It is acceptable to use water of higher quality for activities requiring lower quality water but not vice versa.

CHAPTER 4

PREDEPLOYMENT PLANNING AND PREPARATION

4-1. General

a. Overview. This chapter describes PVNTMED participation in the predeployment planning and preparation phase of the field water support mission. For PVNTMED personnel, predeployment planning includes determining detailed support requirements and using medical and nonmedical strategic and tactical intelligence to develop the PME. Predeployment preparation includes assisting in preparation of the battlespace and conducting strategic-level coordination.

b. Background. During the predeployment phase of the operations process, PVNTMED personnel assist commanders and CSS personnel in planning and preparing the field water support mission. PVNTMED participation is important because it helps ensure successful execution of the field water support mission. Table 1–1 lists organizations from the three services that can provide technical support during this phase.

4-2. Predeployment planning

Force commanders are responsible for integrating operational and CSS planning through the common operation picture. To do this effectively, commanders rely on their staffs to provide them with detailed CSS requirements based on planning factors and CSS estimates of resource capabilities. For the field water support mission, PVNTMED personnel assist CSS planners by providing detailed field water support requirements and developing the PME.

a. Detailed field water support requirements.

(1) *Individual consumption requirements.* In support of the detailed field water support planning process, PVNTMED personnel estimate the amount of water that personnel must drink to maintain their health and complete their missions. PVNTMED personnel should use guidelines for water replacement based on environmental conditions and workload, as described in chapter 3 and published in TB MED 507/AFPAM 48–152 (I), to determine these estimates.

(2) *Water planning factors*. CSS planners estimate total water support requirements using water consumption planning factors that are contained in the U.S. Army Combined Arms Support Command (CASCOM) Potable Water Planning Guide. These factors are based on estimates found in the U.S. Army Quartermaster School approved Water Consumption Planning Factors Study. PVNTMED personnel may assist CSS planners in applying the water planning factors to the field water planning process.

(3) *Water quality surveillance requirements*. PVNTMED personnel also contribute detailed information on field water quality surveillance requirements, and they estimate the personnel, equipment, and training required to meet those requirements. Chapter 6 describes the basic field water quality surveillance requirements, and table 2–1 shows the levels of PVNTMED support, the respective roles, and typical tasks.

b. Intelligence and the PME. During predeployment planning activities, PVNTMED personnel provide medical intelligence and information, the medical threat, and the PME of the situation to the surgeon or the commander. These information resources assist commanders and CSS planners in predeployment identification of potential water sources, treatment and disinfection methods, monitoring equipment, and the PVNTMED personnel and units required to execute the field water support mission.

(1) *Medical intelligence*. Medical intelligence is an important resource to PVNTMED planners during predeployment planning and in preparing the PME. On receipt of notification of a pending deployment, PVNTMED planners should immediately coordinate with the AFMIC to obtain medical intelligence and health threat information. AFMIC information is available on its Web site at https://mic.afmic.detrick.army.mil/osis/afmic.html and on CD ROMs. (Note: it takes 24 hours to establish an account on the AFMIC Web site before access is granted.) The AFMIC 24-hour telephone number is commercial (310) 619–7574 or DSN (312) 343–7574. The e-mail address is afmicops@afmic.detrick.army.mil. AFMIC maintains up-to-date information that is available to military planners on the chemical and biological quality of surface and ground-water sources in major geographic regions. AFMIC can provide detailed assessments of endemic water-borne diseases, as well as general and sometimes detailed information on the types of industries located in specific areas and the various chemicals associated with those industries. Note that AFMIC accepts information from the field on surface and ground-water source quality to add to and update its water quality data base.

(2) *Medical threat*. PVNTMED personnel obtain and deliver medical threat products and briefings based on medical and nonmedical intelligence information as part of predeployment planning. Prepared medical threat products, including medical threat briefings, are maintained on the USACHPPM Web site at http://chppm-www.apgea.army.mil/mtb/.

(3) *PME*. The PME is the basic tool used by the PVNTMED planner. The purpose of the PME is to provide health risk management recommendations to commanders and other planners. To perform sanitary control and surveillance of water supplies successfully in the field water support mission, PVNTMED plans must be well thought out and based on current and relevant information. The PME includes evaluations of the six topics listed in FM 3–0, chapter 5: mission, enemy, terrain and weather, troops and support available, time, and civil considerations (METT–TC). The METT–TC factors provide a framework for identifying risks and estimating resource needs for planning, preparing, and executing operations. A comprehensive sample format for the PME is presented in FM 4–02.17. A detailed PVNTMED METT–TC checklist to use for field water support mission considerations during the PME process is contained in appendix D of this TB MED.

4-3. Predeployment preparation

Force commanders prepare the battlespace by integrating operational and CSS components. CSS commanders and staff assist by obtaining, managing, and distributing the resources identified during predeployment planning. They also conduct strategic-level coordination. For the field water support mission, PVNTMED personnel assist commanders and staffs in resource management and strategic-level coordination.

a. Resource management. PVNTMED personnel who serve on or support staffs assist in obtaining, managing, and distributing resources identified for conducting sanitary control and surveillance of field water supplies. Chapter 2 outlines the levels of PVNTMED support to the field water mission and provides guidance in managing these resources. Staff-level PVNTMED personnel will assess the PVNTMED resources identified during planning in terms of personnel, equipment, and training readiness. They will recommend corrective actions for any deficiencies found.

b. Strategic-level coordination. For the field water support mission, strategic-level coordination includes addressing issues such as: prepositioned water support equipment, national-level water resource agreements, host nation water resource support, threats to host nation water sources and water supplies, and theater infrastructure including support base and water supply point locations. Staff-level PVNTMED personnel provide assistance and consultation to commanders and staffs based on medical and nonmedical intelligence and information, the PME, and their own experience.

(1) Prepositioned water support equipment may require inspection and assessment to determine its functional and sanitary condition.

(2) National-level water resource agreements and host nation water resources support may require PVNTMED input on water quality requirements and procedures for effective sanitary control and surveillance. The preliminary FWSVA may be an important part of this coordination. Procedures for conducting FWSVAs are presented in appendix E.

(3) Theater infrastructure development, including support base and water supply point locations, should consider PVNTMED recommendations on managing risk based on medical and nonmedical intelligence and the PME. Also consider threat information contained in preliminary FWSVAs.

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CHAPTER 5

WATER SOURCE SELECTION AND BASIC TESTING FOR POTABILITY

5-1. General

a. PVNTMED personnel perform or participate in two kinds of field water monitoring: basic water testing and AWSM. Basic water testing consists of onsite sampling and testing of raw and treated water using organic field water test equipment, generally, the Water Quality Analysis Set–Preventive Medicine (WQAS–PM). In the case of AWSM, in addition to performing some onsite tests, PVNTMED personnel normally collect samples and prepare them for shipment to a laboratory capable of performing AWT to identify contaminants that are not included in the TSFWS or that the WQAS–PM cannot detect adequately.

b. This chapter describes critical PVNTMED responsibilities in the field water support mission during the early stages of deployment. PVNTMED personnel help CSS personnel choose and establish water supply points by assisting in water source selection, which includes performing water source reconnaissance surveys and conducting source water basic characterization testing (BCT). PVNTMED personnel also conduct basic potability testing (BPT) to assess treated water quality and certify its potability based on its meeting the TSFWS. PVNTMED technicians perform both BCT and BPT onsite using organic test equipment, generally the WQAS–PM. These water quality tests produce real-time results for use in ORM and are repeated periodically throughout a deployment. FM 3–100.4/MCRP 4–11B also describes how these procedures and tests may be executed and documented in conjunction with EBSs and environmental health site assessments (EHSAs) in which PVNTMED personnel generally participate.

5-2. Water source reconnaissance surveys

a. General. As presented in chapter 4, PVNTMED personnel will provide medical intelligence and information to CSS planners during predeployment planning to help them identify potential water sources for the field water support mission. However, the accuracy of the intelligence concerning those potential sources needs to be physically confirmed after arriving in the deployment area of operations (AO). Final selection of a source requires an onsite source survey, BCT of the source water, and assessment by a reconnaissance team. PVNTMED personnel should query existing military water quality databases for information on candidate sources. Such databases include the Corps of Engineers worldwide well log database and the USACHPPM database containing previous EBSs and environmental surveillance data. PVNTMED personnel should record the results of water source reconnaissance surveys on DA Form 1712–R (Water Reconnaissance Report) and use that information when performing the FWSVA of the associated water system (see app E). Completed DA Form 1712–Rs should also be forwarded to the USACHPPM DDAPI Program for reporting and archiving.

b. Roles. A properly staffed reconnaissance team will include CSS (typically quartermaster water purification personnel) and PVNTMED personnel, as well as engineering and intelligence/security personnel. PVNTMED personnel (typically Level II or III) perform water source reconnaissance surveys and raw water BCT as described in paragraph 5–3 below. Typically, water purification personnel will also survey the site and perform their own set of water tests. These actions help them evaluate the suitability of the site, the treatability of the raw water source, and what needs to be done for the initial setup of the water purification equipment. FM 10–52–1 describes the actions in detail.

c. Water source sanitary survey. PVNTMED personnel examine the proposed water source and the surrounding area for existing and potential sources of pollution and evidence of contamination. If it was not gathered during predeployment planning, information on potential sources of contamination in the area should be obtained from AFMIC, USACHPPM, and the WHO (see table 1–1). Survey personnel should assess the surrounding watershed vegetation and forestation, accessibility of the site, any obvious chemical and organic contaminants in the water, and the general quality of the source. The source water may have been contaminated accidentally or deliberately through chemical or biological spills or from industrial pollutant discharges. If visible evidence of contamination such as dead fish, rotting vegetation, oil film or sheen, floating or submerged garbage, or discharges from industrial areas is observed, a different source should be considered. If that is not possible, then control measures must be implemented to minimize existing or potential exposure to contamination. Table 5–1 illustrates some items PVNTMED personnel should consider when surveying water sources intended for potable water production, to compare source options, and to decide whether they will require control measures. Actions to control or improve the raw water quality or to minimize the amount of contaminated water that reaches the RO-based WPS intake screen include, but are not limited to, building flow diversion structures, suspending the intake screen 8 to 12 inches (in) below the water surface and keeping the screen off of the bottom.

d. Municipal water system as a source. Where a host nation municipal water system is identified as a potential water source for deployed personnel, even though there may be what appears to be an adequate water treatment system in place, it must be considered a raw water source. The PVNTMED mission is to identify and assess the potential health risks of this water source. PVNTMED personnel will conduct a sanitary survey of the identified municipal source, treatment, and distribution system, and conduct BCT of the water at the point proposed as the source for the military treatment system (RO-based WPS). The surveyors should assess the performance and overall condition of the municipal treatment and distribution system that will serve as the water source. The potential for intentional contamination of the water source by hostile groups or individuals should be considered, with the results recorded in the FWSVA.

Table 5–1
Water source reconnaissance considerations

Parameter	Considerations
Water quantity	Is the source permanent or intermittent, depending on season, temperature, or other factors (human controls such as dams)? The greater the source flow and volume, the lesser the impact from added toxic substances (intentional or accidental).
Pollution sources nearby or geographically located so that runoff/discharge may reach the source by surface runoff or subsurface movement	Landfills; agricultural and livestock wastes; industrial discharges; petroleum refineries, distribution, or storage systems; domestic sewage discharges
Visible evidence of contamination	Dead fish or vegetation, excessive algae growth, oil slicks/sludge, or strange-colored soil or surface residues
Potential for contamination from accidents or hostile action	Upstream industrial facilities with significant quantities of toxic industrial chemicals; toxic industrial chemical transportation routes in upstream watershed area; upstream area controlled by hostile forces
Information from local populations	Smells, tastes, health effects and/or endemic water-borne diseases

5-3. Raw water source—basic characterization testing

a. General. During the raw water source reconnaissance survey, PVNTMED personnel will conduct BCT to evaluate the raw water source from a health-risk standpoint. They might also collect water samples and package and send them to a rear-area laboratory for advanced analysis as part of an EBS or EHSA (see chap 6). PVNTMED personnel use the onsite test results to identify and recommend the highest quality raw water sources. In cases where a lower quality raw water source must be used, they assess health risks due to source quality and make recommendations to mitigate those risks. Quartermaster water purification personnel use their Water Quality Analysis Set—Purification (WQAS–P) to test the suitability of the source for purification and to determine initial purification equipment settings.

b. BCT procedures. Water samples collected for testing should represent, as much as possible, the overall raw water source. For surface waters, samples should be obtained from a location at least 8 to 12 in below the surface at the point where the influent screen will be placed. For local municipal distribution systems that are to be used as raw water sources, samples should be collected from the tap or hydrant from which the water will be drawn for treatment. Taps and hydrants should be flushed to a point of consistent clarity and temperature, if possible, before collecting samples from them.

c. BCT parameters and test kits. PVNTMED personnel will normally perform raw water BCT for the BCT parameters indicated in table B–1. The M272 kit is currently the best available agent detection kit. Coliform testing is not normally a part of BCT. Parameter detection ranges for current field water testing equipment are listed in table B–1. Appendix F provides descriptions and capabilities of the testing equipment, sets, and kits that are currently available.

d. BCT results. The BCT results are used to identify and assess potential raw water health risks, and to help water purification personnel determine the treatability of the raw water and establish initial water treatment equipment settings. PVNTMED personnel should interpret source water BCT results based on contaminant health effects information found in appendix G and RO removal capabilities described in appendix H, in order to identify potential treatment limitations, assess health risks as described in chapter 7, and discuss any concerns with the quartermaster personnel who will set up the water purification equipment. Raw water BCT results do not need to meet the TSFWS listed in table B–1. The TSFWS apply to treated water. Even if the BCT results meet the TSFWS (which might occur when characterizing a municipal water system or a ground-water source), the water will likely need to be treated and disinfected, and must be tested and certified by PVNTMED personnel to be potable before it is used for potable purposes.

5-4. Treated water—basic potability testing

a. General.

(1) After the field water purification operations are fully functional, as determined by the water treatment system operators (see chap 9), PVNTMED personnel must test the treated water to ensure that it is potable. To do that, they must sample and test the treated water to ensure that it meets the TSFWS (see table B–1). If the BPT results confirm that the water meets the TSFWS, PVNTMED personnel will certify that the water is potable, and approve it for distribution and consumption.

(2) When PVNTMED personnel are unable to provide timely inspection, BPT, and certification, the senior operator at a water purification site (usually a Quartermaster NCO) may provisionally approve RO-treated and disinfected water for consumption. The provisional approval must be based on the satisfactory operation of the RO-based WPS and achieving a 2 milligram per liter (mg/L) free-available chlorine (FAC) residual after a 30-min contact time. Such provisional approval is not intended to replace PVNTMED medical certification, but only to allow water consumption during early entry operations and when force protection constraints prevent PVNTMED personnel from performing timely certification of potability.

b. BPT s*ampling procedures*. Water samples should be representative of the bulk treated and disinfected product water. Water purification system operation samples should be collected from a location where the chlorine has had at least a 30-min contact time prior to sampling [for example, from the effluent line from the purified water 3,000-gallon (gal) onion tank].

c. BPT test parameters and kits. PVNTMED personnel use WQAS–PM equipment and reagents to perform BPT of purified water. They perform tests for the all TSFWS water quality parameters listed in table B–1 that their field equipment can detect. The M272 kit is currently the best available chemical agent detection kit, and does not need to be used to test treated water unless raw water tests indicate the presence of chemical agents. Note that there are TSFWS parameters for which field monitoring equipment does not currently exist (indicated in table B–1). Evaluation of these parameters will typically require AWT; that is, field sampling followed by sample transport to and analysis in a laboratory at a higher level of PVNTMED support (see chap 6). The detection ranges of current field water testing equipment used for BPT are listed in table B–1. Descriptions of the testing equipment and their capabilities are provided in appendix F.

d. BPT test results. If the BPT results meet the TSFWS, PVNTMED personnel will certify that the treatment operation produces potable water, and the water may be distributed and issued to personnel. For the TSFWS parameters that are not measurable by field equipment, PVNTMED personnel should review the results from AWT as soon as possible, to ensure that the water meets all the TSFWS. If the treated water does not meet some or all of the TSFWS, it is not potable, and it should not be used for drinking water. In such cases, if there is a critical operational need for the water, the command surgeon or other senior medical authority can conditionally authorize its distribution and use, based on their evaluation and assessment of the risk associated with drinking the water. In this case, PVNTMED personnel will help the command surgeon assess and mitigate the possible health risks if possible. Chapter 7 contains additional information regarding the use of the TSFWS and the interpretation of BPT results. Descriptions of the adverse health effects of drinking water that does not meet the TSFWS are described in appendix G.

e. Recurring testing. In addition to initial testing for potability, if a water point is operated for more than 7 days, PVNTMED personnel should test the treated water weekly, monthly, or quarterly using table B–3 as a guideline. PVNTMED personnel should also test treated water at the point of production for potability whenever there is a change in the quality of the source water (for example, after a rainstorm) and after work is performed on the treatment system (in the case of a RO-based WPS, for example, RO membrane, multimedia filter maintenance, or prefilter replacement). The frequency of recurring testing should also be increased if there is a significant potential for source contamination from environmental accidents or hostile actions.

5-5. Chemical agent testing

PVNTMED personnel can use the M272 kit to conduct water tests for chemical agents as part of BCT and BPT. Since the M272 kit is currently the best available field testing capability for chemical agents, and since it cannot measure agent concentrations as low as the TSFWS concentrations, its test results are acceptable only as gross-level clearance indicators, and will be used on raw water first, because the concentrations in the raw water, if there are any, will be greater and easier to detect than in treated water. Once water purification operations have started, the brine stream from the RO-based WPS can be used to test for chemical agents. Because of membrane rejection of chemical agents and volume reduction of the raw water stream, the agents will be concentrated in the brine stream and thus easier to detect. CBRNE filters are a component of all currently fielded water purification systems. If CBRNE contamination is a concern, or if contaminants are identified at any stage in water source or treatment system evaluations, quartermaster water purification personnel will immediately connect the CBRNE filters. Water purification personnel also conduct regular tests for chemical agent contamination, using the M272 kit, at a frequency that depends on the threat level. This frequency is described in FM 10–52–1 and is shown in table 5–2. The TSFWS for chemical agents shown in table B–1 are only for drinking water used less than 7 days. There are no long-term agent standards, because it is anticipated that an alternate water source would be found as soon as possible if chemical agents were discovered in the source water being used.

Table 5–2
Frequency of chemical warfare agent and radioactivity testing according to threat and MOPP levels[1]

Threat level	MOPP level	Test frequency
No known threat	0	Weekly
Slight threat	1	Daily
Medium threat	2	Twice daily
Severe threat	3	Four times daily
Imminent threat	4	Hourly
Known contamination	4	Hourly and before issue of each batch of water

Note:
[1]Extracted from FM 10–52–1.

5.6. Documenting, reporting, and archiving
PVNTMED personnel will document the results of all sanitary surveys, including field test data and context information; all BCT and BPT results; and recurring test results. This information (data and context information) must be forwarded to the USACHPPM DDAPI Program at USACHPPM DDAPI Program, ATTN: MCHB–TS–RDD, 5158 Blackhawk Road, Bldg. E1675, APG, MD 21010–5403. DDAPI Program personnel can be contacted for assistance at phone: 410–436–6096/DSN 584–6096, fax: 410–436–2407, STU (call voice first): 410–436–4244, e-mail: CHPPM-OEHS-Data@apg.amedd.army.mil, or Web site: http://chppm-www.apgea.army.mil.

CHAPTER 6

ADVANCED WATER SURVEILLANCE AND TESTING

6-1. General

a. Purpose. This chapter describes PVNTMED actions and responsibilities for AWT of raw and treated field water for EBSs and EHSAs, for testing required by a spill or other incident that may contaminate water, and for AWSM of field drinking water supplies. AWT involves analyzing water samples for contaminants that field water testing equipment either cannot detect, or that it cannot detect at levels as low as necessary. AWT analytical methods are more sensitive, have lower detection limits, and involve much more quality assurance and quality control than field testing methods. Some advanced water tests can be conducted by an AML or chemical unit located in the AO, but that is the exception rather than the rule. AWT generally requires advanced (level V) laboratory analysis and takes days to weeks to get results, depending on the priority the samples are given. To initiate AWT, field PVNTMED personnel typically perform minimal field tests onsite, then collect, package, and ship water samples to USACHPPM. Other level V laboratories may be used as necessary.

b. Background. PVNTMED personnel participate in engineer-led multidisciplinary initial and final EBSs by invitation, and should support the survey team leader with regard to the information gathering, water testing, sample kits, and sampling procedures required. PVNTMED personnel should take the team lead on EHSAs which may be performed in conjunction with EBSs or separately as required. PVNTMED personnel also participate in AWSM by collecting treated water samples from water supplies in the deployment area, submitting them to USACHPPM for AWT, evaluating the results and report, and making recommendations to commanders concerning any contaminants identified at levels of concern. PVNTMED personnel must also be ready to respond to reported incidents that may result in contamination of the water supply (raw or treated water). They analyze contaminated water onsite using components of the WQAS–PM, then collect, package, and ship samples for AWT and recommend actions to mitigate health risks from the incident. For all of the above, PVNTMED personnel should ensure that onsite testing, sampling, and incident information, as well as all analytical results, are forwarded to the USACHPPM DDAPI Program for evaluating and archiving.

6-2. Environmental baseline survey

a. Requirement. Military engineer-led multidisciplinary teams document existing deployment area environmental conditions, determine the likelihood of present and past site contamination, and identify potential vulnerabilities, including occupational and environmental health risks. Details of and instructions for conducting EBSs, including the role of PVNTMED, are contained in FM 3–100.4/MCRP 4–11B. Initial EBSs, conducted early in the deployment cycle, may include reconnaissance surveys, some onsite testing, and sample collections of air, soil, ground water, and surface water at base camps, assembly areas, logistical supply areas, and enemy prisoner of war camps. Final or closeout EBSs are performed at the end of the deployment to document any changes that have occurred as a result of deployment operations. The EBS is a tool to help determine whether a site is appropriate for military use, the environmental concerns that should be addressed to ensure effective and safe operations, and whether a site is in compliance with various military, national or foreign environmental compliance requirements and whether deployment operations resulted in environmental degradation in the deployment area.

b. Application to field water supplies. As an extension of BCT of surface or ground water being considered as a source for RO-based WPS treatment, or strictly for the EBS information gathering, AWT of an untreated natural water source at a deployment site is a tool to document that site's water-related environmental conditions. Water samples from existing local or municipal deployment area water treatment systems may also be collected and submitted for AWT as part of an EBS at the discretion of the team leader and PVNTMED personnel.

c. Roles. Task force or combatant command commanders are responsible for EBSs but generally delegate them to engineering units. However, PVNTMED personnel are frequently tasked to assist in the environmental sampling and analysis segment because they have the equipment and experience required to meet the data quality objectives of the EBS. They can conduct the required field tests and collect samples for AWT with organic and USACHPPM-supplied equipment and supplies.

d. AWT sampling considerations. AWT performed in support of EBSs is typically conducted on untreated natural water sources. Since EBS evaluations consider changes in environmental conditions, initial and subsequent samples for AWT must be collected from the same locations using the same sampling techniques and analyzed using the same methods. It is important to document where initial sampling was conducted and then to reference the original test results when evaluating follow-up tests.

6-3. Environmental health site assessment

a. Requirement. The requirements for EHSAs are also documented in FM 3–100.4/MCRP 4–11B. They may be performed concurrently with EBSs; however, their purpose is to identify and document potential environmental exposures that may impact the health of deployed personnel as directed by Presidential Review Directive 5, JCS Memorandum MCM–0006–02, and Department of Defense Instruction (DODI) 6490.3. The focus of the EHSA is to identify complete or potentially complete exposure pathways at deployment sites that may adversely affect the short- or long-term health of deployed personnel. Like EBSs, EHSAs will normally involve site reconnaissance and some sampling and analysis to identify contaminants and then to confirm the presence or absence of complete or potentially complete exposure pathways.

b. Application to field water supplies. As with EBSs, EHSAs document environmental conditions at proposed base camps and other deployment area locations. Like EBSs, they are performed initially and at the end of deployments; therefore, they may include collection and submission of both untreated and treated water samples. EHSAs may also need to be repeated periodically during a deployment because changes in environmental conditions may affect the health of deployed personnel, and that needs to be documented. From a drinking water perspective, the data and information available from AWSM should satisfy all the requirements of mid-deployment EHSAs. Exposure pathways and requirements for monitoring recreational water, which may be of interest when performing EHSAs, are addressed in TB MED 575.

c. Roles. EHSAs are a medical responsibility. PVNTMED personnel are typically tasked to collect samples for AWT of field water supplies (both raw and treated water) in support of EHSAs because they have the experience and equipment to conduct the required field tests and collect samples for advanced laboratory analysis. PVNTMED personnel (onsite or at USACHPPM) also typically evaluate AWT results, perform risk assessments as needed, and provide ORM recommendations to commanders to reduce identified field water supply-related risks.

d. AWT sampling considerations. AWT performed in support of an EHSA, depending on when it is conducted, may include both raw and treated water. AWT sample kits for both are available from the USACHPPM Deployment Environmental Surveillance Program (DESP). It is important to use the sample kit that corresponds with the type of water to be sampled.

6-4. Advanced water surveillance monitoring and advanced water testing

a. Requirement. DODI 6490.3 requires the implementation of deployment occupational and environmental health surveillance (OEHS) including documentation of, as nearly as possible, all occupational, environmental, and CBRNE warfare exposures to deployed personnel. Since the environment is subject to natural, accidental, and intentional changes and contamination, that requirement necessitates constant, or at least frequent, evaluation of the total environment of the exposed deployed individuals. The focus of EBSs and EHSAs is primarily on base camps and other sites occupied or intended to be occupied by deployed personnel.

b. Application to field water supplies. The requirement stated above is accomplished with respect to drinking water in the field through the combination of BPT and AWSM. BPT assesses a few key parameters to ensure potable water supplies are safe for deployed personnel's consumption for up to a year. However, treated water that meets the TSFWS could have contaminants in it that have no TSFWS and that are, therefore, not routinely measured by PVNTMED personnel using the WQAS–PM. Certain undetected contaminants, if present, may affect the short- and/or long-term health of deployed personnel. Those contaminants are addressed by AWSM (which should be initiated after a water supply has been in use for 7 days) and identified through AWT of treated water supplies. Chapter 7 describes the evaluation of AWT results and the application of ORM to reduce field water supply-related risks.

6-5. Advanced water testing procedures

To ensure the quality of analytical results from AWT in support of AWSM, EHSAs, and EBSs, PVNTMED personnel must follow correct procedures for: (1) collecting water samples; (2) documenting sample data, including field test results; (3) shipping samples for advanced testing; and (4) archiving the results.

a. Collecting water samples.

(1) To support AWSM , PVNTMED personnel collect and submit treated water samples for AWT. It is very important to identify the samples as raw or treated water when collecting and shipping them so laboratory personnel will handle and test them appropriately.

(2) USACHPPM has developed packaged water sampling kits complete with all the necessary sample containers, supplies, sampling instructions, and field data sheets for correct documentation to minimize the errors that can lead to invalid results. Separate kits for both treated and raw water are available from the USACHPPM. Appendix F of this TB MED provides additional information.

(3) Personnel who collect samples for AWT must measure the negative log of the hydrogen-ion concentration (pH), water temperature, conductivity, turbidity, FAC, and total dissolved solids (TDS) of the water onsite at the time they collect the samples, using their field water test equipment (WQAS–PM). They record the results on the sample information sheet that comes with the sample kit (or make one up if necessary) and ensure that it accompanies the samples to the laboratory.

(4) AWSM samples for AWT should be collected from all drinking water supplies in a deployment AO that are used for longer than 7 days. This includes bottled/packaged water supplies. PVNTMED personnel may need to delegate sample collection to non-PVNTMED personnel in order to obtain the necessary samples. If so, those collecting the samples must be trained in correct sampling procedures before they are allowed to collect samples. Collection and submission of a single set of representative AWT samples for each water supply in an AO may suffice for some deployments; however, additional sampling will be required if the drinking water supplies are used for longer than 6 months or if contaminants are identified in the initial sampling that pose potential health risks (see chap 7). PVNTMED personnel will make that determination after reviewing the results of the first set of analyses for each water supply. Further, whenever the water source quality changes (for example, due to flooding or a spill upstream) or when the treatment system is modified or shut down and then restarted, additional AWT should be considered as part of AWSM.

b. Documenting sample data. Accurate and complete AWT sample data is critical for the proper testing of samples and accurate evaluation of results. The USACHPPM sampling kits include field data sheets for documenting critical sample information. Personnel who collect samples for AWT must accurately complete a field data sheet and return it with each sample set and kit. If a USACHPPM AWT sample kit is not used, sample collectors must still document all samples with the minimum information listed in appendix F, and submit the information to the analytical laboratory with the samples.

c. Shipping samples for AWT. After collecting and packaging samples for AWT, PVNTMED personnel are responsible for ensuring the samples are properly shipped, together with complete and correct documentation, to an appropriate laboratory (see table 1–1). Typically, this is the final action that field PVNTMED personnel are responsible for in AWT procedures. Prior to shipment, personnel must coordinate with the selected laboratory to ensure that the laboratory is aware of the numbers and types of samples, as well as the approximate arrival date so they will be prepared to accept them. Appendix F provides details regarding the use of the USACHPPM sample kits and analytical laboratory services.

d. AWT results.

(1) The substances tested for in AWT are those which have MEGs listed in USACHPPM Technical Guide (TG) 230. The MEGs were derived from the drinking water assessment criteria

in the Department of Defense (DOD) Overseas Environmental Baseline Guidance Document (OEBGD), the EPA National Primary Drinking Water Regulations list of regulated contaminants with maximum contaminant levels (MCLs), and certain unregulated contaminants that have secondary drinking water standards. The analytical methods used for AWT must be sensitive enough to be able to measure the lowest MEG value for each analyte listed in TG 230. See chapter 7 for additional information. Because AWT samples must be shipped to advanced laboratories for testing, it may be several weeks from the time samples are collected until the results are received. If a more rapid turn around time is required, PVNTMED personnel must coordinate with the laboratory to see if the samples can be expedited.

(2) All AWT results for EHSAs and EBSs must be provided to the USACHPPM DDAPI Program, regardless of what laboratory performed the analyses. PVNTMED personnel who collect and submit the samples can either request that laboratory results be copied directly to the USACHPPM DDAPI Program or they can forward the results themselves to USACHPPM DDAPI Program, ATTN: MCHB–TS–RDD, 5158 Blackhawk Road, Bldg. E1675, APG, MD 21010–5403. DDAPI Program personnel can be contacted for assistance at phone: 410–436–6096/DSN 584–6096, fax: 410–436–2407, STU (call voice first): 410–436–4244, e-mail: CHPPM-OEHS-Data@apg.amedd.army.mil, or Web site: http://chppm-www.apgea.army.mil.

6-6. Use of advanced water testing results. All AWT results from treated water, whether from EBSs, EHSAs or AWSM should be used to assess and control health risks through the ORM process as described in chapter 7.

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CHAPTER 7

EVALUATION OF FIELD TESTS AND ANALYTICAL RESULTS (HEALTH GUIDELINES)

7-1. General

The Army's goal is to provide drinking water to deployed personnel that is, from a health perspective, every bit as good as the water they drink at their home duty station. Generally, that is possible with RO-based treatment systems. However, for situations where that is not possible, the Army has developed minimally acceptable standards for water quality (the TSFWS) that support individual health and mission readiness. USACHPPM has also developed guidelines for chemical contaminants (the MEGs) to be used to evaluate adverse health effects (immediate or delayed—even delayed for several years) to personnel from drinking water that, even after treatment, retains some chemical contamination. PVNTMED personnel compare analytical results from tests of treated water to these standards and guidelines to monitor the overall quality of drinking water provided to deployed personnel. They compare onsite BPT results to the TSFWS and AWT results from remote laboratories to the MEGs. (Note: While basic and advanced testing results from evaluating raw water, such as those acquired when performing BCT, EBSs, and EHSAs may be compared to TSFWS and MEG values, the comparisons are generally used for determining general raw water quality only; they are not used to evaluate health risk from consumption, since raw water is not meant to be consumed.). These procedures allow PVNTMED personnel to determine and monitor the quality of drinking water and identify any health implications for deployed personnel who drink it. The standards and guidelines were developed for consumption and contaminant levels expected to be encountered in a field environment. The identified constituent concentrations are based on the overall dose related to the maximum volume of water expected to be consumed daily and the length of time the water is to be consumed. The following paragraphs describe the TSFWS and MEGs and discuss additional factors to consider when applying them.

7–2. Department of Defense tri-Service field water standards

a. *General*. The health effects of physical characteristics and chemical constituents of water identified in the TSFWS are described in appendix G. The TSFWS were set at levels at which some individuals might be affected, but overall unit performance and mission accomplishment would not be jeopardized. Consuming water that does not meet one or more of the standards is considered a significant operational risk. For some TSFWS parameters, the allowable levels are based on direct toxic effects. For others, they represent points where the water may become so unpalatable that personnel will choose to become dehydrated rather than drink it. As contaminant concentrations become increasingly greater than the TSFWS, a corresponding increase in the number of personnel experiencing adverse effects will likely be observed, and the severity of the effects may intensify. The complete approach used to develop the standards is described in the paper, "Evaluation of Military Field-Water Quality."

b. Actions to take when the TSFWS are not met. When the results from BPT of drinking water do not meet the TSFWS, PVNTMED personnel should immediately retest the water to confirm the results. Upon confirmation, they should—

(1) Immediately notify the provider of the water. This would be, as appropriate, the—

(a) RO-based WPS operator and the noncommissioned officer-in-charge and/or officer-in-charge of RO-based WPS operations.

(b) Military water packaging system operator.

(c) Person in charge of the commercial bottled water production facility.

(d) Civilian or military logistics individual in charge of bottled water at a port of entry or warehouse where testing is performed. (Note: All deficiencies identified in the quality of bottled water should be immediately reported to the nearest Veterinary Services representative who will determine the appropriate actions with respect to investigating, placing a hold on, and recalling lots and shipments, as well as communicating the information to affected commanders and personnel.)

(2) Assess the potential health risk and personnel impact of the particular contaminant.

(3) Determine whether a water sample needs to be sent to an advanced laboratory for confirmatory analyses and AWT (see app F for sampling instructions), and take appropriate action.

(4) Determine whether storage, distribution, and/or transportation assets need to be checked, drained, flushed, or disinfected, and confer with the appropriate personnel, such as unit commanders, FST members, quartermaster and transportation personnel, to implement necessary actions.

(5) Determine what corrective options are available (this will likely involve consultation with others involved in the treatment, procurement, and/or distribution operations). Contact higher echelon PVNTMED assets in theater, to include PVNTMED assets from the other Services, if available, to obtain advice and assistance on corrective actions. PVNTMED assets outside the theater can also be contacted for advice and assistance, for example, CHPPM–EUR, CHPPM–Main, NEPMUs, and NEHC (see table 1–1).

(6) Correct the problem if possible, and report the incident to the command/theater surgeon, the commander, and the USACHPPM DDAPI Program.

(7) If the problem cannot be corrected quickly, report the situation and recommendations to the command surgeon as soon as possible. The command surgeon will advise the commander of the situation and potential health threat, and the commander will decide whether to continue using the water (with or without additional control measures) or not, and what corrective actions will be taken to resolve the situation.

(8) Ensure that information concerning the incident and all test results are provided to the USACHPPM DDAPI Program for archiving and future use.

7–3. Other standards

a. Multinational standards. Field water quality standard agreements have also been established by international agreement among NATO Forces and the Quadripartite Armies (United States, United Kingdom, Canada, and Australia). The allowable constituent concentrations contained in those agreements are listed next to the TSFWS in table B–2. The NATO STANAG 2136 standards are identical to the TSFWS. The current QSTAG 245 water potability requirements differ slightly from the TSFWS, but three of the four Quadripartite nations belong to NATO, and the QSTAG is expected to be revised in the future such that the standards therein will be identical to those in the TSFWS and STANAG 2136. In the meanwhile, water purified by any NATO or Quadripartite Army member nation during multinational deployments is expected to be of a quality that will meet the TSFWS. Discrepancies will be addressed case by case if and when they occur.

b. Emergency situations. Standards do not apply when personnel are cut off from supply lines and treated water is not available from quartermaster supplies. In such cases, each individual should select the clearest, cleanest water with the least odor available and treat the water using one of the procedures described in FM 21–10. The procedures include boiling, using iodine tablets, dry calcium hypochlorite, household bleach (sodium hypochlorite solution), and Chlor-Floc®. (Chlor-Floc is a registered trademark of Deatrick & Associates, Inc., Alexandria, VA.) Raw water that is treated by small unit individual, handheld commercial off-the-shelf (COTS) devices which have not been evaluated and approved by the Office of The Surgeon General (OTSG) should be additionally treated with approved military disinfection materials such as iodine tablets or chlorine compounds. The use of unapproved COTS individual or unit water treatment devices is solely at the risk of individual military personnel and their commanders.

7–4. Military exposure guidelines

a. General. In addition to the contaminants addressed by the TSFWS, numerous toxic industrial chemicals (TICs) potentially capable of producing immediate or delayed adverse health effects in some individuals could be present in treated water and need to be addressed. PVNTMED personnel identify the presence of these contaminants in field water through AWSM. They collect samples from field drinking water supplies (generally, those used longer than 7 days) and submit them, usually to a remote laboratory, for AWT (see chap 6). The analytical results from AWT are compared to the MEGs for water to assess the potential health risk from any chemicals identified, and to use as a basis for making risk mitigating recommendations to commanders. MEG concentrations for 5 and 15 L/d water consumption and exposure durations of less than 7 days, 7 to 14 days, and 1 year are published in USACHPPM TG 230, which is updated periodically and posted on the USACHPPM Web site at http://www.chppm.com (under Resources—USACHPPM Technical Guides). In addition to listing the MEGs, TG 230 contains discussions of risk assessment methods and toxicological data associated with the chemicals of concern, the many uncertainties associated with the development and use of MEGs, example scenarios, and sample risk assessments.

b. MEG development. Water MEGs, which are precisely defined in TG 230, are protective guidelines which were derived by modifying EPA and other civilian drinking water standards to account for the unique military population, deployment durations, and doctrinal field water consumption rates. The modification procedures, described in detail in TG 230 and Reference Document (RD) 230, resulted in some MEGs being higher and some lower than the corresponding EPA drinking water standards. However, all water MEGs represent concentrations below which no immediate or long-term adverse health effects should occur in any deployed individual for the applicable consumption rate and duration.

c. MEG application. When AWSM samples are sent to USACHPPM for AWT and any MEGs are exceeded, the USACHPPM DESP will generally assess the risk represented by the chemicals of concern, and provide that assessment and recommended actions together with the analytical results to the unit that submitted the samples. Alternatively, upon receipt of AWT analytical results, field PVNTMED personnel must compare the results to the MEG values in TG 230 that best match the actual daily volume and duration of water use by deployed personnel. If none of the MEGs is exceeded, the risk from drinking the water is considered to be negligible. If one or more applicable MEGs have been exceeded, the information is used to determine the ORM risk level (see para 7–5). In practice, because AWT analytical results are generally received several weeks after the samples were submitted, the water supply has already been used for some time. The MEG comparison and ORM results help the commander determine what measures, if any, will be taken to mitigate/minimize the ongoing exposure. The decisions depend on overall mission requirements and other risks. PVNTMED personnel will be able to provide the commander with a risk estimate associated with continued use of the water and to recommend potential mitigating courses of action. TG 230, USACHPPM DESP, and USACHPPM Water Supply Management Program (WSMP) are all excellent resources to assist field PVNTMED personnel with these requirements (see table 1–1).

7–5. Force health protection and operational risk management. According to Department of the Army and Joint Staff policy, decisions regarding the acceptance or mitigation of OEH hazards must be part of commanders' overall ORM procedures. PVNTMED personnel support commanders by presenting information regarding risks associated with water supplies according to military risk assessment procedures.

a. Estimating risk. PVNTMED personnel must establish an OEH risk estimate pertaining to any contaminants in the water supply(s) that are detected through AWSM. To do this, PVNTMED personnel must be familiar with the health risk assessment and ORM procedures. Military risks are categorized into one of four levels: Extremely High, High, Moderate, or Low. In general terms, the level of risk is assessed for an identified health hazard by combining its probability (likeliness that personnel experience exposures greater than associated guidelines) with its severity (how much its health consequences will adversely affect mission accomplishment), as shown in table 7–1. FM 100–14 and FM 3–100.12/MCRP 5–12.1C/NTTP 5–03.5/AFTTP(I) 3–2.34 describe general procedures for military risk assessments and ORM. USACHPPM TG 248 provides more detailed information on how ORM is applied to OEH hazards. Most pertinent, TG 230 provides the specific guidance on how to assess OEH data using the MEGs to translate quantitative analytical results into this ORM terminology.

