

**Natural Resources Conservation Service  
Conservation Practice Standard**

**DIKE  
(Ft.)  
CODE 356**

**DEFINITION**

An embankment constructed of earth or other suitable materials to protect land against overflow or to regulate water.

**PURPOSE**

- To permit improvement of agricultural land by preventing overflow and better use of drainage facilities.
- To prevent damage to land and property.
- To facilitate water storage and control in connection with wildlife, irrigation, and other developments. Dikes can also be used to protect natural areas, scenic features and archeological sites from damage.

**CONDITIONS WHERE PRACTICE APPLIES**

1. Class I dikes are those constructed on sites where:
  - a. Failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads, and high value land, crops, or other improvements.
  - b. Unusual or complex site conditions require special construction procedures to ensure satisfactory installations.
  - c. Protection is needed to withstand more than 12 ft of water above normal ground surface, exclusive of crossing of sloughs, old channels, or low areas.
2. Class II dikes are those constructed in highly developed and productive agricultural areas where:
  - a. Failure may damage isolated homes, highways or minor railroads, or cause interruption in service of relatively important public utilities.
  - b. The maximum design water stage against the dike is 12 ft.
3. Class III dikes are those constructed in rural or agricultural areas where:
  - a. Damage likely to occur from dike failure is minimal.
  - b. The maximum design water stage against the dike is 6 ft for mineral soils and 4 ft for organic soils. (Exclude channels, sloughs, swales, and gullies in determining the design water stage.)
4. Class IV dikes are those constructed for wetland hydrology restoration where:
  - a. Failure is unlikely to cause damage (other than minimal damage).
  - b. The maximum design water stage against the dike is 6 ft. (Exclude channels, sloughs, swales, and gullies, in determining the design water stage.)
  - c. The embankment materials consist of mineral soils.
  - d. The work is confined to rural or remote agricultural areas.

Conservation practice standards are reviewed periodically and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

## CRITERIA

### General

In locating dikes, careful considerations shall be given to preserving natural areas, fish and wildlife habitat, woodland, and other environmental resources. If dike construction will adversely affect such values, concerned public agencies and private organizations shall be consulted about the project.

Protection. A protective cover of grasses shall be established on all exposed surfaces of the dike and other disturbed areas. Seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with recommendations in local technical guides.

If vegetation will not control erosion, riprap or other protective measures shall be installed.

Maintenance. All dikes must be adequately maintained to the required shape and height. The maintenance of dikes must include periodic removal of woody vegetation that may become established on the embankment. Provisions for maintenance access must be provided.

### Design-all classes

Interior drainage. 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 and 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 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).

### Design - class I dikes

Location. Conditions to be considered in designing Class I dikes are foundation soils, property lines, exposure to open water, adequate outlets for gravity or pump drainage, and access for construction and maintenance. Mineral soils that will be stable in the dike embankment must be available.

Height. The design height of a dike shall be the design high water depth plus 2 ft of freeboard or 1 ft of freeboard plus an allowance for wave height, whichever is greater. Design elevation of high water shall be determined as follows:

- a. If dike failure is likely to cause loss of life or extensive high-value crop or property damage, the elevation of design high water shall be that associated with the stage of the 100-year-frequency flood or of the maximum flood of record, whichever is greater.
- b. If dike failure is unlikely to result in loss of life or extensive high-value crop or property damage, the elevation of design high water shall be that associated with the peak flow from the storm that will insure the desired level of protection or the 50-year-frequency flood whichever is greater.
- c. If the dike will be subject to stages from more than one stream or source, the criteria indicated shall be met for the combination that causes the highest stage.
- d. If the dike will be subject to tidal influence as well as streamflow, the streamflow peak shall be assumed to occur in conjunction with the mean high tide to determine the design high water depth.

The design height of the dike shall be increased by the amount needed to insure that the design top elevation is maintained after settlement. This increase shall be not less than 5 percent.

Interior drainage. If inflow from the area to be protected by the dike may result in loss of life or extensive high-value crop property damage, provisions shall be included in the plans to

provide interior protection against a 100-year-frequency hydrograph, plus base flow, and an allowance for seepage, and may include storage areas, gravity outlets, or pumping plants, alone or in combination.

