CHAPTER 8

DRAINAGE CONTROL AND TREATMENT UNITS

8.1 INTRODUCTION

Area related guidance is a general SPCC guidance that addresses multiple regulations, not just 40 CFR 112. The Clean Water Act (CWA) Section 311(b)(1) prohibits discharges of oil or hazardous substances (HS) into or upon the navigable waters of the United States, or adjoining shorelines. Drainage controls not only prevent spills from reaching navigable waterways, but they also prevent clean stormwater from entering contaminated areas.

Drainage control is the collection, transfer, treatment, and release of spills and precipitation. During normal area operations, oil and HS areas will have small spills. If the spills are not cleaned up promptly and properly, the spilled material will commingle with precipitation and possibly contaminate the area run-off. Since not all spills will be cleaned up properly and promptly, area stormwater must be contained and/or treated to prevent contaminated precipitation from reaching navigable waterways.

Drainage control structures and equipment include stormwater collection systems (ditches, trench drains, culverts, etc.), pumps, siphons, valves, oil-water separators, and treatment systems. In its simplest form, drainage control requires maintaining a supply of sorbents to be used to remove an oil film before unlocking and opening a drain valve to release the stormwater from a diked area. Drainage control in its most advanced form is an in-plant treatment unit designed to treat both routine and large spills. Whether an oil or chemical area needs a simple or elaborate system is dependent upon the potential for and history of spills at the area. Whatever methods are used, the drainage control system should prevent a spill from reaching navigable waters in the event of equipment failure or human error at the area.

NO TREATMENT DEVICE SHOULD BE INSTALLED THAT DISCHARGES TO THE STORM DRAINAGE SYSTEM / THE ENVIRONMENT WITHOUT CHECKING WITH THE APPROPRIATE NPDES / STATE PERMITTING AUTHORITY.

Drainage control requirements addressed in this chapter include:

- Collection and containment
- Transfer
- Treatment units
- Flow between treatment units

- Bypassing treatment units

8.2 COLLECTION AND CONTAINMENT 112.7(e)(1)(iii) 112.7(e)(1)(iv)

Oil and HS storage, transfer, and process areas routinely experience small operational spills that can contaminate stormwater; every oil and HS area has the potential to contaminate stormwater. To determine if the existing collection systems for an area needs to be upgraded, site topography, drainage patterns, and control systems should be examined. Chapter 7 addresses containment and diversion structures.

A properly designed stormwater collection system segregates “clean” and “dirty” runoff. Stormwater that is diverted around or away from storage areas should remain clean and should not require any treatment or pose any risk of being contaminated. Contaminated stormwater should be directed to ponds, lagoons, catchment basins, or treatment units designed to retain or treat the stormwater prior to discharge into receiving waters. Segregation between the clean and dirty areas is generally accomplished by pavement grading and installation of diversion structures such as curbs, gutters, walls, and other physical barriers, as discussed in Chapter 7. Figure 8-1 illustrates the segregation of area drainage. Figure 8-1 (A) shows a containment area without proper means to segregate clean and dirty stormwater. In Figure 8-1 (B), a diversion swale upgradient of the containment area diverts clean stormwater away from the site. Another example of a drainage segregation design is to install a roof over an outdoor product dispensing area; all of the stormwater landing on roof will be clean and does not require treatment.

Loading/unloading racks, fill ports, and pumps, are areas that often experience small, undetected leaks and spills. These areas should be identified as "dirty,” since they can contaminate stormwater. Roofs, personal vehicle parking lots, grassy areas, and other such areas that are not likely to be contaminated by oil or HS during area operations should be identified as "clean." Though these areas may not be clean in an actual sense (for example, if there are oil leaks in a parking area), these areas are not an operational part of the storage or handling area.

Only uncontaminated stormwater should be released from diked or other drainage areas, unless it is released to a treatment unit capable of processing the volume and type of contamination. Drainage should be controlled by drainage valves, stand pipes, manually operated pumps or ejectors, or other active means. Manual open-and-close valves are preferred, since they minimize the chance of releasing contaminated stormwater. Automated valves may accidentally be opened without the judgment of a person actually at the site and viewing the site conditions. Figure 8-2 shows two methods for securing the drainage control valve. A gate valve (post-indicator type) is preferred because it provides a visual indication of the status of the valve. Flapper type valves, which may be spring loaded, do not stay reliably shut and, per 40 CFR 112.7(e)(1)(ii), should not be used.

