CHAPTER 7

SPILL CONTAINMENT

7.1 INTRODUCTION

Spill containment structures and equipment should prevent spilled material from leaving an area by physically confining the material at the source, diverting it to containment, or returning it to the original area. Areas storing or handling oil that lack secondary containment are in violation of 40 CFR 112.7(c); areas storing or handling HW that lack secondary containment are in violation of 40 CFR 264 and 265; areas storing PCBs prior to disposal without secondary containment are in violation of 40 CFR 761.65; and HS areas without secondary containment are at risk of creating a spill that can contaminate the surrounding soil and waterways.

Design parameters for spill containment structures must be evaluated for compatibility with the type and volume of the material stored. These parameters include:

- Containment Capacity
- Structural Strength
- Impermeability
- Structural Integrity

This chapter provides guidance to identify and evaluate deficiencies related to these parameters. Spill control structures must comply with the performance requirements identified in this chapter. Actual field conditions may determine the corrective actions needed to satisfy the regulatory requirements. Area related guidance is a general SPCC guidance that addresses multiple regulations, not just 40 CFR 112. Good engineering judgment should be exercised when deciding the need for and extent of repair of deficient structures. Navy design manuals and other design standards are referenced for comparison purposes only and deviations from these standards may be warranted.

7.2 SPILL CONTAINMENT SYSTEMS 112.7(c)

Secondary containment should be provided for all areas and equipment, regardless of the type(s) of structure(s) involved, having the potential for significant releases of oil to the environment (40 CFR 112.7(c)) and for HW tank systems and container storage areas (40 CFR 264.175, 264.193, and 265.193) and should be provided for areas storing HS. 40 CFR 280 requires secondary containment for USTs storing HS. Oil areas with a reasonable potential creating of a spill that may impact navigable waters require secondary containment. Spills can impact navigable waters through spills direct discharge into a body of water, from discharge into storm sewers or ditches, or from spills that seep into the ground. All areas with a reasonable spill potential should be checked to determine if secondary containment is needed.

Spill containment structures and equipment must be designed, maintained, and operated properly to prevent discharged oil or HS from reaching a navigable waterway. Preferably, spills should be controlled by spill containment structures immediately adjacent to the potential spill source. However, if this is not possible due to site constraints, then diversionary structures (culverts, gutters, etc.) can direct spills to a remote containment or treatment area. Holding or storage basins and ponds are typically used for remote secondary containment of large spills.

Spill containment structures include dikes, retaining walls, berms, curbs, catchment basins, quick drainage systems, trenches, retention ponds, double walled tanks, or a combination of these structures. Dikes and retaining walls are typically used with aboveground storage tanks; double-walled tanks are typically used for underground storage tanks. Curbs, berms, catchment basins and quick drainage systems are commonly used for loading/unloading areas. Gravity drainage to an oil-water separator can contain and collect relatively frequent but small oil spills in loading and dispensing areas.

40 CFR 112 also allows sorbents, drip pans, and booms to be used as containment systems. Sorbents and drip pans are commonly used to contain small spills around pumps, filters, valves, and other pieces of equipment. Booms can be placed at a storm water outlet as a precautionary measure to catch any oil before it enters a navigable waterway.

If secondary containment is not feasible due to space limitations, the SPCC plan must demonstrate the impracticality. A strong spill contingency plan must be prepared which outlines the resources committed and the methods and procedures to contain, control, and remove any harmful releases. However, the regulatory agency may not agree with the rationale and may still require the installation of secondary containment, even though major site modifications may be required.

This section addresses the various types and applications of these containment systems to the various potential spill sources at a Navy facility.

7.2.1 Dikes, Berms, and Retaining Walls

112.7(c)(1)(i)
112.7(e)(2)(ii)
112.7(e)(2)(xi)

Dikes, berms, and retaining walls are normally used in areas with the potential for large spills, such as single or multiple aboveground storage and processing tanks.

Requirements for dikes are specified in DM-22. To evaluate the adequacy of a spill containment dike, review the following criteria: capacity, material of construction and compatibility with tank contents, integrity, and strength.

Figure 7-1 is an example of a dike used at a fuel farm, and Figure 7-2 is a cross section of such a dike. Where space allows, lined earth dikes are preferred over concrete walls per DM-22. Dikes commonly have sloped walls so that the base of the dike is much wider than the crown or top. The slopes of earth dikes should not be steeper than 1 foot vertical to 1-1/2 feet horizontal. On average, dikes are not to exceed an interior height of six feet. In addition, it is good practice to construct dikes with level, three-foot wide surface on the crown to provide a walking surface for inspections. Dikes are typically constructed of well-compacted earth and coated with reinforced concrete, asphalt with rubberized coal tar sealer, or bentonite for erosion control and to provide an impervious surface. Table 7-1 presents a comparison of various materials used for the construction of containment structures (permeability, resistance to erosion, strength, cost, etc.).

A reinforced concrete retaining wall is used when space is not available for a dike. Retaining walls are usually constructed of either reinforced concrete blocks or reinforced poured concrete.

Concrete block retaining walls have a few drawbacks:

- They have a height limitation of 3 or 4 feet, in order to withstand potential fluid loads.
- Settling separates the blocks and may even crack them, destroying the integrity of the containment wall.
- They require an epoxy coating due to the porosity of the blocks.
- Spalling of the mortar between the walls can destroy the liquid-tightness of the wall.

Due to the limitations of concrete block walls, poured reinforced concrete walls are the preferred alternative. A reinforced poured concrete retaining wall can be used when the height needed for a containment wall exceeds the 3 to 4 foot height limitation of concrete block walls. Figure 7-3 illustrates a typical concrete dike. Figure 7-4 depicts the use of a retaining wall around a small aboveground tank. Figure 7-5 illustrates the construction of a concrete retaining wall.

The area within the dike should be sloped to carry drainage away from the tanks to a drain or sump located at the low point of the enclosure. Drainage from the sump to the outside of the enclosure should be controlled by a lock-type gate valve located outside of the enclosure and in a location that will be safely accessible during a fire.

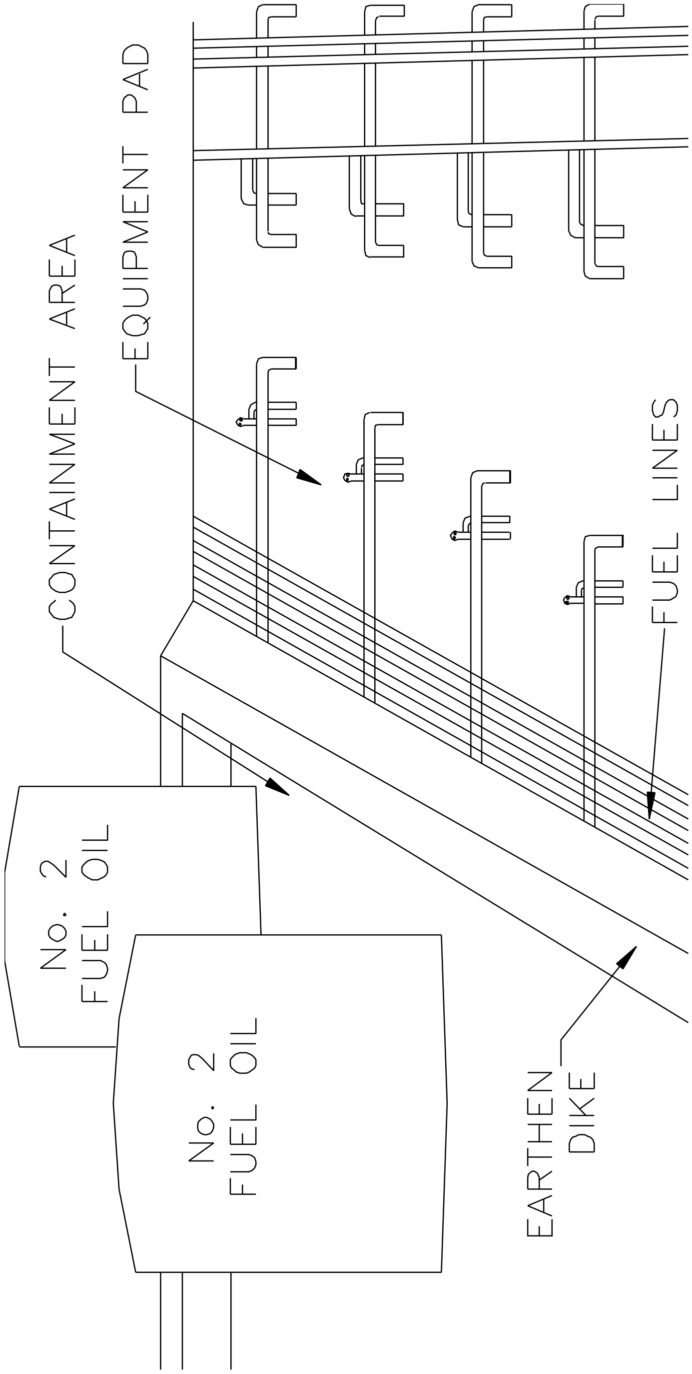
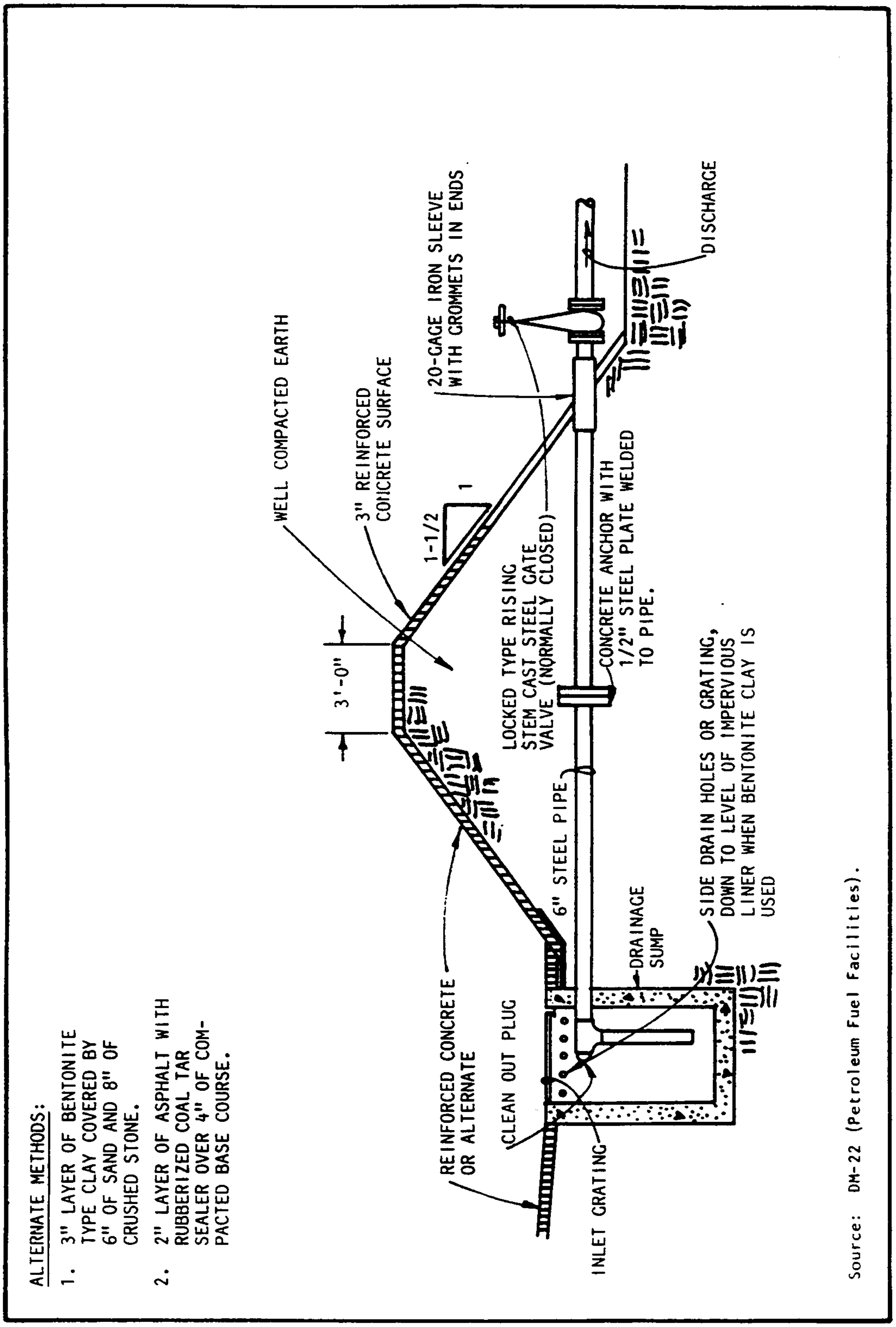


