NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

TERRACE
(ft, m)
CODE 600

DEFINITION

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

PURPOSE

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

- Reduce soil erosion
- Retain runoff for moisture conservation

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

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

DESIGN CRITERIA

General Criteria Applicable to All Purposes

Terraces shall be planned, designed, and constructed to comply with all Federal, State, and local laws and regulations.

Both gradient terraces and level terraces may be parallel or nonparallel. They may be constructed with either a broad base, narrow base, or grassed backslope sections.

Level terraces may be used: (1) on those deep loess soils with high infiltration rates where it is known that level terraces will function properly, and (2) on deep sandy soils where it is known that level terraces will function properly.

Soil loss on each terrace system must be checked to determine needed resource management systems. When the terrace system, combined with existing cultural and management practices, does not reduce soil loss to permissible limits, the landowner will be informed of additional system components needed.

Spacing. Terrace spacing is measured from the channel of one terrace to the channel of the adjacent terrace (see Figure 3). Farming width varies with the terrace cross-section: for broad base terraces, the farming width is measured between the tops of ridges of adjacent terraces; for grassed backslope terraces, the farming width is measured from the toe of the backslope on one terrace to the top of the ridge of the next downslope terrace; for narrow base terraces, the farming width is measured from the toe of the backslope of one terrace to the channel of the next downslope terrace. Horizontal interval is the horizontal slope length or erosion length used to determine terrace spacing (see Figures 1 and 2)

NRCS-Minnesota
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Figure 1

Horizontal Interval for Steep Back-Slope Terraces

Figure 2

Horizontal Interval for Broad-Based Terraces

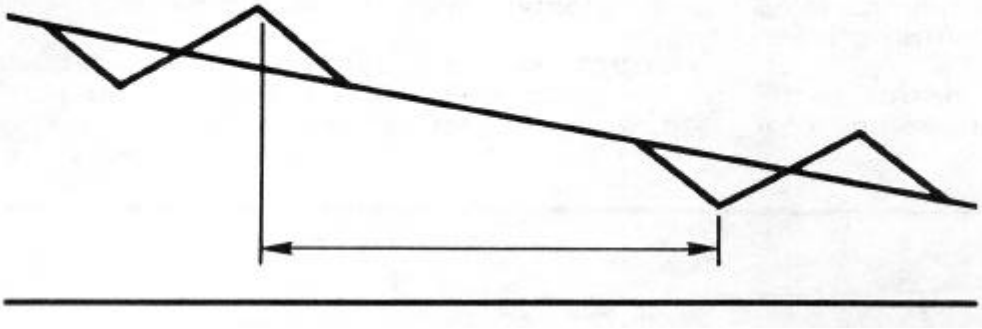
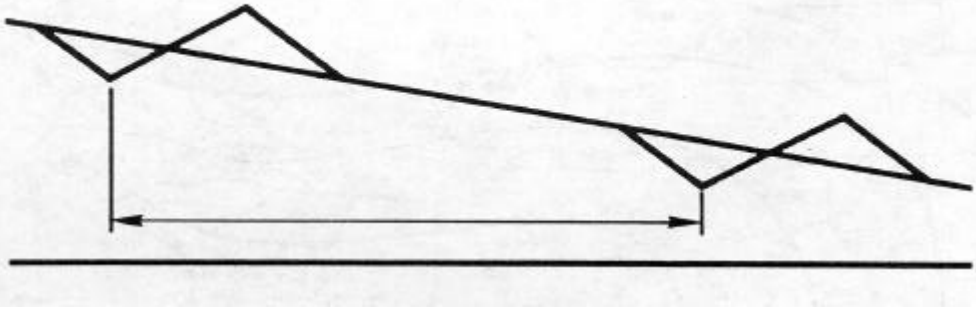


Figure 3

Terrace Spacing



The maximum spacing for terraces for erosion control shall be determined by one of the following methods:

1. *V.I.* = $xs + y$ or *H.I.* = $(xs+y)\ (100/s)$

   Where:

   V.I. = vertical interval in ft(m)

   H.I. = horizontal interval in ft.(m) (see figures 1 and 2) x = a variable with values from 0.4 to 0.8 (0.12 to 0.24)

   s = land slope in percent

   x = 0.8 for Minnesota suggested

   y = a variable with values from 1.0 to 4.0 (0.3 to 1.2)

Soil erodibility, cropping system, and crop management practices influence values of y. A value of 1.0 (0.3) 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 (1.2) 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 or 3.4 metric tons per hectare) on the surface. A value of 2.5 (0.75) shall be used if one of the factors indicated is favorable and the other unfavorable. Other values between 1.0 (0.3) and 4.0 (1.2) may be used according to the estimated quality of the factors. The horizontal spacing does not have to be less than 90 feet.

