United States Department of Agriculture

Natural Resources Conservation Service CONSERVATION PRACTICE STANDARD DIKE

CODE 356

(ft)

DEFINITION

A barrier constructed of earth or manufactured materials.

PURPOSE

This practice is used to accomplish one or more of the following purposes–

- To protect people and property from floods
- 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 the Pond, Water and Sediment Control Basin, Diversion, or Terrace standards 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 comparison to the surface area of the regulated water level.

CRITERIA

General Criteria Applicable to All Purposes

Classification

The dike classification is determined by the hazard to life 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.

Class I dikes are located on sites where failure of the dike may cause loss of life or serious

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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 (3.7m) above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas shall be Class I.

Class II dikes are located on sites where failure of the dike may cause damage to isolated homes, secondary highways, minor railroads, relatively important public utilities, high value land, or high value crops.

Class III dikes are located on sites where damage likely to occur from failure will be minimal.

Constructed Elevation
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 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 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 in Table 1. This is the design high water.
- The larger of the minimum freeboard in Table 1 or the wave height caused by wind of the design frequency in Table 1.
- The allowance for settlement.

Settlement
The allowance for settlement of compacted earth fill material shall be a minimum of 5 percent of the dike height unless an analysis shows that a lesser amount is adequate. For fill material that is hauled from off- site, dumped, and shaped (referred to as “dumped and shaped”), the allowance for settlement shall be a minimum of 15 percent 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 shall be a minimum of 20 percent of the dike height. The allowance for settlement of dumped and shaped or dropped organic soil fill material shall be a minimum of 40 percent of the dike height.

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.
- 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.

- 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 that shown in Table 1.

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 done, 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.
- 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 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 slope 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.
- Slope protection shall be determined and installed based on site conditions.

Dike Materials
Manufactured materials are non-erosive materials such as concrete, PVC, and steel that provides the structural strength for the dike. Manufactured dike 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.

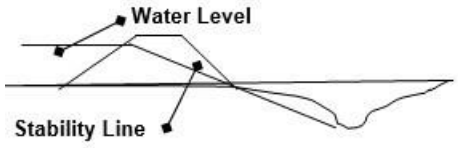
Earth dike materials should be a well-graded mineral soil with a minimum of 95 percent passing the Standard Number 4 Sieve and no fraction being larger than 6 inches in diameter.

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.

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 (H = dike height):

- Minimum of H feet deep for H<3 feet
- Minimum of 3 feet deep for H³3 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. 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.



Interior Design
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.

Pipes
Pipes 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 Class I and Class II dikes shall meet the requirements for a principal spillway in Practice Standard 378, Ponds.

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.

Protection
Dikes shall be protected from sheet, rill, and gully erosion, erosion from flowing floodwaters, and wave action created by wind and/or boat traffic.

A protective cover of grasses shall be established on exposed surfaces of the dike and other disturbed areas, as needed to prevent erosion. Seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with the recommendations in the standard for Critical Area Planting (342).

If grass vegetation will not control erosion, rock riprap, sand-gravel, soil cement, or special vegetation shall be utilized as needed.

Regulatory Requirements
This practice must conform to all Federal, State, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, land disturbance by construction, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

CONSIDERATIONS

General Considerations

Flood of Record
When establishing top of dike elevation for Class I dikes, the flood of record should be considered if it exceeds the minimum 100 year design frequency.

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 geomorphological concepts contained in NEH Part 653, Stream Corridor Restoration Principles, Processes, and Practices should be evaluated when placing a dike near a stream.

Access
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 one-way 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
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

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 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.

Typical items related to proper operations of a dike include, but are not limited to, the following:

- Inspect regularly for damage, especially after storm events. Items to monitor include settlement, seepage, soil cracking, animal burrows and trails, pipe structures, and control gates.

Typical items related to proper maintenance of a dike include, but are not limited to, the following:

- Vegetation should be maintained by removing or reseeding as needed. Earth fill, riprap, and other structural components need to be repaired in a timely manner.

Table 1 – Minimum Design Criteria

Minimum Dike Class	Dike Material[1]	Height (H) in Feet[2]	Minimum Design Frequency in Years	Minimum Freeboard in Feet	MinimumTop Width in Feet	Minimum Side Slope Ratio[3]	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

Minimum Dike Class	Dike Material[1]	Height (H) in Feet[2]	Minimum Design Frequency in Years	Minimum Freeboard in Feet	MinimumTop Width in Feet	Minimum Side Slope Ratio[3]	Berm Width in Feet

[1] Earth includes rock. Manufactured materials are non-erosive 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.

REFERENCES

NONE.