NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

TERRACE

(Feet)
Code 600

DEFINITION

An earth embankment, a channel, or a combination ridge and channel constructed across the slope.

PURPOSE

- Reduce soil erosion.
- Retain runoff for moisture conservation.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to cropland and other land where:

1. Soil erosion by water is a problem,
2. There is a need to conserve water,
3. The soils and topography are such that terraces can be constructed and farmed with reasonable effort,
4. A suitable outlet can be provided, or
5. Excess runoff is a problem.

CRITERIA

General Criteria Applicable To All Purposes

All planned work shall comply with Federal, state, and local laws, rules and regulations. Plans for terraces may need to be permitted by the appropriate Water Management District (WMD) and comply with the appropriate WMD rules contained in Chapter 40-4 Florida Administrative Code (F.A.C.), Environmental Resource Permits: Surface Water Management Systems; Chapter 40-40 F.A.C., Standard General Environmental Resource Permits: Regulation of Stormwater Management Systems; Chapter 40-41 F.A.C., Environmental Resource Permits: Surface Water Management Basin Criteria; Chapter 40-42 F.A.C., Environmental Resource Permits: Regulation of Stormwater Management Systems; Chapter 40-44 F.A.C., Environmental Resource Permits: Regulation of Agricultural Surface Water Management Systems.

Impact to cultural resources, wetlands and Federal and state protected species shall be evaluated and avoided or minimized to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National and Florida policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH) Florida Supplements to Parts 600.1 and 600.6, National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).

Spacing. Determine the maximum spacing for terraces for erosion control by one of the following methods:

1. VI = xs + y or HI = (xs + y) (100/s)

Where:

VI = vertical interval in feet

HI = horizontal interval in feet (see Figures 1 and 2)

x = 0.4 (value of x varies by geographical region from 0.4 to 0.8. For Florida, a value of 0.4 is used.)

s = land slope in percent

y = a variable with values from 1.0 to 4.0.

Values of y are influenced by soil erodibility, cropping system, and crop management practices. Select a value of 1.0 for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. Use a value of 4.0 for erosion-resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent per acre) on the surface. Use a value of 2.5 if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 and 4.0 may be used according to the estimated quality of the factors. For convenience in tillage and other farming operations, a minimum horizontal interval of 90 feet may be used. Table 1 shows HI and VI values for various slopes and y values.

For level terraces used for erosion control and water conservation, determine the spacing as indicated above. An x value of 0.8 may be used for all level terraces used primarily to impound water. Figures 1 and 2 show the horizontal interval or erosion length to be used in calculating terrace spacing (Figure 3).

2. Revised universal soil loss equation (RUSLE).

The spacing shall not exceed the critical slope length as determined using RUSLE. When tables are used to calculate critical slope, refer to Table 2 for terrace P factor. Soil loss in the inter-terrace interval must be less than or equal to the allowable soil loss.

In no case shall the maximum horizontal spacing exceed that shown in Table 1 for the condition shown. The maximum limits may not be exceeded when making adjustments indicated below.

Spacing may be increased as much as 10 percent to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet.

Spacing may be increased an additional 10 percent for terraces with underground outlets. Adjust the spacing to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing row widths.

Consider the likelihood of benching of steep slopes by tillage, land forming, and erosion when determining the terrace interval. For example, use the proposed as-built slope and length in RUSLE calculations.

For level terraces used for erosion control and water conservation, determine the spacing as previously described, but in no case shall the maximum horizontal spacing exceed 600 feet. An x value of 0.8 may be used for all level terraces used primarily to impound water. When using the VI or HI spacing method, Figures 2 and 3 show the horizontal interval or erosion length to be used in calculating terrace spacing (Figure 3).

Design guidance for terraces is contained in NRCS Engineering Field Handbook, Part 650, Chapter 8.

Alignment. Cropland terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery.

Capacity. The terrace shall have sufficient capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, increase the capacity by the estimated 10-year sediment accumulation, unless sediment is removed through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have adequate capacity to control a storm of a frequency consistent with the potential hazard. When the capacity is determined by the formula Q = av and the v is calculated by using Manning's formula, use a minimum n value of 0.035 for bare channels. Use Agricultural Handbook Number 667, Stability Design of Grass-lined Open Channels or equivalent for vegetated channels.

Cross section. Proportion the terrace cross section to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 3 feet at the design elevation. The minimum slope of a vegetated front or back ridge is 2 horizontal to 1 vertical (2:1). Terrace ridges, especially those with steep back slopes, can be very hazardous. All cropped terrace slopes that are to be farmed shall be no steeper than those on which farm equipment can operated safely. Potential hazards must be brought to the attention of the responsible person. The opening at the outlet end of gradient and open-end level terraces shall have a cross section equal to that specified for the terrace channel.

End closures. Level terraces may have open ends, partial end closures, or complete end closures. Partial and complete end closures shall be used only on soils and slopes where the stored water will be absorbed by the soil without appreciable crop damage or where underground outlets are provided.