2. Revised Universal Soil Loss Equation (RUSLE). The spacing shall not exceed the critical slope length as determined using RUSLE. 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 2 for the conditions shown. The maximum limits may not be exceeded when making the 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. 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.

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

For terraces on noncropland, the maximum spacing shall be governed by the capacity requirement of this standard.

For level terraces used for erosion control and water conservation, the spacing shall be determined as indicated earlier, but the maximum horizontal spacing shall not exceed 600 ft (180 m). An *x* value of 0.8 (0.24) may be used for all level terraces used primarily to impound water.

Table 1.- Terrace P factors

Horizontal Interval		Closed Outlets[1]	Open outlets, with percent grade of[2]		
(ft)	*(m)*		0.1 - 0.3	0.4 - 0.7	0.8
Less than 110	Less than 33	0.5	0.6	0.7	1.0
110 - 140	33 - 42	0.6	0.7	0.8	1.0
1.0	43 - 54	0.7	0.8	0.9	1.0
180 - 225	55 - 68	0.8	0.8	0.9	1.0
225 - 300	68 - 90	0.9	0.9	1.0	1.0
More than 300	More than 90	1.0	1.0	1.0	1.0

NOTE: If contouring or stripcropping P factors are appropriate, they can be multiplied by the terrace P factor for the composite P factor.

1 "P" factors for closed outlet terraces also apply to terraces with underground outlets and to level terraces with open outlets.

2 The channel grade is measured on the 300 ft of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less.

Table 2.- Maximum horizontal spacing for terraces

Slope	USLE R factor of						With contour stripcropping		For concentrated flow control	
	0 - 35		35 - 175		More than 175					
Percent	ft	m	ft	m	ft	m	ft	m	ft	m
0 - 2	700	210	500	150	450	130	600	180	700	210
2 - 4	700	210	400	120	300	90	600	180	700	210
4 - 6	600	180	400	120	200	60	600	180	600	180
6 - 9	400	120	300	90	150	45	400	120	500	150
9 - 16	400	120	250	75	150	45	250	75	500	150
12 - 18	250	75	200	60	150	45	150	45	400	120
More than 18	250	75	200	60	150	45	150	45	300	90
Minimum spacing required, all slopes	200	60	150	45	90	27	90	27	200	60

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 mi. long.

Capacity. The terrace shall have enough 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 0.035 shall be used for bare channels; and SCS-TP-61, Handbook of Channel Design for Soil and Water Conservation, or equivalent, or Agricultural Handbook Number 667, Stability Design of Grass-lined Open Channels shall be used for vegetated channels.

Gradient terraces using vegetated outlets will have varying heights according to their length as indicated in table 3. Terraces built in accordance with these heights and other recommended dimensions will have adequate capacity. Lesser heights may be used where design computations support that the capacity requirements have been met.

Terraces with underground outlets:

Terrace height shall be that needed to obtain the necessary storage capacity, except that non-storage sections shall have minimum heights as shown for terraces with vegetated outlets (Table 3).

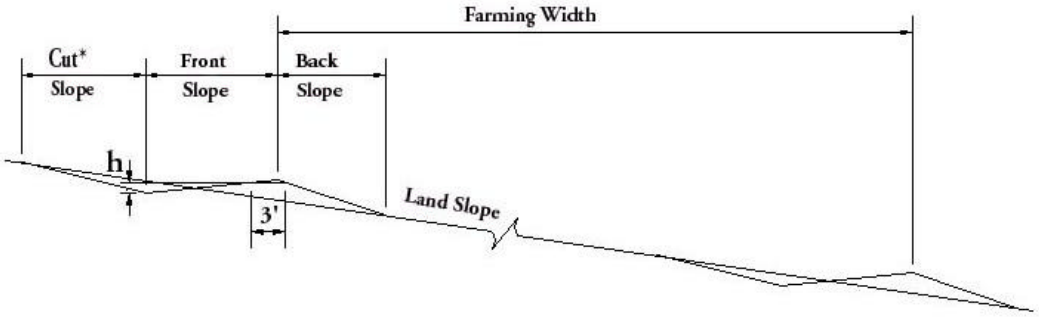
Table 3 Minimum terrace Height for Terraces using Vegetated Outlets, Feet*

