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EXPEDIENT HYGIENE, WATER, AND WASTE METHODS

DEPARTMENT OF THE AIR FORCE

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AIR FORCE TACTICS, TECHNIQUES, AND PROCEDURES 3-32.33V1

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Tactical Doctrine

EXPEDIENT HYGIENE, WATER, AND WASTE METHODS

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PURPOSE: The Air Force Tactics, Techniques and Procedures (AFTTP) presented in this publication provide Air Force (AF) civil engineer (CE) craftsmen with ideas and guidance for establishing temporary or expedient hygiene and sanitation, water and wastewater, and solid waste facilities when standard equipment and materials are not available or when necessary for minimum-essential restoration of damaged facilities and utility systems. This publication supports Air Force Instruction (AFI) 10-209, *RED HORSE Program*, AFI 10-210, *Prime Base Engineer Emergency Force (BEEF) Program*, and Air Force Doctrine Annex 3-34, *Engineer Operations*. Refer recommended changes and questions about this publication to the Office of Primary Responsibility (OPR) using the AF Form 847, *Recommendation for Change of Publication*; route AF Form 847s from the field through the appropriate functional chain of command and Major Command (MAJCOM) publications/forms managers. Ensure that all records created as a result of processes prescribed in this publication are maintained in accordance with (IAW) Air Force Manual (AFMAN) 33-363, *Management of Records*, and disposed of IAW the Air Force Records Disposition Schedule (RDS) in the Air Force Records Information Management System (AFRIMS). The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the AF.

APPLICATION: This AFTTP is nondirective. It applies to all AF active, Air National Guard, and AF Reserve Command CE units. The expedient methods provided here are primarily applicable during wartime and overseas contingency operations, and force beddown in remote or austere locations outside the United States with shortages of standard construction materials. Some expedient methods may be applicable during disaster recovery operations when immediate action is necessary and resources are limited.

SCOPE: The information in this publication does not supersede any legal requirements (domestic US law for operations in the US and for operations outside the US: US law with extraterritorial application, applicable international agreement requirement, or combatant command directive) that specify how things must be done.

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Chapter 1

INTRODUCTION

1.1. Overview. This AFTTP addresses field expedient construction or repair methods for sanitation and hygiene facilities, wastewater, and solid waste systems when time and materials are limited, or when conventional methods are impractical to employ. It does not address the installation of standard contingency hygiene, water, and waste systems such as Basic Expeditionary Airfield Resources (BEAR). For the purpose of this document, expedient is "a means devised or employed in a time and place where prompt action is essential." Expedient engineering does not preclude using normal engineer practices where time and materials are available. This publication contains illustrations of basic material applications and proven construction methods during field applications. Any data and definitions presented are general in nature and serve as field guides. **Note:** The information in this publication does not supersede any legal requirements (domestic US law for operations in the US and for operations outside the US: US law with extraterritorial application, applicable international agreement requirement, or combatant command directive) that specify how things must be done. See **Attachment 1** for a glossary of references and supporting information.

1.2. Environmental Considerations. The United States Air Force (USAF) is committed to maintaining environmental quality to ensure long-term access to the air, land, and water needed to protect United States interests abroad. Although a high level of environmental quality can be difficult to achieve during contingency operations overseas, the health and safety of personnel are critical in any military operation. Safe food and water, and a means of properly disposing of waste is essential. The intention of environmental goals during contingencies is to minimize risks to human health and safety, and prevent unnecessary damage to the environment while maximizing the natural resources available to support readiness and operational effectiveness. Further information on how to integrate environmentally responsible practices during contingency operations can be found in Air Force Handbook (AFH) 10-222V4, *Environmental Considerations for Overseas Contingency Operations*.

1.3. General Safety Practices. The first rules for any situation requiring CE expedient applications are to be flexible and remain safe. Always keep safety in mind when using nonstandard construction methods and materials. Unsafe field operations could cause injuries, disable equipment, and negatively affect the mission. Never compromise safety when employing expedient methods described in this publication.

1.3.1. Construction and repair work involves activities that can injure workers in many different ways. Working from high elevations, flammable fuels, high voltages, dangerous chemicals, and rotating, cutting, and crushing equipment associated with CE operations are significant hazards. Be vigilant; adhere to technical data warnings and cautions, and wear protective clothing and equipment IAW safety information and standards.

1.3.2. Crew leaders should know the capabilities and limitations of assigned personnel and monitor all work efforts accordingly. In addition, ensure activities are coordinated with all involved. For example, debris removal around facilities can be a dangerous task and vibrations from heavy equipment can cause a building to collapse on recovery workers. Worksite personnel should not only be cognizant of this hazard, they should also be able to recognize other potential safety hazards associated with the job.

1.3.3. A key responsibility of supervisors is to ensure personnel have and wear the necessary personal protective equipment (PPE) and individual protective equipment (IPE) for the working environment. Typical items such as lumber, masonry materials, and sheet metal can cause cuts and injuries. Even a small cut can develop into a serious injury if the wound becomes infected. When working in a contaminated environment, be sure to wear the appropriate IPE for the hazard present. In addition, wash contaminated clothing and take a shower as soon as possible after working in a contaminated environment. Additionally, it is important to protect workers from hazards such as high-pressure subsystems and components, harmful solvents and adhesives, and infectious black and gray water products from wastewater systems. **Note:** As used in this publication, black water refers to latrine wastewater containing human waste. Gray water refers to wastewater from non-latrine sources such as showers, laundries, kitchen operations, and handwashing devices.

1.3.3.1. Air Force Instruction (AFI) 91-203, *Air Force Consolidated Occupational Safety Instruction*, lists PPE for selected CE activities. Although technical orders (T.O.) and other job-related publications address proper wear and use of PPE and IPE (for CBRN defense), workers have the ultimate responsibility to properly use, inspect, and care for protective equipment assigned to them.

1.3.3.2. Workers should adhere to AFI 32-1064, *Electrical Safe Practices*, when lethal voltages are involved. PPE that provides appropriate arc flash protection is required for all personnel working on or near exposed energized electrical equipment operating at 50 volts or more. See Unified Facilities Criteria (UFC) 3-560-01, *Electrical Safety, O&M*, and NFPA 70, *National Electric Code*, to identify tasks that require Arc Flash PPE.

1.3.4. Every job or operation has its own particular safety hazards and everyone involved should follow proper safety procedures to prevent injury or illness. This is especially critical during force beddown at austere locations and base recovery activities. Exposure to construction, heavy equipment, power production equipment, fuel systems, mechanical systems, and water or wastewater systems create an assortment of job related hazards—remain vigilant to stay safe.

Chapter 2

FIELD EXPEDIENT HYGIENE AND SANITATION

2.1. Overview. Maintaining health of the force is a central concern during beddown operations and contingency deployments in austere locations. Key requirements include providing sanitation facilities for disposal of human waste and basic personal hygiene. Generally, prepackaged deployable facilities (i.e., BEAR assets) support deployed forces when inadequate or no sanitary systems are present. However, improvised or field expedient methods may be necessary to provide crude, temporary amenities until these deployable, prepackaged facilities arrive. This chapter presents basic concepts for creating expedient, rudimentary sanitation facilities to support initial sanitation and hygiene requirements. These concepts can be expanded to support additional personnel through duplication, but are not considered long-term solutions. Facilities addressed in this chapter include field expedient latrines, urinals, hand-washing stations, and shower-shave stations. These concepts should help personnel accomplish minimum requirements to support temporary hygiene and sanitation needs until assets become available.

2.2. Human Waste Disposal Policy. AF policy directs human waste be disposed of with good sanitary practices. Proper human waste disposal is essential to maintaining good health and requires command emphasis at all levels. At the installation level, base engineers are responsible for constructing, maintaining, and operating fixed sewage systems for human waste disposal. However, during deployments to contingency bases and austere locations, engineer provide support to build temporary, field expedient hygiene and sanitation devices to facilitate human waste disposal. DODI 4715.19, *Use of Open-Air Burn Pits in Contingency Operations*, DODI 4715.22, *Environmental Management Policy for Contingency Locations*, AFH 10-222V4, *Environmental Considerations for Overseas Contingency Operations*, AFPAM 10-219V5, *Bare Base Conceptual Planning*, and AFH 10-222V1, *Civil Engineer Bare Base Development*, has additional information relating to waste disposal requirements and procedures at contingency locations.

2.3. Latrines. The type of latrine selected for a given situation depends on several factors such as the number of personnel, deployment duration, and geological and climatic conditions. Medical public health specialists can assist in determining the right type, number, size, and location of latrines. Usually, latrine location is a compromise between separation requirements from dining facilities and water sources, and convenience for personnel. Multiple latrine sites will be necessary for larger contingency locations. Regardless of the type, number, size, and location of latrines, sanitation and maintenance is critical to prevent disease transmission to and from personnel. Below are four types of latrines typically used in austere contingency locations, however, the primary focus of this section will be the construction of improvised field-expedient latrines. **Note:** Local, state, federal, and host-nation regulations or laws may prohibit burying human waste. Consult theater waste management guidance and check with your local public health or preventive medicine specialists for requirements.

- Portable latrine systems with disposal bags
- Portable chemical latrines set up and maintained by contracted vendors
- Engineered and field-deployable latrines in BEAR assets
- Improvised field-expedient latrines

2.3.1. **Basic Field Latrine Procedures.** Initially, beddown forces may use improvised and expedient latrines at austere locations. Most are basic versions of either pit or aboveground drum-type latrines (**Table 2.1**). These basic latrines are for temporary use until engineers are able to erect suitable facilities or rehabilitate an existing sanitary sewer system. The following general rules apply to field expedient latrines:

2.3.1.1. Location and Set-up. To protect food and water from contamination, locate latrines at least 100 yards from the dining facility and 100 feet from the nearest ground water source. You should not dig latrines to the groundwater table or anywhere they may drain into a water source. The groundwater table can be determined from information given by local inhabitants or by excavating to the groundwater table. Latrines are usually located at least 100 feet from the end of billeting areas but within a reasonable distance for easy access. Place a canvas or brush screen around each latrine or enclose within a tent. If possible, heat the shelter in cold climates and light latrines at night if the military situation permits. If the situation prohibits lighting, tie pieces of cord or tape to trees or stakes as guides to the latrines. **Note:** Latrines should get daily maintenance. Assign specific personnel responsibility for properly the maintaining latrines.

Table 2.1. Improvised Field-Expedient Latrines.

Expedient Latrines
Cross Tree Latrines
Straddle Trench Latrines
Deep Pit Latrines
Bored Hole Latrines
Burn-out Latrines
Mound Latrines
Pail Latrines
Urine Soakage Pits

2.3.1.2. Drainage and Fly Control. Dig a drainage ditch adjacent to latrine facilities to prevent water from pooling around or flowing into the latrine. To control flies and other disease-transmitting insects, spray the shelter with a residual pesticide twice a week. **Note:** Do not spray pit contents. Comply with manufacturer's directions when applying and using insecticides.

2.3.1.3. Hand-Washing Device. Install a simple hand-washing device outside each latrine. The device should be easy to operate and have a constant supply of water. Emphasize the importance of using hand-washing devices. Hands contaminated with fecal material are a common means of disease transmission.

2.3.1.4. Latrine Closing Procedures. Close latrine pits when they fill to within 1 foot of the surface or they are abandoned. Remove the latrine box and close as follows:

- Fill pit to the surface with successive, 3-inch layers of earth and pack each layer down
- Place a l-foot mound of dirt over the length of the pit to prevent fly pupa from escaping the closed latrine
- Install a rectangular sign on top of the mound to indicate the type of pit and the date closed; include the unit designation in non-operational areas.

2.3.2. **Pit Latrines.** All versions of the pit latrine involve digging a pit in the ground. The latrine should be located where the groundwater table is deep enough to prevent groundwater contamination or water standing in the latrine pit. Its use is limited to areas that are free of impervious rock formations near the surface. The following paragraphs address cross tree, straddle tree, and deep pit latrines.

2.3.2.1. **Cross Tree Latrine.** The cross tree latrine (**Figure 2.1**) is a basic, improvised latrine that will usually serve the needs of 6 to 8 personnel. Situate the latrine downwind from the beddown area, but not so far from shelters as to encourage individuals to break sanitary discipline. In areas where it is difficult to dig a pit, ration boxes or similar material should collect waste. Improvise a windbreak using boughs, tarpaulins, ponchos, or a snow wall to provide both privacy and protect the latrine from wind.

2.3.2.2. **Straddle Trench Latrine.** The most common type of latrine for temporary use (one to three days) is the straddle trench latrine. Commonly, the procedure is to dig the straddle trench latrine 1 foot wide, 2 1/2 feet deep, and 4 feet long (**Figure 2.2**). In this configuration, each trench will accommodate two people at the same time. Remove earth and pile it at the end of the trench so that each individual can properly cover his excreta and toilet paper. Provide straddle trenches to serve at least 4 percent of the male population and 6 percent of the female population. For example, a unit of 100 men and 100 women needs at least four latrines for men and six for women. Place trenches at least 2 feet apart. There are no seats with this type of latrine; however, placing boards along both sides of the trench provides better footing. Place toilet paper on a suitable holder and protect it from weather with a tin can or other covering.

Figure 2.1. Cross Tree Latrine.

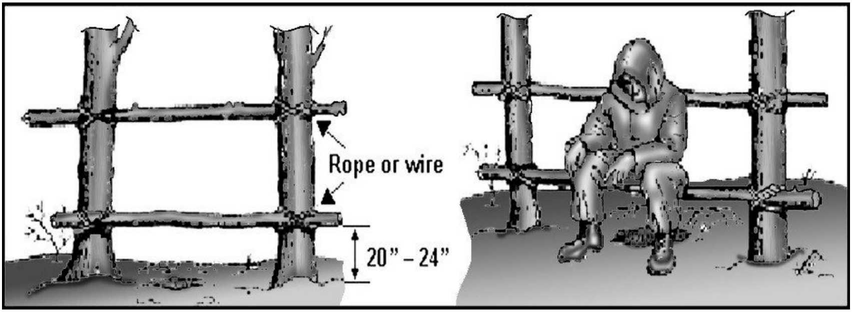
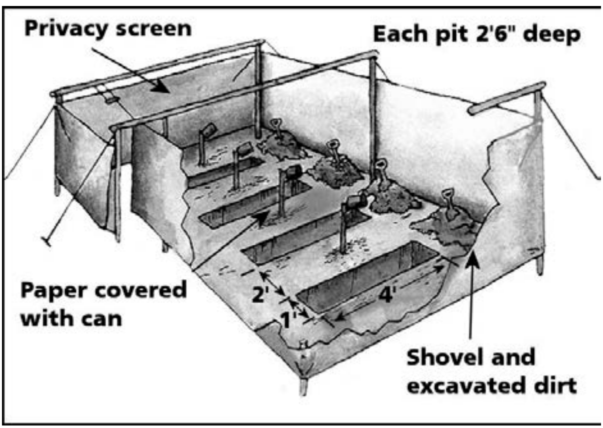
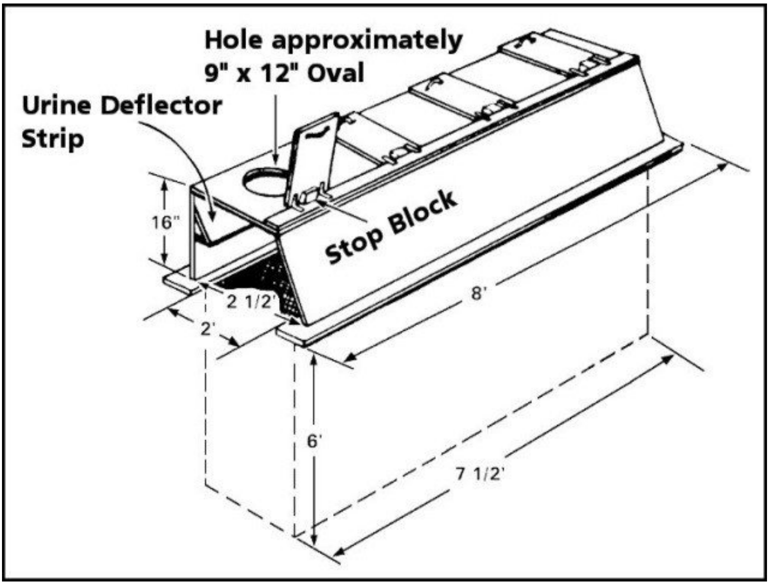


Figure 2.2. Straddle Trench Latrine.



2.3.2.3. **Deep Pit Latrine.** Normally, use of deep pit latrines are for longer periods and often in built-up areas. As shown in **Figure 2.3**, use the deep pit latrine with a latrine box. Although two-seat latrine boxes are sometimes used, the standard latrine box has four seats and is 8 feet long and 2-1/2 feet wide at the base. Cover holes with fly-proof, self-closing lids. Fly proof cracks with strips of wood or tin. Place a metal deflector (e.g. a flattened can) inside the front of the box to prevent urine from soaking into the wood.

Figure 2.3. Four-Seat Deep Pit Latrine.



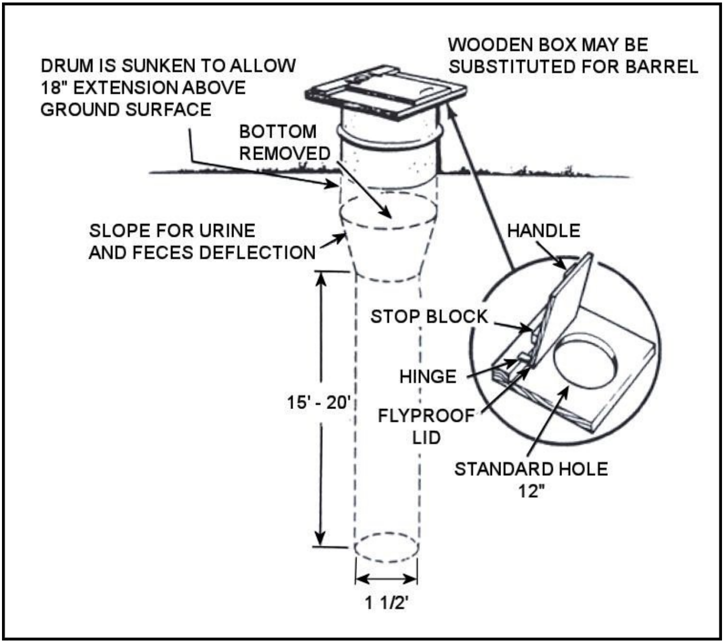
2.3.2.3.1. Dig the pit about 2 feet wide and 7-1/2 feet long. This gives the latrine box 3 inches of support on all sides. The pit depth depends on the latrine's period of use. As a rough guide, allow 1 foot of depth for each week of estimated use, plus 1 foot for the dirt cover when closed. Rock or high groundwater levels often limit the depth of the pit, but the pit should be no deeper than 6 feet. For some soils, support bracing may help to prevent the sides from collapsing; use planking or similar material. Pack earth tightly around bottom edges of the box to seal openings where flies might enter. **Note:** If the ground is too hard for digging or the water table is too high, consider using a **pail latrine** or a **burnout latrine** in place of the deep pit latrine. See each alternative for additional information.

2.3.2.3.2. To prevent flies from breeding and to reduce odors, keep the latrine box clean, seat lids closed, and cracks sealed. Maintain a good fly control program in the area. Applying lime or burning pit contents does not effectively control flies or odor. Scrub the box and latrine seats daily with soap and water daily.

2.3.2.3.3. Create a portable version of the deep pit latrine by building the latrine box inside a portable structure that offers limited privacy and protection from the elements. If prepackaged deployable sanitation assets experience delays, this more substantial portable latrine may serve large groups better than some of the other expedient options discussed in this chapter. Although portable latrines vary in design and construction, most use the same basic principles of mobility, adequate ventilation, proper sanitation, and reasonable privacy. Once the pit reaches capacity, simply relocate the latrine to another spot (usually in the same vicinity), then fill and close the old pit as discussed in **paragraph 2.3.1.4**.

2.3.3. **Bored Hole Latrine.** A bored hole latrine consists of a hole that is about 18 inches in diameter and 15 to 20 feet deep (**Figure 2.4**). The actual diameter is not critical, so make it as large as available augers permit. Remove both ends of a metal drum and sink it into the ground to serve as a box. Make a fly-proof seat cover with a self-closing lid to fit the top of the drum. If a drum is not available, construct a fly-proof, 18-inch high wooden box. A bored hole latrine is better suited for small units.

Figure 2.4. Bored Hole Latrine.

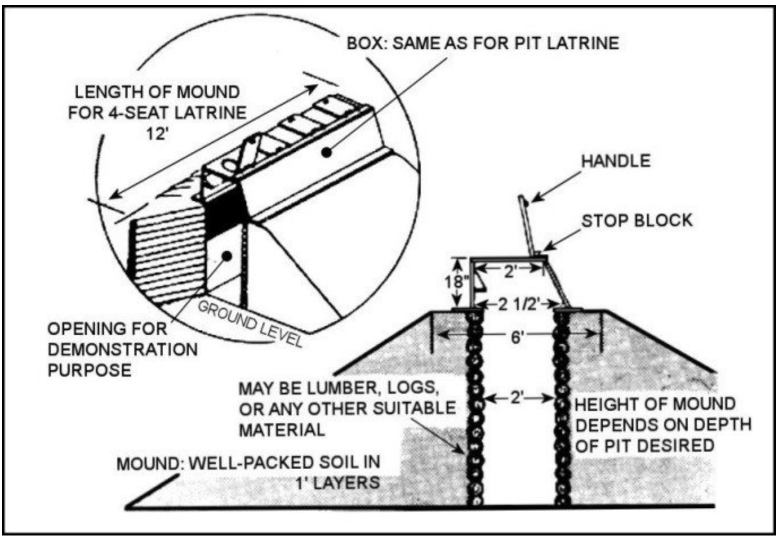


2.3.4. **Expedient Latrines in High Groundwater Areas.** Below are descriptions of expedient latrines normally used when the groundwater table is high and where groundwater contamination or standing water is probable in the latrine pit. These latrines may also be ideal when an impermeable rock formation is close to the surface, preventing adequate dispersal of liquids.

2.3.4.1. **Mound Latrine.** A dirt mound makes it possible to build a deep-pit latrine without the pit extending into water or rock. Construct a mound of earth that is at least 6 feet wide and 12 feet long. It should be able to support a 4-hole latrine box. The mound should be high enough to meet the pit's depth requirement.

Allow 1-foot from the base of the pit to the water or rock level. Break up or plow the area where latrine will be located to aid in seepage of liquids from the pit. If timber is available, build a crib of desired height to enclose the pit and support the latrine box. Build the mound and compact it in successive l-foot layers to the top of the crib as shown in **Figure 2.5**. Roughen the surface of each layer before adding the next. If timber for a crib is unavailable, construct the mound to the desired height in l-foot layers, as described and dig the pit into the mound. If necessary, brace the walls with wood, sandbags, or other material to prevent them from collapsing. Fly proof and enclose a mound latrine as described in **paragraph 2.3.2.3**. **Note:** The size of the mound base depends on the type of soil in the area. Make the mound larger if the slope is steep. In addition, it may be necessary to build steps up a steep slope.

Figure 2.5. Mound Latrine.



2.3.4.2. **Burn Out Latrine.** Often, burn out latrines (**Figure 2.6**) are the preferred method for improvised latrines. These latrines are particularly suitable for jungle areas with high groundwater tables and in desert regions where an impervious rock layer is a short distance under the sand. Ensure the latrine location is downwind of the base camp. A unit of 100 men and 100 women will need at least eight men's latrines and eight women's latrines. As shown in **Figure 2.7**, consolidating burn out latrines within a multiple-station latrine facility with floors, cover, and partial walls provides semi-privacy and ease of maintenance.

Figure 2.6. Burn Out Latrine Details.

2.3.4.2.1. The simplest method to create a basic burn out latrine is to place a 55-gallon drum in the ground and leave enough of the drum above the ground for a comfortable sitting height. Then place a wooden seat with a fly-proof, self-closing lid on top of the drum. However, for easier handling, cut the drum in half, making two latrines of less capacity. Weld handles to the sides of the drum. The handles will allow two people to carry the drums to a suitable location to burn the contents.

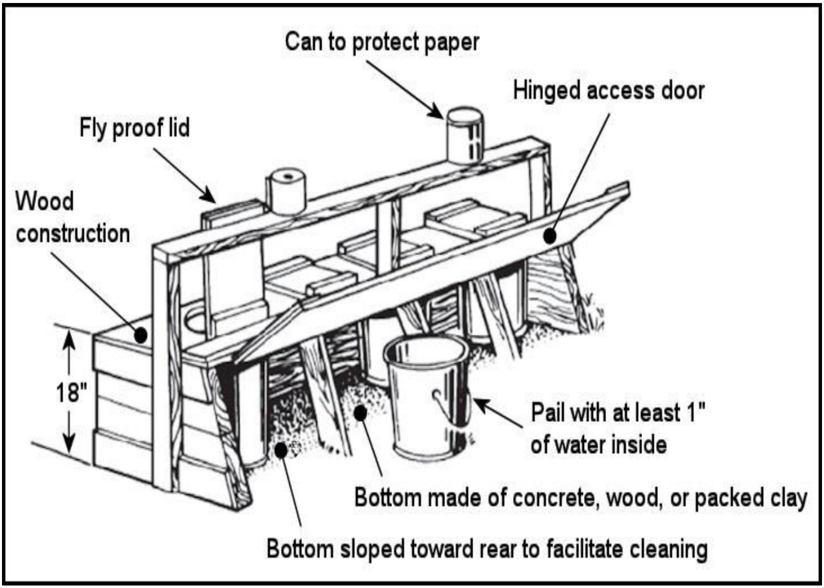
If possible, have two sets of drums so while one set is in use, the other set is being burned out. Encourage male personnel to urinate in a urine disposal facility (see **paragraph 2.4**) rather than a burn out latrine because more fuel is required to clean a latrine with a liquid content.

Figure 2.7. Multiple-Station Burn Out Latrines.

2.3.4.2.2. Burn the contents of each drum daily by adding sufficient fuel to incinerate the fecal matter. Do not use highly volatile fuel because of its explosive nature. A mixture of 1 quart of gasoline to 5 quarts of diesel oil is effective; nevertheless, use it with caution. Burn the contents again if they do not become dry and odorless in one effort. Bury the residual ash once the burning process is complete.

2.3.4.3. **Pail Latrine.** Similar to burn out latrines, consider use of pail latrine facilities when conditions are such that a pit latrine is not feasible (e.g., populated areas, rocky soil, marshes). Construct a standard latrine box according to **paragraph 2.3.2.3**. Add a floor and place a pail under each seat. Place hinged doors on the rear of the box (see **Figure 2.8**) to facilitate removal of pails when emptying. If the box is located within an enclosure, position the box to form a part of the outer wall and ensure the rear of the box opens directly to the outside of the building. The box should be fly proof, and seats and rear doors should be self-closing. Construct the floor of the box with an impervious material (concrete if possible) and allow sufficient slope toward the rear to allow washing water to drain quickly. Clean pails at least once daily and bury, burn, or dispose of the contents by another sanitary method. Plastic liners for the pails reduce the risk of accidental spillage. Tie the filled bags at the top before disposal.

Figure 2.8. Pail Latrines.



2.3.5. **Alternate Latrine Options.** A lack of resources in austere locations could make it difficult to build the aforementioned latrines. In such situations, the makeshift and personal toilets described below may serve as a temporary solution.

