NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

DIKE

(Ft.)

CODE 356

DEFINITION

A barrier constructed of earth or manufactured materials.

PURPOSE

- To protect people and property from floods.
- To control water level in connection with crop production; fish and wildlife management
- To restore or enhance wetland hydrology

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 will 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 for the purpose of restoring or enhancing wetland hydrology:

Dikes are classified as Class III, AND

The embankment does not cross a perennial stream, AND

Failure of embankment will not result in loss of life; in damage to homes, commercial or industrial buildings, highways, or railroads; or in interruption of the use or service of public utilities**.**

Constructed Elevation:

The constructed elevation of a **Class I, II, or III** dike whose purpose is to prevent flooding will 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 allowance for settlement.

The constructed elevation of a **Class I, II, or III** dike whose purpose is to control water level will 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 design frequency shown in Table 1.
- The allowance for settlement.

The constructed elevation of a **Class III dike** whose purpose is to restore or enhance wetland hydrology will be at a minimum the sum of the following:

- Required Freeboard, as shown in Table 2 for the type of dike
- Water elevation in spillway at design storm frequency as shown in Table 2
- The allowance for settlement as shown in Table 2

Settlement:

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

In lieu of an analysis, the allowance for settlement will be as follows:

- Class I, II and III dikes built for the purpose of flood prevention and water level control constructed of compacted earth fill material will be a minimum of 5% of the dike height.
- Class III dikes built for the purpose of restoring or enhancing wetland hydrology see Table 2.
- For Class II or Class III dikes built for the purpose of flood prevention and water level control, constructed of fill material that is hauled from off-site, dumped, and shaped (referred to as “dumped and shaped”), the allowance for settlement will be a minimum of 15% of the dike height. For fill material that is excavated adjacent to the dike and dropped from the excavator (referred to as “dropped”), the allowance for settlement will be a minimum of 20% of the dike height. The allowance for settlement of dumped and shaped or dropped organic soil fill material will be a minimum of 40% of the dike height. 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, Class I, II and III dikes built for the purpose of flood prevention and water level control:

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:

  (a) They have 12 percent or more of organic carbon and no clay, or

  (b) 18 percent or more organic carbon and 60 percent or more clay, or

  (c) A proportional amount of organic carbon, between 12 & 18 %, if the clay content is between 0 & 60 %.

Or

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

For the purpose of this standard, Class III dikes built for restoring or enhancing wetland hydrology:

Organic soils are described as follows:

All soils described in the NY soil survey listed as organic soil (Histosols) and organic horizons within mineral soils.

Top Width and Side Slopes.

The minimum top widths and side slopes for earth embankments will be as shown in Table 1 (Class I, II and III dikes built for the purpose of flood prevention and water level control), or Table 2 (Class III dikes built for the purpose of restoring or enhancing wetland hydrology).

All dikes must be accessible for maintenance activities. Typically, this may be along the top of the dike or along the berm. Access roads will 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:

Class I, II and III dikes built for the purpose of flood prevention and water level control:

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 **Class I, II and III earth dikes** will have berms either constructed or occurring naturally on both sides meeting the following criteria:

- Constructed berms will be at a constant elevation and sloped away from the dike.
- Where dikes cross channels, ditches, borrow areas, streams, sloughs, swales, gullies, etc., they will have a berm constructed on each side. The top elevation of these berms will 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 will be as shown in Table 1.
- The minimum side slope ratio of constructed berms will be 2:1 (Horizontal: Vertical).

Class III dikes built for the purpose of restoring or enhancing wetland hydrology does not require a constructed berm on the embankment.

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 will 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 will be analyzed for stability using acceptable safety factors for each loading condition.

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

Additional Criteria (Materials) for Class III dikes built for the purpose of restoring or enhancing wetland:

Dikes built from organic soils will have a less permeable center core. The core will have a minimum saturated hydrologic conductivity of 1.40 µ/sec (1.4×10^{-4} cm/sec) determined by the engineer in the field, or be built from manufactured materials.

Embankment and Foundation Seepage.