If inflow from the area to be protected by the dike is unlikely to result in loss of life or extensive high-value crop or property damage, storage areas, gravity outlets, or a pumping plant, alone or in combination, shall be included in the plans and designed to handle the discharge from the drainage area based on drainage requirements established for the local area or the peak flow from the storm that will insure the desired level of protection, whichever is greater.

In sizing outlet works in combination with available storage, the minimum design storm duration for interior drainage shall be 10 days. If outlet works are designed using peak flood frequency flows without considering storage, the minimum design storm duration shall be 24 hours.

Embankment and foundation. Embankments shall be constructed of mineral soils, which when placed and compacted will result in a stable earth fill. No organic soil shall be used in the dike. Soils must have high specific gravity and be capable of being formed into an embankment of low permeability. The design of the embankment and specifications for its construction shall give due consideration to the soil materials available, foundation conditions, and requirements for resisting the action of water on the face of the dike and excessive seepage through the embankment and the foundation. The design of the embankment and the foundation requirements shall be based on the length of time and height that water will stand against the dike.

Minimum requirements for certain features of the embankment, the foundation, and borrow pits are as follows:

- a. Minimum top width of Class I dikes shall be 10 ft for embankment heights of 15 ft or less and 12 ft for heights more than 15 ft. If maintenance roads are to be established on the dike top, "turnarounds" or passing areas shall be provided, as needed.

- b. Side slopes shall be determined from a stability analysis, except that an unprotected earth slope on the water side shall not be steeper than 4 horizontal to 1 vertical if severe wave action is anticipated.
- c. If dikes cross old channels or have excessively porous fills or poor foundation conditions, the landslide toe shall be protected by a banquette or constructed berm. Banquettes shall be used to provide construction access and added stability if channel crossings are under water or saturated during construction. Banquettes shall be designed on the basis of site investigations, laboratory analysis, and compaction methods. The finished top width of the banquettes shall not be less than the height of dike above mean ground. The finished top of the banquettes shall not be less than 1 ft above mean ground and shall be sloped away from the dike.
- d. A cutoff shall be used if foundation materials are sufficiently pervious to be subject to piping or undermining. The cutoff shall have a bottom width and side slopes adequate to accommodate the equipment to be used for excavation, backfill, and compaction operations. It shall be backfilled with suitable material placed and compacted as required for the earth embankment. If previous foundations are too deep to be penetrated by a foundation cutoff, a drainage system adequate to insure stability of the dike shall be used.

Ditches and borrow pits. Landside ditches or borrow pits shall be located so the hazard of failure is not increased. Ditches for borrow pits when excavated on the water side of dikes shall be wide and shallow. Plugs, at least 15 ft in width, shall be left in the ditches at intervals not greater than 400 ft to form a series of unconnected basins.

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

Fill height	Minimum berm width
Less than 6 ft	12 ft
More than 6 ft	18 ft

A drainage system shall be used if necessary to insure the safety of a dike. Toe drains, if used, shall be located on the landside and shall have a graded sand-gravel filter designed to prevent movement of the foundation material into the drain.

Subsurface drains shall not be installed, or permitted to remain without protection, closer to the landside toe of a dike than a distance three times the design water height for the dike. If subsurface drains are to be installed or remain closer than the distance stated, protection shall consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

Pipes and conduits. Dikes shall be protected from scour at pump intakes and discharge locations by appropriate structural measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible, or be equipped with antiseep collars.

All conduits through a dike below the design high waterline shall be equipped with antiseep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed water line shall be equipped with a Dayton or a similar coupling to prevent vibration of the pumping plant being transmitted to the discharge conduits.

**Design - class II dikes**

Design water stage. The maximum design water stage permitted is 12 ft above normal ground level exclusive of crossings at channels, sloughs, and gullies.