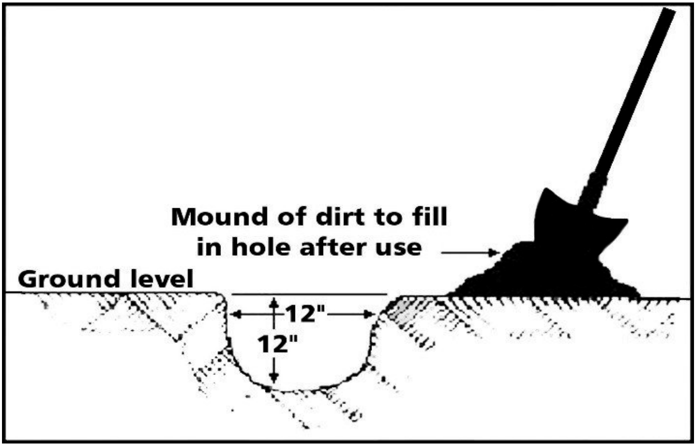
2.3.5.1. Makeshift Toilet. During an emergency or during field activities where digging a hole is not an option, personnel can make an expedient toilet using a common water bucket. Simply line a bucket with a garbage bag and make a toilet seat out of two boards placed parallel to each other across the bucket. After each use, pour a disinfectant such as bleach (1 part liquid chlorine bleach to 10 parts water) into the garbage bag to help avoid infection and stop the spread of disease. Cover the bucket tightly when it is not in use. Bury the garbage and human waste in a pit two to three feet deep and at least 50 feet downhill or away from any well, spring, or water supply.

2.3.5.2. Personal Toilets. During short deployments or special operations in remote and austere locations, personnel may have personal or portable toilets similar to those listed in (**Table 2.2**. When in the field, and away from other facilities, use these personal disposal devices if they are available; if not available, an option may be to dig individual cat holes (**Figure 2.9**). In any case, personnel should try to dispose of the waste immediately.

Table 2.2. Portable and Disposable Human Waste Devices.

Device	National Stock Number (NSN)
Urinal, portable, female	8530-01-470-2805
Urinal bag, disposable	4510-01-379-0177
Portable latrine bag (for solid waste)	4510-01-379-1341
Portable restroom kit (for liquid and solid wastes)	4510-01-379-0190
Portable commode	4510-01-423-0100 / 4510-01-382-4289

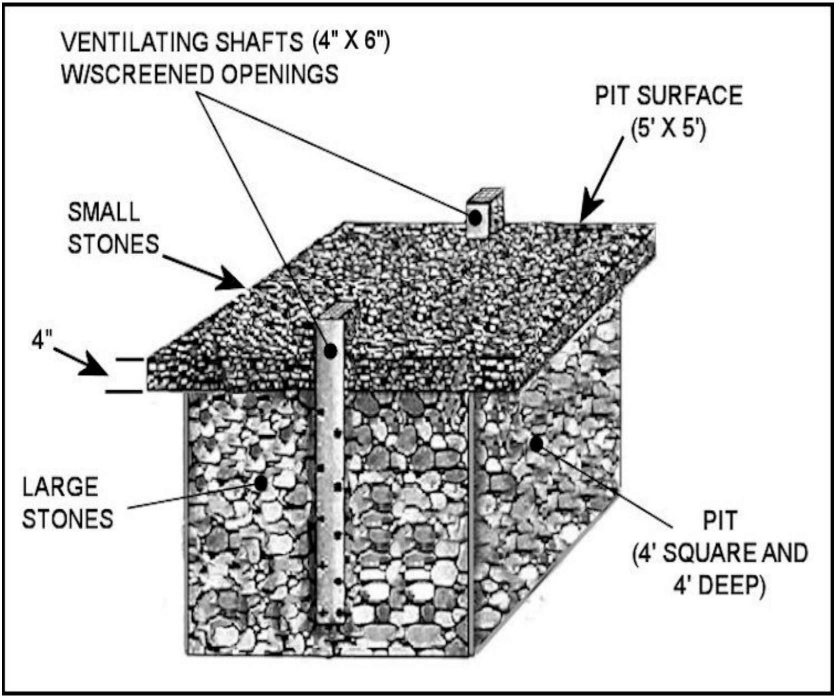
Figure 2.9. Cat-Hole Latrine.



2.4. Urinals. In permanent and semi-permanent camps, urine disposal facilities usually connect to the sewer system. However, in a field environment, separate devices for urine disposal may be necessary. Collocate urinal facilities in or near the male latrines to minimize soiling latrine seats. At least one urine disposal facility is required for each male latrine or per 100 personnel. The following paragraphs describe examples of the more common urine disposal expedient field devices and their applicable maintenance procedures.

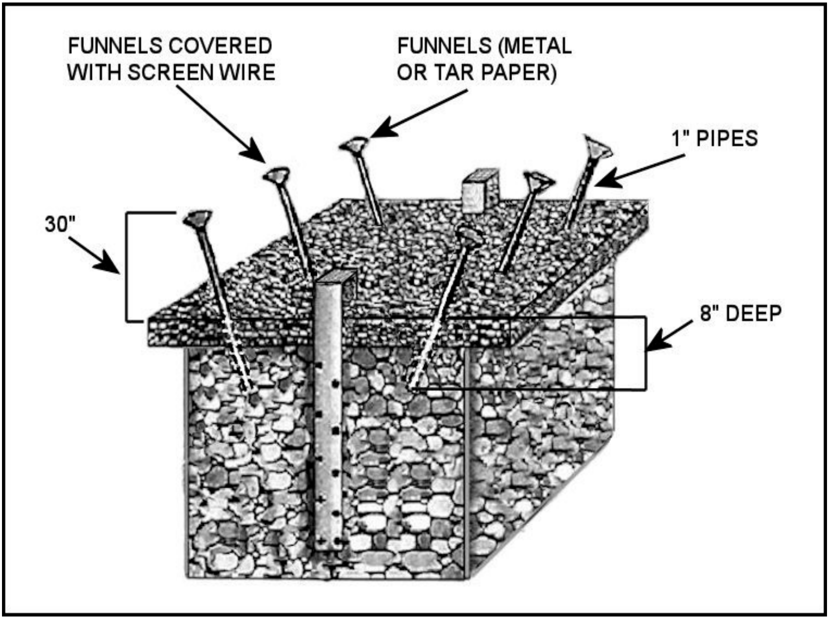
2.4.1. **Urine Soakage Pit.** One of the best expedient devices for urine disposal is a urine soakage pit. Begin by digging a pit 4 feet square and 4 feet deep, fill it with an aggregate material and lay a border along each edge so that each side of the soakage pit's surface is 5 feet long. Ideally, the border should be 6 inches wide, 4 inches deep, and composed of small stones. An optional feature is ventilating shafts as shown in **Figure 2.10**. Finish the facility by adding either a pipe or a trough urinal as described in the following paragraphs.

Figure 2.10. Urine Soakage Pit.



2.4.1.1. **Pipe Urinal.** Pipe urinals should be at least 1 inch in diameter and installed at an angle near each corner of the pit or, if needed, on the sides halfway between the corners (**Figure 2.11**). The pipes should extend at least 8 inches below the surface of the pit. Place a funnel made of tarpaper, sheet metal, or similar material in the top of each pipe. The upper rim of the funnel should extend about 30 inches above the pit's surface. Place a suitable screen in the funnel to prevent foreign objects from clogging the pipe.

Figure 2.11. Pipe Urinal.



2.4.1.2. **Trough Urinal.** If materials are available, another option is to build a trough urinal as shown in **Figure 2.12**. The trough is U- or V-shaped and made of sheet metal or wood. If constructed of wood, line the trough with heavy tarpaper. Cut the trough legs slightly shorter on the end nearest the pit so the urine flows into the soakage pit. Illustrated in **Figure 2.13** is a variation of the expedient urinal trough. When building this type of trough, the four troughs should be no more than 4 1/2 feet long when used with the soakage pit addressed in **paragraph 2.4.1**. Each trough should slope slightly toward one corner where a pipe carries the urine to the soakage pit.

Figure 2.12. Trough Urinal and Soakage Pit.

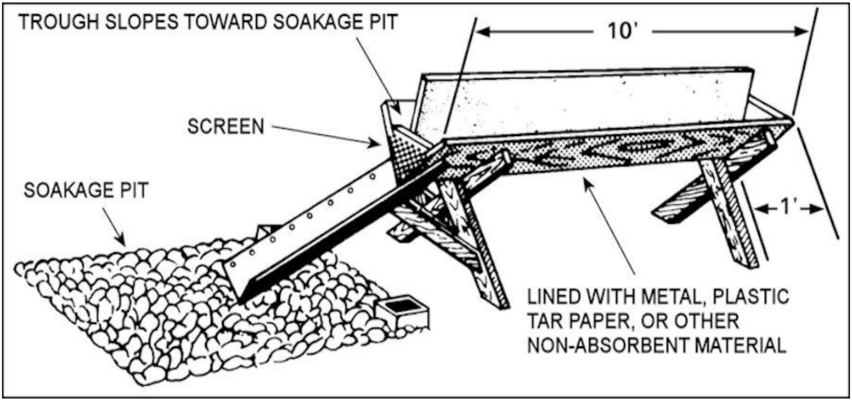
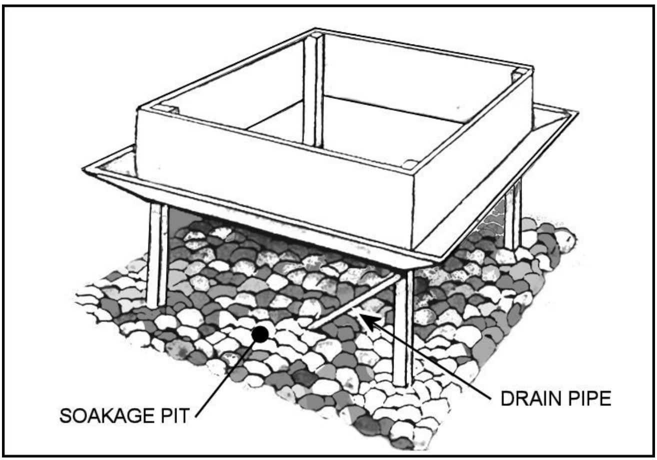
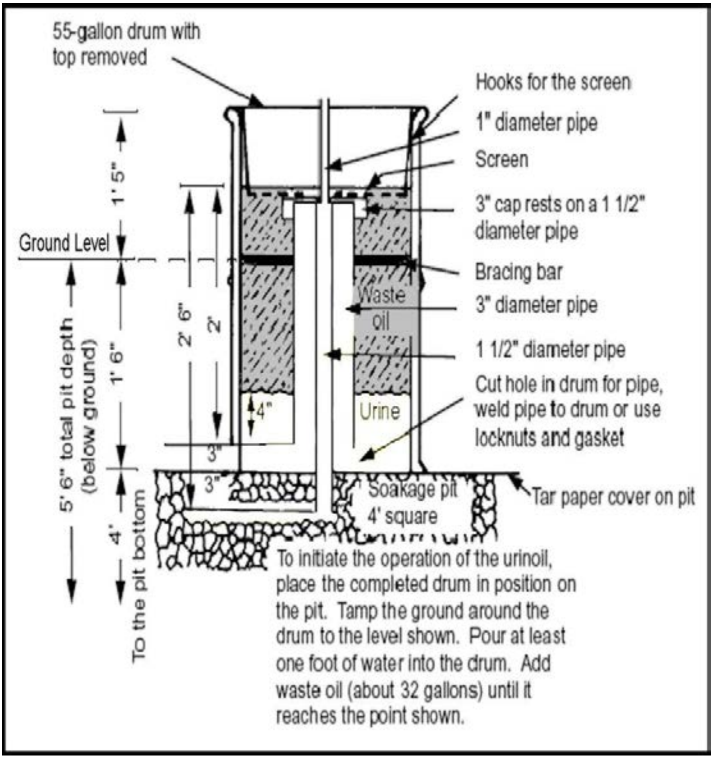


Figure 2.13. Trough Urinal Variation.



2.4.2. **Urinoil.** The urinoil is an expedient urine disposal system appropriate for longer deployments. In its simplest form, the urinoil is a 55-gallon drum containing oil and sitting on top of a recessed soakage pit (**Figure 2.14**). Vegetable oil is preferred, but waste petroleum, oil, and lubricants (POL) may be used. The urinoil operational method is as follows:

Figure 2.14. Basic Urinoil Details.



2.4.2.1. Urine voided through the screen immediately sinks through the oil to the bottom of the drum. The action of the urinal is somewhat like that of a barometer. Adding more urine results in the oil level rising in the 3-inch pipe. This continues until it reaches the 1 1/2-inch notch on the overflow pipe in the center of the drum. Atmospheric pressure and the weight of the oil cause the urine to overflow until reestablishing equilibrium in the drum. The oil also acts as an effective seal against odors and flies.

2.4.2.2. To initiate the operation of the urinoil, place the prepared drum in position on the soakage pit and tamp the ground around the drum to the level shown in the drawing. Next, pour at least one foot of water into the drum. Finally, add oil (about 32 gallons) until the oil reaches the point indicated in the graphic. The urinoil will remain functional as long as the soakage pit will accept urine.

2.4.3. **Maintenance of Urine Disposal Facilities.** Daily inspections are required on urine disposal facilities. Easily lift the screen with attached hooks to remove debris. **Table 2.3** lists additional steps for maintenance of urinals and soakage pits.

Table 2.3. Urinal Facilities Maintenance.

Urinal/Soakage Pit Maintenance	
Step 1	For proper operation and sanitary purposes, individuals should urinate in the trough or the pipe (whichever is available), not directly on the pit's surface.
Step 2	Wash funnels and troughs with soap and water daily.
Step 3	Replace funnels when necessary.
Step 4	Prevent oil or grease from getting into the pit to prevent clogging. Oil leeching through the pit may also contaminate the groundwater.

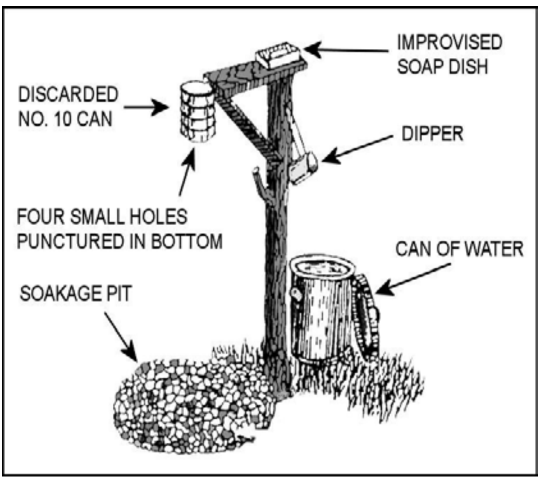
Step 5	If the latrine is located some distance from sleeping areas, place a large can or pail at a convenient location for use as a urinal at night. Empty the can into the trough, pipe, or soakage trench every morning, and wash the pail with soap and water before reusing it.
Step 6	When a urine soakage pit is abandoned or becomes clogged, spray it with insecticide. Mound it over with an l-foot covering of compacted earth and place a rectangular sign on the mound indicating the type of pit and date of closure.

2.5. Expedient Wash and Shower Stations. Just as field expedient latrines, field expedient wash and shower stations are crude but functional devices used when other more appropriate and desirable facilities are not accessible. Showers and hand washing stations are generally located in areas convenient for base residents. Typically, engineer personnel are responsible for the construction and upkeep of these devices to include disposal of the resulting wastewater. While it is preferable to dispose of wastewater into a base sanitary sewer system or expedient wastewater system, during the initial stages of an austere beddown operation, drainage pits and drainage trenches may be the only options to dispose of generated wastewater. See **Chapter 4** for temporary and expedient sanitary sewer systems and wastewater disposal measures.

2.5.1. **Hand-Washing Stations.** When manufactured field washstands are not available, create expedient or improvised hand-washing stations to enhance sanitation. Simple hand-washing devices should be available outside field latrine locations and dining facilities. These devices should be easy to operate and have a constant supply of water. Construct a soakage pit under each device to prevent water from pooling around the hand-washing station. As previously mentioned, emphasize the importance of using hand-washing devices to prevent disease transmission. Shown in **Figure 2.15** and **Figure 2.16** are examples of expedient and improvised hand-washing stations

Figure 2.15. Expedient Hand Washing Station.

Figure 2.16. Improvised Hand Washing Station.



2.5.2. **Improvised Showers.** For obvious sanitary reasons, bathing facilities should be available during field activities. Showers have many advantages over bathtubs; specifically, they use significantly less water and provide for better sanitation. When the field situation permits construction of improvised shower devices, locate shower stations in areas convenient for assigned personnel. Ensure showering devices have a soakage pit under them to prevent water from pooling. For privacy, add a curtain or screen around the shower station. **Figure 2.17** and **Figure 2.18** provide examples of crude, rudimentary shower stations.

Figure 2.17. Single Station Improvised Shower.

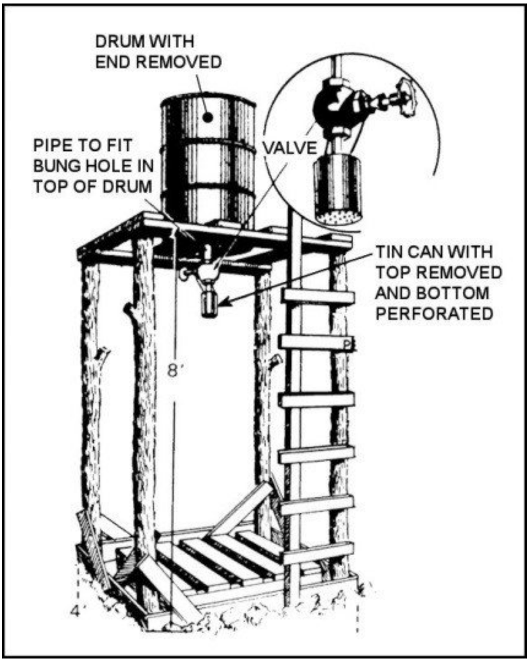
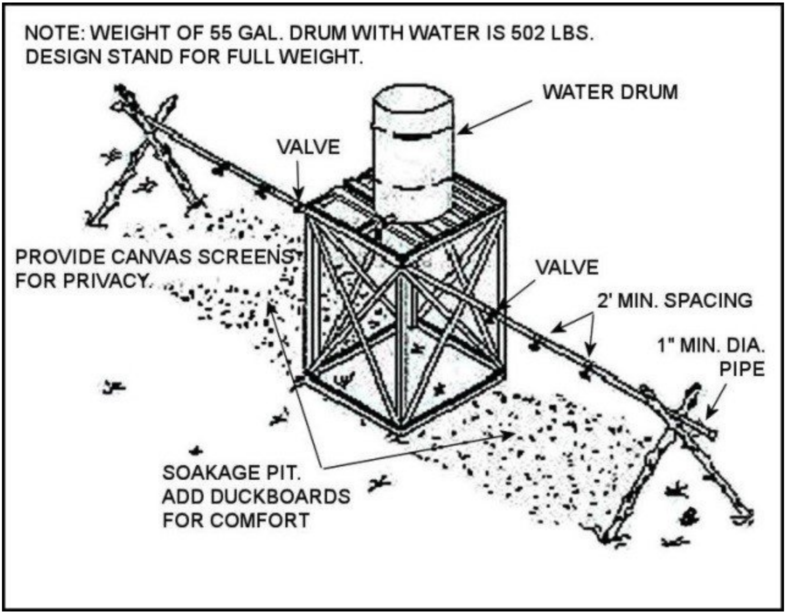
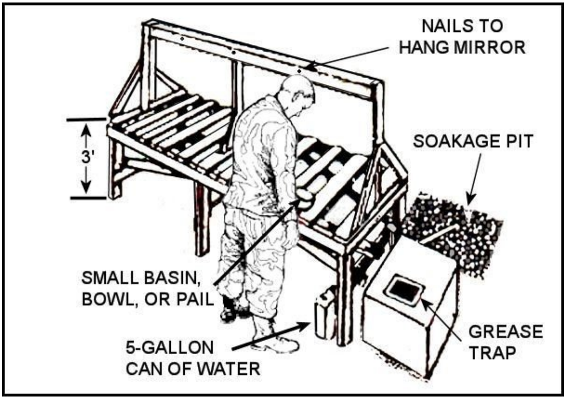


Figure 2.18. Multiple Station Improvised Shower.



2.6. Shave Stations. While it may be difficult maintaining AF appearance standards under field conditions, daily shaving and a beardless face is especially important when wearing a protective mask under chemical or biological warfare conditions. It is difficult to obtain an airtight mask seal with even stubble on the face. When field conditions permit, consider constructing improvised shave stations similar to that illustrated in **Figure 2.19** to support base residents. Discarded wastewater should pass through a grease trap before entering the soakage pit or trench to prevent clogging. See **Chapter 4** for more information on grease traps.

Figure 2.19. Improvised Shave Station.



2.7. Summary. This chapter presented methods for creating field-expedient sanitation and hygiene facilities at contingency locations. The facilities are temporary options until sustainable assets arrive. **Table 2.4** lists additional references for field sanitation and waste disposal methods.

Table 2.4. Chapter 2 Quick References.

Field Expedient Hygiene and Sanitation	
AFPAM 10-219V5	*Bare Base Conceptual Planning*
AFH 10-222V1	*Civil Engineer Bare Base Development*
DODI 4715.19	*Use of Open-Air Burn Pits in Contingency Operations*
DODI 4715.22	*Environmental Management Policy for Contingency Locations*
AFH 10-222V4	*Environmental Considerations for Overseas Contingency Operations*

Chapter 3

DEVELOPING FIELD WATER SOURCES

3.1. Overview. One of CE's fundamental missions is to develop and maintain an adequate supply of safe drinking water for the base population. The need for potable water usually receives increased emphasis during force beddown operations at austere locations or in the aftermath of a disaster if water supplies become limited or unavailable. Typically, engineers know where suitable water sources are located before deploying; however, they confirm those sources upon arrival at the deployed location. Water sources may need further cultivation or development before testing and approved for consumption. Regardless, all field water sources should be treated and/or disinfected, then approved by appropriate medical representatives. This chapter focuses on expedient development of field water sources. Find related information in AFMAN 48-138_IP, *Sanitary Control and Surveillance of Field Water Supplies*, AFH 10-222V4, and UFC 3-230-03, *Water Treatment*.

3.2. Water Source Selection. Generally, engineers use geographic data, survey reports, maps, available drawings, aerial photographs, and other assets to help determine available raw water sources. The engineers should consider factors such as whether the water is fresh, brackish, or salt water; comes from a well, river, lake, or ocean; its temperature; and distance from point of use. Water may be scarce in some locations and require extraordinary efforts to provide the necessary quantity and quality of water. In an arid environment, it is particularly important to determine availability of all potential water sources. If sufficient water sources are not readily available in the immediate area, shipping water from other areas may be required to support the immediate mission until making other arrangements. The water source at contingency locations may be a commercial supplier, ground water source, or a surface water source. Most military installations that do not get water from a municipality often use small potable water systems with a groundwater source and limited or specialized treatment systems. **Table 3.1** lists non-municipal potable and non-potable water sourcing options for selected beddown facilities.

Table 3.1. Non-Municipal Potable and Non-Potable Water Options.

Type	Facility Standard and Water Source		
	Initial (0 - 24 months)	Temporary (6 months - 5 years)	Semi-Permanent (5 - 10 years)
Potable Water	Bottle[1] or ROWPU[2]	Well, Treatment Plants	Well, Treatment Plants
Non-Potable Water	Local Source	Local Source	Local Source
1. Military- and contractor-produced bottled water, including purchased bottled water, should meet Federal bottled water standards, and approved by appropriate medical field units. 2. Reverse Osmosis Water Purification Unit.			

3.2.1. **Basic Considerations.** Water source selection involves a review of alternative sources and their respective characteristics. Review both surface water sources and existing wells in the area. Consider water quality and quantity of the source. Additionally, by reviewing data covering a significant period, you can sufficiently assess seasonal and long-term variability. When choosing a water source, consider the basic factors below and those listed in **Table 3.2**.

- Safe yield
- Water quality
- Collection requirements (intake structure, wells, etc.)
- Treatment requirements (incl. cost and feasibility of residue disposal)
- Transmission and distribution requirements

Table 3.2. Water Source 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, or upstream area controlled by hostile forces
Information from local populations	Smells, tastes, health effects and/or endemic water-borne diseases
Source: AFMAN 48-138(IP), Sanitary Control and Surveillance of Field Water Supplies	

3.2.2. **Environmental Factors.** Pre-deployment planners estimate drinking water requirements based on location, climate, and anticipated level, duration, and frequency of operational activities. The location and climate conditions usually determine availability of water sources and water quantity needed for basic subsistence. **Table 3.3** lists advantages and disadvantages associated with supplying and using water in the world's four major climatic regions.

Table 3.3. Advantages and Disadvantages of Climatic Regions.

Temperate Regions	
Advantages	**Disadvantages**
Abundant Resources • Lakes • Streams • Rivers • Existing Wells • Local Water Systems Sources are convenient to locate, develop, and access. Water sources can be purified at small unit level. Drinking water does not require cooling.	Chemical, biological, radiological, and nuclear (CBRN) munitions easily contaminate surface sources. Natural contamination is possible by organic, disease-bearing organisms, and inorganic salt. Environmental pollution from local development such as septic fields may contaminate ground water.

Table 3.3. Cont'd.

Frigid Regions	
Advantages	**Disadvantages**
Water sources may be abundant, but frozen. Sources include: • Lakes • Streams • Rivers • Existing Wells	Expect increased consumption to prevent dehydration. Water purification, storage, and distribution systems should be protected against freezing. Snow and ice are impractical to melt for other than very small units due to the excessive fuel needed for melting.
Tropical Regions	
Advantages	**Disadvantages**
Water sources available are more scattered than temperate regions. They include: • Lakes • Streams • Rivers • Existing Wells • Local Water Systems Water sources can be purified at small unit level.	CBRN munitions easily contaminate surface sources. Dense vegetation may make access difficult. The presence of waterborne diseases and disease-transmitting parasites may make water unsuitable for bathing and laundry use until disinfected. Higher water use is needed because of high humidity and heat.

Table 3.3. Cont'd.

Desert Regions	
Advantages	**Disadvantages**
None.	Surface/fresh water is almost nonexistent. Available water sources are limited and widely dispersed. Anticipate increased water use to prevent heat casualties. Limited supplies may dictate the tactical scenario. The lack of water abundance makes an extensive storage and distribution system vital.

3.2.3. **Vulnerabilities.** The least vulnerable water source is probably ground water below the surface. Most likely, natural disasters or hostile attacks would not destroy this water source. However, damage could occur to the well and pumping systems that give access to the source (e.g., wells becoming partially filled with debris, well walls and pumping facilities damaged or destroyed). Similarly, damage to a commercial water supply during hostilities or disaster could result in reducing or eliminating the base water supply. Various situations can also affect surface water sources (e.g. water-borne debris associated with a flood or hurricane might block water inlets to the system; nuclear, biological, chemical contaminants used during an enemy attack could make the source unusable; conventional enemy munitions may diminish, divert, or stop access to a river or lake).

3.2.4. **Other Considerations.** At austere contingency locations, any plan to use local water sources should include an evaluation of overall availability and impact of base camp usage on the local population. Drainage and wastewater planning should include methods to prevent contamination of agricultural areas and water supplies. Planning should also include water conservation measures and wastewater treatment methods.