For Class I, II and III dikes built for the purpose of flood prevention and water level control, the embankment and foundation drainage and seepage control will be designed on the basis of site investigation, laboratory data, seepage analysis, and stability analysis. The resulting design will 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≥3 feet.
- Minimum of 4 feet bottom width.
- 1:1 or flatter side slopes.

For Class III dikes built for the purpose of restoring or enhancing wetland hydrology:

- Provide a core trench under the embankment if more than two (2) feet of water is impounded.
- All subsurface drainage must be removed from under the footprint of the dike and upslope to the minimum distance in Table 1 of the Wetland Restoration Standard (657).

Interior Drainage.

For All Dike Classifications and Purposes: a stream, channel, ditch, borrow area, slough, swale, gully, etc. will 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 will 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.

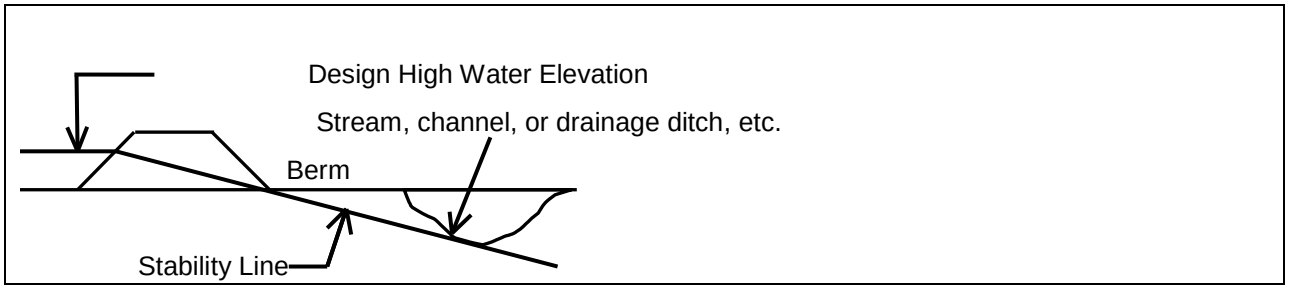

Figure 1

Additional Criteria (Interior Drainage) for Class I, II and III dikes built for the purpose of flood prevention and water level control:

Interior drainage will be provided for the area being protected. The interior drainage system will 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.

Pipes. Pipes installed through a Class I dike below the design high water with a dike height greater than 12 feet will 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 Class II and III dikes built for the purpose of water control and flood prevention will meet the requirements for a principal spillway in NRCS Conservation Practice Standard, Ponds (378).

Dikes will be protected from scour at pipe inlet and outlet locations by appropriate measures. A pump discharge pipe through a dike will be installed above design high water, if appropriate. Pump discharge pipes will be equipped with a flexible connection or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge pipe.

Additional Criteria (Interior Drainage) for Class III dikes built for the purpose of restoring or enhancing wetland hydrology:

Water Control Structures installed through the dike are permitted for vegetative and water level management only (i.e. trickle tube).

Spillway Systems for Class III dikes built for the purpose of restoring or enhancing wetland hydrology

Trickle Tube (i.e. Water Control Structures) installed through the dike are permitted for vegetative and water level management only, and are not meant to function as a “first used” principle or an auxiliary spillway.

Spillway systems for wetland restoration/enhancement projects will be designed based upon the following Criteria **and** Table 2

(A): Dikes with less than a 50 acre drainage area AND drainage area slope less than 10%:

The earth embankment crest may serve as a principle spillway where flows are infrequent enough to establish and maintain vegetation on the embankment.

(B): Dikes with a greater than 50 acre drainage area and/or slopes in excess of 10%:

A spillway system will be provided.

Spillway systems will be erosion resistant and capable of handling the full design discharge.

Install measures to control water, such as armoring with rock, etc., to help maintain and establish vegetation on the embankment and in the spillway

For sites with favorable storage conditions, the 25 year peak discharge may be flood routed to reduce the size of the spillway. A natural swale may be utilized as the spillway if it meets the required capacity and velocity.

(C): Closed Dikes (water source from flood events and precipitation only)

Provide a hardened spillway to allow flood water into and out of the impoundment area.

The top of settled embankment will be a minimum of 0.5' above the spillway crest

Slope Protection:

Slopes of all earthen dikes will 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 will be utilized as needed.

