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 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:

1. Soil erosion by water 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

General. Both gradient terraces and level terraces may be parallel or nonparallel. They may be constructed with either a broad base, narrow base, or grassed back slope cross section. Terraces must generally fit the contour of the land. Deviations from the contour must be limited and allowed only when necessary to obtain good alignment.

Gradient terraces may use either vegetated or underground outlets.

Level terraces may use either the infiltration capacity of the soil as an outlet or underground outlets.

Level terraces may be used on deep soils with high infiltration rates where it is known that level terraces will function properly.

Basin terraces are a specialized case of a closed end level terrace constructed on non-cropland areas, where the contributing watershed is in permanent cover of grass and/or timber.

Predominant land slopes must meet one of the following criteria:

1. Predominant land slope is less than or equal to 18% prior to construction.
2. The land capability class is IV or less.

Spacing. Terrace spacing is measured from channel to channel (Figure 1). For single terrace systems and upper terraces, the terrace spacing is determined as the average distance from the channel to the top of slope. Terrace spacing includes the width of front slope, back slope, and farmed area in between. Factors affecting spacing are the type of terrace cross section, slope and tillage and management practices used.

Terrace spacing may be determined by using the Revised Universal Soil Loss Equation (RUSLE). The spacing may be equal to or less than the maximum slope length that will keep soil loss within allowable limits as determined by the RUSLE with planned levels of management. Slope length used in the RUSLE will be the horizontal interval shown in Figures 2 and 3.

Spacings determined using the RUSLE shall not exceed those given in Table 1. The column for spacings with resource management systems (soil criteria) shall be used only when the soil loss within the terrace interval is reduced to the tolerable soil loss limit (T). The column for spacings without resource management systems (soil criteria) shall be used if the terraces and associated installed practices do not bring the soil loss within the terrace interval down to "T".

Spacing should be adjusted to provide good alignment, an even number of trips for anticipated row crop equipment, and maximum flexibility for changing row width. All adjustments shall be made downward from the maximum given in Table 1.

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

Alignment. Terraces shall be as parallel as practicable. Curves should be long and gentle to accommodate farm machinery. Land forming, extra cut or fill along the terrace line, multiple outlets, variations in grade, channel blocks, and other methods shall be used to achieve good alignment. Correction areas will be used where needed to achieve a better contour row pattern.

Capacity. The terrace shall have enough capacity to control the runoff from a 10-year frequency, 24-hour rainfall without overtopping. For level terraces and 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 the runoff of a frequency consistent with the potential hazard. When the capacity is determined by the formula Q = AV and V is calculated by using Manning's formula, an “n” value of 0.035 shall be used for bare channels. Engineering Field Handbook Chapter 7, Handbook of Channel Design for Soil and Water Conservation (SCS-TP-61), or equivalent shall be used for designing vegetated channels.