3.3. Water Source Development. Water source development includes actions to increase water quantity, quality, or availability for treatment and distribution. Avoid elaborate developments and actions to make a temporary source permanent unless a survey has concluded a source requiring less work is not available. After identifying water sources further develop and maintain these sources using the following processes:

- Developing water points by creating ponds and lakes across streams, deepening and reinforcing existing water collection areas
- Providing drainage to prevent contamination of water sources from storm runoff
- Constructing physical protection structures for water sources
- Constructing and improving roads from water points and well sites to the main supply routes
- Building, maintaining, repairing semi-permanent and permanent water utilities at existing installations
- Repairing and constructing water storage and distribution systems

3.4. Surface Water Resources. Excluding extreme environments, surface water from rivers, streams, lakes, and ponds are the most accessible inland water sources. These sources are easily developed and readily accessible to water purification assets. In regions such as tropical islands with abundant rainfall and rapid surface runoff, rainwater is the primary source for inhabitants; however, water availability may not be sufficient to supply the needs of both the civilian population and the military. Rainwater may be sufficient for small units or limited operations, but should not be a consideration if reliable sources are available.

3.4.1. **Rivers, Streams, and Lakes.** In addition to being easily accessible, rivers, streams, and lakes are usually capable of supplying adequate quantities of water. However, urban and agricultural runoff, industrial waste discharges, landfill leachates, septic tank effluents, or raw and treated sewage outfalls can contaminate surface water. When drawing from these surface water sources, avoid areas of likely contamination. If a small stream is the best option, increase its capacity to meet requirements by constructing small dams or reservoirs. See examples illustrated in **Figure 3.1** through **Figure 3.3**.

Figure 3.1. Improvised Dam for Impounding a Small Stream.

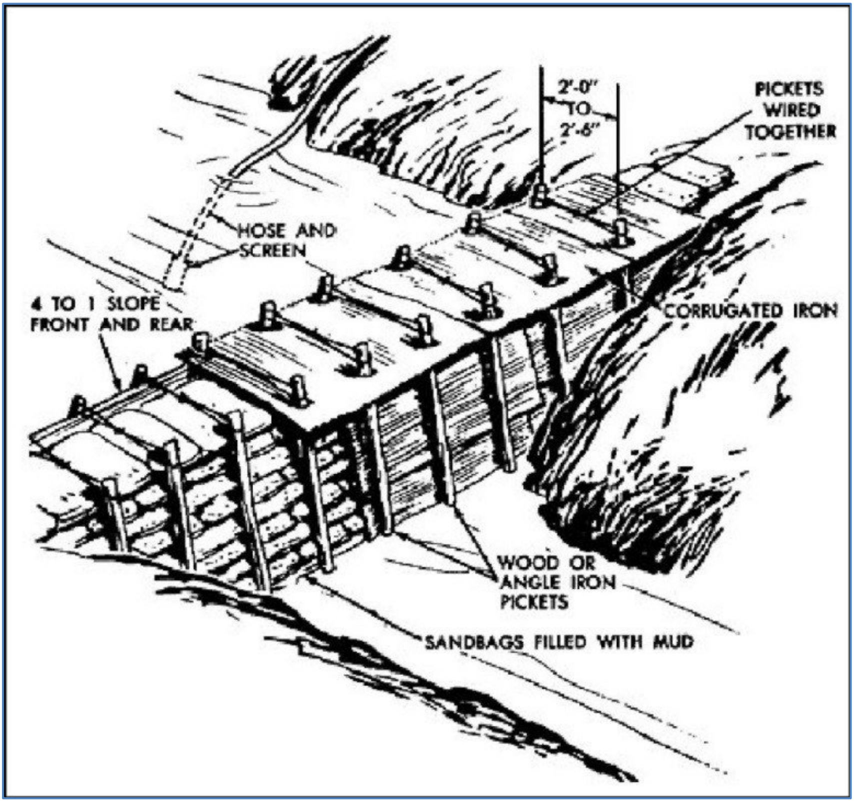
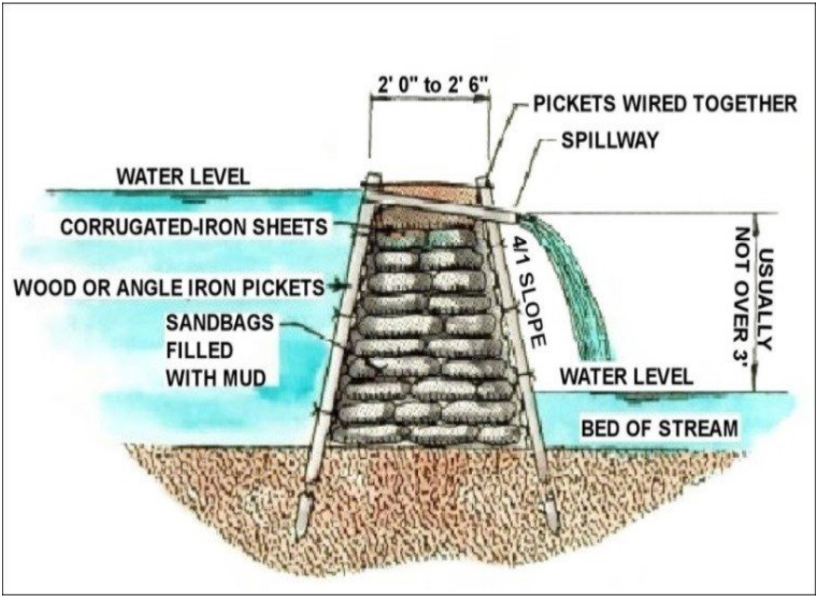
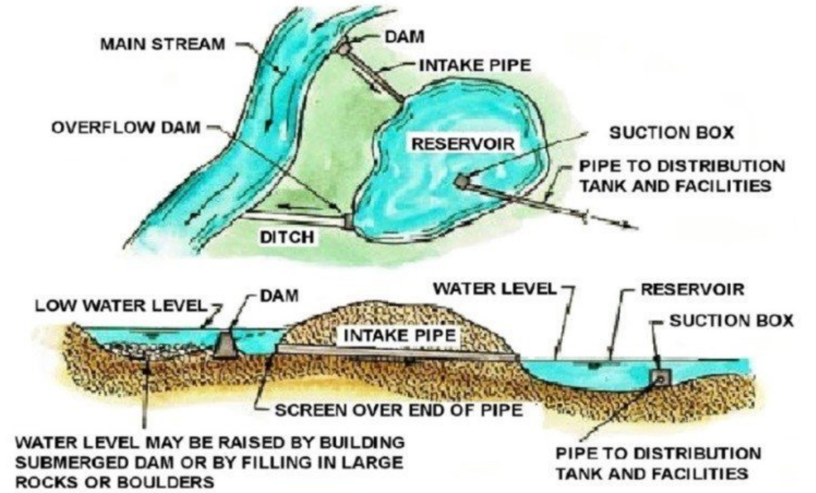


Figure 3.2. Improvised Small Dam (Side Profile).



3.4.2. **Surface Water Intakes.** After confining natural water resources in a reservoir, use pumps or gravity pipelines to deliver it to the point of usage. Intakes provide a means of obtaining water from its source. Screen and carefully position intakes to avoid areas of likely contamination. Water at the intake point should be as clear and deep as possible. Install screens on all intakes regardless of water appearance. Screens keep fish and debris out of the water system. If muck or silt is prevalent on the bottom of the water source, a floating type intake is best. On the other hand, if the bottom is a bed of sand or gravel, surface intake with a screen may be equally effective and easier to use.

Figure 3.3. Expedient Dam and Reservoir Layout.



The intake pipe should be of a size to bring about 1-1/2 times the maximum hourly demand of the water system. The reservoir should be able to store at least one day's supply of water for the system.

3.4.2.1. Floatable Intakes. While manufactured float buoys are part of the contingency water system, expedient floats made of logs, lumber, sealed cans, or empty fuel drums can support the intake strainer in deep water when other assets are not available. They are especially useful in large streams where the quality of water varies across its width or where water is not deep enough near the banks to cover the intake strainer. An adequate depth of water can cover the intake point by anchoring or stationing the float at the deep part of the stream. Secure the intake hose to the top of the float, allowing enough slack for movement of the float. If support lines secure the float to the banks, alter the position of the float to correspond to changes in depth by manipulating the lines. The chief advantage of a float intake is easy adjustments of the screen. **Figure 3.4** and **Figure 3.5** illustrate two improvised intake floats. **Note:** Real world experience indicates placing the strainer on the suction hose of a floating intake at least 12 inches below the water level reduces the likelihood of clogging the strainer with floating debris, or the loss of prime from air entering the suction line.

3.4.2.2. Rock and Stake Supported Intakes. If the stream is not too swift and the water is deep enough, an expedient intake may be prepared by placing the intake strainer on a rock. This will prevent clogging of the strainer by the streambed and provide enough water above to prevent sucking air into the intake pipe. If the water source is a small stream or shallow lake, secure the intake pipe to a post or pile as shown in **Figure 3.6**.

Figure 3.4. Drum Float Type Water Intake.

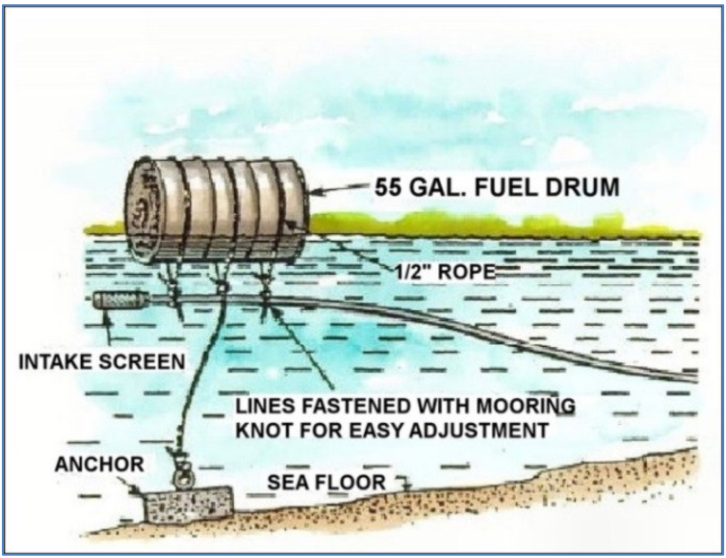


Figure 3.5. Log Float Type Water Intake.

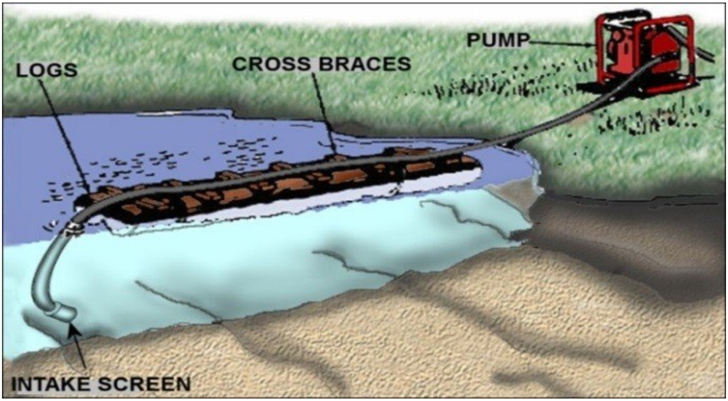
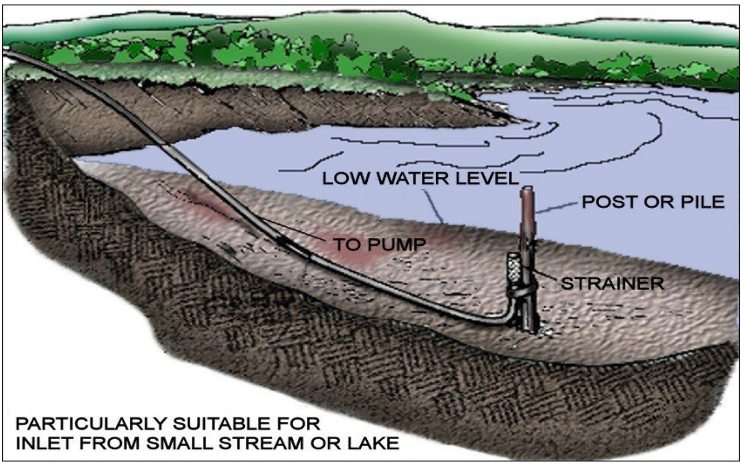


Figure 3.6. Stake Supported Water Intake.



3.4.2.3. Pit Supported Intakes. When a stream is so shallow that at least 12 inches of water does not cover the intake screen, dig a pit and lay the screen on a rock or board placed at the bottom of the pit. Line those pits dug in streams with clay or silt bottoms with gravel to prevent dirt from entering the purification equipment (**Figure 3.7**). Surround the screen with gravel to prevent collapse of the sides of the pit and shields the screen from damage by large floating objects. The gravel also acts as a coarse strainer for the water. Enclosing the intake screen in a bucket or other container as shown in **Figure 3.8** may also provide satisfactory results.

3.4.2.4. Using Galleries with Intakes. Improve the water quality from muddy streams by digging intake galleries along the bank. Dig a trench along the bank deep enough so water from the stream percolates into it to intercept ground water flowing toward the stream. Fill the trench with gravel to prevent the sides from collapsing. Place the intake strainer in the gravel below the water line as shown in **Figure 3.9**. Although building a gallery requires some effort, this method reduces the chemicals needed to coagulate the water, decreases the need to frequently backwash the filter, and produces a higher quality water.

3.4.2.5. Drive Points. Many times, it is advantageous to utilize shallow ground water sources or percolated waters adjacent to turbid surface water. Make well points in 2-inch diameter, 54-inch lengths. Place a drive cap over the thread and drive the well point into the ground with a sledge. Add successive sections of pipe, each 5 feet long, and drive into the ground until the screen is well within the water bearing media. Connect several well points in parallel to supply sufficient water to the raw water pump. Remember, when developing drive point sources, most small pumps only have about 15 feet of practical suction lift. In such situations, pumping water from well points deeper than a maximum of 20 feet is mechanically impractical.

3.4.2.6. Self-Jetting Wellpoints. Self-jetting wellpoints uses forced water to jet the wellpoint into the sand, fluidizing the sand and allowing the wellpoint to sink easily into the sand. A water source is required to jet the wellpoint. See TO 40W4-20-1, 1500, *Reverse Osmosis Water Purification Unit*, Subordinate Work Package (SWP) 007 01 for specific instructions on jetting wellpoints.

Figure 3.7. Gravel Pit Intake.

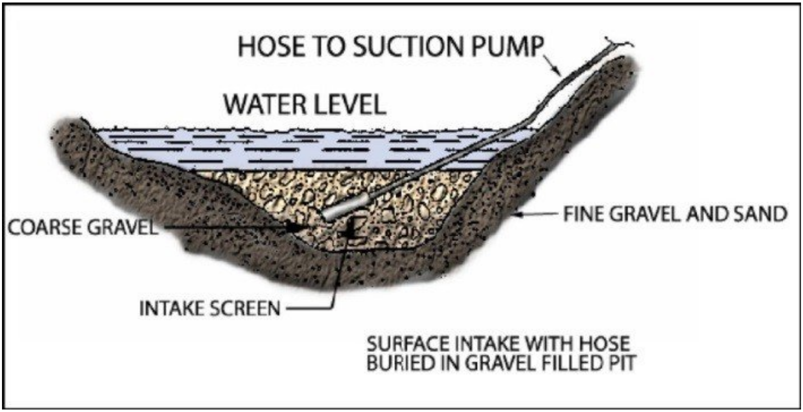


Figure 3.8. Bucket Used with Gravel Pit Intake.

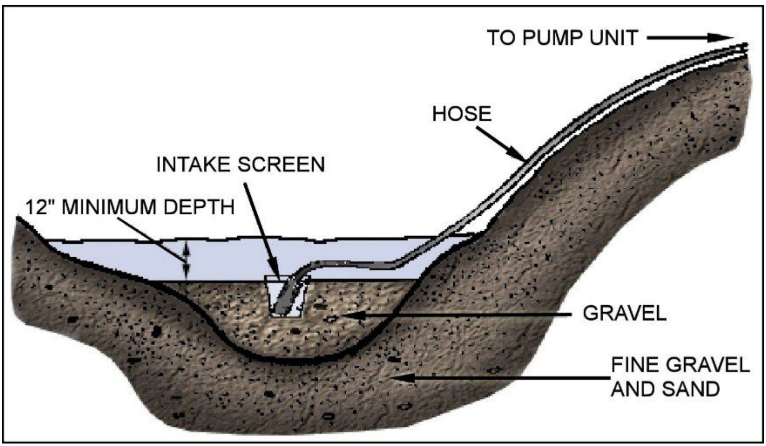
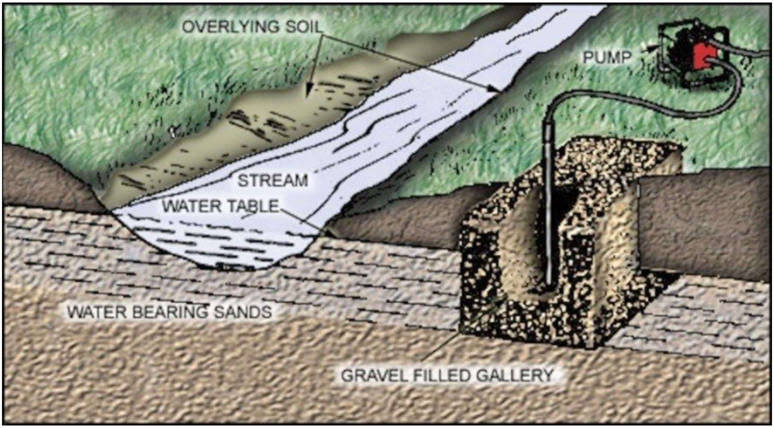


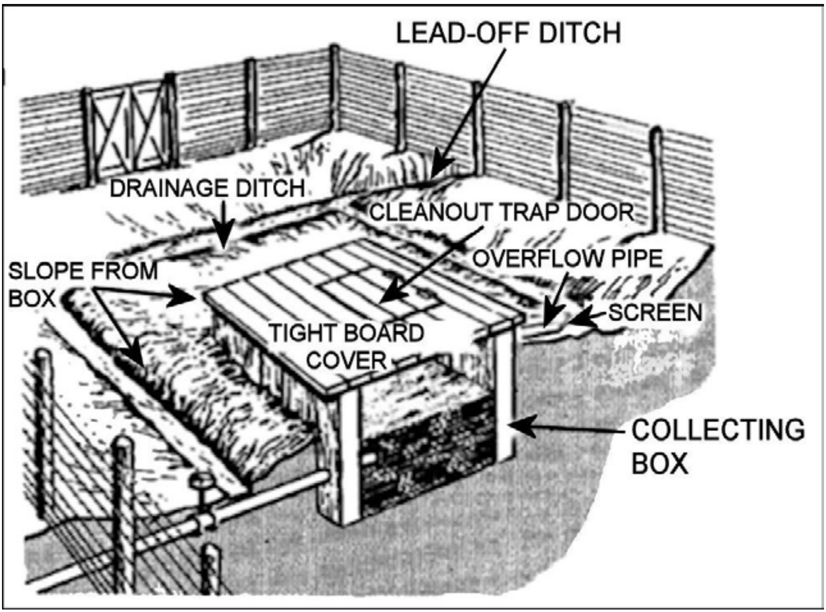
Figure 3.9. Gravel-Filled Gallery Intake.



3.4.3. **Springs and Seeps.** A spring is water that naturally emerges at the surface with a distinctive current; the emerging water is a seep if there is no current. Most springs and seeps consist of water that has slowly gravitated from nearby higher ground. The water's underground course depends on the permeability and structure of the material it passes through. A spring with a temperature higher than the yearly average of a given region is termed a *thermal spring* and indicates a source of heat other than the surface climate. In gravity springs and seeps, subsurface water flows by gravity, not by hydrostatic pressure, from a high point of intake to a lower point of issue. Water table springs and seeps are normally around the margin of depressions, along the slope of valleys, and at the foot of alluvial fans. Contact springs appear along slopes, at almost any elevation depending on the position of the rock formations. Springs yielding 20 gallons per minute or more of water can be a source of field water supply if properly developed. A common method of development is to enlarge the outlet of the spring and reduce loss of water by damming it and conducting it to storage. To reduce possible pollution, clear the springs of all debris, undergrowth, topsoil, loose rocks, and sand.

3.4.3.1. Water Collection. Collect water that flows from rocks and accumulates in depressions or from seepage areas of water-bearing material in boxes or basins of wood, tile, or concrete. Place the collecting box (or spring box) below ground level so only the top is slightly above the surface and be large enough to capture most of the flow. Be sure to cover the box tightly to prevent contamination and lessen evaporation. Design the inlet to exclude surface drainage and prevent pollution. This may require fencing off the area and providing proper drainage. **Figure 3.10** shows a spring inlet protected in this manner. The screen on the overflow pipe prevents insects and small animals from entering the spring.

Figure 3.10. Collecting Box.



3.4.3.2. Dealing with Steep Slopes. Collect the flow of spring water from a steep slope of loose earth by constructing deep, narrow ditches leading from the spring to the collecting point, or by constructing pipeline tunnels from the spring to the collecting point. Large diameter pipe is desirable for this purpose. Trap the water from the pipeline tunnels by constructing a dam at the point of collection.

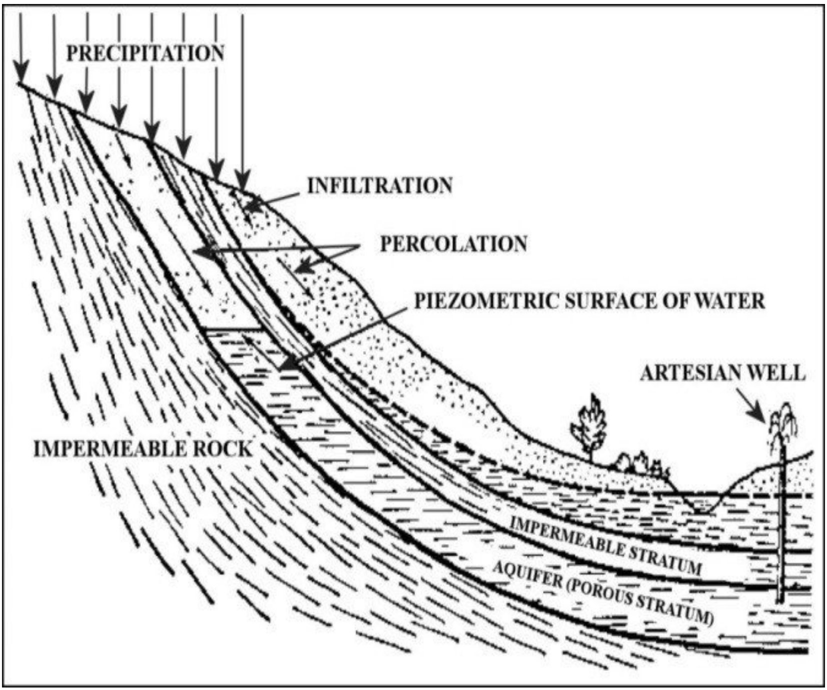
3.4.3.3. Excavating. Digging is often better and more economical to develop a spring than blasting. Using explosives in spring development is usually not the ideal method, however, any use of explosives should proceed with great caution to prevent dislocating rocks or shifting sand and gravel in such a way as to stop the existing flow or divert the flow to another location.

3.5. Ground Water Resources. A subsurface or ground water resource exists below Earth's surface. Any water that collects or flows underground filling the porous spaces in the soil, sediment, and rocks is ground water. The water table is the upper surface of ground water. The water table is not a level surface, but it is irregular and reflects the surface features, rising high under the hills and falling back low under flat areas. Ground water can range from a few inches or feet below the ground's surface (shallow ground water) to hundreds or thousands of feet deep in confined aquifers (Artesian water).

3.5.1. **Shallow Ground Water.** Typically, shallow ground water is reachable by excavation with traditional hand tools (e.g. shovels, picks) or digging equipment. From the top of the water table, shallow ground water reside in near-surface, unconfined aquifers and often yield less quantity and lower quality water than deeper, confined aquifers. Although easier to access, lower quantities may render shallow water resources inadequate to sustain medium and large populations. Additionally, shallow ground water can require more extensive purification measures due to potential contamination from surface pollutants.

3.5.2. **Artesian Water.** When water is confined below layers of relatively impermeable rock (under pressure), an artesian condition is said to exist. Specifically, there is a permeable aquifer with impervious layers above and below it to confine water. There should also be an intake area so water can enter the aquifer and a structural dip has to exist to produce hydrostatic pressure in the water at lower areas of the aquifer. Whenever a natural outlet occurs in an artesian aquifer, it forms an artesian spring. While most springs may appear as pools of water, some springs may result when natural or human forces cut underground layers of soil and rock exposing flowing water. Drilling a well into an artesian aquifer creates an artesian well. **Figure 3.11** illustrates an artesian condition and artesian well.

Figure 3.11. Artesian Condition and Well.



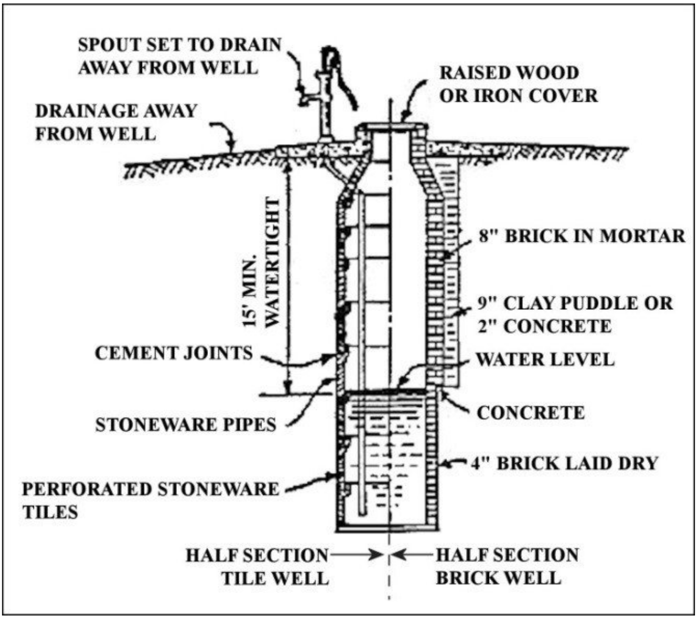
3.6. Water Wells. Typically, engineers use wells to tap into ground water resources when surface water quantities are insufficient. Generally, there are five well classifications, according to their method of construction. They include dug, bored, driven, jetted, and drilled methods (**Table 3.4**).

Table 3.4. Water Well Excavation Methods.

Method	Description
Dug	A dug well is one in which the excavation is made by the use of picks, shovels, spades, or digging equipment, such as sand buckets or clamshell buckets.
Bored	A bored well is one in which the excavation is made by the use of hand or power augers.
Driven	Construct a driven well by driving a pointed screen, referred to as a drive point, into the ground. Attach casings or lengths of pipe to the drive point as it is being driven into the ground.
Jetted	A jetted well is one in which the excavation is made by use of a high velocity jet of water. Steam is used for jetting instead of water in some regions of the Arctic.
Drilled	Excavate drilled wells by using either percussion or rotary drills. The excavated material is brought to the surface by means of a boiler, sand pump, suction bucket, hollow drill tool, or hydraulic pressure.