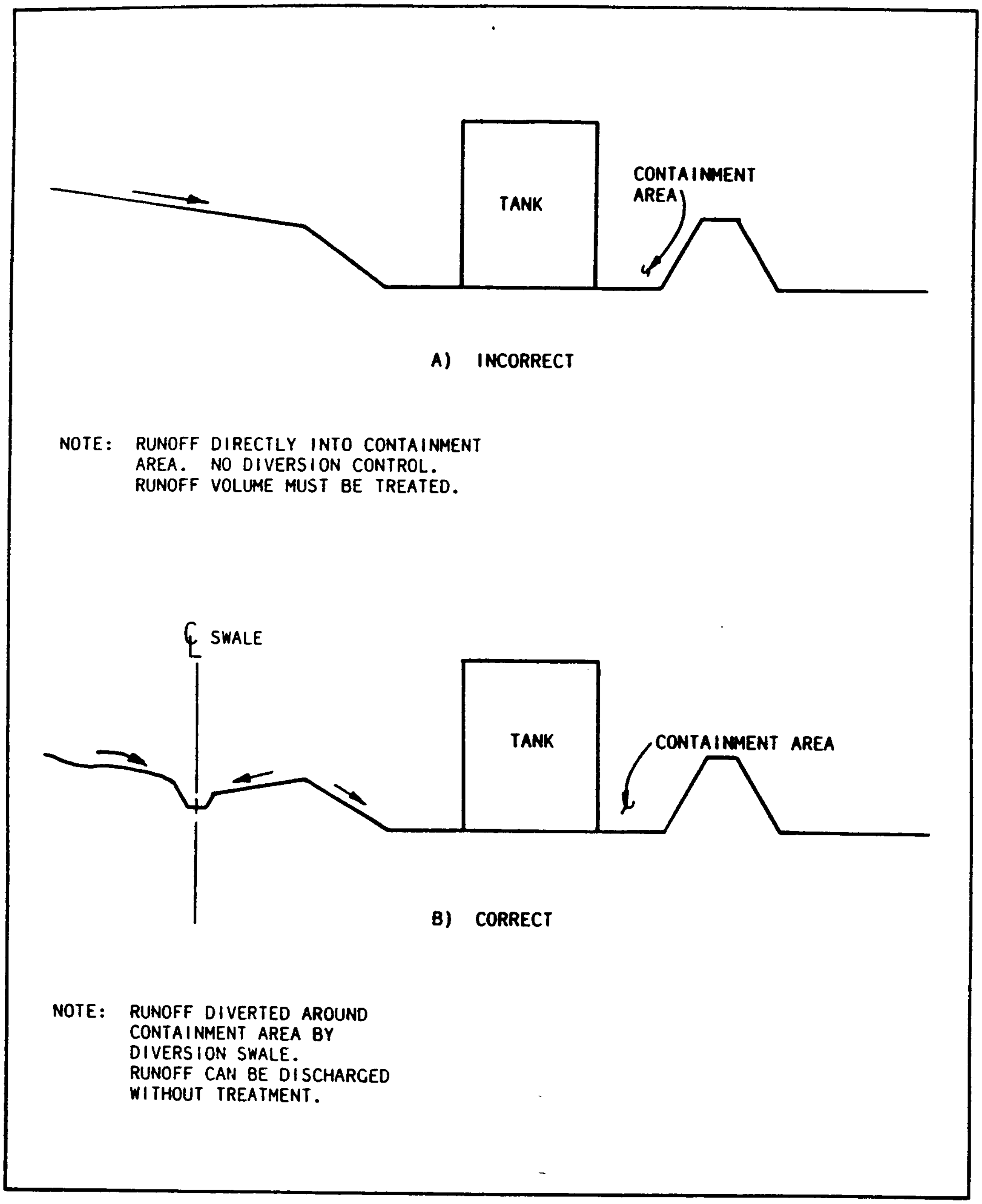

Figure 8-1
Use of Diversion Structure To Control Storm Runoff

Lack of valves on drainage pipes, valves inadvertently left open or sabotaged, and valves that do not provide adequate protection are the most prevalent ways of violating the integrity of a containment system. The best way to avoid accidental releases is to eliminate all drains from the area. While this can be perceived as an extreme measure, it may be preferable to testing the stormwater for pollutants and pumping the contaminated water into tanker trucks.