Figure 7-1
Typical Diked Area

The drain valve should be normally closed and only be opened for draining water from the diked basin.



ALTERNATE METHODS:

1. 3" LAYER OF BENTONITE TYPE CLAY COVERED BY 6" OF SAND AND 8" OF CRUSHED STONE.
2. 2" LAYER OF ASPHALT WITH RUBBERIZED COAL TAR SEALER OVER 4" OF COMPACTED BASE COURSE.

Source: DM-22 (Petroleum Fuel Facilities).

Figure 7-2
Cross Section of Typical Dike

Table 7-1
Characteristics Of Construction Materials Used For Containment Structures (Dikes)

Material	Permeability	Resistance to Erosion Weathering	Resistance to Weed Growth	Strength	Chemical Compatibility	Maintenance Requirements	Capital Cost
1. Earthen Dikes							
• Natural Soil	H	L	L	L/M	H	H	L
• Clay Core	L	L	L	M	H	M	L
• Clay Cap or Cover	L	M	L	M	H	H	M
• Asphalt Cover	L*	H	H	M	L/H*	M	M
• Synthetic Membrane	L	M	M	M	H	M	M
• Cement Mortar Cover	L	H	H	M	H	L	H
2. Reinforced Concrete Dikes	L	H	H	H	H	L	H
3. Concrete Block Dikes	M/H	H	H	M	M	L	M

H = High
M = Medium
L = Low

7.2.2 Curbs 112.7(c)(1)(ii)

Curbs are a very effective means of secondary containment around drum storage areas, product dispensing areas, bulk loading and unloading areas, and pump equipment areas. Curbing can be used where only small spills are expected. Curbing can also be used to direct spills to drains or catchment systems. Curbed areas typically consist of a reinforced concrete or asphalt apron surrounded by a concrete curb. Curbs can be of a uniform rectangular cross section or combined with mountable curb sections to allow access to loading/unloading vehicles and material handling equipment. Standard and mountable curb sections are shown in Figure 7-6. Typical applications of curbs are illustrated in Figure 7-7 through Figure 7-9.

The flooring should be sloped so that any oil or rainfall flows to a collection point. Figure 7-10 illustrates the use of a curb and a sloped floor to direct spills at a loading and unloading rack to the spill containment area drain.