If the design water depth against dikes, based on the required level of protection, exceeds 4 ft the design shall be based on at least a 25-year-frequency flood. If this degree of protection is not feasible, the design shall approach the 25-year flood level as nearly as possible, and planned fuse plug sections and other relief measures shall be installed where appropriate.

Height. The design height of an earth dike shall be the design water depth plus a freeboard of at least 2 ft or freeboard of 1 ft

plus an allowance for wave height, whichever is greater.

The constructed height of the dike shall be the design height plus allowance for settlement necessary to insure that the design top elevation is maintained but shall be no less than 5 percent of the design height.

Interior drainage. Provisions must be made for adequate drainage for the area to be protected by the dike.

Cross section. The minimum requirements for the cross section of the dike where fill is compacted by hauling or special equipment shall be as follows:

Design water height	Minimum top width	Steepest side slope
<i>ft</i>	<i>ft</i>	
0-6	6	1-1/2:1
6-12	8	2:1

If soils or water conditions make it impractical to compact the dike with hauling or special equipment, dumped fill may be used and shall have minimum cross section dimensions incorporated in the fill as follows:

Design water height	Minimum top width	Steepest side slope
<i>Ft</i>	<i>ft</i>	
0-6	8	2:1
6-12	10	2-1/2:1

Side slopes of 3 horizontal to 1 vertical on waterside and 2:1 on landside may be used instead of 2-1/2:1 for both slopes.

The cross sections shall be strengthened or increased as required to provide additional protection against floods of long duration. The top width shall be less than 10 ft if a maintenance road is planned on top the dike. "Turnarounds" or passing areas shall be provided as required on long dikes.

The side slopes shall be 3:1 or flatter on the waterside if severe wave action is expected or if a steeper slope would be unstable under rapid drawdown conditions. Side slopes shall be 3:1 or flatter on both sides where

permeable soils of low plasticity, such as SM and ML, are used in construction.

A banquette (or constructed berm) shall reinforce the landside toe if a dike crosses an old channel or if excessively porous fill or poor foundation conditions justify such reinforcement. Such banquettes shall be used if, during construction, the channel crossing is under water or saturated. The top width of the banquette shall be equal to or greater than the fill height of the dike above the top of the banquette unless a detailed investigation and analyses show a different design is adequate.

Foundation cutoff. A cutoff shall be installed if there are layers of permeable soils or layers creating a piping hazard through the foundation at a depth less than the design water depth of the dike below natural ground level. The cutoff trench shall be of sufficient depth and width and filled with suitable soils to minimize such hazard.

Ditches and borrow pits. Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

Fill height	Minimum berm width
Less than 6 ft	10 ft
More than 6 ft	15 ft

A landside ditch or borrow pit shall be far enough away from the dike to minimize any hazard to the dike because of piping through the foundation.

For dikes having a design water depth of more than 5 ft, the landside ditch or borrow pit shall be far enough away from the dike so that a line drawn between the point of intersection of the design waterline with the waterside of the dike and the landside toe of a dike meeting minimum dimensional requirements shall not intersect the ditch or borrow pit cross section.

Pipes and conduits. The dike shall be protected from scour at a pump intake and discharge by appropriate structural measures. A pump discharge pipe through the dike shall be installed above design high water, if feasible, or else equipped with antiseep collars.

All conduits through the dike below the design high waterline shall be equipped with antiseep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed waterline shall be equipped with a Dayton or a similar coupling to prevent vibrations of the pumping plant being transmitted to the discharge conduits.

Drains. Drains shall be used where necessary to insure safety of dikes and shall be located on the land side, have a graded sand-gravel filter, and be designed and installed in accordance with Natural Resources Conservation Service standards for such drains.

Field subsurface drains shall not be installed or permitted to remain without protection closer to the landside toe of a dike than a distance three times the design water height for the dike. If such drains are to be installed or remain closer than the distance stated above, protection shall consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

### **Design - class III dikes**

The design criteria shall be based on site conditions for mineral or organic soils as applicable.

Top width. Minimum top width is 4 ft.

Side slopes. Minimum side slope is 1:1.