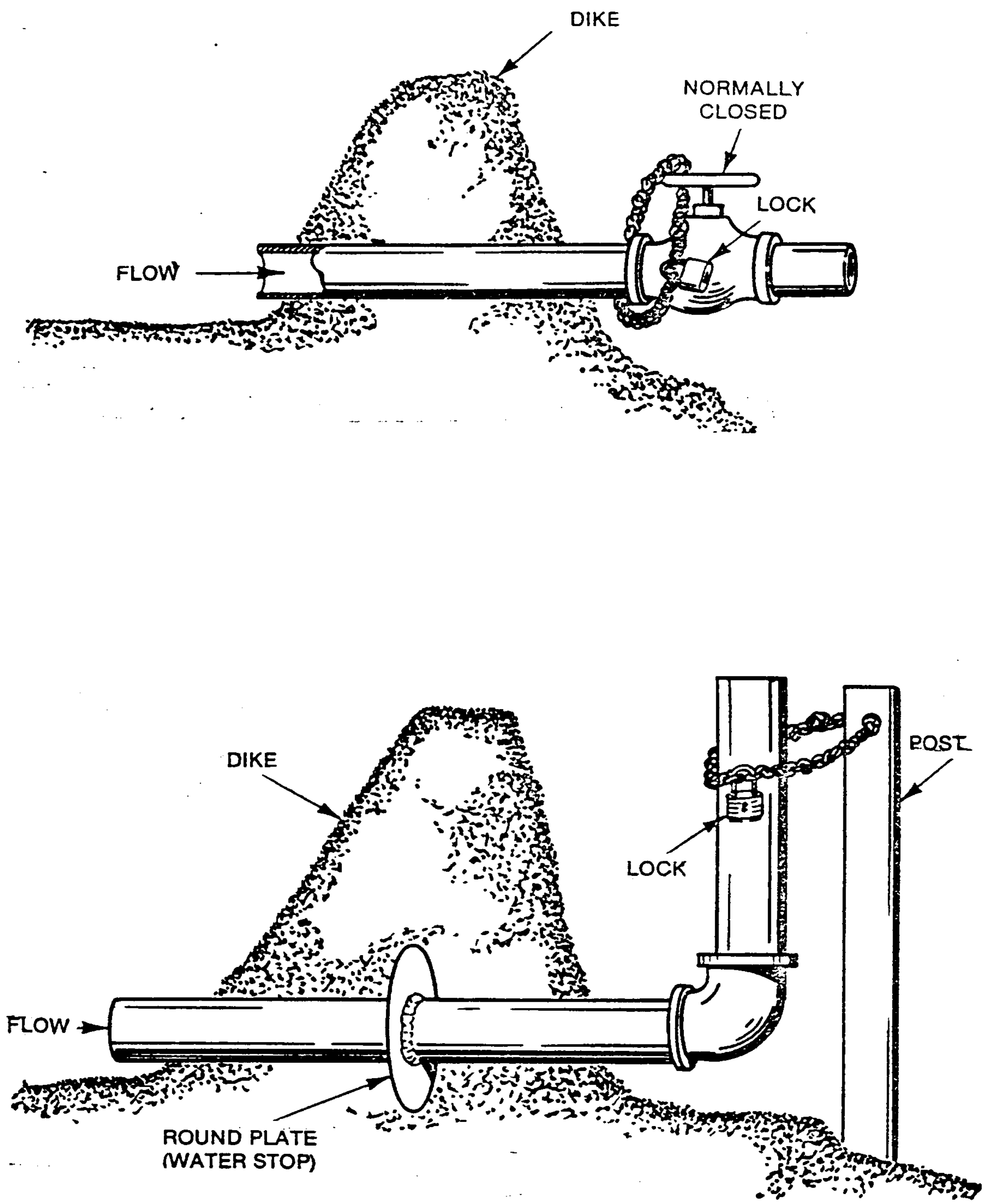

Figure 8-2
Examples of Locking Drainage Valves

Most facilities maintain rigid control over the drain valves in containment areas by keeping valves in the locked-closed position. Prior to draining, the water quality must be assessed to determine if it is in compliance with applicable water quality standards. Once the area is drained, the valve should be locked and the date recorded in a log for legal protection. Discharging the drainage into an oil-water separator (i.e., for lighter than water insoluble products) or draining the water through a bed or filter of sorbent material can remove any residual contaminants. Manufacturers can recommend sorbent materials that are effective in removing specific contaminants.

Not all drainage pipes are valved, and depending on the volume of oil or HS stored this situation may be a serious deficiency, which must be corrected immediately to prevent a significant contamination or spill problem.

8.3 TRANSFER 112.7(e)(1)

Once the stormwater is collected and contained, it must be disposed. Spills should be collected and transferred using the best technology available for the material spilled; each spill should be evaluated individually. It is recommended that secondary containment drainage be appropriately documented/logged. The following are management methods for transferring the stormwater from the storage area to the treatment system.

- The stormwater is retained until it is released directly to a waterway (if "clean") or a treatment unit (if "dirty").
- The stormwater is retained until any contamination or sheen is removed from the water using a sorbent material or other method.
- The stormwater is retained in the containment area until it evaporates. This is useful only when the containment design and average annual rainfall quantities allow use of such a method. It is important that the stormwater does not leave the containment area through percolation into the ground (which is a deficiency in the spill control structure).
- The stormwater is not retained, but flows to a treatment unit that is sized to retain and treat the stormwater and spill volumes.

After inspecting the stormwater for contamination or sheen, the containment area should be drained, preferably by gravity (see Figure 8-3), or pumped to a treatment system or retention pond. Whenever possible, gravity flow should be used to transfer stormwater contaminated with oil to treatment units. This prevents the emulsification of the oil which inhibits the oil removal. One method is to open a manual, open-and-close valve. Manually-activated pumps and ejectors may also remove collected run-off from a containment area; however, the accumulated liquid must be monitored for contamination or a sheen. The exception to this monitoring requirement is when the containment drains directly to a treatment unit.

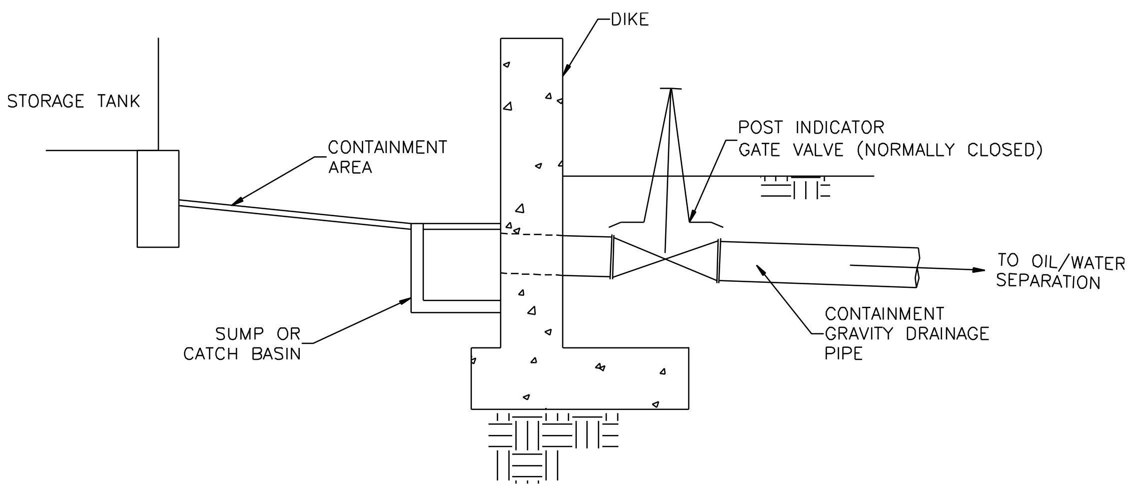

Figure 8-3
Gravity Drainage From Containment Area

A siphon system, as shown in Figure 8-4, is the preferred method of stormwater transfer. This system prevents accidental discharge through a valve that may inadvertently be left open. In addition, with a siphon, no piping goes through the dike, eliminating a potential seepage route.

8.4 TREATMENT UNITS

A variety of wastes can be generated at an oil and HS areas such as free oils and HS liquids (floating and dispersed droplets), emulsified oils and HS liquids (physical and chemical), dissolved oils and HS, oil and HS adsorbed on particulate matter, oily sludges, and HS solids. These wastes can be generated from maintenance shops, aircraft service aprons, POL areas, tank farms, other oil-related operations, HS storage areas, HW storage areas, and industrial shops. This section provides general guidance on treatment units, detailed guidance can be found in MIL-HDBK-1005/9 (Military Handbook Industrial and Oily Wastewater Control).