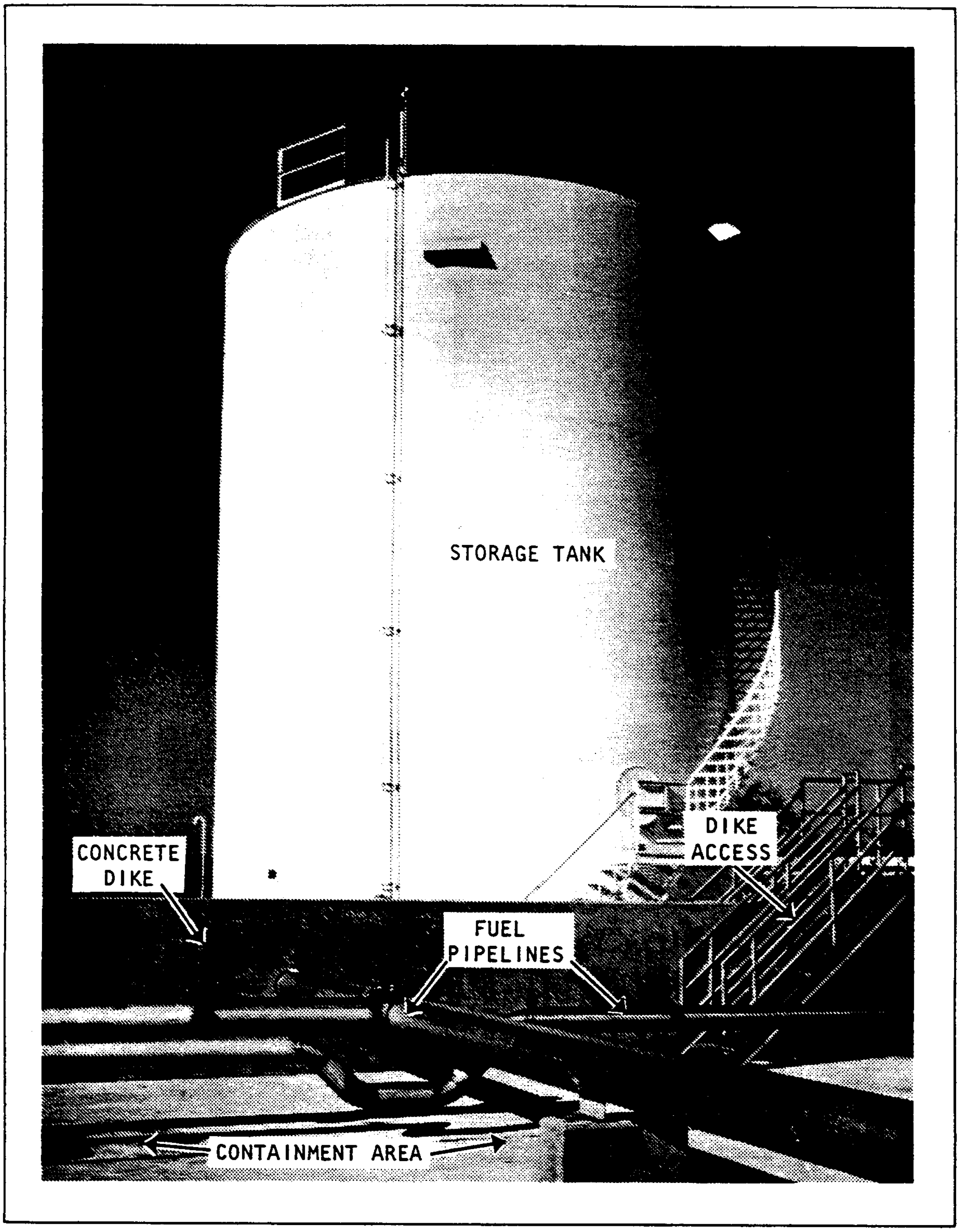


Figure 7-3
Typical Concrete Dike

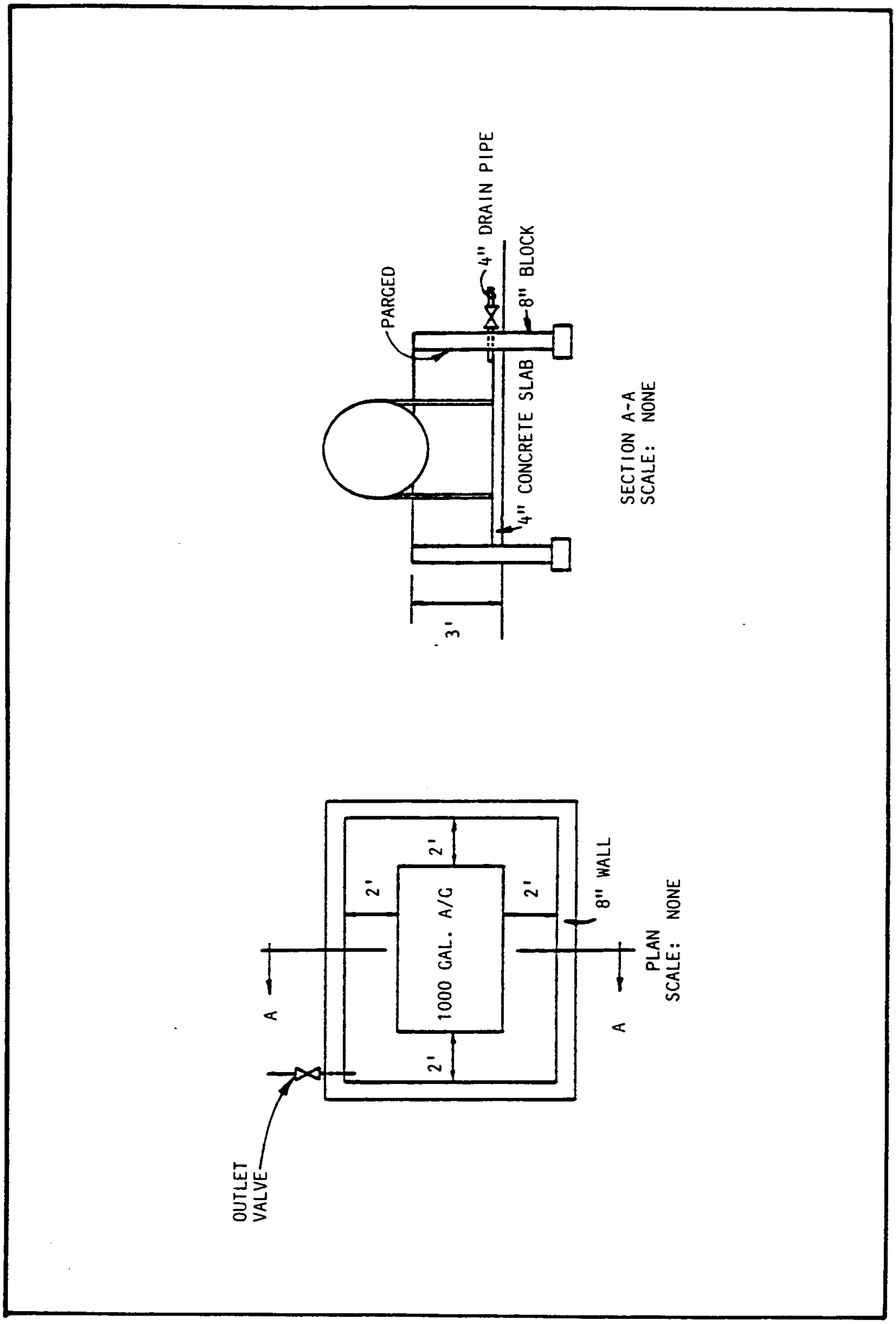
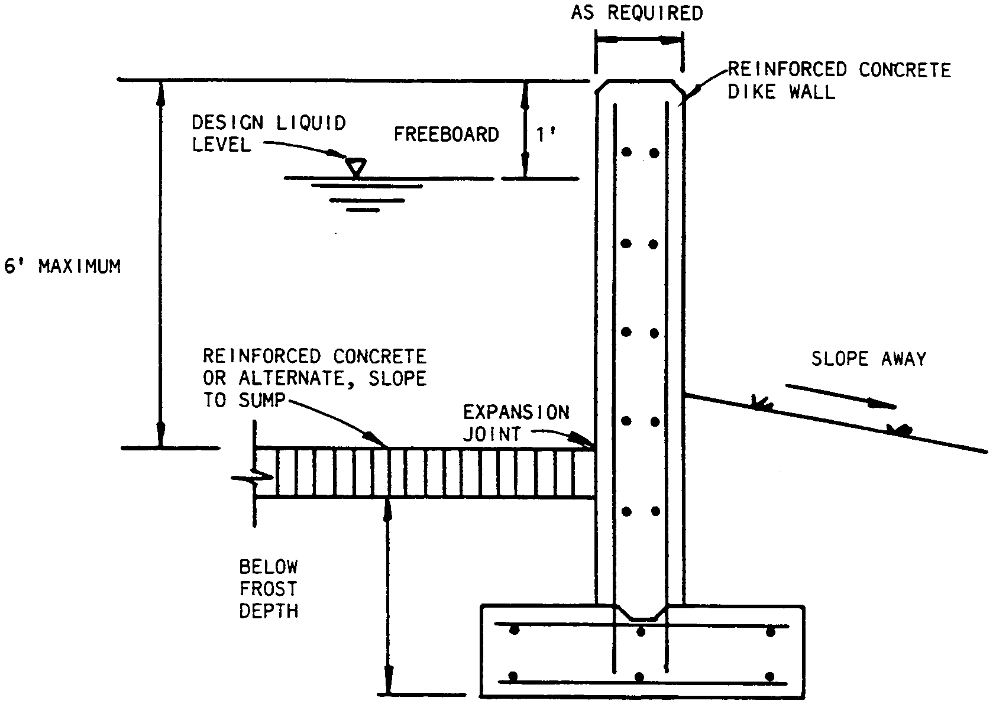


Figure 7-4
Use of Retaining Wall for Small Aboveground Tank

ALTERNATE METHODS:

1. 3" LAYER OF BENTONITE TYPE CLAY/SOIL MIXTURE, COVERED BY 6" OF SAND AND 8" OF CRUSHED STONE.
2. 2" LAYER OF ASPHALT WITH RUBBERIZED COAL TAR SEALER OVER 4" OF COMPACTED BASE COURSE.



NOTES:

1. SIZE FOOTINGS, WALL SECTIONS AND REINFORCEMENT TO RESIST STATIC AND HYDROSTATIC FORCES.
2. PROVIDE EXPANSION JOINTS AT STRUCTURAL INTERFACES AND AS NEEDED FOR WALL EXPANSION AND CONTRACTION.
3. JOINT MATERIAL MUST BE SUITABLE FOR USE WITH OILS.

Source: DM-22 (Petroleum Fuel Facilities).