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

Adverse Impacts. Adverse environmental impacts from any 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.

Additional Criteria (Adverse Impacts) for Class III Dikes for the purpose of restoring/enhancing wetland hydrology:

The work associated with installation of the dike will not adversely affect adjacent properties or other water users unless agreed to by signed written letter, easement or permit.

CONSIDERATIONS

Flood of Record. For Class I dikes, the flood of record will 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.

Hardened Spillways: Consider armoring the spillway to minimize erosion and Operation and Maintenance issues

Beaver Protection: Consider using an anti-vortex device and trash guard around low flow trickle tubes, and armoring the low flow spillway to deter beaver activity.

Floodplain: Consider the impacts on the floodplain flows when designing a closed dike.

PLANS AND SPECIFICATIONS

Plans and specifications will be prepared in accordance with the criteria of this standard and will 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 will 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 will be completed and provided to the owner.

Erosion and sediment control structures will be maintained periodically and after every major runoff event until the disturbed area is fully protected.

REFERENCES

New York Standards and Specifications for Erosion and Sediment Control (blue book)
http://www.dec.ny.gov/chemical/29066.html

Drainage Guide for New York State
ftp://ftp-fc.sc.egov.usda.gov/NY/engineering_tools/drainage_guide_ny.pdf

New York Soil Survey
http://www.soils.usda.gov/survey/geography/ssurgo/

NRCS EFH, Chapter 13 – Wetland Restoration, Enhancement or Creation
http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17765.wba

NRCS Wetland Science Institute - Wetland Restoration, Enhancement and Management

NRCS Technical Note #4
ftp://ftp-fc.sc.egov.usda.gov/NDCSMC/Stream/pubs/TechNote4_UnderstandingFluvialSystems.pdf

Table 1

Minimum Design Criteria for Class I, Class II and Class III Dikes built for the Purpose of Flood Prevention and Water Level Control

Classification	Material [1/]	Height (H) in Feet [2/]	Minimum Storm Design Frequency in Years	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio [3/] (H:V)	Berm Width in Feet
Class I	Earth	0 to 6	100	H/3	10	2:1	12
		>6 to 12	100	2	10	Note 4/	Note 4/
		>12 to 25	100	3	12	Note 4/	Note 4/
		>25	100	3	14	Note 4/	Note 4/
	Manufactured	0 to 8	100	H/4	N/A	N/A	Note 4/
		>8 to 12	100	2	N/A	N/A	Note 4/
		>12	100	3	N/A	N/A	Note 4/
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 4/
		>8 to 12	25	2	N/A	N/A	Note 4/
Class III	Mineral Soils	0 to 3	10	H/3	4	2:1	8
		>3 to 6	10	1	6	2:1	8
		>6 to 12	25	2	8	2:1	8
	Organic Soils [5/]	0 to 2	10	H/2	4	2:1	10
		>2 to 4	10	1	6	2:1	10
		>4 to 6	10	2	8	2:1	15

[1/] Earth include 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 will 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 d

Table 2 – Design Criteria for Class III Dikes built for the Purpose of Restoring or Enhancing Wetland Hydrology

	Type	Height	Minimum Design Storm	Minimum Free Board	Minimum Top Width	Minimum Side Slope	Overfill for settlement (% of height)
Earthen	**A**	**≤ 6**	10 year	0	6	5:1	5%
	B	**≤ 6**	25 year	0.5 (1)	6	3:1	5%
Closed (2)	**C**	**≤ 6**	N/A	N/A	6	5:1	10%
Organic (3,4)	**A**	**≤ 6**	10 year	0	20	10:1	20%
	B	**≤ 6**	25 year	0.5	20	10:1	20%
Manufactured	**A**	**≤ 6**	10 year	0	N/A	N/A	N/A
	B	**≤ 6**	25 year	0.5	N/A	N/A	N/A

(1) No Free board needed if downstream side slopes = 5:1 or flatter
(2) Water source is from flood events and precipitation only, closed off to external watershed
(3) All soils described in NY soil survey listed as organic soil (Histosols) and organic horizons within mineral soils
(4) Organic soils will be constructed with an impermeable center core