

**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 for one or more of the following purposes:

- Reduce erosion by reducing slope length
- Retain runoff for moisture conservation

**CONDITIONS WHERE PRACTICE APPLIES**

This practice applies where:

- Soil erosion caused by water and excessive slope length 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

For treatment of sheet and rill erosion where the soil loss is within the allowable tolerance, ephemeral gully erosion, or other concentrated flow erosion, diversions must be designed using criteria in Oklahoma NRCS Conservation Practice Standard, Diversion (362), instead of terraces.

**CRITERIA**

**General Criteria Applicable To All Purposes**

**Spacing.** Spacing for terraces as set forth in this standard is for the control of sheet and rill

erosion that exceed the allowable soil loss tolerance.

The maximum spacing for terraces shall be determined by the following formula:

$$\text{V.I.} = \text{xs} + \text{y} \quad \text{OR} \quad \text{H.I.} = (\text{xs} + \text{y}) (100/\text{s})$$

Where:

V.I. = vertical interval in feet

H.I. = horizontal interval in feet

(See figure 1 and 2)

x = 0.6 for areas of the state west of I-35;

0.5 for areas of the state east of I-35.

0.8 for level terraces that impound water

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. Values for y are given in Table 1.

Table 1. Values for "y"

CP <sub>f</sub> *	y Values	
	T/K ≥ 15.2	T/K < 15.2
< 0.22	4.0	3.5
0.22 – 0.35	3.5	3.0
0.36 – 0.43	3.0	2.0
> 0.43	2.0	1.0

\* CP<sub>f</sub> is calculated from the RUSLE2 Net C factor (C) times P<sub>f</sub>. P<sub>f</sub> is the Net Contour factor (Pc) times the Net Ridge factor (Pr).

$$\text{CP}_f = \text{C} \times \text{Pc} \times \text{Pr}$$

Table 2. Maximum horizontal interval for terraces

	RUSLE2 R Factor of			With Contour Stripcropping
	0 - 35	35 – 175	> 175	
Percent Slope	Ft	Ft	Ft	Ft
0 - 2	700	500	450	600
2.1 - 4	700	400	300	600
4.1 - 6	600	400	200	600
6.1 - 9	400	300	150	400
9.1 - 12	400	250	150	250
12.1 - 18	250	200	150	150
> 18	250	200	150	150

The average horizontal interval does not have to be less than 100 feet.

In no case shall the maximum horizontal interval exceed that shown in Table 2 for the condition shown. The maximum limits may not be exceeded when making adjustments indicated below.

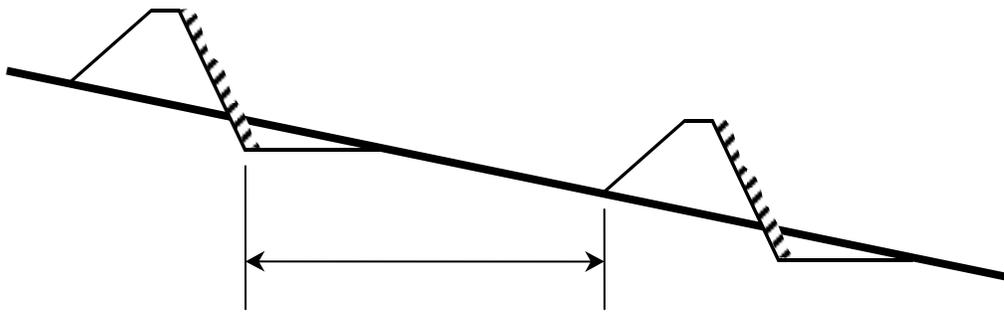
Spacing may be increased as much as 10 percent to provide better location or alignment, to adjust for farm machinery, or to reach a satisfactory outlet, if the additional distance between terraces does not exceed the values in Table 2.