Figure 7-5
Construction of Typical Retaining Wall

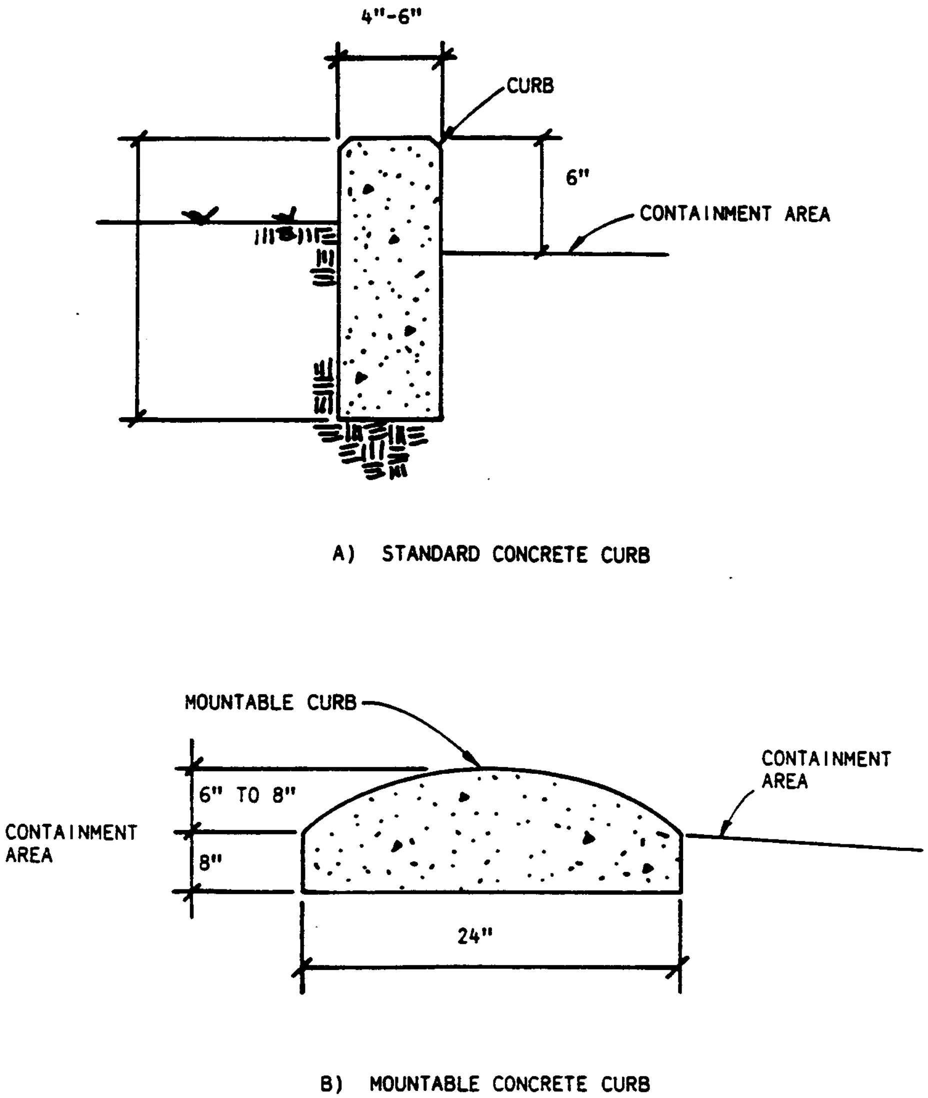


Figure 7-6
Typical Concrete Curb Sections

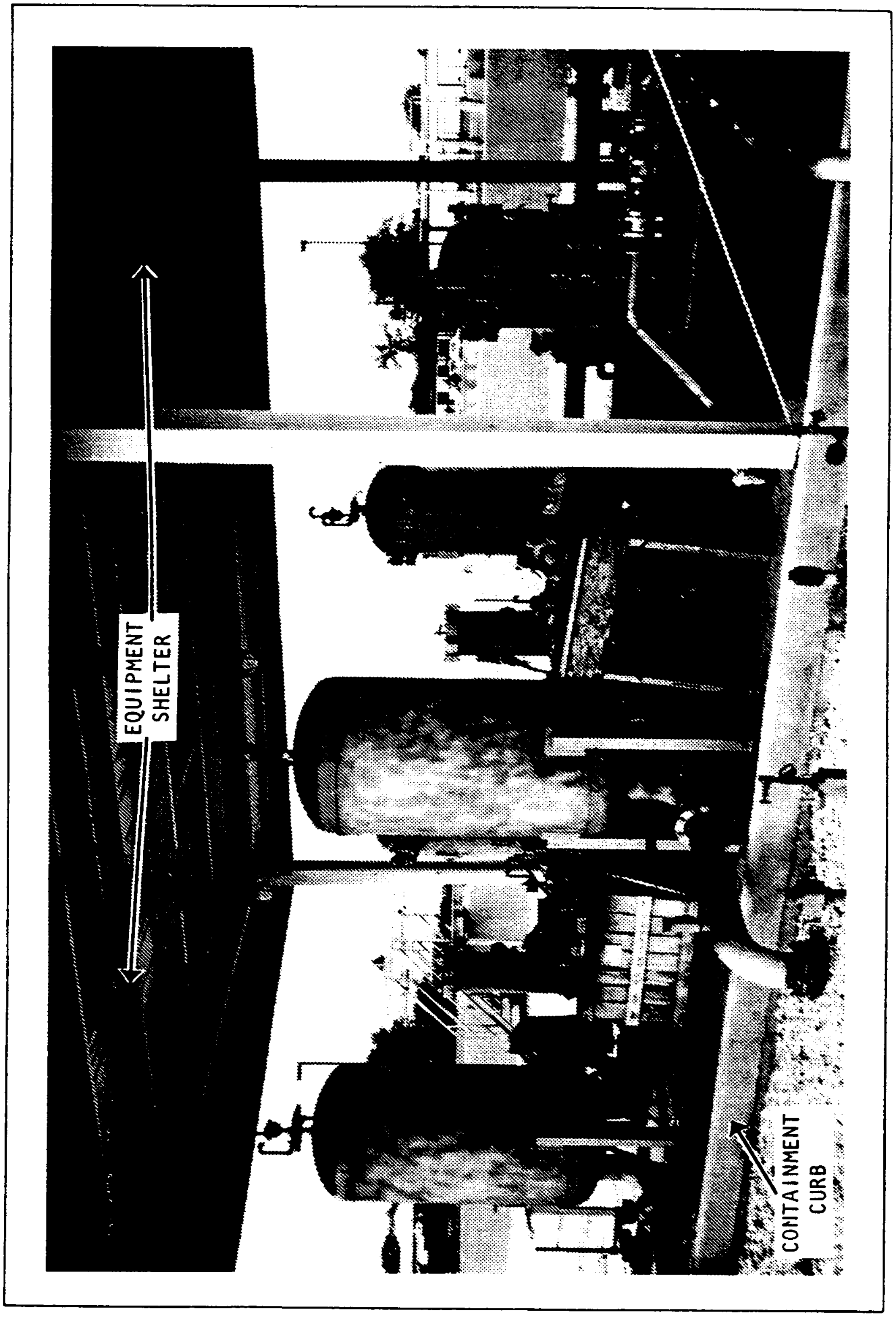
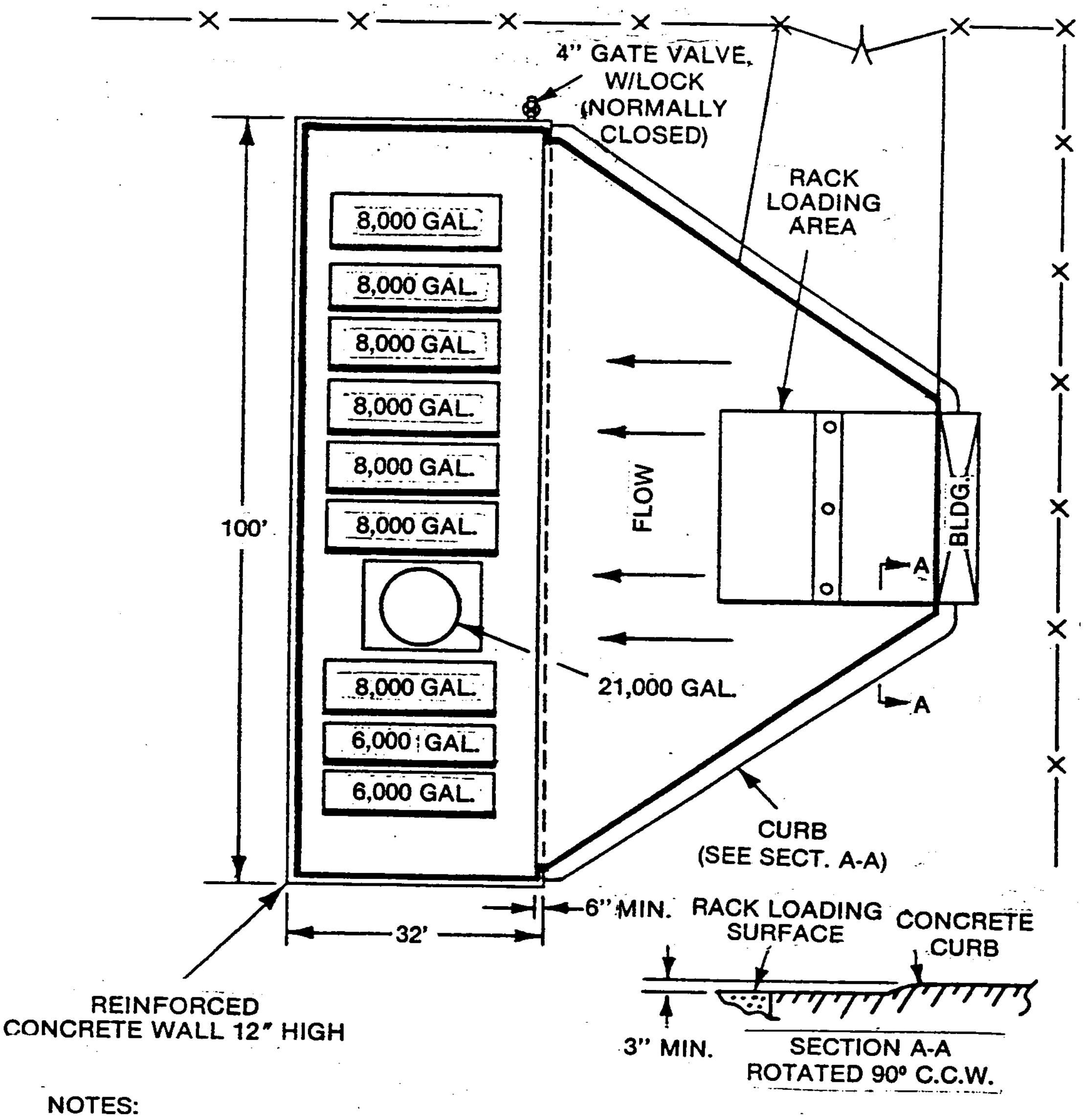


Figure 7-7
Example of Containment Curb in Equipment Shelter



NOTES:

1. SECONDARY CONTAINMENT IS AREA SHOWN INDICATED BY HEAVY LINE.
2. DIKE AROUND RACK AREA SHALL CAUSE DRAINAGE/SPILLS TO FLOW INTO TANK CONTAINMENT AREA.

Figure 7-8
Example of Containment Curb at Loading Rack and Storage Tanks

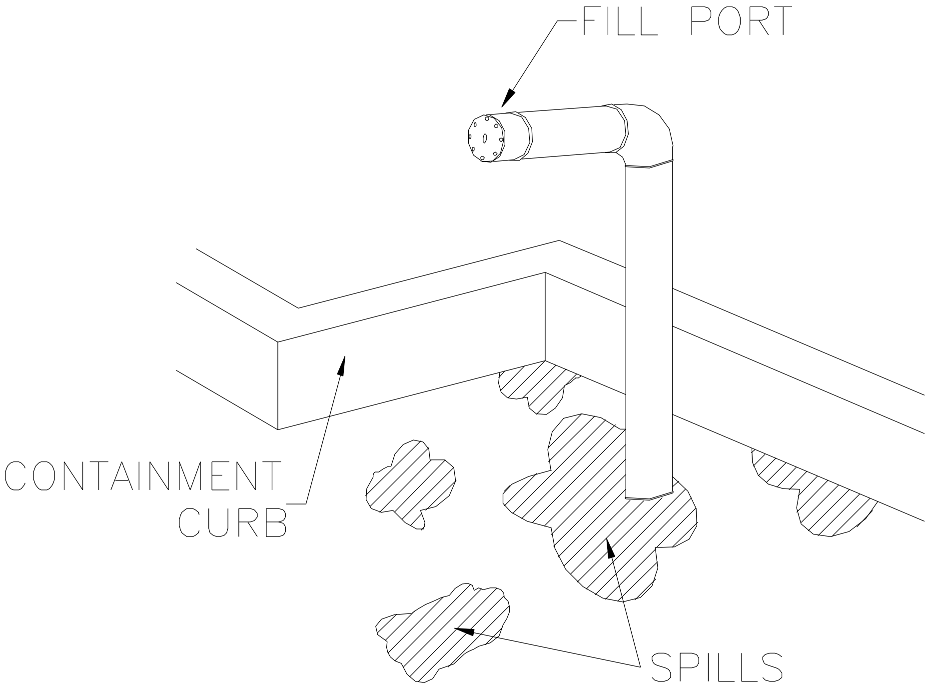
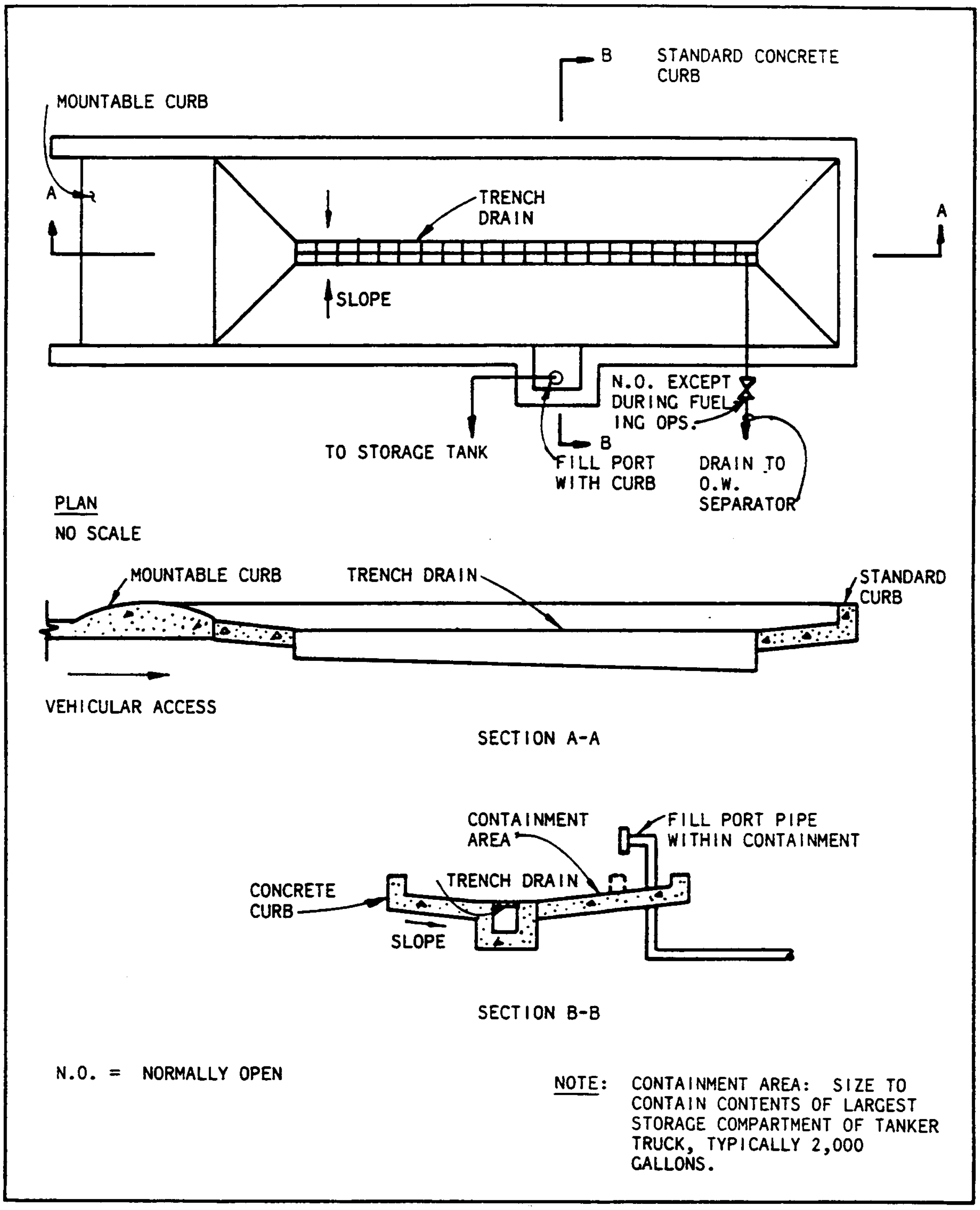


Figure 7-9
Example of Containment Curb Used at Fill Port



N.O. = NORMALLY OPEN

NOTE: CONTAINMENT AREA: SIZE TO CONTAIN CONTENTS OF LARGEST STORAGE COMPARTMENT OF TANKER TRUCK, TYPICALLY 2,000 GALLONS.

