

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

**DIKE
(Ft.)**

CODE 356

DEFINITION

A barrier constructed of earth or manufactured materials.

PURPOSE

1. To protect people and property from floods.
2. To control water level in connection with crop production; fish and wildlife management; or wetland maintenance, improvement, restoration, or construction.

CONDITIONS WHERE PRACTICE APPLIES

All sites that are subject to damage by flooding or inundation and where it is desired to reduce the hazard to people and to reduce damage to land and property.

Sites where the control of water level is desired.

The dike standard does not apply to sites where NRCS conservation practice standards Pond (378), Water and Sediment Control Basin (638), Diversion (362), or Terrace (600) are appropriate. Dikes used to reduce flooding are normally constructed adjacent and/or parallel to a stream, river, wetland or water body and are not constructed across the stream, river or water body. Dikes used to control water levels usually have small interior drainage areas in relation to the surface area of the regulated water level.

CRITERIA

Classification. The dike classification is determined by the hazard to life, the design water height, and the value of the protected

land, crops, and property. Classification must consider land use changes likely to occur over the life of the dike.

Dikes are classified as Class I when located on sites where failure may cause loss of life or serious damage to homes, primary highways, industrial buildings, commercial buildings, major railroads or important public utilities.

All dikes with a design water height of more than 12 feet above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas shall be classified as Class I.

Dikes are classified as Class II when located on sites where failure may cause damage to isolated homes, secondary highways, minor railroads, relatively important public utilities, high value land, or high value crops.

Dikes are classified as Class III when located on sites where damage likely to occur from failure will be minimal. Class III dikes are further divided into 2 groups. Class III Ag Land dikes are for the purpose of protecting agricultural land of relatively low capability or improvements of low value. Class III Wetland dikes are for the purpose of creating new or developing existing wildlife wetlands.

Constructed Elevation – Flood Prevention.

The constructed elevation of a dike whose purpose is to prevent flooding shall be the sum of the following:

- The water elevation attained by a flood or high tide of the design frequency shown in Table 1 with the critical duration and timing. This is the design high water.

- The larger of the minimum freeboard in Table 1 or the wave height caused by wind or boat traffic.
- The additional freeboard needed for fetch lengths greater than 1000 feet as shown in Table 2.
- The allowance for settlement as shown in Table 3.

Constructed Elevation – Water Control.

The constructed elevation of a dike whose purpose is to control water level shall be the sum of the following:

- The water elevation at the highest water level control.
- The rise in water height above the highest water level control caused by a flood of the design frequency shown in Table 1. This is the design high water.
- The larger of the minimum freeboard shown in Table 1 or the wave height caused by wind of the minimum storm design frequency shown in Table 1.
- The additional freeboard needed for fetch lengths greater than 1000 feet as shown in Table 2.
- The allowances for settlement as shown in Table 3.

Settlement. Settlement shall be based on an analysis of the fill material, foundation material and condition, and compaction methods.

In lieu of an analysis, the minimum allowances for settlement shall be as shown in Table 3.

Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.

For the purpose of this standard, organic soils are described as follows:

- Soil layers that are not saturated with water for more than a few days at a time are organic if they have 20 percent or more organic carbon.

or

- Layers that are saturated for longer periods, or were saturated before being drained, are organic if:
 - They have 12 percent or more of organic carbon and no clay, or
 - 18 percent or more organic carbon and 60 percent or more clay, or
 - A proportional amount of organic carbon, between 12 and 18 percent, if the clay content is between 0 and 60 percent.

or

- All soils described in the local soil survey as an organic soil.

Top Width and Side Slopes. The minimum top widths and side slopes for earth embankments shall be as shown in Table 1.

All dikes must be accessible for maintenance activities. Typically, this may be along the top of the dike or along the berm. Access roads shall provide adequate width for the maintenance equipment and inspection vehicles. The minimum width for vehicular traffic should be 12 feet. Provide wider areas for passing and turning around at regular intervals. Access roads may need to be controlled to prevent vandalism, accidents, and damage.

Berms. The need for a constructed berm on an embankment will be based on the results of an embankment and foundation stability analysis. If a stability analysis is not performed, all earth dikes shall have berms either constructed or occurring naturally on both sides meeting the following criteria:

- Constructed berms shall be at a constant elevation and sloped away from the dike. There shall be a total of 0.2' fall in elevation across the width of the berm.
- Where dikes cross channels, ditches, borrow areas, streams, sloughs, swales, gullies, etc., they shall have a berm constructed on each side. The top elevation of these berms shall be at least 1 foot above the average ground surface on each side of the channel, ditch, borrow area, stream, slough, swales, gully, etc., and sloped away from the dike.