The type and flow of drainage from diked and other spill-prone areas into a treatment system should be controlled so that the system can handle the discharge without being damaged. Treatment systems typically require a unit designed for the specific requirements of the type and quantity of waste. The types of waste present and the capability of the treatment unit to handle the different types of waste should be considered when evaluating the area's drainage control. Before discharging any effluent, the National Pollutant Discharge Elimination System (NPDES) permit must be checked to verify any restrictions.

A review of available treatment methods for HS is beyond the scope of this manual; however, MIL-HDBK-1005/9 (Military Handbook Industrial and Oily Wastewater Control) provides general guidance, design data, and information related to industrial and oily wastewater control.

8.4.1 Oil-Water Separators

Oil-water separators operate on a gravity separation principle: most oils are lighter than water and rise to the top of a water column. However, some synthetic oils, e.g. transformer oil, may be denser than water and may be retained by an oil-water separator.

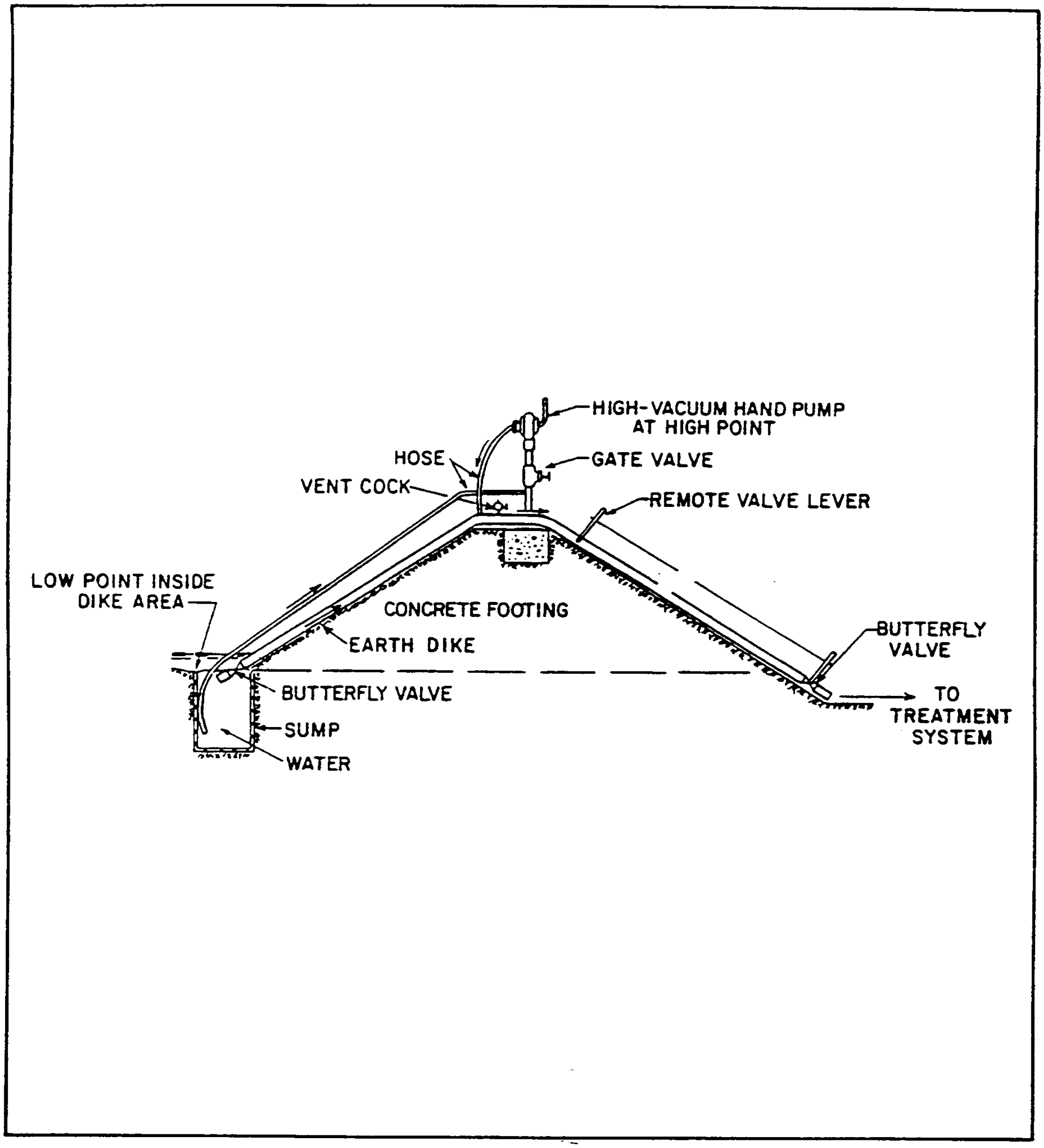

Figure 8-4
Dike Drainage Transfer System Using Siphon

Figure 8-5 presents a simplified schematic of two types of oil-water separators both operating on the same principle: oily water enters the separator and is retained; oil droplets rise to the surface and form an oily layer; the layer is removed, and clean water is withdrawn from near the bottom of the tank by gravity flow or by pumping.