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

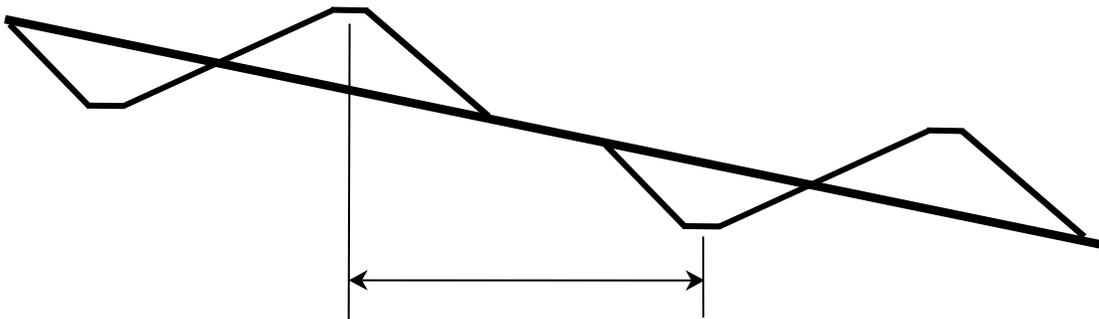
When estimating sheet and rill erosion for terraces spaced using the V.I. or H.I. spacing method, Figures 1 and 2 show the erosive slope length to be used. Figure 3 represents actual terrace spacing.

**Alignment.** Cropland terraces shall be parallel if feasible and as parallel as practical. Curves shall be long and gentle to accommodate farm machinery and farming operations. Terraces shall be aligned such that water is not diverted from one watershed to another, unless proper permits are obtained.

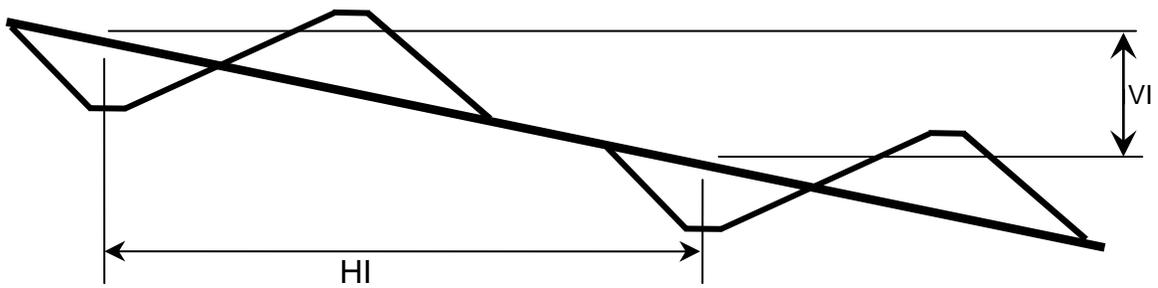
**Cross section.** Dimensions for field terraces are given in Table 3. The terrace cross section shall be proportioned to fit the land slope, the crops grown, and the farm machinery used. Additional height shall be added if necessary to provide for settlement, channel sediment deposits, ridge erosion, the effect of normal tillage operations, and safety. The ridge shall have a minimum width of 4 feet at the design elevation. The front and back slopes of the terrace shall be approximately the same except when a grass back slope is used. 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 operate 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.



**Figure 1.** Erosive Slope Length for Steep Back-slope Terraces



**Figure 2.** Erosive Slope Length for Broad-Based Terraces



**Figure 3.** Terrace Spacing

Table 3 - Dimensions for Field Terraces

Percent Slope	Height above Channel Ft.	Channel Bottom Width Ft.	Cross Section Area of Channel Ft. <sup>2</sup>	Width*	
				Standard Ft.	Broadbase Ft.
4% or less	1.2	8	20	22	30
4.1 to 8	1.4	8	20	20	28
8.1 to 10	1.0	4	10	20	28
10.1 to 12	1.0	4	10	20**	28

\* Width is measured from the intersection of the toe and the channel on the front slope to the intersection of the toe and natural ground on the back slope.

\*\* Use permanently vegetated grass back slope and top for terrace ridge. Back slope would be 3:1 or steeper.

