

industrial uses of radioactive materials). The residual radioactivity in surface waters from fallout

due to atmospheric nuclear weapons testing is mainly strontium-90 and tritium.

### Section III. WATER SOURCES

	<i>Article</i>
General .....	5-9
Selection of Water Source .....	5-10
Wells .....	5-11
Springs .....	5-12
Surface Water Sources .....	5-13
Rainwater .....	5-14
Snow and Ice . . . . .	5-15
Sea Water .....	5-16
Bottled Water .....	5-17

#### 5-9. General.

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

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

3. Many installations have isolated water sources, such as wells and springs, for service of training areas. In many cases, these isolated water sources do not service residents and are not classified as public water systems. Water systems that meet these criteria will be classified

as field sources. Sanitary control of field sources is addressed in Chapter 9 of this manual, "Preventive Medicine for Ground Forces."

#### 5-10. Selection of Water Source.

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

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

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

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

#### 5-11. Wells.

1. Ground water occurs in geologic formations called aquifers. Aquifers contain saturated permeable material which yields water to wells and springs. An aquifer serves as a transmission conduit and storage reservoir that transports water under a hydraulic or pressure gradient from recharge areas to water-collecting areas. Ground water, when available, is usually an excellent source of water supply. Such water can be expected to be clear, cool, colorless, and quite uniform in character. It is generally of better microbiological quality and contains much less organic material than surface water, but may be more highly mineralized. At present, wells serve small to medium-size installations although a system of multiple wells may be used to develop a supply for large installation. Consult NAVFAC DM-5.7 on this subject. More information may be found in NAVFAC Guide Specification NFGS 02734, Rotary-Drilled Water Wells and AWWA A-100-66, American Water Works Association Standard for Deep Wells.

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

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

wells:

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

b. For artesian aquifers, the casing must be sealed into the overlying impermeable formations to retain the artesian pressure.

c. When a water-bearing formation containing water of poor quality is penetrated, the formation must be sealed off to prevent the infiltration of water into the well and developed aquifer.

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

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

f. Disinfection.

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

TABLE 5-1.

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

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

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

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

### 5-12. Springs.

1. Springs are formed at the intersection of an aquifer with the ground surface, or by leakage of

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

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

3. Spring Disinfection. Spring encasements will be disinfected by scrubbing the inside of the encasement above the water line with a stiff brush or broom and 100 ppm chlorine solution. When the flow can be stopped or maintained within the encasement, determine the volume of water and add enough chlorine solution to the water to obtain a 100 ppm FAC residual in the water. Let the spring stand 24 hours and discharge to waste until the FAC residual is approximately 1.0 ppm. Take samples and place in service as described for wells. When the spring flow cannot be stopped, enough chlorine must be continuously fed into the contained water in the spring encasement, near the inlet, to result in 100 ppm FAC in the outlet. This residual will be maintained for at least 24 hours.

### 5-13 Surface Water Source.

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

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

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

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

#### 5-14. Rainwater.

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

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

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

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

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

#### 5-15. Snow and Ice.

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

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

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

3. In arctic areas during the summer, surface sources are obtained and treated the same as surface supplies in other geographic regions. The milky water of a glacial stream is not harmful. Sedimentation will settle out most of the color. In summer, a muskeg area can sometimes

be used as a water source. Muskeg is a resilient soil covered with bog and has a high water table. Muskeg water can be collected by building ditches.

#### 5-16. Sea Water.

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

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

#### 5-17. Bottled Water.

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