Figure 7-10
Example of Curbing and Drainage

7.2.3 Quick Drainage Systems 112.7(e)(4)(ii)

When a potential spill at a loading or unloading rack cannot be drained by gravity to a catchment basin or a treatment plant, an automatic pump must be used to transfer the material. Such an arrangement is called a quick drainage system and is shown in Figure 7-11. The pump for a quick drainage system is located in a small catchment basin or sump. The quick drainage system pumps the spilled fluids to another catchment basin, tank, or treatment system. Figure 7-12 illustrates the use of a quick drainage system at a bulk fuel storage area.

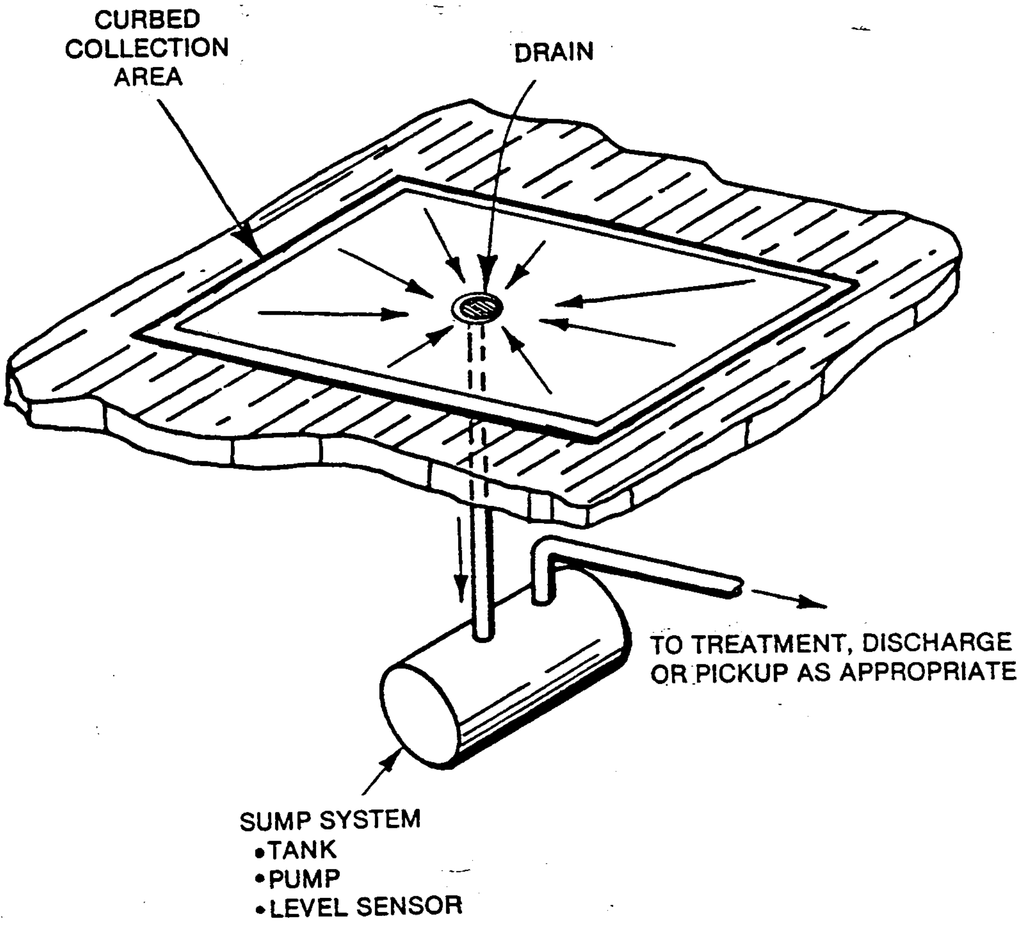


Figure 7-11
Quick Drainage System

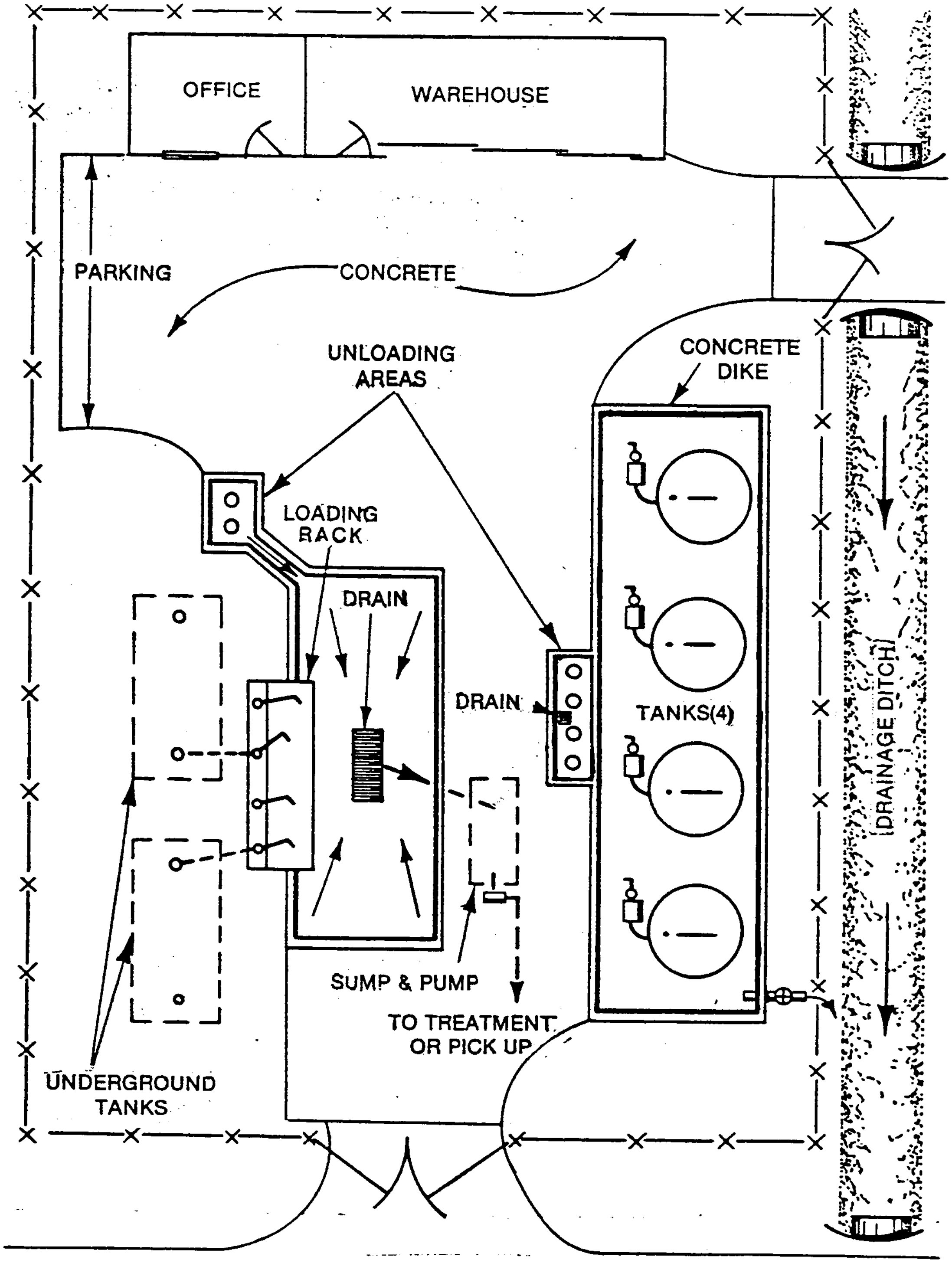


Figure 7-12
Use of Quick Drainage System at Bulk Fuel Storage Area

The design of a quick drainage system must allow for collection and treatment of rainwater that will collect in the system. During a rainstorm the basin, trench, or tank could overflow. Additionally, rainwater standing in the basin, trench or tank will reduce the containment capacity of the system.

7.2.4 Trenches, Retention Ponds, and Surface Impoundments

112.7(c)(1)(iii), (v), and (vi)
112.7(e)(1)(iii) and (iv)

Secondary containment, such as dikes, is not always feasible; drainage trenches, culverts, sewers, swales, or gutters that direct a spill to a retention pond or catchment basin are acceptable alternatives. Closed systems, such as pipelines, should be used for volatile compounds rather than open drainage ditches. Drainage from undiked areas should, if possible, flow into retention areas designed to retain spills or return the material to activity property. Retention ponds and basins should not be located in flood plains or areas subject to flooding. Information regarding flood plains is available from the U.S. Geological Survey, the Corps of Engineers, or local government agencies.

Surface impoundments present significant potential for water and groundwater contamination due to seepage or overflow and must be properly designed. Also, leaks are difficult to detect and expensive to correct; therefore, RCRA requirements impose very strict design and operation standards. Surface impoundments can contain spills if the area is designed to treat the spilled material or collect it and return it to the area. If hazardous wastes are collected or treated in the surface impoundment, then the impoundment is strictly regulated under 40 CFR 264.220 (RCRA); surface impoundments also require a Part B Permit to operate.

Containment structures in an environmentally sensitive area may not always be the most practical means of spill containment. Figure 7-13 illustrates the use of a diversion trench or depression to intercept spills from an aboveground pipeline rupture. Figure 7-14 shows a diversion trench that directs surface spills to a retention basin.

Trenches, drainage ditches, and sewers segregate stormwater run-off from chemical storage, transfer, process, and other areas to prevent commingling run-off. Diversion and drainage structures also segregate individual operations to contain spills and prevent incompatible mixing. Figure 7-15 illustrates a typical diversion trench in a containment area. The diversion trench separates the drainage from the two tanks and minimizes the potential spill area associated with each tank. This is a recommended practice when several tanks are within one containment area, such as a tank farm.