	Length, Feet				
	200	400	600	800	1000
Channel Grade, 0.2% - 0.4%	0.9	1.1	1.2	1.3	1.4
Channel Grade 0.4% - 0.6%	0.8	1.0	1.1	1.2	1.2
Channel Grade > 0.6%	0.8	0.9	1.0	1.1	1.1

*** These heights are settled heights and apply to all broad base and grassed backslope terraces and to narrow base terraces on land slopes = 8%.**

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 ft. (1 m) at the design elevation. The steepest slope of a vegetated front or back ridge slope is 2:1. If necessary, steeper slopes may be used for special purposes but must be stable. Terrace ridges, especially those with steep back slopes, can be very hazardous. All cut and fill slopes that are to be farmed shall be no steeper than those on which farm equipment can operate safely. Any 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.

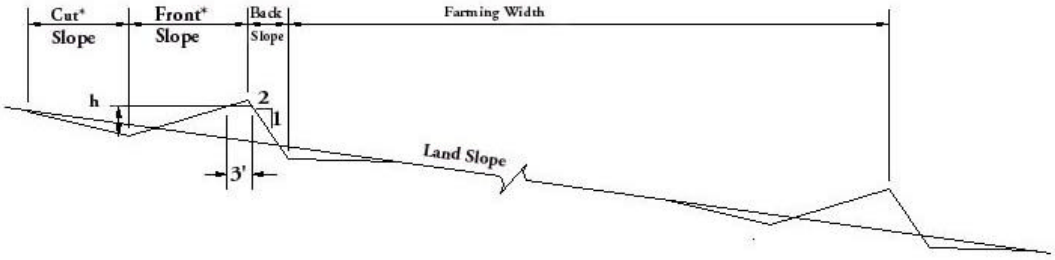
Terrace cross sections will comply with the minimum dimensions shown for broad base terraces (Figure 4), grassed backslope terraces (Figure 5), or narrow base terraces (Figure 6). The increment of machinery width noted on these figures is considered as the full width of machinery not capable of conforming to the breaks in slope, or the width of "gangs" of components on machinery capable of conforming to these breaks in slope.



h = Design height of terrace

* Length of cut slope, front slope, and back slope shall be in increments of machinery width, but not shorter than 15 ft. nor steeper than 5:1.

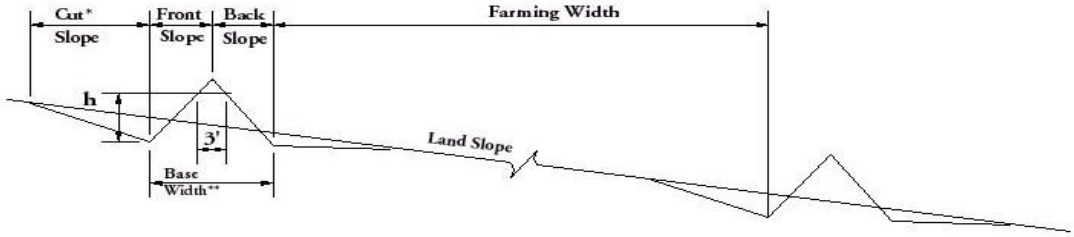
Figure M-4. Typical Dimensions of Broad Base Terraces



h = Design height of terrace

*** Length of cut slope and front slope shall be in increments of machinery width but not shorter than 15 ft. nor steeper than 5:1.**

Figure M-5, Typical Dimensions of Grassed Back Terraces



h = Design height of terrace

*** Length of cut slope shall be in increments of machinery width but not shorter than 15 ft. nor steeper than 5:1.**

**** Base width shall be constant for each terrace and shall be calculated at maximum design height with 2:1 front slope and 2:1 back slope.**

Figure M-6, Typical Dimensions of Narrow Base Terraces

With the broad base cross section, excavation for the terrace ridge is generally taken on the uphill side. All portions of the broad base terrace may be farmed, that is, the cutslope, frontslope, and backslope. Building a broad base terrace from the uphill side increases the slope of the land by three to five percent. On gently sloping land this can be tolerated. This is not recommended on land with slopes steeper than 8%, as the backslope will be so steep as to make farming difficult.

