Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

TERRACE

CODE 600

(ft)

DEFINITION

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

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Reduce erosion and trap sediment.
- Manage runoff.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies only where the soils and topography are such that terraces can be constructed and reasonably farmed, a suitable outlet can be provided, and where one or more of the following conditions exist:

- Soil erosion caused by water and excessive slope length is a problem.
- Excess runoff is a problem.
- There is a need to conserve water.

CRITERIA

General Criteria Applicable to All Purposes

Alignment

Terraces must generally follow the contour of the land. Limit deviations from the contour and allow only when necessary to obtain good alignment. To accommodate farm machinery and farming operations, design cropland terraces with long gentle curves, where feasible. When multiple terraces are used in a field, design the terraces to be as parallel to one another as practicable. Refer to NRCS Conservation Practice Standard (CPS) Contour Farming (Code 330) for guidance on planning farming operations.

Spacing

Space terraces at intervals across the slope to achieve the intended purpose. The maximum spacing of terraces for erosion control is that necessary to achieve the soil loss tolerance (T) or other soil loss criteria that is documented in the Field Office Technical Guide. Maximum spacing for erosion control based on soil loss tolerance may be increased by as much as 10 percent to provide better location and alignment to accommodate farm machinery or to reach a satisfactory outlet.

The methods to determine terrace spacing include the current NRCS accepted erosion prediction technology, the vertical interval equation, or State-developed methods that address unique soil, cropping, or other farming practices that affect terrace spacing. Refer to the current NRCS-accepted erosion prediction software and user guide to determine soil loss. Include both the terrace system with planned

as-built slopes and cultural practices such as residue management when determining soil loss. The slope length used when checking soil loss for a proposed terrace spacing is the distance from the terrace ridge to the next lower terrace channel measured along the natural flow direction. Refer to the NRCS National Engineering Handbook (NEH) (Title 210), Part 650, Chapter 8, “Terraces” for use of the vertical interval equation.

Determine the maximum spacing for erosion control by either method 1 or method 2.

Method 1. Vertical Interval Equation

Refer to the Engineering Field Handbook, Chapter 8, Terraces for use of the Vertical Interval Equation.

Method 2. Revised Universal Soil LossEquation Version 2 (RUSLE2)

Use the proposed as-built slopes and cultural practices (including residue management) in the RUSLE2 model to determine a slope length that will achieve the allowable soil loss tolerance (T) in the inter-terrace interval.

Capacity
Design terraces to have enough capacity to control the runoff from a 10-year-frequency, 24-hour storm without overtopping. For terrace systems designed to control excess runoff or to function with other structures, choose a larger design storm that is appropriate to the risk associated with the installation.

For terraces with underground outlets, the capacity to contain the design storm can be a combination of storage and outflow through the underground outlet. For terraces that store runoff (storage or level terraces), increase the storage capacity by the estimated 10-year sediment accumulation, unless the operation and maintenance plan specifically addresses the periodic removal of sediment.

For terraces with open outlets, base the terrace channel size on the capacity using the densest and longest vegetation. Base the capacity of the channel on a bare earth channel for cropped fields, or in the case of a permanently vegetated channel, the appropriate vegetation. For bare earth channels, use a Manning’s n value of 0.035 or greater to calculate capacity. For permanently vegetated channels, refer to NRCS CPS Grassed Waterway (Code 412) for design criteria to determine capacity and NRCS CPS Critical Area Planting (Code 342) for seeding criteria. For terraces with open outlets, design the capacity of the outlet to be equal to or greater than the capacity of the terrace channel.

Terrace cross section
Proportion the terrace cross section to fit the land slope, the crops grown, and the farm machinery used. Avoid the use of terrace cross sections that result in disturbance of all of the soil in the spacing between terraces. Add ridge height, if necessary, to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, or safety. At the design elevation, the ridge must have a minimum width of 3 feet. Design all farmable terrace slopes no steeper than 5:1 in order to allow safe operation of farming equipment. For nonfarmable terrace slopes, the steepest slopes allowable are 2 horizontal to 1 vertical unless an analysis of site specific soil conditions indicate that steeper slopes will be stable.

Channel grade
Design the terrace channel to be stable with nonerosive velocities but with sufficient grade to prevent prolonged flooding that would damage crops or delay farming activities. For cultivated terraces, base the channel stability on a bare earth condition using a maximum Manning’s n value of 0.035. For permanently vegetated channels, base the channel stability on the appropriate vegetation. Refer to NRCS CPS Grassed Waterway (Code 412) and 210-NEH-650, Chapter 7, “Grassed Waterways” and Illinois supplements for design criteria and procedures to determine stability for both bare and vegetated conditions. In the upper reaches of a channel, grades may be increased to improve alignment. For terraces with an underground outlet, channel grades can be steeper within the impoundment area.

Level terraces
The volume of water stored in level terraces is proportional to the length. To reduce the potential risk from failure, limit the length of level terraces to 3,500 feet unless the channel is blocked at intervals not exceeding 3,500 feet. Level terraces can have either full- or partial-end closures or be open-ended. If a partial-end closure is used, areas downstream from the end closure must be protected from damage by flow that will exit from the closure before the design storm is reached.

Outlets
All terraces must have adequate outlets. The outlet must convey runoff water to a point where it will not cause damage. Combinations of different outlet types may be used on the same terrace system to optimize water conservation, improve water quality, to accommodate farming operations, or to provide for economical installation.

Vegetated outlets are suitable for gradient or open-end level terraces. Naturally vegetated drainage ways may be used as vegetated outlets. The capacity of the vegetated outlet must be large enough so that the water surface in the outlet is at or below the water surface in the terrace at the design flow. If a grassed waterway is to be constructed as an outlet, use NRCS CPS Grassed Waterway (Code 412). Install and stabilize grassed waterways prior to the construction of the terrace so that the terrace will have a stable outlet when it is constructed.