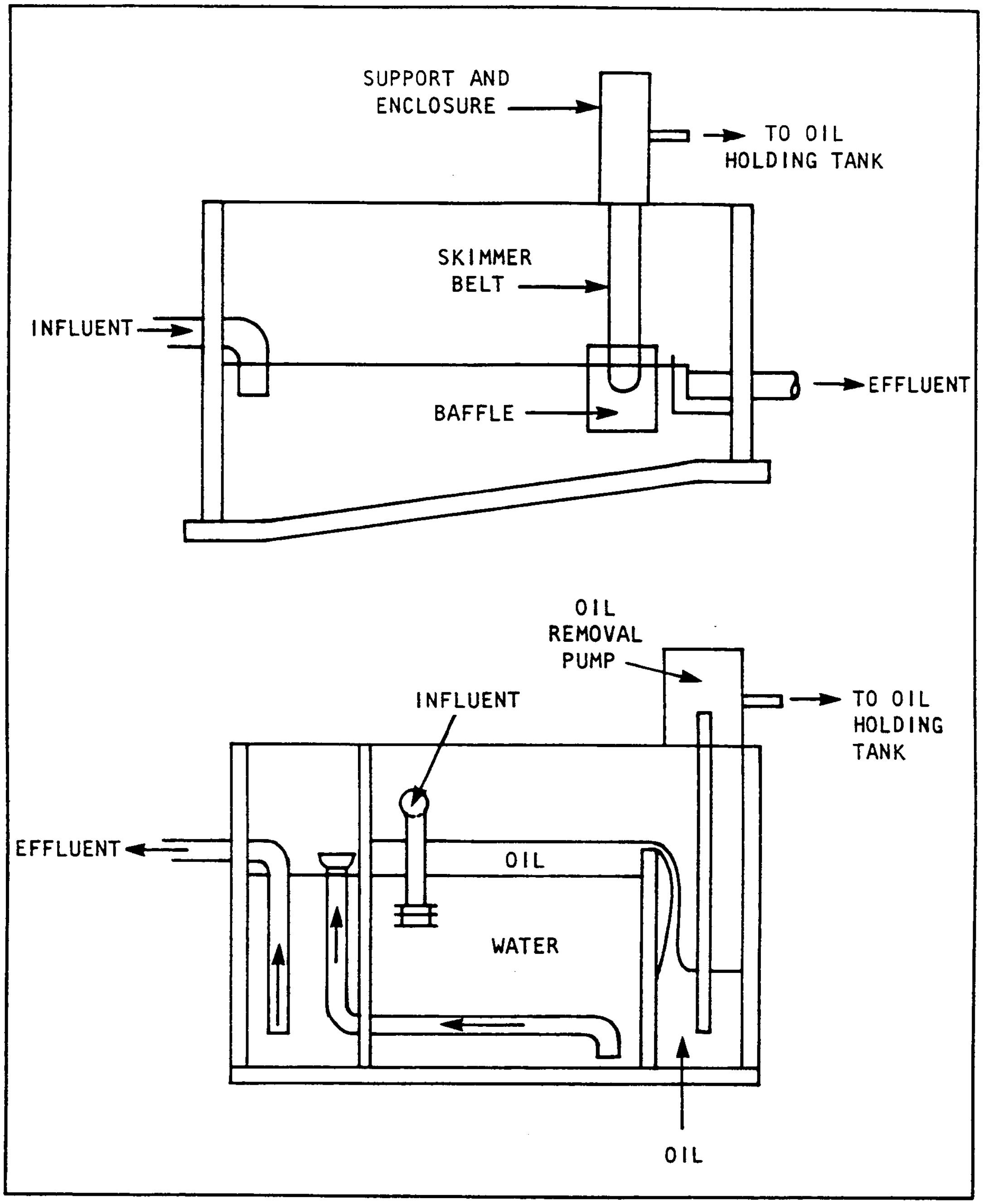

Figure 8-5
Two Typical Oil-Water Separator Configurations

Most of the oil present in oily effluents can be separated by gravity and skimmed, provided that it is not emulsified or too finely divided. To avoid the formation of such finely divided droplets, it is important to avoid pumping oily streams before they have passed through the main gravity separation, especially if there is detergent present. Detergent may prevent an oil-water separator from working properly.

Oil-water separators fail due to poor maintenance, improper installation, undersizing, selection of the wrong separator type, and too much detergent in the water. Problems arise with oil-water separators when accumulated oil is not periodically removed. Oil builds up and displaces water in the tank resulting in reduced retention time and a decrease in efficiency. Ultimately, if the oil build-up becomes severe, oil will fill the entire unit and discharge through the outlet pipe. If the oil build-up must be removed daily or weekly, then the unit may be undersized and should be replaced by a properly sized unit. The API publication, "Manual on Disposal of Refinery Wastes," provides information on sizing and proportioning oil-water separators.

Run-off from parking lots, runways, roads, taxiways, and grassy areas can be routed through small oil-water separators to remove small volumes of oil. Drainage from aircraft and vehicle wash racks, maintenance areas and POL areas is generally more polluted and should be directed through larger capacity oil-water separators, skimming dams, or drainage interceptors.

Oily effluents are almost invariably passed first through a gravity separator such as a simple rectangular basin, preferably of American Petroleum Institute (API) design, or a circular clarifier or a plate separator. Oily effluents should flow by gravity to the gravity separator. These separators are usually at the lowest elevation of the site, recessed in the ground, or both.

An oil treatment unit should remove any oily sheen from the surface of the water. A visible sheen on water is generally at least 10 to 15 ppm of oil. Often the simplest way to evaluate the effectiveness of an oil treatment unit is to observe drainage operations and monitor for sheen.

8.4.2 API Separator

The principle of the API separator is to slow the oily water entering the inlet bay and to allow it to pass slowly, smoothly, and undisturbed along the length of the main bays (at least two similar parallel bays). API separators operate on the principle of Stokes Law. Stokes Law states that the velocity in which an oil droplet rises is proportional to the difference in the specific gravity of the oil and the water. API separators provide ample detention time to allow droplets of oil to rise to the surface, coalesce, and are skimmed to a recovery chamber. Figure 8-6 shows a schematic of an API separator.

