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

This practice may be applied as a part of a conservation management system to support one or more of the following purposes:

- To reduce sheet and rill erosion.
- To reduce sediment content in runoff water.
- To improve water quality.
- To intercept and conduct surface runoff at a nonerosive velocity to a stable outlet.
- To prevent gully development.
- To improve farmability.
- To reduce downstream flooding.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to cropland and other land where:

1. Water erosion 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. Runoff and sediment can damage land or improvements downstream or impair water quality.

CRITERIA

All planned work shall comply with all Federal, state, and local laws 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.

Spacing. The maximum spacing for terraces for erosion control shall be determined by one of the methods below.

1. V.I. = xs + y or

   H.I. = (xs + y) (100/s)

Where:

V.I. = vertical interval in feet

H.I. = 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. A value of 1.0 shall be selected for erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 shall be used 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. A value of 2.5 shall be used 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, the spacing shall be determined 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 slope length determined by using the allowable soil loss, the most intensive use planned, the expected level of management, and the terrace P factor (Table 2). See Chapter 6 of NRCS Florida Agronomy Field Handbook for additional guidance on using RUSLE.

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. The spacing shall be adjusted to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing row widths.

For terraces on non-cropland, the maximum spacing shall be governed by the capacity requirement.

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

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.

Alignment. Terraces shall be parallel if feasible and as parallel as practicable. Curves shall be long and gentle to accommodate farm machinery. Land forming, extra cut fill along the terrace line, multiple outlets, variations in grade, channel blocks, and other methods shall be used to achieve good alignment.

Field efficiency may be used to compare alternative terrace systems. Field efficiency is the ratio of time required to farm the field being planned, to that required to farm a rectangular field of the same acreage ½ mile long.

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, the capacity shall be increased by the estimated 10-year sediment accumulation, unless provisions are made to maintain the design capacity 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, an n value of 0.06 shall be used for bare channels. SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation, or equivalent, shall be used for vegetated channels.

Cross section. The terrace cross section shall be proportioned 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). If necessary, steeper slopes may be used for special purposes but must be stable. 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. The end closures shall be designed 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.

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.

Channel grade. Channel grade shall be determined by one of the following methods:

1. Maximum channel grade in the lower reaches of the channel shall not exceed 0.6 percent.
2. Maximum channel velocity for farmed 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.
3. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.

Channel grades may be uniform or variable. Channel velocity shall not exceed that which is nonerosive for the soil and planned treatment. 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 channel, thus reducing the velocity and allowing steeper channel grades near the outlet. Minimum grades shall be such that ponding in the channel because of minor irregularities will not cause serious damage to crops or delay field operations. A maximum grade of 2 feet per 100 feet within the storage pool limits of the terrace is permissible to allow flexibility in a straightening terrace alignment.

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 gradient terrace length is controlled by the capacity and the nonerosive velocity requirements.

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 vegetated before the terrace is constructed if necessary to provide a stable nonerodible outlet or to ensure establishment of vegetative cover. 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 when more than one terrace discharges into the same conduit. The discharge, when combined with the storage, shall be such that a 10-year frequency, 24-hour storm will not overtop the terrace, and growing crops will not be damaged significantly by standing water. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops, depending on soils characteristics and water tolerance of crops to be grown.

The underground conduit shall meet the requirements specified in NRCS conservation practice standard for Underground Outlet, Code 620 or for Subsurface Drain, Code 606. Conduits 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 and subsequent raising of the terrace ridge. 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 crops are not significantly damaged by standing water.

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.

CONSIDERATIONS

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.

The likelihood of benching of steep slopes by tillage, land forming, and erosion shall be considered when determining the terrace interval.

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 will reduce erosion and the movement of sediment, pathogens, and sediment-attached substances that would normally be carried by runoff.

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.

OPERATION AND MAINTENANCE

A good maintenance program will help assure long life and continued benefits from a terrace system. A program shall be established for maintaining terrace capacity, storage, ridge height, and outlets.

The terrace's capacity to hold or channel water must be maintained. The terrace ridge height is critical to maintaining adequate capacity and protecting lower terraces. Any damages to the terrace ridge must be immediately repaired. If sediment accumulates in channels, remove it by mechanical means.

Periodically check underground outlets, animal guards, and tile inlets. Each inlet must be kept clean and sediment buildup redistributed so that inflow is not restricted. Be careful that farming operations do not build ridges around inlet pipes.

Inlets damaged or cut off by farm machinery must be replaced or repaired immediately. To protect inlets from damage by equipment, livestock, and wildlife, use high-visibility paint and risers.

Terrace ridges, especially those with steep back slopes, can be very hazardous. For this reason, some farmers prefer steep front slopes, thus keeping machinery away from the steep back slopes. All cut and fill slopes that are to be farmed must be no steeper than those on which farm equipment can be operated safely. Any hazards must be brought to the attention of the responsible person.

All areas to be vegetated shall be established to grass as soon as practicable after construction. Vegetation shall be maintained and trees and brush controlled by chemical or mechanical means.