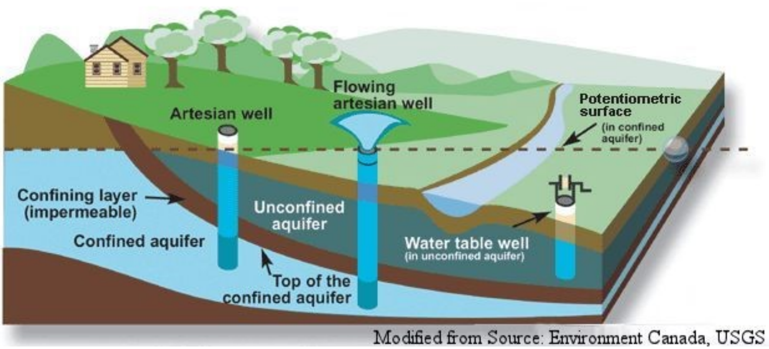
3.6.1. **Shallow Wells.** Although not considered practical for sustaining a contingency airbase, shallow wells may be the only option available to fulfill needs for a small supply of potable water. **Figure 3.12** shows a basic shallow well configuration with a manual pump. Personnel can dig rudimentary wells by hand and lined with stone, wooden timber, metal pipe or other materials available at the site. Hand dug wells should be large enough for access and shored to prevent cavein during construction. Water retrieval is usually accomplished by bucket or hand pump. Obviously, low volume shallow wells are grossly inadequate when it comes to meeting the water needs of medium or large populations. To satisfy large potable water requirements, consider using BEAR assets to reach nearby surface water sources, or construct deep wells to obtain higher volumes of water. Additional information on well development and expedient excavation of shallow wells is in AFMAN 32-1072, *Water-Well Drilling Operations*.

Figure 3.12. Basic Shallow Well Configuration with Manual Pump.



3.6.2. **Artesian Wells.** Drilling is usually associated with artesian or deep-well excavations. Specific RED HORSE units are equipped and trained to accomplish well-drilling tasks. If an artesian well has enough pressure to bring water above ground, it is a flowing artesian well; if water rises only to an intermediate level it is a non-flowing artesian well (**Figure 3.13**). Although some artesian wells can produce significant volumes of potable water, most only provide limited amounts. If a discovered well is satisfactory, simply install a wellhead and move the water to storage facilities.

Figure 3.13. Aquifers and Wells.



3.7. Expedient Water Storage. During initial force beddown operations, items such as portable water tanks, onion bladders, and improvised methods are options for expedient water storage. The examples shown in **Figure 3.14** and **Figure 3.15** are simple, field-expedient water storage concepts that can be implemented using local resources when no other assets are available. Flexible bladders, water distribution trucks and trailers, and even sandbag or earthen berms lined with plastic sheeting are other possible alternatives worth considering. Regardless of storage methods used, ensure they are large enough to meet daily peak demands. To prevent potential sabotage by clandestine groups, storage facilities should be located well within the secure area of the base.

Figure 3.14. Improvised Water Storage Concepts.

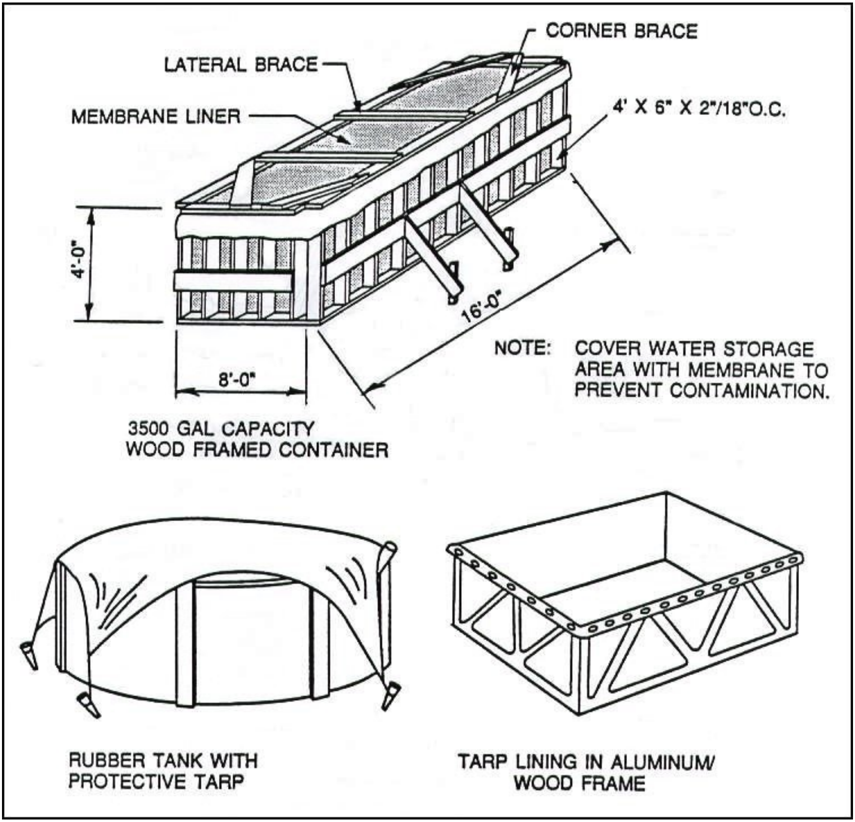
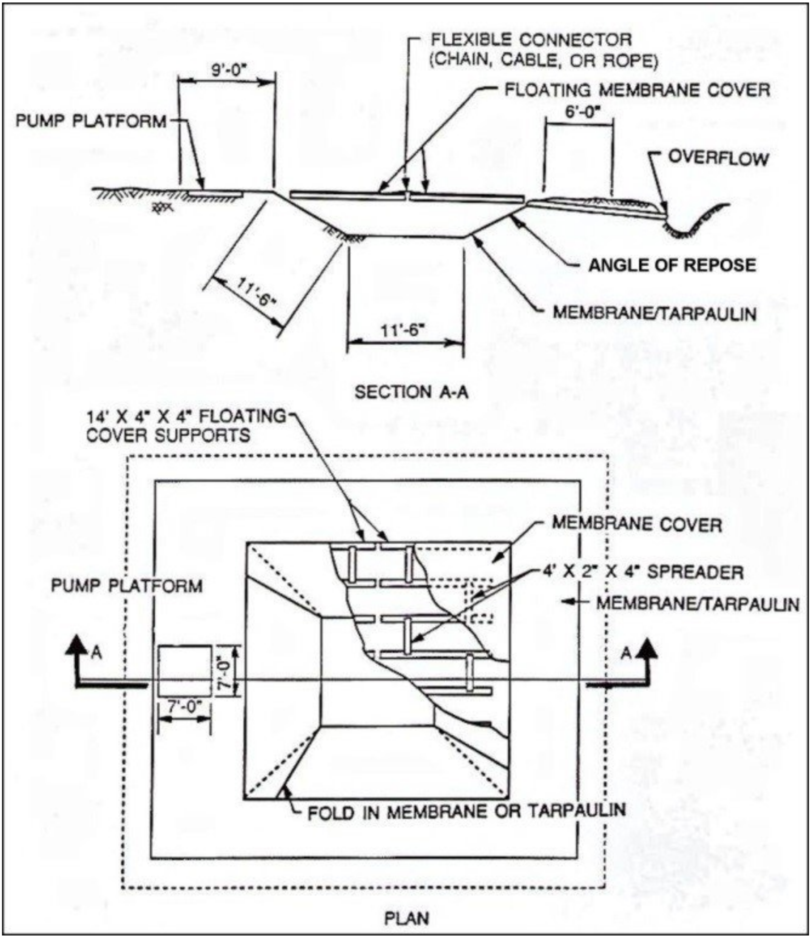


Figure 3.15. Earth Pit Water Storage.



3.8. Water Treatment. Treat water sources according to established procedures and standards to ensure they are potable before use. The degree of treatment provided to the water supply will usually depend upon its source. For example, ground water is normally free of contaminants such as silt and microorganisms and treatment is normally minor. Surface water may require extensive treatment. Regardless, test all water to determine treatment required and ensure it is potable after treatment. Assume water from untested sources is contaminated, and requires disinfection before drinking.

3.8.1. Field water treatment processes include straining; chemical addition; coagulation; sedimentation; various kinds of filtration including multimedia, cartridge, microfiltration, and ultrafiltration; reverse osmosis (RO); carbon adsorption; and ion exchange. Currently, most water purification systems in U.S. military service use RO membranes to provide the ultimate barrier to chemical, microbial, organic, and radiological contaminants. The AF primarily uses the 1500 ROWPU and chlorination for field water treatment. Review T.O. 40W4-20-1, *1500 Reverse Osmosis Water Purification Unit (ROWPU)*, for information on water purification procedures.

3.8.2 When cut off from supply lines and military-approved water is not available, select the clearest and cleanest water with the least odor available, and treat the water by boiling or using iodine tablets, Chlor-Floc dry calcium hypochlorite, household bleach (sodium hypochlorite solution), or the Marine Corps-approved individual water purification system (IWPS). Consult AFMAN 48-138 for details on the use of these and other field water treatment guidelines.

3.9. Summary. For austere location beddowns, drinking water is at the forefront of operational planning. Installation commanders take measures to ensure water sources are developed and potable water is readily available. It is a fundamental requirement for CE to develop field water sources and produce potable water whenever needed. The methods presented in this chapter are expedient options to provide this capability. For additional information on developing and treating raw water sources, consult the references listed in **Table 3.5**.

Table 3.5. Chapter 3 Quick References.

Developing Field Water Sources	
DODI 4715.22	*Environmental Management Policy for Contingency Locations*
AFH 10-222V4	*Environmental Considerations for Overseas Contingency Operations*
AFMAN 32-1072	*Water-Well Drilling Operations*
AFMAN 48-138_IP	*Sanitary Control and Surveillance of Field Water Supplies*
UFC 3-230-03	*Water Treatment*
T.O. 40W4-20-1	*1500 Reverse Osmosis Water Purification Unit (ROWPU)*

Chapter 4

EXPEDIENT SEWAGE AND WASTEWATER DISPOSAL

4.1. Overview. Generally, CE establishes a temporary sanitary sewer system where none exists or when expeditious repairs to existing systems is not feasible. Expedient sewage and wastewater disposal methods are potential options at austere contingency locations until prepackaged systems become available. In some situations, expedient systems such as septic tanks, ponds, and lagoons may be required for extended periods. This chapter addresses expedient sewage and wastewater disposal methods, including site evaluations and employment of septic tanks and absorption fields, seepage pits, sewage lagoons, evaporation beds, kitchen soakage pits and trenches, and grease traps. Some disposal methods such as grease traps and septic tanks may suffice as temporary replacement measures for damaged or missing components on a short-term basis. Additional information is available in AFH 10-222V4, UFC 3-240-02, *Domestic Wastewater Treatment*, UFC 3-230-03, and EPA 625/1-80-012, *Onsite Wastewater Treatment and Disposal Systems*, at http://water.epa.gov/infrastructure/septic/technical.cfm.

4.2. Site Evaluations. Engineers usually accomplished a thorough site survey before installing an expedient or temporary sewage or wastewater disposal system. The survey includes evaluating the proposed site's land area, terrain, and soil conditions for suitability; noting the location of existing utilities, wells, storm sewers, future use areas, and other important features. Typically, engineers address some of these survey elements during preliminary site studies, geotechnical investigation, or topographic survey of the area. Therefore, be sure to review any previously accomplished site surveys that may be available. Also, examine historical geological conditions, including year-round data for environmental extremes and drainage or flooding issues.

4.2.1. **Terrain.** Perform a visual examination of the terrain in and around the potential site. Be sure to examine landscape position for surface and subsurface drainage patterns. Hilltops and side slopes will probably have good surface and subsurface drainage, while depressions and foot slopes will likely have poor drainage. If slopes appear to limit planned treatment systems, survey the area to determine slope measurement, likely effects, and potential options.

4.2.2. **Soil Conditions.** Review pertinent soil data from published sources and examine soil characteristics for the potential absorption area. Evaluate the soil's texture, structure, color, density, and hydraulic conductivity. Excavate tests shafts and test pits to investigate soils in situ. Also, use these excavations to determine the depth to groundwater, and thickness of topsoil. In some situations, the examination of road cuts or foundation excavations will provide useful information.

4.2.2.1. It is common to excavate test shafts with hand tools (e.g., shovel, posthole digger, or solid auger with an extension handle), while backhoes are often use to excavate test pits. An experienced soils tester can do a satisfactory job using a test shaft excavated with a hand auger or probe; however, observation and evaluation of soil characteristics is better from larger test pits dug by a backhoe or other excavating equipment. The best approach may be to use both test shafts and test pits. However, be aware that test pits used within the absorption area can settle after the treatment system has been installed, disrupting the distribution network. Therefore, use backhoes to excavate test pits at the perimeter of the expected soil absorption area where settling will be less disruptive. Hand augers can make multiple test shafts within the absorption area with little to no disruption. In both cases, excavations help describe soils in the area. Be sure to excavate deep enough to assure sufficient thickness of unsaturated soil exists below the absorption area. If a detailed analysis of the soil structure is necessary, the sidewall of test pits should be carefully examined using a pick or similar tool to expose the soil's natural cleavages and planes of weakness.

4.2.2.2. Soil texture is an important physical property of soil because of its close relationship to pore size, distribution, and continuity. Soil structure has a significant influence on soil's acceptance and transmission of water. Soil structure refers to the aggregation of soil particles into clusters of particles separated by surfaces of weaknesses. These surfaces of weakness often result in voids or cracks in soil, which can greatly modify the influence of soil texture on water movement.

Well-structured soils with large voids between clusters will transmit water more rapidly than structureless soils of the same texture. **Table 4.1** lists the textural properties of mineral soils. **Table 4.2** is a listing of various grades and characteristics of soil structure.

Table 4.1. Textural Properties of Mineral Soils.

Soil Type	Texture and Appearance	
	Dry Soil	**Moist Soil**
Sand	Loose, single grains, that feels gritty. Squeezed in the hand, the soil mass falls apart when the pressure is released.	Squeezed in the hand, it forms a cast that crumbles when touched. Does not form a ribbon between thumb and forefinger.
Sandy Loam	Aggregates easily crushed; very faint velvety feeling initially but with continued rubbing the gritty feeling of sand soon dominates.	Forms a cast that bears careful handling without breaking. Does not form a ribbon between thumb and forefinger.
Loam	Aggregates are crushed under moderate pressure; clods can be quite firm. When pulverized, loam has velvety feel that becomes gritty with continued rubbing. Casts bear careful handling.	Cast can be handled quite freely without breaking. Very slight tendency to ribbon between thumb and forefinger. Rubbed surface is rough.
Silt Loam	Aggregates are firm but may be crushed under moderate pressure. Clods are firm to hard. Smooth, flour-like feel dominates when soil is pulverized.	Cast can be freely handled without breaking. Slight tendency to ribbon between thumb and forefinger. Rubbed surface has a broken or rippled appearance.

Clay Loam	Very firm aggregates and hard clods that strongly resist crushing by hand. When pulverized, the soil takes on a somewhat gritty feeling due to the harshness of the very small aggregates, which persist.	Cast can bear much handling without breaking. Pinched between the thumb and forefinger, it forms a ribbon whose surface tends to feel slightly gritty when dampened and rubbed. Soil is plastic, sticky and puddles easily.
Clay	Aggregates are hard; clods are extremely hard and strongly resist crushing by hand. When pulverized, it has a grit-like texture due to the harshness of numerous, very small aggregates, which persist.	Casts can bear considerable handling without breaking. Forms a flexible ribbon between thumb and forefinger and retains its plasticity when elongated. Rubbed surface has a very smooth, satin feeling. Sticky when wet and easily puddled.

Table 4.2. Grades of Soil Structure.

Grade	Characteristics
Structureless	No observable aggregation.
Weak	Poorly formed and difficult to see; will not retain shape on handling.
Moderate	Evident but not distinct in undisturbed soil, moderately durable on handling.
Strong	Visually distinct in undisturbed soil, durable on handling.

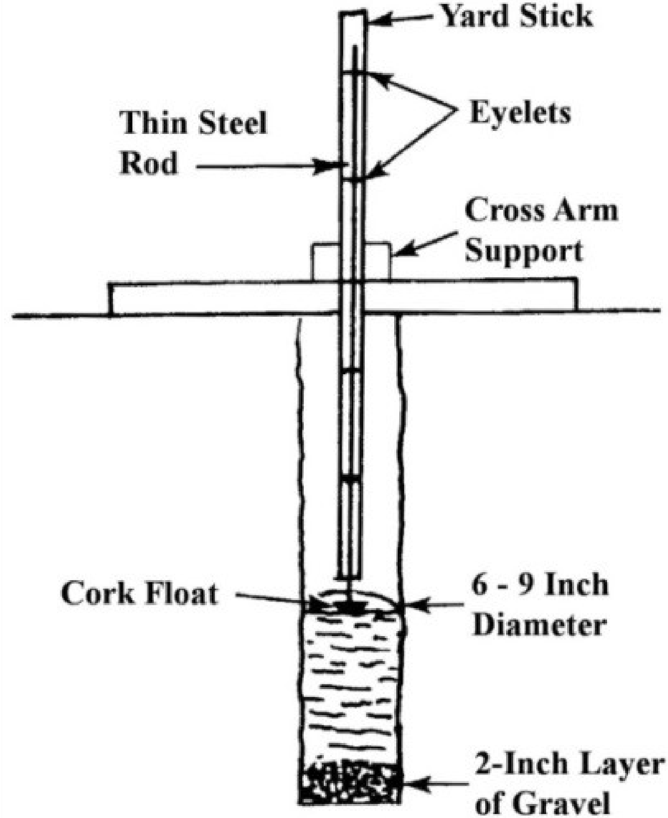
4.2.2.3. The color and color patterns in soil are good indicators of its drainage characteristics. Soil properties, location in landscape, and climate influence water movement in soil. These factors cause some soils to be saturated or seasonally saturated, affecting their ability to absorb and treat wastewater. Interpretation of soil color aids in identifying these conditions. Soil density is another important characteristic. Soil bulk density relates to porosity and the movement of water. High bulk density indicates low porosity and restricted water flow. Detect relative bulk densities of different soil horizons by pushing a knife or other instrument into each horizon. If one horizon offers considerably more resistance to penetration than the others, its bulk density is probably higher. However, in some situations, cementing agents between soil grains or soil clusters may be the cause of resistance to penetration.

4.2.2.4. In addition to field evaluations, the U.S. Department of Agriculture (USDA) National Resources Conservation Service (NRCS) offers substantial data and resources on global soil conditions. **Attachment 2** provides the link to the NRCS website along with links to engineer reachback and other useful sites.

4.2.3. **Percolation Tests.** If subsurface investigation indicates soil may be suitable for a planned subsurface absorption treatment system, conduct percolation tests to estimate the percolation rates (liquid absorption) of the soil; determine the acceptability of the site; and serve as the basis of design for liquid absorption. **Figure 4.1** and **Figure 4.2** illustrate how to construct floating and fixed indicator percometers, respectively. Perform a minimum of three percolation tests within the planned area of the absorption field. Position tests uniformly throughout the absorption field. If soil conditions are highly variable, more tests may be required. Perform tests as indicated in the following paragraphs. For additional information on percolation test procedures, consult EPA 625/1-80-012.

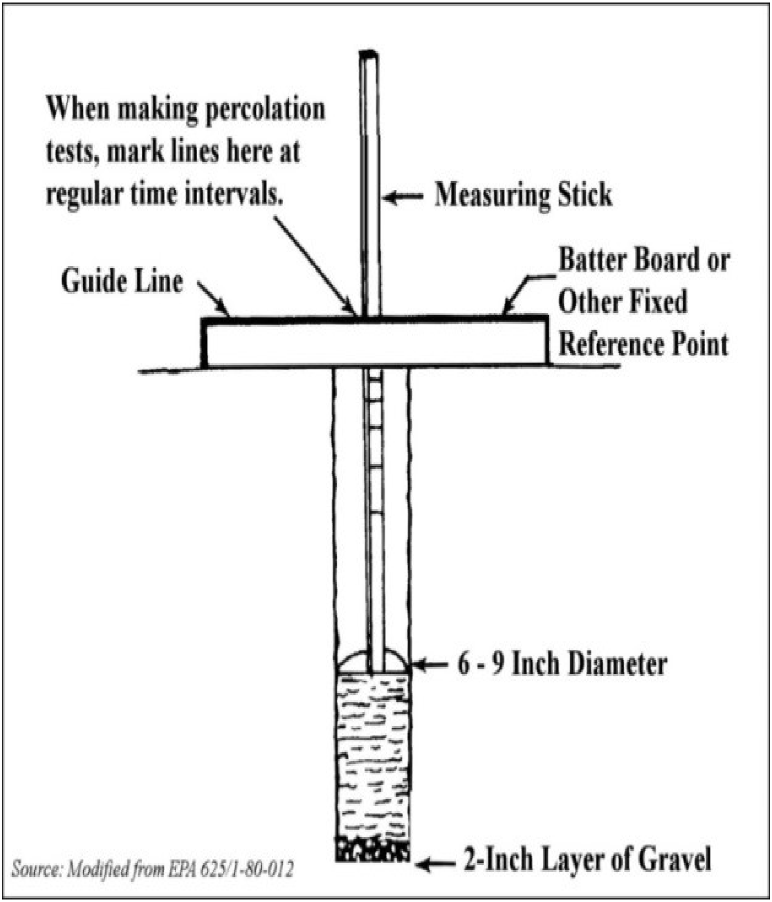
4.2.3.1. Preparation of Test Hole. Dig or bore 6- to 9-inch diameter test holes to the proposed depths of absorption system or most limiting soil horizon. To expose a natural soil surface, scratch sides of the hole with a sharp pointed instrument and remove the loose material from the bottom of the hole. Place two inches of coarse sand or fine gravel in the hole to protect the bottom from scouring action when adding water.

Figure 4.1. Percometer (Floating Indicator).



Source: Modified from EPA 625/1-80-012

Figure 4.2. Percometer (Fixed Indicator).



4.2.3.2. Presoak the Soil. Carefully fill the hole with at least 12 inches of clear water; maintain this depth for at least 4 hours and preferably overnight. In most soils, it will be necessary to augment the water as time progresses. A funnel with an attached hose or similar device may prevent water from washing down the sides of the hole. For accurate results, it is important the soil soak for a sufficient period to allow it to swell. **Note:** In sandy soils with little or no clay, soaking is not necessary. If, after filling the hole twice with 12 inches of water, the water seeps completely away in less than ten minutes, the percolation test can proceed.

4.2.3.3. Measurement of Percolation Rate. Except for sandy soils, perform percolation rate measurements between 15 and 30 hours after the soaking period began. Remove any soil that sloughed into the hole during the soaking period and adjust the water level to 6 inches above the gravel (or 8 inches above the bottom of the hole). Do not allow the water level to rise more than 6 inches above the gravel. Immediately after adjustment, measure the water level from a fixed reference point to the nearest 1/16 inch at 30-minute intervals. Continue testing until two successive water level drops do not vary more than 1/16 inch. Make at least three measurements. After each measurement, adjust the water level to 6 inches. Use the last water level drop to calculate the percolation rate. In sandy soils or soils where the first 6 inches of water added after the soaking period seeps away in less than 30 minutes, measure water level at 10-minute intervals for a 1-hour period. Use the last water level drop to calculate percolation rate.

4.2.3.4. Calculation of the Percolation Rate. Calculate the percolation rate for each test hole by dividing the time interval between measurements by the magnitude of the last water level drop. For example, if the last measured drop in water level after 30 minutes was 11/16 inch, calculate the percolation rate as shown below. Be sure to record and track the percolation test data (**Figure 4.3**).

Last measured water drop: 11/16 in. drop in 30 min. = 30 min. / 11/16 in.
Convert 11/16 in. to decimal (Numerator / Denominator) (11 ÷ 16) = 0.6875 in.
Calculated rate/min: 30 min/in. / 0.6875 in. or (30 ÷ 0.6875) = 43.63
Percolation rate: ≈ 44 min/in.

Figure 4.3. Percolation Test Data Record Example.

PERCOLATION TEST DATA			
Location:	Site 1 Alpha		
Test Hole Number:	3		
Depth to bottom of hole:	28 Inches	Diameter of hole:	6 Inches

Depth (inches)	Soil Texture
0-4	Blk top soil (Black top soil)
4-1/2	Brn sl (Brown silt loam)
12-28	Brn scl (Brown silty clay loam)
Percolation test by:	Christine B. Jones, Capt., USAF
Date of test:	12/03/15

Time	Time Interval (Minutes)	Measurement (Inches)	Drop in Water Level (Inches)	Percolation Rate (Minutes per Inch)	Remarks
0930	-	44	-		
1000	30	43	1		
1020	20	43	1		
1050	30	43-1/4	3/4		
1120	30	43-1/16	15/16		
1200	40	43-1/4	3/4		
1230	30	43-3/16	13/16		
1300	30	43-5/16	11/16		
1330	30	43-5/16	11/16	44	

Percolation rate = 44

Source: Modified from EPA625/1-80-012

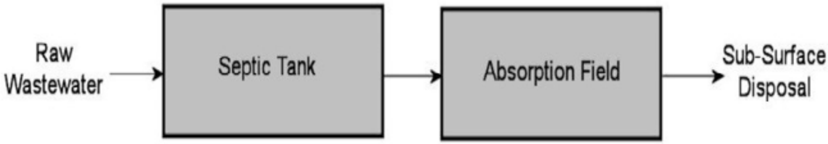
4.2.3.5. Although hydraulic conductivity of specific soils is consistent, the actual soil percolation test can produce widely varying results. Data in EPA 625/1-80-012 indicates percolation tests conducted in the same soils can vary by 90 percent or more. Attribute this large variability to the procedures used, soil moisture conditions at the time of the test, and individuals performing the test. Despite these shortcomings, the percolation test results can be useful, especially when combined with soil excavation data. Use the test to rank the relative hydraulic conductivity of the soil. **Table 4.3** lists estimated percolation rates for various soil textures.

Table 4.3. Estimated Hydraulic Characteristics of Soil.

Estimated Hydraulic Characteristics of Soil		
Soil Texture	Permeability (in./hr)	Percolation (min/in.)
Sand	>6.0	<10
Sandy loams: (porous silt loams; silty clay loams)	0.2-6.0	10-45
Clays, compact: (silt loams; silty clay loams)	<0.2	>45

4.3. Expedient Septic System. This system is a temporary, simple, and relatively economical means to treat and dispose of domestic wastewater for initial arriving forces or small unit deployments. It can provide sewage treatment and wastewater disposal at austere contingency locations. If soil conditions permit, use subsurface absorption after septic tank treatment. As illustrated in **Figure 4.4**, the basic configuration consists of a septic tank and absorption field (sometimes referred to as a leach field or drain field). However, if land, terrain features, and soil conditions are not favorable, use a seepage pit, sand filter system, or other disposal method in lieu of an absorption field. The expedient septic system is frequently the preferred wastewater treatment and disposal method because of its moderately low maintenance, configuration flexibility, and comparatively small real estate requirement. Consult EPA 625/1-80-012 and AFH 10-222V4 for more data on wastewater treatment procedures.

Figure 4.4. Basic Low-Flow Septic System.



4.3.1. **Septic Tanks.** Most low-flow septic system designs are basic. Septic tanks usually have one or two compartments. Single-compartment tanks give an acceptable performance. However, multi-compartment tanks perform somewhat better than single-compartment tanks of the same total capacity. The multi-compartment tanks provide better protection against solids carrying over into discharge pipes during periods of surges or upset due to rapid digestion.

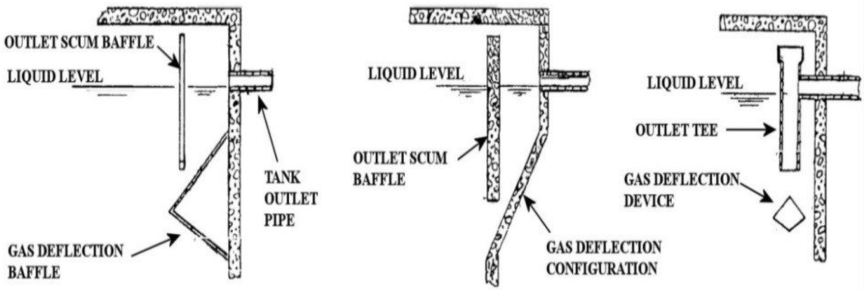
4.3.1.1. The material used for septic tank construction vary (e.g., concrete, fiberglass, polyethylene); however, the most commonly used material is concrete. The walls usually have a thickness of 3 to 4 inches. Plastic and fiberglass tanks are lightweight, easily transported, and resistant to corrosion and decay. They also minimize the chance of damage during installation.