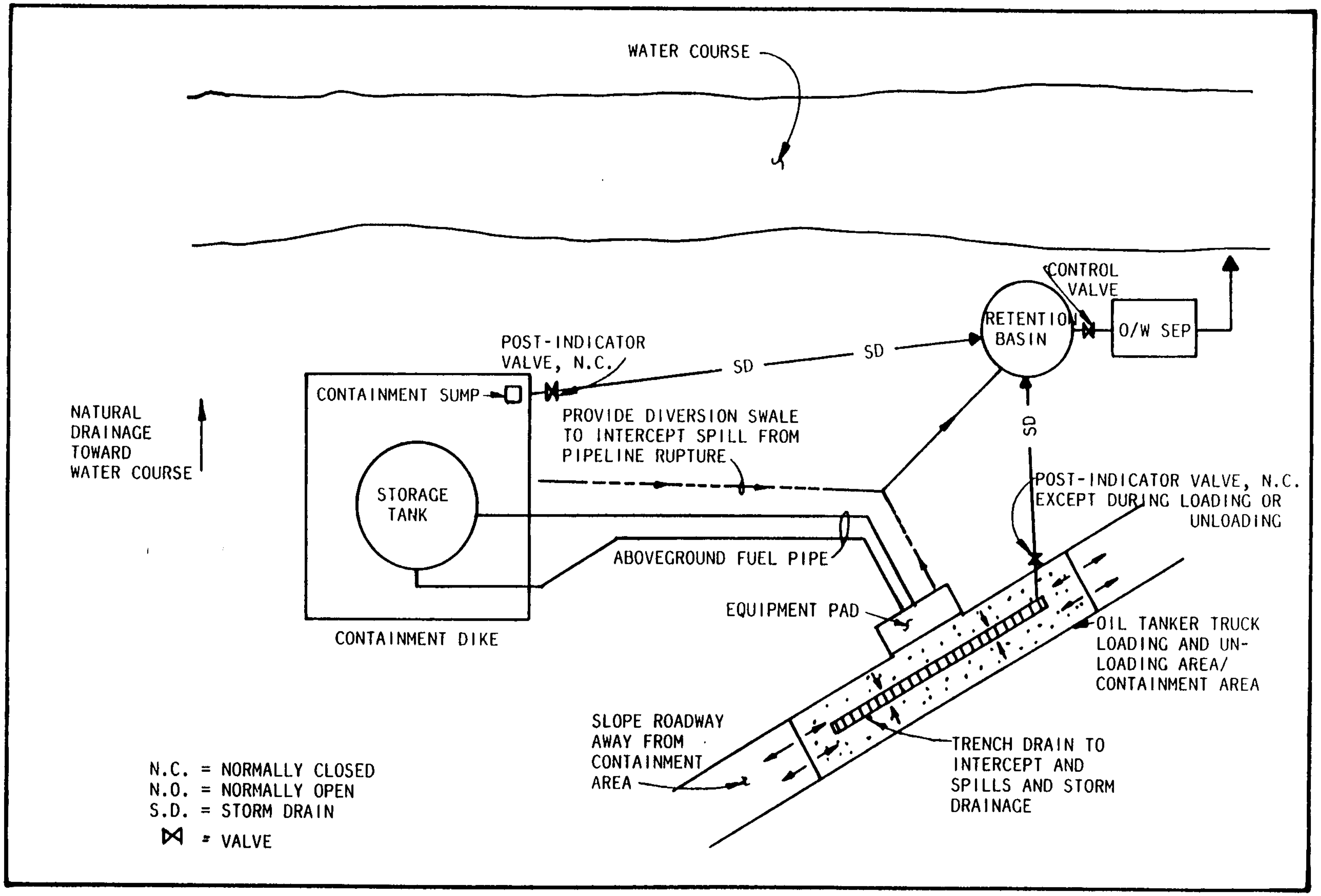


Figure 7-13
Use of Diversion Trench for Aboveground Pipeline

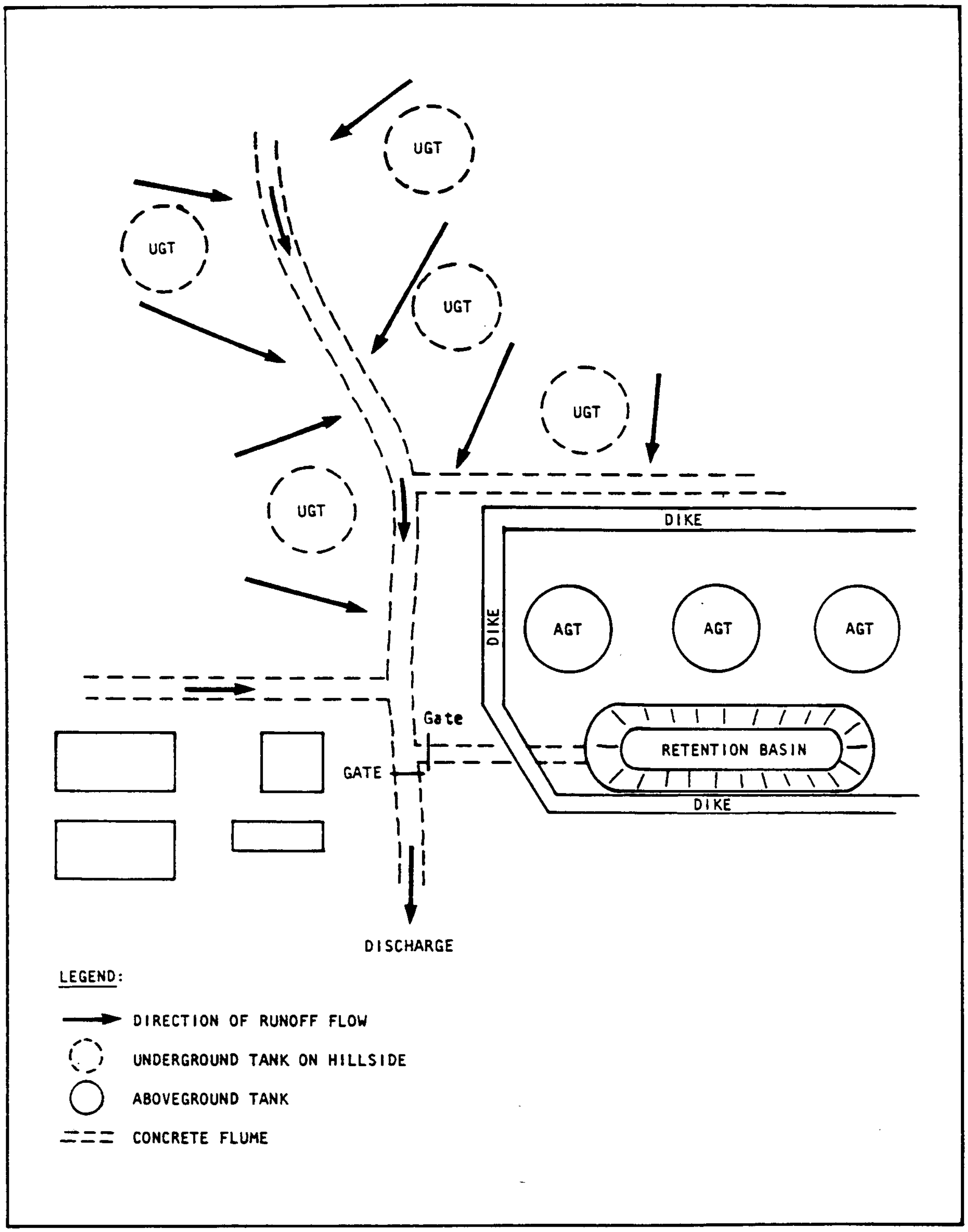


Figure 7-14
Typical Diversion Trench

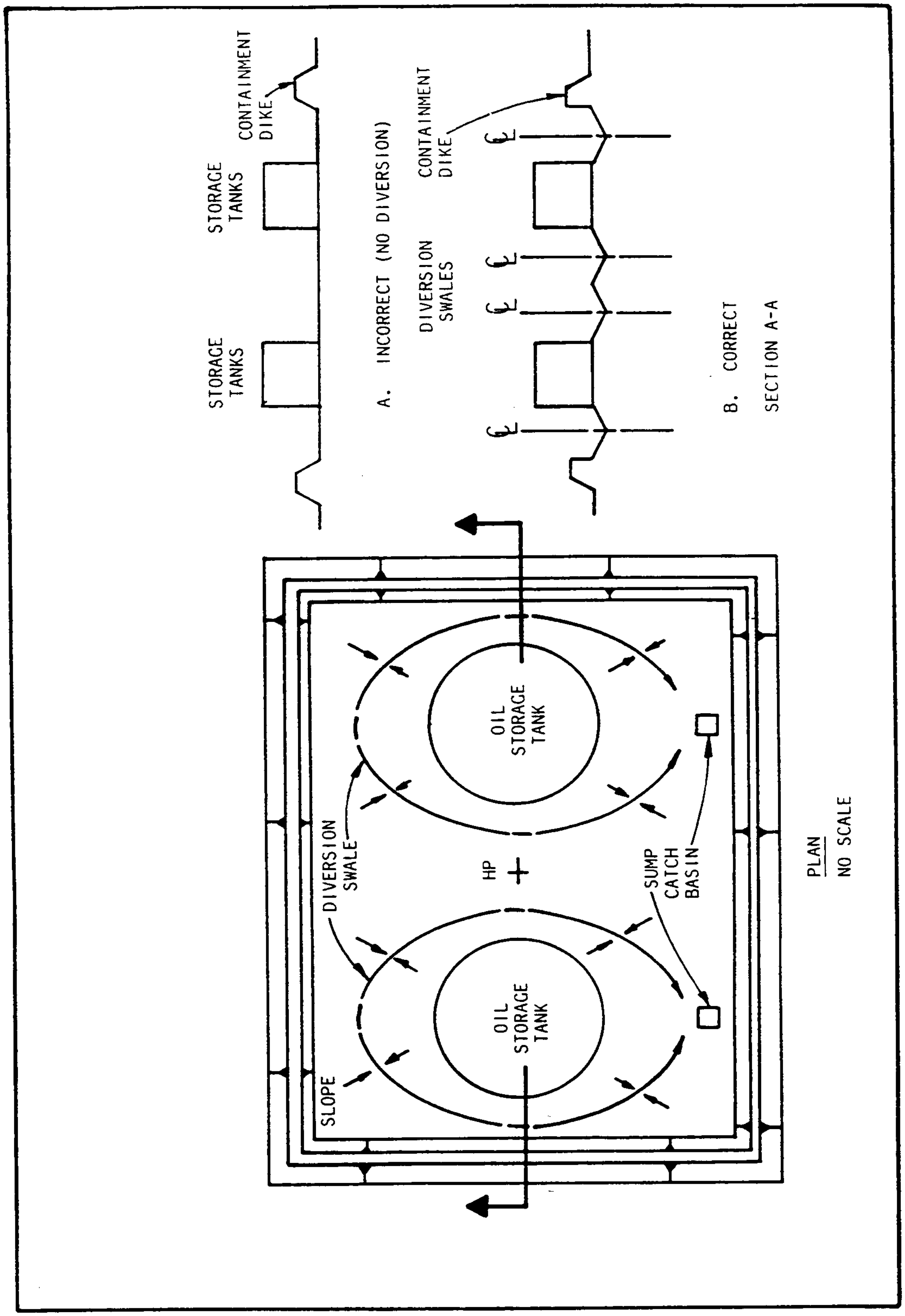


Figure 7-15
Typical Diversion Trench in Tank Containment Area

7.2.5 Sorbents and Drip Pans

112.7(c)(1)(vii)
112.7(c)(2)(i)

Sorbent materials, drip pans, and drainage mats are used to isolate and contain small drips or leaks until the source of the leak is repaired. Material handling equipment, such as valves and pumps, often have small leaks and are applications for using sorbents, drip pans, or drainage mats.