Underground outlets are suitable for use on all terrace types. The outlet consists of an intake and an underground conduit. If underground outlets are to be constructed, use NRCS CPS Underground Outlet (Code 620). Design the outlet so that the flow release time does not exceed the inundation tolerance of the planned crop or 48 hours, whichever is less. If sediment retention is a primary design goal, adjust the release rate according to sediment particle size. Locate the intake structure for the underground outlet to accommodate farming operations and to allow for sediment accumulation.

Soil infiltration may be used as the outlet for level terraces. Soil infiltration rates under average rainfall conditions must permit infiltration of the design storm from the terrace channel within the inundation tolerance of the planned crops.

Underground outlets may be designed for either pressure or gravity flow. If a pressure system is designed, all pipes and joints must be adequate to withstand the design pressure, including surges and vacuum. For gravity flow systems, use a flow-restricting device such as an orifice or weir to limit flow into the conduit or choose conduit sizes that are large enough to prevent pressure flow.

Vegetation
Stabilize all areas planned for vegetation as soon as possible after construction. Refer to NRCS CPS Critical Area Planting (Code 342) or State planting guide for seeding criteria, and as needed, use the criteria in NRCS CPS Mulching (Code 484).

Additional Criteria for Managing Runoff

For terraces installed to retain runoff for moisture conservation, perform a water budget analysis to determine the volume of water that must be collected to meet the requirements of the water budget.

For terraces installed to manage runoff to reduce flooding or ponding, size the detention volume of all terraces in the system such that the necessary downstream flood protection is achieved.

As a minimum, the terrace must still meet the design storm and sediment volume requirements in the Capacity section above.

CONSIDERATIONS

One of the keys to a successful terrace system is to make sure that the terrace layout fits the farm equipment. This includes making curves long and gentle and spacing terraces so that the operator can

make an even number of trips between terraces in order to end up on the same side of the field they started on.

Terrace ridges and cut slopes can introduce steep and potentially hazardous slopes into a crop field. Where slopes will be farmed, make sure they can be safely negotiated with the operator's equipment. Where steep slopes are unavoidable make sure the operator is aware of the location and potential danger of the slopes.

The soil survey can be a valuable resource when planning and designing terrace systems. The soil survey can identify potential problems such as the presence of layers in the soil profile that will limit plant growth. Field investigations can then identify problem areas to avoid such as shallow bedrock or dense, acid, or saline layers that will adversely affect plant growth if construction brings them into the root zone.

Where necessary to restore or maintain productivity, salvage topsoil and spread over the disturbed area after construction is complete. Temporarily stockpile the topsoil away from the site and provide erosion protection, as needed.

When revegetation is needed, consider revegetating using species or diverse mixes that are native or adapted to the site and have multiple benefits. In addition, where appropriate, consider a diverse mixture of forbs and wildflowers to support pollinator and other wildlife habitat.

Consider establishing temporary cover on disturbed areas such as channels and borrow areas that are not planned for permanent vegetation, but will not have a crop planted within 90 days.

Steep-sided terraces that are in permanent vegetation can provide significant areas of habitat for wildlife. Consider planting native species that provide food and cover for wildlife. Do not mow these areas until after the nesting season to improve wildlife production.

Hillside seeps in a crop field can cause cropping problems. Consider aligning terraces and/or installing subsurface drainage to intercept and correct seepage problems. Install the drainage prior to terrace construction by using NRCS CPS Subsurface Drain (Code 606).

Erosion can be a problem at the outfall of an underground outlet. To ensure an adequate outlet, protect the outfall of the underground outlet so that it is stable. Use NRCS CPS Underground Outlet (Code 620) to properly plan, design, and install underground outlets.

Outlets from terraces might provide a direct conduit to receiving waters for contaminated runoff from cropland. Terraces should be installed as part of a conservation system that addresses issues such as nutrient and pest management, residue management, and filter areas.

Intakes for underground outlets can be easily damaged during cultivation, planting, and harvesting operations. Using brightly colored inlets, barriers around the inlet, or otherwise clearly marking the inlet will help prevent damage.

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 must include—

- A plan view of the layout of the terrace system.
- Typical cross sections of the terrace(s).
- Profile(s) or planned grade of the terrace(s).
- Details of the outlet system.
- If underground outlets are used, details of the inlet and profile(s) of the underground outlet.
- Seeding requirements, if needed.
- Bill of materials needed for the construction.

- Site-specific construction specifications that describe in writing the installation of the terrace system.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator to follow for the design life of the terrace system. The minimum requirements to be addressed in the written operation and maintenance plan are—

- Intended orientation of the primary farming operations, usually parallel to the terrace(s).
- Periodic inspections, especially immediately following significant runoff events.
- Prompt repair or replacement of damaged components.
- Maintenance of terrace ridge height, channel profile, terrace cross sections and outlet elevations.
- Removal of sediment that has accumulated in the terrace channel to maintain capacity and grade.
- Regular cleaning of inlets for underground outlets. Repair or replacement of inlets damaged by farm equipment. Removal of sediment around inlets to ensure that the inlet remains the lowest spot in the terrace channel.
- Where vegetation is specified, complete seasonal mowing, control of trees and brush, reseeding and fertilizing as needed.
- Repair damages from burrowing animals.
- Notification of hazards about steep slopes on the terrace.

REFERENCES

USDA NRCS. 2004. Revised Universal Soil Loss Equation, Ver. 2 (RUSLE2). http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm

USDA NRCS. 2007. National Engineering Handbook (Title 210), Part 650, Engineering Field Handbook, Chapter 7, Grassed Waterways. Washington, D.C. https://directives.sc.egov.usda.gov/

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