4.3.1.2. Septic tank design should ensure removal of almost all settleable solids. To accomplish this, the tank must provide:

- Liquid volume sufficient for a 24-hour fluid retention time at maximum sludge depth and scum accumulation
- Inlet and outlet devices that prevent the discharge of sludge or scum in the effluent
- Sufficient sludge storage space to prevent the discharge of sludge or scum in effluent
- Venting to allow accumulated methane and hydrogen sulfide gases to escape

4.3.1.3. The design of septic tank inlet should dissipate energy of incoming water and minimize turbulence. The inlet should preferably be a sanitary tee or have a baffle to prevent solids from blocking the inlet pipe. The position of septic tank outlet pipe is lower than the inlet pipe to help prevent sewage from backing up into the sewer line. As illustrated in **Figure 4.5,** septic tank outlets can be a tee or have baffles and other special structures installed. Gas deflection baffles and wedges prevent gas-disturbed sludge from entering the rising leg of the outlet.

Figure 4.5. Septic Tank Outlet Structures.



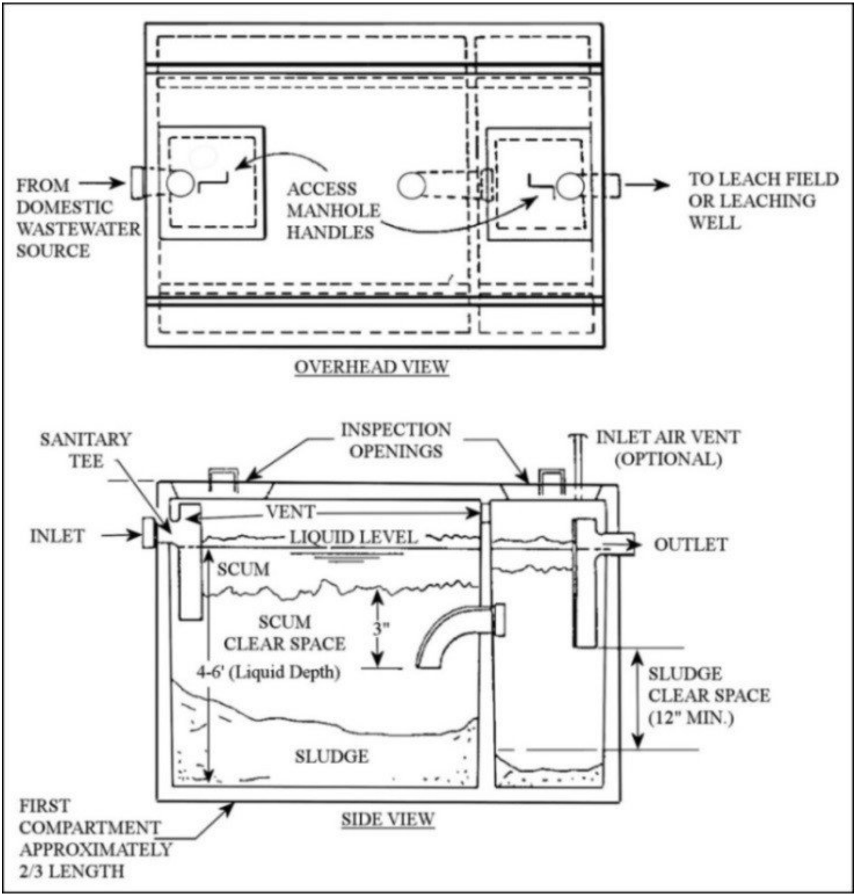
Source: Modified from EPA625/1-80-012, Design Manual, Onsite Wastewater Treatment and Disposal Systems

4.3.1.4. Septic tank settling and digestion functions are effective in treating up to 300 population equivalents of waste (a population equivalent is approximately 100 to 120 gallons [380 to 450L] per capita per day of domestic strength wastewater). However, septic tanks should only be used for population equivalents up to 25 (3,000 gal.), unless septic tanks are the most economical solution for larger populations. Minimum tank size is usually 500 gallons (1,900-L). The length-to-width ratio should be between 2:1 and 3:1, and the liquid depth should be between 4 and 6 feet (see **Figure 4.6**). The septic tank size should provide required detention (below the operating liquid level) for the designed daily flow plus an additional 25 percent capacity for sludge storage. Refer to UFC 3-240-02 when determining wastewater design flows. When effluent is disposed of in subsurface absorption fields or leaching pits, 24 hours detention time based on average flows is required; reduction to 18 hours permitted if secondary treatment provided, such as a subsurface sand filter or an oxidation pond. Open sand filter treatment can further reduce detention time to 10 to 12 hours. See additional treatment methods later in this section.

4.3.1.5. The function of a septic tank is relatively simple. Wastewater flows into the septic tank through the sewer distribution or inlet pipe. Heavier solids in the wastewater settle to the bottom of the tank forming a sludge layer. Lighter solids (including grease and oils) float to the surface forming a scum layer. This leaves a clarified wastewater layer in the middle of the tank. The clarified liquid discharges through the tank's outlet pipe to an absorption field or other treatment and disposal system. **Note:** Facility users should not discharge grease and non-biodegradable products into septic systems because they can clog system components.

4.3.1.6. Over time, natural processes decompose some of the sludge and scum in septic tanks. However, personnel will eventually need to pump the accumulated solids from the tank. If garbage grinders are used, the grinders will increase the settleable and floatable solids in the wastewater and the accumulation of solids in the septic tank. Studies indicate the increase in sludge and scum accumulation rates are approximately 37 percent when using garbage grinders. The increase in accumulation will require more frequent pumping or a larger tank to keep the pumping frequency down. A common expedient response is to add 250 gallons to the tank size when using garbage grinders, although this volume is arbitrary. It is generally a good idea to avoid the use of garbage grinders with septic tank systems.

Figure 4.6. Two-Compartment Septic Tank.



4.3.1.7. When installing septic tanks, the most important requirement is to place tanks on a level grade and at a depth that provides adequate gravity flow from the facility and matches the invert elevation of the facility's sewer. Place tanks on undisturbed soil so that settling does not occur. If the excavation is too deep, backfill to the proper elevation with sand to provide an adequate bedding for the tank. If tank position does not remain level, the inlet and outlet structures will not function properly and tank performance will be impaired. Be sure to seal the tank for water tightness after installation with two coats of bituminous coating. Also, seal around the inlet and outlet pipes with a bonding compound that will adhere both to concrete and the inlet and outlet pipes. Other considerations include:

- Use cast iron inlet/outlet structures in tanks used in disturbed soil areas where tank settling may occur
- Use flotation collars in areas with high groundwater potential
- Place tank so the manhole is slightly below grade to prevent accidental entry
- Place tank in an area with easy access to alleviate pump-out problems
- Repair any damage to watertight coating during installation; test the tank for water tightness after installation by filling it with water
- During installation in areas with large rocks, take care to prevent undue localized stresses on the tank
- Baffles, tees, and elbows should be made of durable and corrosion-proof materials; fiberglass or acid-resistant concrete baffle materials are most suitable; vitrified clay tile, plastic, and cast iron are best for tees and elbows

4.3.1.8. It is probably a good idea to place manholes over the inlet and outlet to allow personnel to access and inspect the septic tank, and permit cleaning behind the baffles or tees. The manhole cover should extend above the actual septic tank to a height not more than 6 inches below the finished grade. The actual cover can extend to the ground surface if a proper seal prevents escape of odors and accidental tank entry. Because the tank is below ground, soil removal from over the access cover is necessary before tank-cleaning operations.

4.3.1.9. Normally, septic tanks are the first component of an onsite treatment system, followed by additional treatment or disposal units. In most instances, septic tank effluent is discharged to a soil absorption system (trench, bed, or leaching well) where wastewater percolates down through the soil. In areas where soils are not suitable for percolation, septic tank effluent may discharge to evapotranspiration (ET) beds for treatment and disposal, or to sand filters or lagoons for further treatment.

4.3.2. **Absorption Fields.** In subsurface soil absorption systems, the pretreatment unit (i.e., septic tank) should remove nearly all settleable solids and floatable grease and scum so a reasonably clear liquid discharges into the soil absorption field. Absorption fields (i.e., drain field or leach field) distribute effluent from the septic tank and normally consist of several perforated distribution pipes laid in trenches or beds filled with rock. The distribution box (usually a reinforced concrete structure) distributes the septic tank effluent evenly throughout the absorption field via distribution pipes. The absorption field treats the wastewater by allowing it to slowly trickle from the pipes out into the gravel and down through the soil. The gravel and soil act as biological filters. This section addresses absorption fields in the form of trenches or beds. Absorption trenches and beds are excavations of relatively large areas; see **Table 4.4** and consult EPA 625/1-80-012 to review site criteria for these systems.

4.3.2.1. **Absorption Trenches.** Absorption trenches are usually shallow, level excavations, typically 1 to 5 feet deep and 1 to 3 feet wide (**Figure 4.7**). Fill trench bottoms with a minimum of 6 inches of 3/4 to 2-1/2-inch rock or gravel. Lay the perforated distribution pipe on top of this rock; carefully place more rock over the pipe network, and then use a semipermeable membrane or barrier over the rock layer to prevent backfill from clogging the drainage zone (**Figure 4.8**). Distribution pipes may be spaced as close as 2 feet if the rock beneath is deep, the subsoil porous, and distance to bedrock greater than 4 feet. Generally, distribution pipelines are 3 to 6 feet apart laterally and are no longer than 100 feet.

Table 4.4. Site Criteria: Subsurface Absorption Trenches and Beds.

Item	Criteria
Landscape Position	Level, well-drained areas, crests of slopes, convex slopes most desirable. Avoid depressions, bases of slopes, and concave slopes unless suitable surface drainage is provided.
Slope	0 - 25%. Slopes over 25% can be used, but use of construction machinery may be limited. Bed systems are limited to 0 - 5%.
Horizontal Separation	See UFC 3-240-02 for specific requirements.
Soil: Texture	Soils with sandy or loamy textures are best. Gravelly (particles 2 - 75 mm) and cobbley (particles 75 - 250 mm) soils with open pores and slowly permeable clay soils are less desired.
Structure	Strong granular, blocky or prismatic structures are desirable. Platy or unstructured massive soils should be avoided.
Color	Bright uniform colors indicate well-drained, well-aerated soils. Dull, gray, or mottled soils indicate continuous or seasonal saturation and are unsuitable.
Layering	Soils exhibiting layers with distinct textural or structural changes should be carefully evaluated to ensure water movement will not be severely restricted.
Unsaturated Depth	2 to 4 feet of unsaturated soil should exist between the bottom of the system and the seasonally high water table or bedrock.
Percolation Rate	l-60 min/in. (average of at least 3 percolation tests. Systems can be constructed in soils with slower percolation rates, but soil damage during construction should be avoided.

Figure 4.7. Absorption Trench (Overhead View).

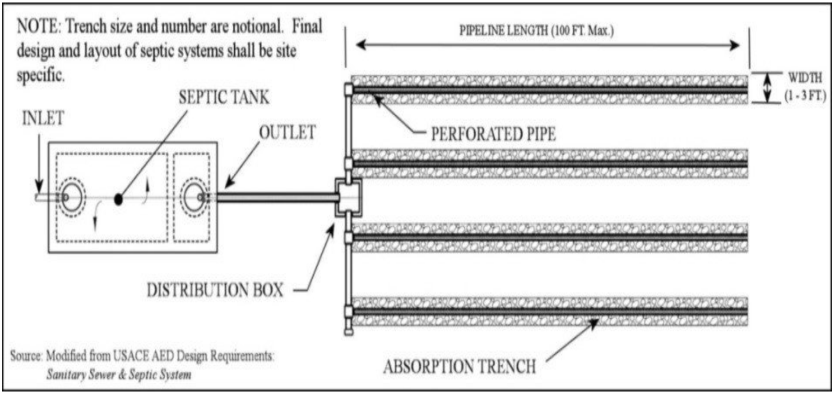
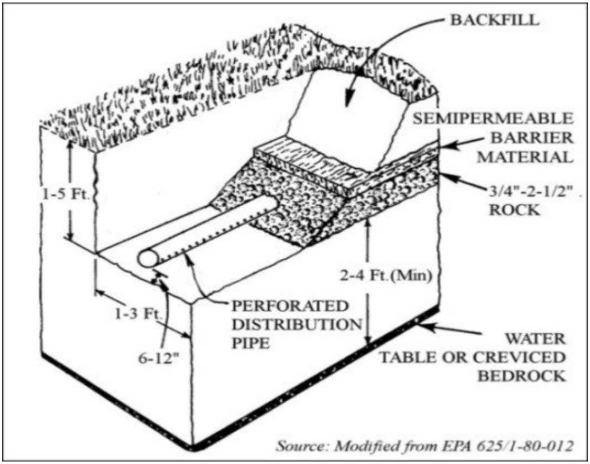
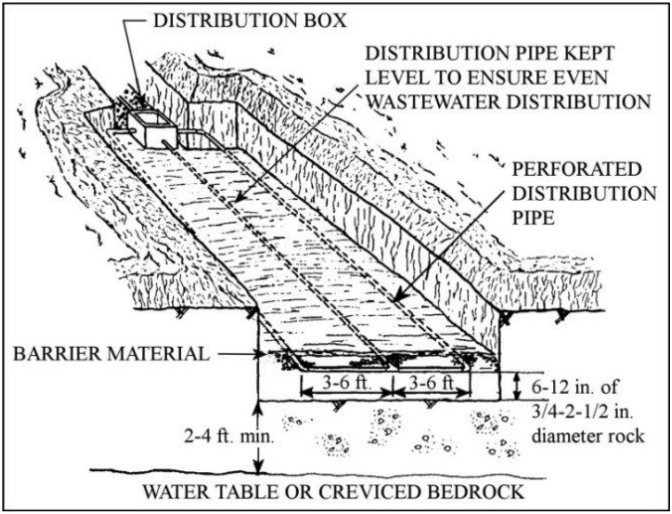


Figure 4.8. Absorption Trench (Sectional View).



4.3.2.2. **Absorption Beds.** Absorption beds differ from trenches in that they are wider than 3 feet and may contain more than one line of distribution piping (**Figure 4.9**). Absorption beds can be as wide as needed, based on the total area needed for absorption.

Figure 4.9. Absorption Bed.



4.3.3. **Seepage Pits.** Although absorption fields are generally preferred, site characteristics and cost considerations may encourage the use of a seepage pit (aka leaching well or leaching tank). Specifically, seepage pits may be advisable when the land area is too limited for trench or bed systems, and either the groundwater level is deep at all times or the upper 3 to 4 feet (0.9 to 1.2 m) of the soil profile is underlain by a more permeable unsaturated soil material of great depth. Generally, seepage pits are an option for septic tank effluent disposal where subsoil is porous.

4.3.3.1. Illustrated in **Figure 4.10** is a two-seepage pit layout fed through open joint lines coming from a distribution box. Wastewater enters the chamber where it is stored until it seeps out through the chamber wall and infiltrates the sidewall of the excavation. The bottom of the seepage pit should be at least 4 feet above seasonal high water table. Maintaining sufficient separation between the bottom of the seepage pit and the high water table is an important consideration for protection of groundwater quality. Pit construction using masonry blocks or stone with lateral openings and gravel outside prevents sand from entering the pit. However, other material (i.e., stones, bricks, tiles) may also be used. **Figure 4.11** shows a small seepage pit made using a stone wall.

Figure 4.10. Seepage Pits.

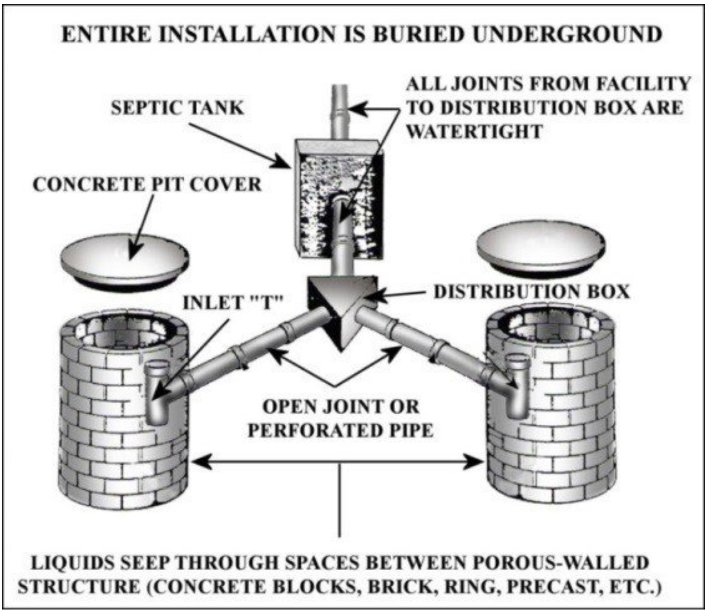
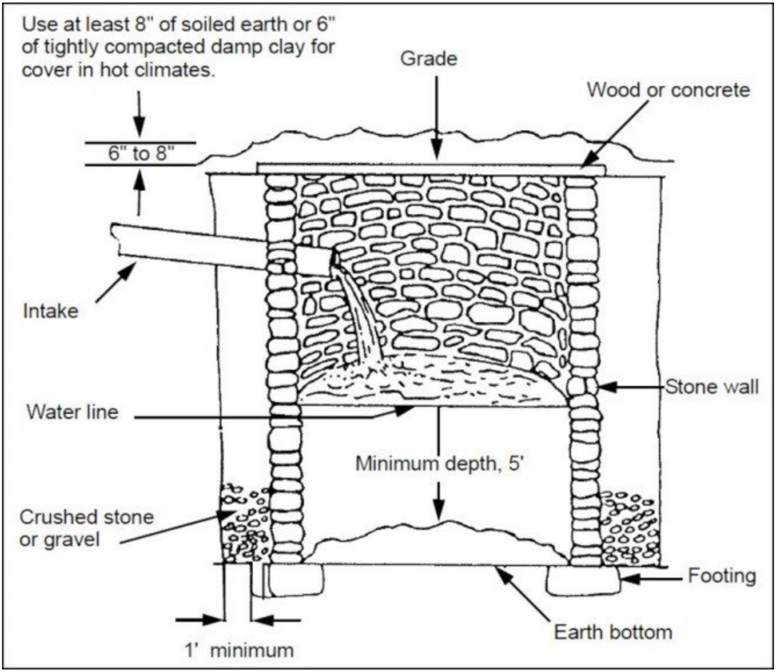


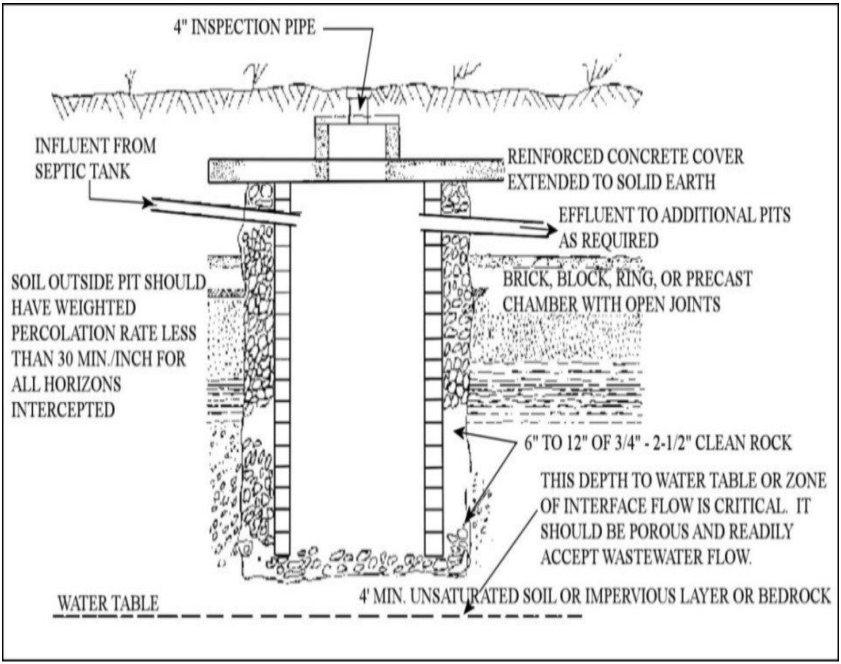
Figure 4.11. Small Seepage Pit (Stone Wall).



4.3.3.2. Siting criteria for seepage pits are similar to those for trench and bed systems summarized in **Table 4.4**. Reserve an additional area at the site for installing more pits should it become necessary. Because the excavation sidewall is the main infiltrative surface for seepage pits, run percolation tests in each soil layer encountered in pit excavation to determine overall percolation rate. A weighted average of the percolation test results (sum of thickness times percolation rate of each layer divided by the total thickness) is used. Generally, exclude soils with percolation rates slower than 30 min/in.

4.3.3.3. Seepage pits may be any diameter or depth provided they are structurally sound. Pit construction is possible without seriously damaging the soil. Typically, seepage pits are 6 to 12 feet in diameter and 10 to 20 feet deep, but engineers have constructed pits 18 inches in diameter and 40 feet deep. If more than one seepage pit is required, space pits at intervals 2 to 3 times the diameter of the pit from sidewall to sidewall. **Figure 4.12** illustrates a typical seepage pit plan and basic construction details.

Figure 4.12. Seepage Pit Plan Construction Details.



4.3.3.4. Dig pits with conventional excavating equipment or with power augers. Ensure soils are not too wet before starting construction. If powered bucket augers are used, widen pits to a larger diameter than the bucket to minimize compaction and smearing of the soil. Use power screw augers in granular soils because smearing of the sidewall is difficult to prevent with such equipment.

4.3.3.5. To maximize wastewater storage, porous walled chambers without bottoms are typically used. Common options include precast concrete seepage chambers, chambers made of clay, or concrete brick blocks or rings. Rings must have notches to provide for seepage. Lay bricks or blocks without mortar and with staggered open joints. If laying hollow block on its side, maintain a 4-inch wall thickness. Large-diameter perforated pipe standing on end are options for small diameter pits. Place 6 to 12 inches of clean gravel or 3/4 to 2-l/2 inch crushed rock at the bottom of the excavation prior to placement or construction of the chamber. This provides a firm foundation for the chamber and prevents removal of bottom soil if the pit requires pumping. Construct the chamber 1 to 2 feet smaller in diameter than the excavation. Fill the annular space left between the wall of the chamber and the excavation with clean gravel or crushed rock to the top of the chamber.

4.3.3.6. Place covers of suitable strength over the chamber and extend at least 12 inches beyond the excavation to support the soil cover and any anticipated loads. Use a manhole to provide access to large pits for inspection purposes. If a manhole is used, cover it with 6 to 12 inches of soil. An inspection pipe can extend to ground surface. Use a noncorrosive, watertight cap with the inspection pipe. A well-designed and constructed seepage pit requires no routine maintenance, although a failure occasionally occurs. Pumping and resting is the only reasonable rehabilitation technique available.

4.3.4. **Intermittent Sand Filters.** With some soil conditions, an absorption field or seepage pit may not be a viable option. If soil tests indicate percolation rates are very high, intermittent sand filters (ISF) may be more appropriate. ISFs are well suited to onsite wastewater treatment and disposal. The process is highly efficient and usually requires minimal operation and maintenance support. The basic components of an ISF system are a primary treatment unit (septic tank or other sedimentation system), distribution network, and a sand filter (**Figure 4.13**). Other components may include a dosing tank, pump and controls (or siphon), and a disinfection tank. ISFs normally treat effluents from septic tanks and potentially followed by disinfection prior to reuse or disposal to land or surface waters.

4.3.4.1. ISFs may be single-pass, bottomless, or recirculating sand filters (RSF). Although mostly buried partially or completely in the ground, ISFs built above the ground (open filter) is an option to avoid bedrock or a high water table. The ISF treatment method provides secondary treatment in three ways; filtration, chemical sorption, and assimilation (see **Table 4.5**). Treatment begins by applying wastewater intermittently to the surface of the bed through distribution pipes or troughs. Wastewater filters through the granular medium where it collects in the underdrain and then discharged. This technique is one of the oldest known treatment methods and if designed, constructed, and operated properly, it produces high quality effluent.

4.3.4.2. Typically, ISF treatment beds consist of granular materials and underlain by graded gravel and collecting pipe. Although sand is commonly the medium used as the granular material, anthracite, garnet, ilmenite sand, mineral tailings, bottom ash, etc., are also options. The granular material used should be durable and insoluble in water. Any clay, loam, limestone, or organic material may increase the initial absorption capacity of the sand, but may lead to serious clogging conditions as the filter ages.

4.3.4.3. Early ISF designs had filter bed depths between 4 to 10 feet. However, later studies indicated most of the wastewater purification occurred within the top 9 to 12 inches of the bed. Additional bed depth did not improve wastewater purification to any significant degree. Today, media depths generally range between 24 to 42 inches. Shallow filter beds helps save time and resources during construction. Conversely, deeper beds tend to produce a more constant effluent quality, less affected by rainfall or snowmelt, and permit the removal of more media before replacement becomes necessary.

Figure 4.13. Basic ISF Components.

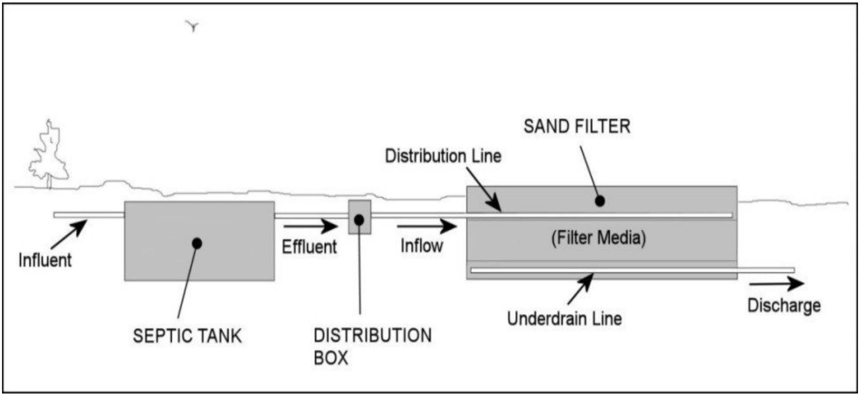
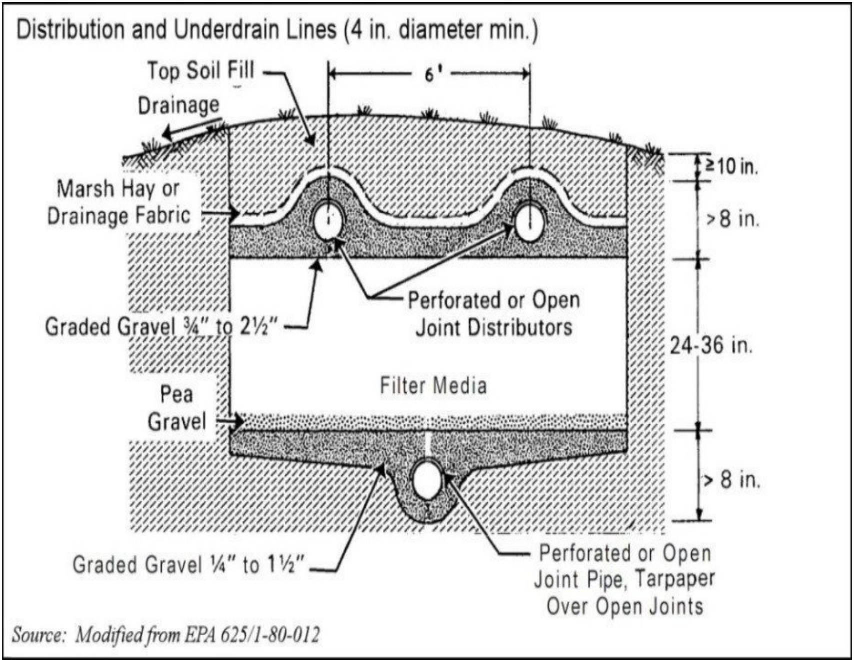


Table 4.5. ISF Secondary Treatment Method.