Table 7–1
Risk assessment matrix [1]

	Hazard probability				
Hazard severity	**Frequent (A)**	**Likely (B)**	**Occasional (C)**	**Seldom (D)**	**Unlikely (E)**
	Corresponding levels of risk				
Catastrophic (I)	**Extremely high**	Extremely high	High	High	Moderate
Critical (II)	Extremely high	High	High	Moderate	Low
Marginal (III)	High	Moderate	Moderate	Low	Low
Negligible (IV)	Moderate	Low	**Low**	Low	Low

Note:
[1]Adapted from FM 100–14.

b. Confidence level in a risk assessment. After determining the estimated level of risk using table 7–1, an indication of the degree of confidence the estimate deserves should be determined. The confidence level depends on several variables including, but not limited to, the number of samples analyzed, how well they represent the bulk water, any fluctuations in the source of the contaminants, and the level of knowledge concerning who drinks the water and how much they drink. Table 7–2 lists criteria by which confidence in a risk estimate can be considered: High, Medium, or Low.

7–6. Risk management options

a. After the risk level and degree of confidence have been determined, PVNTMED personnel identify potential strategies to manage the risk such as:

(1) Accepting the water "as is" together with its inherent risks because the risks are minimal, because of mission expediency, or because of some other overriding factor(s);

(2) Continuing to use the water while somehow reducing/minimizing the risk; or

(3) Deciding the risk is too great and that a new source must be found.

b. Table 7–3 lists some options that may be considered for risk management strategies. For specific recommendations as to how best manage or control contaminant hazards in water supplies, contact higher echelon PVNTMED assets in theater, to include PVNTMED assets from the other Services, if available, to obtain advice and assistance on corrective actions.

c. PVNTMED assets outside the theater can also be contacted for advice and assistance, for example, CHPPM–EUR, CHPPM-Main, NEPMUs and NEHC (see table 1–1).

7–7. Documentation and reporting of risk assessments
The steps taken and conclusions reached in the ORM process, together with all related information (for example, field and laboratory results) are required to be documented and transmitted to the USACHPPM DDAPI Program. All deployed units must report all results back through service channels.

Table 7–2
Example criteria for assigning confidence levels

Confidence level	Criteria
High	• Sampling data quality is good. • Field activity patterns are well known. • True exposures are reasonably approximated. • Relationship between exposure and symptoms is well known. • No important information is missing. • The predicted health outcome is plausible or already demonstrated.
Medium	• Field data quality is good. • Field exposures are likely to be overestimated due to incomplete knowledge of actual exposure frequency and duration. • Information is lacking regarding true personnel activity in the field. • Symptoms are well known for each individual hazard, but some scientific evidence suggests that the combined effects of all hazards may exacerbate symptoms. • Predicted health outcome is plausible but not demonstrated.
Low	• Important data gaps and/or inconsistencies exist. • Exposure conditions are not well defined. • Field personnel activity patterns are basically unknown. • Predicted health outcome is not consistent with events/experience.

Table 7–3
Risk management strategies

Risk management strategies	Strategy attributes
No action/accept risk	An implicit acceptance of the risk by the command, presumably with respect to other risks and mission requirements. This still requires documentation of personnel exposures and appropriate risk communication.
Avoid/reduce risk by minimizing severity	Use of control measures to reduce hazard severity usually by reducing chemical concentration/changing chemical makeup (such as additional treatment/filtration for drinking water supply) or providing prophylactics that reduce human susceptibility.
Avoid/reduce risk with exposure controls	Use of engineering or administrative methods to prevent or completely avoid exposures of concern, such as getting drinking water from another water supply point.
Enhanced OEHS	Increasing water quality and health surveillance to more closely monitor conditions and personnel (biomonitoring). This is not a means to directly control chemical hazards, but it can provide information to support or change a chosen risk management strategy and/or improve the level of confidence/certainty of risk estimates. In all cases, regardless of the risk management strategies used, documentation of personnel exposures and appropriate risk communication is required.

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CHAPTER 8

PREVENTIVE MEDICINE INSPECTIONS AND REPORTING

Section I
Preventive Medicine Inspection Program

8-1. General

PVNTMED sections and detachments are responsible for providing commanders and command surgeons the best possible situational awareness on any health risks associated with field water supply, and making recommendations on how to mitigate risks from water supplies that do not meet field water quality standards. They accomplish this task through routine and special inspections and evaluations of entire water systems including the source, treatment and disinfection equipment and operations, stationary and mobile storage containers, and distribution systems, and through liaison with medical treatment facility personnel to determine if symptoms of personnel seeking medical care could be caused by contamination of the water supply. The inspections include visual observations, discussions and interviews, onsite sampling and analysis, and collection of water samples for submission to higher echelon laboratories to identify constituents and contaminants in the water beyond the capabilities of field test equipment. All inspections need to be documented. For semifixed installation water supplies, where a host nation water system is used either to provide water for direct consumption or as a "raw" water source for an RO-based WPS, PVNTMED personnel can use TB MED 576 to evaluate the permanent water system components.

8-2. Garrison inspections

Field water systems are best inspected when they are set up, operating, and producing water in the field. If that is not possible or feasible, they should be inspected semiannually in the operating mode in garrison to ensure their deployment readiness. The quartermaster water unit water treatment supervisor or other knowledgeable individual(s) will accompany the PVNTMED inspector to answer questions and note deficiencies. Personnel from PVNTMED sections and detachments should maintain liaison with water purification teams and conduct joint training sessions on WQASs.

8-3. Field inspections

a. Inspection requirements. PVNTMED personnel perform the following periodic inspections according to the inspection criteria outlined in section II below.

(1) Each water supply operation must be inspected before it can be certified as providing potable water. Follow-on inspections of water production sites should be performed monthly. The command medical authority may direct PVNTMED to inspect water supply operations more frequently if needed. These inspections are documented using DA Form 5456 (Water Point Inspection).

(2) Potable water containers such as water trailers, tank racks, and fabric tanks or drums must be inspected prior to deployment. For deployments lasting more than 45 days, the supporting PVNTMED assets will inspect containers monthly. For deployments less than 45 days, FSTs will conduct routine monitoring according to FM 21–10 and FM 4–25.12. Use DA Form 5457 (Potable Water Container Inspection) to document the inspections.

(3) Shower/decontamination operations need to be inspected within the first 30 days of operation. Monthly inspections will then be conducted to ensure sanitary conditions and acceptable water quality. Use DA Form 5458 (Shower/Decontamination Point Inspection) to document these inspections.

b. Reporting requirements.

(1) Inspection findings and water sample analytical results are recorded on the applicable DA forms indicated in appendix A.

(2) PVNTMED will retain the original report, leave one copy with the inspected unit, and send copies to the command surgeon, to the headquarters of the unit that was inspected, and to the OEHS data repository.

(3) FSTs will record the results of their chlorine residual testing and actions on locally generated forms, and submit them at least monthly to the nearest PVNTMED unit who will archive and report the results according to current command policies.

Section II
Preventive Medicine Inspection Criteria

8-4. General
The inspection criteria provided in this section are applicable to all types of bulk water purification, storage, and distribution equipment and operations, and include site conditions around water supply point points. The criteria help to ensure the production and distribution of potable and palatable water. Water purification unit personnel operating and maintaining the equipment and FST members are responsible for prompt corrections of any deficiencies noted in the PVNTMED inspection.

8-5. Site conditions
a. Water site development. Water purification and FST personnel will ensure that:

(1) Drainage is provided to prevent pooling of water at fill points,

(2) Dust control measures are practiced to prevent dust-borne bacteria from contaminating water and equipment, and

(3) Rodent and insect breeding areas are controlled to prevent the spread of disease.

b. Bivouac areas.

(1) Bivouac areas must be located at least 100 yd downgradient from water supply wells and a similar distance downstream from surface water intakes.

(2) Latrines will be located at least 100 yd downstream or downgradient from water sources and/or purification operations and will be properly constructed and maintained.

(3) Hand-cleaning stations must be stocked with hand-cleaning supplies.

(4) Garbage and trash must be properly stored, handled, and disposed of at least 100 feet (ft) from any water point operations.

c. Sources of pollution. Sources of pollution should not exist in the immediate surrounding area and as far as 2 miles upstream or upgradient from water points.

8-6. Reverse osmosis-based water purification system operations inspections

PVNTMED personnel will perform inspections to ensure the following conditions are met at RO-based WPS operations. (Note: PVNTMED personnel will also verify that appropriate permissions to discharge have been obtained and that any discharge permit requirements are met; see chap 11.)

a. Intake line.

(1) Intake strainer is attached to intake hose.

(2) Float and anchor hold the intake at least 8 in from the surface and bottom of the source.

b. Effluent line.

(1) Backwash water sump is present.

(2) Sludge sump is present (if necessary).

(3) RO-based WPS wastewater effluent discharges are at least 25 yd away (downstream, if the source is flowing) from the intake.

c. RO-based WPS.

(1) Ensure unit is level.

(2) Filter backwash tank is filled with brine.

(3) Separate storage tanks are used for raw and brine water if raw water storage is necessary.

d. Generator.

(1) The unit is adequately grounded.

(2) Fire extinguishers are present and charged.

(3) Personnel use hearing protection within 50-ft of the generator.

(4) Ventilation is adequate to prevent carbon monoxide intoxication (generally, outdoor operation of generators will provide sufficient ventilation).

e. Operators' protective equipment.

(1) Operators wear rubber hip boots, long rubber gloves, rubber aprons, and industrial safety eye protection meeting American National Standards Institute (ANSI) Z87.1 when working in water or with wastewater especially where diseases such as schistosomiasis and leptospirosis are endemic or prevalent.

(2) Operators wear MOPP gear beneath the water protective equipment specified in the preceding subparagraph when chemical agents are likely to be present or deployed.

8-7. Monitoring, storage, and distribution inspections

PVNTMED personnel will verify the adequacy of the following conditions and procedures during periodic visits to the water production and supply point and provide assistance to rectify any problems identified.

a. Water monitoring (operator)—

(1) The operators' WQAS–P (National Stock Number (NSN) 6630–01–343–8495) does not contain expired, damaged, or corroded chemicals.

(2) Water purification personnel conduct tests for pH, temperature, TDS, turbidity, and chlorine residual as often as necessary to ensure proper equipment performance, water potability prior to issue, and detection of significant changes in source water quality that could affect equipment operation. Tests for chemical agents in water should be performed as noted in table 5–2.

(3) Operators complete DA Form 1713–R (Daily Water Production Log – ROWPU), or its equivalent, with all appropriate operational information including the time, the knob settings, and the charges of citric acid, sodium hexametaphosphate, calcium hypochlorite, and polymer.

(4) The pH and chlorine residual of treated water be checked at least every hour and recorded on DA Form 1713–R or its equivalent.

(5) Water testing kit chemical agents (M272) (NSN 6665–01–134–0885) contain sufficient materials for 1 day of testing at MOPP 4.

b. Water storage—

(1) Storage tanks are level.

(2) Safety bottom aprons are placed under tanks.

(3) Open-top tanks are covered.

(4) Tanks are maintained in a sanitary condition.

(5) Water storage capacity is sufficient to support issue requirements.

c. Water distribution—

(1) Standpipe hoses are at least 4 ft above the ground to prevent contamination.

(2) Hose nozzles are clean and kept off the ground.

(3) Operators check water container interiors for cleanliness prior to filling them (see chap 10 for equipment cleaning and sanitizing guidance).

(4) Tankers, trailers, drums, cans, pumps, or other containers or equipment intended or previously used for storage or distribution of petroleum products or other materials not intended for human consumption are not used to store or distribute potable water under any circumstances.

8-8. Potable water containers

PVNTMED inspectors will ensure the following with regard to water containers:

a. The interiors and exteriors of containers are clean and in good repair.

b. The exterior of the containers are stenciled on both long sides with the words "POTABLE WATER ONLY."

c. Nonstandard containers used for storage and transportation of water will comply with requirements in paragraphs 8–8*a* and *b*. Additionally, they will have water contact surface materials that are nontoxic and preferably approved by the National Sanitation Foundation or an equivalent organization.

8-9. Water trailer inspections

The following list contains important points that must be checked each time a water trailer is inspected.

a. Manhole covers.

(1) Manhole covers are sealed effectively to prevent contamination of contents. Rubber gaskets are intact and do not have cracks, missing pieces, or excessive dry rot, and fit properly.

(2) The locking mechanism functions.

(3) The cover and interior are not rusted.

(4) The insulation is not damaged.

(5) The pressure relief valve operates effectively. To test the pressure relief valve, blow air into the bottom. The valve is operating effectively if air escapes through the holes in the top of the valve.

b. Dispensing spigots.

(1) All spigots function properly.

(2) The "T" handle opens and closes freely.

(3) The spigot protective box is intact and free of excessive rust.

(4) Locking devices for spigot protective boxes function properly.

c. Drain plugs.

(1) Drain plugs are installed hand-tight only.

(2) Drain plugs can be easily removed.

(3) Threads in plug and drain holes are not be stripped or damaged. Thread corrosion is removed at least semiannually.

d. Interior surfaces.

(1) Interior seams are free of rust and corrosion; seams are scrubbed with a nonmetallic brush using a nonabrasive, nonchlorinated cleanser, such as hand dishwashing detergent, and are thoroughly rinsed.

(2) Interiors are not painted or coated with any material.

(3) Cracks and dents that expose the polyurethane foam insulation are not permitted, and tanks in which such cracks are found are repaired. (Note: Fiberglass tanks are no longer authorized for use, and should be turned in to the installation Defense Reutilization and Marketing Office (DRMO).)

8-10. Tank truck inspections

a. Manhole covers. Inspection criteria are the same as those for 400-gal water trailers except that paragraph 8–9*a*(5) is not applicable.

b. Dispensing valves.

(1) Valves operate freely and close tightly.

(2) Threads for hose couplings are intact and undamaged.

(3) Dust caps are attached to dispensing valve ports whenever the valve is not in use.

c. Filling ports.

(1) Rubber gaskets are intact, fit properly, and free of dry rot.

(2) Mesh screens inside the port are intact and free of rust or corrosion.

d. Interior surfaces. Metal interiors will not be painted and will be free of rust and corrosion.

8-11. Fabric water tank and drum inspections

a. Exterior. If the container has been repaired, any patch or temporary plug is secure.

b. Valve assembly.

(1) The check-valve adapter is undamaged.

(2) The check valve opens easily.

(3) The dust cap is attached to the coupler whenever the coupler is not in use.

8-12. Water trailer location and dry distribution point inspections

a. Site conditions.

(1) Manholes and ports are closed.

(2) Soakage pits are constructed.

b. Water quality.

(1) Water is tested for chlorine residual prior to initial issue and periodically thereafter.

(2) At locations where purification operations do not occur, but water tanks or other bulk containers have been prepositioned for potable water resupply (sometimes called dry distribution points), potable water chlorine residuals are normally be maintained at 2 mg/L. Higher levels may be prescribed by the command/theater or unit surgeon.

(3) When unit water supplies have been replenished from a potable water distribution point, the required minimum chlorine residual at the point of consumption (such as in unit water trailers) is 1 mg/L. The unit or theater/command surgeon may prescribe a higher level.

(4) When units do not have access to RO-based WPS-treated water and must disinfect raw water from a surface water or ground-water source, a minimum residual FAC of 5 mg/L is required after a 30-min chlorine contact time. The theater/command or unit surgeon may prescribe a higher minimum level.

c. Documenting inspection results. All inspection results and water quality test data will be documented and reported according to the guidance in paragraph 8–3*b*.

8-13. Shower and decontamination point inspections

PVNTMED personnel will ensure the following when performing inspections of shower and decontamination points.

a. Site conditions.

(1) The site is located on firm, well-drained ground.

(2) Rodent and insect breeding areas are controlled to prevent the spread of disease.

(3) Separate latrines are provided for males and females. The numbers of latrines are based on the population served and the duration of use as prescribed in FM 8–250.

(4) Hand-washing devices are supplied with soap and water.

(5) Garbage and trash are properly stored and disposed of.

b. Water sources.

(1) Nonpotable water that must be used for sanitation is chlorinated to at least 1 mg/L chlorine residual or greater as prescribed by the theater/command or unit surgeon.

(2) Water purification personnel conduct tests for chemical agents and radioactivity weekly. The required frequency of tests is based on MOPP conditions as shown in table 5–2.

(3) Records are kept of where the water was procured or supplied from.

c. Wastewater control.

(1) Drainage ditches convey shower wastewater away from the area.

(2) Wastewater and runoff are discharged at least 25 yd downstream from the raw water intake.

(3) For decontamination stations, contaminated wastewater is drained to soakage pits or sumps away from the water source.

(4) Soakage pits and decontamination waste sumps are closed out and marked properly when the unit vacates the area.

d. Intake lines. These criteria are the same as those specified in paragraph 8–6*a*.

e. Shower units.

(1) Shower surfaces, nozzles, and floors are kept clean of dirt, soap scum, and mold.

(2) Air circulation is provided to reduce humidity and odors.

(3) If the shower water is not potable, a sign is posted at the shower entrance stating "NONPOTABLE WATER. DO NOT DRINK."

f. Generator.

(1) The generator is located at least 50 ft from the shower area and will be sandbagged to reduce noise hazards.

(2) Other criteria are the same as those specified in paragraph 8–6*d*.

g. Operator water monitoring.

(1) Operators monitor and record pH and chlorine residuals every hour. The chlorine residual is maintained at least 1 mg/L or higher as directed by the command/theater or unit surgeon.

(2) Operators also test raw and treated water using the Water Testing Kit, Chemical Agents (M272) at the frequency specified in table 5–2. The kit must contain sufficient analysis materials for 1 day of testing at MOPP 4.

(3) Shower water temperatures are monitored by operating personnel and should be maintained between 95 and 100 °F.

h. Water storage. These criteria are the same as those specified in paragraph 8–7*b*.

8-14. Recordkeeping and supply storage

a. Records. Water production personnel maintain records of equipment gauges and meters, chlorine residual and pH of treated water, chemical usage, amount of water issued, and the units that have been issued water. For shower points, a bath and clothing exchange log are used to report daily, weekly, and monthly activities. A suggested report format is discussed in FM 10–280.

b. Supply storage.

(1) Fuel and chemicals on hand are sufficient for the anticipated duration of operations or until resupply can be effected.

(2) Chemical containers are labeled properly, capped tightly, and kept dry.

(3) Activated carbon and calcium hypochlorite are stored separately to prevent mixing. Combining these chemicals will result in a violent reaction.

(4) Fuels, chemicals, and other supplies are stored at a location and in a manner to avoid contamination of the raw water supply in the event of an accidental or intentional spill, or release from hostile fire.

CHAPTER 9

WATER TREATMENT AND DISINFECTION

Section I
Water Treatment

9-1. General

a. The purpose of disinfection following treatment is to kill or inactivate pathogenic microorganisms that were not removed by the treatment processes and to provide a measurable disinfectant residual. The purpose of water treatment is twofold:

(1) To reduce the concentrations of health-related contaminants in the water to levels that will make the water potable.

(2) To improve its aesthetic characteristics to make it palatable.

b. The first two sections in this chapter briefly describe the treatment and disinfection capabilities currently available to deployed personnel.

c. The third section describes individual water disinfection procedures to use in emergency situations when a potable water supply is not available.

9-2. Overview

Water treatment consists of one or more processes that remove unwanted contaminants from drinking water. Typical field water treatment processes include straining, chemical addition, coagulation, sedimentation, and various kinds of filtration including multimedia filtration, cartridge filtration, microfiltration, ultrafiltration, RO, carbon adsorption, and ion exchange. In the field, these processes are contained in mobile packages that can be operated efficiently by one or a few personnel. Quartermaster water treatment specialists, MOS 92W, establish sites and set up and operate RO-based WPS water treatment systems, water storage facilities, and distribution systems. They also monitor these assets to ensure their security and continued proper operation.

9-3. Reverse osmosis-based water purification systems

a. General. RO-based WPSs are used in the Army to treat field water because they reliably and consistently produce potable water from virtually any water source. The Army's RO-based WPSs are multiprocess systems that will remove all waterborne infectious materials such as parasites, bacteria, and viruses. The RO membranes' removal/rejection capabilities for chemicals are more variable. In general, rejection of simple salts exceeds 98 percent or better, while rejection of small (low molecular weight) organic substances may be less than 50 percent. Some inorganic materials, such as weak acids (hydrogen cyanide, for example), may also be poorly removed. When there is a risk of contamination by highly toxic materials such as chemical warfare (CW) or nuclear agents, RO-based WPS product water is passed through activated carbon and ion exchange filters to ensure contaminant removal. This additional treatment is also effective against most TICs. A properly set up and operational RO-based WPS with these additional treatment units attached will produce safe drinking water from nearly any raw water source. No other individual pieces or combinations of field water treatment equipment will remove as wide a range of inorganic and organic contaminants as completely as the RO-based WPS. Regardless of the treatment unit to be used, it is always important to select the best available raw water source.

b. Available systems. Five different RO-based WPSs are available in the Army system. They produce drinking water at rates of 125 gallons per hour (gph), 600 gph, 1,500 gph, 3,000 gph, and 150,000 gallons per day (gpd).

(1) The 125-gph lightweight water purifier (LWP) is used to purify water for small military units and detachments, Special Operations Forces, and temporary medical facilities during a range of contingency operations. The LWP is transported in the bed of a high-mobility multipurpose wheeled vehicle (HMMWV) and provides a more mobile, further-forward deployed water production capability than other RO-based WPSs. The LWP incorporates many of the contamination barriers mentioned above with its ultrafiltration membrane-based pretreatment distinguishing it from other RO-based WPS process designs. Figure 9–1 illustrates the basic water treatment processes employed on the LWP.

(2) The 600-gph trailer-mounted reverse osmosis purification unit (ROWPU) incorporates many of the contaminant barriers mentioned above and is used by divisional and brigade water purification elements, and in some cases, by corps and echelons above corps (EAC) units, for the production of potable water from fresh, brackish, and saline water sources. Its functional equipment consists of various pumps and hoses, intake screens, chemical feeds, multimedia and cartridge filters, and a bank of RO membrane vessels. Figure 9–2 illustrates the basic water treatment processes of the 600-gph ROWPU. The 600-gph ROWPU is being replaced by the 1,500-gph tactical water purification system (TWPS).

(3) The 1,500-gph TWPS is contained within an International Organization for Standardization (ISO)-compatible flatrack and is transportable by the load handling system or palletized load system trucks. The 1500-gph TWPS is designated as an enhancement to the Stryker Brigade Combat Team and provides a means for producing a safe, reliable supply of potable water to support current and future forces. The water treatment processes employed by the TWPS are similar to those illustrated in figure 9–1 for the LWP with the exception that the ultrafiltration membrane is replaced by a microfiltration membrane-based pretreatment system.

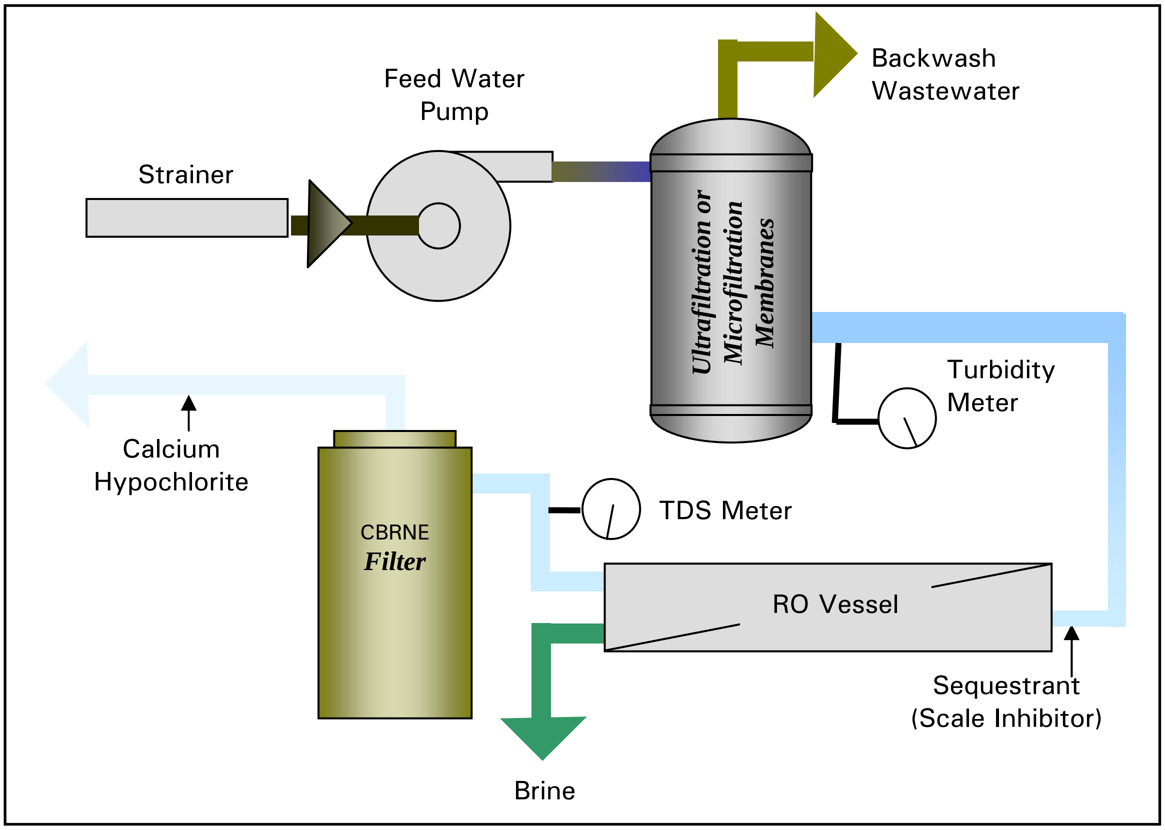

Figure 9–1. Lightweight water purifier or TWPS water flow diagram

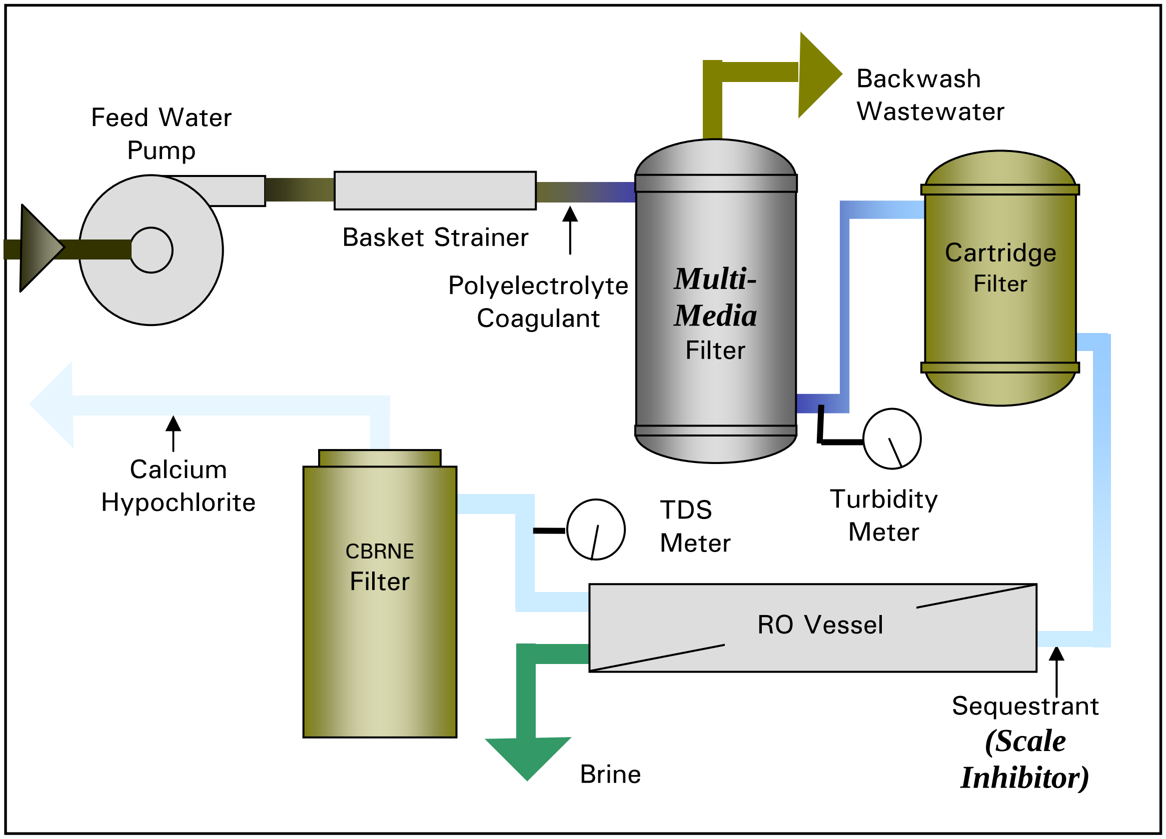

Figure 9–2. 600-gph ROWPU water flow diagram

(4) The 3,000-gph ROWPU is similar to the 600-gph ROWPU in terms of treatment processes but has a larger capacity. It is intended for use by nondivisional corps and EAC units for direct support (DS) and general support (GS) water production operations. It is contained in a special 8-ft by 8-ft by 20-ft ISO container with an overpack. The 3,000-gph ROWPU is mounted on a standard 30-ft military trailer and can be shipped aboard U.S. Air Force aircraft. Detailed descriptions of the equipment and operations of the 600-gph and 3,000-gph ROWPUs are available in USACHPPM TG 283 and FM 10–52–1.

(5) The 150,000-gpd ROWPU is intended for use by corps and EAC water purification units to support operations requiring GS water supply operations. The unit is designed to operate on seawater and is not specifically designed to reduce the presence of chemical or biological agents or radioactive byproducts. However, a 90 to 95 percent CBRNE agent reduction capability is inherent in its operation.

9-4. Emergency water treatment—individual devices

a. General. The performance, durability, and applicability of COTS individual water treatment devices have not been reviewed, tested, or endorsed by the Surgeon General or his representatives. Nevertheless, commanders have either accepted or purchased such medically unapproved COTS individual water treatment devices to support missions in which bottled water and bulk potable water supply have been limited, impractical, or impossible. Such individual water treatment devices vary in form, function, and efficiency, but the devices typically employ ceramic, paper, or glass-fiber filters, or semipermeable membranes to remove microorganisms and other contaminants from the feed water. Commanders who authorize the use of such medically unapproved devices must ensure that the water produced from them is still disinfected with iodine or chlorine disinfectants prior to consumption. Such disinfection is discussed in the following section.

b. *Current guidance.* Use only medically approved COTS individual water treatment devices. The use of medically unapproved devices is entirely at the risk of the commander who chooses to do so. Information about and assistance in selecting individual water treatment devices are available through USACHPPM (see table 1–1).

Section II
Disinfection

9-5. General

If the water contains a measurable concentration of residual disinfectant until the water is consumed, that residual is an indicator that neither regrowth nor subsequent contamination has occurred. It also provides some minimal amount of protection in case contamination does occur. The Army's RO-based WPSs will remove all waterborne infectious microorganisms such as protozoa, parasites, bacteria, and viruses, including biological weapons (BW) agents, provided the RO system is in good condition, and the units are operated properly. Because the membranes can develop holes with age, and because sometimes the seals may leak, drinking water produced by RO-based WPSs is always disinfected prior to distribution. Disinfection prior to distribution also prevents microbial growth on the walls of pipes and tanks in the distribution system. Disinfection provides an excellent barrier to microorganisms that may be present in water and is a necessary step in reducing the risk of illness from drinking both treated and untreated water. If circumstances dictate that untreated water or water of unknown quality must be consumed, disinfecting that water using proper field methods will inactivate any pathogenic microorganisms in the water, and appreciably reduce the risk of acute illness, thus conserving individual and unit fighting strength. The Army requires all field drinking water to be disinfected before PVNTMED personnel will certify that it is potable. Options for adequately disinfecting field drinking water are discussed in the following paragraphs.

9-6. Disinfectants and disinfection procedures

a. Field water disinfectants. The water disinfectants available in the field are typically chemicals that are added to water and allowed to remain in contact with the microorganisms in the water for a specified period of time (usually 30 min). Chemicals issued to Army units and individuals for disinfection include calcium hypochlorite, Chlor-Floc, and iodine (in tablet form). COTS disinfection devices that generate chlorine and other proprietary chemical oxidants from salt, water, and an electric current are available and may eventually be approved for issue to individuals for emergency drinking water disinfection. Many other disinfectants might be encountered in the field including chlorine gas, sodium hypochlorite (bleach), chlorine dioxide, bromine, ozone, and UV radiation. Upper echelon PVNTMED support should be sought to determine the adequacy of disinfectants other than chlorine. Chlorine is discussed in the following paragraphs.

b. Chlorine disinfection.

(1) Chlorine is the disinfectant normally specified for military use. Currently, it is the only widely accepted chemical that destroys organisms in water and leaves an easily detectable residual. No other disinfectant has been shown to be as acceptable or adaptable for field potable water treatment operations. A low-level or nonexistent chlorine residual in drinking water may be the result of inadequate disinfection procedures, subsequent contamination, or both. The sudden disappearance of normal chlorine residuals in a water system or storage container may indicate that contamination has occurred.

(2) The most important variables in the effectiveness of chlorine disinfection of drinking water are the chlorine dose, demand, residual concentration, and contact time after the demand has been exceeded. The chlorine dose is the amount of chlorine added per unit volume of water, and is usually expressed in parts per million (ppm) or its equivalent, mg/L. The chlorine demand is the amount of chlorine per liter of water that reacts with inorganic and organic matter, including microorganisms, and is no longer available for disinfection. After the demand is completely satisfied, any remaining chlorine will be free chlorine that is available to be measured as a residual. The residual chlorine will react with any contaminants that subsequently get into the water as well as prevent regrowth of inactivated bacteria in any storage and distribution system that may be in use.

(3) Raw water contaminant characteristics that should not pass through the RO-based WPS, but if they did would affect the effectiveness of the chlorine disinfection process include:

(a) The type and density of organisms present (viruses, bacteria, protozoa, helminthes, or others) and their resistance to chlorine. Vegetative bacteria and viruses are the most susceptible to chlorine disinfection, whereas the cysts or oocysts of the protozoa *Entamoeba histolytica*, *Giardia lamblia*, and *Cryptosporidium parvum* are the most resistant.

(b) The concentration of chemical compounds containing oxidizable substances, ammonia, or organic matter that exert a chlorine demand.

(c) The suspended solids concentration. In addition to exerting their own chlorine demand, suspended solids can surround microorganisms and protect them from the chlorine.

(4) The effectiveness of chlorine disinfection can also be influenced by variables that are affected little, if at all, by the RO-based WPS treatment. They include—

(a) Mixing. Adequate mixing of the chlorine into the water to ensure direct contact with the target microorganisms. The chlorine must be well dispersed and thoroughly mixed to ensure that all of the disease-producing organisms come in contact with the chlorine for the required contact time.

(b) Contact time. It takes time for the chlorine to react with and inactivate the pathogenic microorganisms. The lower the residual chlorine concentration, the longer the time that is necessary to achieve complete disinfection. An increase in contact time provides better disinfection.

(c) Water pH. As the pH of the water increases from 5 to 9, the form of the FAC residual changes from hypochlorous acid (HOCl), the most effective form, to the hypochlorite ion, which is less effective. The most effective disinfection occurs when the pH is between 5.5 and 6.5. The typical pH of RO-based WPS-treated water is around 5.5, the most effective pH for chlorine disinfection.

(d) Water temperature. At lower temperatures, microorganism inactivation tends to be slower. To obtain the same level of disinfection at low temperatures as at higher temperatures, higher chlorine residuals or longer contact times are required.

9-7. Chlorine residual requirements

a. Point of production. Current field drinking water chlorine residual doctrine is presented below.

(1) *RO-based WPS-treated water.* RO-based WPS operator personnel are to add sufficient chlorine to RO-based WPS-treated water at the production site to provide a 2.0-mg/L FAC residual after a 30-min contact time. Appendix I contains information describing how to achieve the desired FAC residuals in various size containers.

(2) *Water treated by other methods.* For water that is treated by any method other than an RO-based WPS, the operators are to add sufficient chlorine at the production site to provide a 5.0 mg/L FAC residual after a 30-min contact time.

b. Issue points. Water purification personnel will adjust the chlorine level at potable water issue points along the TWDS, in storage systems (800K, 300K, and 40K gal), and during bulk transport (tank racks and 3K and 5K semitrailer-mounted fabric tanks (SMFT)) so that FAC residuals remain at least 1.0 mg/L. Maintaining 1.0 mg/L FAC residual in the distribution system may require adjusting chlorine levels at the production site higher than 2.0 mg/L after a 30-min contact time. If chlorine residuals at the completion of bulk water transport have trace levels of chlorine which are less than 1.0 mg/L FAC, the water must be rechlorinated to 2.0 mg/L FAC. After being rechlorinated, the water may be immediately issued. If chlorine residuals fall to 0.0 mg/L FAC during transport, the water must be rechlorinated to 2.0 mg/L and held for 30 min prior to issue.

c. Individual and unit level. Regardless of the treatment method, a minimum of 1.0 mg/L FAC residual must be maintained in unit level distribution containers (400-gal water trailers, 900-gal unit water pod systems (Camels), and lightweight collapsible pillow tanks). The intent of this requirement is to provide water that is both potable and palatable. FSTs and organic PVNTMED personnel will monitor unit water supply chlorine residuals to ensure and maintain potability. There is no requirement to measure the chlorine residual in individual canteens or personal hydration systems.

d. Chlorine-resistant organisms. Disease-producing organisms such as *Entamoeba histolytica, Giardia lamblia*, and *Cryptosporidium parvum* are resistant to normal chlorine residuals. The RO-based WPS removes these organisms completely when it is operating properly; however, as a precaution, in areas where they are prevalent, theater/command and unit surgeons may specify higher than normal residuals, longer contact times, and increased frequency of chlorine residual measurements.

9-8. Chlorine residual measurement frequencies

a. RO-based WPS operators or PVNTMED personnel will measure chlorine residuals at the following frequencies depending on the location and function of the water supply.

(1) Water purification points: at least every hour of operation.

(2) Bulk water distribution points: prior to bulk loading for transport.

b. FSTs will measure chlorine residuals in their unit water trailers (or other unit bulk water storage devices) at least twice daily.

c. Field food service personnel will measure chlorine residuals in their water supply prior to starting food preparation for each meal.

Section III
Individual/Emergency Disinfectants

9-9. General

Even in emergency situations, personnel should only consume water that has been disinfected. If a treated and disinfected water supply is not available, personnel must individually treat and/or disinfect water before they drink it. Individuals should start with the clearest, cleanest, least odorous water they can readily find and treat and/or disinfect the water using personal water purification procedures.

a. Calcium hypochlorite. Calcium hypochlorite is a white granular or powdered chemical. When fresh, it typically contains 68 to 70 percent by weight available chlorine. It is commonly referred to as high test hypochlorite (HTH) and is frequently used as a disinfectant in swimming pools. Calcium hypochlorite may be obtained through Army supply channels in 6-ounce (oz) bottles (NSN 6810–00–255–0471). The volumes of calcium hypochlorite that will provide specific mg/L doses when dissolved in different volumes of water are presented in appendix I. The procedures for disinfecting water in a canteen using calcium hypochlorite ampules are described in FM 21–10. After filling a canteen, or personal hydration system, or other container with the cleanest water available, add the appropriate amount of calcium hypochlorite or calcium hypochlorite solution. Close the container and shake it vigorously for a few seconds. Slightly loosen the closure and tip the container to allow leakage around closure. Tighten the closure again and wait 30 min before drinking the water.

b. Chlor-Floc.

(1) Chlor-Floc is an emergency disinfectant mixed with a settling aid that helps remove dirt and other suspended particles from water by flocculation and sedimentation. If it is available, it should be used when the water to be treated is cloudy or discolored and the operational situation is such that the treatment bag can remain motionless for the required settling period and can then be filtered. The Chlor-Floc treatment system (NSN 6850–01–374–9921) includes 3 packages of 10 tablets each (NSN 6850–01–352–6129), a treatment bag (NSN 6850–01–374–9923), and a cloth filter (NSN 6850–01–374–9922). Each tablet adds 8 mg/L of chlorine to 1 qt of water.