- The minimum top width of natural or constructed berms shall be as shown in Table 1.
- The minimum side slope ratio of constructed berms shall be 2:1 (Horizontal:Vertical).

Earth Dike Materials. Earth dike materials shall be obtained from required excavations, spoil available from excavated drainage channels and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the engineer or designer. Fill materials shall contain no frozen soil, sod, brush, roots, or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to placement and compaction of the fill. The types of materials used in the various fills shall be as listed and described in the specifications and drawings.

Class III Ag Land dikes are usually built where the spoil from excavated drainage channels is available. The design and installation shall be based on engineering surveys and investigations as provided for in the NEH Part 624 (Section 16 Drainage of Agricultural Land) Chapter 2 for mineral soils and Chapter 8 for organic soils.

Class III Wetland dikes shall be constructed on soil suitable for embankment construction and the structure and embankment foundations.

Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition. If the dike is to be constructed in a primary organic material, soil borings will be taken to determine the depth of the organic material. Ordinarily, embankments cannot be constructed in one lift where organic material exceeds 2 feet in depth.

If it becomes necessary to construct a dike with organic material deeper than 2 feet, then suitable mineral earth materials shall be hauled in and used to construct the dike across the area, or this may require construction of the dike in stages that may take several months, or years, during which the dike can be constructed in several stages.

Manufactured Dike Materials. Manufactured materials are erosion resistant materials such as concrete, PVC, steel, or other material that provides the required structural strength and durability for the dike. Dikes constructed of manufactured materials shall have a structural analysis completed for the various loads the dike will be subjected to during its life. These include hydrostatic, ice, uplift, earth, and equipment. The dike shall be analyzed for stability using acceptable safety factors for each loading condition.

Embankment and Foundation Seepage. Embankment and foundation drainage and seepage control shall be designed on the basis of site investigation, laboratory data, seepage analysis, and stability analysis. The resulting design shall minimize seepage, prevent piping or undermining, and provide a stable embankment and foundation.

An analysis is required on all Class I dikes that have a height of six (6) feet or greater and Class II dikes that have a height of eight (8) feet or greater.

In the absence of more detailed data and analysis, the following criteria for a foundation cutoff apply for Class I dikes less than 6 feet in height, Class II dikes less than 8 feet in height and Class III dikes:

- Minimum of H feet deep for $H < 3$ feet.
- Minimum of 3 feet deep for $H \geq 3$ feet.
- Minimum of 4 feet bottom width.
- 1:1 or flatter side slopes.

A stream, channel, ditch, borrow area, slough, swale, gully, etc. shall be far enough away from the dike so that the extension of a line drawn from the design high water elevation on one side of the dike to the dike toe on the opposite side shall not intersect any stream, channel, etc. (See figure 1). This line criterion applies to both sides of the dike. This criterion will minimize the hazard to the dike caused by piping through the foundation.

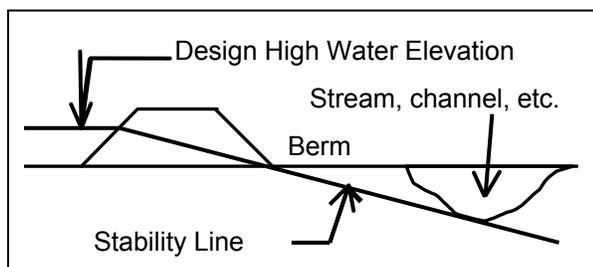


Figure 1

Interior Drainage.

Class I, II and III Ag Land Dikes. Dikes to prevent flooding shall be provided with interior drainage systems for the area being protected. The interior drainage system shall prevent flood damage to the interior area from a flood of the design frequency in Table 1 for both the 1-day and the 10-day storm duration. The interior drainage system may include storage areas, gravity outlets, and pumping plants as needed to provide the required level of flood protection.

All structures shall conform to NRCS conservation practice standard Structure for Water Control (587).

Class III Wetland Dikes. One or more structures shall be provided which will automatically draw water down after rains to the planned surface elevation in the impoundment where there is a contributing drainage area outside the impoundment. However, where the maximum water depth against a dike is 24 inches or less, drawdown structures may be eliminated when recommended by a biologist. Written documentation to the case file is required by the biologist regarding elimination of the water control structure and written documentation by the engineer also to the case file is required regarding requirements for an earthen spillway.

Water control structures may be designed to pass less than the design storm peak flows provided the design frequency event shown in Table 1 is routed and the design height criteria is met. The impoundment shall not be allowed to cause the stage and duration of flooding for the design storm to exceed the stage and duration of the design storm that existed on adjacent property prior to the construction of the dike and water control structures.