Note: For terraces with  $\leq 0.1'$  grade per 100 ft and for terraces with end closures, add 0.2 ft. to height above channel for freeboard.

**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 to contain the design storm can be a combination of storage and out flow through the underground outlet. In addition, the capacity for terraces with underground outlet shall be increased by the estimated 10-year sediment accumulation, unless sediment is removed annually through maintenance. For terrace systems designed to provide flood protection, 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 open outlets, the capacity is based on the terrace channel size and stability. Base the capacity of the channel on a bare earth channel for crop fields or in the case of a permanently vegetated channel, the appropriate vegetation. In place of Table 3, the capacity for an individually designed terrace with a bare soil channel shall be calculated using a Manning's "n" value of 0.06 or greater and the additional depth for freeboard and overfill for settlement shall be waived. For permanently vegetated channels refer to Oklahoma NRCS Conservation

Practice Standard, Grassed Waterway (412) for design criteria to determine capacity.

**Channel grade.** When making an individual terrace design, channel grade shall be determined by one of the following methods:

1. For permanently vegetated channels, base the channel stability on the appropriate vegetation. Refer to Oklahoma NRCS Conservation Practice Standard, Grassed Waterway (412) for design criteria to determine stability.
2. For cultivated channels, the maximum channel velocity shall be non-erosive for the soil and planned treatment. Maximum design velocities or channel grades are:

2.5 ft/s or a channel grade of 0.5 percent for erosion-resistant soils (c, sic, sc, cl);

2.0 ft/s or a channel grade of 0.4 percent for erodible soils (l, sil, sicl, scl); and

1.5 ft/s or a channel grade of 0.2 percent for easily erodible soils (sl, fsl, vsl).

Velocity shall be computed by Manning's formula, using a maximum n value of 0.035 to determine velocity for channel stability.

Channel grades may be uniform or variable. For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment. If a terrace is designed utilizing Table 3, in no case shall the designed grade exceed the length and grade requirements listed in the Terrace Length section of this standard. 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. As a result, channel grades for terraces with underground outlets are allowed to be steeper for short distances 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.

**Freeboard.** The Height above Channel values found in Table 3 include freeboard. No additional freeboard is needed except as noted in Table 3 for terraces with very flat or level grades and for terraces with end closures. In place of Table 3, individually designed terraces shall include no less than 0.3 ft of freeboard, unless otherwise specified in this standard.

**End closures.** 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 uphill side of the end closure (away from the terrace ridge) before overtopping the terrace ridge.

End closures less than or equal to half the effective height of the terrace ridge are considered partial closures while those greater than half the height are considered complete closures. The base width of the end closures and blocks shall be equal to that of the terrace.

**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. For gradient terraces, the capacity and the non-erosive velocity requirements will normally control length. Maximum length for gradient terraces shall be governed by the following:

2500 feet for terrace grades of  $\leq 0.1\%$ ,

3000 feet for grades  $> 0.1\%$  and  $\leq 0.3\%$ ,

2000 feet for terrace grades of  $0.4\%$

1000 feet for terrace grades of  $0.5\%$

If lengths longer than those specified above are needed for a gradient terrace, an individual design is required.

**Outlets.** All terraces must have adequate outlets. The outlet must convey runoff water to a point where the outflow will not cause damage.

Vegetated outlets may be used for gradient or open-end level terraces. Such an outlet may be a grassed waterway or other vegetated area. 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 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. The release time shall not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops depending on soil characteristics and water tolerance of crops being grown. If sediment retention is desired, adjust release rate according to particle size.

The underground conduit shall meet the requirements specified in Oklahoma NRCS Conservation Practice Standard, Underground Outlet (620) or Oklahoma NRCS Conservation Practice Standard, Subsurface Drain (606). 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 (also known as French drains) may be used where they are effective.

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

Upper terraces in a system, especially level terraces or those with complete or partial end closures, shall not discharge into lower terraces unless the lower terrace is designed to handle the additional water.

