NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

TERRACE

(Ft)

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 resource management system to reduce soil erosion.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- Soil erosion by water is a problem
- 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

CRITERIA

Utilities and Permits. The landowner shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

The landowner shall obtain all necessary permissions from regulatory agencies, including the US Army Corps of Engineers, US Environmental Protection Agency, and Illinois Department of Natural Resources – Office of Water Resources, or document that no permits are required.

General Criteria

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

Spacing. The maximum interval 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 feet

H.I. = horizontal interval in feet

(See figures 2 and 3)

x = a variable with values from 0.4 to 0.8

s = land slope in percent

y = a variable with values from 1.0 to 4.0

Values of x for different geographical zones are shown in Figure 1. 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. The horizontal interval does not have to be less than 90 feet.

2. Revised Universal Soil Loss Equation Version 2 (RUSLE2). The interval shall not exceed the critical slope length as determined using RUSLE2. 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.

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

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

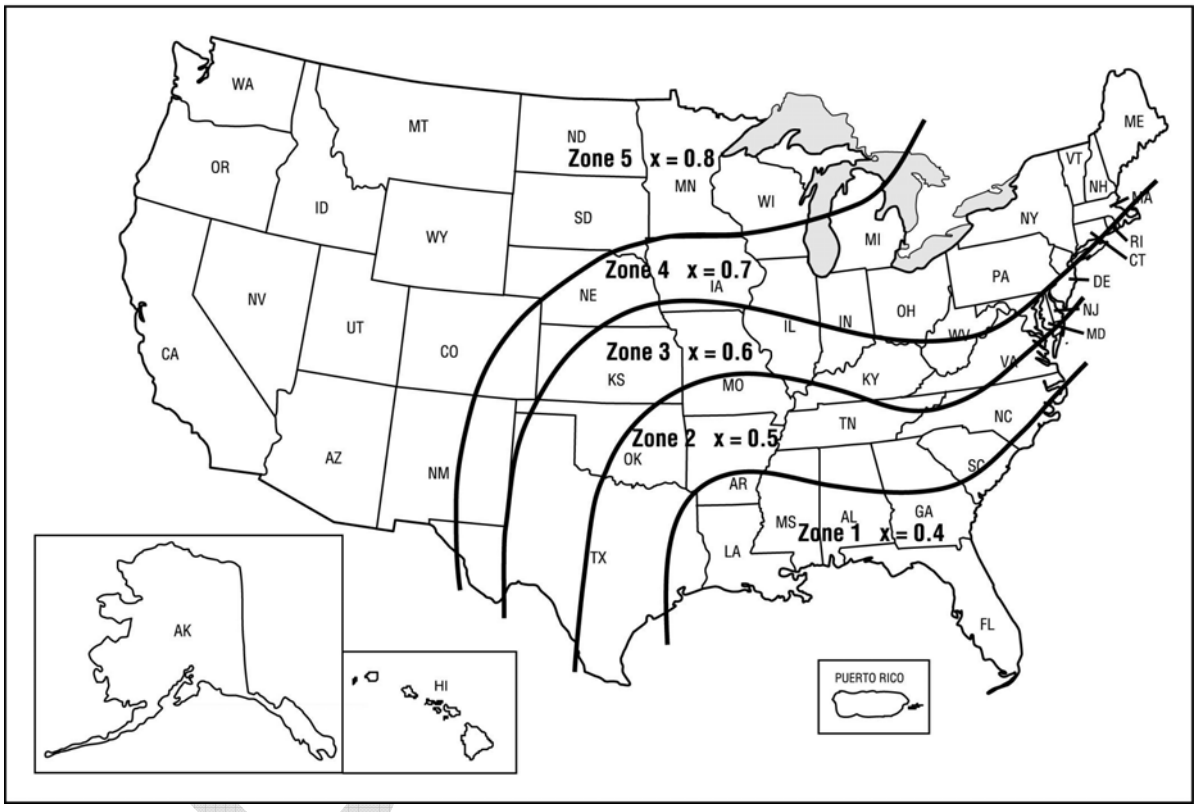

Figure 1. Values of x in equation V.I. = xs + y or H.I. = (xs + y) (100/s)