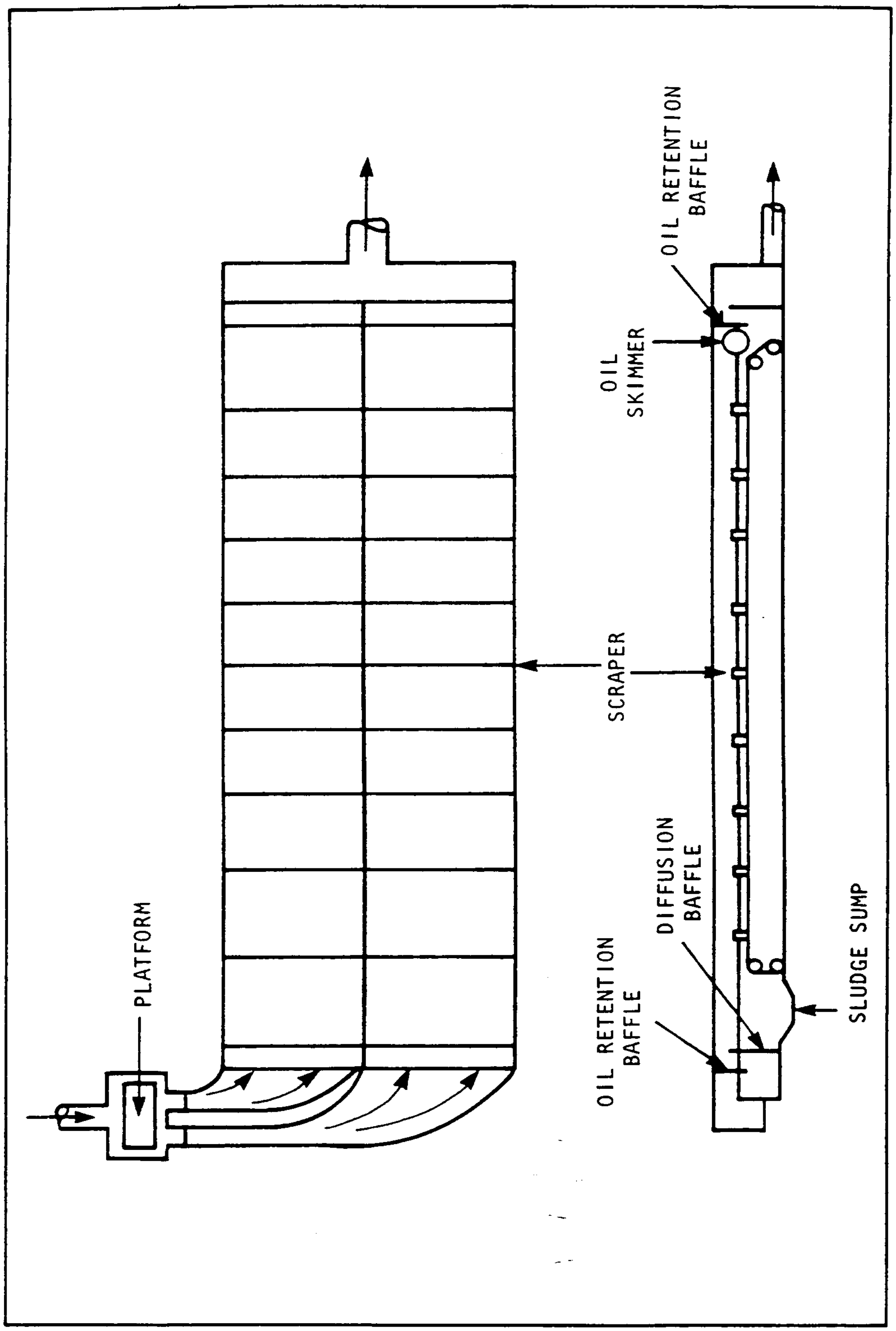

Figure 8-6
Schematic of API Separator

The efficiency of the separator depends upon how effectively the incoming water is slowed before it enters the main bays. It is important to avoid turbulence, since mixing the oil and water defeats the purpose of the separator. Separating the inlet bay from the main bays with vertical concrete pillars does remove the turbulence of the incoming water. Since much of the oil in the incoming oily water will be in the form of large globules that separate very easily, a considerable amount of the oil separates in the inlet bay and is skimmed. The medium-sized globules rise to the surface in the main bays and are also skimmed. The water containing the smallest oil globules, emulsified oil, soluble materials, and suspended matter with an effective density close to that of water passes through the main bays. The water then flows through a series of weirs into the outfall bay, from which it can flow by gravity or be pumped to the next treatment stage.

Oil is typically skimmed from the surface using a slotted pipe skimmer, a rotating disc skimmer, a belt skimmer, or a rope skimmer. The slotted pipe method skims a large quantity of water with the oil, which is then allowed to separate in an oil sump. The water is pumped back to the inlet of the API separator, and the oil layer is pumped to a recovered oil tank. With the rotating disc type of skimmer, a number of discs on an axle rotate and dip through the oil, picking up the oil. The oil is scraped into pouches that drain the oil away to a recovery tank. The belt and rope skimmers use either a belt or plastic tube that rotate and dip through the water. The oil attaches to the belt or the rope and is then scraped off. The rotating disc, belt, and rope skimmers have the advantage that they recover oil with very little water and can be left running; the slotted pipe skimmer requires intermittent manual operation and can remove a large quantity of water with the oil. Debris floating on the surface of the bays hinders the skimming process no matter which oil removal method is used.

Solids either settle at the bottom of the separator or are carried through the separator with the water, depending on their settling rate and density.

API separators are large by necessity, but they have a number of important advantages. They accept widely varying proportions and varieties of oil and solids, including viscous, sticky, or waxy oil. They also can retain very large quantities of oil after major accidents.