Excavation for the grassed backslope cross section should be taken from the downhill side except where borrow from other locations is needed to enhance alignment or farmability. The backslope must be seeded to grass. This type of terrace decreases the slope of the land that is farmed. Grass backslope terraces are recommended over broad base terraces for field slopes 6% or greater. On flatter slopes, they are also well adapted and should be considered for use.

With the narrow base cross section terrace, both the frontslope and the backslope are seeded to grass and not farmed. Excavation for this type of terrace should be similar to that recommended for grassed backslope terraces.

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.

Upper terraces in a system with open ends or partial end closures shall not discharge into lower terraces unless the minimum required storage is retained in the upper terrace before outflow occurs.

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 cultivated channels shall be nonerosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 ft/s (0.75 m/s); for average soils, 2.0 ft/s (0.6 m/s); and for easily erodible soils, 1.5 ft/s (0.45 m/s). Velocity shall be computed by Manning's formula, using an n value of 0.025.

The erosion resistances of soils for the purpose of determining permissible velocities for non-vegetated terrace channels, are shown in Table 4.

Table 4 Permissible Velocities for Non-vegetated Terrace Channels

Material on Channel Bottom and Sides			
Descriptive Term or Name	Soil Classification		Permissible Velocity, fps
	USDA	Unified	
Fine Sand (noncolloidal)	s, fs,vfs, lvfs, vfsl	ML(PI=5), SM(PI=10) SP, SW, SP-SM	1.5 Easily Erodible
Sandy Loam (noncoloidal)	fsl, sl, ls, lfs, si	SM(PI=10), ML(PI=5-10), ML-CL, SM-SC, SC(PI<10)	
Silt Loam (noncolloidal), Alluvial silts when noncolloidal	sil, scl, GR-s	ML(PI=10-15), CL(PI=10), SC(PI=10-15), Coarse clean sand (D50>#10 sieve)	
Ordinary Firm Loam Fine Gravel	l, scl, GR	CL(PI=10-20), ML(PI>15), MH(PI<20), Clean gravels (D50>#4 sieve)	2.0 Average
Stiff Clay (very colloidal) Graded, loam to cobbles, when noncolloidal Alluvial Silts when colloidal	cl, sicl, c, sc, GR-1	CL(PI>20), CH, MH(PI>20), SC(PI>20), GC(PI<10), GM(PI>10)	2.5 Erosion Resistant
Graded, silt to cobbles, when colloidable Coarse Gravel (noncolloidal)	Coarse GR, GR-c	GC(PI>10), Clean gravel (D50>¾")	
Cobbles and Shingles	Cobbles & Flaggy	Cobbles	

Unweathered shales and hardpans	

3. Maximum channel velocities for permanently vegetated channels shall not exceed those used for grassed waterways.

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 grades shall be such that ponding in the channel because of 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 ft (1,000 m) unless the channel is blocked at intervals not exceeding 3,500 ft. (1,000) m). Normally, the capacity and the nonerosive velocity requirements control the gradient terrace length.

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 or a vegetated area. 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 insure 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 for Underground Outlets (620) or for Subsurface Drains (606). Conduits must 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 with a reasonable period 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.

Where vegetation is required, seedbed preparation, seeding, and fertilizing shall comply with practice standard 342, Critical Area Planting.

Where it is necessary, topsoil is to be stockpiled and spread over excavations and other areas to facilitate restoration of productivity.

Drainage. Install subsurface drainage to stabilize terrace where needed. It shall be designed taking

into consideration the effect of snowcatch and melt on water budget components.

CONSIDERATIONS

Consider adjusting the spacing to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing row widths.

Consider width of equipment when determining spacing of terraces.

Consider aligning terraces to correct seepage problems.

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

An operation and maintenance plan shall be prepared for use by the operator. The plan shall include specific instructions for maintaining terrace capacity, storage, ridge height, and outlets.

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

1. Provide periodic inspections, especially immediately following storms with a 10-year or greater return frequency.

2. Promptly repair or replace damaged components as necessary.

3. Maintain terrace capacity, ridge height, and outlet elevations.

4. Remove sediment that has built up in the terrace to maintain a positive channel grade.

5. 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.

6. Vegetation shall be maintained and trees and brush controlled by chemical or mechanical means.

7. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

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 us.

Provisions must be made to prevent piping if underground circuits 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 standard 606). Terrace ridges constructed across gullies or depressions shall be compacted by machinery travel or by other suitable means to insure 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 specifications in technical guides.