Freeboard. The minimum freeboard is 1 ft plus wave height. The constructed height shall be increased by the amount necessary to insure that the settled top is at design elevation but not less than 5 percent.

Foundation cutoff. A cutoff shall be installed if necessary to insure dike stability.

Ditches and borrow pits. Minimum berm widths between the toe and the dike and the edge of the excavated channel or borrow shall be two times the depth of the ditch but not less than 8 ft.

Permanent Pads. Permanent pads constructed around the perimeter of a field to

the extent necessary to control the level of irrigation water shall have a top width of not less than 12 feet and no more than 24 feet. The maximum fill height shall be 3 feet. Sideslopes shall be no steeper than 1.5 horizontal to 1.0 vertical and no flatter than 3.0 horizontal to 1.0 vertical.

**Design – class IV dikes**

The design criteria shall be based on site conditions for mineral soils only (not organic.)	
Design Storm	2" removal/24 hrs. Where Drainage Area is controlled by a land management unit established by easement or ownership. 6" removal/24 hrs. (Offsite Drainage Area)
Pipes, Conduits, Weirs, and other Structures	All pipes, conduits, weirs, and other structures shall be installed in accordance with Grade Stabilization Structure Specifications (410) or Structures for Water Control (578), National Handbook of Conservation Practices. Where a pipe structure is used, the minimum size shall be 15" diameter. Additional features may be required on pipe and riser structures to facilitate operation as designed.
Top Width	12.0'
Side Slopes	6:1 all sides
Emergency Spillway	20' (min.) width per 100 acres of drainage area 1.0' between Principal Spillway & ESW unless otherwise approved by NRCS. Spillway details will be shown on all drawings (ie. widths, side slopes, kickers, and exit slopes). On non-spillway end, the embankment will be tied and blended to natural ground when natural ground elevation is greater than or equal to top of embankment elevation within 75' from end of dike. Otherwise, embankment end will descend with a 6:1 slope to an elevation on natural ground 0.5' above emergency spillway elevation.
Freeboard (Max. Design Height)	1.0 between ESW and Top of Dike. The design height of the dike shall be increased by the amount needed to insure that the freeboard elevation is maintained after settlement.

	This increase shall be not less than 5 percent.
Berm Width	Minimum berm width between the toe and the edge of the excavated channel or borrow shall be 10 feet. 10.0' Toe to Cut (Minimum)
Control Flow	Pipe Flow
Embankment Material	Compaction shall be C class-optimum moisture. Section (c)(1) Part (ii) through (v) Chapter 13, EFH shall be used as a guide for embankment design. Site conditions for which this standard are based are typically classified as CH, CL, OL, or MH as described in Table 13-2 of the EFH.
Foundation Prep for Fill Placement	All levee bankments shall be constructed with a minimum distance of 50' between the downstream toe and the top bank of any existing stream, ditch, or water body. Under normal conditions (foundation void of permeable soil layers) the surface shall be stripped and scarified.
Microtopography Excavation	6.1 Side Slopes (Minimum) 30' Width (Minimum)
Microtopography Mounds	6.1 Side Slopes (Minimum) 60' Width (Minimum) 2' Height (Maximum)

**CONSIDERATIONS**

Water quantity

- Effects upon components of the water budget, especially on volumes and rates of runoff, infiltration, evaporation, and transpiration.
- Potential for changes in rates of plant growth and transpiration because of changes in the volume of soil water.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Effects on the rate or volume of downstream flow to prohibit environmental, social, or economic effects.

Water quality

- Effect on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.
- Effects on the movement of dissolved substances to ground water.
- Short-term, construction, and maintenance related effects on the quality of water resources.
- Potential for earth moving to uncover or redistribute toxic materials such as saline soils and make them available for undesirable effects on water or vegetation.
- Effects on temperature of water resources to prevent undesired effects on aquatic and wildlife communities.
- Effects on wetlands or water-related wildlife habitats that would be associated with the practice.
- Effects on the visual quality of water resources.

#### **PLANS AND SPECIFICATIONS**

Plans and specifications for constructing dikes shall be in keeping with 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. 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 for Class I and Class II dikes.