8.4.3 Plate Separator

A plate separator is, in effect, a large number of shallow separators stacked on top of each other and operating in parallel. The plate packs are spaced up to 4-inches apart. The oil droplets only have to rise this short distance before reaching the oil-wet surface above. Upon contact with the oil-wet surface, the oil coalesces into larger droplets. The plates are sloped and perforated so that the oil rises to the top of the pack and sludge settles downward. To avoid corrosion problems, the plates are usually plastic. The separated oil accumulates in a layer at the top of the plates and is pumped to a recovery tank. Figure 8-7 shows a schematic of a plate separator.

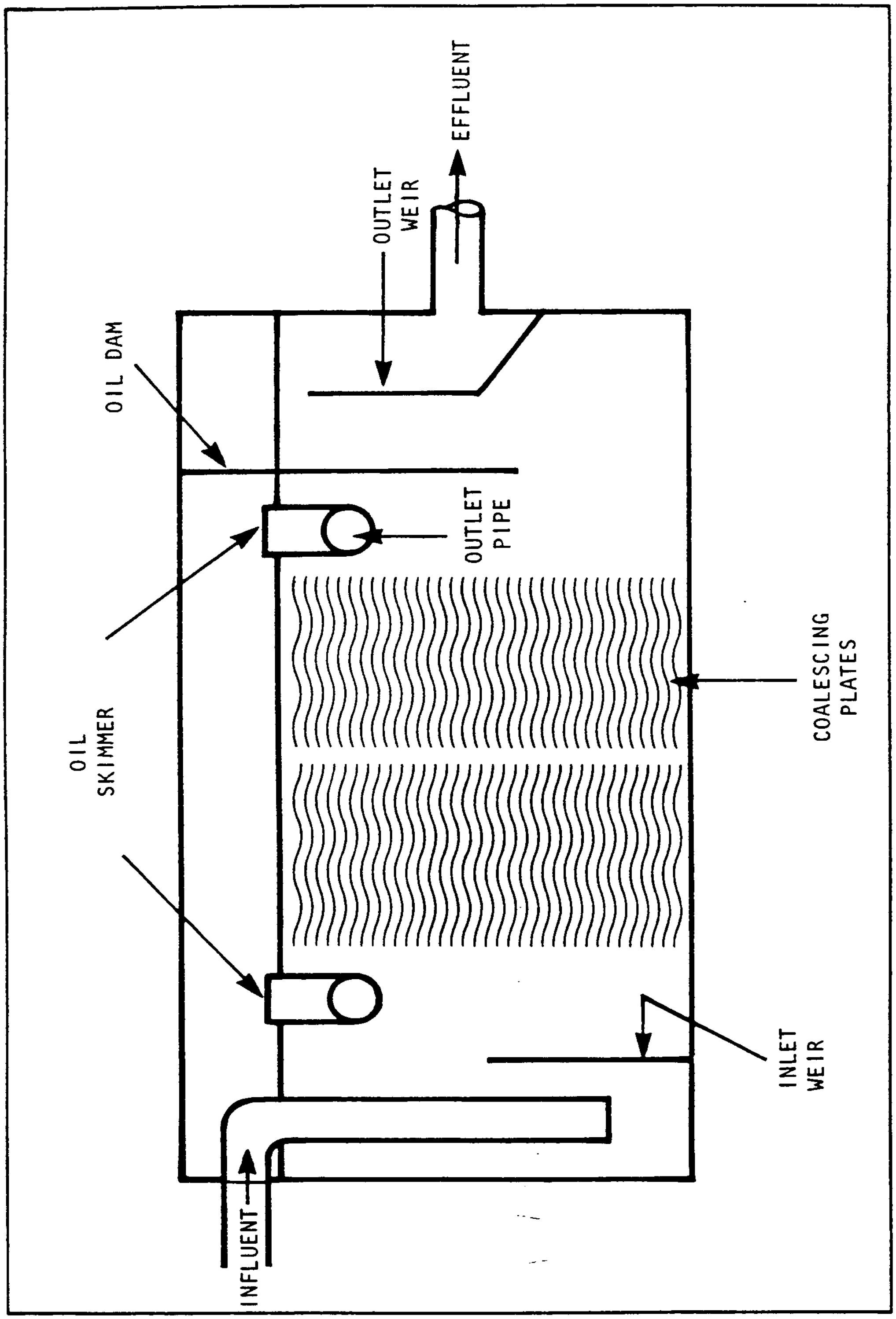

Figure 8-7
Schematic of Plate Separator

An advantage to plate separators is that they have no moving parts, are relatively compact, and can separate oil droplets down to a diameter of 60 microns (0.06 mm). Additionally, the separator can be enclosed and operated full of liquid to prevent vapor loss, and they can be enclosed in a pressure vessel.

The disadvantages to using plate separators are that they have very little capacity for retaining large "slugs" of oil following accidents, and they need frequent cleaning. Plate separators are easily blocked by viscous or waxy oil and thick sludge, and the large plate surface area has a strong tendency to grow bacterial films that are difficult to remove. Provisions for cleaning should be included when the plate separator is installed. Different plate shapes, the direction of slope, and attachments to the separator can facilitate removal of oil from the plates. A level controller and a pumping system to automatically begin oil removal when the oil level reaches a certain height is another method to assist in cleaning the separator.

8.4.4 Three-Chamber Gasoline Interceptor

A three-chamber gasoline interceptor is a simple structure made of brick or concrete and consists of three small chambers in series, as depicted in Figure 8-8. The three-chamber gasoline interceptor is designed for trapping spills of gasoline, jet fuel, or similar easily separable light liquids from small water flows. The water enters the first chamber through a pipe and flows through the other chambers via pipes coming from the lower region of each previous chamber. A visual inspection of the volume of gasoline or other material in the last chamber indicates when the interceptor needs cleaning.

