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SANITARY CONTROL AND SURVEILLANCE OF FIELD WATER SUPPLIES

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HEADQUARTERS, DEPARTMENT OF THE ARMY

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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.

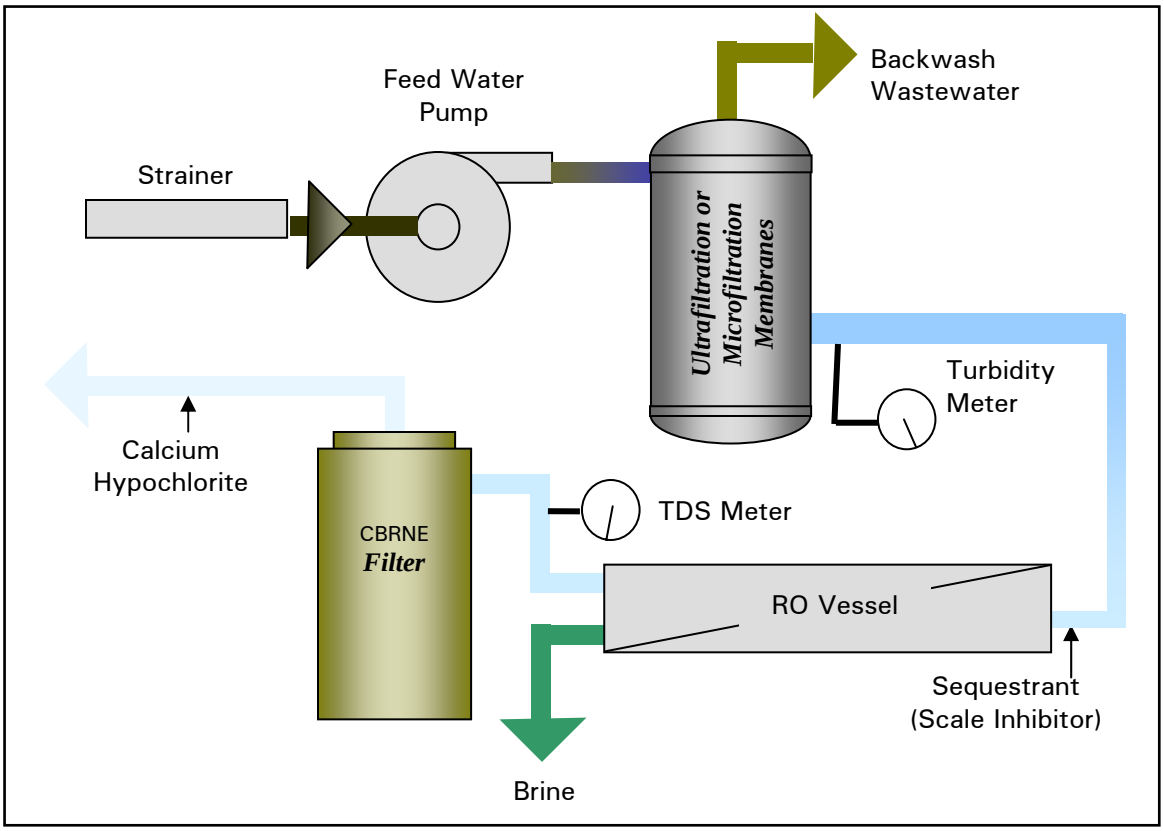

Figure 9–1. Lightweight water purifier or TWPS water flow diagram

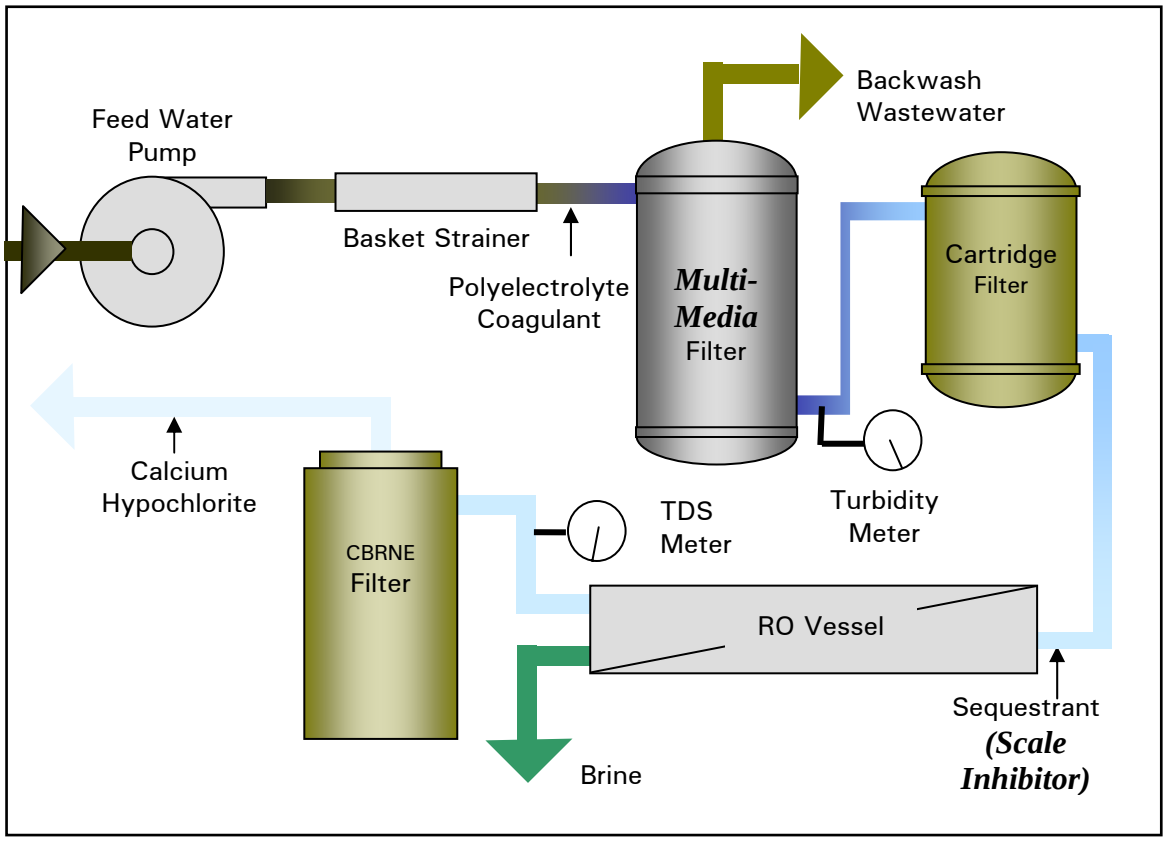

Figure 9–2. 600-gph ROWPU water flow diagram

(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.