(2) Use Chlor-Floc with the provided water treatment bags as follows:

(a) Add 1 qt of water to the water treatment bag (provided in the kit). The bag will be about half full. A different clean container can be used if the water treatment bag is not available.

(b) Add one Chlor-Floc tablet to the water in the bag.

(c) Fold the bag tightly three times and fold the tabs in.

(d) Shake the bag for about 1 min or until the tablet dissolves completely.

(e) Swirl the water in the bag for 10 seconds.

(f) Let the bag sit for 4 min.

(g) Swirl the water in the bag for an additional 10 seconds.

(h) Let the bag sit for an additional 15 min.

(i) Being careful not to disturb the settled material, pour the clear water above the settled material through the cloth filter (provided in the kit) into a clean canteen or other container. Avoid pouring settled material into the filter. Do not drink the water from the treatment bag without filtering it. If the correct filter cloth is unavailable, a clean cotton t-shirt can be used.

(j) Rinse the filter and treatment bag with treated water so they can be reused. Always filter the water through the same side of the cloth.

(3) Use Chlor-Floc with reservoirs in the following manner:

(a) Personal hydration systems require two Chlor-Floc tablets for 70- and 72-oz reservoirs and three tablets for 100- and 102-oz reservoirs.

(b) Use a separate clean container and fill it with the amount of water desired to treat.

(c) Add the recommended number of tablets to the water (one per quart/32 oz) and stir to dissolve the tablets completely (at least 1 min).

(d) Wait 4 min.

(e) Stir for 10 more seconds.

(f) Wait 15 min.

(g) Pour the water through the cloth filter provided with the kit into the reservoir of the personal hydration system. Always filter through the same side of the cloth.

Chlor-Floc should not be used in the reservoir itself, skipping the filtration step, because of the location of the drinking tube at the bottom of the reservoir. This is where all the flocculent will settle which greatly affects the quality of the water drawn into the straw during consumption.

c. Iodine tablets. Iodine water purification tablets (NSN 6850–00–985–7166) are intended to disinfect water contained in small containers such as canteens or water jugs. The tablets are composed of an iodine compound and are available through the Army supply system in bottles of

50 tablets. The tablets are subject to deterioration in storage. They must be inspected for signs of physical change before they are used; otherwise, they may not disinfect the water. Iodine tablets that are completely yellow or brown, that stick together, or crumble easily are no longer effective and must not be used. Iodine tablets in good condition will be steel gray. The procedures for disinfecting small quantities of water with these tablets are as follows:

(1) *Canteens*.

(a) Fill the canteen with the cleanest, clearest water available.

(b) Add two iodine tablets to each 1-qt canteen full of water, or four tablets to 2-qt canteens. Tincture of iodine, 2 percent, may be used in place of the tablets. Five drops of the liquid are equivalent to one iodine tablet.

(c) Put the cap on canteen. Shake the canteen to dissolve tablets.

(d) Wait 5 min. Loosen the cap and tip the canteen over to allow leakage around the canteen threads.

(e) Tighten the cap and wait an additional 25 min before drinking.

(2) *5-gal containers.*

(a) Fill a 5-gal container with the cleanest, clearest water available.

(b) Dissolve 40 iodine tablets in a canteen cup full of water to disinfect any type of water. Add this solution to the 5-gal container of water and agitate the solution.

(c) Place the cap on the container loosely. Wait 5 min and then agitate the container vigorously to allow leakage to rinse the threads around the neck of the can.

(d) Tighten the cap and wait an additional 25 min before using the water for any purpose.

(3) *Personal hydration systems.*

(a) Use four iodine tablets for 70- or 72-oz water reservoirs and six for 100- or 102-oz reservoirs.

(b) Allow 30 min of contact time before consuming the water.

(c) If the water to be treated is cloudy or discolored, either double the dosage or use Chlor-Floc in a separate container.

d. Chlorine bleach.

(1) In emergency situations, when calcium hypochlorite is not available for disinfection of bulk supplies, standard chlorine bleach (unscented sodium hypochlorite) can be used in its place. Bleach is normally a 5 percent or 50,000 mg/L chlorine solution. Add two drops of bleach per quart of water to be disinfected and let it stand for 30 min before drinking. If a dropper is not available, wet a cloth or stick with bleach and allow it to drip into the water.

(2) For a 70-oz reservoir, use four drops from a standard 10-milliliter (mL) dropper or six drops for the 100-oz reservoir. Mix the added bleach in the reservoir water and let it stand 30 min before drinking it.

(3) See appendix I for the amounts of bleach needed to disinfect larger volumes of water. Always allow at least 30 min for contact time.

e. Boiling. Boiling is an expedient means of disinfecting small quantities of water when no other means is available. To be effective in killing most disease-producing organisms, the water must be held at a rolling boil for 5 min at sea level. At sea level, water boils at 212 ˚F or 100 ˚C. However, the boiling temperature decreases by about 1 ˚F for every 500-ft increase in elevation and 1.1 ˚C per 1,000-ft increase. To achieve the same microbiological kill at higher elevations, the water must be boiled for longer periods. Hence, the command surgeon may prescribe longer boiling times at higher altitudes and in areas where certain heat-resistant organisms are prevalent. Boiled water must be kept in a covered, uncontaminated container since boiling does not impart any residual disinfectant. Where *Cryptosporidium parvum* is suspected to be present in untreated water, boiling is the recommended emergency water treatment method because of the relative ineffectiveness of chlorine and iodine against that organism.

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CHAPTER 10

DISTRIBUTION AND STORAGE EQUIPMENT OPERATION AND MAINTENANCE

10-1. Storage and distribution

After water is produced and certified potable by PVNTMED personnel, it may be consumed immediately. In many situations, the water will be stored and distributed locally or transported to storage and distribution operations as close to operating elements as possible. There are several storage and distribution items/systems in the inventory to assist in execution of these requirements.

a. 3,000-gal onion tank. The 3,000-gal onion tank is a highly mobile, easily transportable, manually inflatable/collapsible fabric water tank. Packaged, the tank is 23 x 28 x 42 in and weighs 130 pounds (lb). Filled with water, the tank is 56 in x 148 in x 94 in and weighs 25,020 lb. More information on the 3,000-gal tank is available in TM 5–5430–213–13&P.

b. Potable water storage and distribution system (PWS/DS). The PWS/DS is the primary means for the receipt and storage of bulk drinking water and for issue to combat forces under tactical conditions. The PWS/DS is intended for use in arid environments by both direct and general support water units. The total capacity of each PWS/DS is dependent on the number and size of fabric tanks assigned and used. Each PWS/DS can distribute water to and receive it from hose lines and tank trucks. The PWS/DS can deliver water to tank trucks, water trailers, forward area water point supply systems (FAWPSS), or small unit containers such as 5-gal cans. The systems operate on a modular concept; that is, any combination of storage tanks may be used collectively or individually, as connected tanks can be valved off at either their input or output valves. More information on the PWS/DS is available in TM 10–4610–237–12 and TM 10–4610–242–13.

c. FAWPSS. The FAWPSS is a portable, self-contained, gas- or diesel-operated unit that dispenses potable drinking water to troop units. The FAWPSS employs a 125-gal/min centrifugal pump to distribute water from combinations of 500-gal water storage and dispensing drums attached two at a time. Quick-disconnect couplings connect the drums to the pump. The drums provide water to the pump, which pumps water through hoses and valves to four distribution nozzles. More information on the FAWPSS is available in TM 10–4320–346–12&P.

d. SMFT. SMFTs are used to transport only drinking water. The assembled unit consists of a collapsible tank with a pressure gauge, end fittings, tie down straps, emergency repair items, hoses, and tools. These large rubberized tanks can be mounted on the bed of an empty flatbed trailer, filled with water, and driven by truck from origin to destination. Because the fabric tank must be emptied completely at its destination and is unstable with partial loads of potable water, the SMFT is truly an "all or nothing proposition." The flatbed trailer that hauls the SMFT also lacks off-road mobility and, therefore, cannot deliver water far forward. The SMFT has no pumps. The 3,000-gal SMFTs are used by direct support water supply units to deliver water to major users that have no organic transportation capable of retrieving needed water supplies directly from the water points. The 5,000-gal SMFTs are used by medium truck companies for line haul of potable water as well as some local haul to users that have no organic transportation capability. More information on the 3,000- and 5,000-gal SMFTs is available in TM 5–5430–213–13&P and TM 5–5430–212–13&P, respectively.

e. TWDS. The TWDS is a highly mobile water distribution system. It consists of pumping stations, 6-in diameter fabric pipes, storage assemblies, and distribution points. It is designed to distribute water for distances up to 10 miles on level terrain. More information on the TWDS is available in TM 10–4320–317–13.

f. Water distribution and waste management system (WDWMS). The WDWMS is composed of three modules: the water distribution set, hospital, Deployable Medical System (DEPMEDS); the wastewater management set, hospital, DEPMEDS; and the wastewater augmentation set, hospital, DEPMEDS. The WDWMS is the primary means for the receipt and storage of bulk potable water and for wastewater management for the DEPMEDS hospital under tactical conditions. The total capacity of each WDWMS is dependent on the size of fabric tanks assigned and used (usually between 18,000 and 20,000 gal).

g. 400-gal water trailer. The Army employs the M149A2 and M1112 water trailers to distribute drinking water to field units. The M149A2 water trailer with a stainless steel tank replaced the M149 and M149A1 fiberglass tank water trailers. The M1112 is a newer eight-wheeled water trailer with a cylindrical stainless steel tank and a wider footprint which makes it more stable during movement. More information on the M149A2 and M1112 water trailers is available in TM 9–2330–267–14&P and TM 9–2330–397–14&P, respectively. PVNTMED concerns with these trailers are presented in USACHPPM IP 31–035.

h. 5-gal water can. Five-gal cans, NSN 7240–00–089–3827, are part of the unit water storage and distribution capabilities. Replacement lids are available as NSN 7240–00–089–7312.

i. Individual water storage equipment. Individually carried water storage devices include 1- and 2-qt canteens and personal hydration systems. Most personal hydration systems hold 45 to 100 oz of water. More information on personal hydration systems is available in USACHPPM IP 31–037.

j. Load handling system water tank rack (Hippo). The Hippo is compatible with the Army's load handling system and consists of a 2,000-gal, hard-walled water tank rack with an integrated water pump. The Hippo will function fully whether mounted on or dismounted from its prime mover and will be mobile whether filled, partially filled or empty. The Hippo performs retail and bulk water distribution. The current equipment for bulk distribution, the SMFT, cannot distribute potable water at the unit level and has limited tactical mobility. Because of these shortcomings, the SMFT cannot support emerging operational concepts. The Hippo meets the Army's critical need for a mobile, flexible, hardwall water distribution system for current and future forces.

k. Camel. The Camel will replace the current M149A2 and M1112 water trailers at the unit level. The Camel has a 900-gal capacity, an integrated heater/chiller, and filling stands for individual soldiers, all on a dual axle trailer platform. The water chiller on the Camel will significantly improve unit water palatability in arid environments. The Camel will increase units' water storage capacities and increase water trailer mobility. The Camel initiatives will improve water delivery to the individual soldier.

10-2. Equipment cleaning, sanitizing, and decontamination

All equipment associated with the purification, storage, and distribution of potable water will be cleaned, sanitized, and inspected by the owning unit and its FST at least quarterly. During noncombat operations, when working in containers large enough to accommodate a person, workers will adhere to standards for working in confined spaces set by the National Institute for Occupational Safety and Health (NIOSH). These standards are presented in NIOSH Publication No. 80–106.

a. Personal hydration systems.

(1) *Manufacturers' recommendations*. Under ideal conditions, manufacturers suggest the following basic steps for cleaning personal hydration systems:

(a) Remove the reservoir (water bladder) from the cloth pack.

(b) Clean the reservoir with mild soap and hot water by scrubbing the inside with a bottlebrush.

(c) Air dry the reservoir leaving the top opened.

(d) To remove odors, fill the reservoir with water and add 2 teaspoons (tsp) of baking soda. Let it sit overnight. Rinse thoroughly and air dry.

(e) Sanitize the reservoir with water and 2 tsp of liquid bleach. Let it sit for 30 min. Rinse thoroughly and air dry. Run the water/bleach cleaning solution through the tube and scrub it with a long pipe cleaner, a flexible wire covered with cloth, or one of the specially made brushes. Be careful not to puncture the tube.

(f) Machine wash the cloth pack in cold water with a mild detergent, and let it air dry. You may also hand wash the pack in a field environment.

(g) Dry the pack thoroughly and completely before storing. This is the safest way to store the pack.

(2) *Reservoir bite valve maintenance*. A primary source of potential contamination is the delivery tube bite valve. To properly clean the valve, first pull the valve off of the tube end. Alternatively, if you just want to clean debris out of the diaphragm core, the valve body may be left on the tube's end. Second, grasp the rib at the valve's face and roll it backwards. This exposes the core piece with the slit opening. Third, pull the core off of the ribbed post. Then clean the valve parts with a cotton swab or toothbrush and some soapy water. Finish by rinsing all parts thoroughly and repositioning the valve core on the center post of the valve body. Then roll the outer sleeve forward again to complete the job.

b. 5-gal water can. The general cleaning procedures for a 5-gal water can are:

(1) Add 1 gal of the soap solution. Shake the can vigorously for 1 min and then drain the solution out of it. Drain some of the solution through the spigot to clean it.

(2) Rinse the can at least twice with warm water to remove the soap solution. Ensure to rinse clean water through the spigot.

(3) Sanitize the can prior to filling it with drinking water.

c. Water storage containers larger than 5 gal.

(1) *General information.* Prior to general cleaning, rust and mineral deposits should be removed from metal tanks.

(a) Rust. DO NOT use a mechanical grinder or sanding device to remove rust. These devices will degrade the surface of the tank and cause more rust. To remove the rust in a stainless steel tank, clean the rusted areas with water and scouring powder (NSN 7930–01–423–1147) and a nonmetallic, nylon brush (NSN 7920–00–061–0038). Be sure to flush the tank thoroughly with clean water.

(b) Mineral deposits. Mineral deposits on the bottom of the tank can be removed by putting 8 gal of vinegar (NSN 8950–01–079–3978) in the tank, leaving it for 5 to 6 hours, and then emptying and flushing the tank with clean water.

(2) *General cleaning procedures.*

(a) Clean the outside of the water container with water and a stiff brush (soap is recommended, but is optional).

Note: For the 400-gal water trailer, remove the drain plug located beneath the rear portion of the water trailer, and elevate the front of the trailer so the water will flow toward the drain.

(b) Prepare a soap solution by adding 1/3 cup of liquid detergent to 10 gal of hot water.

(c) Thoroughly wash the inside surfaces of the water container with the soap solution and a long handle scrub brush such as the one identified by the NSN 7920–00–061–0038.

(d) Clean the valves and spigots by flushing the soap solution through them. Drain the container by removing the drain plug.

(e) Rinse the container and spigots twice with water (preferably warm water) to completely remove the soap solution.

(f) Sanitize the container prior to filling it with drinking water.

(3) *Sanitizing method 1.* Use this method if both water and the required chemicals are plentiful.

(a) Fill the container full of water with about a 100-mg/L chlorine concentration.

(b) Mix or slosh the solution around so it contacts all the surfaces.

(c) Run some of the solution through the valves and spigots.

(d) Keep all interior surfaces wet with the solution for at least 60 min.

(e) Drain the disinfecting solution into a sanitary sewer or other approved location (not into a lake, stream, or storm drain).

(f) Rinse the container and spigots twice with potable water.

(4) *Sanitizing method 2.* Use this method if either water or the required chemicals are in short supply.

(a) Prepare 5 gal of water with a 100-mg/L chlorine concentration (see table 10–1).

(b) Using a long-handled brush, stick, or rod with a cloth secured to the end (or some other method), swab the interior walls of the tank every 10 min or as often as necessary to keep the walls wet with the solution.

(c) Run some of the solution through the valves and spigots.

(d) Drain the accumulated solution from the container into a sanitary sewer or other approved location (not into a lake, stream, or storm drain).

(e) Rinse the container and spigots twice with potable water.

(5) *Storage*. Upon completion of method 1 or method 2, if the water container is not going to be used for more than 30 days, open the faucets, valve, drain plug, and manhole cover, and allow the tank to air dry. After it is dry, close it up and repeat the cleaning and disinfection procedures prior to using it.

d. Options for making 100 mg/L chlorine water solutions. The mixtures presented in tables 10–1 and 10–2 will result in a concentration in the water of approximately a 100 mg/L chlorine. Table 10–3 presents information for ordering equipment cleaning and sanitizing supplies. Appendix I presents more detailed information on preparing chlorine solutions.

Table 10–1
Requirements to make 5 gal of water with an FAC of approximately 100 mg/L (assuming no chlorine demand)

Measurement	Bleach (5 percent)	Dry HTH (70 percent)	HTH Solution (~2.3 percent)
dp	568	n/a	1243
mL	38	1.2	82.8
tsp	8.0	1/4	17
tbls	2.5	0.08	5.6

Table 10–2
Requirements to make 400 gal of water with an FAC of approximately 100 mg/L (assuming no chlorine demand)

Measurement	Bleach (5 percent)	Dry HTH (70 percent)	HTH solution (~2.3 percent)
mL	n/a	92	n/a
tsp	n/a	19	n/a
tbls	n/a	6 (6.2)[1]	n/a
oz	102	3 (3.1)	224
cp	13	0.40	28
pt	6.5	0.20	14
qt	3 (3.2)	0.10	7
L	3	0.10	6.5 (6.6)
gal	0.8	n/a	1.75

Note:
[1]More accurate values are shown in parentheses.

Table 10–3
Nomenclature for ordering equipment cleaning and sanitizing supplies

NSN	Item description
7920–00–061–0038	Brush, scrub, plastic Item used to scrub the interior surfaces of water purification, storage, and distribution equipment.
7920–00–753–5242	Pad, scouring, type II, 6 in x 9.5 in x 1/4 in
7930–00–205–0442	Scouring powder, 14-oz can Item used to clean steel and aluminum surfaces of water purification, storage, and distribution equipment.
7930–00–899–9534	Dishwashing compound, 5-gal bottle Item used to prepare a soap solution for cleaning equipment.
6810–00–242–4770	Calcium hypochlorite, technical, 3.75-lb bottle
6810–00–255–0471	Calcium hypochlorite, technical, 6-oz bottle
6810–00–255–0472	Calcium hypochlorite, technical, 100-lb drum
6810–00–598–7316	Sodium hypochlorite, 5-gal bottle

10-3. Chemical, biological, radiological, nuclear, and explosives decontamination of equipment

a. General.

(1) *Organized decontamination.* The CBRNE defense company or detachment (Army, Navy) or the Equipment Decontamination Team (Air Force) performs large-scale CBRNE decontamination operations.

(2) *Unit decontamination.* The unit CBRNE officer or NCO will supervise unit decontamination.

b. Field expedient decontamination. Water purification and supply personnel and unit FSTs regularly work with calcium hypochlorite which is an effective chemical and biological agent decontaminant. They can use this chemical to decontaminate equipment surfaces by following the procedures described below.

(1) *Preparation.*

(a) Construct a soakage pit or sump into which the decontamination waste and rinse water can be discharged. Seepage pits should be located at least 100 ft from an existing water source such as a stream, lake, or well. Greater distances may be required if hydrogeological conditions include highly fractured rock. The dimensions will vary greatly due to soil type and water table elevation. For a silt and loam soil, a 1,000-gal volume of wastewater requires the construction of a 7-ft x 7-ft x 7-ft seepage pit backfilled with gravel. A 5-ft x 5-ft x 5-ft pit backfilled with gravel will adequately handle up to 400 gal. Seepage pits are described in FM 21–10.

(b) Determine the surface area of the equipment to be disinfected. See table 10–4 for the surface areas of selected equipment.

(c) Determine the amount of decontamination solution required. One gal (3.8 L) of decontamination solution should cover 8 square yd (7 square meters). One square yd equals 9 square ft.

Table 10–4. Surface areas of selected equipment

Equipment	Area (square ft)
400-gal water trailer	90
FAWPSS:	
Pump	16
500-gal drum	63
Distribution components	48
TWPS	1280
LWP	40
Camel	200
Hippo	1024

(d) Wear a rubber apron and rubber gloves over MOPP gear, and prepare a 5 percent (50,000 mg/L) solution of chlorine using table 10–5 (household bleach may be used for this application).

(2) *Decontamination procedures.*

(a) Apply the solution to the exterior of the equipment or container using brushes or brooms. The decontamination solution must remain in contact with the surface for at least 30 min and may have to be reapplied occasionally to keep the surface wet.

(b) Thoroughly wash the surface with potable water.

Table 10–5
Volume of dry HTH required to make a 5 percent (50,000 mg/L) bleach solution in different volumes of water, and the area each volume will decontaminate

Amount of dry calcium hypochlorite	Gallons of water	Square yards [1] covered	Square meters covered
½ cup (.499) [2]	1	8	7
2 ½ cups (2.43)	5	40	35
5 cups (4.86)	10	80	70
7 1/3 cups (7.30)	15	120	105
3 quarts (3.04)	25	200	175
6 quarts (6.08)	50	400	350
2 gal, 1 1/5 quarts (2.28)	75	600	525
3 gal (3.03)	100	800	700
4 ½ gal (4.55)	150	1200	1050
6 gal (6.08)	200	1600	1400
7 gal, 2 ½ quarts (7.599)	250	2000	1750

Notes:
[1] 1 square yd = 9 square ft.
[2] More accurate values are shown in parentheses.

CHAPTER 11

MANAGEMENT OF WASTE FROM FIELD WATER OPERATIONS

11-1. General

a. Role of PVNTMED. The responsibility for legally and appropriately managing the wastes from field water treatment, storage, and distribution systems lies with the quartermaster unit that operates the systems according to the policy stated in FM 3–34.471. Army policy directs that wastewater and waterborne wastes be collected and disposed of in a manner that protects water resources and preserves public health. These procedures must have a minimal impact on unit readiness. The Army is required to comply with Federal, state, and local environmental pollution and wastewater laws on U.S. territory. While in other countries, units may have to comply with the host nation's laws and procedures as determined by the theater commander. In a true contingency operation, the theater commander determines if local environmental laws apply in the AO. Regardless of laws and regulations, proper wastewater disposal is essential to protect the health of the force. Proper disposal prevents the contamination of water supplies and development of rodent and insect breeding sites. Large volumes of wastewater may impact on unit operations and help the enemy locate and identify the unit. PVNTMED personnel should be familiar with the waste streams generated by RO-based WPS operations and be available to consult with and provide recommendations to operator personnel on management options for those waste streams. Detailed information on the management of waste streams resulting from RO-based WPS operations is available in USACHPPM IP 32–024 and through the USACHPPM WSMP (see table 1–1).

b. Environmental considerations. When operating in a field or garrison environment, commanders must comply with EPA, state, local, or host nation standards. Commanders with field water purification units participating in field training exercises or contingency operations in the U.S. or its possessions will coordinate with the appropriate director of public works (DPW) environmental office to determine how to legally dispose of wastewater and other treatment wastes. Outside the U.S., commanders will meet wastewater disposal requirements by coordinating with the appropriate Installation Management Agency, Area Support Group and/or base support battalion, or local command engineer.

c. Procedures.

(1) *Regulated discharges.* In cases where a discharge permit has been secured, the commander of the quartermaster unit responsible for water supply will comply with the permit to prevent contamination of the receiving water body. In cases where a permit has been denied, the quartermaster unit’s designated representative will contact the installation environmental officer to determine if wastewater could be discharged into a sanitary sewer system, or held in a tank at the point of production, pumped into a truck, and transported to the wastewater treatment plant. Such action will also involve coordination with the chief of the wastewater treatment plant.

(2) *Unregulated discharges.* If a discharge permit is not required, the water purification section chief will take precautions to avoid contaminating any receiving body of water. Wastewater should be discharged according to paragraph 11–2.

11-2. Disposal of wastewater

a. Regulatory information.

(1) In the United States, the EPA (or a State with an EPA-approved program) establishes rules and regulations for wastewater discharges under the National Pollutant Discharge Elimination System (NPDES) established under the Clean Water Act. Dischargers, with close coordination, support, and representation by the installation's DPW environmental office, must apply for and obtain a site-specific NPDES permit (or State equivalent) or general NPDES permit. These permits set limits for discharges. Water purification operations must meet these limits.

(2) Foreign countries have their own rules and regulations on disposal of wastes as well as ambient water quality criteria. Usually, the host nation Final Governing Standards (FGS) and the host nation standards contain these requirements. If FGS have not been developed, then the DOD OEBGD should be consulted. Planners must always consult and coordinate with the appropriate DPW environmental office or equivalent organization prior to operations to determine the requirements for discharges.

b. Wastewater generation.

(1) RO-based WPS operations produce three separate waste streams that must be managed. They include the brine, the filter backwash, and wastewater from cleaning ultrafiltration membranes, microfiltration membranes, or reverse osmosis membranes (ROMs). The newer 1,500-gph TWPS and the LWP do not use multimedia filters but generate a backwash wastewater stream which is more dilute in suspended solids than the 600-gph and 3,000-gph ROWPUs. In addition to these "real" waste streams, the chlorinated product water may also have to be disposed of as wastewater if it is not issued to personnel to drink (the case in some training exercises).

(2) The amount of wastewater generated will depend on the source water quality and operational practices. However, table 11–1 shows the typical volumes that can be used as a basis for planning. Rinsewaters generated after performing chemical cleaning operations have not been included in the table. For fresh water sources, approximately 50 percent product water and 50 percent brine is produced. If the water source is brackish to saline, approximately 35 percent product water and 65 percent brine is generated. Generally, the multimedia filter on the 600-gph and the 3,000-gph ROWPU is backwashed every 20 hours of operation or when the pressure loss across the filter rises more than 5 lb per square inch above the initial readings and when the RO-based WPS is shut down. Approximately 1,000 gal of backwash wastewater is produced during a 13-min backwash cycle. The TWPS and LWP microfiltration and ultrafiltration membranes are automatically backwashed every 15 min. Because of the frequent backwashing on these newer systems, the wastewater is more dilute in suspended solids than the backwash wastewater generated by the 600- and 3,000-gph ROWPUs.

Table 11–1
Wastewater production guidelines for various RO water treatment systems

ROWPU unit	Source water	Raw water flow rate (gph)	Product water (gph)	Brine (gph)	Backwash (gal/cycle)	ROM cleaning (gal)	Ultra filter (UF)/micro filter (MF) cleaning (gal)
600 gph	Fresh	2000	900	1100	1000	350	0
	Brackish/Sea	2000	600	1400	1000	350	0
3000 gph	Fresh	6000	3000	3000	1000	350	0
	Brackish/Sea	6000	2000	4000	1000	350	0
TWPS	Fresh/Brackish	4200	1500	1750	240	260	260
	Sea	4200	1200	2050	240	260	260
LWP	Fresh/Brackish	300	125	90	20	40	40
	Sea	300	75	140	20	40	40

(3) Water treatment operators clean the UF, MF, and RO membranes based on indicators of system performance. The source water quality will directly affect how often the multimedia filters will need to be backwashed and the frequency of UF, MF, and RO membrane cleaning. Operators clean the membranes by circulating citric acid, a detergent, or hypochlorite solution through the membrane vessels. The cleaning process generates various quantities of wastewater for each RO-based WPS. The characteristics of the cleaning solutions are presented in paragraph 11–2*e*.

(4) As a simplistic example of the information someone would need in order to initiate discussions with the appropriate authority about plans and needs to discharge, say the plan is to use one 600-gph ROWPU for an exercise or deployment operation, and the water source is a fairly muddy river. The operators will produce water for 20 hours each day, at an intake rate of 2,000 gph, and will have to backwash the multimedia filter twice daily because the river is muddy. The operators don't anticipate having to clean the RO elements during this operation. From table 11–1, the estimated daily water and waste production would be—

(a) Total daily flow = 2000 gph x 20 hr/d = 40,000 gpd
(b) Water production = 900 gph x 20 hr/d = 18,000 gpd
(c) Brine production = 1,100 gph x 20 hr/d = 22,000 gpd
(d) Backwash waste = 2 cycles/d x 1,000 gal/cycle = 2,000 gpd

(5) These are the numbers one would use to begin coordinating with the appropriate office/individual to ensure that the operation complies with applicable legal requirements to discharge. Note that if all of the treated water is not consumed, the water that remains will have to be discharged as a waste too. If the operators collect the brine water and use it to backwash the multimedia filter, the volume of brine that needs to be disposed of would be reduced by 2,000 gpd in the example above.

c. Brine management. The contaminants present in the brine include most of the contaminants that are in the source water, but they are at different concentrations. The suspended solids concentration is less than that of the raw water because they are removed by the pretreatment filtration systems. However, the dissolved solids, alkalinity, metals, and chloride concentrations in the brine are as much as two times their respective concentrations in the source, since they are not removed by pre-RO filtration and are rejected by the ROMs. The phosphate concentration is greater in the brine than in the raw water when sodium hexametaphosphate (600-gph ROWPU) is added during the treatment process. Four options may be considered for brine disposal.

(1) Return the brine to the raw water source. The impact of returning brine to the source water is largely dependent on the volume of the source body of water and also mixing zones and flows particularly at the point of discharge. Brine that is returned to the source should be discharged at least 50 yd downstream from the raw water intake for flowing sources, and as far as possible from the intakes for standing bodies of water. For training exercises, each discharge site should be evaluated by the local regulatory authority to determine if a permit is required.

(2) Discharge the brine to a sewage treatment plant (STP). This includes disposal to a sewer line and discharge directly to the STP. Most brine can be treated without difficulty at an STP. However, there is a possibility that elevated metals concentrations in the brine could upset biological processes at the STP, so coordination with the STP operator prior to discharging to his system is strongly recommended. This is more of a concern in brackish or saline sources with high TDS content.

(3) Discharge the brine to the ground. In lieu of other options, the standard field wastewater disposal method, a soakage pit or trench (see FM 21–10), is an alternative in many areas except where high ground-water tables exist. Other options include evaporation ponds in arid areas and various conventional land treatment methods applicable to the local climate. For discharge of brines produced by treating seawater, returning the brine to the source water is more favorable than land disposal because of the increased potential to degrade ground water and the negligible impact on the source.

(4) Blend the brine and product water and then dispose of it using one of the three methods above. The concept of blending brine and product water should only be considered for training situations for RO-based WPS operators and not for field training exercises. If the brine is unable to be disposed of because of the contaminant concentrations and extra product water is available, the two can be blended to dilute the constituent concentrations. The controlling authority may then allow the blended solution to be returned to the source, discharged to an STP, or discharged to the ground. To dilute the brine to a concentration low enough to discharge would require most of the product water.

d. Filter backwash management. The high total suspended solids concentration presents the greatest challenge to disposal of backwash waters. Metals and phosphate levels may also exceed EPA water quality criteria. Returning the backwash waters to the source is not a likely option for the 600- and 3,000-gph ROWPUs because of the inability to obtain a discharge permit or other form of approval. Ideally, the backwash water can be discharged directly to a sanitary sewer manhole, or if that is not possible, by collecting it and hauling it to an STP. As a last resort, the backwash water may be discharged to soaking pits, trenches, or other similar ground-disposal options. Discharge of backwash waters from the TWPS and LWP to the source may be possible since the suspended solids concentrations are not as high as those backwash waters from the 600- and 3,000-gph ROWPUs. The approval/concurrence of the local environmental management authority must be obtained first.

e. Membrane cleaning wastewater management.

(1) The membranes (RO, UF, MF) are cleaned with citric acid, detergents or hypochlorite solutions. For RO-based WPSs (TWPS and 600-gph ROWPU) that use copper-nickel alloy tubing in conveying water, wastewater produced during the citric acid cleaning may contain high levels of copper, nickel, lead, and zinc. The concentrations will diminish over successive citric acid element cleaning cycles for the lifetime of the equipment.

(2) Direct discharge of wastewaters generated during either citric acid, detergent or hypochlorite cleaning cycles to surface waters is unlikely to be allowed because of the high 5-day biochemical oxygen demand, the high or low pH, the presence of hypochlorite, the presence of surfactants, and the high suspended solids in the wastewaters.

(3) As with backwash water, the membrane cleaning solutions should be discharged to a sewer or hauled to an STP. For high or low pH wastewaters it may be necessary to adjust the wastewater pH before discharging to the sewer. To reduce the potential impact of the concentrated wastewater on the STP processes, it can be discharged to the sewer or STP slowly rather than being discharged all at once. The elevated metal content in wastewater generated during citric acid cleaning of new RO-based WPSs using a copper-nickel alloy tubing in conveying water could negatively impact the biological processes at the STP depending on its size in relation to the volume and rate of wastewater discharged to it.

(4) Land disposal methods for wastewater generated during membrane cleaning should not be used.

f. Product water. The amount of product water that is consumed during an exercise that involves RO-based WPS water treatment varies from nearly all to almost none. If it is not consumed or used for some other purpose, and it has been treated and chlorinated, permission must be obtained to dispose of it like any other form of wastewater. Optimally, the treated water can be discharged back to the source from which it was taken; however, a permit will likely be required to do that. A permit may or may not be required to discharge it to a sanitary or storm sewer or perhaps even to discharge directly on the ground.

g. Operator protective equipment. Material Safety Data Sheets for all chemicals used in water purification should be consulted for safety information and personal protective equipment. Under normal operation, RO-based WPS operators must—

(1) Wear shoulder-length butyl-rubber gloves, rubber aprons, and rubber boots when handling potentially contaminated ROMs and when using cleaning solutions.

(2) Wear a full face shield when working with membrane cleaning solutions which are severe eye and skin irritants.

(3) Wash their faces and hands with antibacterial soap and water at the completion of operations or before they eat or smoke.

(4) Wear safety spectacles with side shields or chemical splash goggles with a face shield, and a NIOSH-approved dust mask when there is a potential for contaminated water from the ROMs to be aerosolized. The operators can substitute a military chemical protective mask for the NIOSH-approved mask only when there is potential for a CBRNE environment.

11-3. Disposal of solid wastes, spent ultra filter, micro filter, and reverse osmosis membranes, and cartridge filters in a nonchemical, biological, radiological, nuclear, and explosives environment

a. Regulatory information.

(1) The Resource Conservation and Recovery Act, reflected in parts 260–280, title 40, Code of Federal Regulations (40 CFR 260–280), defines hazardous wastes and provides regulatory controls for handling and managing hazardous wastes. To be considered a hazardous waste, spent cartridge filters must display one of the following characteristics as defined in 40 CFR 261: ignitability, corrosivity, reactivity, or toxicity. Under most circumstances, UF, MF or RO membranes and cartridge filters will not meet these criteria and thus will not be considered hazardous. Questions should be directed to the appropriate environmental staff with jurisdiction in the training or operating area. Additional information may be obtained from the USACHPPM WSMP (see table 1–1).

(2) In foreign countries, coordinate with the installation point of contact or the environmental coordinator in the host nation and the host nation environmental authorities to obtain information on disposal of spent UF, MF or RO membranes and cartridge filters. Maintain good housekeeping practices to include containing and collecting spent membranes and cartridge filters in a central location. The spent membranes and cartridge filters may have to be transported back to the U.S. for disposal. Contact the USACHPPM WSMP for additional information as recommended in the preceding paragraph.

b. Disposal. Dispose of spent RO-based WPS cartridge filters and membranes as a solid, nonhazardous waste according to state, local, and FGS or the OEGBD if no FGS exists.

11-4. Disposal of chemical, biological, radiological, nuclear, and explosives-contaminated wastes

a. Treatment of CBRNE-contaminated water. Water purification units will normally treat water in an uncontaminated environment only (that is, in an area where the soil and air is not contaminated). CBRNE-contaminated water will be treated only as a last resort if no other source exists. If water must be treated in a contaminated environment (that is, CBRNE weapons have been extensively used on the battlefield and uncontaminated areas are nonexistent), containerize the treated water to prevent further post-treatment contamination. Surface water sources should be avoided, and ground-water sources should be used if possible.

b. Decontamination. If contaminated source water must be treated, the treatment equipment must be thoroughly decontaminated before it is used again. Chemical corps and PVNTMED personnel should be consulted for proper decontamination procedures for the equipment and for protective measures for individuals performing the decontamination.

c. Disposal. Brine and backwash generated from CBRNE purification operations should only be discharged back to the original source. Brine should be disposed of downstream or away from shore so that it does not increase the contaminant concentrations of the water drawn into the RO-based WPS for treatment. Discharging the brine to a sump or another surface source would likely contaminate clean soil, ground water, or surface water. The multimedia filter media, cartridge filters, UF/MF/RO membranes, and ion exchange and activated carbon media must all be disposed of as CBRNE-contaminated wastes. Chemical corps and PVNTMED personnel should be consulted on the proper procedures for handling and disposal.

d. Radiation safety. If appropriate radiation safety measures are taken, health risks to the operators and the service member will be minimized. The principles of time, distance, and shielding should be applied to the waste generated as a result of contaminated water purification. Operators should keep their exposure time to a minimum by staying away from the equipment except when it is necessary to make adjustments and by shielding the waste container with whatever is available. Radiation warning signs can be posted, if available, to keep unauthorized personnel away from the purification equipment. Other areas occupied by personnel should be set up well away from the purification operation if possible.

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Appendix A
References

Section I
Required Publications

No entries for this section.

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. Except as noted below, Army regulations are available online from the U.S. Army Publishing Directorate (APD) Web site: http://www.apd.army.mil. Field manuals are available online from the General Dennis J. Reimer Training and Doctrine Digital Library Web site: http://atiam.train.army.mil/portal/application (Library Search). Technical bulletins, medical, are available online from the USACHPPM Web site: http://chppm-www.apgea.army.mil (also available by contacting USACHPPM, ATTN: MCHB-CS-IPD, 5158 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5403). Technical manuals are available at: http://www.usace.army.mil/inet/usace-docs/armytm/. Codes of Federal Regulations are available online from the National Archives and Records Administration Web site: http://www.gpoaccess.gov/cfr/index.html. Standardization Agreements (NATO) (STANAG) and the Quadripartite Standardization Agreement (QSTAG) are available online at: http://assist.daps.dla.mil/. USACHPPM technical guides listed below are available online at: http://chppm-www.apgea.army.mil/tg.htm). USACHPPM information papers listed below are available online at: http://chppm-www.apgea.army.mil/dehe/pgm31/FldWaterRef.aspx).

ALARACT Message 156/2004
Office of The Surgeon General, September 2004, subject: ALARACT Interim Guidance for Testing and Surveillance of Bottled Water for Military Deployments (For information regarding this message, contact Proponency Office of Preventive Medicine, Office of The Surgeon General, DASG–PPM–NC, 5115 Leesburg Pike, Falls Church, VA 22041–3258).