REFERENCES

WMD Rules Chapters 40-4, 40-40, 40-41, 40-42, 40-44 F.A.C.
Florida Agronomy Field Handbook
NRCS Conservation Practice Standards:
Critical Area Planting, Code 342
Grassed Waterway, Code 412
Subsurface Drain, Code 606
Underground Outlet, Code 620
NRCS Engineering Field Handbook, Part 650, Chapter 8
SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation

Figure 1 - Horizontal Interval for Steep Back-Slope Terrace

Figure 2 - Horizontal Interval for Broad-Based Terrace

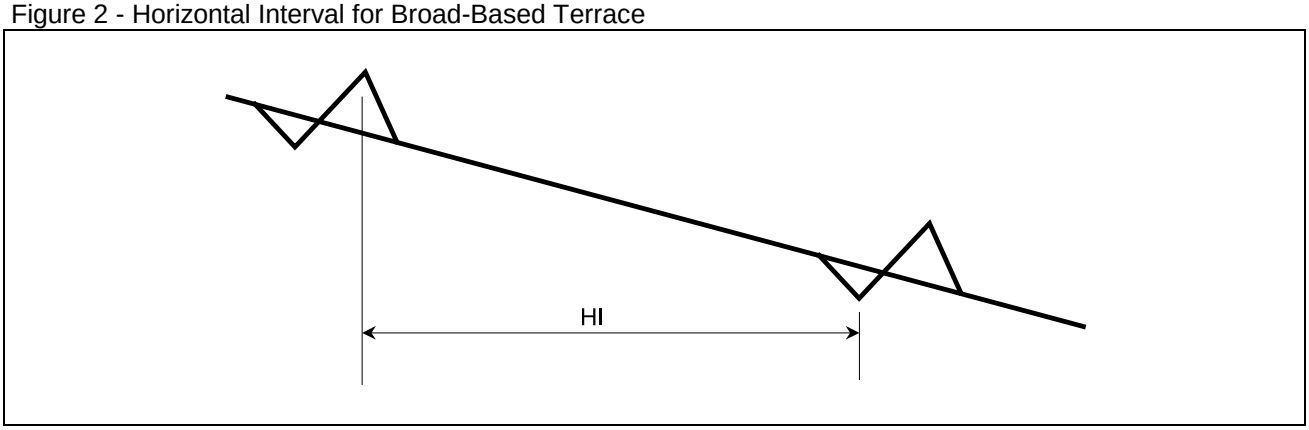
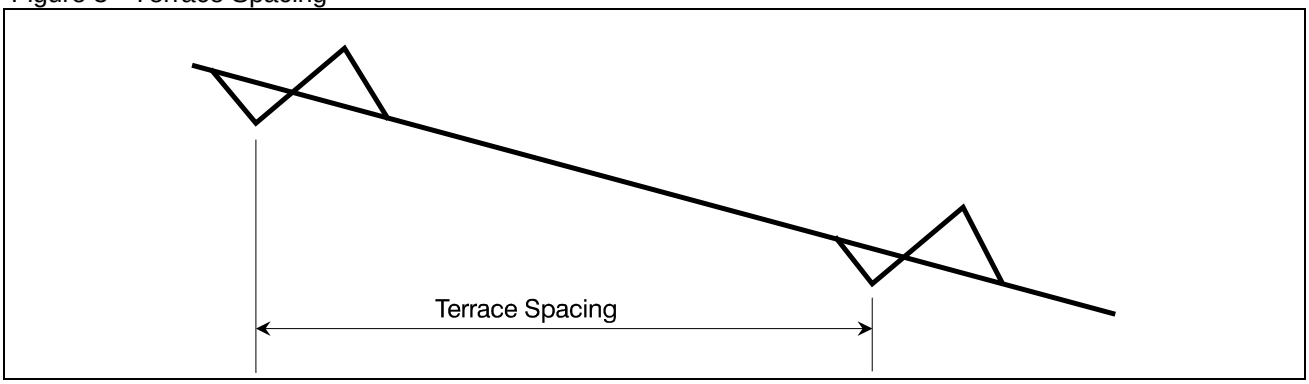


Figure 3 - Terrace Spacing



NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS

TERRACE

(Feet)
Code 600

CONSTRUCTION

All dead furrows, ditches, or gullies shall be filled before constructing the terrace or shall be part of the construction. All old terraces, fence rows, hedge rows, trees, and other obstructions shall be removed, as necessary, to install a farmable system.

The terraces shall be constructed according to planned alignment, grade and cross section with the specified overfill for settlement and the channel graded to drain reasonably well.

Any ditch or depression at the bottom of the back slope shall be filled and smoothed so that drainage will be away from the terrace and not parallel to it.

Provisions must be made to prevent piping if underground outlets are located under terrace ridges. Mechanical compaction, water packing, trench sidewall sloping, and installation and backfill of conduit trenches early enough to allow adequate settlement are methods that can be used. The materials used for the inlet and the conduit shall be suitable for the purpose intended (see conservation practice standard Subsurface Drain, Code 606). Terrace ridges constructed across gullies or depressions shall be compacted by machinery travel or by other suitable means to reduce settlement and ensure proper functioning of the terrace.

The surface of the finished terrace shall be reasonably smooth and present a workmanlike finish.

If necessary, topsoil shall be stockpiled and spread over excavations and other areas to facilitate restoration of productivity.

If vegetation is required, seedbed preparation, fertilizing, seeding, and mulching shall comply with NRCS conservation practice standard, Critical Area Planting, Code 342.