**Vegetation.** All areas to be vegetated shall be established as soon as practicable after construction. Refer to Oklahoma NRCS Conservation Practice Standard, Critical Area Planting (342) for seeding criteria.

**Additional Criteria Applicable To Retaining Runoff For Moisture Control**

Perform a water budget analysis to determine the volume of water that must be collected to meet the requirements of the water budget. As a minimum the terrace must still meet the design storm and sediment volume requirements in the General Criteria for Capacity section of this standard.

**Additional Criteria Applicable to Level Terraces**

Level terraces are applicable only on land slopes of 8% or less.

**Spacing.** For level terraces used for erosion control and water conservation, the spacing shall be determined as previously described, but in no case shall the maximum horizontal interval exceed 600 ft. The average horizontal interval does not have to be less than 100 feet; however, if spacing formulas indicate a horizontal interval less than 100 feet and a 100 foot spacing is used, the capacity shall be checked. The height shall be set at either that specified in Table 3 or that needed for capacity for an individually designed terrace, whichever is greater.

**Capacity.** Design level terraces to contain the runoff from a 10-year 24-hour rainfall event, and the expected 10-year sediment accumulation, unless sediment is removed annually through maintenance.

**Terrace Length.** Level terrace length shall not exceed 3,500 ft. unless the channel is blocked at intervals not exceeding 3,500 ft.

**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.

For level terraces that have end closures that are lower than the terrace ridge elevation, areas downstream from the end closure must be protected from flow that will exit from the closure before the design storm is reached.

**Outlets.** 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 standing water does not significantly damage crops.

**Additional Criteria Applicable To Individual Terrace Designs**

When terraces are spaced with an individual terrace design, sheet and rill erosion rates shall be analyzed. If sheet and rill erosion are not a concern, Oklahoma NRCS Conservation Practice Standard, Diversion (362) shall be used.

**Additional Criteria Applicable To Evaluating Existing Terraces**

Existing terraces may need to be evaluated for two reasons: 1) Adding new terraces below the existing terraces, and/or 2) Justifying the need to rebuild.

**Adding Terraces Below Existing Terraces.**

When adding new terraces below existing terraces, a visual inspection is needed to assure that the terraces are functioning properly and do not have any ridge breaks or channel blocks. At least one cross section shall be taken at a point that appears to be the weakest in the terrace system. This cross section must meet the criteria outlined in Table 4 in order to construct new terraces below the existing ones.

Table 4. Existing Terrace Evaluation

Ht. Above Channel (Ft)	Channel Cross Sectional Area (Ft <sup>2</sup> )
0.7	20
0.8	18
0.9	17
1.0	16

An alternative evaluation would be to show by individual terrace design that the existing terraces meet the channel capacity and grade requirements of this standard.

#### **Justifying the Need to Rebuild Terraces.**

Terrace reconstruction is warranted only if the terraces meet current spacing and channel grade criteria and have a stable outlet.

Terraces meeting any of the following should be considered for rebuilding:

Terrace has numerous breaches,  
Ht. Above Channel is < 0.7 feet,  
Channel Cross Sectional Area is  
< 50% of design.

Each terrace in a system must be evaluated. Terraces not meeting the above criteria are considered adequate and would not need to be rebuilt.

Existing terraces shall not be removed prior to rebuilding. Rebuilt terraces shall meet all criteria for a new terrace.

Isolated low points in the terrace profile should be repaired through normal operation and maintenance.

#### **Additional Criteria Applicable To Removing Old Terraces**

Old terraces shall be removed if new terraces will not function properly due to the existence of the old terraces, if the old terraces will cause erosion or ponding in the field, or if the old terraces will concentrate flows into portions of the new terrace system. In addition, terraces that exceed current spacing limits or current channel grade criteria, or terraces that lack a stable outlet shall be removed. Other justifications for removing terraces beyond that listed above must be approved by an engineer.

The entire old terrace system shall be removed prior to or in conjunction with the installation of the new terrace system. Removal shall be in accordance with this standard.