Although sorbents are usually used to control small isolated spills, they can also be used to contain and collect large-volume spills before they reach a watercourse. Sorbents include clay, vermiculite, diatomaceous earth, and man-made materials. Trade name sorbents composed of specially processed compounds are available; however, these specialty absorbents are generally for non-oil-related (hazardous material) spills or for collecting oil from water without sorbing the water. Sorbents are generally maintained in small quantities at HS handling or storage areas to clean up minor spills.

Since sorbents are usually used for minor cleanup, several 50-pound bags per area is generally adequate. Sorbent pads or socks, especially sorbents designed for oil/water mixtures, are ideal for removing small sheens of oil on stormwater before releasing. Each area must have a pre-planned location for storage and disposal of sorbents. Two large durable trashcans or drums usually suffice: one for storage and one for disposal.

Drip pans are widely used to contain small leaks from product dispensing containers (usually drums), uncoupling of hoses during bulk transfer operations, and for pumps, valves, and fittings. Drip pans are typically 5 to 15 gallons and may be plastic or metal, depending upon the type of chemical handled. They may be single pans for individual dispensing drums or gutter-type continuous pans built into multiple drum dispensing racks. Drip pans must be checked regularly and emptied when necessary so an overflow spill does not occur.

Drainage mats are sometimes used to prevent spilled product from entering into an uncontrolled drainage or sanitary sewer system. The mat is placed over a storm drain, sealing the drain against the entry of spilled material. Drainage mats are especially applicable in areas where constructing a secondary containment or diversion structure is impractical, such as a congested tanker truck unloading area. Drainage mats are typically made of synthetic rubber materials and can be stored on site or carried on a fuel delivery truck. The use of drainage mats is a low-cost solution to providing a degree of containment; however, it is not as fail-safe as the other containment techniques, since it is dependent upon the operator properly placing the mat.

Materials such as foams and gelling agents are commonly used at Navy activities to contain small spills in areas where physical secondary containment is not available. Foams that solidify to form a physical barrier or dike are highly effective forms of emergency secondary containment.

7.2.6 Weirs and Booms 112.7(c)(1)(iv)

Weirs and booms are devices that take advantage of the fact that oil products are lighter than water and float on the surface. Booms are floating barriers that contain the oil that is floating on water. Weirs, on the other hand, do not contain oil but skim the oil off the surface of the water. Booms and weirs can be used on stormwater outfalls that flow into sensitive areas to contain oils which might accidentally have passed through other spill containment systems. The use of booms can be combined with floating sorbents or skimmers for collecting oil from bodies of water.

7.2.7 Spill Containment Alternatives 112.7(d)

All applicable oil and hazardous waste areas are required to have spill containment structures. However, it may be impractical or impossible to build SPCC structures due to the physical surroundings; or it may be impractical, since the area is to be permanently closed in the near future. 40 CFR 112.7(d) requires that a strong contingency plan be prepared when constructing a spill containment structure is impractical. The contingency plan must meet the requirements of 40 CFR 109. In addition, a written commitment of manpower, equipment, and materials (booms, sorbents, shovels, etc.) must be made which details the control and removal of harmful quantities of spilled material.

7.3 UNDIKED AREA DRAINAGE

While all areas storing or handling oil or hazardous waste require some form of secondary containment, not all areas can be diked. Some areas may be more suited to stormwater controls to reduce the volume of runoff and concentration of contaminants in the runoff.

A system of trenches or drains, leading to retention ponds or a treatment system may be an adequate secondary containment system. The secondary containment system must retain the hazardous substance, return it to the area, or render it nonhazardous. If the treatment unit treats the material, it must be designed and permitted for the specific type of treatment. Drainage control and treatment is discussed further in Chapter 8 of this manual.

7.4 DESIGN CAPACITY

The most widely-accepted practice for sizing secondary containment is based on 40 CFR 112.7(e) which states that secondary containment should be sized to contain the volume of the largest single tank or container in the drainage area plus sufficient freeboard for precipitation. A recommended practice is to use 110% of the largest tank or container volume. Another practice is to use 100% of the largest tank or container plus a 24-hour, 10-year design storm. Using a 25-year design storm provides an extra margin of safety. However, final sizing for each particular application should be determined based on good engineering judgment.

A simple method for determining if an existing containment area has adequate capacity is shown in Figure 7-16. This example assumes a design storm of 6 inches and a 2-foot high containment curb. Note that the volume displaced by all storage tanks and structures within the containment area must be subtracted from its gross holding capacity. In addition, the required height of the berm must include the additional height required to contain the design storm. DM-22, Chapter 4, Section 5.0, requires a containment structure have a minimum of 1 foot of freeboard over the required capacity of the largest tank; this is to accommodate precipitation and is usually more than adequate. Other types of containment structures will use similar calculations but must take into account the site-specific factors, such as curb or berm height, storm volume, volume of storage tanks, and other factors not shown in this example.

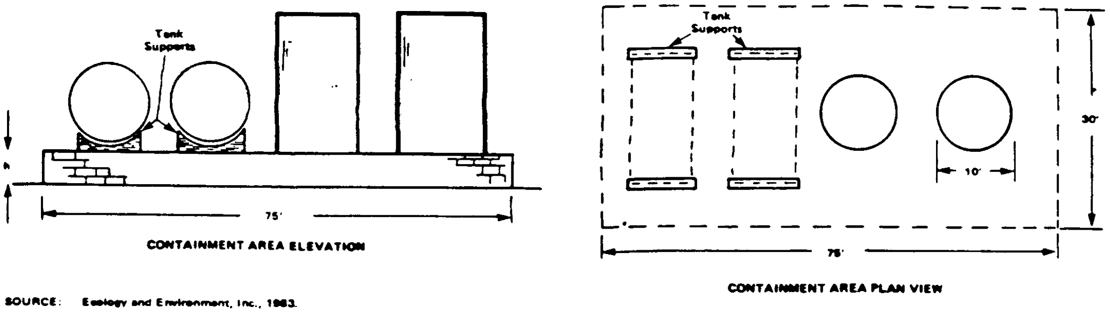
40 CFR 264.221(g) requires HW surface impoundments to have dikes designed to prevent overflow from overfilling, wind and wave action, rainfall, run-on, malfunctions of level controllers, alarms and other equipment, and human error. A surface impoundment should at least two (2) feet of freeboard. However, overflow can be prevented by controlling the filling rate of the impoundment and by providing a means of controlled releases during emergencies, such as overfilling due to rainfall. Also, run-on control should be provided using dikes or diversion channels.

Figure 7-17 shows an example of a surface impoundment containment and diversion structure. The outlet pipe extends through the bottom of the dike into a concrete-lined pump chamber (sump). A sluice gate controls the discharge from the pond to the sump. Pumps, controlled by level indicators and high-level alarms, discharge the wastewater to a treatment unit/plant.

If the capacity of a containment area is insufficient, one or more of the spill containment systems discussed in Section 7.2 should be installed. Raising the dike or curb walls, installing a sump or catch basin, or diverting excess volume to a remote containment area are also ways of increasing containment capacity. The best alternative will depend upon space limitations, required volume, feasibility, and costs. In general, containment structures are simpler, more effective, easier to inspect and maintain, and less expensive to construct than diversion structures. However, diversion structures are sometimes the only alternative, particularly for older areas with severe space restrictions. Before diverting flow to a waste treatment area, certain considerations must be evaluated, such as material compatibility, loading capacity, and other factors that could impact on the operation of the area.

7.5 STRUCTURAL STRENGTH

Spill control structures should withstand the fluid loads placed upon them by a full-capacity spill and rainfall. A structural engineer should design these structures according to DM-22 and other appropriate design standards. Poorly designed, constructed, or maintained dikes, particularly concrete blocks, may result in a failure.



CONTAINMENT AREA ELEVATION

CONTAINMENT AREA PLAN VIEW

SOURCE: Ecology and Environment, Inc., 1983.

Computations:

- Measure height (h), length (L), and width (B) of containment structure. Design storm = 6 in.
- Calculate available surface area (A) (ft^2):

$A = A_w - A_t$

where A_W = Walled area

A_t = Floor space inside walled area physically occupied by tanks, containers, and other structures

$A = (75 \times 30) - 2(pi)(10/2)^2$

$A = 2{,}093\ ft^2$

- Calculate available capacity (C) of dike (ft^3):

$C = A \times h$

$C = 2{,}093 \times 2 = 4{,}185\ ft^3$

- Check if available capacity is adequate to hold volume of largest tank/container (V_t):

$V_t = 20{,}000\ gal. \times .1337\ ft^3/gal = 2{,}674\ ft^3/gal = 2{,}674\ ft^3 < 4{,}185\ ft^3$ OK

- Check if containment area allows sufficient freeboard (h_D) for precipitation:

$h_D = [(C - V_t)/A] \times 12$

$h_D = [(4{,}185 - 2{,}674)/2{,}093] \times 12 + 6 = 8.7\ in. > 6\ in.$ OK

Therefore, capacity of containment area is adequate.

Figure 7-16
Example Calculation of Secondary Containment Capacity

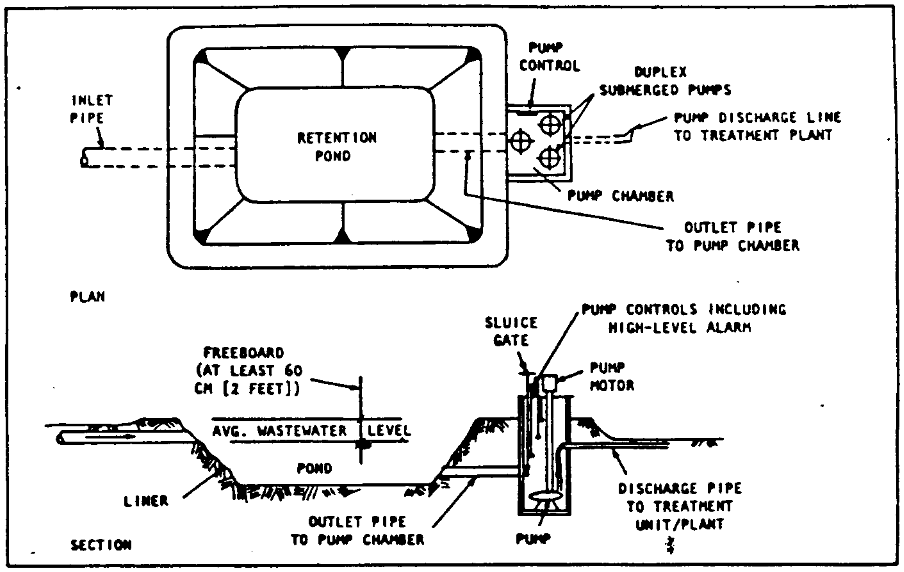


Figure 7-17
Retention Pond with Overflow Prevention And Control System

Fluid density is a major consideration in the selection of secondary containment systems. Since some chemicals have triple the density, or more, of water, secondary containment structures should not be used indiscriminately for substances with greater than design densities.