If terraces with closed or partly closed ends are specified, the end closures must be installed before the terraces are completed. Design the end closures so that the water flows over the end closure before overtopping the terrace ridge.

Partial end closures shall not be more than half the effective height of the terrace ridge. Complete end closures are more than half the height of the ridge. The cross section of the closures may be less than the terrace cross section.

Channel grade. Determine channel grade by one of the following methods:

1. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.
2. Maximum channel velocity for cultivated channels shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s; for average soils, 2.0 ft/s; and for easily erodible soils, 1.5 ft/s. Velocity shall be computed by Manning's formula, using an n value of 0.035.

For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. If terraces have an underground outlet, water and sediment will pond in the lower reaches of the channel, thus reducing the velocity in those reaches and allowing steeper channel grades within the impoundment area. Minimum grades shall be such that ponding in the channel caused by minor irregularities will not cause serious damage to crops or delay field operations.

Terrace length. The volume of water stored in level terraces is proportional to the length. Therefore, it is necessary that the length be held within reason so that damage in case of a break is minimized. Level terrace length shall not exceed 3,500 feet unless the channel is blocked at intervals not exceeding 3,500 feet. Normally, the capacity and the nonerosive velocity requirements will control the gradient terrace length.

Table 1 - Vertical Interval (VI) and Horizontal Interval (HI) [1/] for x = 0.4

Slope, %		Value of y		
		1	**2.5**	**4**
2	VI, feet	1.8	3.3	4.8
	HI, feet	90	165	240
3	VI, feet	2.2	3.7	5.2
	HI, feet	73	123	173
4	VI, feet	2.6	4.1	5.6
	HI, feet	65	102	140
5	VI, feet	3.0	4.5	6.0
	HI, feet	60	90	120
6	VI, feet	3.4	4.9	6.4
	HI, feet	57	82	107
7	VI, feet	3.8	5.3	6.8
	HI, feet	54	76	97
8	VI, feet	4.2	5.7	7.2
	HI, feet	53	71	90

[1/] HI values below 90 feet are not requirements. The minimum required spacing is 90 feet.

Table 2 - Terrace P Factors [1/]

Horizontal Interval (ft)	P Factors			
	Closed Outlets [2/]	Open outlets, with percent grade of [3/]		
		0.1 - 0.3	0.4 - 0.7	0.8
< 110	**0.5**	**0.6**	**0.7**	**1.0**
110 - 140	**0.6**	**0.7**	**0.8**	**1.0**
140 - 180	**0.7**	**0.8**	**0.9**	**1.0**
180 - 225	**0.8**	**0.8**	**0.9**	**1.0**
225 - 300	**0.9**	**0.9**	**1.0**	**1.0**
> 300	**1.0**	**1.0**	**1.0**	**1.0**

[1/] If contouring or stripcropping P factors are appropriate, they can be multiplied by the terrace P factor for the composite P factor.

[2/] P factors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.

[3/] The channel grade is measured on the 300 feet of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less.

Figure 1 - Horizontal Interval for Steep Back-Slope Terrace

Figure 2 - Horizontal Interval for Broad-Based Terrace

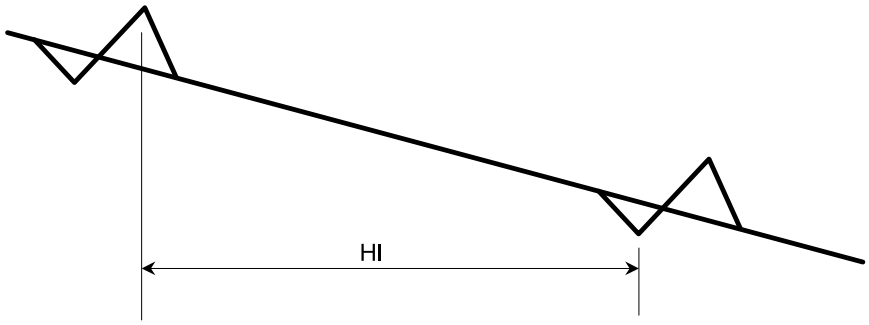
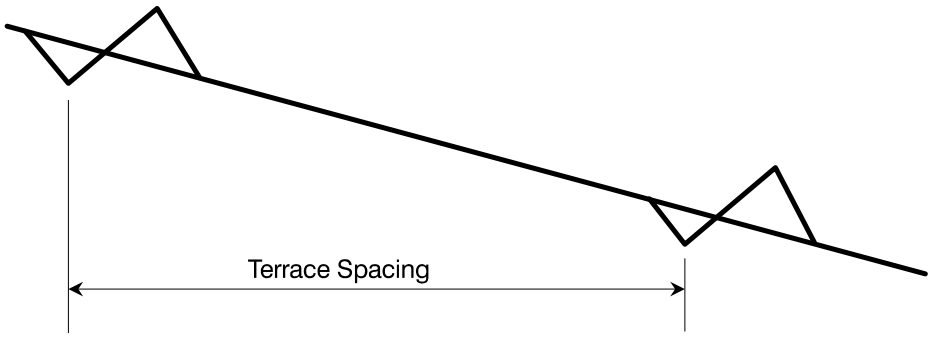