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These structures shall consist of one of the following: (1) a weir type drop structure equipped with removable flashboards; (2) a pipe provided with an elbow and riser; (3) a pipe provided with a riser and a gate or plug at the pipe entrance; or (4) a structure of treated timber or concrete approved by the engineer.

Structures to automatically draw water down are not required where there is no contributing drainage area from outside the impoundment, but are recommended.

For Class III Wetland dikes, provisions shall be made to drain water stored in the impoundment area as follows:

FOOD CROP	MINIMUM REMOVAL RATE
Corn, Browntop Millet, Rice	1.5" in 24 hours
Chufas, Japanese Millet	1.0" in 24 hours
Native wetland plants, Bottomland hardwoods	0.5" in 24 hours

Adequate surface drains shall be provided to remove surface water from approximately seventy-five percent (75%) or more of the impoundment area. However, a lesser degree of drainage may be used when recommended by a biologist.

All structures shall conform to NRCS conservation practice standard Structure for Water Control (587).

Pipes. Pipes installed through a Class I dike below the design high water with a dike height greater than 12 feet shall meet the requirements for PRINCIPAL SPILLWAYS as found in NRCS TECHNICAL RELEASE 60 – Earth Dams and Reservoirs, except for the minimum size requirements.

Pipes through all other dikes shall meet the requirements for a principal spillway in NRCS Conservation Practice Standard, Ponds (378).

All dikes shall be protected from scour at pipe inlet and outlet locations by appropriate measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible. Pump discharge pipes shall

be equipped with a flexible connection or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge pipe.

Auxiliary Spillways. When a Class III Wetland dike completely surrounds an impoundment and has no runoff discharging into it an auxiliary spillway is not required. Where there is a contributing drainage area outside the impoundment the auxiliary spillway capacity shall be sufficient to carry the design frequency event shown in Table 1. Reduction of spillway size due to temporary detention may be considered. The auxiliary spillway shall consist of (1) a concrete or earthen spillway, (2) conduit (pipe), or (3) a combination of a concrete or earthen spillway and a conduit. If an earthen spillway is used, the crest of the spillway shall be at least 0.2 foot above the normal reservoir water elevation.

Slope Protection. Slopes of earthen dikes shall be protected from sheet, rill, and gully erosion; erosion from flowing floodwaters; and wave action created by wind and/or boat traffic. Erosion protection measures such as non-woody vegetation, berms, rock riprap, sand-gravel, or soil cement shall be utilized as needed.

Regulatory Requirements. Dikes shall meet the requirements of all federal, state, and local laws or regulations.

CONSIDERATIONS

Flood of Record. For Class I dikes, the flood of record should be considered when establishing the top of dike elevation.

Location. When locating the site for the dike, consider the foundation soils, property lines, setbacks from property lines, exposure to open water, distance to streambanks, availability of outlets by gravity or pumping, buried, utilities, cultural resources, and natural resources such as wetlands, natural areas, and fish and wildlife habitat.

Fluvial geomorphologic concepts contained in National Engineering Handbook (NEH) Part 653, Stream Corridor Restoration Principles,

Processes and Practices should be considered when placing a dike near a stream.

Berms. Give special consideration to wider berms, additional setbacks, or protecting the berm side slope when adjacent to actively eroding or moving streams to protect the dike for its design life.

Adverse Impacts. Adverse environmental impacts from the proposed dike will be evaluated. Any increases in flood stage caused by dike-induced flow restrictions will be evaluated for adverse impacts to unprotected areas. Adverse impacts should be minimized.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

OPERATION AND MAINTENANCE

Operation and maintenance requirements for all dikes will be provided to the landowners. For Class I dikes with a height greater than 12 feet, an emergency action plan meeting the requirements of 500.70 of the National Operation and Maintenance Manual shall be completed prior to construction of the dike. For Class I and Class II dikes, a detailed written Operation and Maintenance Plan in accordance with 500.40 through 500.42 of the National Operation and Maintenance Manual shall be completed and provided to the owner.

All dikes must be adequately maintained to the required shape and height. Vegetation to control erosion shall be established on dikes as required by climatic conditions and the need for protection against wave action according to the guidelines in conservation practice standard 342, Critical Area Planting.