AR 40–5
Preventive Medicine

AR 40–657/ NAVSUPINST 4355.4H/ MCO P10110.31H
Veterinary/Medical Food Safety, Quality Assurance, and Laboratory Service

AR 200–1
Environmental Protection and Enhancement

AR 700–135
Soldier Support in the Field

AR 700–136
Tactical Land Based Water Resources Management in Contingency Operations

FM 3–0
Operations

FM 3–19.30
Physical Security

FM 3–34.471
Plumbing, Pipe Fitting, and Sewerage

FM 3–100/MCWP 3–3.7.1
Chemical Operations Principles and Fundamentals

FM 3–100.4/ MCRP 4–11B
Environmental Considerations in Military Operations

FM 3–100.12/ MCRP 5–12.1C/ NTTP 5–03.5/ AFTTP(I) 3–2.34
Risk Management for Multiservices Tactics, Techniques, and Procedures

FM 4–02
Force Health Protection in a Global Environment

FM 4–02.17
Preventive Medicine Services

FM 4–25.12
Unit Field Sanitation Team

FM 8–10–8
Medical Intelligence in a Theater of Operations

FM 8–250
Preventive Medicine Specialist

FM 10–52
Water Supply in Theaters of Operations

FM 10–52–1
Water Supply Point Equipment and Operations

FM 10–280
Mobile Field Laundry, Clothing Exchange, and Bath Operations

FM 21–10
Field Hygiene and Sanitation

FM 71–100–2
Infantry Division Operations, Tactics, Techniques, and Procedures

FM 100–14
Risk Management

TB MED 507/AFPAM 48–152 (I)
Heat Stress Control and Heat Casualty Management

TB MED 575
Swimming Pools and Bathing Facilities

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

TM 3–6665–319–10
Operator's Manual for Water Testing Kit, Chemical Agents: M272

TM 5–810–5
Plumbing

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

TM 5–813–3
Water Supply: Water Treatment Systems

TM 5–813–4
Water Supply: Water Storage

TM 5–813–5
Water Supply: Water Distribution

TM 5–813–6
Water Supply for Fire Protection

TM 5–813–7
Water Supply for Special Projects

TM 5–813–8
Water Desalination

TM 5–813–9
Water Supply: Pumping Stations

TM 5–5430–212–13&P
Operator, Organizational, and Direct Support Maintenance Manual for Tank, 5000 Gallon Fabric, Collapsible, Potable Water, Semi-Trailer Mounted

TM 5–5430–213–13&P
Operator, Unit and Direct Support Maintenance Manual for Tank, 3000 Gallon Fabric, Collapsible, Potable Water, Semi-Trailer Mounted

TM 5–6630–215–12
Operator's and Organizational Maintenance Manual for Water Quality Analysis/Sets: Preventive Medicine

TM 9–2330–267–14&P
Operator's, Organizational, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Trailer, Tank, Water, 400 Gallon, 1-1/2 Ton 2 Wheel M149

TM 9–2330–397–14&P
Operator's, Unit, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Water: 400 Gallon, 1 ½ Ton, 8-Wheel M1112

TM 10–4320–317–13
Operator's, Unit, and Direct Support Manual for Tactical Water Distribution Equipment System

TM 10–4320–346–12&P
Operator's and Unit Maintenance Manual (Including Repair Parts and Special Tools List) for Forward Area Water Point Supply System Model Lab 9095

TM 10–4610–232–24P
Unit, Direct Support and General Support Maintenance Repair parts and Special Tools List for Water Purification Unit Reverse Osmosis, 3000 GPH, Trailer Mounted, Flatbed Cargo

TM 10–4610–237–12
Operator's and Unit Maintenance Manual for 20k Gallon Water Storage and Distribution System Model 20KWSDS

TM 10–4610–240–10
Operator's Manual for Water Purification Unit, Reverse Osmosis, 600-GPH Trailer-Mounted Flatbed Cargo

TM 10–4610–241–24P
Model Direct Support and General Support Maintenance Repair Parts and Special Tools List for Water Purification Unit, Reverse Osmosis, 600-GPH, Trailer-Mounted Flatbed Cargo

TM 10–4610–242–13
Operator's, Unit and Direct Support Maintenance Manual for 300K Water Storage and Distribution System Model WSDS310

TM 10–4610–243–13
Operator's, Unit and Direct Support Maintenance Manual for 800K Water Storage and Distribution System Model WSDS810

TM 10–6630–246–12&P
Operator's and Unit Maintenance Manual (Including Repair Parts and Special Tools Lists) for Water Quality Analysis Set: Purification

TM 10–6630–245–13&P
Operator, Unit, and Direct Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Water Quality Analysis Set Preventive Medicine

TM 10–8110–201–14&P
Operator, Organizational, Direct Support, and General Support Maintenance Manual (Including Repair Parts and Special Tools Lists) for Drums, Fabric, Collapsible Non-Vented, 500 Gallon, Liquid Fuel

Potable Water Planning Guide, Directorate of Combat Developments for Quartermaster, U.S. Army Combined Arms Support Command, Fort Lee, VA, June 15, 1999. (Available by contacting Commander, CASCOM, DCD QM, ATTN: ATCL-QM, 3901 A Avenue, Suite 210, Fort Lee, VA 23801-1809)

Study Report - Water Consumption Planning Factors, Directorate of Combat Developments (Quartermaster), U.S. Army Combined Arms Support Command, Fort Lee, VA, June 15, 1999 (Available by contacting Commander, CASCOM, DCD QM, ATTN: ATCL-QM, 3901 A Avenue, Suite 210, Fort Lee, VA 23801-1809)

USAREUR Circular 40–657
European Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement
(Available at: http://vets.amedd.army.mil/86256F90007C2D1D/Europe)

VETCOM Circular 40–1
DoD Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement
(Available at: http://vets.amedd.army.mil/VETSVCS/approved.nsf)

JCS Memorandum
MCM–0006–02, Subject: Updated Procedures for Deployment Health Surveillance and Readiness, 1 February 2002
(Available at: http://amsa.army.mil/Documents/Docs.htm)

DOD 4715.5–G
Overseas Environmental Baseline Guidance Document (OEBGD)
(Available at: https://www.denix.osd.mil/denix/Public/Library/Intl/OEBGD/toc.html)

DODI 6490.3
Implementation and Application of Joint Medical Surveillance for Deployments

MIL STD 3006A
Department of Defense Standard Practice, Sanitation Requirements for Food Establishments
(Available at: http://www.dscp.dla.mil/subs/support/specs/crds/milstan.htm)

21 CFR 129
Processing and Bottling of Bottled Drinking Water

21 CFR 165
Beverages

21 CFR 165.110
Bottled water

40 CFR 141
National Primary Drinking Water Regulations

40 CFR 142
National Primary Drinking Water Regulations Implementation

40 CFR 143
National Secondary Drinking Water Regulations

40 CFR 260-280
Resource Conservation and Recovery Act

40 CFR 261
Identification and Listing of Hazardous Waste

Presidential Review Directive 5
A National Obligation – Planning for Health Preparedness for and Readjustment of the Military, Veterans, and Their Families After Future Deployments (Available at: http://www.fas.org/irp/offdocs/prd-5-report.htm)

NIOSH Publication No. 80–106
Criteria for a Recommended Standard: Working in Confined Spaces (Available at: http://www.cdc.gov/niosh/80-106.html)

STANAG 2136
Minimum Standards of Water Potability During Field Operations and in Emergency Situations

STANAG 2473
Commanders Guide to Low Level Radiation Exposures in Military Operations

STANAG 2885
Emergency Supply of Water in War

QSTAG 245
Minimum Requirements for Water Potability (Short and Long Term Use)

TG 188
U.S. Army Food and Water Vulnerability Assessment Guide

TG 230
Chemical Exposure Guidelines for Deployed Military Personnel

RD 230
A Companion Document to Chemical Exposure Guidelines for Deployed Military Personnel

TG 248
Guide to Deployed Preventive Medicine Personnel on Health Risk Management

IP 31–032
Hand Held Water Treatment Devices

IP 31–034
Use of Bottled Water for Deployment Support

IP 31–035
Preventive Medicine Concerns of the M149 Water Trailer

IP 31–037
Preventive Medicine Concerns of Personal Hydration Systems

IP 32–024
Disposal Options and Procedures for Wastes Generated by Reverse Osmosis Purification Units (ROWPUs)

ANSI Z87.1
American National Standard Practice for Occupational and Educational Eye and Face Protection
(Available at: http://www.ansi.org)

American Society for Testing Materials (ASTM) E 2318–03
Standard Guide for Environmental Health Site Assessment Process for Military Deployments
(Available at http://www.techstreet.com)

Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement in the Republic of Korea
(Available at: http://vets.amedd.army.mil/86256F90007C2D1D/korea

Daniels, J.I. and G.M. Gallegos, eds., Evaluation of Military Field-Water Quality, Lawrence Livermore National Laboratories, 1990
(Available by contacting U.S. Army Medical Research and Material Command, 504 Scott Street, Fort Detrick, MD 21702-5012)

Section III
Prescribed Forms
The DA Forms listed below are available on the Army Electronic Library (AEL) CD-ROM (EM 0001) and the APD Web site, www.apd.army.mil.

DA FORM 5456
Water Point Inspection. (Prescribed in para 8-3*a*(1).)

DA FORM 5457
Potable Water Container Inspection. (Prescribed in para 8-3*a*(2).)

DA FORM 5458
Shower/Decontamination Point Inspection. (Prescribed in para 8-3*a*(3).)

DA FORM 7575
FWSVA Worksheet. (Prescribed in para E-6*a*(3)(f).)

DA FORM 7576
FWSVA Summary Data Sheet. (Prescribed in paras E-6*b*(3) and E-6*c*.)

DA FORM 7577
Treated Water Sampling Field Data Sheet. (Prescribed in para F-2*d*.)

Section IV
Referenced Forms

DA FORM 1712–R
Water Reconnaissance Report

DA FORM 1713–R
Daily Water Production Log – ROWPU

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Appendix B
Drinking Water Standards and Recommended Monitoring Frequencies

Table B–1
Basic water quality surveillance parameters and field equipment capabilities

Constituents/characteristics of water (mg/L unless otherwise noted)		DOD tri-Service standards (June 1996)		Field equipment: Detection ranges (mg/L unless otherwise noted)			
				WQAS-PM			WQAS-P
	BCT*	5 L/day	15 L/day	HACH® WQL	Test Strips	M272	
Physical properties							
Nephelometric turbidity unit (NTU)	X	1	1	0.1 – 400	--	--	0 – 150
pH (pH units)	X	5 – 9	5 – 9	-2.0 – 13.9	--	--	2 – 12
TDS	X	1000	1000	0 – 50000	--	--	0 – 50000
Temperature (C°)	X	4 – 35 / 15 – 22[3]	4 – 35 / 15 – 22[3]	-5.0 – 105	--	--	0 – 48
Color (color units)	X	50 / 15[3]	50 / 15[3]	5 – 500	--	--	0 – 100
Chemical properties							
Arsenic	X	0.3 / 0.06[3]	0.1 / 0.02[3]	--	0 – 0.5	--	--
Cyanide	X	6	2	--	0 – 1.0	--	--
Magnesium		100	30	10 – 4000	--	--	--
Chloride		600	600	10 – 10000	--	--	0 – 1500
Sulfate		300	100	2 – 70	200 – 1600	--	0 – 3000
Lindane[2]		0.6	0.2	--	--	--	--
Microbiological properties							
Coliform (#/100 mL)		0	0	P/A	--	--	--
Radioactivity[2] (µCi/L)		8 / 3[3]	0.1 / 0.05[3]	--	--	--	--
Chemical warfare agents							
Hydrogen cyanide[1]	X	6	2	--	--	20	--
Lewisite[1] (as arsenic) (µg/L)	X	80	27	--	--	2000	--
Sulfur mustard[1] (µg/L)	X	140	47	--	--	2000	--
Nerve agents[1] (µg/L)	X	12	4	--	--	20	--
BZ (µg/L)[2]		7	2.3	--	--	--	--
T-2 toxins (µg/L)[2]		26	8.7	--	--	--	--

Legend:
* BCT – basic characterization testing – Xs in the column indicate the parameters applicable to BCT
®HACH is a registered trademark of The HACH Company, Loveland, Colorado.
WQL – DREL / 2400 Water Quality Laboratory; **mg/L** – milligrams per liter; **µg/L** – micrograms per liter; **mL** – milliliters; **µCi/L** – microcuries per liter; **NTU** – nephelometric turbidity unit; **WQAS** – water quality analysis set; **PM** – preventive medicine; **WQAS-P** – water quality analysis set-purification; **TDS** – total dissolved solids; **BZ** – 3-quinuclidinyl bensilate; **P/A** – presence/absence

Notes:
[1] M272 kit is not able to measure this agent at the concentrations required by the TSFWS, but it is used as an acceptable gross level clearance.
[2] Currently, field equipment that is capable of detecting this constituent at the indicated concentration is not available. Water may still be certified potable without testing for this constituent. When the testing capability becomes available, the water must meet the indicated standards to be certified potable.
[3] Where duration of use will exceed 7 days.

Table B-2
DOD and international military potable field water quality standards

Duration of use→	Short-term: For use less than 7 Days				Long-term: For use more than 7 days			
Type of standard→	QSTAG 245	STANAG 2136	DOD tri-Service standards		QSTAG 245	STANAG 2136	DOD tri-Service standards	
Consumption rate→	5 L/day	5 L/day	5L/day	15 L/day	5 L/day	5 L/day	5 L/day	15 L/day
Physical properties								
Color (color unit)	–	50	**50**	**50**	15	15	**15**	**15**
Odor (threshold odor number)	–	3	**3**	**3**	–	3	**3**	**3**
pH	5 - 9.2	5 - 9	**5 - 9**	**5 - 9**	5 - 9.2	5 - 9	**5 - 9**	**5 - 9**
TDS (mg/L)	1500	1000	**1000**	**1000**	1500	1000	**1000**	**1000**
Temperature (^{O}C)	4 - 35	–	**4 - 35**	**4 - 35**	15 - 22	–	**15 - 22**	**15 - 22**
NTU	5	–	**1**	**1**	1	1	**1**	**1**
Chemical properties								
Arsenic (mg/L)	2	0.3	**0.3**	**0.1**	0.05	0.06	**0.06**	**0.02**
Chloride (mg/L)		600	**600**	**600**	600	600	**600**	**600**
Cyanide (mg/L)	20	6	**6**	**2**	0.5	6	**6**	**2**
Lindane (mg/L)	–	0.6	**0.6**	**0.2**		0.6	**0.6**	**0.2**
Magnesium (mg/L)	–	100	**100**	**30**	150	100	**100**	**30**
Sulfate (mg/L)	–	300	**300**	**100**	400	300	**300**	**100**
Microbiological properties								
Coliform (#/100 mL)	1	0	**0**	**0**	1	0	**0**	**0**
Spores/Cysts (#/100 mL)	1	–	–	–	1	–	–	–
Virus (#/100 mL)	1	–	–	–	1	–	–	–
Chemical warfare agents								
Hydrogen cyanide (microgram (µg)/L)	–	–	**6**	**2**	–	–	**6**	**2**
BZ (Incapacitants) (µg/L)	–	7	**7**	**2.3**	–	–		
Lewisite (arsenic fraction) (µg/L)	–	80	**80**	**27**	–	–	–	–
Sulfur mustard (µg/L)	200	140	**140**	**47**	50	–	–	–
Nerve agents [1] (ug/L)	–	12	**12**	**4**	5	–	–	–
GA[2] (µg/L)	–	–	**140**	**46**	–	–	–	–
GB[2] (µg/L)	–	–	**28**	**9.3**	–	–	–	–
GD[2] (µg/L)	–	–	**12**	**4**	–	–	–	–
VX[2] (µg/L)	–	–	**15**	**5**	–	–	–	–
T-2 toxins[2] (µg/L)	–	26	**26**	**8.7**	–	–	–	–
Radiological	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**
Radiological (µCi/L)	–	300 Bq/mL	**8**	**3**	0.06	5 Bq/mL	**0.1**	**0.05**

Legend:
mg/L = milligram per liter; **µg/L** = microgram per liter; **Bq/mL** = Bequerel per milliliter
Notes:
[1] Interim standards are based on GD because the current test method is nonspecific for the different organophosphate (OP) nerve agents, and GD has the lowest standards.
[2] These are goal values for individual OP nerve agents. They will become the standards when field tests capable of analyzing water for the specific agents and concentrations become available.

Table B-3. Water surveillance monitoring parameters and recommended frequencies

Parameter	Sampling Frequency				Recommended equipment
	ROWPU production point	Distribution system[3]	Field storage container	Bottled/ packaged water	
Total coliforms[1]	Weekly/monthly	Monthly		Monthly[4]	Colilert P/A, HPC total count sampler
TDS[1]	Weekly/monthly	-	-	-	TDS tester
Chlorine residual[1]	Weekly/monthly	Weekly	Daily	-	DPD chlorine residual test
Temperature[1]	Weekly/monthly	Monthly	-	-	Thermometer
pH[1]	Weekly/monthly	Monthly	Daily	-	pH tester/phenol red test
Color/odor[1]	Weekly/monthly	-	-		Color disk
Turbidity[1]	Weekly/monthly y	-	-	-	Turbidimeter
Arsenic	Quarterly	-	-	-	Test strips
Cyanide	Quarterly	-	-	-	Test strips
Magnesium	Quarterly	-	-	-	Titration/test strips
Chloride	Quarterly	-	-	-	Test strips
Sulfate	Quarterly	-	-	-	Test strips
Lindane	Quarterly	-	-	-	Laboratory analysis
Radiological	Quarterly	-	-	-	Laboratory analysis
ECOCs/AWSM[2]	Quarterly/ annually	Quarterly/ annually	-	-	Laboratory analysis
Chemical agents	5-2	Table 5-2	-	-	M272 chemical agent test kit

Legend:
TDS – total dissolved solids; P/A – presence/absence; HPC – heterotrophic plate count;
DPD – N,N- diethyl-p-phenylenediamine
Notes:
[1] These parameters should be monitored weekly during the initial phase of field operations, and monthly as the theater matures and the water system is stabilized.
[2] Environmental contaminants of concern/advanced water surveillance monitoring (ECOCs/AWSM) samples are collected using the deployment field water sample kit available from USACHPPM, described in appendix H, and submitted to a fixed facility laboratory for analysis.
[3] Where host nation distribution system (semi-fixed facility) or the tactical water distribution system (TWDS) is used.
[4] See appendix C for detailed information.

Appendix C

Use of Bottled and Packaged Water for Deployment

C-1. Overview

This appendix discusses the use of bottled and packaged drinking water to augment or replace quartermaster bulk water purification and distribution operations in contingency or combat operations. It provides information and guidance useful to PVNTMED personnel charged with the responsibility of ensuring that bottled and packaged water is potable, palatable, and acceptable for use in a deployed environment. This appendix does not address the use of bottled drinking water at fixed-facility installations, although some of the information may be applicable.

C-2. Background

Bottled water is frequently used as a means of providing potable drinking water to deployed troops around the world. It is readily available and offers flexibility to planners. In some cases, it has been linked to soldier morale as a perceived quality-of-life issue by offering convenience and good taste compared to RO-based WPS-treated water. The use of bottled water may reduce the required force structure in a theater, particularly early on, by partially or completely eliminating requirements for potable water production and distribution units. Bottled water is frequently used extensively throughout a deployment in spite of the tremendous stress it places on transportation and waste disposal operations. An expanded discussion is available in USACHPPM IP 31–034.

C-3. Bottled water regulations and industry standards

Bottled water production, quality, and packaging are regulated in CONUS by the U.S. Food and Drug Administration (FDA), DOD regulations, and bottling industry association guidelines.

a. FDA. FDA regulations establish standards for bottled water production facilities and operations, including water quality. They are documented in 21 CFR 129 and 21 CFR 165.110(b). The processing standards include regulations for bottling plant construction and design and for adequate sanitation of facilities and operations, equipment, procedures, processes, and controls. In many cases, the water quality standards are identical to the EPA MCLs for public drinking water systems.

b. DOD regulations.

(1) AR 40–657/NAVSUPINST 4355.4H/MCO P10110.31H addresses the inspection and certification requirements for bottling facilities to become approved providers of bottled drinking water. It is the basis for the publication of directories of approved sources for DOD procurement of food items which include bottled drinking water. It requires each overseas MACOM and the VETCOM Commander to publish a directory of approved sources (short title, “Directory”).

(2) Military Standard (MIL STD) 3006A contains inspection checklists and certification processes. Appendix K of the standard specifically addresses bottled water and soft drink plants. The standards and inspection criteria in MIL STD 3006A are very similar to the FDA standards for processing and water quality of bottled water, and are applicable to bottled water produced within CONUS and OCONUS for DOD procurement.

(3) In 1996, the Army OTSG published guidance for the microbiological testing of bottled water quality. The guidance was reaffirmed and expanded by an All Army Action message published by OTSG in 2004. The guidance addresses all bottled water used during deployments and must be implemented once bottled water is received in a port of entry, central storage facility, warehouse, or other theater area issue point. Paragraph C-7 provides specific guidance and testing requirements.

c. The International Bottled Water Association (IBWA) represents the bottled water industry. IBWA's member companies produce and distribute approximately 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 by states and municipalities as basis for their regulations, 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. The IBWA Model Code is unenforceable except when it is adopted by a state or local governing body.

C-4. Bottled water considerations

a. Health protection considerations. From PVNTMED and health protection perspectives, no commercially bottled water can be assumed to provide equal or better quality water or protection from the risk of waterborne disease than quartermaster bulk field water treatment and disinfection operations. As long as the bottling source has been inspected and approved by a DOD veterinary or PVNTMED activity, and the periodic monitoring discussed in paragraph C-7*d* is conducted, bottled water from that source can be considered safe. In many cases, bottled water receives treatment similar to water produced and distributed by fixed facility municipal drinking water plants or field equipment such as the RO-based WPS. However, most bottled water is not packaged with a disinfectant residual such as chlorine. If transportation, handling, and storage conditions are poor, bottled water may pose a greater risk of illness for consumers than water from quartermaster-operated bulk water supply systems. In such situations, when no other potable water source is available, the bottled water should be disinfected using one of the methods discussed in FM 21–10 and in chapter 9, section III.

b. Logistical considerations. Bottled water is properly employed during the initial deployment of most operations when bulk water systems have not yet been established. Planners carefully consider the need for bottled water when preparing for deployments. Two days of supply (DOS) is considered optimal in most cases. However, more than two DOS may be required because of mission, environmental, or transportation considerations. Accumulating more than five DOS burdens the transportation and distribution system, requires a great deal of testing by PVNTMED units, is expensive, and delivery and waste disposal operations create undesirable unit location signatures. Daily consumption factors listed in the U.S. Army CASCOM Potable Water

Planning Guide include values for personnel who are not supported by bulk water systems and could be supported with bottled water. In a temperate environment, the planning factor is 1.5 gal per person per day.

c. Cost considerations. Cost may be a significant factor in the decision to use bottled water. In a snapshot of costs to support troops in Uzbekistan, the Defense Logistics Agency estimated that the total cost for purchasing and transporting approximately 1 million liters of bottled water was $871,000. Estimated costs for transporting and using a RO-based WPS with required ancillary equipment and consumables for the same operation were only $315,000. The timeframes for the estimates were not provided; however, in general, the longer RO-based WPS support is sustained the greater the cost savings.

d. Other considerations. Other issues addressed in determining the need for bottled water include solid waste disposal, intentional or unintentional chemical contamination, and force protection. Disposal of plastic bottles, bulk packing, and packaging material is a solid waste issue that must be addressed. Bottled water use places a larger burden on solid waste management and disposal systems than RO-based WPS operations. Incidents of chemical contamination of bottled water, such as the unintentional benzene contamination of Perrier bottled water in the 1980s, illustrate that bottled water is not guaranteed to be free of contaminants. PVNTMED units do not have the expertise or equipment to routinely conduct extensive monitoring of chemical quality on a frequent basis. A bottling facility and supply chain that are not controlled by the military provide avenues for intentional or unintentional contamination. Although annual certification of U.S. bottled water manufacturers includes verification of organic and inorganic chemical contamination, chemical water quality cannot be guaranteed at the point of consumption, especially in OCONUS areas. Routine and repetitive deliveries of bottled water to base camps or other troop locations present the potential for terrorist activity that is avoided when RO-based WPSs or other military-controlled water production assets are used.

C-5. Identifying approved sources for bottled water procurement

Updated versions of the Directory of Approved Food Sources for each MACOM (CONUS and South America, Europe, United States Central Command (CENTCOM), and Korea) can be found on the VETCOM Web site. The directories can be searched by food item, vendor name, or vendor location. Other sections provide information on providers recently added or deleted from each directory. In searching the directory, it should be noted that bottled water can be classified by several different names, some of which include “bottled water,” “bottled potable water,” and “bottled drinking water.” If a potential bottled water source is not listed in the directory, an audit/inspection can be requested and performed using information from the Web site.

C-6. Managing the risk of bottled water use

The risk management approach described in FM 100–14, which uses estimates of hazard probability and severity to determine risks arising from operational factors, can be applied to examine and manage the risks associated with bottled water use during deployments. Following the FM 100–14 methodology, planners can manage the risk by establishing controls and judging their effectiveness. A gastrointestinal (GI) tract illness caused by microbiological contamination is the primary hazard associated with bottled water use. Determining the probability and severity of a microbiological contamination event on an individual or unit basis is somewhat subjective. Three primary factors to consider include the source quality, the PVNTMED assets available to conduct testing and monitor health trends, and supply and storage conditions. These factors are discussed below. Paragraph C-8 lists different combinations of the three factors and their associated risk categories. Hazards from low concentrations of chemical contamination normally will not impact mission accomplishment or sustainment of the force for the duration of a deployment or contingency operation because they pose chronic (slow onset, long term) rather than acute (rapid onset, short term) health threats.

a. Source quality.

(1) *Probability.* In this case, source quality refers to the level of sanitation and the past history of the manufacturer providing the bottled water. The probability of a contamination event occurring at a DOD-approved commercial bottling source with a good record (that is, no past incidents of microbial contamination) and plant construction and operations that are conducive to sanitation will be seldom or unlikely. Bottling plants that are approved but that have had microbial contamination incidents in the past will be classified as having a likely or occasional probability depending on the number and frequency of past events. Recently approved bottling plants with no details of past microbial contamination incidents will be classified as occasional. Bottlers that are not in the directory, and consequently not DOD-approved, should *never* be used. Hence, there will never be a frequent probability that a contamination event will occur.

(2) *Severity.* The degree of susceptibility to waterborne diseases from microbial contamination varies from individual to individual. It is affected by factors such as general health and fitness, the amount of rest the individual regularly receives, and immunological and genetic factors. The severity of a microbial contamination event can range from marginal to catastrophic. When evaluating severity for an individual soldier (a health threat), contamination and the resulting illness would often result in lost workdays (that is, a marginal severity). When evaluating the risk to an entire unit (a medical threat), multiple soldiers in the same unit experiencing lost workdays simultaneously due to contaminated bottled water could severely impact a unit's ability to accomplish its mission. In such cases, the severity of an incident on mission accomplishment would be considered critical.

b. PVNTMED monitoring assets.

(1) *Probability.* If adequate PVNTMED assets are available to conduct microbiological sampling of bottled water, monitor routine health trends, and identify a possible contamination event, the probability of an illness is negligible to marginal. If limited PVNTMED personnel assets are available, and they have other duties and surveillance activities that are higher priorities, the probability of an illness affecting a unit's ability to accomplish a mission is increased.

(2) *Severity.* PVNTMED monitoring assets also have an indirect effect on the severity of a contamination event. The severity of GI tract illness in one or two soldiers due to microbiological contamination of drinking water is marginal (that is, minor mission degradation or lost workdays) for individuals. However, PVNTMED personnel can greatly influence whether or not a large quantity of bottled water affects the health of a unit. If medical units are monitoring health trends such as sick call attendance and diagnoses, potential contamination events may be detected soon enough to prevent additional soldiers or an entire unit from becoming sick.

c. Supply chain and storage conditions.

(1) *Probability.* The longer the supply chain (in days), and the warmer the climate, the greater probability of an event. Higher temperatures promote bacterial growth, and the increased time allows for the bacterial growth cycle to occur. Since most bottled waters are not produced with a disinfectant residual, this growth can go unchecked. What was a good bottle of water when it was packaged and tested at the plant can become contaminated from bacterial growth in several weeks or in very poor conditions several days. The storage time and conditions at the consuming unit, as well as central receiving/distribution, must be evaluated in determining the probability of an event.

(2) *Severity.* Conditions in the supply chain including transportation and storage have an indirect effect on the severity of a contamination event. The severity must be judged jointly with the other factors in mind. The severity of a contamination incident could increase as the time in the supply chain increases and/or as conditions in the chain become poor. The severity increase is due to the probability that a higher number of individual containers could develop growth that would in turn mean that more soldiers could contract the illness if not detected by PVNTMED testing.

C-7. Monitoring bottled and packaged water

*a. General***.** Bottled water is water that is sealed in bottles, packages, or other containers by a commercial (*nonmilitary*) source for human consumption. Packaged water is water that has been produced and packaged by the military for military use in the field environment. Bottled and/or packaged water should not be stored in direct sunlight because it encourages bacterial growth. It should be stored in shaded, well-ventilated areas and in boxes which keep the bottles upright. Bottled water stored in direct sunlight for more than 5 days should be tested for coliform contamination using the methods described in paragraph C–7*d*. Stored or warehoused bottled/packaged water should be used on a first in, first out basis. Properly stored and tested packaged water may continue to be issued indefinitely so long as PVNTMED or veterinary service (VS) personnel approve expiration date extensions.

b. Usage. There are occasions where bottled or packaged water may be beneficially used until tactical water purification/storage/distribution assets are established and become available to commanders. Commanders of recent deployments have relied on bottled water throughout the mission even though it is expensive and severely stresses transportation assets. As soon as quartermaster bulk water production facilities are established, commanders should maximize their usage to sustain the force for the duration of the deployment, and bottled water should be relegated to a secondary role.

c. Production facilities inspections and testing.

(1) *Water packaging facilities.* Water that is produced by RO treatment, disinfected, and packaged by the military in the field will meet the TSFWS in table B–2 prior to packaging. PVNTMED personnel will periodically inspect military treatment, disinfection, and packaging operations to ensure compliance with this TB MED. Specifically, water will be free of coliform microorganisms and contain at least 1 mg/L of residual chlorine at the time of packaging. PVNTMED personnel should verify this prior to the onset of distribution. However, as with bulk water production operations, if PVNTMED personnel are not available, packaged water may be issued after the water treatment system operators are satisfied that the treatment system is performing correctly and as long as the water contains the above specified chlorine residual when it is packaged. Packaged water will be tested for the presence of coliform bacteria as specified in paragraph C–8*d* below.

(2) *Water bottling facilities.* The military must approve all bulk sources of bottled water intended for consumption by deployed personnel. Army VS personnel inspect and approve bottling facilities to ensure compliance with acceptable sanitation standards. They submit source and product water samples to an accredited laboratory for testing according to 21 CFR 165 prior to initial approval. VS personnel also perform periodic sanitary inspections of approved CONUS and OCONUS bottling facilities according to MIL STD 3006A. During these sanitary inspections, they collect samples from randomly selected bottles of treated water and submit them to an accredited laboratory for complete microbiological and chemical analyses. Continued approval and military use of the facilities' bottled water product is contingent on satisfactory sanitary inspections and acceptable analytical results. The VS should ensure that all analytical results from testing bottled water samples are forwarded to the USACHPPM DDAPI Program for archiving.

d. PVNTMED monitoring.

(1) *Procedures.* Quartermaster personnel may begin issuing bottled water from VS-approved sources upon receipt. However, PVNTMED personnel are required to monitor bottled water quality initially and periodically at three levels of storage and distribution in the TO. A representative sample is defined as 1 percent of the total number of bottles up to a maximum of 10 randomly selected bottles per lot. PVNTMED personnel —

(a) Upon delivery/receipt in theater, prior to distribution to storage and issue points, initially inspect shipments of each brand of OCONUS-produced commercial bottled water for damage, leakage, clarity, expiration, and potential tampering. They should perform field testing of representative samples from each brand and certify the brand's potability with respect to the DOD TSFWS.

(b) Upon receipt at ports of entry, central storage facilities, warehouses, and other theater distribution points, inspect shipments for damage, leakage, clarity, expiration, and potential tampering, and perform total coliform analysis on each lot of OCONUS- and CONUS-produced bottled water, and on military-produced packaged water.

(c) At major storage sites and end user locations, similarly inspect and test each lot of bottled and packaged water for total coliforms every 30 days until the lot is consumed. This procedure will allow expiration dates to be extended in 30-day increments if necessary.

(2) *Methods and results.*

(a) Total coliform testing will be performed using the membrane filter technique or by the defined substrate method such as Colilert® and Colisure® (Colilert and Colisure are registered trademarks of IDEXX Laboratories, Inc., Westbrook, ME). One copy of the inspections and testing results should be maintained by the PVNTMED inspectors, and one copy should be maintained by the facility manager and made available to subsequent inspectors. PVNTMED personnel should ensure that all inspections and testing results are forwarded to the USACHPPM DDAPI Program (see table 1–1) according to DODI 6490.3.

(b) If the water is cloudy, tampering is suspected, or coliform positive samples are identified, the nearest veterinary detachment will be notified immediately, and issue from the suspicious lot will be suspended pending investigation of the matter and/or immediate resampling to confirm coliform presence. In the case of coliform-positive samples, a representative sample of the suspect lot should be retested. If the confirmation results indicate the presence of coliforms, the lot should not be used for potable purposes. In all cases of suspected nonpotable bottled or packaged water, the notified veterinary detachment will initiate appropriate suspension of issue and recall actions. If no other source of potable water is available, bottled or packaged water that has tested positive for coliforms may be issued for consumption with the stipulation that an additional disinfectant such as iodine, Chlor-Floc, or chlorine bleach is used to disinfect the contaminated water according to FM 4–25.12 (or using information from appendix I in this TB MED).

C–8. Bottled water risk assessment procedures

a. Consider each of the three primary factors involved in the risk: (1) source quality, (2) adequacy of PVNTMED support, and (3) supply and storage conditions, as follows:

(1) *Source quality.*

(a) Approved. A source approved for DOD procurement and listed in the Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement for the respective command.

(b) Unapproved. A source not listed or removed from the Directory of Sanitarily Approved Food Establishments for Armed Forces Procurement for the respective command. Note that unapproved sources should never be used. Requests for approval of new sources according to MIL STD 3006A should be submitted to the appropriate PVNTMED or veterinary activities.

(2) *Adequacy of PVNTMED support*.

(a) Adequate. There are sufficient PVNTMED assets in theater to test bottled water as described in paragraph C–7 at multiple locations in theater while also accomplishing other PVNTMED surveillance activities.

(b) Marginal. PVNTMED assets are available in theater, but other duties and surveillance activities reduce their ability to test bottled water as described in paragraph C-7.

(c) Low. There are not enough PVNTMED personnel in theater to test bottled water as described in paragraph C–7 in addition to other PVNTMED surveillance activities.

(3) *Supply and storage conditions.*

(a) Adequate. Shipping and storage facilities protect individual bottles from the sun and temperatures exceeding 90 °F, and shipping / storage times from the manufacturer to the individual service member are less than 3 weeks.

(b) Marginal. Shipping and storage facilities protect individual bottles from the weather, the sun, and temperatures exceeding 90 °F, but shipping/storage time from the manufacturer to the individual service member is longer than 3 weeks.

(c) Low. Shipping and storage facilities do not protect individual bottles from the weather, the sun, and temperatures exceeding 90 °F, and shipping/storage time from the manufacturer to the individual service member is longer than 3 weeks.

b. Based on the assessment of each factor, identify the applicable scenario using table C–1. Note that the numbers in each box of figure C–1 correspond to the scenario in table C–1.

c. Using figure C–1, determine the level of risk of soldier illnesses or reduced mission performance as a result of ingesting microbiologically contaminated bottled drinking water.

C–9. Additional support

Additional support on topics associated with bottled water use in deployment operations can be obtained from the USACHPPM WSMP at DSN (312) 584–3919, comm (410) 436–3919, and e-mail: water.supply@apg.amedd.army.mil.

Table C-1
Evaluation of the risk of soldier illnesses from ingesting microbiologically contaminated bottled drinking water[1]

Scenario	Source	PVNTMED support	Supply & storage conditions	Risk	Risk class
1	Approved	Adequate	Adequate	Low	IV/E
2	Approved	Adequate	Marginal	Low	IV/D
3	Approved	Adequate	Low	Low	IV/C
4	Approved	Marginal	Adequate	Low	III/E
5	Approved	Marginal	Marginal	Low	III/D
6	Approved	Marginal	Low	Moderate	III/C
7	Approved	Low	Adequate	Low	II/E
8	Approved	Low	Marginal	Moderate	II/D
9	Approved	Low	Low	High	II/C
10	Unapproved	Adequate	Adequate	Low	II/E
11	Unapproved	Adequate	Marginal	Low	II/D
12	Unapproved	Adequate	Low	Moderate	II/C
13	Unapproved	Marginal	Adequate	Low	II/E
14	Unapproved	Marginal	Marginal	Moderate	II/D
15	Unapproved	Marginal	Low	High	II/C
16	Unapproved	Low	Adequate	Moderate	II/D
17	Unapproved	Low	Marginal	Moderate	II/D
18	Unapproved	Low	Low	High	II/C

Note: [1] No scenarios present an Extremely High Risk, and only one presents a High Risk. The risks determined must be factored in with other risks for the commander to consider courses of action.

			Probability				
			Frequent	**Likely**	**Occasional**	**Seldom**	**Unlikely**
			A	**B**	**C**	**D**	**E**
Severity	**Catastrophic**	**I**					
	Critical	**II**			**9,15,18**	**8,14,16,17**	**7,13**
	Marginal	**III**			**6,12**	**5,11**	**4,10**
	Negligible	**IV**			**3**	**2**	**1**

Numbers in risk level boxes correspond to scenario numbers in table C-1.

Key	Risk Level
	Extremely High
	High
	Moderate
	Low

Figure C–1. Risk levels associated with the factors involved in a bottled water microbiological contamination event

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Appendix D

Predeployment Planning: Preventive Medicine Estimate Checklist for Drinking Water

D-1. General
The PME checklist for drinking water addresses the METT–TC (see FM 3–0). Each METT–TC term is explained below.

D-2. Mission
PVNTMED personnel should identify the following when developing the PME and input to the intelligence preparation of the battlefield (IPB) with regard to drinking water quality requirements and the specified mission:

a. What units will be involved in the operation, what is their manpower strength, and what will they be doing?

b. What is the mission, and what level of risk is the commander willing to accept?

c. Where and when will the operation begin, and how long will it last?

d. What is the plan for using bottled water? What is the plan and timeframe for transitioning to quartermaster-unit purified and distributed water?

e. Are there potential biological, chemical, or radiological contaminants or endemic waterborne diseases in the projected AOs that could adversely affect individual or unit health and jeopardize the mission?

D-3. Enemy
Doctrinally, the analysis of the enemy includes current information about the enemy's strength, location, activity, and capabilities. It is very important to review historical and predict probable enemy actions. That will require information and assistance from G/J/S–2 units and personnel and/or USACHPPM DDAPI Program's DOD Occupational and Environmental Health Surveillance Data Repository. Information to gather/consider/address with respect to drinking water threats includes—

a. The likelihood that terrorists, enemy units, local insurgents, or sympathetic local national civilians might target water system components.

b. The types of chemical, biological, or radiological agents the enemy might use.

c. The existence of any residual biological, chemical, or radiological contamination resulting from prior military or industrial activity that could have contaminated potential water sources.

d. The local population or government's track record with respect to creating and allowing/ignoring or preventing/mitigating environmental contamination.

D-4. Terrain and weather
The terrain and weather may significantly impact the presence and concentrations of various contaminants in surface water, ground water, and water from existing wells. Information to gather includes—

a. What kinds of industrial activities are/were present in the projected AO, what chemical, biological, or radiological materials do/did they use, how/where were they stored, and what was done with the waste products?

b. What kinds of pesticides have or might have been used on any agricultural land in the projected AO?

c. What potential effects will runoff from the local terrain have on the quality of water sources in the area? Where will it go? What contaminants will it carry?

d. What are the local weather patterns, and how will they affect the quality of potential water sources?

e. How will the local weather affect water consumption?

D-5. Troops and support available
Unit and individual exposures to contaminants that may get into field water will vary among units and soldiers depending on unit employment and individual tasks. Individual training, fitness, and climate acclimation levels will also affect individual exposures through the different volumes of water they drink. Questions to address include—

a. What percent of deploying units/soldiers are acclimated to the temperature and humidity of the anticipated AO?

b. What are their general levels of physical fitness?

c. Are there endemic diseases other than waterborne that could impact individual or unit health and readiness?

d. Have PVNTMED units and FSTs been adequately staffed, equipped, and trained in sampling and analyzing water and in assessing and managing risk? Do they have the resources to conduct adequate surveillance and implement anticipated control measures?

e. Will operational units require additional support from PVNTMED detachments or other PVNTMED levels (III-V)? Have these needs been coordinated?

D-6. Time available
The severity of the health risks resulting from any of the contaminants discussed in this TB MED will be proportional to the frequency (daily consumption) and duration of exposure to each contaminant. The following are specific items that should be investigated during the potential contaminant identification process:

a. Will one or more drinking water sources be used during the operation? How long (days, weeks, months) will each source be used to provide water to a specific unit?

b. Will it be necessary to identify additional water sources to be used intermittently to reduce the duration of use of lower quality water? Are such sources available?