Treatment	Process
Filtration	Particles are physically strained from the passing wastewater
Chemical sorption	Contaminants stick to the surface of the sand and to biological growth on the sand surface
Assimilation	Aerobic microbes consume the nutrients in the wastewater

4.3.4.4. Buried ISF. Illustrated in **Figure 4.14** is a typical profile of a subsurface sand filter. Build the filter in the ground with a natural topsoil cover in excess of 10 inches over the crown of the distribution pipes. The filter should be carefully constructed after excavation and granular fill settled by flooding. Construct distribution and underdrain lines of an acceptable material with a minimum diameter of 4 inches. If tile pipes are used, the tile is normally laid with open joint sections spaced between 1/4- to 1/2-inches apart. If continuous pipeline is used, conventional perforated pipe provides adequate distribution and collection of wastewater within the filter. Surround the distribution and underdrain lines with at least 8 inches of washed durable gravel or crushed stone. For distribution lines, the gravel or stone is usually smaller than 2-1/2-inch, but larger than 3/4-inch; the size range of the gravel or stone for the underdrain is between 1-1/2 to 1/4-inch. Slopes of underdrain pipe range from 0.5 to 1%. **Table 4.6** summarizes the design criteria for buried ISFs.

Figure 4.14. Profile of Buried ISF.



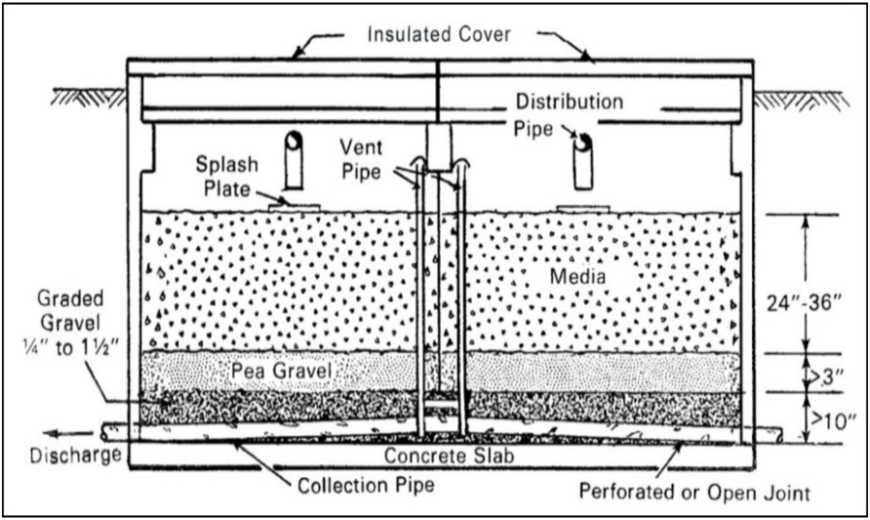
Source: Modified from EPA 625/1-80-012

Table 4.6. Buried ISF Design Criteria.

Item	Design Criteria
Pre-treatment	Minimum level – sedimentation (septic tank or equivalent)
Hydraulic Loading All year Seasonal	 <1.0 gpd/ft^2 <2.0 gpd/ft^2
Media Material Effective size Uniformity Coefficient Depth	 Washed durable granular material (<1% organic matter by weight) 0.50 to 1.00 mm <4.0 (<3.5 preferable) 24 to 36 inches
Underdrains Material Slope Bedding Venting	 Open joint or perforated pipe 0.5 to 1.0 percent Washed durable gravel or crushed stone (1/4 to 1-1/2 in.) Upstream end
Distribution Material Bedding Venting	 Open joint or perforated pipe Washed durable gravel or stone (3/4 to 2-1/2 in.) Downstream end
Dosing	Flood filter; frequency greater than 2 per day *Source: EPA 625/1-80-012*

4.3.4.5. Free Access ISF. The free access ISF has open or free access to the surface of the filter. Built often within the natural soil, constructing it completely above the ground surface is an option. As illustrated in **Figure 4.15**, free access ISFs are usually surrounded by sidewalls, often of masonry construction, to prevent earth from washing into the filters and to confine the flow of wastewater.

Figure 4.15. Free Access ISF (Profile).



4.3.4.5.1. If necessary, cover filters to protect against severe weather conditions, and to avoid encroachment of weeds and animals. The cover also serves to reduce odor conditions. Build covers with treated wooden planks, galvanized metal, or other suitable material. Screens or hardware cloth (metal mesh material) mounted on wooden frames may also serve to protect filter surfaces. Insulate the covers where weather conditions dictate. Be sure to allow a space of 12-24 inches between the cover and sand surface.

4.3.4.5.2. The media characteristics of free access ISFs are similar to buried filters. The design of the pipeline distribution system directs effluent onto splash plates located at the center or corners of the sand surface (**Figure 4.16**). However, troughs or spray nozzles sometimes distribute effluent onto the sand surface. Filter maintenance usually involves resting the clogged filter; therefore most free access ISF systems have dual filters. **Table 4.7** lists other design measures and criteria.

Figure 4.16. Free Access ISF (Overhead View).

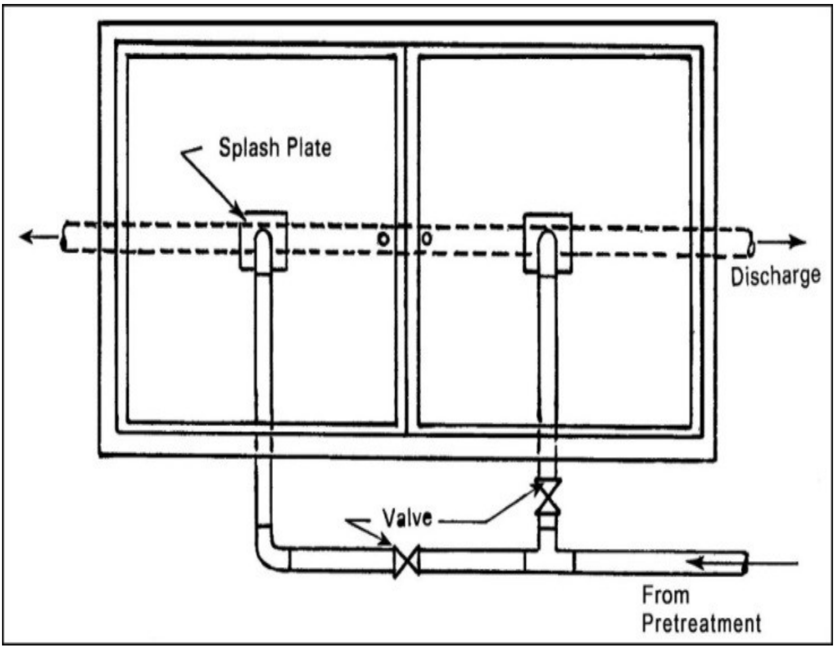


Table 4.7. Free Access ISF Design Criteria.

Item	Design Criteria
Pre-treatment	Minimum level – sedimentation (septic tank or equivalent)
Hydraulic Loading Septic tank feed Aerobic feed	 2.0 to 5.0 gpd/ft^2 5.0 to 10.0 gpd/ft^2
Media: Material Effective size Uniformity Coefficient Depth	 Washed durable granular material (<1% organic matter by weight) 0.35 to 1.00 mm <4.0 (<3.5 preferable) 24 to 36 inches
Underdrains Material Slope Bedding Venting	 Open joint or perforated pipe 0.5 to 1.0 percent Washed durable gravel or crushed stone (1/4 to 1-1/2") Upstream end
Distribution	Troughs on surface; splash plates at center or corners; sprinkler distribution
Dosing	Flood filter to 2 inches; frequency greater than 2 per day
Number Septic tank feed Aerobic feed	 Dual filters, each sized for design flow Single filter *Source: EPA 625/1-80-012*

4.3.4.6. Recirculating ISF. The recirculating ISF is a free access ISF with a recirculation (dosing) tank between the pretreatment unit (e.g., septic tank) and the filter (**Figure 4.17**). The recirculation tank incorporates a pump to recycle sand filtered effluent and septic tank overflow. The pump pushes the wastewater mixture to the filter surface. Normally submersible and rated for 1/3 horsepower, the pump should be sized to empty the recirculation tank in less than 20 minutes. The strength and material of recirculating tanks is comparable to septic tanks. Its size is normally 1/4 to 1/2 the size of the septic tank (or a volume equivalent to at least on day's volume of raw wastewater flow). The tank should be easily accessible to accomplish maintenance of the recirculation pump, valves, timers, etc. **Table 4.8** lists additional design measures and criteria.

Figure 4.17. Recirculating ISF Components.

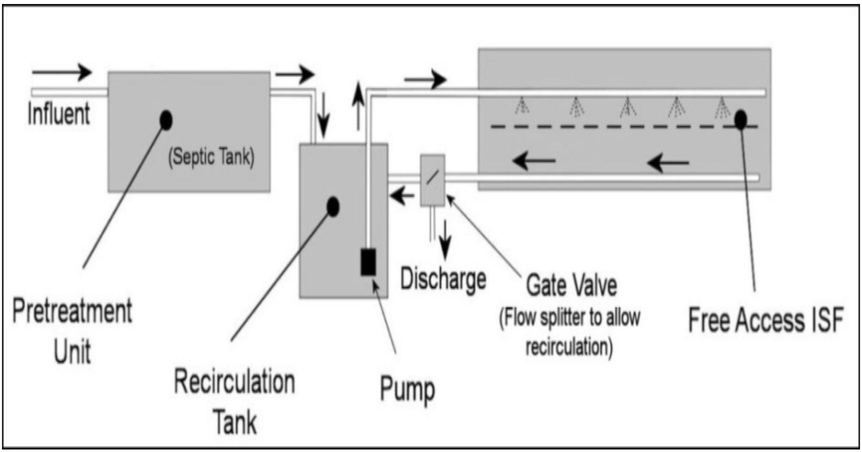


Table 4.8. Recirculating ISF Design Criteria.

Item	Design Criteria
Pre-treatment	Minimum level – sedimentation (septic tank or equivalent)
Hydraulic Loading	3.0 to 5.0 gpd/ft^2 (forward flow)
Media	
Material	Washed durable granular material (<1% organic matter by weight)
Effective size	0.3 to 1.5 mm
Uniformity Coefficient	<4.0 (<3.5 preferable)
Depth	24 to 36 inches
Underdrains Material Slope Bedding Venting	Open joint or perforated pipe 0.5 to 1.0 percent Washed durable gravel or crushed stone (1/4 to 1-1/2”) Upstream end
Distribution	Troughs on surface; splash plates at center or corners; sprinkler distribution
Recirculation Ratio	3:1 to 5:1 (5:1 preferable)
Dosing	Flood filter to approximately 2 inches; pump 5 to 10 minutes per 30 minutes; empty recirculation tank in less than 20 minutes *Source: EPA 625/1-80-012*

4.3.5. **Lagoons.** Lagoons are a cost-effective method of wastewater treatment. Sometimes referred to as ponds, lagoons can treat a variety of wastewaters, from domestic wastewater to complex industrial waters. Mostly used in smaller communities for domestic wastewater treatment, lagoons are well suited for remote wastewater treatment at locations where land is readily available and skilled labor is limited. When used at contingency bases, lagoons should meet combatant command (CCMD) design, construction, and use requirements. Lagoons are classified by the dominant type of biological reaction that occurs (i.e., aerobic, anaerobic, facultative, aerated), duration and frequency of discharge, extent of treatment ahead of the pond, or their arrangement (if more than one is used). Use lagoons alone or in combination with other treatment methods and systems. A lagoon system may have several cells with varying degrees of organic loading and biological reactions. Liquid disposal occurs by percolation and evaporation or by separate infiltration bed. The pH levels may require adjustment to help control odors. While lagoons vary in size, depth, construction, and operation, all treatment and storage lagoons should have at least two feet of freeboard. **Figure 4.18** illustrates alternative flow patterns for lagoon systems with different cells and stages of treatment. **Table 4.9** lists the advantages and disadvantages of using lagoons. Although lagoon types and classifications vary, common design considerations include the following:

- Sewage waste volume
- Site location
- Distance to dwelling, etc.
- Depth to groundwater or bedrock
- Distance to surface water
- Depth of liquid, surface area
- Climate
- Aquifer characteristics
- Monitoring wells
- Solids removal and disposal

Figure 4.18. Alternative Lagoon Flow Schematics.

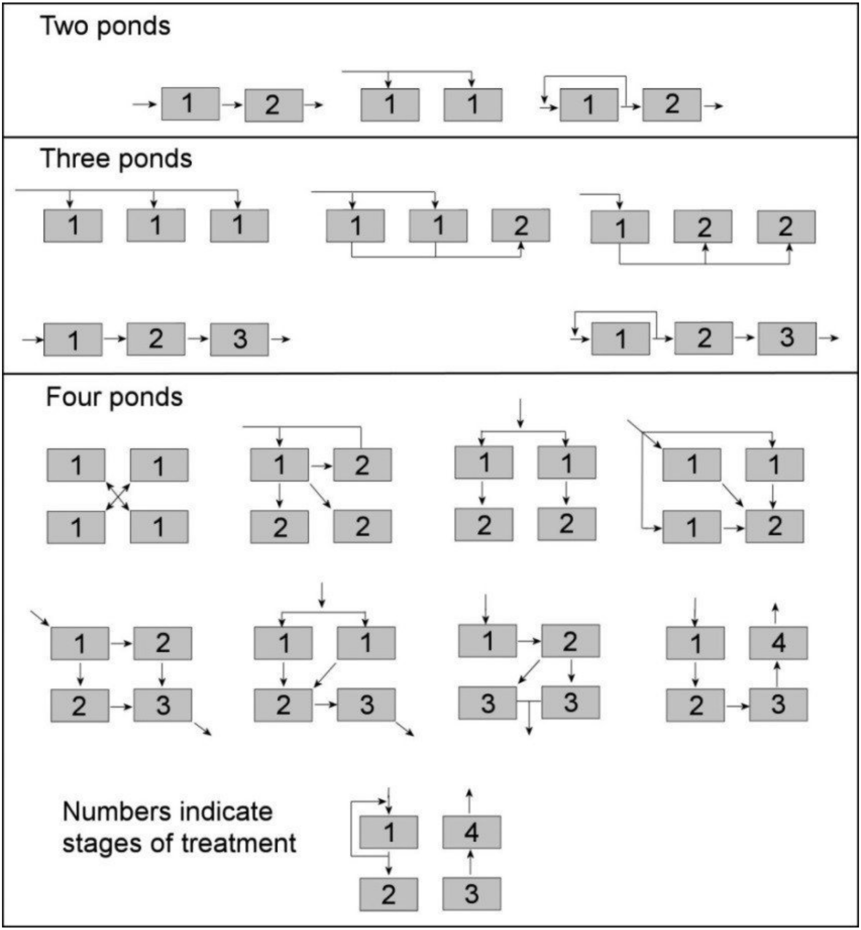


Table 4.9. Advantages and Disadvantages of Lagoons.

Lagoons	
Advantages	**Disadvantages**
Low cost Simple operation	Odor problems if pH not maintained Cannot use in areas with high water table Possible vector problem Soil clogging may stop percolation Effluent may require additional treatment

4.3.5.1. Aerobic. Generally, aerobic lagoon systems treat effluent from other processes. Aerobic lagoon systems maintain dissolved oxygen throughout their entire depth and are mostly limited to warm sunny climates. Sometimes referred to as shallow oxidation ponds because of their narrow depth (usually 12 to 18 inches) and oxygenated biological activity. The chief advantage of the high-rate aerobic pond is that it produces a stable effluent with low land and energy requirements and short detention times (between 5 to 20 days). However, operation is somewhat more complex than for a facultative pond. In addition, unless provided an algae removal step, the effluent will contain high-suspended solids. Short detention times also mean very little coliform die-off will result. Because of their shallow depths, paving or covering the bottom of the ponds is required to prevent weed growth.

4.3.5.2. Anaerobic. Anaerobic lagoons have no aerobic zone because they receive such a heavy organic loading; fermentation occurs in the absence of oxygen. Anaerobic systems typically treat strong industrial and agricultural wastes. In most situations, follow-on treatment is required. This type of lagoon system may pretreat industrial waste if waste is a significant contributor to domestic systems. They are usually 8 to 16 feet deep and have detention times of 20 to 50 days. An important disadvantage of anaerobic ponds is the production of odorous compounds. Sodium nitrate combats these odors, but is expensive and in some cases has not proven effective. Another common approach is to recirculate water from a downstream facultative or aerobic pond to maintain a thin aerobic layer at the surface of the anaerobic pond; this prevents transfer of odors to the air. Crusts have also proven effective, either naturally formed, as with grease, or formed from Styrofoam balls. A further disadvantage of the anaerobic pond is that the effluent usually requires additional treatment prior to discharge. Anaerobic lagoons do not have wide application for treatment of domestic wastewaters.

4.3.5.3. Facultative. This is the most common type of lagoon system. It is the easiest to operate and maintain, but requires a large land area. Facultative ponds are used to treat raw domestic wastewater and primary or secondary effluent. In industrial applications, they provide additional stabilization following aerated or anaerobic ponds. Facultative ponds generally have both aerobic and anaerobic layers. Anaerobic fermentation occurs in the lower layer and aerobic stabilization occurs in the upper layer. A pond may be aerobic through the entire depth if it is lightly loaded. Facultative ponds are usually 4 to 8 feet deep and have long detention times ranging from 25 to 180 days.

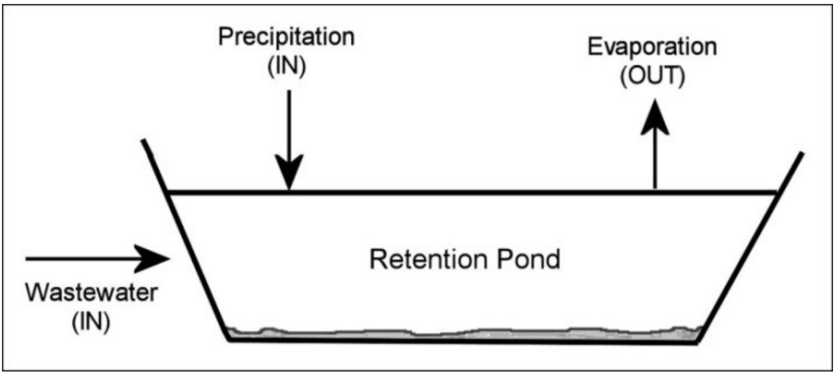
4.3.5.4. Aerated. Oxygen supply to aerated lagoon systems is through mechanical or diffused air aeration. Aerated ponds treat domestic or industrial wastewater and may evolve from overloaded facultative ponds by adding an aerator to increase oxygenation. For industrial wastes, aerated ponds are sometimes a pretreatment step before discharge to a domestic sewerage system. Aerated ponds are generally 6 to 20 feet deep with detention times of 7 to 20 days. Aeration provides oxygen transfer for biological reactions and keeps solids partially or completely suspended, depending on level of mixing. The suspended solids are removed by settling (solid-liquid separation) before effluent is discharged. Settling is an integral part of the aerated lagoon system process and accomplished using a settling basin or a dormant/resting portion of the aerated cell. Aerated lagoon cells should operate either in series or in parallel flow patterns. **Figure 4.19** displays two aerated cells and two additional treatment stages (settling, evaporation, or percolation).

Figure 4.19. Lagoon System with Several Cells.

4.3.6. **Evaporation Systems.** Evaporation is an alternative wastewater disposal method if site conditions or contamination concerns preclude wastewater treatment and disposal using subsurface disposal or discharge to surface waters is not permitted or feasible. Evaporation systems, normally used in arid and semiarid locations, use the natural energy of the sun, wind, and temperature to dispose of wastewater to the atmosphere. Designs should ensure the net evaporation potential equals or exceeds the total water input to the system (wastewater volumes plus precipitation). Since water input correlates to the size and number of facilities needed, land availability is an important consideration for system designers. While some evaporation system designs combine evaporation with soil absorption (i.e., evaporation lagoons and evapotranspiration/absorption beds) or surface water discharge, total retention evaporation ponds and ET beds utilize liners to prevent groundwater and surface water contamination.

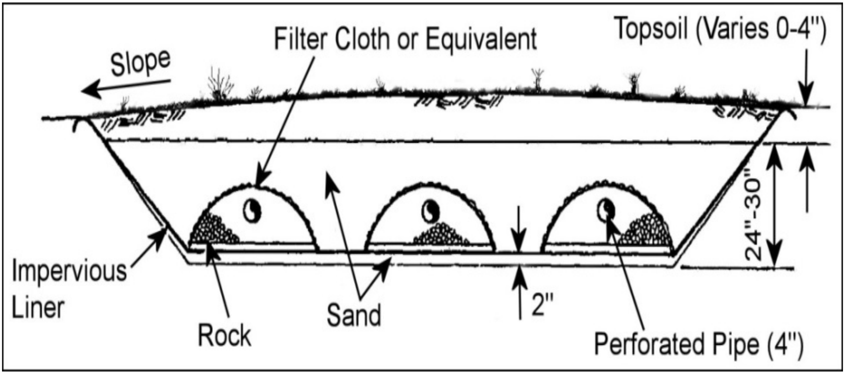
4.3.6.1. Total retention ponds. As illustrated in **Figure 4.20**, lined retention ponds return water to the hydrologic cycle by evaporation only and concentrates remaining pollution for subsequent disposal. Consider monthly evaporation and precipitation rates when properly sizing the system. Total retention ponds usually require large land areas, and these areas are not productive once they have been committed to this type of system. The land should be naturally flat or be shaped to provide ponds that are uniform in depth, and have large surface areas.

Figure 4.20. Total Retention Pond.



4.3.6.2. ET beds. ET beds are designed to use both evaporation and vegetation transpiration to return water to the hydrologic cycle. ET disposal normally consists of a sand bed with an impermeable liner and wastewater distribution piping (**Figure 4.21**). Plant vegetation in the surface of the sand bed for vegetation transpiration. Wastewater entering the bed is normally pretreated to remove settleable and floatable solids. An ET bed functions by raising the wastewater to the upper portion of the bed by capillary action in the sand, and then evaporating it to the atmosphere. In addition, the vegetation transports water from the root zone to the leaves for transpiration.

Figure 4.21. ET Bed (Cross Section).



4.3.6.3. Evapotranspiration/absorption (ETA) beds. The ETA method is a modification of the ET bed. It disposes of wastewater into the atmosphere and to the groundwater. By omitting the impervious liner, a portion of the wastewater seeps into the soil. This method is not appropriate in areas where wastewater percolation might contaminate groundwater supplies, such as areas with shallow or creviced bedrock, or high water tables.

4.3.6.3.1. As with ET beds, a favorable climate and planted vegetation improves the efficiency. While various factors can influence specific design characteristics, ETA design is very similar to the ET beds (see **Figure 4.21**). **Table 4.10** lists some desirable construction features for both ETA and ET bed.

4.3.6.3.2. When constructing ETA beds, be sure to follow accepted construction procedures and practices for subsurface disposal systems.

Table 4.10. Construction Design Features for ET and ETA Beds.

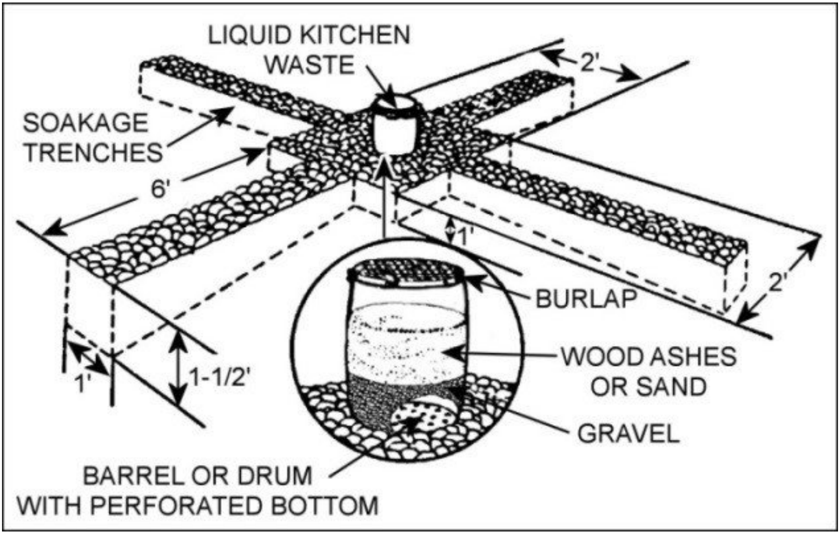
ET and ETA Construction Features.	
1.	Synthetic liners should have a thickness of at least 10 mil; it may be preferable to use a double thickness of liner material so that the seams can be staggered if seams are unavoidable.
2.	Synthetic liners should be cushioned on both sides with layers of sand at least 2 inches thick to prevent puncturing during construction.
3.	Surface runoff from adjacent areas should be diverted around the system by berms or drainage swales.
4.	Crushed stone or gravel placed around the distribution pipes should be 3/4 to 2-l/2 inches.
5.	Filter cloth or equivalent should be used on top of the rock or gravel to prevent sand from settling into aggregate and reducing the void capacity.
6.	Care should be exercised in assembling the 4-inch perforated distribution pipes to prevent pipe glues and solvents from contacting the synthetic liner.
7.	The bed surface should be sloped for positive drainage.
8.	Relatively porous topsoil, such as loamy sand or sandy loam, should be used if required to support vegetation to prevent erosion, or to make the appearance more acceptable.
9.	The bed should be located in conformance with local codes/command requirements.

4.4. Kitchen Soakage Pits and Trenches. Beddown locations may require soakage pits or soakage trenches to dispose of wastewater from kitchens and dining facilities (DFAC) for short periods until a more suitable means of disposal is available. Climate and soil conditions usually determine the effectiveness of these devices. Normally, pits and trenches disposes small volumes of wastewater, but with proper design and operation, they can be effective for larger volumes. Pretreatment using grease traps is necessary to remove grease, particulate, and organic material to prevent prematurely clogging the soakage pit.

4.4.1. **Soakage Pit.** Construct a kitchen soakage pits in the same manner as the urine soakage pit addressed in **paragraph 2.4.1**, and will normally dispose of liquid kitchen waste for 200 persons. A grease trap replaces pipes or troughs used in the urine soakage pit. If deployment is lasting (e.g., last for several weeks) make two kitchen soakage pits and alternate their usage on a daily basis; a rest period helps to prevent clogging. Ensure clogged soakage pits are properly closed. To close a kitchen pit, backfill and compact with soil 1 foot above the grade and mark the pit with a rectangular sign indicating the type of pit and date of closure.

4.4.2. **Soakage Trench.** Use a kitchen soakage trench when the groundwater level or a rock formation precludes digging a soakage pit. The soakage trench has a 2 feet square and l foot deep pit (**Figure 4.22**). The pit has a trench radiating outward from each side for a distance of 6 or more feet. Dig trenches 1-foot wide, varying depth from 1 foot at the center to 1-1/2 feet at the outer ends. Fill the pit and trenches with material similar to that used in the soakage pit. Build two units for every 200 persons fed and alternate their usage daily. Use a grease trap with the soakage trench, and close it in the same manner as a soakage pit described in the previous paragraph.

