Recreation Management Tech Tips

United States Department of Agriculture
Forest Service
National Technology & Development Program

August 2007

2300 0723 1307—SDTDC

Large-Group Water Treatment System

by
Brenda Land, Sanitary Engineer

Providing safe drinking water for large groups of people in back-country locations is challenging. It can be even more challenging if the back country is a designated wilderness area, with restrictions on motorized devices. Outfitters in some wilderness areas have been using an electrically operated water treatment system that is inconsistent with wilderness regulations, policies, and guidelines. The Forest Service, U.S. Department of Agriculture (USDA), Intermountain Region, submitted a project to San Dimas Technology and Development Center (SDTDC) to find and evaluate nonmotorized alternatives to treat water for large groups.

The alternative must:

- Treat water for up to 30 people, 2 to 3 times each day, 20 to 30 gallons each time.
- Produce clean water with treatment for protozoa, bacteria, and viruses.
- Transport easily on river-rafting trips.
- Comply with wilderness regulations, policy, and guidelines.

River guides are not the only people who need to treat water for large groups in back-country locations. Trail crews, volunteer groups, packers (figure 2), and research groups also need to be able to treat water. Crew supervisors and group leaders are depended upon to ensure an adequate supply of safe drinking water is available.

Figure 2—Loading packstock for a back-country trip.

An adequate supply of safe drinking water is necessary for any back-country experience. Active people should drink 2 to 3 liters of water a day, according to the USDA Food and Nutrition Service. When cooking, cleaning, and personal hygiene

For additional information, contact: Recreation Management Program Leader, San Dimas Technology & Development Center, 444 East Bonita Avenue, San Dimas, CA 91773-3198; Phone 909-599-1267; TDD; 909-599-2357; FAX: 909-592-2309
Lotus Notes: Mailroom WO SDTDC@FSNOTES • Intranet (web site): http://fsweb.sdtdc.wo.fs.fed.us • Internet e-mail: mailroom_wo_sdtdc@fs.fed.us

(figure 3) are included, 15 liters per person per day may be needed (World Health Organization guidelines). It is seldom practical to carry enough water to last the duration of an extended trip. The alternative is to find water along the way.

Figure 3—Personal hygiene in camp.

Surface water, such as lakes, rivers, and streams, may be used to provide safe water; however, it must be treated to remove potentially harmful pathogens. Protozoa, bacteria, and viruses may all be present in cold, clear, mountain water. Many mammals carry protozoa (figure 4). During the 2003 to 2004 surveillance year, the U.S. Department of Health and Human Services' Centers for Disease Control and Prevention (CDC) confirmed 202 cases of gastrointestinal illness caused by ingesting lake or river water.

Figure 4—Water may be contaminated with beaver fever (giardia) from many mammals.

The most reliable way to ensure safe water from an untreated source, such as a lake or river, is to boil it. Boiling water as recommended will kill parasitic, bacterial, and viral causes of diarrhea. Boil water vigorously for 1 minute, or 3 minutes at elevations above 2,000 meters (6,500 feet) (From CDC). If boiling is not practical, an alternate way to ensure safe drinking water is to filter and disinfect it.

Filters (figure 5) may remove protozoan cysts and bacteria, but they do not remove viruses. Disinfection kills the viruses. Only clear water should be used. Filter cloudy water before adding a chemical disinfectant.

Figure 5—Katadyn Expedition filter.

The U.S. Environmental Protection Agency (EPA) recommends the following chemical disinfectants for water of unknown quality.

- Chlorine – Use 8 drops unscented 5.25-percent household bleach (figure 6) per gallon of clean water (do not use scented or nonchlorine bleach) and let stand 30 minutes. If the chlorine taste is too strong, a carbon filter can be used to remove the chlorine from the water. A few drops of liquid vitamin C will also remove the chlorine.

Figure 6—Unscented household bleach.