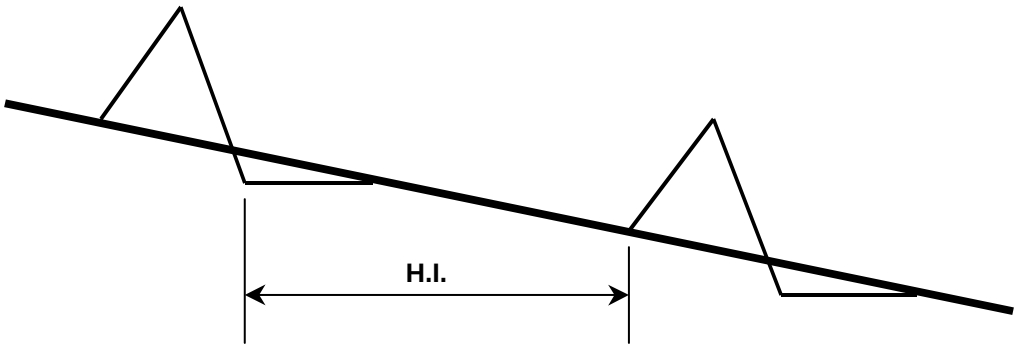

Figure 2. Horizontal Interval for Steep Back-slope Terraces

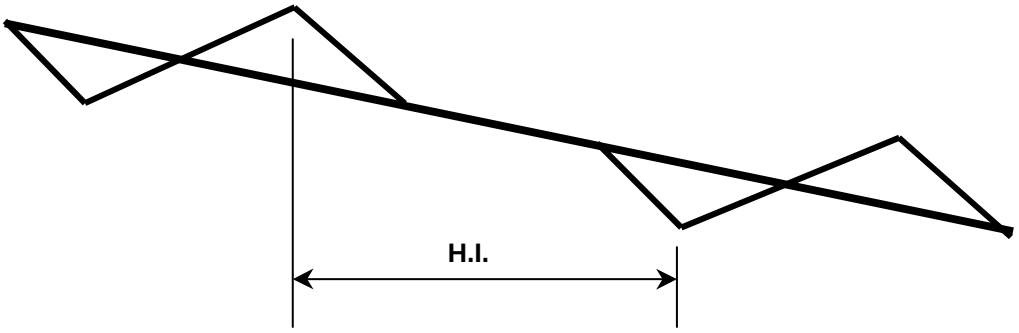

Figure 3. Horizontal Interval for Broad-Based Terraces

Table 1. Maximum horizontal interval for Terraces

Percent Slope	Ft
0-4	700
4-6	600
6-12	400
12-18	250
> 18	250

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 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 sediment is removed through maintenance. Terrace systems designed to provide flood protection or to function with other structures shall have the appropriate larger design capacity. When the capacity is determined by the formula Q = AV and the V is calculated using Manning's formula, a minimum n value of 0.035 shall be used for bare channels. Agriculture Handbook Number 667, Stability Design of Grass-lined Open Channels, 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 ft. at the design elevation. The steepest slope of a vegetated front or back ridge slope is 2 horizontal:1 vertical. 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 terraces shall have a cross section equal to that specified for the terrace channel.

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

1. Maximum channel velocities for permanently vegetated channels shall not exceed those specified Conservation Practice Standard 412, 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 a maximum 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. Normally, the capacity and the nonerosive velocity requirements will control the gradient terrace length.

Outlets. All terraces must have adequate outlets.

Vegetated outlets may be used for gradient terraces. Such an outlet may be a grassed waterway or other vegetated area. 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 outlet. 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 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. Orifice plates may be omitted if a pressure flow outlet system is designed. Terraces shall be designed to control a 10 year frequency, 24-hour storm without overtopping. 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. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified for Conservation Practice Standard IL 620 Underground Outlet. Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet shall consist of a vertical perforated pipe or other structure 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.

Combinations of different types of outlets may be used on the same system to affect water quality, 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.

Drainage. Install subsurface drainage to stabilize terrace where needed.

CONSIDERATIONS

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

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

Potential for development of saline seeps or other salinity problems may result from increased infiltration in soils that have restrictive layers.

Potential for uncovering or redistributing toxic materials such as saline soils may result during construction.