Figure 4.22. Soakage Trench.



4.5. Graywater Evaporations Beds. The evaporation bed is a field expedient method to dispose of small flows of graywater. They are suited for hot and dry climates and locations where clay soil prevents use of standard soakage pits. Although simple to build, they can be labor intensive to maintain. Normally, evaporation beds measure 8 by 10 feet (**Figure 4.23**). Construct beds to allow 3 square feet per person per day for kitchen waste and 2 square feet per person per day for wash and bath waste. Space beds to allow waste distribution to any one bed. Scrape topsoil to the edges, forming a small dike around the bed. Spade earth in the bed to a depth of 10 to 15 inches. Rake it into a series of rows with the ridges approximately 6 inches above the depression. Form rows either lengthwise or crosswise, depending on which allows for best water distribution. If land is limited, configure beds in three tiers **(Figure 4.24**).

Figure 4.23. Evaporation Bed.

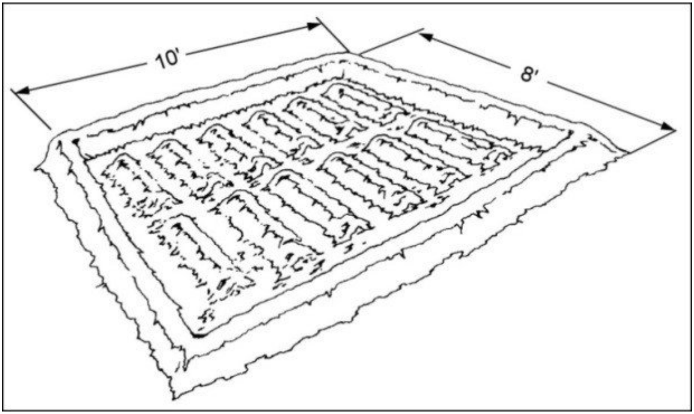
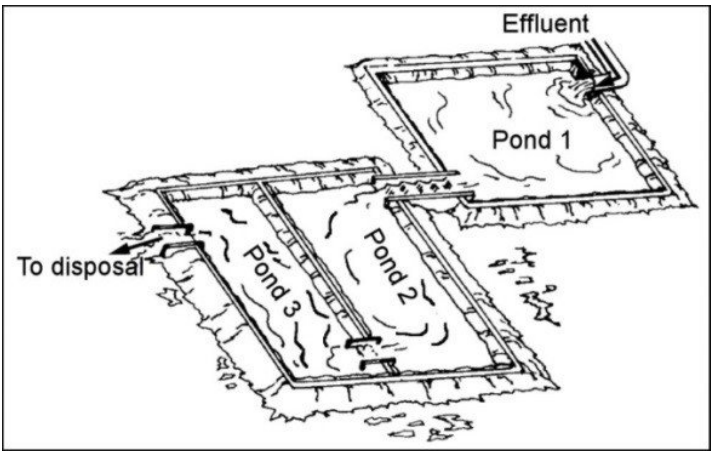


Figure 4.24. Three-Tier Evaporation Beds.



4.5.1. During the day, flood one bed with liquid waste to the top of the ridges. This is equivalent to an average depth of 3 inches over the bed. Allow liquid waste to evaporate and percolate. After three or four days, the bed is usually sufficiently dry for re-spading and reforming. Flood other beds on successive days and follow the same sequence of events.

4.5.2. Give careful attention to proper rotation, maintenance, and dosage. It is essential that kitchen wastewater run through an efficient grease trap (see **paragraph 4.6**) before flowing to an evaporation bed. If used properly, evaporation beds create no insect hazard and only a slight odor. Other waste disposal methods are possible if they are more adaptable to the particular situation.

4.6. Wastewater Collection Pit Box. During initial stages of beddown operations, certain facilities may generate wastewater requiring temporary collection until disposed of properly. While this situation is uncommon, a pit box offers an expedient, temporary means to collect wastewater should the need arise. A 1,000-gallon pit box should be adequate for facilities producing relatively small quantities of wastewater. Facilities producing larger amounts of wastewater may require a 2,000-gallon pit box. **Table 4.11** and **Table 4.12** list building materials and **Figure 4.25** provides construction details for pit boxes. Empty collection pits using wastewater disposal trailers and trucks.

Table 4.11. Materials for 1,000-Gallon Wastewater Collection Box.

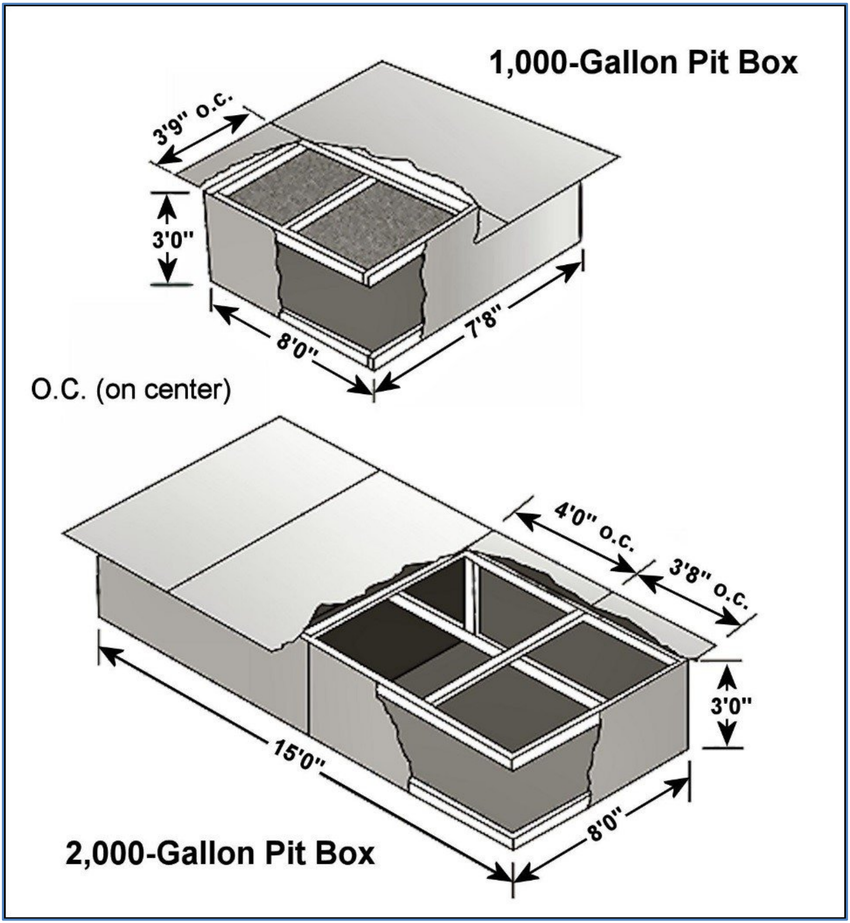
1,000-Gallon Pit Box		
Description	Number Required	Remarks
1/2″ x 6′-0″ x 7′-6″	1 ea.	Floor
1/2″ x 3′-0″ x 7′-6″	2 ea.	Side Panel
1/2″ x 3′-0″ x 6′-0″	2 ea.	End Panel
2 x 4 x 7′-6″	4 ea.	Framework
2 x 4 x 5′-8 3/4″	4 ea.	Framework

2 x 4 x 5′-8 3/4″	1 ea.	Brace*
15′ x 15′ Sheet Plastic	1 ea.	Liner
Nails, sizes 6d / 10d	1.00 lb. each size	
*Line box with plastic before installing braces.		

Table 4.12. Materials for 2,000-Gallon Wastewater Collection Box.

2,000-Gallon Pit Box		
Description	Number Required	Remarks
1/2″ x 6′-0″ x 7′-6″	2 ea.	Floor
1/2″ x 3′-0″ x 7′-6″	4 ea.	Side Panel
1/2″ x 3′-0″ x 6′-0″	2 ea.	End Panel
2 x 4 x 15′-0″	4 ea.	Framework
2 x 4 x 5′-8 3/4″	4 ea.	Framework
2 x 4 x 5′-8 3/4″	2 ea.	Upright
2 x 4 x 5′-8 3/4″	3 ea.	Brace*
1/2″ x 4′-0″ x 8′-0″	4 ea.	Cover
15′ x 15′ Sheet Plastic	1 ea.	Liner
Nails, sizes 6d / 10d	1.50 lb./ 2.00 lb.	
*Line box with plastic before installing braces.		

Figure 4.25. Construction of Wastewater Collection Pit Boxes.



4.7. Grease Traps. Sometimes referred to as grease interceptors, grease traps separate and hold grease from wastewater for later removal and disposal. Whenever grease-laden wastewater is to be disposed of into a wastewater septic system, install a grease trap before the septic tank or separate drain field. DFACs create a significant amount of grease-laden wastewater; use grease traps when discarding wastewater from DFACs into soakage pits and trenches. In addition to wastewater volume, grease and food particles present a complicating factor for wastewater treatment and disposal. The grease trap removes grease from wastewater to prevent clogging the soil and stopping absorption in the drain fields. The grease trap should be large enough to prevent the addition of hot, greasy water from heating the cool water already in the trap. Otherwise, grease will pass through the trap instead of congealing and rising to the top of the water. Furthermore, poorly maintained grease traps causes grease to interfere with the performance of both the collection and treatment system. To assure effectiveness, clean grease traps frequently and burn or bury removed material if permitted by regulations and CCMD guidelines. The following paragraphs address construction details for various field-expedient grease traps used with contingency wastewater treatment and disposal systems.

4.7.1. **In-line Grease Traps.** Similar to septic tanks, the most effective in-line grease traps are usually located outside, in an underground tank with ground-level access. Usually, permanent systems are watertight concrete tanks with inlet and outlet piping. However, as illustrated in **Figure 4.26** and **Figure 4.27**, wood and 55-gallon drums are optional methods for constructing in-line field expedient or improvised grease traps.

Figure 4.26. Wooden-Sheathed Grease Trap.

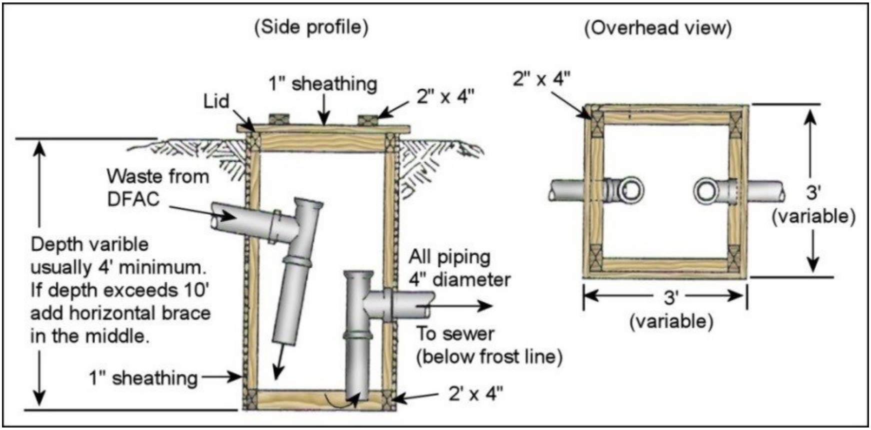
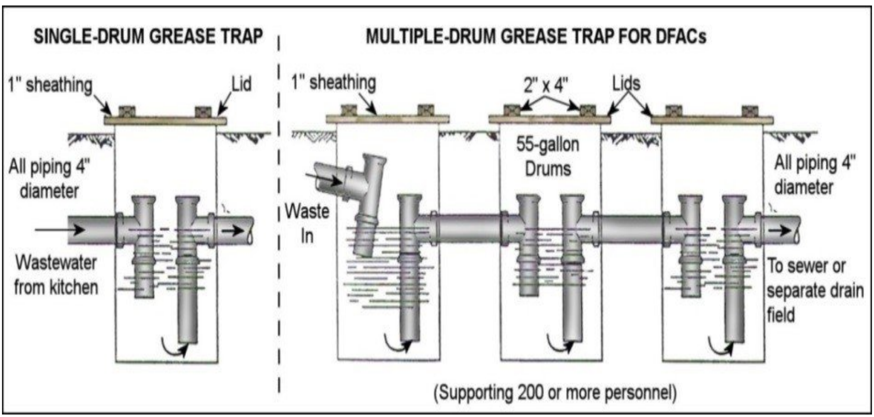


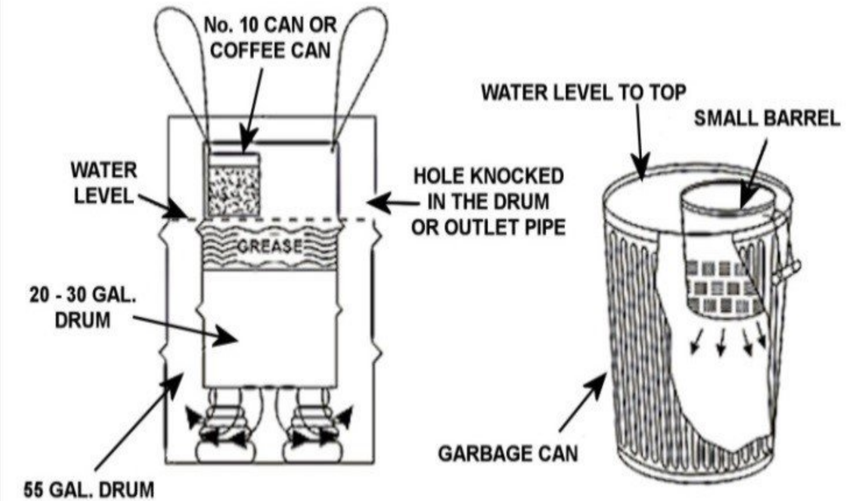
Figure 4.27. 55-Gallon Drum Grease Trap.



4.7.2. **Barrel-Filter Grease Trap.** Construct the barrel-filter grease trap from a 30- to 55-gallon barrel or drum (**Figure 4.28**). Remove the barrel top and bore a number of large holes into the bottom. Place 8 inches of gravel or small stones in the bottom of the barrel and cover them with 12 to 18 inches of wood ashes or sand. Next, fasten a piece of burlap to the top of the barrel to serve as a coarse strainer. Place the trap directly over the soakage pit or on a platform with a trough leading to the pit. Be sure to empty the trap every two days. Wash the trap, remove and bury the ashes or sand, and refill the trap with fresh ashes or sand. Also, wash the burlap strainer every day or replace it. **Figure 4.29** depicts two additional versions of expedient barrel-type grease traps.

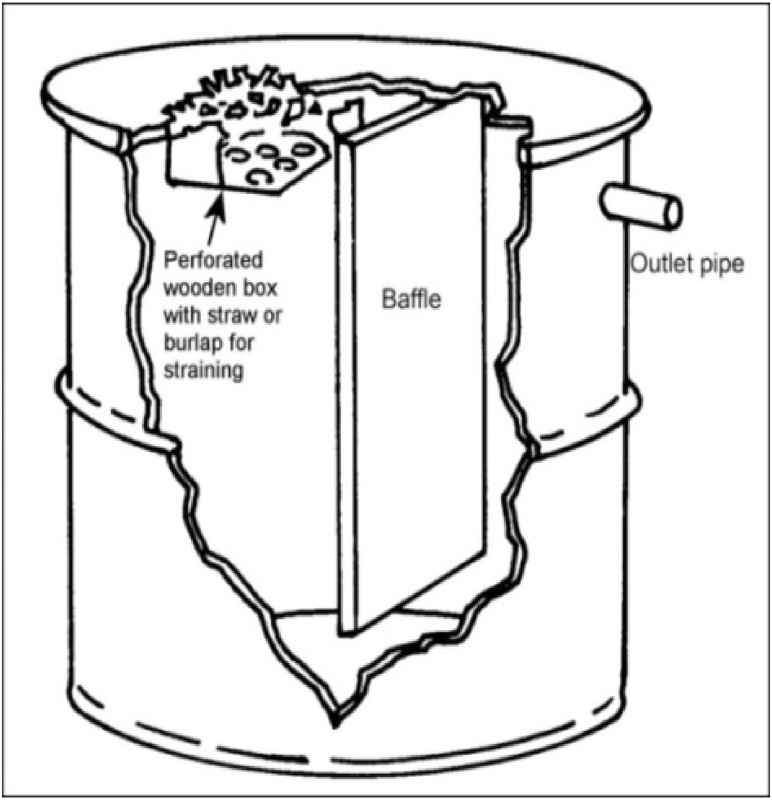
Figure 4.28. Barrel-Filter Grease Trap.

Figure 4.29. Other Expedient Grease Traps.



4.7.3. **Baffle Grease Trap.** Construct a baffle grease trap from a 55-gallon drum or box (**Figure 4.30**). Divide the trap vertically into unequal chambers with a wooden baffle. This baffle should extend to within 1 inch from the bottom. Waste pours through a strainer into the large chamber, then passes under the baffle and flows into the small chamber. The large chamber should have a removable lid and strainer. The strainer may be a box with openings in the bottom. Fill the strainer with straw or burlap to remove coarser solids. Clean the strainer frequently by scrubbing it with soap and water to prevent clogging. Insert a 1-inch pipe 3 to 6 inches below the top of the smaller chamber to carry liquid from the trap to the soakage pit. Clean the trap frequently to ensure proper operation. Remove the grease, drain the trap, and remove the sediment from the bottom. Burn or bury the grease, sediment, and strained material.

Figure 4.30. Baffle Grease Trap.



4.8. Summary. This chapter presented expedient options for sewage and wastewater disposal during contingencies. While not applicable in every situation, some methods and techniques may be useful as interim measures until prepackaged contingency materials, equipment and supplies arrive; existing systems repaired; or engineers build a more sustainable, wastewater treatment system. For additional information on sewage and wastewater disposal techniques and procedures, consult references listed in **Table 4.13**.

Table 4.13. Chapter 4 Quick References.

Sewage and Wastewater Disposal	
AFH 10-222V4	*Environmental Considerations for Overseas Contingency Operations*
UFC 3-230-03	*Water Treatment*
UFC 3-240-02	*Domestic Wastewater Treatment*
EPA 625/1-80-012	*Design Manual: Onsite Wastewater Treatment and Disposal Systems*

Chapter 5

SOLID WASTE DISPOSAL

5.1. General Information. Properly disposing of solid waste (SW) can be challenging at austere beddown locations. A large volume of SW is generated during force beddown. Materials such as wood pallets and crates; scrap building materials; cardboard boxes; food waste and packaging; and many other paper, wood, plastic, and metal remnants are part of the waste stream. This waste can create excellent breeding grounds for rodents and insects if not properly managed and disposed of expeditiously. Not only does overall health and environmental protection necessitate proper waste disposal, the safety risks to personnel from inadequate or improper waste disposal is very high. For contingency locations, DODI 4715.19, DODI 4715.22, and CCMD directives and guidance apply. Additionally, the Solid Waste Management Plan (SWMP) for each contingency operation provides detailed SW management procedures. Local disposal options usually depend on the capabilities and services available at each location. **Table 5.1** lists typical methods of non-hazardous SW disposal for contingency bases relative to their planned construction and period of use.

5.2. Overview. Incinerators, landfills, and contracted services are often top choices for disposal of large volumes of SW at contingency bases. Sometimes, recycling and composting augment other disposal methods. This chapter provides common SW disposal methods for contingency bases, followed by expedient and improvised procedures to dispose of small quantities of non-hazardous SW for short periods. When consistent with the SWMP, engineers may find the improvised procedures useful as interim disposal measures, especially when alternative disposal options are not available. For additional information on SW disposal, consult the references addressed in **paragraph 5.5**.

Table 5.1. Disposal of Non-Hazardous SW at Contingency Bases.

Solid Waste Disposal			
Initial		Temporary	Semi-Permanent
Expeditionary (<90 days)	Initial (<6 months)	(6 to 24 months)	(2 to 10 Years)
• Landfills • Field incinerators • Burn pits	• Landfills • Field incinerators • Burn pits	• Landfills • Field incinerators • Composting • Contracted removal and disposal	• Landfills • Incinerators • Composting • Contracted removal and disposal • Recycling

5.3. SW Disposal Methods. Regardless of the planned methods of SW disposal (e.g., sanitary landfill, incineration, recycling, composting) at contingency locations, the operation requires additional personnel and resources to setup, operate, and maintain. When developing SW disposal methods, bioenvironmental engineers and units generating the waste should be major players. Plan to build collection points throughout the encampment and especially at locations convenient to major waste producers. Units should carry their own trash to pick-up points. Encourage units to minimize the amount of garbage they generate and reduce volume by flattening boxes and cans. Set up a collection schedule and assign trash collection and disposal duties. Ensure SW disposal methods adhere to CCMD guidance. While CE has responsibility for the base SW disposal program, contractors often dispose of base-generated SW. **Table 5.2** lists typical contracted SW services managed by the Air Force Contract Augmentation Program (AFCAP).

Table 5.2. AFCAP Contracted SW Services.

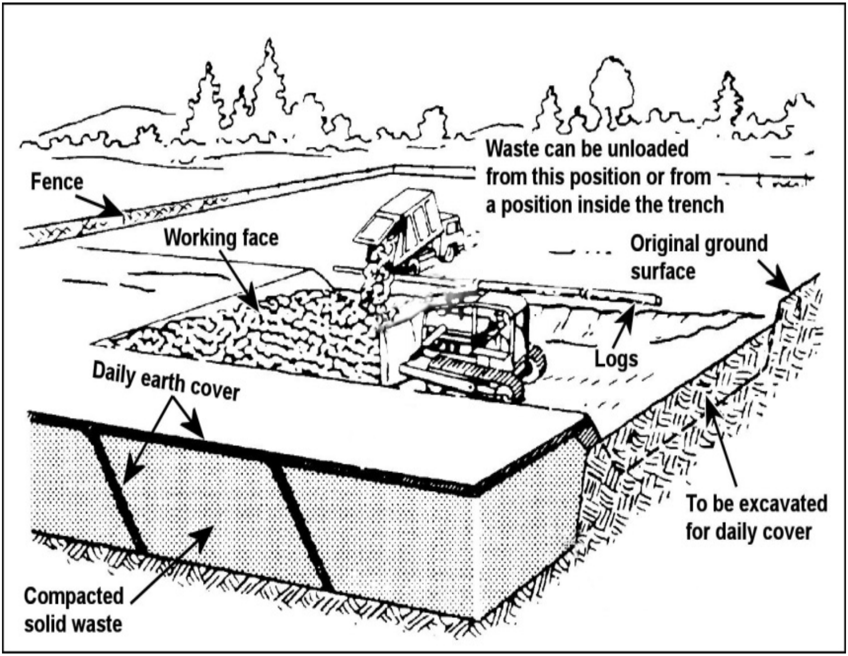
Provider Service	Potential Tasks
Solid waste management	Establish pickup points and appropriate containers, pickup and transport to landfill or commercial solid waste pickup point
Incineration	Establish, operate, maintain, and repair facility; dispose of residue waste
Landfill	Establish, operate, maintain, repair, and close
Recycle	Establish and operate recycling program as appropriate and required by a specific task order (e.g., paper, plastic, glass, metals, chemicals, etc.)

5.3.1. **Landfills.** Typically, deployed forces use landfills to dispose of non-hazardous SW and/or ash created by incinerators and burn pits. When properly designed, landfills accommodate the population over the anticipated life span of the contingency. Since there is no “best method” for all contingency bases, design landfills according to prescribed methods in the SWMP. The specific design of the landfill usually depends on site conditions and the amount and types of SW processed. Various landfill design information is available in UFC 3-240-10A, *Sanitary Landfills*.

5.3.1.1. Two basic landfilling methods are the trench and area methods; other approaches are usually modifications to these two methods.

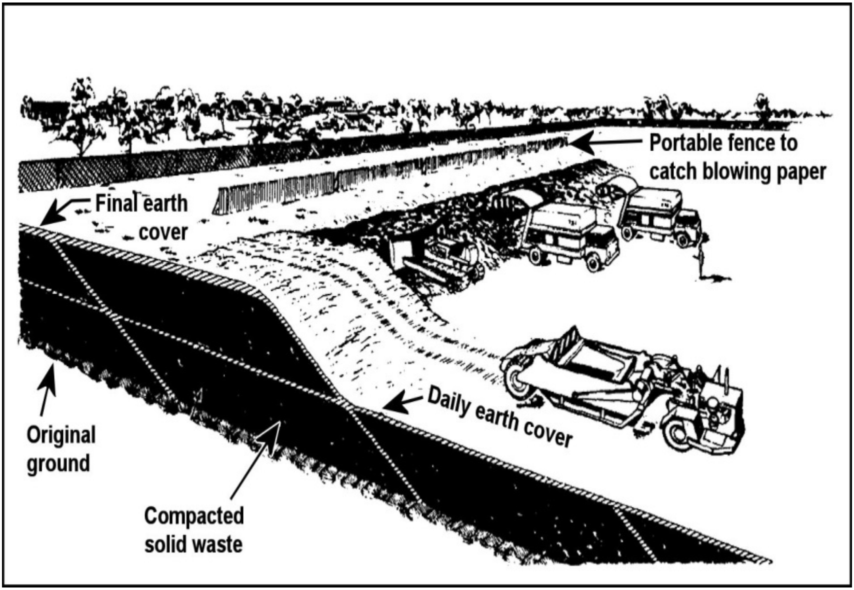
5.3.1.1.1. The trench method involves dumping into a trench and covering it with material from the trench excavation (**Figure 5.1**). Generally, engineers may select the trench method when ground water is low, soil is more than 6 feet deep, and the land is flat or gently rolling. Landfill trenches should be perpendicular to the prevailing winds; deep enough to contain the long-term waste stream expected, and covered daily with not less than 6 inches of earthfill with a final cover of 30 inches.

Figure 5.1. Typical Trench Landfill Layout and Operation.



5.3.1.1.2. The area landfill method (**Figure 5.2**) places waste in a large open excavation. Workers, spread, compact, and then cover the waste with suitable material. The area method is an option on most topography and has the potential to dispose of large quantities of SW. A combination of the two methods may be used.

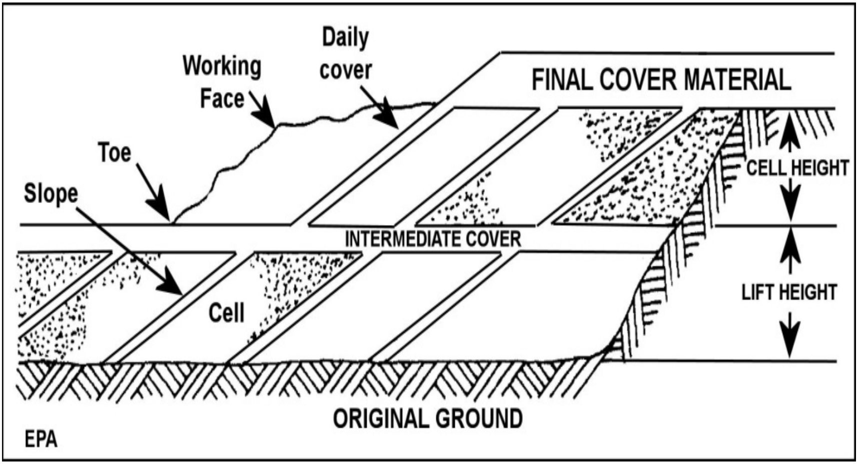
Figure 5.2. Typical Area Landfill Layout and Operation.



5.3.1.1.3. The building block common to both the trench and area methods is the cell. At the end of each working day, or more frequently, create the cell according to the steps below and as illustrated in **Figure 5.3**. The compacted waste and soil cover constitute a cell. A series of adjoining cells all of the same height makes up a lift. For large SW disposal operations, the completed landfill may consist of one or more lifts.

- Spread and compact the SW
- Cover the SW completely with a thin, continuous layer of soil
- Compact the soil cover

Figure 5.3. Landfill Cells and Lifts.