D-7. Civilian considerations

Environmental water quality is often affected by the attitudes and capabilities of the local population and government with respect to public health, sanitation, and environmental protection. The following are specific items that should be investigated as early as possible in the planning stages of deployments:

a. What are the local practices for handling and disposal of sanitary sewage, solid wastes, and industrial wastes?

b. What technologies does the local population or government have for protecting natural waters from contamination by liquid and solid waste, and to what extent are those technologies employed?

c. What environmental protection laws/rules/regulations have been enacted to protect natural waters in the projected AO, and to what extent are they followed/enforced?

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Appendix E

Field Water System Vulnerability Assessments

E-1. Introduction
Drinking water is a critical asset on the battlefield. Water for cooking and sanitation are also important and necessary to preserve force readiness, health, and morale. Any disruption of the normal flow of potable, palatable water from the raw water source to the cups, canteens, and personal hydration devices of field personnel is undesirable. Depending on the current tactical situation, such disruptions can cause unacceptable reductions in force protection and readiness ranging from individual disgruntlement to dehydration, sickness, and death. FWSVA is a tool used to evaluate a drinking water system and its operation from the standpoint of vulnerabilities or weaknesses that could be exploited by aggressors. The vulnerabilities of concern, if exploited, could result in physical damage to or destruction of water system assets, or chemical, biological, or radiological contamination of the field water supplies. After the vulnerabilities have been identified and prioritized by risk level, focus actions and resources on those vulnerabilities with higher risk levels to reduce them to acceptable levels.

E-2. Responsibility for field water system vulnerability assessment
PVNTMED units are responsible for conducting FWSVAs according to JCS Memorandum, MMCM-0006-02. It states, "For all deployments, subordinate medical activities [will] conduct timely, standardized, comprehensive surveillance, risk assessments, and … water-vulnerability assessments identifying difficulties in maintaining a potable water source, essential nonpotable water availability needs, and vulnerability to sabotage or process upsets." The FWSVA process and procedures need to be presented to and discussed with other units and individuals who have access to and responsibility for various aspects of water treatment and distribution including the commander of the area served by the water system.

E-3. Methodology
Fixed facility water system vulnerability assessments (WSVAs) are described in USACHPPM TG 188. This appendix is a distillation of the information and procedures described therein with a focus on field drinking water systems. As with the WSVAs described in TG 188, the risk assessment method employed for FWSVAs is based on the ORM processes described in FM 100-14. The FWSVA is concerned with steps 1 and 2, and the first actions of step 3. At that point, the documented FWSVA is briefed and given to the commander, and the commander incorporates it into the overall ORM process for the entire operation and decides whether or not to implement the recommended actions. The risk management process described in FM 100-14 consists of six major steps with subtasks similar to the following:

a. Step 1, identify hazards (vulnerabilities) of the field water system:
(1) Identify the potential aggressors.
(2) Identify the system assets.
(3) Determine potential threat events for each asset.

(4) Evaluate current security and mitigating factors to prevent threat events.

b. Step 2, assess hazards (vulnerabilities):

(1) Estimate the probability of occurrence of each threat event.

(2) Estimate the severity of each threat event if it were to occur.

(3) Determine the risk levels for all threat events and prioritize them.

c. Step 3, develop risk reduction actions and estimate residual risks:

(1) Generate actions that will reduce unacceptable risks (reduce either the probability or severity or both).

(2) Estimate potential residual risks.

(3) Decide whether to implement risk reduction actions.

d. Step 4, implement selected actions.

e. Step 5, monitor and evaluate effectiveness of implemented actions.

f. Step 6, return to Step 3 if the evaluation indicates the need for additional actions.

E-4. Classification guidance

Generally, all information collected during the FWSVA will be considered For Official Use Only (FOUO) and maintained with positive control. In the field, the FWSVA team leader will discuss the security classification of the collected information with the appropriate security personnel responsible for the area the water system supports. The final written report will be given to the commander, and he will determine its proper disposition in consultation with his security advisors.

E-5. Predeployment preparation

If time is available prior to the deployment, the individual responsible for conducting the FWSVA will gather as much information about the planned water system as possible. He should participate in the PVNTMED IPB, the predeployment water source reconnaissance, and water treatment unit site selection, or at least discuss the information with the person who does, and provide appropriate guidance and recommendations concerning procedures to minimize water system vulnerability from the outset. Sources of intelligence concerning proposed deployment areas are discussed in chapter 4. Any information that can be garnered from engineer, quartermaster, security, or other personnel who are involved in field water system planning, establishment, operation, or security will be helpful to have for the onsite FWSVA.

E-6. Performing the FWSVA

FWSVAs should be performed by a team led by a PVNTMED Officer (Environmental Scientist, Sanitary Engineer, Entomologist, or Health Physicist) or NCO (91S). At least two individuals should conduct the assessment, but additional team members can reduce the burden of collecting information and making subjective judgments. One or more personnel who have interaction with and responsibility for the operation and protection of the personnel, location, equipment, and supplies related to drinking water production, distribution, and quality can make up the rest of the team. Paragraph E–7 contains a list of units and personnel and their responsibilities associated with field water systems to help identify potential team members and sources of information.

a. Step 1, identify the hazards. In terms of field water system vulnerabilities, a hazard exists when an aggressor is potentially capable of adversely affecting any part of the water system. To define the hazards, the team must identify the potential aggressors and targets and evaluate their accessibility to the potential targets.

(1) *Potential aggressors.* In the field combat setting the most obvious external aggressor is the enemy. However, the team must also consider the possibilities that members of the local population, terrorists, vandals, and angry or disgruntled soldiers and civilian personnel might want to poison, destroy, or disrupt the water system. The ability of these different aggressors to be successful depends on the complexity of the intended threat event, the aggressors' technical prowess, their knowledge and understanding of the water system components and operation, and the equipment, vehicles, and weapons, including chemical and microbiological contaminants, they have at their disposal. Team members should get as much threat information as possible from intelligence and security personnel concerning the presence and abilities of these different groups in the AO. Commanders as well as chaplains and other support personnel can provide insight as to the morale of units and deployed personnel to help assess the potential internal threat of sabotage. In lieu of definitive or adequate information, the assessment team can presume that there are both external and internal adversaries that are technically savvy, well acquainted with the water system and its operation, well equipped, and highly motivated. Such an approach will produce a worst-case scenario and result in a conservative FWSVA.

(2) *Potential targets. I*dentifying the water system components that would be considered targets of opportunity by potential aggressors in field water systems is not difficult since there is not a lot of variability among field water systems and operations. Table E-1 identifies seven major components and typical sub-elements of field water systems that could be targeted by aggressors. The assessment team should contact engineer, quartermaster, and transportation units as necessary, review available system maps, and visit the location of each potential target to gain a good understanding of the overall AO water system and the function and importance of each component.

(3) *Onsite system assessment.*

(a) Commander's briefing. It is important to brief the commander of the AO that the water system serves to let him know the importance and usefulness of the FWSVA. Use the list in paragraph E-1 to develop an invitation list for the briefing. Have the commander's staff setup the briefing and contact those who should attend. Some units and individuals who might not otherwise be supportive will attend a briefing at the invitation of the commander, and he can task them to support you. The purpose of the briefing is to meet the stakeholders and to explain the purpose and scope of the project. It will be important to record the attendees' names and contact information to facilitate possible later discussions. The team leader should present the following information at the briefing:

Table E-1
Typical target field water system components

Target component	Elements of concern
Water sources	Existing water systems, surface water (lakes, rivers, springs), ground water (community wells, rural wells, drilled wells), bottled/packaged water, potential contamination from an accidental or intentional release of a toxic industrial chemical from a facility upstream from the water source
Intakes and pumping stations	RO-based WPS intakes, hoses, valves, pumping and distribution stations, chemical storage, chemical injectors (hypo-chlorination tanks)
Treatment units	600-, 1500-, and 3000-gph ROWPU and associated equipment, bottled and packaged water production facilities, host nation treatment plants
Distribution systems	Water supply points, potential cross connections in laundry and shower services, valves, hose lines, tactical distribution systems, access points within distribution system, host nation distribution systems
Water storage	20,000- and 50,000-gal collapsible fabric tanks, 3000-gal onion tanks, water tank trucks, water trailers, 5-gal containers, canteens, personal hydration devices, and bottled/packaged water facilities
Power supply	Generators, transmission lines, transformers
Communications	Telephones, radios, telemetry

1. The purpose of the FWSVA.
2. The survey procedures to be followed.
3. The time frame for performing the survey.
4. the implications of the FOUO classification of information to be gathered.
5. The disposition and availability of the final report.
6. All other pertinent information relating to meeting with different units/individuals during the assessment.

(b) Review of available military intelligence resources. One of the most important components of an FWSVA is the acquisition of accurate intelligence. Accurate intelligence gathered near the water system and surrounding military assets is used to help the assessment team determine the probability of attack scenarios. Without accurate intelligence, teams bias the assessment by relying solely on personal judgment and experience. If possible, before deploying to the TO, classified threat assessments specific to the local and any surrounding installations should be obtained. These assessments should be reviewed to determine specific types of threats and previous incidents, specifically those concerning water supply. During the assessment, the

unified command intelligence and security representative (J2) should be contacted. Information acquired from the unified command will better describe the overall threat. If possible, the assessment team should visit unified command intelligence representatives enroute to the subject water system/installation. After arriving at the subject water system/installation, local military intelligence representatives should be contacted. Information regarding documented security incidents and threats in the surrounding area should be obtained. Local threat assessments should also be reviewed.

(c) Physical inspection of assets (targets). A critical part of the FWSVA deployment phase is the physical inspection and evaluation of the field water treatment, distribution, and storage assets. The team inspects the assets for four reasons:

1. To become more familiar with the location, capabilities, assets, and operations of the field water system components.

2. To consider potential threat events that could cause physical harm to or contaminate the system.

3. To assess the ability of the current security measures to prevent the aggressors from causing those events.

4. To identify deficiencies in any of those areas that represent weaknesses in the safety and security of the water system.

(d) Teams. During the FWSVA, quartermaster personnel should escort the team, explain the system operating procedures, and answer questions from the team members. Team members should record their observations in field notebooks for reference later in the assessment. After visiting each potential target, team members should review their notes and lists of elements with the system operators to ensure completeness. If possible, digital photographs should be taken of all components and elements for easy reference and as reminders when analyzing vulnerabilities at a later date. Pictures of specific vulnerabilities or weaknesses in security can convey definitive information to the commander and other personnel during the post-assessment briefing. The team leader must get permission to take pictures prior to conducting the FWSVA.

(e) Security evaluation. During the onsite visits, team members should consider how easily an aggressor might be able to contaminate, ruin, or destroy each potential target. They should identify existing physical and operational barriers to an attack. Army FM 3-19.30 is an excellent source of information on physical security. For the purposes of the FWSVA, table E–2 shows different kinds of security items and measures that team members should look for and evaluate for effectiveness. Some of the listed items will obviously not apply in all situations. Physical barriers' presence and function are generally easily discerned. Operational barriers include operator presence and routine checks on equipment and supplies, and security rounds performed by quartermaster operators, unit personnel, and military or contract security personnel. These barriers must be discovered through conversations with appropriate personnel who have knowledge of the specific operations.

Table E-2
Examples of physical and operational security measures that may be employed at various locations in field and semifixed water systems

Types of measures	Security items/measures
Physical security	Fences, locks, signs, bars on windows, lighting, vehicle barriers, anti-climb devices on ladders, screens on vents/drains/overflow outlets, security cameras, intrusion detection systems
Operational security	Security patrols/inspections, operational and maintenance rounds, required ID badges for non-uniformed personnel, parking policy, set-back distance
Other system protection	Chlorine residual test frequency, other routine water quality sampling, shut-off valves, availability of replacement parts, CBRNE filter sets, fire suppression equipment
Practices that monitor protection	Equipment calibration, routine quality control checks, active maintenance/cleaning programs, daily inspections , ID checks, testing of alarms, incident response rehearsals, functional checks of emergency/back-up equipment, monitoring sick call, an aid station, and medical facility illness trends

(f) FWSVA documentation. Team members can use DA Form 7575 (FWSVA Worksheet) to evaluate and document each area of concern for possible threats against each potential target identified either during or after the onsite survey (fig E-1). It may be easier to take notes in a field notebook and fill in the worksheet electronically afterwards. Instructions for completing the worksheets are also in figure E-1.

(g) Document review. After the physical inspection, finish reviewing any quartermaster operation and maintenance logs and PVNTMED inspection checklists concerning field water, water quality testing results, standing operating procedures (SOPs), water quality monitoring plans, and emergency/contingency plans. This review is to ensure that testing and monitoring are being conducted and to ensure that if contamination of field water were to occur, early detection and early containment is possible.

(4) *Interviews*. Personnel who are involved in any portion of the field water operations should be interviewed. The greatest insights about vulnerabilities are frequently gained by speaking with personnel who have the daily responsibilities for the field water treatment and distribution system and those who guard and secure the field water. Paragraph E–8 contains an example of a water system-related interview questionnaire.

b. Step 2, assess the hazards (vulnerabilities).The risk management process described in FM 100-14 is used to determine the overall risk posed by aggressors to each target component. The

FWSVA WORKSHEET

For use of this form, see TB MED 577; the proponent agency is OTSG.

1. COMPONENT	2. ID#	3. LOCATION
Source/Treatment	23 QMC-0105	Near Baghdad 34-34-055N 115-52-030E

4. ELEMENT	5. PICTURE
Source A Infiltration well near river 15' diameter	[X] YES [ ] NO

6. THREAT	7. PHYSICAL DAMAGE/DESTRUCTION	8. CONTAMINATION
SECURITY (ACCESSIBILITY)	Short fence chain link, barbed wire - camouflage	Outside of main fenced compound - underground line
REDUNDANCY (BACKUPS)	No backup for pump or generator	Bottled water available at warehouse 50km-Logistics
OTHER PROTECTION MEASURES	Operators within 50m, 24hr surveillance - but playing cards	Treated by ROWPU
PROTECTION MONITORING	MPs not aware of threat to water system	Quarterly sample to CHPPM daily inspection by ROWPU OPS
KNOWN DEFICIENCIES	No lights at night - near well travelled road - vandals	Industrial area nearby - easy access to chemicals
PROBABILITY	[ ] A [X] B [ ] C [ ] D [ ] E	[ ] A [ ] B [ ] C [X] D [ ] E
SEVERITY	[ ] I [X] II [ ] III [ ] IV	[ ] I [ ] II [X] III [ ] IV
INITIAL RISK	[ ] Extremely High [X] High [ ] Moderate [ ] Low	[ ] Extremely High [ ] High [ ] Moderate [X] Low

9. ELEMENT	10. PICTURE
2 ea. 600gph ROWPU 18hr/day operation	[X] YES [ ] NO

11. THREAT	12. PHYSICAL DAMAGE/DESTRUCTION	13. CONTAMINATION
SECURITY (ACCESSIBILITY)	Inside fenced compound Double fence - concertina top	MP frequent roving patrols
REDUNDANCY (BACKUPS)	3 units available; only use 2 3rd unit in same location	Bottled water - don't know who much possible truck from other nearby units
OTHER PROTECTION MEASURES	No camouflage	No general access - even to GIs Good PA program on water security
PROTECTION MONITORING	Hourly Chlorine - TDS PM does bact wkly	See discussion on back page
KNOWN DEFICIENCIES	Within grenade toss of fence line	Host Nation passersby show great interest in operation
PROBABILITY	[ ] A [ ] B [X] C [ ] D [ ] E	[ ] A [ ] B [ ] C [X] D [ ] E
SEVERITY	[ ] I [ ] II [X] III [ ] IV	[ ] I [ ] II [X] III [ ] IV
INITIAL RISK	[ ] Extremely High [ ] High [X] Moderate [ ] Low	[ ] Extremely High [ ] High [ ] Moderate [X] Low

DA FORM 7575, NOV 2005 APD V1.00

Figure E-1. DA Form 7575, FWSVA Worksheet

Legend for Figure E-1, DA FORM 7575

DA Form 7575 may be used to record and organize information gathered during an FWSVA. Assessment team leaders and members can use it in the following suggested manner. It would probably be filled out by hand during the onsite assessment of each asset.

Component: Use this block to identify the major component or asset of the water system such as: Raw Water Source, Treatment System, Storage Facility, Distribution Point.

ID #: Give the component an ID number. It can be any alphanumeric number you like, as long as it is unique and identifies this component uniquely compared to other components visited during the FWSVA.

Location: Identify the location using GPS if possible. If not, use a map and list grid locations.

Element: If the water system component has multiple parts that are differentiable with respect to the threat, enter the specific element here. See table E-1 for examples of elements of water system components.

Picture Y___ N___: Check here whether or not the team took a picture of this particular element.

Threat: The two primary threats of concern for field water systems are listed as column headings for the following five rows. As the assessment is made, some of the measures observed and evaluated will apply to physical damage and destruction, and some to contamination. Most will apply to both. The separate columns are provided to help team members maintain the dual threat focus. Also remember to think in terms of the probability and severity of threats against the specific element as the assessment proceeds. Remember to consider, under the contamination heading, the potential for contamination from an accidental upstream release of a toxic chemical.

Security: Enter existing physical security measures that control accessibility to each element.

Redundancy: List any back-up equipment/systems that could be used to replace the specific element if it were disabled or destroyed. Ask, "What options are available if this element becomes inoperable, is destroyed or is contaminated, and how rapidly could they be implemented?" Quartermaster and engineer personnel should be able to answer those questions.

Other protection measures: Identify other measures that provide protection against an attack. Include here, for instance, water quality monitoring information such as the frequency of chlorine residual and bacteriological evaluation of the system by operators, PVNTMED, and other personnel.

Current practices that monitor protection measures: List any actions employed to ensure that that the existing protection measures are functioning. These might include status checks by supervisors, unscheduled inspections by higher commands, and any other practices that add assurance to security measures.

Known deficiencies: Record any existing deficiencies observed or reported in the operation or structure of any of the components and assets. Some may be obvious, and others may become evident through questioning of operators during the assessment visit.

Probability: Check the probability category determined for the element as described in paragraph E-6*c*(1), where the letters A, B, C, D, and E represent the probability categories Highly Likely, Likely, Probable, Questionable, and Unlikely, respectively.

Severity: Check the severity category determined for the element as described in paragraph E-6*c*(2), where roman numerals I, II, III, and IV represent the severity categories Catastrophic, Critical, Marginal, and Negligible, respectively.

Initial Risk: Check the overall initial risk determined for the element by combining the probability and severity ratings using figure G-1 as described in paragraph E-6*c*(3).

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team leader, with other team members if possible, determines the overall baseline risk of each threat event based on the probability that the event will occur and severity of the event if it does occur according to the definitions presented below.

(1) *Probability of event occurrence*. Having gathered all the intelligence and information necessary, the team can at this point estimate the probability, or likelihood, that an aggressor could successfully exploit any weaknesses identified in step one. The determination is subjective and takes into account all those items addressed above. Five categories of probability are used in the risk management process. Table E–3 lists these categories from highest (category A, highly likely) to lowest (category D, unlikely) probability. The five categories provide a fairly continuous spectrum of probabilities that may be difficult to choose from. If the team is more comfortable using only three levels of probability as they make their determinations, any three consecutive categories may be used with the selection based on the overall perceived threat in the area. Based on information gathered from security and intelligence units, if the threat is generally high, the choice would be A, B, and C. If it is minimal, C, D, and E could be used, and if the overall threat level is in between high and low, B, C, and D could be used. If less than all five categories are used to make the determination, it is important to document in the FWSVA report the reasons for the categories selected. The probability of occurrence determined for each threat event should be checked or circled in the appropriate row of the worksheet.

Table E-3
Hazard probability estimates

Probability estimate	Criteria
A **Highly likely**	High value target. Easy to execute. No or minimal deterrent safeguards. No specialized training required and very little equipment required. *(80 to 100 percent success rate)*
B **Likely**	High value target. Low level of training needed, and supplies are easily obtained. Minimal protective measures in place. *(60-80 percent success rate)*
C **Probable**	Any target. Capability exists and current security measures are inadequate to deter. Collusion with an insider could provide the necessary access, training, and equipment. *(40-60 percent success rate)*
D **Questionable**	Remotely possible. Specialized knowledge, training, and equipment required. Information may be obtained by an outsider from generic sources. *(20-40 percent success rate)*
E **Unlikely**	Can assume aggressor would not attempt this or would not be successful due to lack of capability and existing control measures. Relies on facts not easily obtained by an installation outsider. *(0-20 percent success rate)*

(2) *Severity of threat events*. Next, the team determines the extent of the damage that would be done if specific threat events were to occur. To properly evaluate the severity to the system and to personnel, certain criteria must be established from the beginning of the assessment. Severity determination factors include what immediate damage is done and whether the damage is recoverable or not. Can the damage be bypassed? Can the system be repaired or decontaminated? If so, how long will it take? Are there backup equipment and supplies on hand or will they need to be ordered? How many personnel will get a little sick, very sick, or die? Can the mission still be accomplished? Table E-4 contains suggestions on how to weight different kinds of threat events to come up with an estimate of their severity. Consider each threat event, as before, and enter the selected severity in the appropriate row in the worksheet.

Table E-4
Severity rating table

	Physical destruction	**Contamination**
I Catastrophic	• Complete loss of ability to provide safe drinking water to large part of or entire AO • Will take more than 2 days to restore service	• Medical threat - causes death or widespread severe illness in all or large part of AO • Will result in mission failure
II Critical	• Severely damages ability to provide an adequate volume of safe drinking water to specific areas in the AO • Service restoration will take more than 1 day	• Health threat – causes severe illness in some individual soldiers, or minor illness in many, but debilitating none or few • Reduces multiple units' effectiveness, makes mission accomplishment questionable
III Marginal	• Can replace damaged section/unit or bypass damage and still produce water with delay of 1 day or less • Can still meet 75 percent of required daily production	• Health threat - causes minor illness in a few susceptible individuals and/or units • Affects taste and odor only • Mission accomplishment not jeopardized
IV Negligible	• Little or no adverse impact on ability to provide an adequate volume of safe drinking water • Little property damage • Does not affect normal equipment operation	• No apparent adverse effects on individual or unit health • Disinfectant residual can destroy contaminant type and concentration added

(3) *Baseline or initial risk.* Using the probability and severity categories chosen for each element, determine the overall risk posed to that element using the risk assessment matrix below (fig E-2), and enter the result into the last row of the worksheet. Risk is expressed in terms of

Extremely High, High, Moderate, and Low. The categories are presented in the worksheet as EHi, Hi, Mod, and Low, and may be checked or circled. These values represent the baseline or initial risk assessment of the field water system components or assets. The assessment team now lists the components and related elements in priority from highest to lowest risk. The list can be recorded in a table similar to the one shown in figure E–3 (DA Form 7576, FWSVA Summary Data Sheet). The rank-ordered list of target components provides the basis for a presentation to the commander and for recommending improvements to the identified system components to reduce or mitigate unacceptably high risk situations.

	Hazard probability				
Hazard severity	**Highly likely**	**Likely**	**Probable**	**Questionable**	**Unlikely**
Catastrophic	Extremely high	Extremely high	High	High	Moderate
Critical	Extremely high	High	High	Moderate	Low
Marginal	High	Moderate	Moderate	Low	Low
Negligible	Moderate	Low	Low	Low	Low
	Risk estimate				

Figure E-2. Relating hazard probability and severity to overall risk

FWSVA SUMMARY DATA SHEET

For use of this form, see TB MED 577; the proponent agency is OTSG.

FWSVA SUMMARY DATA SHEET PURPOSE	TEAM LEADER	DATE *(YYYYMMDD)*
		20050123

ID #	ELEMENT	INITIAL RISK	RECOMMENDED IMPROVEMENTS	RESIDUAL RISK
23QMC 0105	Source A	Physical High	Have MPs patrol the area 2xdaily Tell operators to be vigilant. Increase fence height PROB C	Still High
23QMC 0105	Source A	Cont. Low	Continue to provide ROWPU treatment. Reevaluate if that changes	Still Low
23QMC 0105	ROWPU	Physical Moderate	Camouflage unit - move backup ROWPU to other side of compound PROB D	Low
23QMC 0105	ROWPU	Cont. Low	Find out how much B.wat is available and contact other units to set up help if needed	Still Low
23QMC 0105	Distribution Waterpoint A	Phys./Cont. Ext High	Stop letting Host Nation personnel use water unmonitored - lock spigots when unattended PROB B	High
23QMC 0105	Distribution Waterpoint B	Cont. Ext High	Close and lock all water buffalo hatches. Get FST to check residual 2xdaily. Provided added training to FST PROB D	Low
	Reminder Comment		Set up exit briefing time with XO, Security, Log, Eng, QM	0800 Fri.
	Comment		Need to check with AAFES on bottled water availability in case of emergency	
	Comment		MPs were very willing to include water assets to their patrol list	

DA FORM 7576, NOV 2005 APD V1.00

Figure E-3. DA Form 7576, FWSVA Summary Data Sheet

Figure E-3, DA Form 7576 Notes

[1] ID#, element, and initial risk are transferred from FWSVA worksheet.
[2] Residual risk is that risk that remains after implementing the recommended upgrade to reduce either hazard probability, hazard severity, or both.

Legend

DA Form 7576 may be used to consolidate and prioritize the risk determinations made for the components and elements of the field water system during an FWSVA. The worksheet and the information in it can be used to provide a summary of pertinent FWSVA results to commanders and other individuals responsible for the safe and secure operation of the field water system.

Starting with the component with the highest initial or baseline risk, and moving downward both on the figure and in risk levels, enter the information in each column as follows:

ID #: Transfer the ID # for the specific component from the FWSVA worksheet that was filled out for that component during the onsite survey.

Element: Enter a short description indicating the specific element of the identified component.

Initial Risk: Enter the initial risk category from the FWSVA worksheet.

Recommended Improvements: Enter the improvements that the team or team leader has identified that, if implemented, will reduce the probability and/or severity related to the element and produce a reduced risk.

Residual Risk: Enter the (reduced) residual risk category from figure E-1 that is expected to describe the element after the recommendations are implemented to reduce the probability and/or the severity.

c. Step 3, develop risk reduction recommendations. Upon completion of the risk assessment, the next step in the FWSVA process is to identify means of reducing the risk to the most vulnerable areas so recommendations can be made to the commander. The recommendations should always be practical and result in a reduction in the initial or baseline risk. Risk is reduced by taking actions that reduce the hazard probability, the hazard severity, or both. As the team considers security improvements for each element with an unacceptable risk, the changes in probability and severity that would result from implementing the recommendations should be considered to determine if they will reduce the risk to that particular component, element, or system. If so, the information should be recorded and presented to the commander for him to make a decision on what priority to give the recommendations in combination with his overall risk management of the operation. DA Form 7576 can be used to present a summary of the FWSVA results to commanders and other concerned parties. After transferring the ID#, target component or element name, and the baseline risk from the FWSVA worksheet onto the report sheet, the recommendations and new risk level should be added. This completed summary sheet should provide a concise view of the FWSVA results that will be useful to decision makers concerned with the protection of field water systems. It should be completed and included with the report that is briefed and presented to the commander. Some suggested methods of increasing protection in the field which may or may not be applicable to a particular operation include:

(1) *Improving physical security.* Emphasis should be placed on restricting access to the water system components at highest risk. Upgrading or installing physical barriers, such as fences, concertina wire, and locks, reduces the likelihood of a terrorist attack. Improving lighting can serve as a deterrent in situations where it does not compromise battlefield cover and concealment requirements. Increasing the frequency of security inspections increases the chance of early detection of an intrusion.

(2) *Increasing water quality monitoring.* Increasing the frequency and locations of water quality monitoring improves the chance that a contamination event will be detected soon after it occurs.

(3) *Developing or improving a field water emergency response plan.* While not required by regulation, written and rehearsed emergency response plans can provide a degree of order amidst the chaos of water system attacks. Each unit and individual knowing what their responsibilities are and how to execute them in an emergency situation will, at a minimum, reduce reaction and recovery times appreciably. Plans should be rehearsed and revised, and should address potential repairs, spare equipment and parts procurement and installation, potential alternate water and power sources, and notifying higher headquarters.

(4) *Repairing observed deficiencies.* One of the easiest methods of reducing vulnerabilities is to fix any observed deficiencies in existing protection measures. These deficiencies were identified in step 1 of the vulnerability assessment. Corrective action can be as simple as repairing a hole in a fence or informing the military police of the locations of distribution lines and asking them to patrol them.

(5) *Increasing medical surveillance.* Interaction with local medical authorities is important in identifying potential water quality problems, especially biological agent contamination. Since

there is a delayed onset of symptoms for many diseases, increased hospitalizations may be the first sign of trouble. PVNTMED personnel need to actively monitor admissions and sick-call visits for illness trends or spikes.

(6) *Optimizing RO-based WPS operations.* A properly operated RO-based WPS is a great countermeasure against contamination of the raw water source. Ensure that the operators are competent and that they perform the required operational testing at prescribed frequencies or more often.

d. Exit briefing. The assessment team leader should brief the unit commander and pertinent staff on assessment team actions to date, highest identified vulnerabilities, countermeasures that could reduce those vulnerabilities, and the reduced risks. Refer to the FWSVA worksheets and show and discuss the summary report sheet using any photographs that were taken to support the assessment findings and recommendations. Baseline and reduced risks can be changed as a result of the commander's input, concerns, or additional information.

e. Final report. The team leader should prepare a final report in the form of a memorandum for the commander upon completion of the vulnerability assessment exit briefing. The memorandum should identify the team leader, assessment team members, and survey dates, and provide a short description of facilities visited, highest risks identified, and recommended actions to reduce the risks. A copy of the memorandum should also be sent via SIPRNET to USACHPPM DDAPI Program for archiving purposes according to paragraph 6-5*d*. The commander, in concert with his security personnel, will determine the distribution to other authorized recipients.

f. Additional assistance. Additional assistance for all aspects of performing and documenting FWSVAs can be obtained from the USACHPPM WSMP by calling DSN (312) 584-3919 or (410) 436–3919, or by e-mailing water.supply@apg.amedd.army.mil.

E–7. Field units and their relationships to field water system vulnerability

*a. Logistics Civil Augmentation Program contractors***.** These contractors handle all of the logistics, treatment, storage, and sometimes delivery and supply of water in certain instances and locations. In locations where they provide drinking water support, they would have knowledge of the locations of wells, treatment systems, water storage and distribution systems, supply points, bottled/packaged water facilities, and so forth.

*b. Engineers***.** Engineer units are responsible for source development. This includes well drilling and development, construction to support and/or improve tactical water supply points (when necessary), and the construction of fixed and semifixed water treatment and distribution facilities. The Corps of Engineers and appropriate J/G/S-4 staff sections are good resources for determining all well locations and water supply points in the specified AO.

c. G–2 intelligence. The G–2 may have accurate intelligence concerning individuals and groups who may constitute a threat to the security of the water system(s) under consideration. They may be able to provide information on the capabilities and intentions of such individuals and groups, and can provide an estimate of the level of threat in the area.

d. G–3 operations. The G–3 develops and recommends the concept of operations. This includes assigning security responsibilities and missions to subordinate commanders who then plan, prepare, and execute security operations. Every unit has a continuous security role as described in FM 71-100-2, chapter 5. Coordinate with the G–3 to determine which units are securing the RO-based WPS sites and any other area of the water distribution system.

e. Installation commander (semifixed facilities). The commander grants access to water system components (either escorted or unescorted) and permission to photograph waterworks structures and any field water operations.

f. Installation security/military intelligence (semifixed facilities). Similar to G–2, above, installation security and local military intelligence units may be able to provide local threat information as well as guidance on the appropriate classification of FWSVA findings.

g. PVNTMED personnel. PVNTMED personnel should lead FWSVAs. They perform periodic inspections of water sources, test treated water to ensure that water quality standards are met, and inspect water treatment and storage locations. PVNTMED personnel will also know the locations of the various sample collection points in the water distribution system.

*h. Quartermaster***.** The quartermaster has the mission to produce, treat, and distribute potable water on the battlefield in a tactical environment. These water purification units are great allies to the PVNTMED Specialist who must ensure the quality of the water. Additionally, these units are good sources of information. They have the most knowledge about field water treatment, distribution, and storage systems. They will also know about the locations of water supply points and RO-based WPS operations.

i. Subordinate commanders. Coordination with the commanders to view SOPs for security, water monitoring and testing, and speaking with unit field sanitation teams.

j. Unit field sanitation teams. At the company level, field sanitation teams are responsible for checking drinking water quality. These soldiers know all their storage assets and can give information on the testing and disinfection of their water supply. Coordinate with each unit's FST to retrieve information on their unit water supply.

*k. Water treatment plant operators and maintenance personnel (semifixed facilities)***.** Plant operators and maintenance personnel can provide information relating to the locations of access points to distribution system components, the availability of backup and replacement equipment and parts, and potential problem areas in the distribution system. They should also know what monitoring is done (parameters, frequency, location) and have information on currently used on-line monitors, copies of security SOPs/policies of information release, and any ongoing problem areas in the plant.

E–8. Interview questionnaire

The following questions are examples of the kinds of questions to ask key field water personnel during the assessment.

a. What do you think are some of the vulnerabilities of the field water treatment, distribution, and storage system (in ranked order of risk)?

b. How do you think an aggressor would attack the field water system or how would you attack the system based on what you know?

c. What would some of your suggestions be to harden the field water system from these vulnerabilities?

d. Have you witnessed any problems with security? If so, please explain them.

e. Have there been any recent events anywhere in the field water system, such as threat, suspicious activity, or vandalism?

f. What areas of the field water system do you have access to? What is your role in the monitoring program for the field water system?

g. What monitoring equipment do you have? Is it calibrated and maintained?

h. Who has access to the water sampling locations?

i. What is security like at these locations? Is there any guard coverage? If so, where and describe coverage (for example, 2 soldiers at RO-based WPS each 8-hour shift, 24 hours per day).

j. Have the Military Police ever visited this site? Did they recommend any security improvements?

k. Have the Military Police ever been called for an incident? If so, what was the incident, and what was their response like?

l. Are there any concerns with local protestors?

m. Do you receive any alerts from local law enforcement?

n. Do you have an emergency/contingency and response plan? If so, has the plan been tested and when was the last time it was updated?

o. How are sick calls tracked and assessed for incidents of waterborne illness?

p. Who has access to the bottled/packaged water facility?

q. What security measures are in place to guard the bottled/packaged water facility?

r. Is there a monitoring program for the bottled/packaged water?

s. How often is the bottled/packaged water inspected/tested? By whom?

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Appendix F

Field Water Quality Test Kits, Sampling Procedures, and Documentation

F-1. Field water test kits

a. During deployments, PVNTMED personnel collect raw and treated water samples for onsite and remote laboratory analyses to evaluate their quality. Several pieces of field test equipment are available for units to conduct onsite analysis for a variety of contaminants. The WQAS-PM has the capability to test for all TSFWS parameters in the field except for lindane, radioactivity, BZ, and T-2 Toxins. Table B-1 in this TB MED lists the TSFWS and detection ranges for the corresponding test kits in the WQAS-PM.

b. Equipment currently available through the Army Supply System includes—

(1) *WQAS–P: NSN 6630–01–365–5588.* Water treatment personnel use this kit to conduct operational monitoring of the treatment processes. The WQAS–P is capable of testing for pH, temperature, TDS, turbidity, and chlorine residual. It includes an M272 chemical agent water testing kit which is also available separately. It is designed for RO-based WPS operators to monitor water quality parameters that indicate whether or not the raw water is suitable for RO-based WPS treatment during the site selection process, whether CBRNE filters are required, and if the RO-based WPS is operating correctly. It is issued to quartermaster units along with the RO-based WPS. Operational monitoring should be performed as frequently as necessary to ensure proper equipment performance, water potability prior to issue, and detection of significant changes in source water quality that can affect treatment. The operator's manual for the 600-gph ROWPU (TM 10–4610–240–10) recommends hourly checks of the water quality. The WQAS–P replaced the old WQAS–Engineer (NSN 6630–00–140–7820). The operator and unit maintenance manual for the WQAS–P is TM 10–6630–246–12&P.

(2) *WQAS–P: NSN 6630–01–367–9402.* Medical or PVNTMED personnel use this kit along with operational monitoring data they get from the treatment system operators to determine if drinking water is potable according to the TSFWS. The set is designed for onsite testing of raw water sources and treated drinking water. The WQAS–PM consists of: the M272 Chemical Agent Test Kit, the HACH DREL/2400 Complete Water Quality Laboratory (CWQL), and the Bacteriological Test Kit. A brief summary of each of these is provided below. Two individually packaged colorimetric test kits for arsenic, NSN 6550–01–504–2603 and cyanide, NSN 6515–01–504–9610, and the lead test strip kit, NSN 6550–01–504–8617, are also included in the WQAS–PM. The operator's manual for the WQAS–PM is TM 5–6630–215–12.

(3) *M272 Chemical Agent Water Test Kit, NSN 6665–01–134–0885.* The M272 test kit is used to detect and identify harmful amounts of cyanide, mustard, lewisite, and nerve agents in raw water sources. Quartermaster and PVNTMED personnel are required to conduct tests for chemical agents in treated and raw water during CBRNE operations based on the MOPP levels. Table 5–2 shows the required test frequency. The M272 kit consists of 25 containers of reagents, a thermometer and holder, a test bottle, a container of waterproof matches, and instruction cards, enough to do 25 tests for each agent. The presence of chemical agent is detected by distinctive

color changes in the detector tubes when levels of the various agents are present in the water sample. Although the cyanide and lewisite tests cannot detect contamination as low as the TSFWS require, acute health effects resulting from consumption of water contaminated with cyanide or lewisite at concentrations below the detection limits of the M272 test kit are not likely. The operator's manual for the M272 Test Kit is TM 3–6665–319–10.

(4) *DREL/2400 CWQL (HACH #2844700), NSN 6630–01–507–7459.*

(a) The CWQL instrumentation includes the DR/2400 potable spectrophotometer, a digital titrator, a pH and conductivity meter, and a portable turbidimeter. It also provides the apparatus and reagents specifically for monitoring water quality in the field. Every portable laboratory also includes a power supply (110-volt adapter), a comprehensive illustrated procedures manual, and two durable carrying cases, one for equipment and one for reagents. A rechargeable battery unit (HACH catalog # 5949500) is available as an option.

(b) The CWQL provides PVNTMED personnel with the capability to measure 6 physical characteristics of water and to determine the concentrations of 22 chemical constituents. A replacement reagent set (NSN 6550–01–504–8593) is available and reduces the burden on the logistics system by having one NSN for resupply rather than 22 separate items.

(c) The CWQL is expandable and with the addition of specific reagent sets and apparatus it can be used to perform approximately 130 additional water analyses (see HACH Web site @ www.hach.com).

(5) *Microbiological Test Kit (Colilert).* Colilert is an EPA-approved presence/absence test for coliforms in water. The Colilert method detects both total coliforms and *Escherichia-coli* simultaneously using ortho-nitrophenyl-ß-D-galactopyranoside and 4-methylumbelliferyl-ß-D-glucuronide (ONPG–MUG) indicators. All coliforms produce a yellow color in ONPG after 24 hours incubation, and *E. coli* fluoresce in UV light in the presence of the MUG indicator. A color comparator standard to help confirm positive results is available as an optional accessory (IDEXX catalog # WP104). The comparator displays the lowest level of yellow and fluorescence which can be considered positive. A typical positive test is much more intense than the comparator. Another growth media is available as an option that can be used to identify *enterococci*, a natural bathing area contaminant (see the IDEXX Web site, www.idexx.com for additional information). The kit consists of the following equipment:

(a) Colilert Media, 20 or 200-Pack (NSN 6630–01–357–5910 & NSN 6630–01–362–8299, respectively)

(b) Colilert Sample Bottles, 120 mL (NSN 6640–01–389–7029)

(c) Vessel Labels (NSN 7690–01–506–5566)

(d) Field Incubator (NSN 6640–01–466–9987)

(e) Pocket Fluorescent UV Lamp (NSN 6530–01–451–5144)

c. Additional testing equipment is currently being evaluated including commercially available portable water quality laboratories and individual analyte water test kits not part of the military supply system but are being fielded in some situations. If equivalent or better test equipment or kits are available to field personnel, they may be used as substitutes for the issued items described above. Results from testing for constituents not in the TSFWS should be evaluated using the ORM process discussed in chapter 7. Questions should be directed to the USACHPPM WSMP (see table 1–1).