The maintenance of dikes must include periodic removal of woody vegetation which may become established on the embankment. Design of the project shall include provisions for maintenance access. Table 1 – Minimum Design Criteria for Dikes

Classification	Material ^{1/}	Height (H) in Feet ^{2/}	Minimum Storm Design Frequency in Years	Minimum Freeboard in Feet ^{8/}	Min. Top Width in Feet	Min. Side Slope Ratio ^{3/} (H:V)	Berm Width in Feet ^{6/}
Class I	Earth	0 to 6	100	H/3	10	2:1	12
		>6 to 12	100	2	10	Note <u>4/</u>	Note <u>4/</u>
		>12 to 25	100	3	12	Note <u>4/</u>	Note <u>4/</u>
		>25	100	3	14	Note <u>4/</u>	Note <u>4/</u>
	Manufactured	0 to 8	100	H/4	N/A	N/A	Note <u>4/</u>
		>8 to 12	100	2	N/A	N/A	Note <u>4/</u>
>12		100	3	N/A	N/A	Note <u>4/</u>	
Class II	Earth	0 to 6	25	H/3	6	2:1	12
		>6 to 12	25	2	8	2:1	15
	Manufactured	0 to 8	25	H/4	N/A	N/A	Note <u>4/</u>
		>8 to 12	25	2	N/A	N/A	Note <u>4/</u>
Class III Ag Land	Mineral Soils	0 to 3	10	H/3	4	2:1	10 ^{6/}
		> 3 to 6	10	1	6	2:1	10 ^{6/}
		> 6 to 12	10	2	8	2:1	15 ^{6/}
	Organic Soils ^{5/}	0 to 2	10	1	4 ^{7/}	2.5 :1	10
		>2 to 4	10	1	6 ^{7/}	2.5 :1	15 ^{6/}
Class III Wetland	Mineral Soils	0 to 3	10	H/3	0	2:1	10 ^{6/}
		> 3 to 6	10	1	4	2:1	10 ^{6/}
		> 6 to 12	10	2	6	2:1	15 ^{6/}
	Organic Soils ^{5/}	0 to 2	10	1	4 ^{7/}	2.5 :1	10
		>2 to 4	10	1	6 ^{7/}	2.5 :1	15

^{1/} Earth includes rock. Manufactured materials are erosion resistant materials such as concrete, PVC and steel that provides the structural strength for the dike.

^{2/} Height is the difference between normal ground elevation at the dike centerline and the design high water elevation. When determining normal ground elevation, exclude crossings of channels, sloughs, small low areas, small ridges, swales, or gullies.

^{3/} Minimum side slope ratios are for compacted earth fill. Dumped earth fill without compaction will be flatter.

^{4/} Side slope ratios and berm widths shall be determined by a stability analysis.

^{5/} Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.

^{6/} For Class III dikes, a berm width of 8 feet will be allowed on constructed berms.

^{7/} Where water is likely to remain against the dike for extended periods of time (approximately one month or longer) the minimum top width shall be 10 feet.

^{8/} Additional freeboard shall be provided as shown in Table 2, to contain waves, for dikes having longer surface exposure (fetch) than 1000 feet.

Table 2 - Minimum Additional Freeboard Allowance For Fetch in Feet

Design High Water Depth in Feet	Fetch in Feet				
	1001 to 1250	1251 to 1500	1501 to 1750	1751 to 2000	2001 to 5000
2	0.2	0.3	0.4	0.5	1.0
4	0.3	0.4	0.5	0.6	1.2
6	0.3	0.4	0.5	0.7	1.4
8	0.4	0.5	0.6	0.7	<u>1/</u>
10	0.4	0.5	0.7	0.8	
12	0.4	0.6	0.7	0.9	
> 12 to 25	0.5	0.6	0.8	0.9	

1/ Special design required.

Table 3 – Minimum Settlement Allowance for Dikes

Classification	Construction Method	Soil Type	Min. Settlement Allowance in Percent
Class I	Compacted Earthfill ^{1/}	Mineral	5
Class II	Compacted Earthfill ^{1/}	Mineral	5
	Dumped & Shaped ^{2/}		15
	Dropped ^{3/, 4/}		20
Class III Ag Land	Compacted Earthfill ^{1/}	Mineral	5
	Dumped & Shaped ^{2/}		15
	Dropped ^{3/, 4/}		20
	All	Organic	50
Class III Wetland	Compacted Earthfill ^{1/}	Mineral	5
	Dumped & Shaped ^{2/}	Clays and silty soils	15
		Sandy soils	15
	Dropped ^{3/, 4/}	Clays and silty soils	20
		Sandy soils	20
All	Organic	50	

^{1/} Compacted Earthfill is defined as fill material that is compacted as specified by the construction specifications by means of a specified number of passes of compaction equipment such as sheepsfoot rollers or fully loaded scrapers or earthmovers.

^{2/} Dumped & Shaped is defined as fill material hauled from off-site dumped and shaped or scraped on-site and shaped with blade type equipment such as bulldozers, motor graders, or scrapers

^{3/} Dropped is defined as fill material that is excavated adjacent to the dike and dropped from excavation type equipment such as draglines or excavators

^{4/} The use of draglines alone is not recommended for dikes with maximum fill heights exceeding 10 feet.