Surface impoundment dikes must be designed, constructed, and maintained with sufficient structural integrity to prevent massive failure of the dikes (40 CFR 264.221 (h)). Cracks in the structure indicate poor structural strength and integrity. A spill control structure with insufficient structural strength could result in a massive failure (i.e., dike washed away by spill). Such areas should be retrofitted (strengthened or relieved by spill diversion systems or catch basins) or replaced based on a specialist's recommendations.

7.6 IMPERMEABILITY

Both the dike and the bottom of secondary containment structures, retention ponds, and lagoons should be sufficiently impervious to contain and prevent seepage of the spillage until it can be removed or treated. Suitable liner materials include concrete, asphalt, synthetic membranes, reinforced air-blown cement mortar, clay soils, and specially treated bentonite/soil mixtures. The construction material must be suitable for the stored material (i.e. asphalt, will provide impermeable containment for heavier fuels, but not for lighter fuels such as jet fuels).

The Naval Facilities Engineering Command has a Design Manual entitled "Petroleum Fuel Facilities, Design Manual" which contains guidelines on the term impermeable from the BMP perspective as follows:

Earthen dikes shall be constructed of impervious clay or covered with a layer of such clay, concrete, or asphalt with rubberized coal tar sealer. The sides and top of the dike and the basin floor around the tank shall be covered with one of the following materials:

- 3 inches of impervious clay such as bentonite covered by 6 inches of sand and 8 inches of crushed stone.
- 3 inches of concrete paving or air-blown cement mortar reinforced with woven wire fabric. Expansion and contraction joints shall be provided as necessary. Joint material shall be impervious to the fuel.
- 2 inches of impervious asphalt with rubberized coal tar sealer over 4 inches of compacted base course.

It also states that the drainage system can serve more than one storage tank. The drains shall be constructed of petroleum resistant impervious material.

Legally the term impermeable refers to the containment of spills such that they do not reach navigable waters. The material that could potentially spill, needs to be evaluated in conjunction with the spill containment measures to see that a spill not reach navigable waters.

Poured reinforced concrete and asphalt are the most common materials used. Clays are commonly used to construct earthen dikes, due to their relatively impervious characteristics. The containment side of concrete blocks must be treated with sealers. Special epoxy coatings are sometimes used on floors, swales, and channels to provide chemical-resistant and impervious surfaces.

Per 40 CFR 264.221(a), hazardous waste surface impoundments require a liner. Single-liner systems are usually composed of clay or synthetic flexible membranes. However, clay performs poorly with highly acidic or alkaline wastes or wastes with high concentrations of dissolved salts. Table 7-2 presents a summary of flexible membrane liner and applications. Flexible membranes used in an application not shown in this table may leak.

Double-liner systems are generally preferred for hazardous waste surface impoundments. New surface impoundments must have two or more liners and a leachate collection system between such liners (40 CFR 264.221(c)). The leachate collection system may consist of a sand, gravel, and/or geotextile layer underlying the entire area to provide continuous coverage. A typical double-lined hazardous waste surface impoundment with a leachate collection system is illustrated in Figure 7-18.

7.7 COMPATIBILITY

Spill control structures and liners must be compatible with the contained material. Cost and durability are important factors in selecting the lining material. A qualified engineer should evaluate the specific site conditions and construction/lining materials prior to construction.

Signs of erosion, deterioration, or liquid seepage through the control structure can indicate a compatibility problem. Incompatibility problems require prompt correction to prevent the deterioration of the control structure. Lining the surface with a resistant material such as an epoxy coat, tar, or other material is a relatively common and usually an inexpensive method.

7.8 INTEGRITY

Spill control structures should be structurally sound and free of cracks, holes, or other defects that could lead to a structural failure. Breached dike walls, cracked containment floors, unsealed penetrations, and damaged or nonexistent joint sealants are all indications of a breach in the structural integrity of a containment system. If a spill control structure is in poor condition and can not adequately contain a spill, the structure should be repaired or replaced immediately. Any materials used in repairs should be compatible with and resistant to any potentially spilled material.

Table 7-2
Comparison of Various Synthetic Polymeric Membranes

Liner Type	Advantages	Disadvantages	Relative Cost
Polyvinyl Chloride (PVC)	Good resistance to ozone and ultraviolet light when properly stabilized Good resistance to puncture, abrasion, and microbial activity High tensile strength	Poor resistance to hydrocarbons, solvents, and oils May deteriorate in presence of certain chemicals and in contact with heat	Low
Oil-Resistant PVC	Improved resistance to aromatic hydrocarbons relative to standard grades of PVC	Poor low temperature handling properties	Moderate to high
Polyethylene*	Excellent resistance to bacterial deterioration Good tensile strength Few restrictions on chemical exposure Good low-temperature characteristics	Poor puncture resistance Poor tear strength Susceptible to weathering and stress cracking	Low
Chlorinate Polyethylene (CPE)	Excellent weatherability Good tensile and elongation strength Good resistance to ultraviolet light and ozone Excellent crack and impact resistance at low temperatures Moderate to good hydrocarbon resistance Resistant to acids and bases	Limited range of tolerance for chemicals, oils, and solvents Low recovery when subject to tensile stress	Moderate
Butyl Rubber (continued)	High tolerance for temperature extremes Good tensile and shear strength Good resistance to puncture Ages well in general, but some compounds will crack on ozone exposure	Slightly affected by oxygenated solvents and other polar liquids Poor sealability and workability	
Neoprene	Excellent aging and weathering characteristics Overall good resistance to hydrocarbons, but shows some swell when exposed to aromatics and other cyclic hydrocarbons Flexible and elastic over a wide range of temperatures	Not heat- or solvent-sealable	High

Table 7-3 Cont.
Comparison of Various Synthetic Polymeric Membranes

Liner Type	Advantages	Disadvantages	Relative Cost
Elasticized Polyolefin (DuPont 3110)	Resistant to ultraviolet light; does not require earth cover Good resistance to weathering and aging Good resistance to ozone attack and soil microorganisms Good resistance to hydrocarbons: will accommodate a broad range of solvents	Relatively untested Vulnerable at low temperatures	Moderate
Chlorosulfonated Polyethylene (CSPC or Hypalon)	Good puncture resistance Good resistance to microbial attack Excellent resistance to low temperature cracking Excellent weather resistance Good resistance to ozone and ultraviolet light Flexible and resilient	Low tensile strength Poor resistance to aromatic hydrocarbons	
Ethylene Propylene Diene Monomer (EPDM)	Good weathering characteristics Good temperature flexibility Good heat and ultraviolet light resistance Resistant to mildew, mold, and fungus Excellent resistance to water vapor transmission	Low peel and shear strength Not recommended for petroleum, aromatic, or halogenated solvents Resistant only to dilute acids and alkalis	
Butyl Rubber	Excellent resistance to water Excellent resistance to ultraviolet light and ozone	Poor resistance to hydrocarbons, particularly petroleum solvents, aromatics, and halogenated solvents	Moderate to high
Epichlorohydrin Rubbers	Resistant to hydrocarbon solvents, fuels, and oils Resistant to ozone and weathering High tolerance for temperature extremes Good tensile and tear strength	Permeable to gas and water vapor	Moderate

* Refers to low-density polyethylene. High-density polyethylene is much less susceptible to puncture, tear, weathering, and stress cracking.

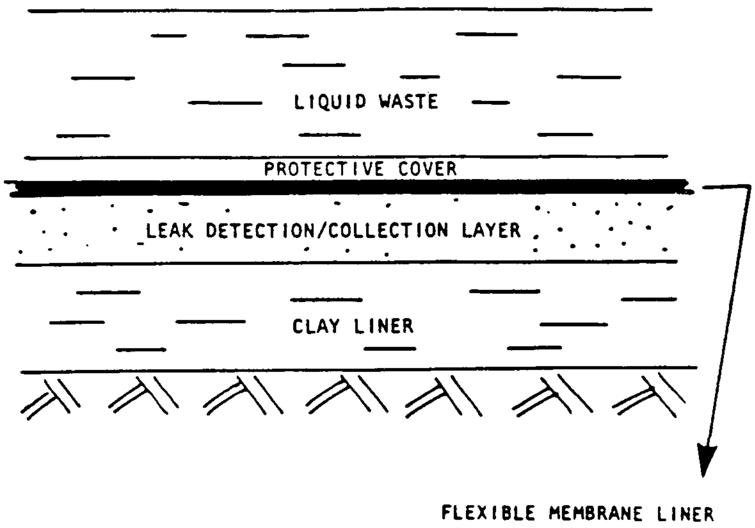


Figure 7-18
Cross Section Of Lined Industrial Waste Impoundment

The integrity of a bulk storage tank's spill containment system includes not only the dike and the floor of the containment area, but also the tank foundation. The bottom of bulk fuel storage tanks can develop leaks that undermine the surrounding soil. To prevent this, DM-22 requires that bulk tanks rest on a reinforced concrete ringwall with compacted fill material inside the ringwall. DM-22 also requires an oil-resistant plastic membrane be installed between the fill and the ringwall. This membrane provides an impervious layer between the tank and the groundwater. A drainpipe installed under the tank through the concrete ring wall drains any water collected between the tank and the membrane. Drainage through this pipe can be an indicator of tank bottom leaks. The only other method to detect and remedy a bulk tank bottom leak is to inspect the inside of the tank regularly; repairs must be done from the inside.

Where transfer and drainage pipelines pierce a spill control structure, they should be grouted to provide a fluid-tight seal.

7.9 FLOODING PROVISIONS

Considerations should be made for flooding potential when designing secondary containment, drainage systems, or treatment units. Retention ponds, basins, and mobile tanks and their associated secondary containment should not be located in flood plans or areas subject to flooding. Information regarding flood plains is available from the U.S. Geological Survey, the Corps of Engineers, or local government agencies.

HW areas regulated by 40 CFR 264 or 265 and located in a 100-year flood plain must be designed to prevent washout of any HW. An exception can be made if the waste can be removed before floodwaters can reach the area.