Stripping and stockpiling of topsoil prior to excavation, then spreading the salvaged topsoil on the completed terrace will improve the growth of vegetation after construction.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for terraces that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications shall include:

1. A plan view of the layout of the terrace system.
2. Typical cross sections of the terrace(s).
3. Profile(s) or planned grade of the terrace(s).
4. Details of the outlet system
5. For underground outlets, details of the inlet and profile(s) of the underground outlet.
6. Seeding requirements if needed.
7. Site specific construction specifications that describe in writing the installation of the terrace system.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be prepared for and reviewed with the landowner or operator. The plan shall specify that the treated areas and associated practices are inspected annually and after significant storm events to identify repair and maintenance needs.

The minimum requirements to be addressed in the O&M plan are:

1. Provide periodic inspections, especially immediately following runoff events.
2. Promptly repair or replace damaged components as necessary.
3. Maintain terrace ridge height and outlet elevations.
4. Remove sediment that has accumulated in the terrace to maintain capacity and 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, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.
7. Vegetated outlets should be established before construction when feasible.
8. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

REFERENCES

Natural Resources Conservation Service, Revised Universal Soil Loss Equation, Ver. 2 (RUSLE 2), 2004.

Natural Resources Conservation Service, National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 8, Terraces.

USDA-Agricultural Research Service, Agriculture Handbook 667, Stability Design of Grass-Lined Open Channels.

NATURAL RESOURCES CONSERVATION SERVICE

CONSTRUCTION SPECIFICATION

TERRACE

1. Scope

The work shall consist of constructing the terrace channels and ridges, and excavating, filling and shaping as required by the construction plans.

2. Location

The location of the terrace shall be as shown on the construction plans or as staked in the field.

3. Site Preparation

All dead furrows, ditches, and gullies shall be filled prior to or as a part of construction. Old terraces, fencerows, brush, and tall standing vegetation shall be removed from the area occupied by the terrace ridge and the area from which the earthen construction material will be taken.

4. Material

Earth fill material shall be free from frozen particles, roots, sod, brush, and other objectionable materials that might endanger the performance of the terrace. The fill material shall have no rock particles larger than 3 inches in diameter.

The moisture content of the earth fill material shall be sufficient to permit satisfactory compaction. The moisture content can generally be considered as satisfactory if the fill material can be molded into a round ball between the hands without readily separating or squeezing out free water.

For broadbase terrace ridges, required fill material shall come from the terrace channel unless otherwise specified. For grassed back and narrow base terrace ridges, fill material shall come from the downhill side of the terrace ridge, except for cuts that are required to construct the channel to the specified grade and cross section.

5. Placement of Earthfill

All ridges shall be constructed to the planned alignment, grade and cross-section shown on the plans, 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. All fill cross sections shall conform to that specified for all stations. The ridge portion of the terrace shall be compacted by routing the hauling and spreading equipment over the fill material in such a manner that the entire surface of the completed ridge will be traversed by not less than one tread/track of equipment. The terrace channels, side slopes, ridges, cut areas, and fill areas shall be finished to a smoothness so the surface can be readily traveled upon by farm-type equipment.

When topsoil salvaging is specified, areas to receive topsoil shall be brought to within 4 inches of final grade, or as specified on the construction plans. Topsoil shall be evenly placed and spread over specified area to bring it to final grade.

6. Outlets

Underground tile outlets are to be installed at locations shown on the drawings or as staked in the field. Provisions must be made to prevent piping if underground conduits 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. Refer to Construction Specification 620, Underground Outlet, for detailed installation requirements.

Terrace outlet structures are to be installed at locations shown on the drawings or as staked in the field. Refer to Construction Specification 410, Grade Stabilization Structures, for detailed installation requirements.

Where terraces outlet into established grassed waterways or vegetated areas, care shall be taken during construction to minimize disturbance of existing vegetation. The transition from the terrace channel to the center of the waterway shall be free of abrupt changes in grade.

7. Vegetation

A protective cover of vegetation shall be established on steep back slope and narrow-based terraces when specified in the design plans. Refer to Construction Specification 342, Critical Area Planting, for detailed seeding requirements.

8. Utilities

The landowner shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.