Old terraces replaced with cropland diversions shall be removed if any of the above criteria applies. Criteria for this type of removal are found in the Oklahoma NRCS Obstruction Removal (500) standard.

Cropland that is being converted to grass should have existing terraces removed. Criteria for this type of removal are found in the Oklahoma NRCS Obstruction Removal (500) standard. If the existing terraces are broken and causing active erosion, removal is required.

Proper planning procedures shall be utilized when removing old terraces in non-cropland areas to minimize erosion problems prior to establishment of vegetation. This may include staggered removals or vegetating between terraces prior to removal.

#### **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 so that they 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 limiting layers to plant growth in the soil profile. 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.

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.

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.

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

Inlets 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.

For terraces that will be farmed or otherwise revegetated, the stripping and stockpiling of topsoil from the construction area prior to excavation and then spreading the 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. If underground outlets are used, 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

A written operation and maintenance plan shall be prepared for the operator. The minimum requirements to be addressed in the operation and maintenance 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, channel profile, terrace cross-sections and outlet elevations.
4. Perform tillage operations as close to the contour of the terrace channel as is practical. Tillage operations which cross over the terrace ridge may reduce the height of the terrace, thereby decreasing its effectiveness at controlling erosion.
5. 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.
6. 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.
7. Vegetation, where specified, shall be maintained and trees and brush controlled by chemical or mechanical means.
8. Keep machinery away from steep back sloped terraces. Keep equipment operators informed of all potential hazards.

## REFERENCES

USDA, NRCS. 2004. Revised Universal Soil Loss Equation, Ver. 2 (RUSLE2).

USDA, NRCS. National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 8.

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE GENERAL SPECIFICATIONS**

**TERRACE  
(FT.)**

**CODE 600**

**CONSTRUCTION SPECIFICATIONS**

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 banks of gullies and ditches to be crossed shall be sloped to a minimum of 1.5:1 before the fill is made.

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

The entire cross section of the channel and ridge shall be uniform, full bodied, and smooth to the extent that farming operations may be accomplished with regular farm equipment.

The slopes on excavated areas shall be approximately equal to the ridge slopes. The openings at the outlet end of the terrace shall have a cross section at least equal to that specified for the terrace channel. End closures, where specified, shall be made before the terrace is considered complete.

The channel grade shall be constructed to such uniformity that unnecessary water impoundment will not be caused by blocks in the channel. Channel blocks or "highs" of 0.2 feet will be allowed in erosion resistant and average soils, 0.3 feet in easily eroded soils, where such tolerance does not affect the minimum height requirements. For level terraces, variations in grade may be undulating so that the average grade will approach zero.

Where terraces are to be constructed across field ditches and gullies, channel lows will be permitted at these locations when the original ditch or gully is deeper than the normal cut to construct the terrace. Such lows will, therefore, not be used when checking terrace channel grade. The terrace ridge height shall be maintained across these lows in order to meet minimum height requirements. Additional compaction by machinery routing or other suitable means may be required to insure proper function of the terrace.

Acceptable average grades for terraces are those within  $\pm 0.10$  feet per 100 feet of design grade as long as there is positive grade. This average grade shall be figured for the terrace length excluding 100 feet on each end. A tolerance of  $\pm 0.20$  feet per 100 feet may be allowed for not more than 300 feet consecutive length even though the average grade is within the specified tolerance of the design grade. A constructed grade of 0.6 feet is allowed on the last 100 feet of the spill end.

Provisions shall be made to prevent piping if conduits for underground outlets are located under terrace ridges. The conduit shall be placed deep enough to prevent damage by machinery for both present and future conditions. In no case shall the conduit have less than 2 feet of cover.

If necessary, top soil 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.

When terraces are removed and replaced with a new or improved terrace system, the land shall be graded such that there is no impoundment of water from the old terraces and that the land slope is not greater than twice the slope of the surrounding ground or greater than a 10:1 slope, whichever is less.