F–2. USACHPPM deployment field water sampling kit

*a***.** The USACHPPM deployment field water sampling kit (DFWSK) was developed as a field-expedient tool for PVNTMED personnel to collect and submit treated water AWSM samples required for all deployments greater than 30 days and any water supply operated for 7 days or longer. The kit is specifically designed for sampling treated water sources (to include host country municipal water or bottled water) to meet OEH/EHSA requirements as described in chapter 6. It can also be used to sample ground-water sources for the EBS as these sources (wells or springs) are not grossly contaminated. For raw water surface water a more traditional EPA kit is available.

b. The DFWSK contains appropriately prepared and prepreserved small sample containers to properly collect drinking water samples to ensure that a laboratory can analyze constituents regulated by the EPA Drinking Water Regulations and Health Advisories. It was specifically designed to accommodate military logistical requirements by minimizing volume and weight. The reduced kit size and sample volume also reduce the levels of quality assurance and quality control measures employed, resulting in somewhat less confidence in the analyses.

c. DFWSKs are shipped to units from USACHPPM and include sets of 40- and 125-mL bottles with the necessary preservative chemicals in the sample bottles and packing material. Each kit also includes instructions that provide step-by-step procedures for collecting and shipping the water samples to a supporting lab. Collecting one set of samples usually takes about half an hour or less. Regardless of whether samples are collected with this kit or other sampling equipment, the water should be analyzed for all the parameters listed in table B–3 to determine if they are present at or above the lowest listed exposure guidelines.

d. Field personnel must follow the instructions that come with the DFWSK to ensure its proper use and submission to an appropriate support laboratory. If this is not done correctly, some or all of the analytical results for the chemical parameters in the AWSM, EBS, or EHSA suites will be invalid. It is important to coordinate with the receiving laboratory prior to shipping the samples to it to ensure that it can perform all the analyses listed in table B–3 using the sample containers in the kit. The USACHPPM main laboratory has developed procedures for accurately analyzing the samples from the kit and achieving the necessary detection levels. Some laboratories may not be able to accommodate the reduced sample sizes, so coordination with analytical laboratories other than USACHPPM is essential. Finally, ALL SAMPLES MUST BE ACCOMPANIED BY A CORRECTLY FILLED OUT DA Form 7577 (Treated Water Sampling Field Data Sheet). Instructions for filling out this data sheet are on the reverse side of DA Form 7577.

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Appendix G

Water Quality Information and Health Effects

G-1. Physical characteristics and chemical and constituents of water

Specific physical characteristics and chemical constituents of water determine whether water is potable or palatable. If any of the parameters are excessive, the water may not be desirable or safe to drink. Both situations can significantly impact the health of personnel and the ability of a unit to complete its mission.

a. Turbidity and color.

(1) *General*. Turbidity and color are physical attributes of natural water that generally make it uninviting to drink. The presence of color and turbidity may or may not represent direct health risks. Historically, the two primary health risks stemming from turbidity and color remaining in treated field-water supplies centered on 1) individuals' refusal to drink the water and their subsequent dehydration, 2) obtaining water from unapproved, more aesthetically pleasing, but contaminated supplies, and 3) microbial contamination protected by particulate matter creating turbidity. Clearly, drinking contaminated water that looks and tastes good results in a reduction in individual readiness when those who drink it become sick with acute waterborne illness. As the percentage of personnel in a unit who drink contaminated water increases, the health threat becomes a medical threat, and unit readiness and effectiveness are compromised. The effects of dehydration are initially more subtle, yet it will result in significant performance degradation and thereby potentially jeopardize mission accomplishment. The debilitating effects of dehydration progress in sequence from discomfort, weariness, apathy, impaired coordination, and delirium to heat stroke.

(2) *Turbidity.* The relationship between turbidity and water rejection has been documented through the use of action-tendency scales that are used to attempt to quantify behavioral responses to stimuli. The relationship illustrated in figure G–1 is direct with the percentage of personnel refusing to drink the water increasing with increased turbidity. The TSFWS for turbidity is 1 nephelometric turbidity unit (NTU) where an estimated 2.6 percent of personnel might refuse to drink the water for short- and long term-uses (5 and 15 L/d consumption). Turbidity levels greater than 1 NTU may make the water appear slightly cloudy and can interfere with disinfection. This is particularly true when the turbidity is caused by organic matter. Achieving turbidity less than 1 NTU will improve the efficiency of disinfection for most pathogenic microorganisms. *Giardia* and *Cryptosporidium*, two organisms that are resistant to disinfection, can only be eliminated by filters that reduce turbidity to less than 0.1 NTU. Fortunately, RO-based WPS-treated water has very low turbidity if the ROMs function properly and the water is clear and free of disease-producing organisms. Providing a 2 mg/L FAC residual and a 30-min contact time after RO-based WPS treatment provides additional assurance that the water is microbiologically safe to drink.

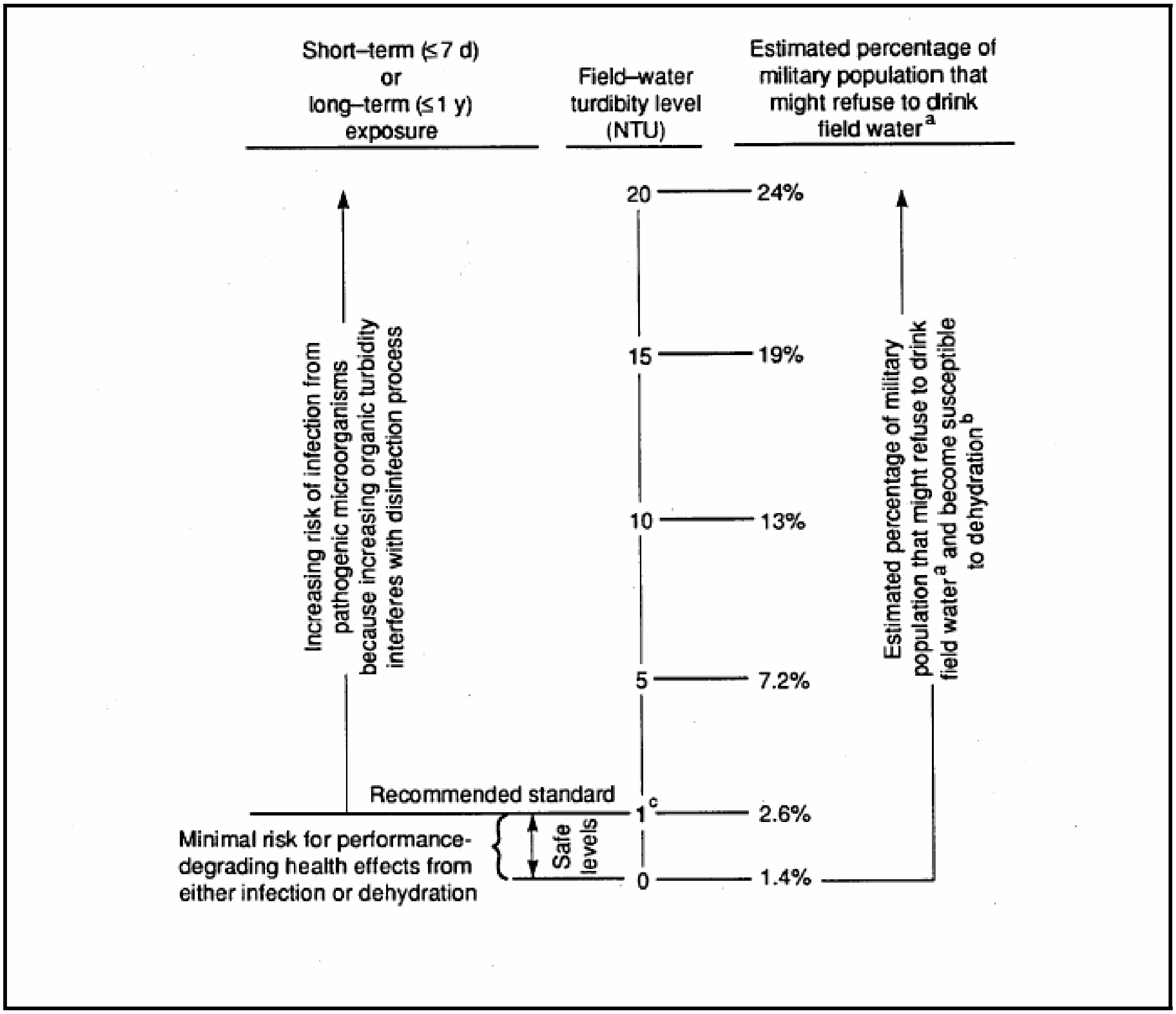

Figure G-1. Health-effects summary for turbidity with color absent (= zero) and threshold odor number equal to three

Notes:

[a] For any combination of color, turbidity, and odor values: military population (MP) = 1.1 + 0.575(C) + 1.15(T) + 0.115(S), where MP = percent of military population that might refuse to drink field water and thereby become susceptible to the performance-degrading effects of dehydration; C = color units; T = nephelometric turbidity units (NTU); and S = threshold odor number (TON). Estimates presented are computed on the basis of zero color units (C) and a TON (S) of three.

[b] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[c] Because turbidity is an organoleptic property of water (i.e., appearance), the recommended field-water quality standard for both short- and long-term exposure is applicable to any consumption rate, including ones of 5 and 15 L/d.

(3) *Color*. The TSFWS for color are the same for 5 and 15 L/d consumption scenarios, and are 50 color units (CU) for short term and 15 CU for long term. Color levels greater than 50 CU for short term and exceeding 15 CU for long term make the water undesirable. These levels also increase the risk of dehydration from reduced consumption, even though they are not associated directly with adverse health effects. Figure G-2 shows that at the indicated short- and long-term levels, 30 percent and 10 percent of personnel, respectively, might refuse to drink the water and either become dehydrated or seek another source of water.

b. TDS. Total dissolved solids include inorganic salts and small amounts of organic matter that are dissolved in water. The principal constituents are usually the cations calcium, magnesium, sodium, and potassium; and the anions carbonate, bicarbonate, chloride, sulfate, and, particularly in ground water, nitrate (from agricultural use). As with color and turbidity, the primary health concerns related to field drinking water with TDS concentrations greater than the TSFWS are the risks of water rejection and the associated consequences of the personal choices described above. Figure G-3 provides a health-effects summary for the range of TDS concentrations. From the graph, about 2 percent of a military population might refuse to drink water containing the recommended TDS standard of 1,000 mg/L and thereby choose dehydration or another water supply. At TDS concentrations above 2,800 mg/L, about 50 percent of the exposed military population might refuse to drink the water.

c. Taste and odor. Taste and odor are called "organoleptic" properties. These properties affect the palatability of water and, like the constituents discussed above, can encourage voluntary dehydration or the use of unapproved sources. Taste and odor may be naturally occurring, in which case the RO-based WPS should remove them, or they might be imparted to the water by the treatment processes. The most common are the well-known taste and odor attributed to high chlorine residuals in military water supplies.

d. Temperature. The palatability of all water is greatly enhanced by cooling it. Whether or not mobile chillers are available, water trailers and containers in hot regions should be shaded to keep water as cool as possible using tents, shelter halves, or tarpaulins. In addition, 5-gal water containers can be covered with an insulating jacket (NSN 7240-01-119-4956) to maintain an acceptable temperature in either hot or cold regions.

G-2. Waterborne diseases

Waterborne diseases are a threat to nearly all international travelers. They take on extra significance in military environments where their occurrence can result in mission failure. The following subparagraphs provide information about waterborne diseases that could be present in drinking water due to inadequate water treatment or poor sanitation conditions. Many of the associated pathogenic (disease-causing) organisms are carried in the feces of warm-blooded animals and could be present in untreated water sources, especially surface water sources. The identified organisms are generally difficult to detect in environmental (including water) samples. Therefore, treated water is tested for the presence of indicator bacteria, which, if detected, signal water contamination and potentially the presence of pathogenic organisms. PVNTMED personnel conduct presence/absence tests for total coliform bacteria in treated water. If total coliforms are found, they test further for fecal coliforms, specifically *Escherichia coli* (*E. coli*), which further verifies whether the contamination is of a fecal origin.

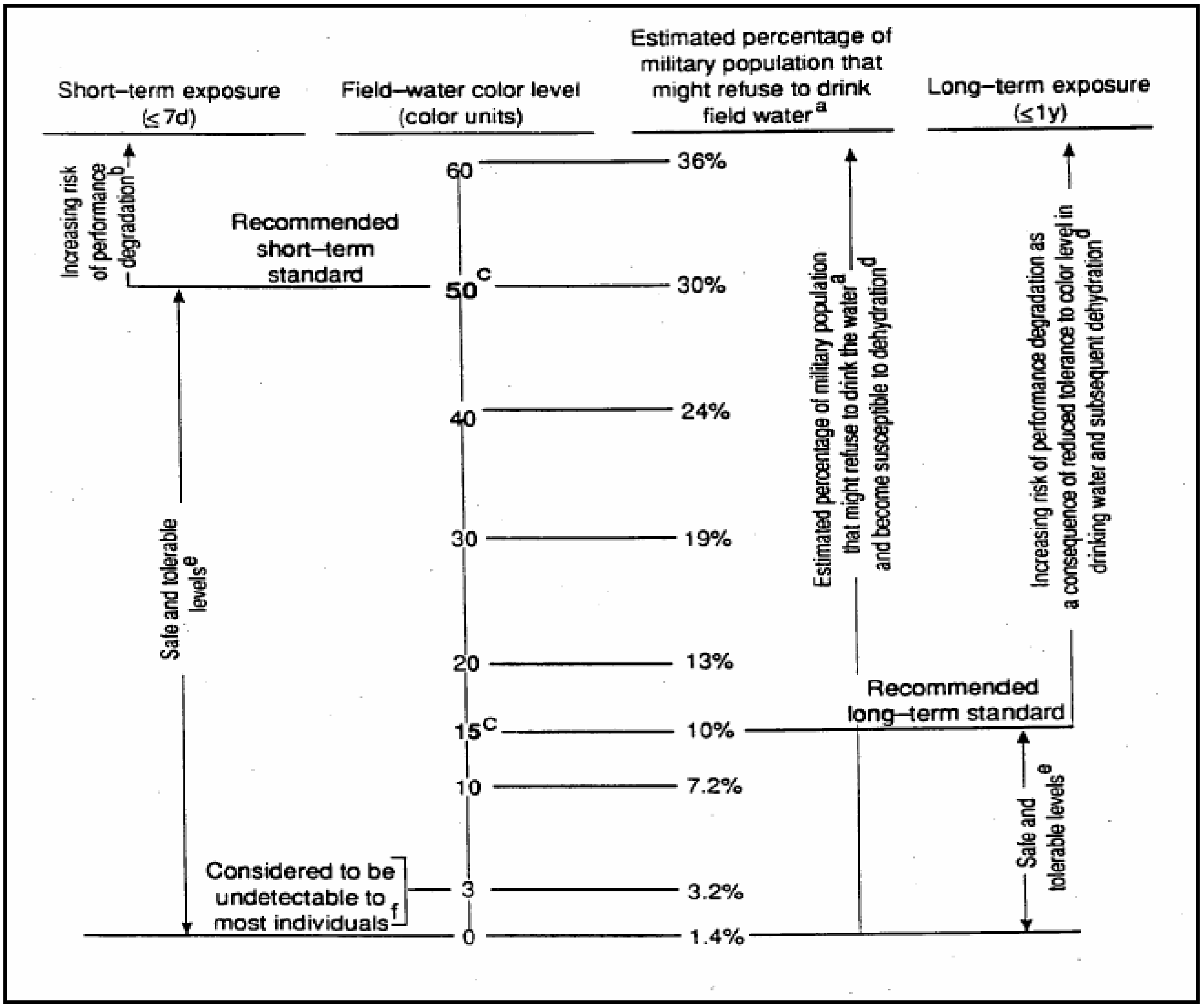

Figure G-2. Health-effects summary for color with turbidity absent (= zero) and threshold odor number equal to three

Notes:

[a] For any combination of color, turbidity, and odor values: MP = 1.1 + 0.575(c) + 1.15(T) + 0.115(S), where MP = percent of military population that might refuse to drink field water and thereby become susceptible to the performance-degrading effects of dehydration; C = color units; T = nephelometric turbidity units (NTU); and S = threshold odor number (TON). Estimates presented are computed on the basis of zero turbidity (T) and a TON (S) of three.

[b] Performance degradation results from decreased tolerance to color level in drinking water and subsequent dehydration.

[c] Because color is an organoleptic property of water (i.e., appearance), the recommended field-water quality standards are applicable to any consumption rate, including ones of 5 and 15 L/d.

[d] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[e] Safe and tolerable color levels are ones that should not impact the performance of military personnel, but may require acclimation.

[f] The EPA cites evidence indicating that a color level of three color units will not be detectable to many individuals.

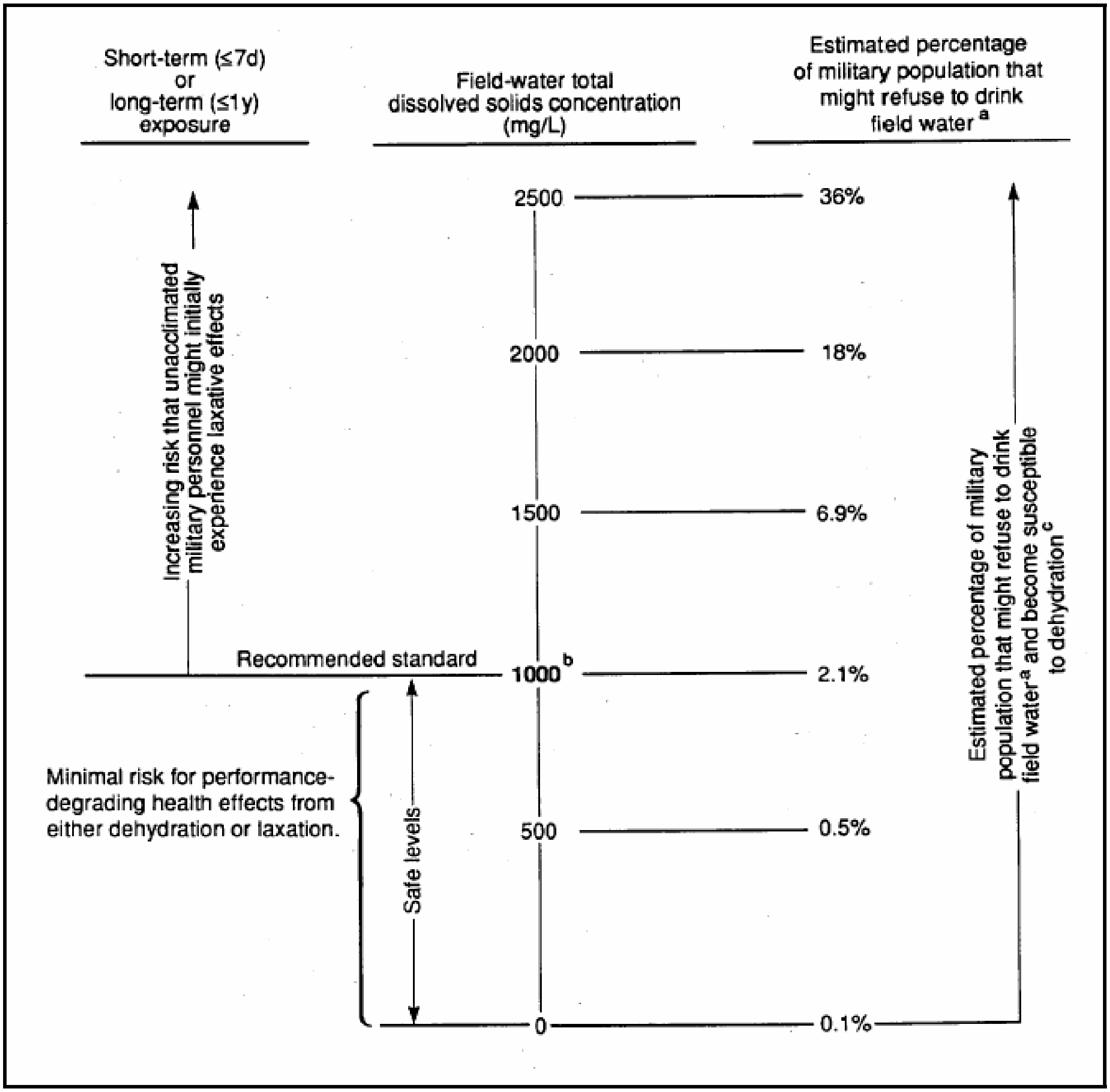

Figure G-3. Health-effects summary for TDS

Notes:
[a] Determined using the z-score for Action-Tendency ratings and a table of values for the standard normal distribution.
[b] Because total dissolved solids at concentrations less than or equal to 1000 mg/L are only organoleptically of concern (i.e., affect taste), the recommended field-water quality standard for both short- and long-term exposures is applicable to any consumption rate, including ones of 5 and 15 L/d.
[c] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

a. Amebiasis. Amebiasis is caused by a protozoan, *Entamoeba histolytica*. This protozoan may be acquired via the infective cyst which is passed in the feces. Although most cases are asymptomatic, acute cases exhibit fever, chills, and bloody diarrhea. Occurrence of *E. histolytica* is worldwide and is estimated to cause 40,000 deaths annually. The incubation period is commonly 2 to 4 weeks but can range from several days to 120 days. Infectivity continues through the period of cyst passing which may last several years. The infectious dose has been shown to be as low as 2,000 to 4,000 cysts. The primary reservoirs for *E. histolytica* are humans. Transmission is via the fecal-oral or person-to-person route or through ingestion of contaminated food or water. Additionally, flies can spread cysts. Susceptibility is general.

b. Campylobacteriosis. The majority of all *Campylobacter* infections are caused by the bacterium *C. jejuni*, causing fever, abdominal cramps, nausea, vomiting, and diarrhea that is often bloody and typically lasts 1 week. *Campylobacter* is widely distributed and is generally regarded as the most common bacterial cause of gastroenteritis in the world. The primary reservoirs are wild and domestic animals, particularly birds. Illness usually occurs 2 to 5 days after exposure, but onset can range from 1 to 10 days. Transmission through contaminated water or ice is a recognized source of infection, as well as ingestion of contaminated food and contact with infected animals, particularly cats and puppies. The infectious dose is very small – fewer than 500 bacteria. Generally, cases tend to occur sporadically rather than in outbreaks. All age groups are at risk, but infants and young adults are at higher risk of infection. Immunocompromised individuals that contract Campylobacteriosis are at risk of developing sepsis. In some cases, infection leads to Guillain-Barre syndrome which is a temporary paralysis typically requiring intensive care. On average, there are approximately 100 fatalities resulting from *Campylobacter* infections each year.

c. Cholera. Cholera is caused by an enterotoxin produced by the bacillus *Vibrio cholerae*. Although mild cases exhibiting diarrhea are common, acute cases can result in death within a few hours after onset if untreated. This intestinal disease produces profuse watery stools, occasional vomiting, rapid dehydration, and circulatory collapse. Cholera occurs mainly in Asia, Africa, Latin America and parts of the Mediterranean, but it also presents some risk worldwide largely to those living in poverty. The majority of cases have occurred in Africa since the mid-1990s. Humans are the main reservoirs for *V. cholerae*, and there is evidence supporting the idea that there are environmental reservoirs such as copepods and other zooplankton. The disease is transmitted primarily by consuming contaminated food or water. Large outbreaks have occurred from fecal contamination of water supplies and street vendor supplied food. Eating naturally contaminated, undercooked shellfish has also transmitted cholera. The infectious dose associated with ingesting contaminated water is 10^3 to 10^6 organisms. The incubation period can be from a few hours to 5 days, but is usually 2 to 3 days. The contagious period continues until a few days after recovery, though a carrier state may persist for several months. Susceptibility is variable, and, in endemic areas, most persons acquire strain-specific antibodies by early adulthood. Presently, the manufacture and sale of the only licensed cholera vaccine in the United States has been discontinued. Cholera vaccines have offered only brief and incomplete immunity. There is no current military requirement for the cholera vaccine.

d. Cryptosporidiosis. Cryptosporidiosis is an infection caused by the *Cryptosporidium parvum* oocyst, which is most often transmitted through the feces of a number of carrier organisms such as cattle, other domestic animals, and humans. The occurrence is worldwide with higher rates of infection occurring in underdeveloped countries. *Cryptosporidium* is ubiquitous; all surface water supplies are considered to be contaminated with the parasite. Infection with this organism is not easily detected unless looked for specifically. The incubation period is not precisely known, but 1 to12 days is the likely range with an average of about 7 days. The infectious dose is estimated to be very low–approximately 30 to 100 oocysts. People with intact immune-system functions may have asymptomatic or self-limited infections. Individuals with impaired immunity generally clear their infections when the causes of immunosuppression are removed. Symptoms include diarrhea which may be profuse and watery and associated cramping abdominal pain. General malaise, fever, nausea, and vomiting occur less often. Immunocompromised individuals are at greater risk of contracting cryptosporidiosis and are more likely to develop severe, life-threatening symptoms.

e. Diarrhea. Most cases of travelers' diarrhea worldwide are caused by C*ampylobacter*, certain strains of *Escherichia coli*, and some noncholera *Vibrio*. These bacteria are often involved in cases of waterborne diarrhea as well. These bacteria may be spread by food or other routes as well as by water. The acute onsets of nausea, fever, vomiting, abdominal pain, and diarrhea occurs after an incubation period of about 2 to 5 days. The acute illness is usually limited to 3 to 5 days or less.

f. Escherichia coli (E. coli) O157:H7. The bacterium *E. coli* serotype O157:H7 produces Shiga toxin(s); infected individuals exhibit acute bloody diarrhea and abdominal cramping lasting about 1 week. The incubation period ranges from 2 to 8 days. Little is known about susceptibility and immunity; the infectious dose is very low. *E. coli* O157:H7 is transmitted via ingestion of contaminated food (especially ground beef) and water, swimming in contaminated water, and person-to-person transmission. Cattle are the primary reservoirs of *E. coli* O157:H7. It is a recognized disease in North America, Europe, South Africa, Japan, the southern cone of South America, and Australia along with various other enterohemorrhagic *E. coli* serotypes. Its importance is not well recognized in the rest of the world.

g. Giardiasis. Giardiasis, another protozoan infection, principally affects the upper small intestine. *Giardia* cysts can be passed by wild animals such as beavers; thus, apparently pristine waters could be unsafe to drink without disinfection. They can be found in any locale, even arctic waters. As with amebiasis, most cases are asymptomatic. Ingestion of only one cyst may be enough to cause illness. After an incubation period of 7 to 21 days, acute cases may present with abdominal cramps, flatulence, diarrhea, fatigue, and weight loss. If untreated, passage of cysts may continue for 3 months or, rarely, longer. The reservoirs for *Giardia* include humans and domestic and wild animals. *Giardia* is transmitted via the fecal-oral route, especially ingestion of fecally contaminated food or water, person-to-person transmission by way of institutional environments (for example, daycare centers), and sexual activity. The cysts may also be transmitted to humans from animals.

h. Legionellosis. Both Legionnaires' disease (LD) and Pontiac Fever are caused by the bacteria *Legionella*. Approximately 46 species and 70 serogroups have been identified with

L. pneumophila accounting for over 90 percent of LD documented in the U.S. While Pontiac Fever is primarily a flu-like, self-limiting illness, LD is a debilitating, pneumonia-like illness (fever, chills, cough, muscle aches, headache) that can be very severe. The incubation period for LD is 2 to 10 days, and as little as several hours to 2 days for Pontiac Fever. *Legionella* is transmitted via inhalation of contaminated aerosol (as from showers and faucets) or aspiration of contaminated water. The infectious dose is unknown. *Legionella* bacteria thrive in water temperatures between 32 to 45 °C, so they can commonly be found in significant numbers in hot water systems that maintain tap temperatures below 50 °C or hot water tanks with temperatures set below 60 °C. Although persons of any age can contract LD, those most at risk are middle-aged or elderly individuals, smokers, individuals with chronic lung disease, and immunocompromised persons. Pontiac Fever can affect any individuals. Legionellosis occurs worldwide. The true occurrence is difficult to determine, and it is suspected to be vastly underreported. Most reporting comes from industrialized countries. This is most likely because they have reporting systems in place as well as ecological niches that act as reservoirs that support *Legionella* such as hot water plumbing systems.

i. Leptospirosis. Leptospirosis is a bacterial disease contracted through skin contact with surface water contaminated with urine from infected animals. *Leptospira* penetrate the skin readily through abrasions or mucus membranes. The disease is characterized by the rapid onset of fever, headache, chills, severe muscular pain in the calves and thighs, and conjunctival suffusion. Leptospirosis occurs worldwide in urban, rural, industrialized, and developing areas. Individuals exposed to river, canal, stream, and lake water contaminated with domestic and wild animal urine as well as tissues and urine of infected animals are at greatest risk. These groups include military troops, veterinarians, sewer workers, campers, and sportsmen. Wild and domestic animals are reservoirs, particularly rats, swine, cattle, dogs, and raccoons. The primary mode of transmission is dermal exposure, especially through abraded skin. To a lesser extent, contaminated food or inhalation of contaminated aerosols can spread leptospirosis. The incubation period is 4 to 19 days, most commonly 10 days. Infected persons may excrete *Leptospira* in the urine for 1 to 11 months after the acute illness.

j. Metabolites of cyanobacteria (bluegreen algae) and related aquatic bacteria. Cyanobacteria produce two different types of toxins: neurotoxins and hepatotoxins. Symptoms may include abdominal pain, nausea, vomiting, diarrhea, fever, muscle, and joint pain. Dermal contact may produce skin irritation that eventually produces a rash. The primary mode of transmission is ingestion of contaminated water, but dermal contact in waters where there is a cyanobacteria bloom can also cause illness. Cyanobacteria are found worldwide, particularly in polluted, stagnant surface waters. The main reservoirs are stagnant water, sediments, and soil. Drinking water standards have not been established for most of the toxic substances associated with cyanobacteria in algal blooms. However, the WHO has set a drinking water standard of 1.0 µg/L total microcystins for lifetime exposure. Use of an algaecide to eliminate the algal mass in order to obtain drinking water may be inadvisable, because killing algae releases toxins. Furthermore, the chemical nature of these contaminants makes chlorination ineffective against them. RO treatment is effective at removing tastes, odors, and health-risk contaminants associated with algae.

k. Noroviruses. The term “norovirus” is the recently-approved official genus name of the group of viruses also known as “Norwalk-like viruses,” caliciviruses, or small round-structured viruses. The incubation period is usually 24 to 48 hours, although symptoms can appear as early as 12 hours, and the illness generally lasts 24 to 60 hours. Symptoms include nausea, vomiting, watery diarrhea and abdominal cramps, and occasionally low-grade fever. Noroviruses are very common and occur worldwide. They are extremely contagious and are spread primarily via the fecal-oral route, via contaminated food or water or spreading directly from person to person. Infections may also be spread via environmental or fomite contamination. There is also evidence that norovirus infections may be spread from inhalation of aerosolized vomitus particulates. The infective dose is unknown but is assumed to be low. It is unlikely individuals can build immunity to norovirus due to the wide genetic variety of noroviruses; any immunity appears to be strain-specific and generally only lasts a few months. Waterborne outbreaks of norovirus have often been traced to sewage contamination of wells and recreational water.

l. Salmonellosis. Salmonellosis is a bacterial disease caused by enterobacteriaceae of the genus *Salmonella*. The incubation period is usually 6 to 72 hours and typically lasts 12 to 36 hours. Symptoms include fever, abdominal cramps, and diarrhea that may be bloody; the illness generally lasts 4 to 7 days. In some cases, the diarrhea may become so severe that the infection progresses to sepsis (that is, it passes to the bloodstream) which could lead to death if not treated. Although any person is potentially at risk of contracting salmonellosis, the immunocompromised as well as infants and the elderly are at greater risk of severe disease. Salmonellosis occurs worldwide but is reported more in North America and Europe most likely due to better reporting systems in those areas. The majority of *Salmonella* cases in the United States are caused by two serotypes: *S. typhimurium* and *S. enteriditis*. Domestic and wild animals are reservoirs as well as humans. The infective dose varies depending on several variables, including the serotype involved and patient characteristics, but can be as low as 15 to 20 bacteria. Transmission routes are contaminated food, water, and contact with infected animals.

m. Schistosome dermatitis (cercarial dermatitis). Also known as swimmer's itch, it is caused by the larvae of certain schistosomes of birds or mammals that may penetrate the human skin and cause dermatitis. These organisms do not enter the blood stream or cause other systemic effects. Such infections may occur among bathers in lakes in many parts of the world including the Great Lakes region of North America and certain coastal beaches. The larvae are found worldwide and the disease has been reported in many European and American locations.

n. Schistosomiasis. Schistosomiasis is a disease that is contracted simply by being in contact with water containing schistosomes. Three blood flukes, *Schistosoma mansoni*, *S. japonicum*, and *S. haematobium*, are the major species that cause human disease. Each of these species has a specific geographic distribution and affects 200 million people worldwide. *S. mansoni* occurs in the Arabian Peninsula, Africa, South America, and the Caribbean; *S. japonicum* in Japan, China, and the Philippines; and *S. haematobium* in Africa and the Middle East. Two major factors are responsible for the occurrence of schistosomiasis in specific geographic areas: the presence of the specific snail intermediate host and the lack of sanitary disposal of human feces. Humans are the primary reservoirs for *S. mansoni* and *S. haematobium*; humans and various domestic animals are the potential reservoirs for *S. japonicum*. After maturation within the body, adult flukes can cause intestinal or urinary tract complications. Symptoms from *S. japonicum* and *S. mansoni* infections include diarrhea, abdominal pain, and enlarged liver. If an infection is caused by *S. haematobium*, symptoms include painful urination and changes in urinary frequency. The incubation period lasts 4 to 6 weeks after infection. The period of infectivity lasts as long as the person discharges eggs in feces or urine (up to 10 years or longer). Susceptibility is general.

o. Shigellosis. Known also as bacillary dysentery, shigellosis is an acute bacterial disease primarily involving the large intestine. It is characterized by diarrhea accompanied by fever, nausea, and sometimes vomiting. Humans are the principal reservoir for the disease. The severity of the illness is a function of the patient's age and state of nutrition, the size of the infecting dose, and the serotype of the organism. Shigellosis is endemic in both tropical and temperate climates. It is found worldwide, and outbreaks tend to occur in poor areas where basic sanitation is lacking. The disease is spread through direct and indirect human contact via the fecal-oral route, ingestion of contaminated food or water, and transference of *Shigella* from feces to food surfaces by flies. The infectious dose is 10 to 100 bacteria and the incubation time is 1 to 7 days. Persons infected remain capable of spreading the disease until *Shigella* is no longer present in the feces (usually within 4 weeks of the onset of the illness). Susceptibility is general.

p. Typhoid. Typhoid fever, the most studied enteric fever, is a severe prolonged disease with a high rate of complications. It is characterized by sustained fever, headache, malaise, anorexia, enlargement of the spleen, a nonproductive cough, constipation, and involvement of lymphoid tissues. Caused by the bacillus *Salmonella typhi*, typhoid occurs worldwide at a rate of 21 million cases and 200,000 deaths annually but is not common in industrialized countries. The period of incubation usually lasts 1 to 3 weeks. Infectivity continues from the first week through convalescence. Susceptibility is general. Humans are the primary reservoirs for *S. typhi*. The infective dose varies depending on several variables, including the serotype involved and patient characteristics, but can be as low as 15 to 20 bacteria. Transmission of the illness occurs from ingesting contaminated food or water. People living in poverty and unsanitary conditions in developing countries are at greatest risk of contracting typhoid fever.

q. Viral hepatitis A (viral hepatitis). Caused by the hepatitis A virus, viral hepatitis ranges from a mild illness lasting 1 to 2 weeks to a severely disabling disease lasting several months. The onset of the symptoms is abrupt with fever, malaise, anorexia, nausea, and abdominal discomfort, followed by jaundice. Viral hepatitis occurs worldwide, particularly on the Indian subcontinent, North Africa, parts of Eastern Europe, and Asia, and tends toward cyclic recurrences. The incubation period can be 15 to 50 days but is more commonly 28 to 30 days. Maximum infectivity occurs during the latter half of the incubation period until after the first week of jaundice. Susceptibility is general. Although unknown, it is assumed the infective dose is 10 to 100 virus particles. Humans are the main reservoir for the hepatitis A virus. Transmission is through direct and indirect person-to-person contact, as well as ingestion of fecally contaminated food or water and swimming in sewage-contaminated surface waters. Although water is an important means of transmitting hepatitis A, contaminated food tends to account for the majority of cases.

r. Testing for water-related infectious organisms. There are no relatively simple field tests for measuring the specific concentration of any of the variety of infectious organisms of concern. Particularly in the case of viruses and some parasites, analysis can be extremely difficult and require very large amounts of water essentially becoming an impossible task in the field. There are tests available that can determine gross contamination of water such as Eclox™, Microtox®, and various other sentinel indicators (Eclox is a trademark of Severn Trent Services, Fort Washington, PA; Microtox is a registered trademark of Strategic Diagnostics Inc., Newark, DE). However, they have obvious limitations, such as pinpointing specifically what type of contamination is occurring. Until such tests are available for determining the concentration of specific infectious organisms in field water, the membrane-filter technique or other test methods, such as Colilert, that can detect the presence of total and fecal coliforms should be used to determine the presence of coliform organisms in water. The effectiveness and reliability of the treatment and disinfection operations of a unit is important. This is especially true in developing countries where there is a high level of acquired immunity, and concentrations of pathogenic organisms are likely to be higher. With proper water treatment and disinfection, along with follow-up monitoring, a reasonably safe water supply may be supplied to personnel in the field.

G-3. Chemical contamination

a. BZ. BZ is a hallucinatory chemical with unpredictable effects at high doses. These effects, which may include changes in heart rate or blood pressure, weakness, disorientation, and delirium are not observed in subjects consuming BZ in water at levels equivalent to 7 ug/L (at 5 L/day consumption) or 2.3 ug/L (at 15 L/day consumption) for up to 7 days. Figure G–4 summarizes the health effects for BZ in field water. Because BZ is considered a less viable threat today than a decade ago, and because there is no available field detection capability, BZ is under consideration to be eliminated from the TSFWS.

b. Chloride. Although chloride might produce laxative effects at concentrations exceeding 600 mg/L, the health effects of greatest concern for military populations exposed to elevated concentrations of chloride ion in field water are not direct. Rather, they are associated with dehydration and use of unapproved sources by personnel who reduce their consumption of treated field water because of its poor taste. Figure G–5 summarizes the chloride concentration-related health risks. Only about 2 percent of a military population would be at risk of dehydration due to refusing to drink water with the recommended chloride standard of 600 mg/L; however, more than 10 percent might refuse to drink field water containing a chloride concentration of 1,000 mg/L.

c. Cyanide and hydrogen cyanide.