8.4.5 Other Treatment Units

Spilled products and contaminated water are treated in a variety of unit processes depending on the nature (petroleum-based, acids, bases, solvents, metal solutions, etc.) and concentration (pure product or spill residual) of the oil and HS involved. Chemical, physical, thermal, and biological treatment processes such as pH neutralization, precipitation, distillation, filtration, or activated sludge processes are used routinely at Navy facilities. However, materials routinely spilled should be considered when designing treatment areas.

8.5 FLOW BETWEEN TREATMENT UNITS

If treatment units are installed in series, flow between the units should use gravity flow. If a pump is required, positive displacement pumps are preferred over centrifugal pumps. The positive displacement pumps do not shear the entrained oil that can result in emulsification as centrifugal pumps do.

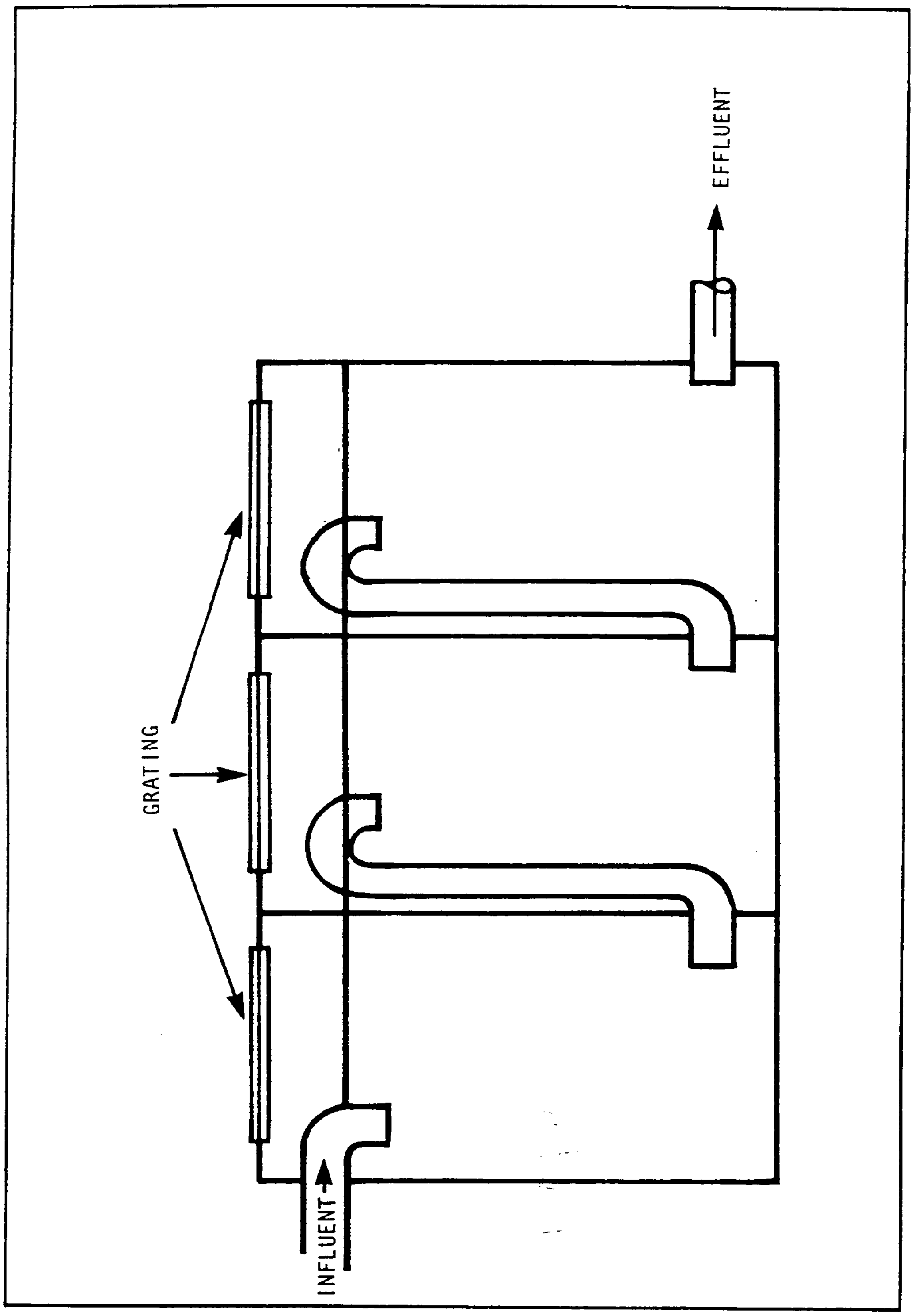

Figure 8-8
Schematic of Three-Chamber Gasoline Interceptor

If a pump is used to transfer drainage between the treatment units, two pumps should be available. If treatment is continuous, then at least one pump should be permanently installed. A portable pump will suffice as the second (backup) pump if maintenance personnel can respond quickly to install the pump in the event of failure of the primary pump. However, two permanently installed pumps are preferred for reliability.

8.6 BYPASSING TREATMENT UNITS

112.7(e)(1)(ii)
112.7(e)(2)(iii)

Treating discharge from containment areas and area drainage systems is not always required or desirable, since treating uncontaminated water adds to the cost of operating and maintaining an area. Bypassing a treatment area is generally accomplished by opening control valves. For example, the valve from the diked area to the treatment area would normally be open, and the valve on the piping bypassing the treatment area would be closed and locked. To by-pass the treatment system, the valve leading to the treatment system is closed and the bypass valve is opened.

Per 40 CFR 112.7(e)(2)(iii), bypassing treatment is only allowable if the following conditions are met:

a) The bypass valve is normally closed and locked.

b) Stormwater or discharge is inspected or tested for the presence of pollutants, and oil sheen is not present.

c) The bypass valve is opened, and then resealed and locked following drainage under responsible supervision.

d) Adequate records are kept.