FIGURE 1. TERRACE SPACING

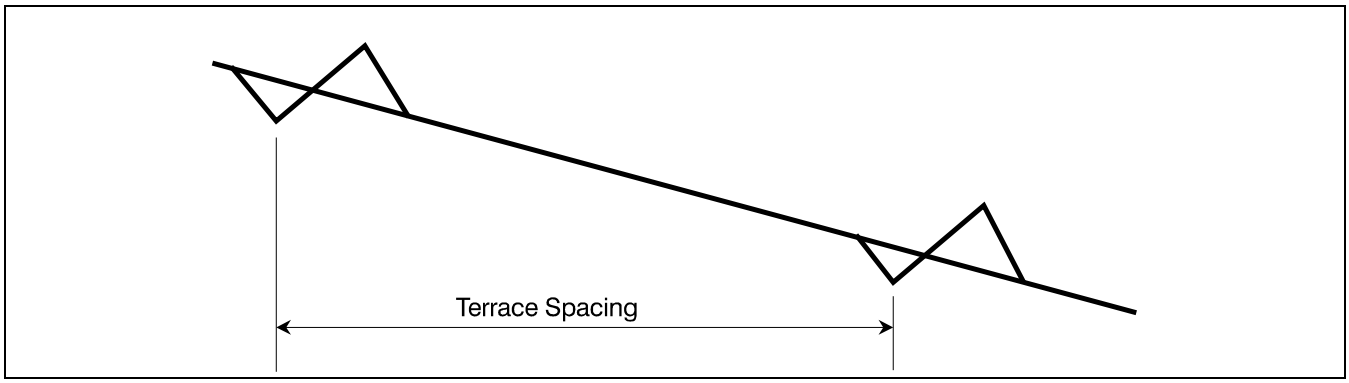
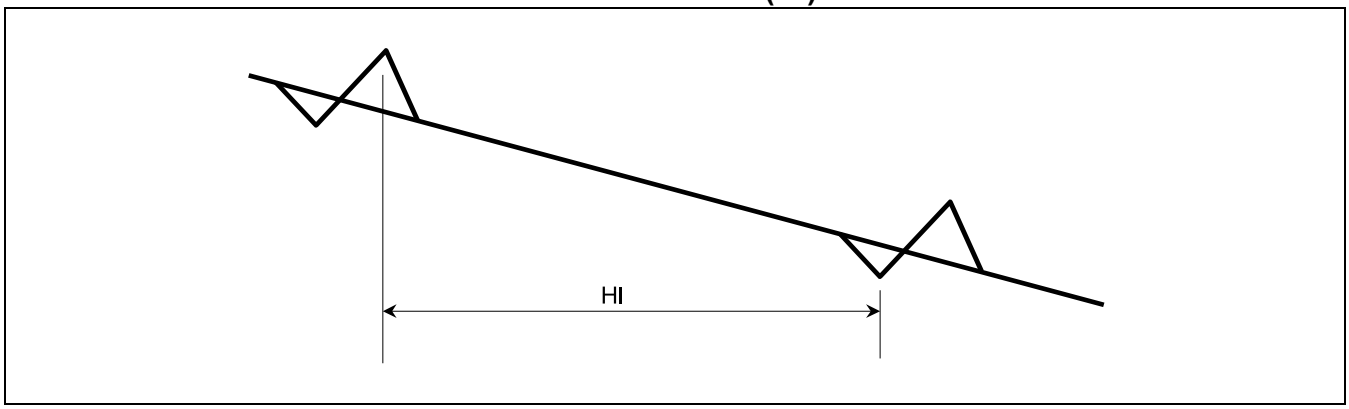


FIGURE 2. HORIZONTAL INTERVAL FOR (HI) STEEP BACK SLOPE TERRACE

FIGURE 3. HORIZONTAL INTERVAL FOR (HI) BROAD BASED TERRACE



Gradient terraces and non-storage sections of level terraces and terraces with underground outlets shall have a minimum height of 1 foot. This is a settled fill height and applies to all types of terrace cross sections.

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 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 back slope terraces (Figure 5), or narrow base terraces (Figure 6).

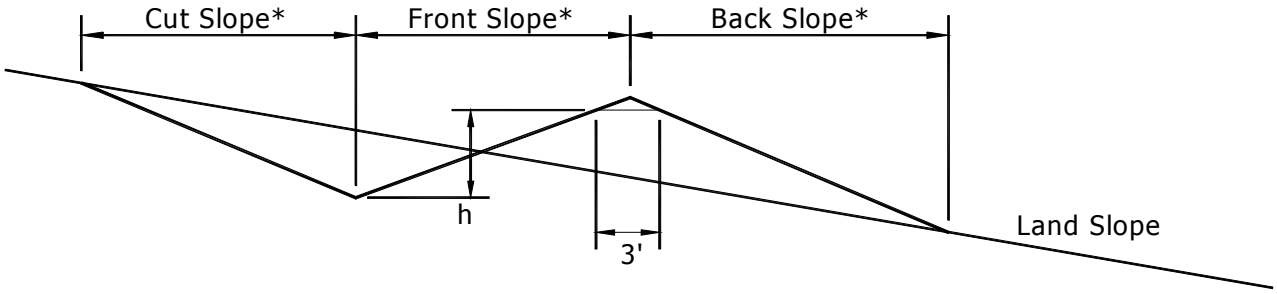
The increment of machinery width noted on these figures is considered as the full width of machinery not capable of conforming to the breaks in slope.