(1) *Cyanide*. Exposure to cyanide in drinking water can lead to a variety of performance-degrading health effects. Once a toxic level has accumulated in the blood, the cyanide exerts its effects rapidly acting as a chemical asphyxiant. The nervous and respiratory systems are the first to fail. Headache, breathlessness, weakness, palpitation, nausea, giddiness, and tremors are

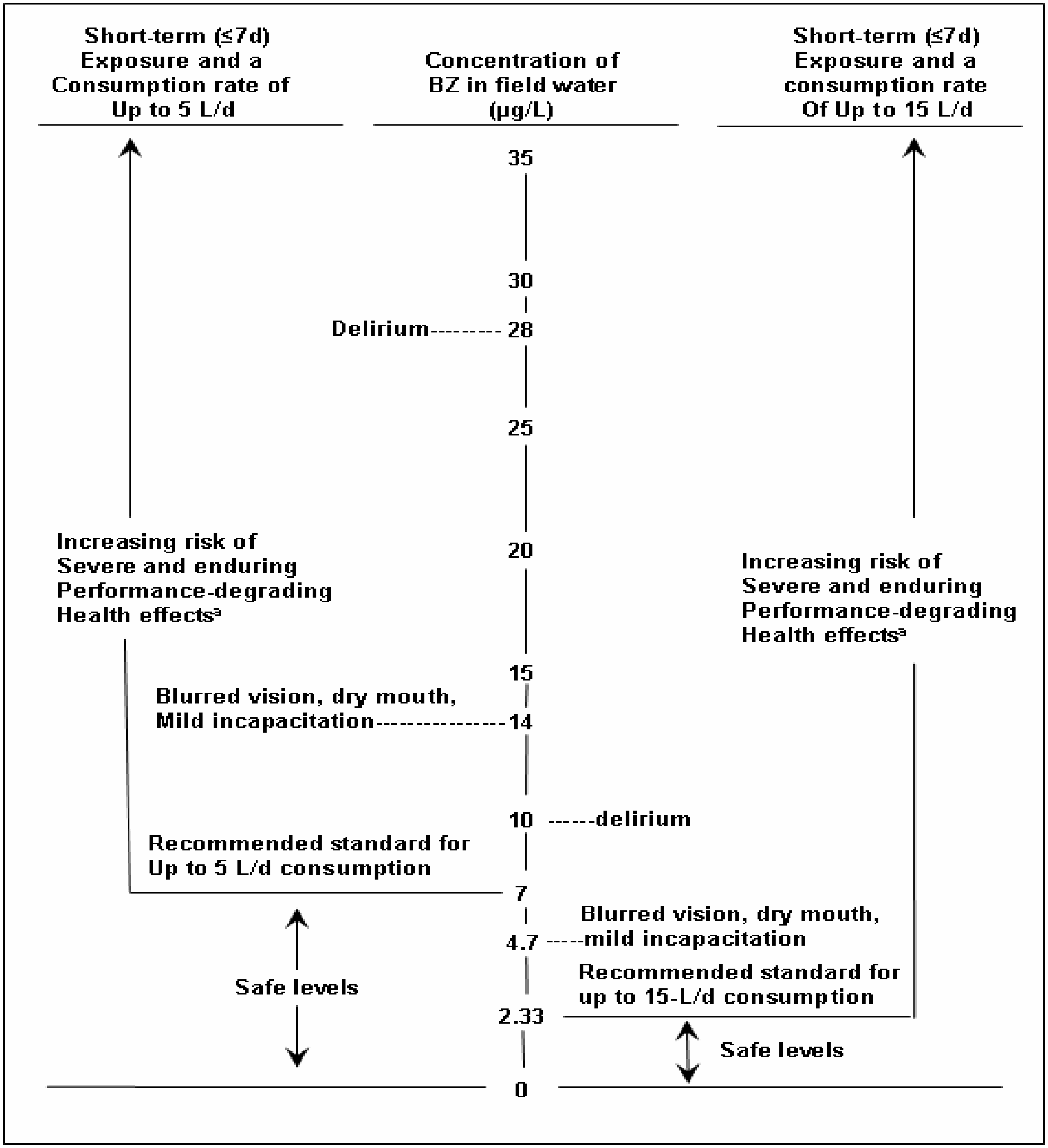

Figure G-4. Health- effects summary for BZ

Note:
[a]Performance-degrading health effects may include rapid pulse, decreased salivation, blurred near vision, decreased mental performance, poor coordination, restlessness, stupor, hallucinations, delirium.

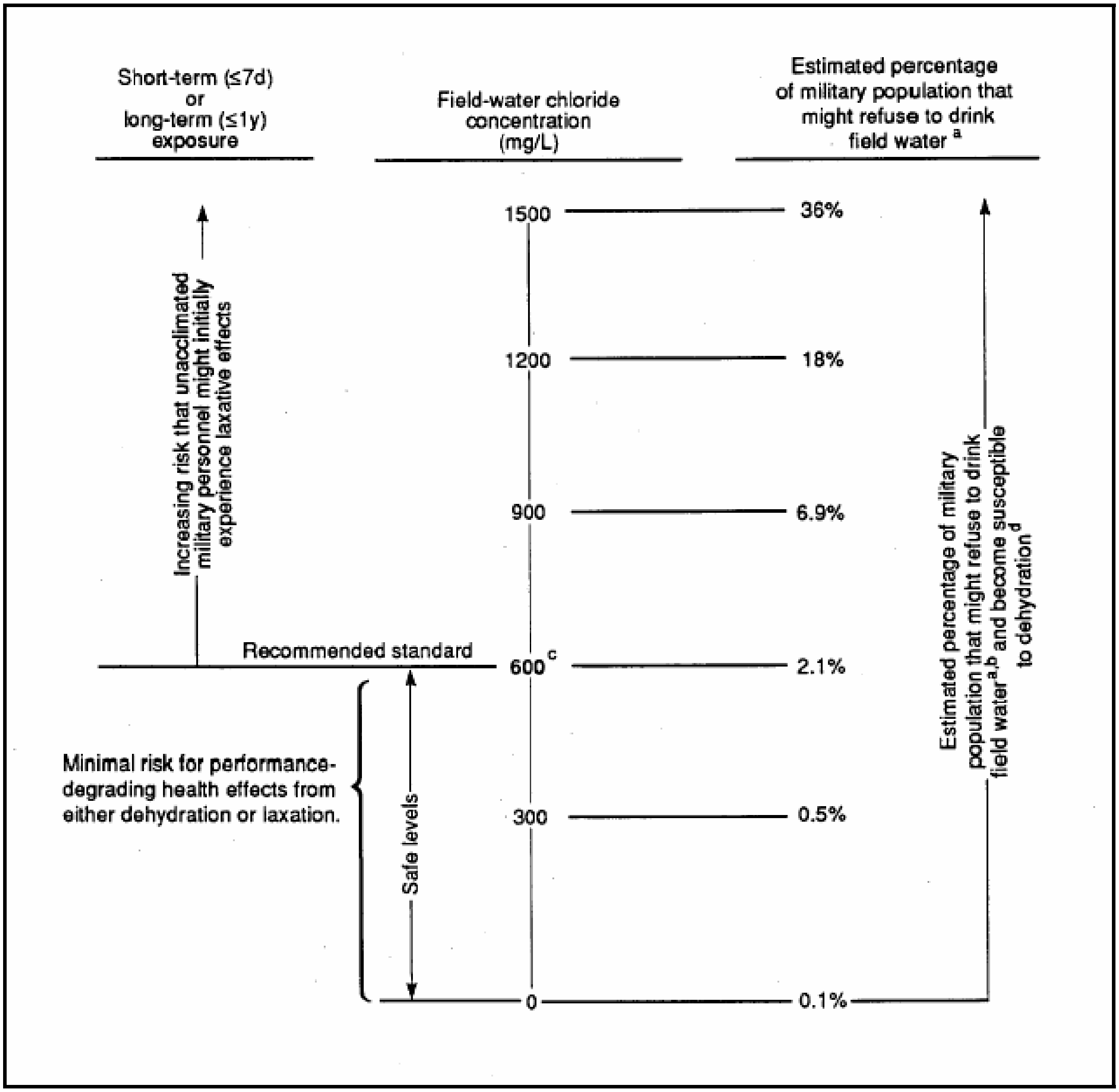

Figure G–5. Health-effects summary for chloride

Notes:

[a] Determined using the z-score for Action-Tendency ratings and a table of values for the standard normal distribution.

[b] Estimates are made assuming chloride ion constitutes 60 percent of total dissolved solids (TDS) concentration because sodium and chloride ions are considered to be the predominant constituents of the TDS content of most field waters, particularly seawater processed through the reverse osmosis water purification unit (ROWPU).

[C] Because chloride ions at concentrations less than or equal to 600 mg/L are only organoleptically of concern (i.e., affect taste), the recommended field-water quality standard for both short- and long-term exposures is applicable to any consumption rate, including ones of 5 and 15 L/d.

[d] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

typical symptoms of acute exposure. Concentrations of cyanide in field drinking water that could produce toxic levels in the blood and lead to performance-degrading health effects in personnel consuming up to 5 or 15 L/d for both short- and long-term periods are estimated to be greater than 6 and 2 mg/L, respectively. Figure G-6 shows the basis for these standards. Moreover, the higher the cyanide concentration is above the safe levels, the greater the risk that many of the exposed military personnel will develop symptoms that can be performance degrading or lethal. Concentrations of 24 to 48 mg/L for a consumption of 5 L/day cause metabolic acidosis, and concentrations greater than 48 mg/L cause life-threatening toxicity.

(2) *Hydrogen cyanide.* Hydrogen cyanide, also referred to as hydrocyanic acid or prussic acid, is used in some common industrial practices and as a chemical agent. Its effects are the same as those described for cyanide, above, and the recommended standards to prevent performance-degrading effects are considered to be the same.

d. Lewisite and arsenic. Lewisite is a man-made arsenic-based warfare (threat) agent manufactured in limited quantities. While ingestion of lewisite can cause GI injury and may be lethal, it breaks down rapidly into other constituents one of the most persistent and toxic being arsenic. Arsenic is also naturally occurring and can exist in many forms in water. Generally speaking, organic forms of arsenic are more toxic than inorganic forms. Reports of human exposure to inorganic arsenic via ingestion include several in which the arsenic was consumed in drinking water. Where exposures are high enough to cause observable health effects, several different organ systems are affected including the circulatory, gastrointestinal, integumentary (skin), nervous, hepatic, renal, and immune systems. Four epidemiological studies document adverse effects when the levels of arsenic exceed 0.40 mg/L over the long term. In addition, while the literature suggests that people may be able to tolerate levels of arsenic in drinking water approaching 1 mg/L for short periods, higher concentrations could cause facial edema and GI symptoms such as anorexia, nausea, epigastric fullness, vomiting, and abdominal pain. Skin lesions, upper respiratory symptoms, headache, chill, sore throat, rhinorrhea, and signs of neuropathy are among chronic symptoms that might also occur. These effects would certainly interfere with the performance of military personnel. Consequently, the recommended standards for arsenic were derived to protect military personnel from acute and chronic effects. Figure G–7 summarizes arsenic health effects. For exposure periods of up to 7 days, the standards are based on a daily dose of 1.5 milligrams per day (mg/d), and for exposure periods up to 1 year, the standards are based on a daily dose of 0.32 mg/d. These standards correspond to total arsenic levels of 0.3 and 0.1 mg/L for 5 and 15 L/day consumption rates (short term) and 0.06 and 0.02 mg/L for the same consumption rates (long term). The recommended arsenic-based standards for lewisite are 0.08 and 0.027 mg/L for 5 and 15 L/day consumption rates, respectively, corresponding to lewisite concentrations of 0.22 and 0.075 mg/L (note that only short-term standards apply). These standards were developed from the daily dose of the arsenic fraction of lewisite that showed no effects from ingestion by rabbits. Figure G–8 summarizes lewisite health effects. Unfortunately, the proportion of the exposed military population that could be affected by performance-degrading symptoms at concentrations above recommended safe levels cannot be estimated from the available data.

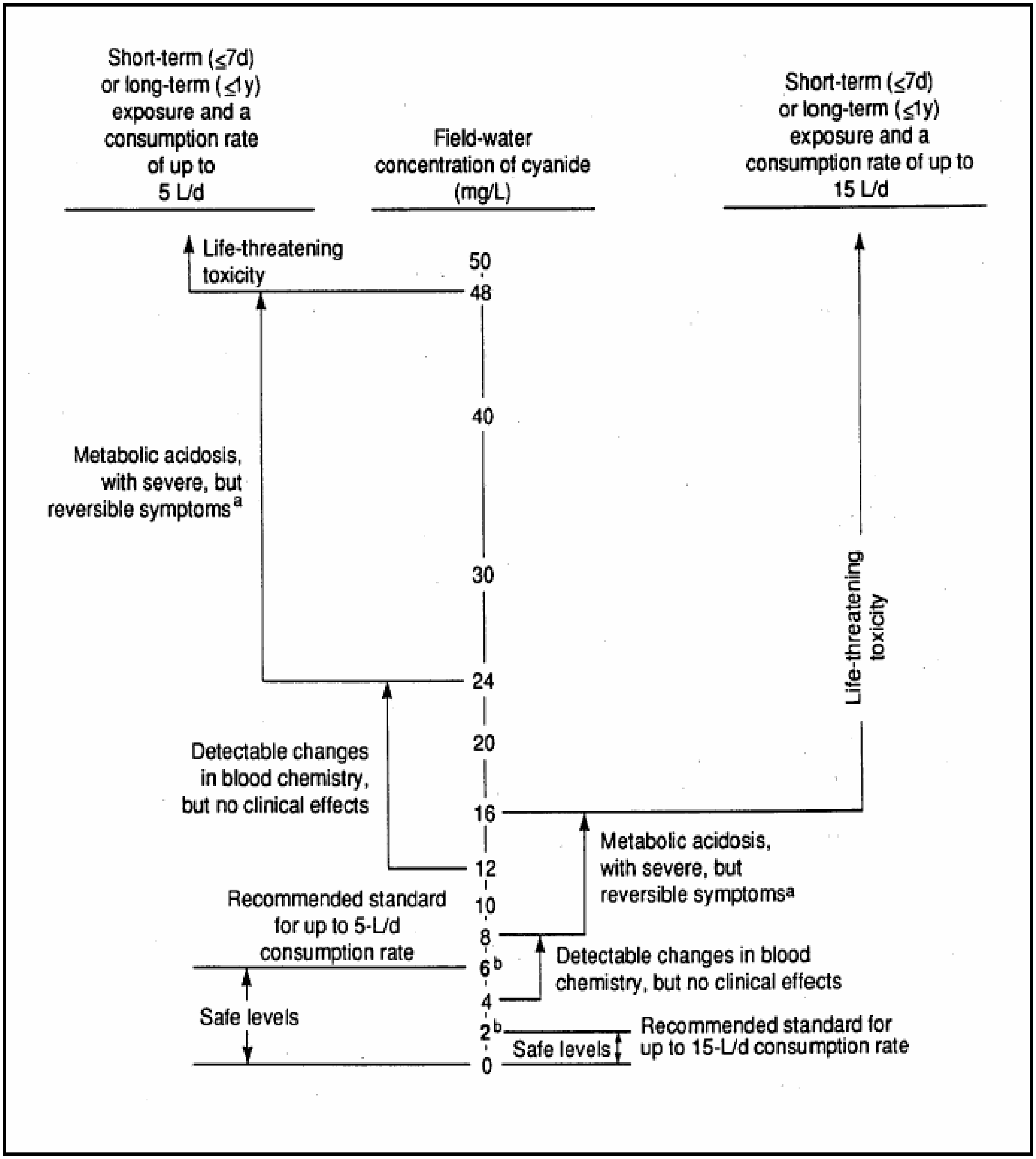

Figure G-6. Health-effects summary for cyanide and hydrogen cyanide

Notes:

[a] Symptoms of acute cyanide toxicity can include headache, weakness, palpitation, nausea, giddiness, and tremors.

[b] Recommended field-water quality standard for indicated daily consumption rate and exposure period.

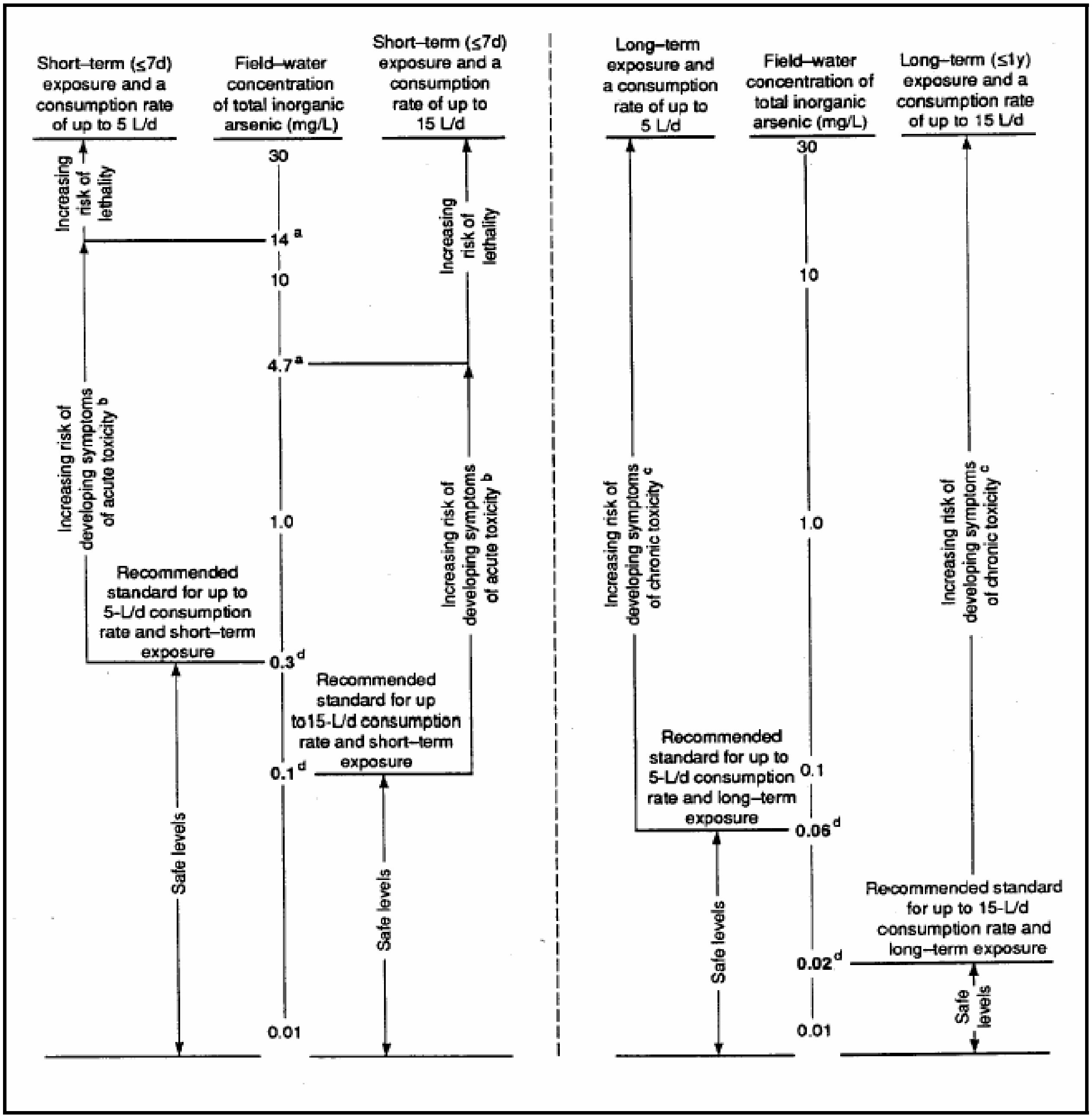

Figure G–7. Health-effects summary for arsenic

Notes:

[a] Concentration corresponding to an increasing risk of lethality was calculated based on a single, oral does of 70 mg of arsenic.

[b] Symptoms of acute arsenic toxicity may include edema, nausea, vomiting, headache, and abdominal pain.

[c] Characteristic symptoms of chronic arsenic toxicity include skin effects (pigmentation changes, keratosis, and skin cancer), gastrointestinal problems, peripheral vascular disease, and neurological changes.

[d] Recommended field-water-quality standard for indicated daily consumption rate and exposure period.

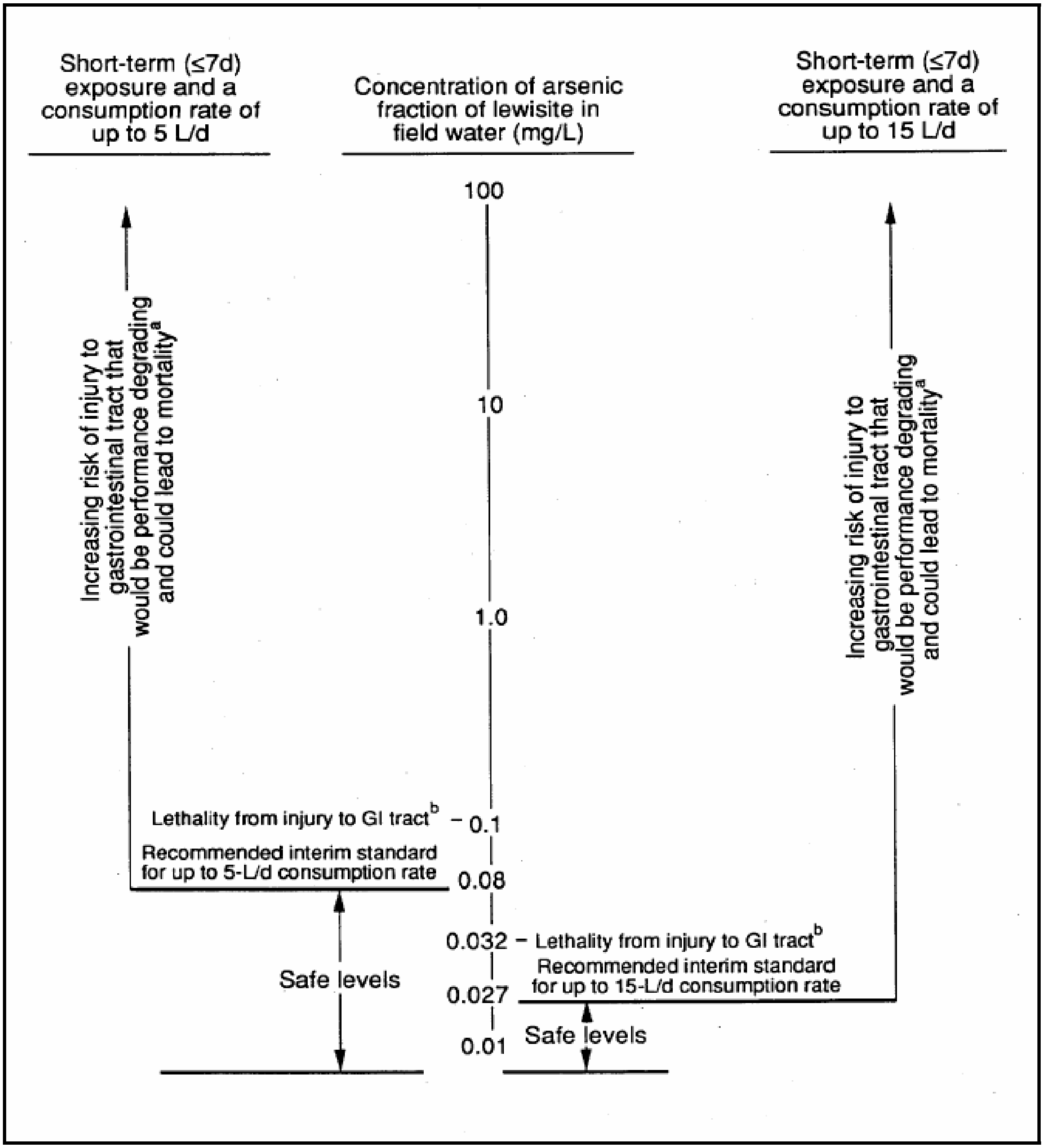

Figure G–8. Health-effects summary for lewisite

Notes:
[a] Based on extrapolation from effect of doses above the no observable effect level (NOEL) for rabbits.
[b] Based on lowest dose reported to produce mortality in rabbits (0.07 mg/kg x 0.1 x 70 kg/(5 or 15) L/d).

e. Lindane. The use of this pesticide has decreased somewhat over the past decade, and because there are still no available field tests or equipment to assess it, there is ongoing consideration to eliminate this constituent from the TSFWS. Lindane is a chlorinated organic pesticide in the same chemical family as DDT. It has been listed by the EPA as a persistent, bioaccumulative and toxic chemical meaning that it lingers for a long period in the environment, moves up the food chain, and is toxic to humans and wildlife. Lindane is also a priority pollutant, a hazardous material, and a bioaccumulative chemical of concern. A pesticide that has been used worldwide, lindane induces a wide variety of dose-dependent symptoms when ingested in drinking water. These symptoms include nausea, vomiting, frontal headache, restlessness, upper abdominal pain, diarrhea, tremors, ataxia, and reflex loss. At high doses, seizures can occur followed by major systemic failure and even death. The lowest daily dose of lindane reported to cause adverse health effects in humans was 30 mg/d. However, the proportion of an exposed military population that could be affected by performance-degrading symptoms at concentrations above recommended safe levels cannot be estimated from the available data. Figure G–9 summarizes lindane health effects. Derived standards for 5 and 15 L/day consumption of drinking water are 0.6 and 0.2 mg/L, respectively, for both short- and long-term exposures.

f. Magnesium. Figure G–10 summarizes the performance-degrading health risks stemming from elevated levels of magnesium leading to dehydration caused by acute laxative action. Synergism between laxative-producing solutions such as chloride, magnesium, and sulfate may be important but cannot be addressed quantitatively because of a lack of data. Field-water quality standards are based on a single dose of 480 mg of magnesium ions prescribed clinically to induce laxative effects in fasting individuals (that is, a group that is more sensitive to saline laxatives than are nonfasting individuals). The derived field-water quality standards for 5 and 15 L/day consumption are 100 and 30 mg/L of magnesium, respectively, for either short- or long-term exposure. It is presumed that higher levels of magnesium would be associated with increasing incidences of laxative effects, which could lead to performance-degrading dehydration, but the severity of these effects and the percentage of population that would experience them cannot be estimated from available data.

g. Mustard. Sulfur mustard, a blistering agent, may be used in any of three formulations: distilled mustard, thickened mustard, or impure mixture containing 60 percent distilled mustard. All formulations are only slightly soluble in water. Based on animal studies, acute effects, such as nausea or GI upset, are not expected to occur following consumption of water containing 140 ug/L (at 5 L/day consumption) or 47 ug/L (at 15 L/day consumption) for up to 7 days provided that no other toxic compounds are present. Sulfur mustard is a known human carcinogen, and the risk based on established acceptable concentration, consumption, and specified duration is 1 in 100,000 people exposed.

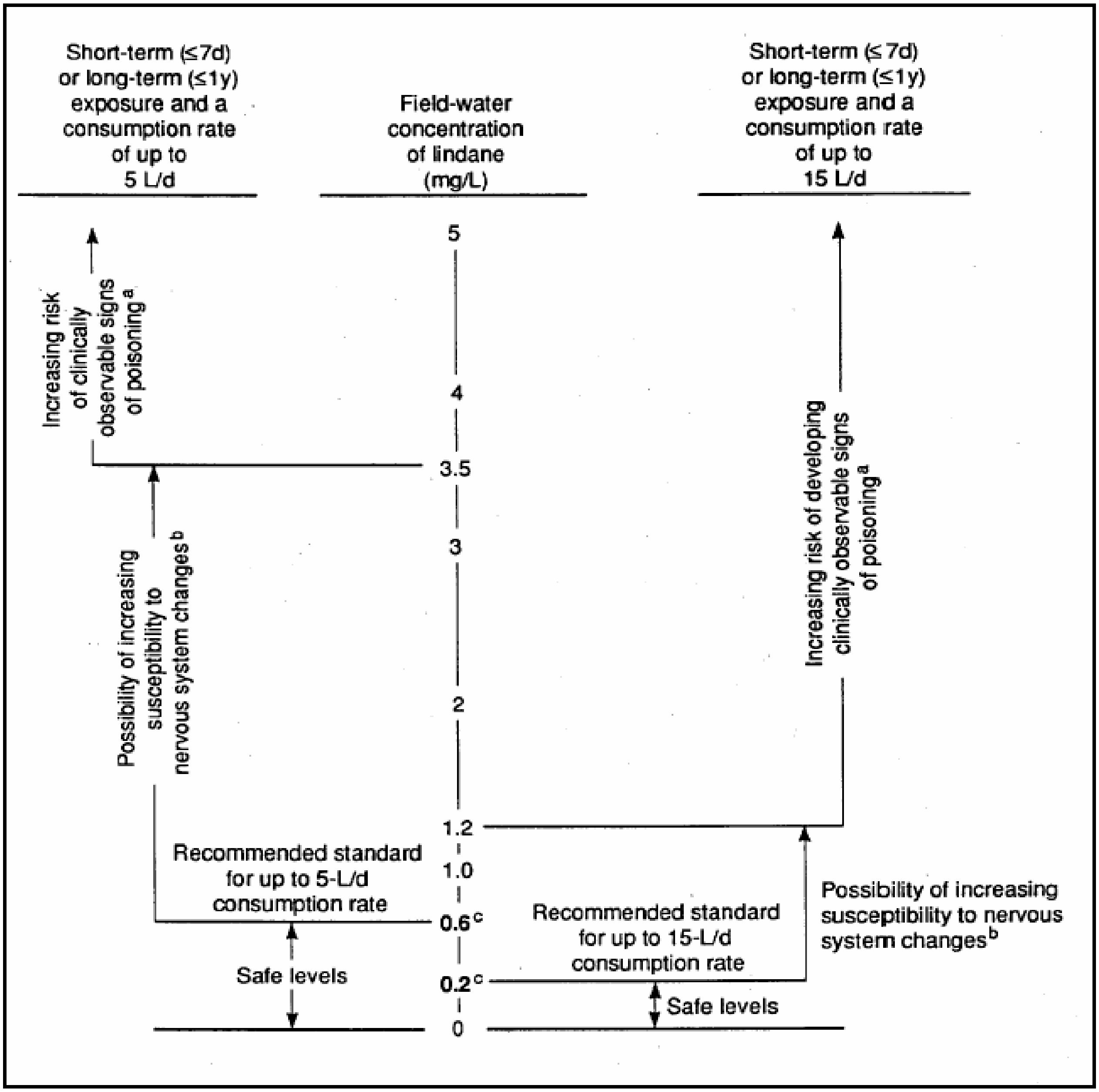

Figure G–9. Health-effects summary for lindane

Notes:
[a] Based on extrapolation to humans from a minimal-effects dose reported in a lifetime feeding study of laboratory animals and the application of a 10-fold safety factor.
[b] Evidence from long-term feeding studies of laboratory animals indicates that low doses of lindane may be associated with subclinical effects on the nervous system.
[c] Recommended field-water quality standard for indicated daily consumption rate and exposure periods up to either 7 d or 1 y. Based on human data and the application of a 10-fold safety factor.

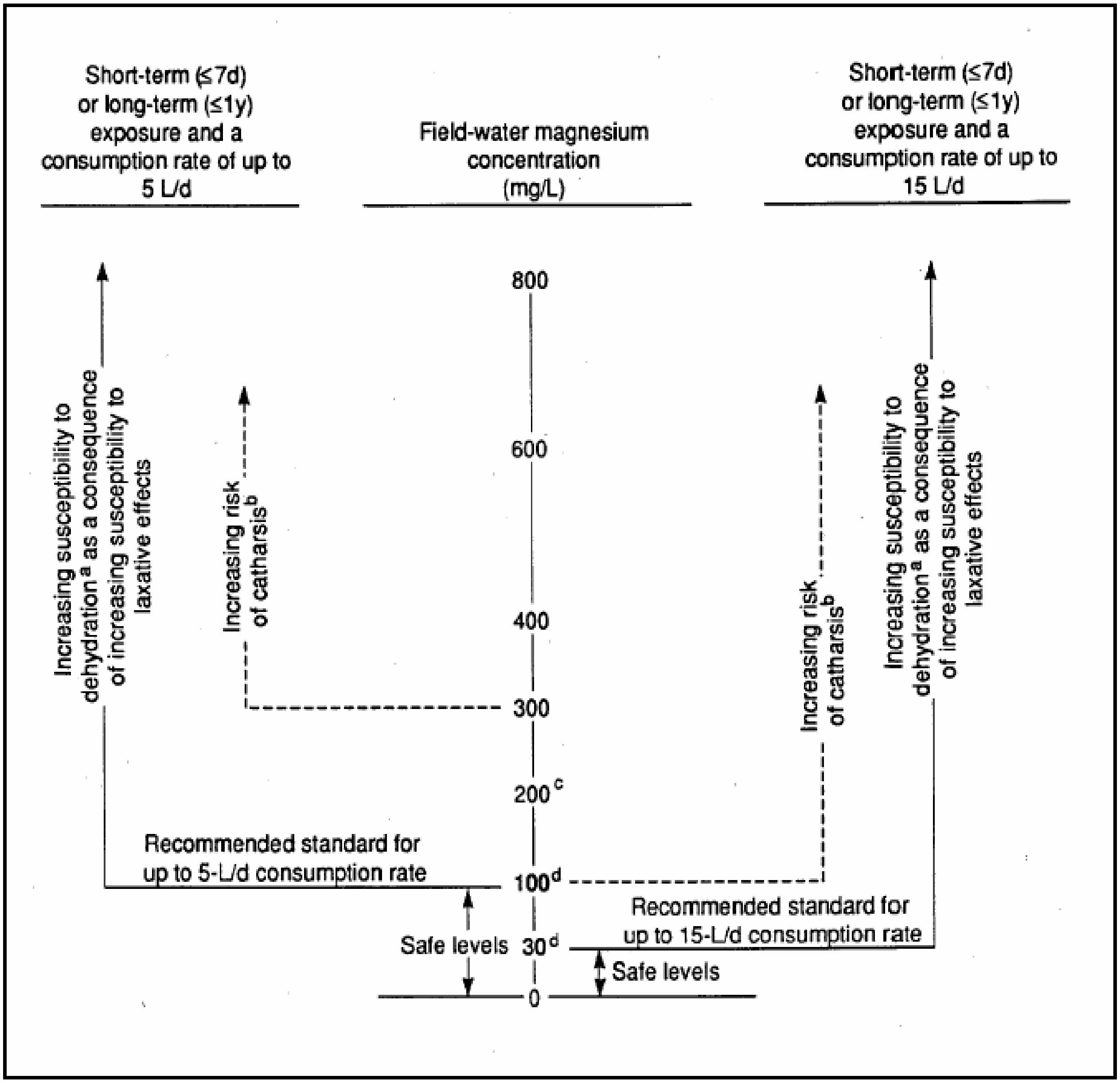

Figure G–10. Health-effects summary for magnesium

Notes:

[a] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[b] Based on a laxative dose of 15 g of Epsom salts (MgSO4* 7H20), effects include semi-fluid or watery evacuation in 3 hr or less. Doses lower than 15 g produce laxative effects with a longer latency period.

[c] Although many individuals would perceive water to have an inferior taste, a few individuals might consider water consumable and for them taste alone might not be an effective warning of laxative effects.

[d] Recommended field-water quality standard for magnesium-ion concentration for indicated daily consumption rate and exposure periods up to either 7 d or 1 y.

h. Organophosphorus (OP) nerve agents. Concentrations of OP nerve agents, including the CW agents GA, GB, and VX, in field water at concentrations greater than the recommended standards can produce performance-degrading health effects that include abdominal cramps, vomiting, diarrhea, and headache. Sufficiently high levels consumed over the course of a 7-day period may even lead to death. The concentration of OP nerve agents at which some performance degradation might occur from repeated ingestion in drinking water over the course of several days has not been determined. Consequently, an estimate of that level for exposure lasting up to 7 days is no less than 12 ug/L for a consumption rate of 5 L/d and 4 ug/L for a consumption rate of 15 L/d. Because OP nerve agents are designed to be poisonous, there is probably a narrow margin between safe levels in water and those producing performance-degrading health effects, even under circumstances where an OP nerve agent is ingested in several drinks separated in time over the course of a day for an exposure period lasting up to 7 days. Figure G–11 summarizes the basis for these standards.

i. Sulfate. Adverse health effects stemming from consuming levels of sulfate ions greater than the recommended standards also result from the risk of dehydration caused by acute laxative action. Figure G–12 summarizes these effects. This dehydration can cause significant performance degradation, but the relationship between sulfate concentrations in drinking water and laxative effects is poorly documented. Field-water quality standards are based on a single dose of 1,490 mg sulfate ions prescribed clinically to induce laxative effects in fasting individuals (that is, a group that is more sensitive to saline laxatives than would be nonfasting individuals). The derived field-water quality standards for 5 and 15 L/day consumption are 300 and 100 mg/L of sulfate, respectively, for either short- or long-term exposure. It is presumed that higher levels of sulfate would be associated with increasing laxative effects, which can lead to performance-degrading dehydration, but the severity of these effects and the percentage of population experiencing them cannot be estimated from available data.

j. Trichothecene (T–2) mycotoxin. Mycotoxins are naturally occurring substances produced by fungi as a secondary metabolite that typically affords the organism survival benefit (for example, penicillin). Thus, many of the toxins produced are pathogenic to animals and humans. More than 300 mycotoxins are reportedly produced by some 350 species of fungi. T–2 mycotoxin is the only one of them known to have been used as a BW. T–2 is nonvolatile, relatively insoluble in water, and highly soluble in ethanol, methanol, and propylene glycol. The toxin is highly heat stable and resistant to UV light destabilization—two important factors when considering it as a BW agent. The first performance-degrading effects to occur after ingestion of concentrations of T–2 mycotoxin in field water greater than the recommended standards are nausea and vomiting as shown in figure G–13. On the basis of data from clinical trials where cancer patients were treated with a chemotherapeutic agent considered analogous to T–2 mycotoxin, the mildest symptoms would be associated with concentrations just above the short-term (less than 7 days) interim exposure limit of 26 ug/L for a consumption rate of 5 L/d and 8.7 ug/L for a consumption rate of 15 L/d. The data from clinical tests also indicate that the most severe symptoms are associated with concentrations more than 30 times greater than these levels.

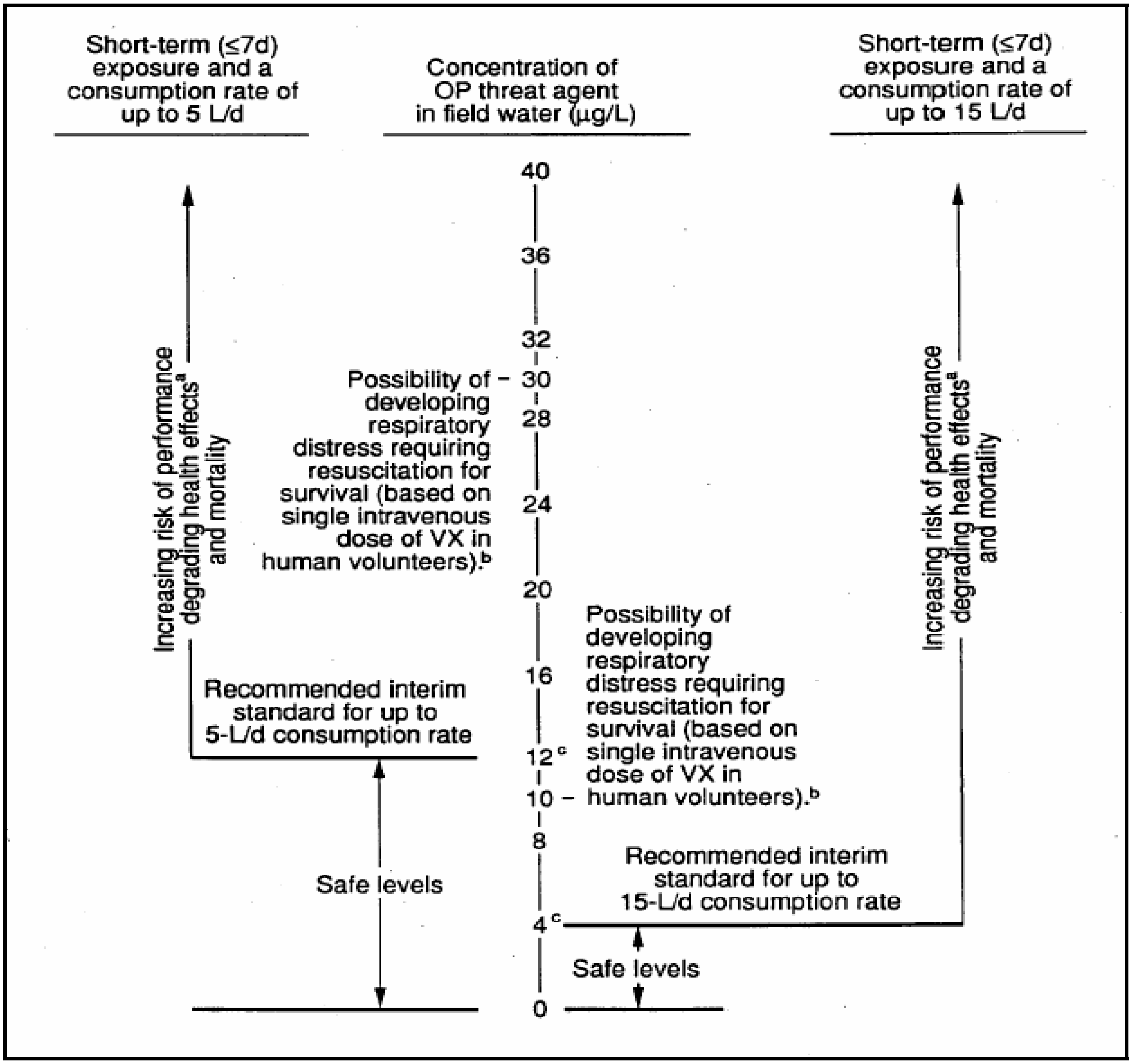

Figure G–11. Health-effects summary for organophosphorus (OP) nerve agents

Notes:

[a] Performance-degrading health effects can include abdominal cramps, vomiting, diarrhea, and headache.