- Tincture of iodine – Use 5 drops of 2-percent tincture of iodine per quart of clean water and let stand 30 minutes. A few drops of liquid vitamin C will remove the iodine taste from water. Tincture of iodine and liquid vitamin C are available at drug stores.

Ultraviolet light (UV) has recently been approved by the EPA to disinfect water. Partner Steel Co., Inc.'s Aqua-Partner™ water treatment system uses UV disinfection (figure 7). Partner Steel modified its motorized unit to work with a manual foot pump (figure 8). The system uses a prefilter to remove sediment, a 0.5 micron carbon-block cyst filter to remove protozoan cysts, and a battery-powered UV light to inactivate bacteria and viruses.

Figure 7—Aqua Partner™ water treatment system.

Figure 8—Nonmotorized foot pump.

Partner Steel provided a manual Aqua-Partner™ system to SDTDC for evaluation. SDTDC sent the system to the University of California, Riverside (UCR) Department of Environmental Sciences, Microbiology, to evaluate its ability to inactivate bacteria and viruses. The 0.5-micron carbon-block cyst filter had already been independently evaluated for cyst removal and was not evaluated.

UCR operated the system at 1 gallon per minute for 240 hours on clean water (turbidity less than 1 NTU [nephelometric turbidity unit]). UCR challenged the system with E. coli 11775 bacteria and bacteriophage phiX174 virus. The challenge tests were performed at 5 percent of filter life (12 hours), 50 percent of filter life (120 hours), and 95 percent of filter life (228 hours). The unit demonstrated 5-log removal/inactivation for both bacteria and viruses during the clean-water tests. The system was operated on highly turbid (30 NTU) water for an additional 12 hours. Both bacteria and virus were nondetectable after treatment.

The battery was kept on a charger during the test. In the field, a solar package is required to keep the battery charged. **If the battery is low, the UV light will not operate at full power and a chemical disinfectant must be added to the filtered water.** An indicator light will warn the user when the battery is low.

UCR did not use the manual foot pump to pump water through the system during the test. Water was supplied by pressure and regulated to 1 gallon per minute. Solitude River Trips, a Middle Fork of the Salmon River outfitter, evaluated the system in the field using the foot pump. They reported that it worked very well. They were pleased with the overall ease of use, portability, and operation of the manual Aqua-Partner™ water treatment system.

Whatever method is used by outfitters, guides, and group leaders to provide potable water, an understanding of how the system functions is needed. Filtration alone does not ensure safe water. It needs to be both filtered to remove protozoan cysts and disinfected to kill bacteria and viruses. Chemical disinfection is a well-understood and accepted practice. UV light to disinfect drinking water is an emerging technology.

Partner Steel Company, Inc.
http://partnersteel.com/
3187 Pole Line Rd
Pocatello, ID 83201-6119
Phone: 208–233–2371
FAX: 208–233–2536

Solitude River Trips
P.O. Box 128
Carmen, ID 83462

SDTDC staff thanks Kathie Snodgrass, Missoula Technology and Development Center, and Randy Welsh, Intermountain Region, wilderness specialist, for their review of this publication.

SDTDC's national publications are available on the Internet at: http://www.fs.fed.us/eng/pubs/

Forest Service and U.S. Department of the Interior Bureau of Land Management employees also can view videos, CDs, and SDTDC's individual project pages on their internal computer network at http://fsweb.sdtdc.wo.fs.fed.us/

For additional information on large-group water treatment systems, contact Brenda Land at SDTDC. Phone: 909–599–1267 ext 219. E-mail: bland@fs.fed.us

The information contained in this publication has been developed for the guidance of employees of the Forest Service, U.S. Department of Agriculture, its contractors, and cooperating Federal and State agencies. The Forest Service assumes no responsibility for the interpretation or use of this information by other than its own employees. The use of trade, firm, or corporation names is for the information and convenience of the reader. Such use does not constitute an official evaluation, conclusion, recommendation, endorsement, or approval of any product or service to the exclusion of others that may be suitable.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.