5.3.1.2. Landfills have advantages over most other methods of refuse disposal processes: they do not require large operating crews; they can receive all categories of solid wastes, except hazardous waste (HW); they can accommodate large fluctuations in the daily accumulation of refuse without additional personnel or equipment; and they provide reasonable control of vectors. Most landfills can accommodate a wide variety of SW types; nearly all rubbish, garbage, trash, ashes, solid organic waste, and miscellaneous solids may be disposed of safely. However, sanitary landfills constructed with stringent requirements offer better protection against pollution. Most domestic-type solid waste can be disposed of without presorting or in combination with SW reduction techniques (e.g., incineration, baling, compacting, shredding). Certain waste products are not appropriate for landfills including hazardous waste, toxic substances, liquids, untreated infectious waste, and volatile, explosive, or flammable wastes. When filled or no longer required, close and mark landfills following procedures in the SWMP.

5.3.1.3. Depending on the size of the installation, multiple landfill sites may be necessary, all of which require approval of the CCDR responsible for the area where the landfill is located. Depending on the circumstances, coordination with the host nation (HN) may be a consideration. Construct, operate, and close landfills IAW procedures in the SWMP.

5.3.1.4. Base planners follow CCMD guidance for integrating environmental considerations into the development of SW disposal processes. Planning for landfill operations should include the following considerations:

5.3.1.4.1. Locate the landfill downwind from the base (or at least downwind from housing, medical, and dining facilities), and in a controlled area where personnel using the site are not subject to enemy attack and local civilians will not have access. It should also be away from runways (bird hazard), floodplains, wetlands, aquifers, seismic zones, and unstable areas. **Note:** If off-site landfills are used, temporary holding facilities at the base will be required.

5.3.1.4.2. If HN contractors are dumping at the site, coordinate with the supported unit for security considerations.

5.3.1.4.3. Provide recommendations to the base camp residents on items to avoid placing in the landfill, including liquid or hazardous waste.

5.3.1.4.4. Plan for daily and final landfill soil cover materials with proper compaction for control of vectors, water infiltration, gas migration, and erosion, as well as support for vegetation, vehicular traffic, and fire resistance.

5.3.1.4.5. If necessary, due to the depth of the groundwater level and the slope of the land, plan for a liner and leachate collection system (**Figure 5.4**), and monitoring during the life of the landfill and post-closure for contamination that may migrate into other areas off-site.

5.3.1.4.6. Provide proper drainage control around the landfill and address any additional environmental requirements (for example, explosive gas control).

5.3.1.4.7. Develop record keeping requirements for the closure plan. Ensure each closed SW landfill is marked "Solid Waste Landfill" and "CLOSED (date)."

Figure 5.4. Liner Placement during Landfill Construction.

5.3.2. **Incinerators.** In the absence of HN support, thermal destruction (incineration) is the most common and preferred method of SW disposal for US forces at contingency bases. Incinerators reduce SW to a relatively small, non-combustible residue using controlled combustion; the residue can then be further processed or disposed of (often in landfills). Over the years, incinerator technology has significantly improved, including clean burning innovations, efficient waste-to-energy production (steam, hot water, or electricity), and advanced pollution control equipment. The technology uses extremely high temperatures, and primary and secondary combustion processes to destroy toxic materials. Not only do high-efficiency SW incinerators reduce the burden on the environment and prevent exposure of base personnel to hazardous emissions (smoke, gases, and particulates), they can also ease the strain on the entire supply chain. Because of the wide variety of incinerators, engineering personnel should be aware of CCMD requirements for SW disposal, including medical and explosives waste, and live ammunition.

5.3.2.1. Packaged, modular, and field-erected incinerators are available in various models and sizes and are capable of satisfying the SW disposal needs for most bases—large and small (**Figure 5.5**). Other incinerator designs are especially for medical waste or explosive waste. Medical incinerators should be the standard incinerator for medical waste because of their optimum design to withstand high temperatures. For explosives or explosives-contaminated waste, use only incinerators designed for that type of material. Likewise, use specially designed ammunition incinerators, like that shown in **Figure 5.6**, for destroying live ammunition.

Figure 5.5. Solid Waste Incinerator Complex at Bagram Air Field.

Figure 5.6. Ammunition Incinerator at Expeditionary Airfield.

5.3.2.2. Generally, field-erected and modular incinerator plants provide for receiving, weighing, unloading, storing, charging, combustion, emission control, and removal and handling of residues. However, smaller packaged incinerators without all the accommodations of larger systems can usually be set up relatively quickly. As with other SW disposal methods, consider how waste for incinerators will be collected, transported, stored, etc. Collect non-combustibles and waste prohibited from incineration by the SWMP separately; do not deliver this waste to the incinerators. Carefully sort SW to remove ammunition, glass, batteries, metals, and most wood products.

5.3.2.3. Other than the incinerator itself, the main operating area for SW incinerator facilities is the tipping floor. The tipping floor is the receiving pad where incoming trucks unload, dump, or "tip" the incoming SW on the floor. Additionally, it is where further SW sorting and storing occurs before feeding into incinerators. Ideally, the floor should be a finished and sealed, reinforced concrete slab designed to handle heavy loads. It should be large enough to accommodate anticipated SW sorting and storage requirements. The floor should be capable of enduring heavy abuse from constant dumping of SW; spills; and material handling equipment (MHE), such as frontend loaders, operating, sorting, and moving waste around the floor. **Note:** Frontend loaders that service incinerators should be large enough to deliver an adequate amount of waste to the feed hoppers, but have a bucket narrow enough to access the feed hopper opening on the incinerator.

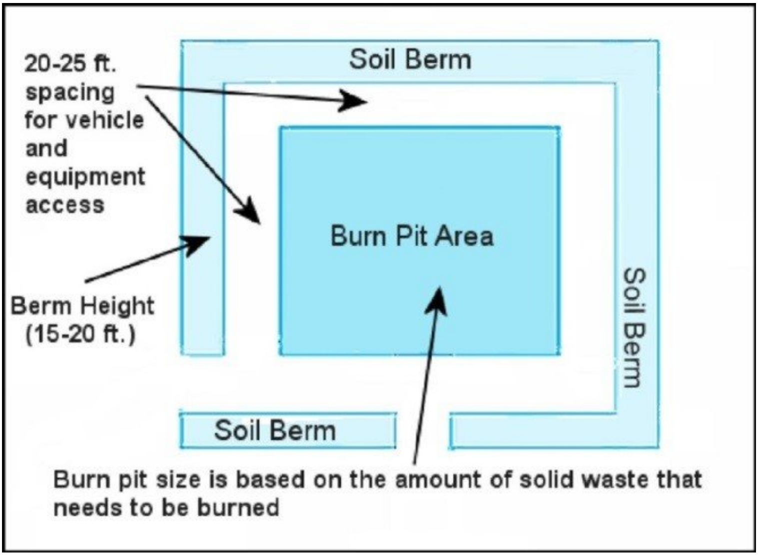
5.3.2.4. Safety during incinerator operations and maintenance is always a primary concern. Incinerator work crews should be vigilant when using or working around heavy equipment. Inattentiveness during the collection and processing of SW around incinerator facilities can easily lead to personnel injury or equipment damage. Further, operate and maintain MHE according to manufacturers' recommendations. Keep MHE assets clean to prevent the propagation or attraction of vectors and the creation of nuisances around the incinerator facility. Because incinerators operate at extremely high temperatures, exercise caution to avoid injury. Make sure personnel have the appropriate PPE. Standard equipment includes eye and face protection (face shields or safety goggles), heavy gloves, safety shoes, hard hats, and respirators. Safety belts may be required for fall protection when working on elevated platforms. Maintain good housekeeping and ensure appropriate warning signs and instrumentation are posted in appropriate areas. Incinerator safety equipment and devices should be attached and functioning properly (e.g., fire suppression and firefighting equipment such as sprinkler systems, fire hoses, and extinguishers; safety valves; ladders; guardrails; toe boards; screens; lighting; and first aid kits). Good lighting is crucial during night operations and periods of reduced visibility.

5.3.3. **Burn Pits.** Open-air burn pits may be an option as an interim measure to dispose of SW at contingency locations during initial establishment and stand-up operations. DOD policy imposes restrictions on the use of burn pits (see **Attachment 1** for DOD definition of burn pits). Readers should consult DODI 4715.19 for specific requirements. When consistent with DODI 4715.19, DODI 4715.22, and CCMD guidance, open-air burn pits are optional for short periods to dispose of SW during contingency operations if no other feasible method of disposal is available. For longer term, use incinerators, engineered landfills, or other accepted SW management practices, when permitted and practical. When open-air burn pits are used, SW plans should include provisions to transition to a more acceptable means of disposal. This becomes particularly important as bases mature and populations surge. Waste disposal activities that do not meet the definition of open-air burn pits should strive to meet the intent of DODI 4715.19. Follow CCMD engineering and medical guidance to maximize protection of human health and safety at those locations where covered waste is burned because no alternative is feasible or the facility does not meet the definition of an open-air burn pit.

5.3.3.1. Though burn pits reduce the overall waste volume and may be an effective means of disposing of certain waste streams, they can present some health and quality-of-life issues. They must be operated IAW the CCMD SWMP and in a manner that prevents or minimizes risks to human health and safety of DOD personnel and, where possible, harm to the environment. For short periods, burn pits are a potential solution for smaller camps that do not have contracted support or any other feasible means of SW disposal. Mobile incinerators and mobile waste-to-energy systems are much better than burn pits, provided they are modular, mobile, and simple enough for service members to use and maintain.

5.3.3.2. Open-air burn pits should be located so that prevailing winds carry smoke away from base camps, including housing, medical facilities, DFACs, and other troop concentrations. Monitor the content entering the burn pit to prevent the disposal of hazardous waste/hazardous materials (HW/HM) and other restricted waste products. Keep live ammunition and batteries out of SW burn pits. When constructing the pit, determine the size by the amount of solid waste that needs burning. Place a soil or earthen berm (usually 15’-20’ high) around the burn pit for safety. Determine the height of the berm based on factors at the beddown location. Factors such as groundwater table, pit design (above or below ground, loading ramps), maintenance equipment, personnel safety, etc., may affect the required height of the berm. Although berms for burn pits are similar to other expedient berms, other design and construction features may be incorporated. For example, added dirt ramps allow access by dozers and compactors to perform routine maintenance on the pit, and additional fencing around berms to contain blowing trash and prevent unwanted entry. **Figure 5.7** is one example of a burn pit that uses a soil berm. See other AFTTP 3-32.33 series publications for specific berm construction procedures.

Figure 5.7. Burn Pit Example (Surrounded by a Soil Berm).



5.3.4. **Air Curtain Destructors.** Often used for vegetative waste, air curtain destructors (ACD) may be an alternate method of SW disposal that produces lower smoke emissions than open-air burn pits. An ACD, also called a “burn box” is a type of incineration device that introduces a controlled velocity of air across the upper portion of a combustion chamber in which the waste is loaded. The curtain of air created in this process traps unburned particles under the curtain in the high temperature zone where temperatures can reach 2000º F. Increased combustion time and turbulence of air curtain burning results in a re-burn and more complete combustion of the loaded waste. Generally, there are two types of ACDs, the self-contained firebox system and the trench burner system.

5.3.4.1. The self-contained ACD is a skid-mounted system that requires no setup or teardown (**Figure 5.8**). However, it is very heavy (small units weigh over 20,000 lbs.) and difficult to transport over soft soil. It incorporates the engine, fuel tank, blower system, and combustion chamber. The combustion chamber is a refractory walled firebox that aids combustion by retaining and reflecting the high temperatures within the firebox.

Figure 5.8. Self-Contained ACD.

5.3.4.2. Contemporary trench burners are usually trailer-mounted systems with a motor, blower, and manifold (**Figure 5.9**). They are mobilize quickly and towed easily behind a truck. These trench burners require excavation of an earthen pit or trench to function as a combustion chamber or firebox. Open pit and trench burner units are the least efficient and less desirable ACD because of the resultant air pollutants and high fuel demand.

Figure 5.9. Trench Burner ACD.

5.3.5. **Recycling.** Units must comply with CCMD policy, if any, on recycling. Consult with the designated lead Service or CCMD environmental management POC for guidance on recycling policy and options available at the contingency location. Recycling and reuse reduces SW disposal requirements. Logistics readiness personnel can help determine the best recycling option based on the waste stream and available recycling capabilities, including HN recycling services. In most overseas deployment locations, shipping recyclable materials back to the United States is cost prohibitive, whereas participating in the local community-recycling program may be feasible.

5.3.6. **Composting.** Composting is a form of organic waste treatment that reduces SW disposal requirements. It is an engineered process to promote the biochemical decaying of organic material. Compost product is useful in a variety of ways, including erosion control, improved soil properties, or application to agricultural, forest, or reclaimed mined lands. The suitability of composting as a waste disposal method depends upon the amount of organic waste generated, susceptibility to vectors, available land and labor, and duration of occupancy. Composting is typically the preferred method to remove DFAC waste, paper, and cardboard from the SW stream.

5.3.6.1. During initial base beddown at austere locations, composting may be impractical unless the HN or local municipality has an operational composting program and can provide composting services. As the base matures, composting options may become available, such as the covered and aerated composting system shown in **Figure 5.10**.

Figure 5.10. Covered Forced Air Composting System.

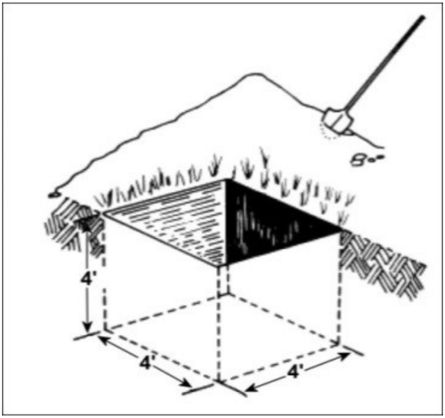
Source: Army Logistician (PB 700-06-04 Volume 38, ISSUE 4, July - August 2006

5.3.6.2. This system uses forced air, semipermeable covers, and computer control and monitoring technology to accelerate natural composting processes. This type of unit is mobile, efficient, and allows composting to occur within the confines of a small base camp because the system reduces odors and vector attraction. It increases composting efficiency by using cardboard and paper waste generated by the base population to balance the carbon-to-nitrogen ratio in the heap. This balance is critical to the successful composting of food waste. The covered and aerated composting system is one of various composting methods that range in complexity in terms of labor and equipment requirements. Review CCMD guidance to determine permitted composting methods.

5.4. Improvised SW Disposal. During the initial days of beddown at bases in austere locations, it is unlikely a fully organized SW collection and disposal operation will be in place. Even if contract SW services are used, it could take several weeks to achieve full service. Furthermore, interruption of such services is likely during periods of increased security, particularly after an attack against the installation. At all contingency locations (initial, temporary, and semi-permanent), backup expedient and improvised SW disposal plans should be available in case of interruption to regular or conventional methods. Airmen should perform basic SW disposal duties to maintain health of the force. Ensure CCMD guidance permits any improvised SW disposal methods used. Two common improvised SW disposal methods are garbage burial pits, garbage trenches, and barrel incinerators.

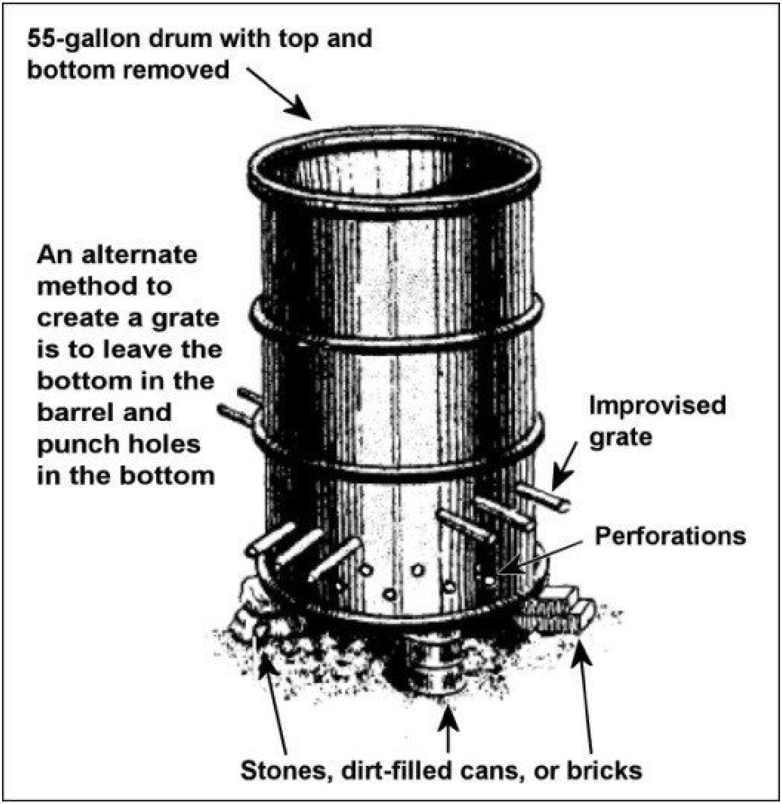
5.4.1. **Garbage Burial Pits and Trenches.** Garbage burial pits and trenches are interim or temporary measures to handle small quantities of SW during initial base beddown. For short-term operations, bury garbage in small pits. A 4 feet square and 4 feet deep pit can handle one day's garbage for 100 personnel (**Figure 5.11**). Fill these pits no closer than 1 foot below ground surface, spray with insecticide, and mound over with compacted earth to 1 foot above ground level. Mark each pit with a rectangular sign on top of the mound indicating the type of pit and date closed. When larger pits are used, cover the garbage daily. Insecticide is not required if 2 feet of compacted soil are used for cover. For enduring operations, bury garbage in a continuous trench or combine with other solid waste in a sanitary landfill. The trench size depends upon the size of force supported and their length of stay. Using this method, dirt excavated while extending the trench covers and mounds the garbage already deposited. When using burial pits and trenches, closely monitor "self-help" garbage burial operations to prevent uncontrolled refuse disposal, which can lead to serious fire and sanitation hazards. Also, establish a stringent pest control program to alleviate danger of disease spread.

Figure 5.11. Garbage Burial Pit.



5.4.2. **Barrel Incinerators.** Improvised barrel incinerators, typically constructed from 55-gallon drums, handle relatively small amounts of garbage (**Figure 5.12**). Before modifying the drum, remove toxic, flammable, or combustible contents. Like other improvised SW disposal methods, use barrel incinerators in temporary/emergency situations only if allowed by SWMP. Conduct burn operations where prevailing winds carry smoke away from troop locations and living areas. Do not incinerate HW; explosions or toxic gases may result in personnel or equipment damage.

Figure 5.12. Barrel Incinerator.



5.5. Summary. During initial bare-base development, expedient SW disposal methods (e.g., burial pits, burn barrels, burn pits) may be required until enduring methods and processes are established. Whenever contract disposal is unavailable, engineers should implement methods to manage SW disposal consistent with theater SWMP. If external disposal sites are out of service or inaccessible, identify internal locations. Garbage, refuse and debris can either be buried, burned, or a combination of both. It is important to consider all available methods of solid waste disposal, including incinerators, landfills, open-air burn pits, composting, and recycling facilities. When evaluating options, recognize that the operation of open-air burn pits involve severe restrictions. Use open-air burn pits as a short-term solution during contingency operations and operate them in a manner that prevents or minimizes risk to humans and the environment. Consult DODI 4715.19 for specific requirements and restrictions on use of burn pits. For additional information on SW disposal tactics, techniques, and procedures, consult references listed in **Table 5.3**.

Table 5.3. Chapter 5 Quick References.

Solid Waste Disposal	
AFH 10-222V4	*Environmental Considerations for Overseas Contingency Operations*
DODI 4715.19	*Use of Open-Air Burn Pits in Contingency Operations*
DODI 4715.22	*Environmental Management Policy for Contingency Locations*
UFC 3-240-10A	*Sanitary Landfills*

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Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

AFI 32-1064, *Electrical Safe Practices*, 29 December 2016

AFI 91-203, *Air Force Consolidated Occupational Safety Instruction*, 15 June 2012

AFMAN 32-1072_IP, *Water-Well Drilling Operations*, December 2008

AFMAN 33-363, *Management of Records*, 1 March 2008

AFMAN 48-138_IP, *Sanitary Control and Surveillance of Field Water Supplies*, 1 May 2010

AFH 10-222V4, *Environmental Considerations for Overseas Contingency Operations*, 1 September 2012

DODD 3000.10, *Contingency Basing Outside the United States*, 10 Jan 2013

DODI 4715.19, *Use of Open-Air Burn Pits in Contingency Operations*, 15 February 2011

DODI 4715.22, *Environmental Management Policy for Contingency Locations*, 18 February 2016

EPA 625/1-80-012, *Design Manual: Onsite Wastewater Treatment and Disposal Systems*, October 1980

T.O. 40W4-20-1, *1500 Reverse Osmosis Water Purification Unit (ROWPU)*, 31 January 2015

UFC 3-230-03, *Water Treatment*, 1 November 2012

UFC 3-240-02, *Domestic Wastewater Treatment*, 1 November 2012

UFC 3-240-10A, *Sanitary Landfill*, 16 January 2004

UFC 3-560-01, *Electrical Safety, O&M*, 6 December 2006

Prescribed Forms

No prescribed forms are implemented in this publication.

Adopted Forms

AF Form 847, *Recommendation for Change of Publication.*

Abbreviations and Acronyms

ACD—Air Curtain Destructor

AF—Air Force

AFCAP—Air Force Contract Augmentation Program

AFCEC—Air Force Civil Engineer Center

AFH—Air Force Handbook

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFPAM—Air Force Pamphlet

AFRIMS—Air Force Records Information Management System

AFTTP—Air Force Tactics, Techniques and Procedures

BEAR—Basic Expeditionary Airfield Resources

CBRN—Chemical, Biological, Radiological, and Nuclear

CE—Civil Engineer

CCMD—Combatant Command

CCDR—Combatant Commander

DFAC—Dining Facilities

DOD—Department of Defense

DODI—Department of Defense Instruction

EPA—Environmental Protection Agency

ET—Evapotranspiration

ETA—Evapotranspiration/Absorption

FGS—Final Governing Standards

HN—Host Nation

HW—Hazardous Waste

HM—Hazardous Materials

IAW—In Accordance With

IP—Interservice Publication

IPE—Individual Protective Equipment

ISF—Intermittent Sand Filter

IWPS—Individual Water Purification System

MAJCOM—Major Command

MHE—Material Handling Equipment

NRCS— National Resources Conservation Service

OPLAN—Operation Plan

OPORD—Operational Order

OPR—Office of Primary Responsibility

PPE—Personal Protective Equipment

RDS—Records Disposition Schedule

RO—Reverse Osmosis

ROWPU—Reverse Osmosis Water Purification Unit

RSF—Recirculating Sand Filter

SOFA—Status of Forces Agreements

SW—Solid Waste

SWMP—Solid Waste Management Plan

T.O.—Technical Order

UFC—Unified Facilities Criteria

US—United States

USACE—US Army Corps of Engineers

USAF—United States Air Force

USDA—U.S. Department of Agriculture

Terms

Air Force Civil Engineer Center (AFCEC)—Headquartered at Joint Base San Antonio-Lackland, AFCEC is a 1,900-person primary subordinate unit, assigned to Air Force Materiel Command and attached to the Air Force Installation and Mission Support Center, responsible for providing responsive, flexible full-spectrum installation engineering services. AFCEC missions include facility investment planning, design and construction, operations support, real property management, readiness, energy support, environmental compliance and restoration, and audit assertions, acquisition and program management. The unit conducts its operations at more than 75 locations worldwide.

Base—A locality from which operations are projected or supported, or an area or locality containing installations which provide logistic or other support.

Basic Expeditionary Airfield Resources—Facilities, equipment, and basic infrastructure to support the beddown of deployed forces and aircraft at austere locations; a critical capability to fielding expeditionary aerospace forces. Also known as BEAR, the resources include tents, field kitchens, latrine systems, shop equipment, electrical and power systems, runway systems, aircraft shelters, and water distribution systems needed to sustain operations.

Beddown—The act of providing facilities, utilities, services, construction, operations and maintenance support to a deployed force with the overall intent of establishing a basic mission capability.

Contingency—A situation requiring military operations in response to natural disasters, terrorists, subversives, or as otherwise directed by appropriate authority to protect US interests. (JP 5-0)

Contingency Location—A non-enduring location outside of the United States that supports and sustains operations during named and unnamed contingencies or other operations as directed by appropriate authority and is categorized by mission life-cycle requirements as initial, temporary, or semi-permanent. (DODD 3000.10)

Force Beddown—The provision of expedient facilities for troop support to provide a platform for the projection of force. (JP 3-34)

Host Nation—A nation which receives the forces and/or supplies of allied nations and/or NATO organizations to be located on, to operate in, or to transit through its territory. Also called HN. (JP 3-57)

Initial Contingency Location—A contingency location occupied by a force in immediate response to a named or unnamed contingency operation and characterized by austere infrastructure and limited services with little or no external support except through Service organic capabilities. (DODD 3000.10)

Open-Air Burn Pit—An area, not containing a commercially manufactured incinerator or other equipment specifically designed and manufactured for burning of solid waste, designated for the purpose of disposing of solid waste by burning in the outdoor air at a location with more than 100 attached or assigned personnel and that is in place longer than 90 days.

Overseas—A geographic area located outside the jurisdiction of the United States, which includes land and associated territorial sea, contiguous zones, and exclusive economic zones of the United States; an area outside the United States (e.g., a foreign country).

Reverse Osmosis Water Purification Unit (ROWPU)—A water purification device which uses a series of membranes to eliminate impurities. The ROWPU is capable of removing dissolved minerals.

Semi-permanent Contingency Location—A contingency location that provides support for a prolonged named or unnamed contingency operation and characterized by enhanced infrastructure and support services consistent with sustained operations.(DODD 3000.10)

Temporary Contingency Location—A contingency location that provides near-term support for a named or unnamed contingency operation and characterized by expedient infrastructure and support services that have been expanded beyond Service organic capabilities.(DODD 3000.10)

United States—The several States, District of Columbia, Commonwealths of Puerto Rico and Northern Mariana Islands, American Samoa, Guam, Midway and Wake Islands, United States Virgin Islands, any other territory or possession of the United States, and associated navigable waters, contiguous zones, and ocean waters of which the natural resources are under the exclusive management authority of the United States. See DODI 4715.05, DODI 4715.08, and DODD 3000.10. (AFI 32-7091)

Attachment 2

ENGINEER REACHBACK AND OTHER USEFUL LINKS

Table A2.1. Useful Organizational and Product Links.

Useful Links
Air Force Civil Engineer Center (AFCEC): www.afcec.af.mil/
AF Publications and Forms: www.e-publishing.af.mil/
AF Design Guides (AFDG): www.wbdg.org/ccb/browse_cat.php?o=33&c=129
Whole Building Design Guide (WBDG): www.wbdg.org/
Unified Facilities Criteria (UFC): www.wbdg.org/ccb/browse_cat.php?o=29&c=4
Construction Criteria Base (CCB)/(WBDG): www.wbdg.org/ccb
USACE Reachback Operations Center (UROC): https://uroc.usace.army.mil
Army Publications and Forms: www.apd.army.mil/ProductMap.asp
USACE Afghanistan Engineer District Design Library: www.aed.usace.army.mil/Design.asp
Navy Doctrine Library System: https://ndls.nwdc.navy.mil
DOD Issuances: www.dtic.mil/whs/directives/
Joint Publications: www.dtic.mil/doctrine/new_pubs/jointpub.htm
NRCS World Soil Resources: http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/use/worldsoils