[b] Response considered possible on the basis of a single intravenous dose of VX in humans of 2.12 μg/kg converted to a drinking water concentration. This response and corresponding concentration are presented because lethality data for repeated ingestion of OP threat agents over time are not available for humans. Furthermore, VX is the most toxic OP threat agent when administered intravenously in a single dose to humans, but appears to be less toxic than GD when ingested in several divided doses over time.

[c] Interim standards for OP threat agents are based on the MPC for GD because GD appears to be the most toxic OP threat agent where a total dose from field water is ingested in several drinks separated in time over the course of a day for an exposure period lasing up to 7 d.

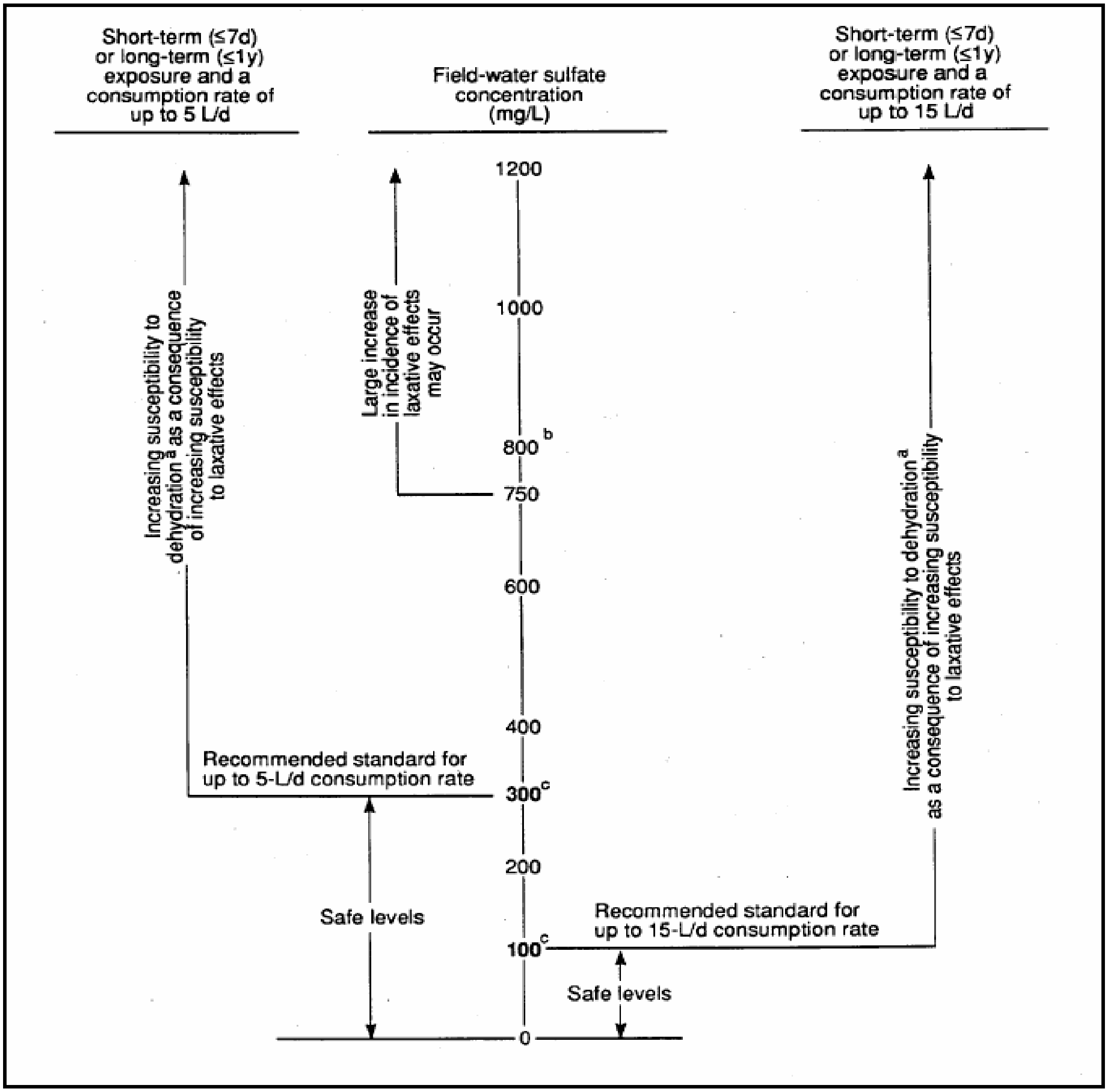

Figure G–12. Health-effects summary for sulfate

Notes:

[a] Symptoms of dehydration may include weariness, apathy, impaired coordination, delirium, and heat stroke.

[b] Although many individuals would perceive water to have an inferior taste, a few individuals might consider water consumable and for them taste alone may not be an effective warning of laxative effects.

[c] Recommended field-water quality standard for sulfate-ion concentration for indicated daily consumption rate and exposure periods up to either 7 d or 1 y.

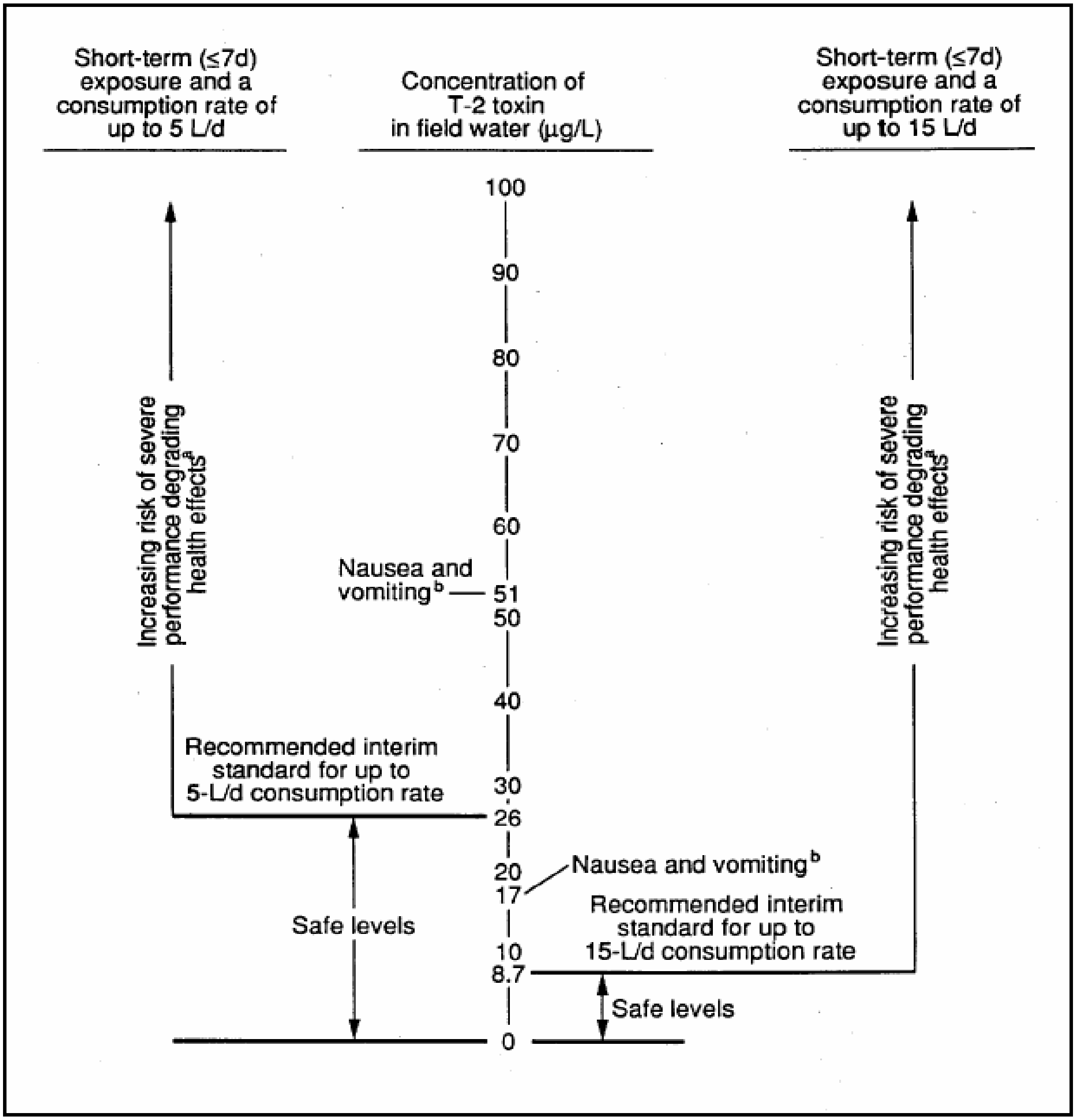

Figure G–13. Health-effects summary for trichothecene mycotoxin, T–2

Notes:

[a] Potentially performance-degrading health effects may include nausea, vomiting, diarrhea, generalized burning erythema, and mental confusion according to studies where patients were treated with a chemotherapeutic agent considered analogous to trichothecene mycotoxin, T-2.

[b] Based on lowest daily intravenous dose of a chemotherapeutic agent considered analogous to T-2 that caused nausea and vomiting in cancer patients. Most severe health effects were reported in cancer patients administered a daily dose of the agent by rapid intravenous infusion for 5 d that was about 30 times greater than the one used to calculate the standards. Therefore, concentrations of T-2 toxin that are 30 times greater than the recommended interim field-water quality standards are expected to produce the most severe toxic symptoms.

G-4. Radioactivity

Field water supplies may be contaminated with radioactive materials if nuclear weapons, radiation dispersal devices, or "dirty bombs" are employed. Contaminated particles from the area of detonation may become airborne and eventually fall out of the atmosphere downwind from the explosion. Some of the particles may fall into water and contaminate it. While contaminated fallout particles are generally insoluble, they may be so small that they remain suspended in the water and do not settle out. Particles that do settle may be resuspended if the sediment is disturbed by natural or mechanical actions and drawn into raw water intake systems. The TSFWS for radiation are designed to limit the amount of radioactive substances taken into the body by drinking water.

a. Wartime or Emergency Operations. Tables G–1 and G–2 are intended for emergency use only to protect against performance degradation during a 7-day or 1-year period. The recommended standards in tables G–1 and G–2 should only be used during wartime or emergency operations. These tables are based on the TSFWS. These recommended standards shall not be applied to personnel engaged in stability and support operations (SASO). Table G–3 lists recommended standards for SASO. The recommended standards for wartime or emergency operations are based on a radiation dose limit of 1.0 sievert (Sv) (100 rem) to the organs of the GI tract. These values should be appropriately reduced if exposure via other pathways (for example, external or inhalation) is also occurring. Currently, field equipment that is capable of detecting the concentrations listed in tables G–1 and G–2 is not available. When the testing capability is available, the water must meet the indicated standards to be certified potable for wartime and emergency operations. If the radioactivity in the water is above these levels, PVNTMED personnel should contact qualified experts such as those at USACHPPM or consider alternative water sources prior to allowing consumption.

Table G–1
Recommended standards for radionuclides in military field water supplies for wartime or emergency operations

Duration of use short-term – for use more than 7 days		**Duration of use long-term – For use less than 7 days**	
Water-consumption rate		Water-consumption rate	
5L/day	15L/day	5L/day	15L/day
8 µCi/L[1] (300 kilo Bq/liter (kBq/L))	3 µCi/L[1] (100 kBq/L)	0.1 µCi/L[1] (5 kBq/L)	0.05 µCi/L[1] (2 kBq/L)

Note:
[1] For gross beta and/or gross alpha activity (excluding tritium which can be found in table G-2).

Table G–2
Recommended standards for only tritium (H-3) in military field water supplies for wartime or emergency operations

Duration of use short-term – for use more than 7 days		**Duration of use long-term – for use less than 7 days**	
Water-consumption rate		Water-consumption rate	
5L/day	15L/day	5L/day	15L/day
57,000 µCi/L (2.1 GBq/L)	19,000 µCi/L (700 MBq/L)	1,000 µCi/L (37 MBq/L)	350 µCi/L (13 MBq/L)

b. SASO. Table G–3 lists recommended standards for personnel engaged in SASO such as humanitarian operations, peacekeeping operations, and field training exercises. This table is based on the WHO Guidelines for Drinking-Water Quality. The recommended standards are based on a committed effective dose limit of 0.1 mSv/year (10 milliroentgen equivalent, man (mrem)) from 1 year's consumption of drinking water at a rate of 2 L/day. Drinking water analyses results equal to or less than the concentrations listed in table G–3 would require no further actions. Radionuclide concentrations greater than those listed in table G–3 do not necessarily prevent the use of the water source for consumption. If the radionuclide concentrations exceed the values in table G–3, a qualified expert should be consulted before consuming the water. As shown in table G–4, consumption rates greater than 2 L/day will result in committed dose equivalents greater than 10 mrem (1 mSv) in a year. However, these levels are considered safe.

Table G-3
Recommended standards for radionuclides in military field water supplies for support and stability operations regardless of consumption rate

Radioanalyte	Concentration standard
Gross alpha	13.5 picocuries (pCi)/L (0.5 Bq/L)
Gross beta	27 pCi/L (1 Bq/L)
Tritium	270,000 pCi/L (10,000 Bq/L)
If any of the values in this table are exceeded, a qualified expert must be consulted before consuming the water.	

Table G-4
Committed effective dose as a function of consumption rate at the concentrations listed in table G–3

Water-consumption rate (L/day)	Committed effective dose from 1 year's consumption (mrem)
2	10
5	25
15	75

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Appendix H

Reverse Osmosis Membrane Removal Capabilities

H-1. Introduction
This appendix provides information about the solute rejection capabilities demonstrated by the ROMs currently in the Army inventory.

H-2. Principles of RO
a. General.

(1) Osmosis, for the purpose of this appendix, is the process whereby water passes through a semipermeable membrane (that is, a membrane that obstructs the passage of salt or other material dissolved in the water). The direction of water passage is from the dilute solution side of the membrane to the concentrated side. For example, if a living cell is immersed in distilled water, the cell swells—sometimes to the bursting point—as water flows in through the cell membrane. If, on the other hand, the same cell is immersed in a saturated salt solution, water flows out and the cell is dehydrated. Road salt kills vegetation by that mechanism.

(2) Applying pressure to the concentrated solution side of a membrane reverses this osmotic process. This principle enables the construction of semipermeable membrane devices that will extract pure—or nearly pure—water from solutions of salt and other dissolved materials. The process is somewhat analogous to distillation, except that pressure provides the driving force instead of temperature. The Army's RO-based WPSs contain such semipermeable membrane devices in their ROM canisters.

b. Removal of simple salts.

(1) It is important to understand that the original RO-based WPS (600-gph ROWPU) was designed to produce potable water from seawater or brackish water (that is, to remove sea salts which are principally sodium chloride or common salt). Other significant seawater constituents include salts of magnesium, calcium and potassium, as well as salts of bromine, sulfur (in the form of sulfate) and carbon (in the form of carbonate and bicarbonate). The RO-based WPS removes 98 to 99 percent of the sodium chloride and at least that much of the other sea salts. Said another way, 1 to 2 percent of the original salt concentration will pass through the membrane. Ordinary seawater contains about 3.5 percent (35,000 mg/L) sea salts, so the product water should contain 350 to 700 mg/L dissolved salts. This is more salt than in most municipal drinking water systems, but it is still well below the Army field water standard of 1,000 mg/L. Note that if the seawater contains more than 3.5 percent salts, as is the case in the Persian Gulf, the RO-based WPS still removes just 98 to 99 percent. If the seawater contains 6 percent (60,000 mg/L) salts, the product water should contain 600 to 1,200 mg/L and may taste slightly salty. If, at the other extreme of salt content, the RO-based WPS is used to purify fresh water, the product water may contain almost no salts and will taste quite flat.

(2) As stated above, RO-based WPS membranes are designed and manufactured to remove sea salts. Any other chemical removal is a bonus, and the removal efficiency must be determined experimentally for the particular membrane, for each chemical, and for the particular

operating conditions (temperature, pH, pressure) under which the membrane will be used. Table H–1 presents some typical rejection information for commercial membranes similar to those used in the RO-based WPSs. Many new membranes, tailored for specific purposes, are currently being marketed. Some of these membranes may give significantly improved salt rejection and may provide greatly altered selectivity.

Table H-1
Rejection of salts by a typical ROM[1]

Salt	Rejection, percent
Sodium chloride	98
Magnesium chloride	98
Calcium chloride	99
Magnesium sulfate	99
Sodium bicarbonate	98
Sodium nitrate	93
Sodium fluoride[2]	98

Notes:

[1]Filmtec, spiral wound, thin-film composite polyamide membrane. Percentages provided by the manufacturer for pure solutions of each salt; they are not applicable to mixtures of salts.

[2]Fluoride rejection is pH-dependent: about 75 percent at pH 5, 50 percent at pH 4, 30 percent at pH 3.5, and 0 percent at pH <3.

c. Industrial inorganic chemicals.

(1) Most inorganic salts, including industrial chemicals, are rejected equally as well as sodium chloride by the RO-based WPS; however, some inorganic salts are much more poorly rejected.

(2) RO-based WPS product water from a river that has been contaminated with plating wastes will probably have 98 to 99 percent of the nickel, copper, and zinc, and 96 to 98 percent of the cadmium that was present in the source removed, but perhaps only 90 percent or less of the chromium and cyanide (table H-2). This may not seem like much of a difference, but note that a process that removes only 90 percent of a pollutant leaves 10 times as much of the pollutant in the product water as one that removes 99 percent. Removal efficiency is comparatively poor for mercury (33 to 78 percent) and arsenic (69 to 99 percent, depending on

the chemical form). Removal efficiency is good for iron and manganese, but these metals may cause excessive fouling of the membranes as they are removed and stay in contact with the membranes.

Table H-2
Rejection of heavy metal salts by typical ROMs

Salt	Rejection, percent
Nickel sulfate	99
Copper sulfate	99
Arsenic (+5) salts	99
Arsenic (+3) salts	69 and lower
Cadmium salts	99
Lead salts	97
Mercury salts	37-78
Chromium (+6) salts	97
Chromium (+3) salts	96

(3) Many common heavy metals found in polluted waters (lead, mercury, cadmium, arsenic, and chromium in particular) are highly toxic. While the RO-based WPS may remove these metals well enough to meet health standards, it is still important to select the best raw water source available. This places increasing importance on the role of PVNTMED personnel in the process of water point site selection.

d. Organic chemicals.

(1) Removal of organic materials may depend on size (that is, molecular weight), structure, and substitution (table H-3). Natural organic materials in water (lignins, tannins, fulvic substances) are essentially all removed, as are carbohydrates, proteins, and amino acids. Rejection of contaminants from industrial sources is highly variable. Removal efficiency is poor for low molecular weight alcohols such as methyl, ethyl, propyl and isopropyl alcohol, as well as for most low molecular weight solvents including chlorinated solvents. In general, short-term removal improves with increasing molecular weight, but it may be deceptive. Many organic contaminants that show good short-term removal in bench tests may leak through the membrane in days or even hours. For example, removal of lindane may fall from an initial 97 percent

removal to only 85 percent after 24 hours. Weak organic acids of low molecular weight (acetic acid and its simple derivatives, propionic acid, butyric acid, and phenol) are poorly removed.

Table H-3
Rejection of some organic chemicals by typical ROMs

Chemical	Rejection, percent
Aldehydes and Alcohols	
Formaldehyde	35
Methanol	25
Ethanol	70
Isopropanol	90
Sucrose (cane sugar)	99
Acids	
Acetic acid	60-90
Fluoroacetic acid[1]	98-99
Phenol	56-87
Benzoic acid	87-92
Solvents	
Trihalomethanes	50-80
Chloroethylenes	15-90
BTEX	15-50
Chlorobenzene	40-50
Herbicides	
Atrazine	96
Alachlor	98
Linuron	98

Note: [1]Rodenticide; extremely toxic to humans

(2) Again, it is important to select the least-contaminated source water available for treatment because of the uncertainty in efficiency of rejection of industrial organics. Surface waters immediately downstream from municipal or industrial outfalls should be avoided, and outfalls from a petrochemical complex would be of particular concern.

e. CBRNE agents. RO removal of CBRNE agents from water has received only limited investigation (table H-4). One study indicates that the biotoxins, such as ricin, are reduced below detection limits by membranes similar to those in the RO-based WPS. Other studies indicate better than 99 percent removal for chemical agents and 95 percent or better removal for certain radioactive chemicals (nuclear agents). However, it is also known that radioactive materials eventually damage ROMs. Furthermore, it can be assumed that membranes exposed to a constant challenge will eventually pass larger concentrations of chemical agents (but not most biotoxins).

Table H-4
Rejection of CBRNE agents by RO

Agent	Rejection, percent
T-2	100
Microcystin	100
Ricin	100
Saxitoxin	100
GB	>99
VX	>99
BZ	>99
Hydrogen cyanide	<25[1]
^{131}I	>95
^{85}Sr	>99
^{134}Cs	>98

Note: [1]pH ≤ 8.5

f. Parasites, bacteria, and viruses. For the most part, ROMs have not been specifically tested for removal of bacteria, viruses, and parasites such as *Giardia* or *Cryptosporidium* cysts. Based on size exclusion, it may safely be assumed that an undamaged membrane will remove virtually 100 percent of all microbiological organisms (although recent studies have indicated that virus removal efficiency may be subject to quality control limitations in membrane manufacture). Thus, the RO-based WPS is an effective barrier to waterborne pathogens. However, it is still important to avoid source water that may contain human or other animal wastes and to disinfect the RO-based WPS product water in order to prevent possible bacterial recontamination.

H-3. Conclusions

RO-based WPSs are highly effective devices for removing water pollutants and can provide an ample supply of assured safe drinking water if reasonable care is exercised in selecting raw water sources. It must be emphasized that the tabular data presented in this TB MED are for illustrative purposes only and should not be used to estimate RO-based WPS product water quality except in the most general sense. Reverse osmosis performance depends, among other things, on the operating parameters, the choice and condition of the membrane, and the pH and temperature of the water. Knowledge of RO-based WPS performance with respect to individual source water constituents is still limited.

H-4. Additional information

Field PVNTMED personnel and others with specific health-related questions on treatment of water for both potable and nonpotable use are urged to contact the USACHPPM WSMP at DSN (312) 584-3919, comm. (410) 436-3919, Fax (410) 436-8104, or e-mail: water.supply@apg.amedd.army.mil.

Appendix I

Chlorine Dosage Calculations and Measurements

I-1. General
Tables I-1 and I-2 provide volumes in drops (dp), milliliters (mL), teaspoons (tsp), tablespoons (tbls), cups (cp), and gallons (gal) of liquid bleach, dry calcium hypochlorite (HTH), and a concentrated calcium hypochlorite solution that, when added to the indicated volume of water, will provide the approximate chlorine dose (mg/L) indicated. The chlorine residual achieved using these values will be dependent on the chlorine demand exerted by the water that is chlorinated. If there is no chlorine demand, the residual will equal the dose. The greater the chlorine demand, the lower the residual will be. Note that for all chlorine residual concentrations in water, values in parts per million (ppm) are equivalent to values in milligrams per liter (mg/L) (for example, 10 ppm = 10 mg/L).

Table I-1
Rounded-up volumes of 5 percent liquid bleach that will provide approximately the indicated chlorine dose when added to the listed volume of water

Gallons to be chlorinated	1 mg/L	2 mg/L	5 mg/L	10 mg/L	100 mg/L
5	6 dp	0.75 mL	1.9 mL	3.8 mL	8 tsp
10	0.75 mL	1.5 mL	3.8 mL	1.5 tsp	16 tsp
25	2 mL	3.8 mL	2 tsp	4 tsp	1 cp
36	3 mL	5.5 mL	2.75 tsp	2 tbls	1.25 cp
50	4 mL	1.5 tsp	4 tsp	3 tbls	1.75 cp
100	7.7 mL	3 tsp	3 tbls	5 tbls	3.25 cp
400	2 tbls	4.25 tsp	0.75 cp	1.5 cp	3 qt
500	3 tbls	0.33 cp	1 cp	1.75 cp	1 gal
1000	0.33 cp	0.67 cp	1.75 cp	3.25 cp	2 gal

Table I-2
Volumes of 70 percent available chlorine HTH (or solution concentrate[1]) that will provide approximately the indicated chlorine dose when added to the listed volume of water

Gallons to be chlorinated	1 mg/L	2 mg/L	5 mg/L	10 mg/L	100 mg/L
5	0.9 mL	1.7 mL	4.1 mL	8.3 mL	0.25 tsp
10	1.7 mL	3.3 mL	8.3 mL	16.6 mL	0.5 tsp
25	4.1 mL	8.3 mL	20.7 mL	41.4 mL	1.25 tsp
36	6 mL	11.9 mL	29.8 mL	0.9 mL	1.75 tsp
50	8.3 mL	16.6 mL	0.6 mL	0.25 tsp	2.5 tsp
100	16.6 mL	33 mL	0.25 tsp	0.5 tsp	5 tsp
400	0.92 mL	1.9 mL	1 tsp	2 tsp	19 tsp
500	1.3 mL	0.5 tsp	1.25 tsp	2.5 tsp	0.5 cp
1000	0.5 tsp	1 tsp	2.5 tsp	5 tsp	1 cp

Note: [1]The shaded area of the table indicates the volume of a concentrated solution made from dissolving 1 tsp of HTH in a half canteen cup (1½ cups) of water.

I-2. Conversion factors

a. Table I-3 is useful in converting from one unit of measurement to another. It shows equivalent values for common units of measurement. Unit volumes increase from left to right and top to bottom. All volumes on the same horizontal line (row) are equal. So, looking at the "ounce" row, we can see that 1 oz, 444 dp, 30 mL, 6 tsp, and 2 tbls are all equal to each other. Continuing to the right on the same row indicates that 1 oz is also equal to 0.125 or 1/8th cp (see table I-4), 0.063 pints (pt), 0.031 quarts (qt), and so on across the table.

b. If you need to add 7 mL of bleach to a container of water, but you only have an eyedropper, you can see that each mL contains 15 dp, so 7 mL would be equivalent to 7 x 15, or 105 dp.

c. The values moving down a single column represent how many of the units at the top of the column make up one of the units on the left of the table. For example, proceeding down the column with "**drop**" at the top, there are 15 dp in a mL, 74 dp in a tsp, 3550 dp in a cp, and 56,775 dp in a gal. Similarly, looking at the "**ounce**" column, there are only 0.002 oz in a dp, 0.5 oz in a tbls, and 32 oz in a qt.

Table I-3
Equivalent volumes

	drop	mL	tsp	tbls	ounce	cup	pint	quart	liter	gal
drop	1	0.067	0.013	0.004	0.002					
mL	15	1	0.200	0.067	0.033	0.0042	0.0021	0.0011	0.0010	
tsp	74	5	1	0.333	0.167	0.021	0.010	0.005	0.005	0.001
tbls	222	15	3	1	0.500	0.063	0.031	0.016	0.015	0.004
ounce	444	30	6	2	1	0.125	0.063	0.031	0.030	0.008
cup	3550	237	48	16	8	1	0.500	0.250	0.240	0.063
pint	7100	473	96	32	16	2	1	0.500	0.480	0.125
quart	14200	946	192	64	32	4	2	1	0.960	0.25
liter	15000	1000	203	68	34	4.2	2.1	1.06	1	0.26
gal	56775	3785	768	256	128	16	8	4	3.785	1

I-3. Fractions and decimals
Table I-4 shows the equivalence between common fractions and decimals.

Table I-4
Common fractions and their decimal equivalents

Fraction	Decimal
1/16	0.0625
1/8	0.125
3/16	0.1875
1/4	0.25
5/16	0.3125
3/8	0.375
7/16	0.4375
1/2	0.500

Fraction	Decimal
9/16	0.5625
5/8	0.625
11/16	0.6875
3/4	0.75
13/16	0.8125
7/8	0.875
15/16	0.9375
16/16	1.0000

I-4. Chlorination formulas
a. If the volume and/or concentration you are working with are not in the tables above, use the following equations to calculate the volume of required bleach, HTH, or concentrated calcium hypochlorite solution in mL; then use table I-3 to convert that volume to enable using the best measuring device you have available.

(1) For Liquid Bleach (~ 5 percent available chlorine):

$$\text{mL required} = \frac{\text{desired concentration in mg/L x number of gallons to be treated}}{13.2}$$

(2) For HTH (~70 percent available chlorine)

$$\text{mL required} = \frac{\text{desired concentration in mg/L x number of gallons to be treated}}{434.6}$$

(3) For a solution made from adding 1 level tsp HTH to half a canteen cup of water:

$$\text{mL required} = \frac{\text{desired concentration in mg/L x number of gallons to be treated}}{6.04}$$

For example: chlorinating 10 gallons of water with a dose of 5 mg/L (ppm), would require the following:

$\frac{5 \times 10}{13.2}$ = 3.8 mL of *bleach*

$\frac{5 \times 10}{434.6}$ = 0.115 mL of HTH, or

$\frac{5 \times 10}{6.04}$ = 8.3 mL of concentrated *hypochlorite solution* made from 1 level tsp HTH in half a canteen cup (1 ½ cups) of water.

b. If your measuring device is not as precise as the number you come up with, it is generally advisable to round the calculated number up to ensure you provide at least the dose you intended to provide. For water destined for drinking, it is always important to provide a 30- min contact time after adding the chlorine and mixing, then to test the water to ensure the desired residual has been achieved.

Glossary

Section I. Abbreviations

AFMIC
Armed Forces Medical Intelligence Center

AML
Area Medical Laboratory

ANSI
American National Standards Institute

AO
area of operations

AR
Army regulation

AWSM
advanced water surveillance monitoring

AWT
advanced water testing

BCT
basic characterization testing

Bq
Becquerel(s) (1 μCi = 37 kBq)

Bq/L
Becquerel(s) per liter

BPT
basic potability testing

BW
biological weapon

BWL
body water losses

BZ
3-quinuclidinyl benzilate

^{o}C
degree(s) Celsius

Camel
unit water pod system

CASCOM
U.S. Army Combined Arms Support Command

CBRNE
chemical, biological, radiological, nuclear, and explosives

CFR
Code of Federal Regulations

CONUS
continental United States

COTS
commercial off-the-shelf

CSS
combat service support

CU
color unit(s)

CW
chemical warfare

CWQL
Complete Water Quality Laboratory

DDAPI
Deployment Data Archiving and Policy Integration

DEPMEDS
Deployable Medical System

DESP
Deployment Environmental Surveillance Program

DFWSK
deployment field water sampling kit

DNBI
disease and non-battle injury

DOD
Department of Defense

DODI
Department of Defense Instruction

DOS
day(s) of supply

DPW
Director of Public Works

DS
direct support

DSN
Defense Switched Network

EAC
echelons above corps

EBS
environmental baseline survey

EHSA
environmental health site assessment

EPA
U.S. Environmental Protection Agency

^{o}F
degree(s) Fahrenheit

FAC
free-available chlorine

FAWPSS
forward area water point supply system

FDA
U.S. Food and Drug Administration

FHP
force health protection

FGS
Final Governing Standards

FM
field manual

FOUO
For Official Use Only

FST
Field Sanitation Team

FWSVA
field water system vulnerability assessment

gal
gallon(s)

GI
gastrointestinal

gpd
gallon(s) per day

gph
gallon(s) per hour

GS
general support

Hippo
load handling system compatible water tank rack system

HTH
high test hypochlorite

IBWA
International Bottled Water Association

IPB
Intelligence Preparation of the Battlefield

ISO
International Organization for Standardization

JCS
Joint Chiefs of Staff

kBq
kilobecquerel(s)

L
Liter(s)

lb
pound(s)

LD
Legionnaires' disease

L/d
Liter(s) per day

LWP
lightweight water purifier

MACOM
major Army command

MEG
military exposure guideline

METT-TC
Mission, Enemy, Terrain and weather, Troops and support available, Time, and Civil Considerations

MF
micro filter

mg/d
milligram(s) per day

mg/L
milligram(s) per liter (equates to part per million, or ppm)

min
minute(s)

MIL STD
military standard

mL
milliliter(s)

MOPP
mission-oriented protective posture

MP
military population

mrem
milliroentgen(s) equivalent, man

NATO
North Atlantic Treaty Organization

NCO
noncommissioned officer

NEHC
Navy Environmental Health Center

NEPMU
Navy Environmental and Preventive Medicine Unit

NIOSH
National Institute for Occupational Safety and Health

NPDES
National Pollutant Discharge Elimination System

NSN
national stock number

NTU
nephelometric turbidity unit(s)

OCl^-
hypochlorite ion

OCONUS
outside the continental United States

OEBGD
Overseas Environmental Baseline Guidance Document

OEH
occupational and environmental health

OEHS
occupational and environmental health surveillance

OP
organophosphate

ORM
operational risk management

OTSG
Office of The Surgeon General

oz
ounce(s)

pCi
picocurie(s)

pH
negative log of the hydrogen-ion concentration

PME
preventive medicine estimate

ppm
part(s) per million

PVNTMED
preventive medicine

PWS/DS
potable water storage and distribution system

QSTAG
Quadripartite Standardization Agreement

qt
quart(s)

RO
reverse osmosis

ROM
reverse osmosis membrane

ROWPU
reverse osmosis water purification unit

SASO
support and stability operations

SMFT
semitrailer-mounted fabric tank

SOP
standing operating procedure

STANAG
Standardization Agreement (NATO)

STP
sewage treatment plant

Sv
Sievert(s)

TB
technical bulletin

TB MED
technical bulletin (medical)

TDS
total dissolved solids

TG
technical guide

TIC
toxic industrial chemical

TM
technical manual

TO
theater of operations

TON
threshold odor number

TSFWS
Tri-Service Field Water Standards

TWDS
tactical water distribution system

TWPS
tactical water purification system

μCi
microcurie(s)

μg
microgram(s)

UF
ultra filter

USACHPPM
United States Army Center for Health Promotion and Preventive Medicine

USAREUR
United States Army Europe

UV
ultraviolet

VETCOM
United States Army Veterinary Command

VS
Army Veterinary Services

WDWMS
water distribution and waste management system

WHO
World Health Organization

WPS
Water purification system

WQAS
water quality analysis set(s)

WQAS-E
water quality analysis set, engineer

WQAS-P
water quality analysis set, purification

WQAS-PM
water quality analysis set, preventive medicine

WSMP
Water Supply Management Program

yd
yard(s)

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Section II. Terms

Acclimatization
The process by which one becomes accustomed to new environmental conditions.

Advanced water testing (AWT)
Procedures that involve the collection, packaging, and shipping of water samples by field PVNTMED personnel to a fixed facility laboratory to undergo analytical procedures far beyond the capabilities of typical field equipment. Used for three purposes: (1) as part of EBSs performed to document the impacts of U.S. deployments on the deployed environment; (2) to test treated field water to determine the concentrations of certain OEH chemical parameters; and (3) to identify suspected contaminants resulting from accidental or intentional contamination of water supplies in the field.

Basic characterization testing (BCT)
Onsite field testing of raw water to determine its basic characteristics, quality, and ability to be treated with Army water purification equipment to meet the TSFWS. Conducted by quartermaster (water purification) personnel and PVNTMED detachments/teams.

Basic potability testing (BPT)
Onsite field testing conducted by PVNTMED personnel to determine if treated water is potable when compared to the TSFWS.

Command surgeon
The brigade, division, corps, or CINC surgeon, or the Air Transportable Hospital or Air Transportable Clinic surgeon, responsible for providing medical support at the corresponding level concerned.

Dehydrate
To lose water from body tissues.

Deployment Occupational and Environmental Health Surveillance
The program described in DODI 6490.3 whereby soldiers' occupational and environmental health exposures during deployments are to be monitored, recorded, and archived for future evaluation should it become necessary.

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

Endemic
A disease or organism that is constantly present to a greater or lesser extent in a particular locality or region.

Environmental baseline survey (EBS)
Required for all deployments, the EBS documents observed and potential toxic substance releases into structures or into the air, ground, ground water, or surface water. EBSs are performed upon initial arrival at a site, and require, at a minimum, a final survey prior to military withdrawal from a site. Evidence may be based on visual observation, documentation, and any tests/analytical results of such environmental media. The EBS serves two purposes: (1) to document the effects that deployed personnel and operations have on the environment; and (2) to identify and quantify OEH health and safety hazards that may pose potential risks to U.S. personnel at U.S. Forces locations.

Environmental health site assessment (EHSA)
An assessment that specifically addresses whether there are potential adverse health implications to troops from OEH hazards is sometimes referred to as the OEH hazard assessment or the EHSA. The OEH/EHSA is based on an assessment of the presence or absence of completed pathways of human exposure to a hazardous substance. For water, this primarily means evaluating drinking water contaminants.

Field facility
A facility intended to endure long enough to support a local tactical or training operation where a fixed facility is not economically feasible or required operationally.

Field water supply system
An assemblage of collection, purification, storage, transportation, and distribution equipment and personnel which provide potable water to field units during training and combat environments.

Free-available chlorine (FAC)
The chlorine equilibrium products present in the forms of hypochlorous acid and hypochlorite ions.

Fresh water
Fresh water has a TDS concentration of less than 1,500 ppm.

Host
A living animal or plant that harbors or nourishes another organism.

Incubation period
The time required between initial contact with an infectious agent and the appearance of the first clinical symptoms of disease.

Maximum contaminant level (MCL)
The maximum permissible level of a contaminant in water which is delivered to the consumer.

Military exposure guideline (MEG)
MEGs are protective guidelines used to assess the degree of risk to troops when exposed to chemical contaminants in environmental media (air, soil, and drinking water). For water, MEGs are used to assess AWSM results of potable water. MEGs are published and updated annually in USACHPPM Technical Guide 230.

Nonpotable water
Fresh, brackish, or seawater that has not been treated or disinfected and has not been approved for human consumption.

Occupational and environmental health hazard assessment
Required by DODI 6490.3, includes identification and assessment of all chemical hazards for which there are direct exposures to troops (see EHSA).

Occupational and environmental health surveillance
See "Deployment Occupational and Environmental Health Surveillance"

Palatable water
Water that is cool, aerated, significantly free from color, turbidity, taste, and odor, and is generally pleasing to the senses. Palatable water is not necessarily potable and may contain disease- or illness-causing substances.

Pathogenic organism
Any disease-producing microorganism.

Pollution sources
Sources of pollution such as landfills, industrial and domestic sewage discharges, and fuel oil storage sites.

Potable water
For purposes of this TB MED - Water that has been tested and certified by PVNTMED personnel to meet the TSFWS, and is therefore considered safe to drink insofar that it will not degrade soldier performance of duty to the extent that mission accomplishment is jeopardized. Potable water may or may not be palatable.

Product water
Water effluent from a water treatment or purification system.

Raw water
Water that has not been treated or purified to improve its quality.

Treated water
Water that has undergone processing such as sedimentation, filtration, and disinfection. Does not imply potability until inspected by PVNTMED personnel and approved by the command surgeon.

Tri-Service Field Water Standards (TSFWS)
Standards developed for selected water characteristics and contaminants which if consumed for short (<7 days) or long (7 -364 days) term at nominal rates of 5 or 15 liters of water daily will not result in mission failure due to personnel illness or disease. Exceeding such standards in water that is to be consumed is thus considered a significant operational risk.

Vector
An insect or other organism that carries and transmits a pathogenic amoeba, bacterium, fungus, virus, or worm.

Water discipline
Consuming water that has been properly treated, conserving and protecting the potable water supply, and ensuring that potable water does not become contaminated from careless or improper handling.

Water point
The location where water is dispensed for use.

Water purification point
The location where the water treatment system is set up and operated.

Water quality
The chemical, physical, radiological, and microbiological characteristics of water with respect to its suitability for a particular purpose.

Water source
Surface water (rivers, ponds, lakes, springs), ground-water wells, and even host nation municipal water systems that can be accessed and treated using Army water purification equipment to produce potable drinking water.

Water source reconnaissance survey
Ground survey of potential water sources to select the most appropriate source and determine its suitability for treatment and production of drinking water. Conducted by a team including, but not limited to, engineers, quartermaster/water purification, PVNTMED, and Intel/security personnel.

Water source sanitary survey
Survey of a proposed or existing water source conducted by PVNTMED personnel to identify existing and/or potential sources of pollution/contamination to a water source (supports the water source reconnaissance survey).

Water supply
Treated potable water that is stored and distributed or otherwise made available for use.

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army
0534910

PIN: 058770-000