Figure 3 - Terrace Spacing



Outlets. All terraces must have adequate outlets.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway constructed in accordance with Florida NRCS conservation practice standard Grassed Waterway, Code 412 or a vegetated area which will convey runoff without causing erosion. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets shall be installed and vegetation established before the terrace is constructed to provide a stable. The water surface in the terrace shall not be lower than the water surface in the outlet at their junction when both are operating at design flow.

Underground outlets may be used on gradient or level terraces. The outlet consists of an intake and an underground conduit. An orifice plate, increase in conduit size, or other features shall be installed as needed to control the release rate and prevent excessive pressure in the conduit. Design terraces to control a 10-year frequency, 24-hour storm without overtopping. The release time shall not exceed the inundation tolerance of the planned crops. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified in Florida NRCS conservation practice standard Underground Outlet, Code 620 or Subsurface Drain, Code 606. Outlets shall be installed deep enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe of a material suitable for the intended purpose. The inlet shall be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, if necessary, provide for the anticipated accumulation of sediment. The outlet of the conduit shall have adequate capacity for the design flow without causing erosion. Blind inlets may be used where they are effective, usually in well-drained soils.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration must permit drainage of the design storm from the terrace channel within a reasonable period so that standing water does not significantly damage crops.

Combinations of different types of outlets may be used on the same system to maximize water conservation and to provide for economical installation of a more farmable system.

Vegetation. All areas to be vegetated shall be established as soon as practicable after construction. Vegetation shall be in conformance with Florida NRCS conservation practice standard Critical Area Planting, Code 342.

Drainage. Install subsurface drainage to stabilize terrace where needed

Additional Criteria Applicable To Retaining Runoff For Moisture Control

Design terrace capacity in accordance with a water budget analysis.

CONSIDERATIONS

Consider adjusting the spacing to allow an even number of trips with the equipment.

Consider aligning terraces and/or installing subsurface drainage to correct seepage problems.

Combining residue management and terraces can be an effective conservation system. Residue management will reduce soil movement between terraces, which will lessen routine maintenance concern.

Terraces will affect the water budget, especially decreasing the volumes and rates of runoff and increasing the infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

Terraces, especially storage terraces, may effect a change in plant growth and transpiration because of changes in the volume of soil water.

Terraces, especially storage terraces, may increase the movement of dissolved substances such as nutrients and pesticides below the root zone and to the ground water.

Terraces construction may cause short-term increases in sediment in on-site and downstream water.

Construction of terraces may reduce crop production immediately following construction. Special treatment should be given to the disturbed area where soil has been taken to construct the terraces. It may include additional liming, fertilizing, and ripping. Many of the

disturbed areas may need the topsoil replaced after construction of the terraces.

PLANS AND SPECIFICATIONS

Plans and specifications for installing terraces shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

As a minimum, the plans and specifications shall include:

- Site plan layout, cross sections, spacing, and grades for gradient terraces.
- Special outlet requirements, if needed.
- Location of tile outlet structures.
- Typical cross section of the outlet structures.

OPERATION AND MAINTENANCE

An operation and maintenance program will help assure long life and continued benefits from a terrace system. An operation and maintenance program shall be established for maintaining terrace capacity, storage, ridge height, and outlets. An operation and maintenance plan shall be prepared for the operator.

The minimum requirements to be addressed in the operation and maintenance plan are:

- Provide periodic inspections, especially immediately following runoff events.
- Promptly repair or replace damaged components as necessary.
- Maintain terrace ridge height and outlet elevations.
- Remove sediment that has accumulated in the terrace to maintain capacity, a positive channel grade, and to maintain capacity where soil infiltration serves as the outlet.
- Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately.
- Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.
- Vegetated outlets should be established before construction when feasible.
- Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

REFERENCES

Agricultural Handbook Number 667, Stability Design of Grass-lined Open Channels
Florida Agonomy Field Handbook, RUSLE
Florida NRCS Conservation Practice Standards:
Critical Area Planting, Code 342
Grassed Waterway, Code 412
Subsurface Drain, Code 606
Underground Outlet, Code 620
General Manual
Title 420-Part 401
Title 450-Part 401
Title 190-Parts 410.22 and 410.26
National Cultural Resources Handbook
National Environmental Compliance Handbook
National Food Security Act Manual
National Planning Procedures Handbook
Florida Supplements to Parts 600.1 and 600.6
NRCS Engineering Field Handbook, Part 650, Chapter 8
WMD Rules Chapters 40-4, 40-40, 40-41, 40-42, 40-44 F.A.C.