Broad Base Cross Section. 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 cut slope, front slope and back slope. Building a broad base terrace from the uphill side may increase the slope of the land by 3% - 5%.

TABLE 1. MAXIMUM TERRACE SPACING - FEET

Field Slope %	Without Resource Management Systems (Soil Criteria)	With Resource Management Systems (Soil Criteria)
0 - 1	300	400
2 - 3	240	350
4 - 5	180	300
6 - 8	150	250
9 - 12	120	200
13 - 18	105	150

FIGURE 4. MINIMUM DIMENSIONS FOR BROAD BASE TERRACES



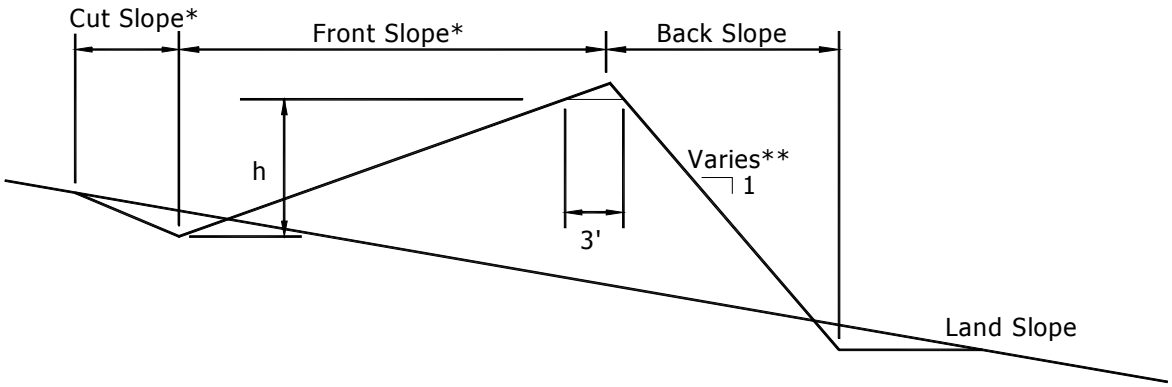
* Length of the cut slope and front slope shall be in increments of machinery width but not shorter than 15 feet nor steeper than 5:1

** The back slope shall not be steeper than 2:1 for all soil types except Ida and Monona which may have the back slope constructed no steeper than 1½:1

h Design height of terrace

Excavation on the upstream side of the terrace is not allowed except to enhance alignment or farmability.

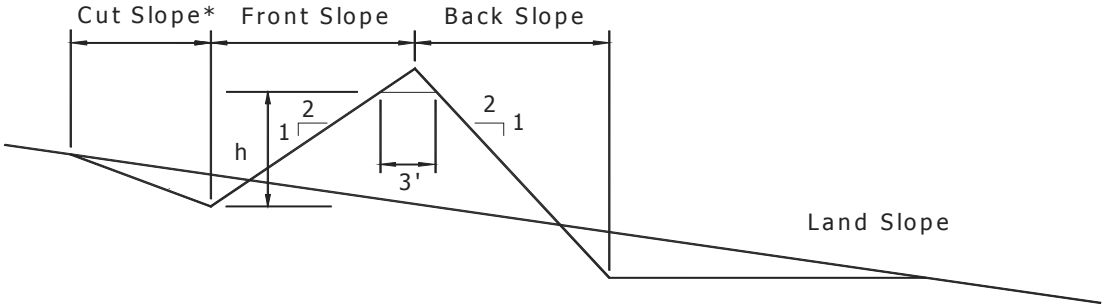
FIGURE 5. MINIMUM DIMENSIONS FOR GRASSED BACK SLOPE



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

h Design height of terrace

FIGURE 6. MINIMUM DIMENSIONS FOR NARROW BASE TERRACES



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

h Design height of terrace

Excavation on the upstream side of the terrace is not allowed except to enhance alignment or farmability.

On flat land this can be tolerated. Broad base terraces shall not be used on land slopes greater than 8%.

The length of the cut slope, front slope, and back slope shall be in increments of machinery width but not shorter than 15 feet nor steeper than 5:1.

Grassed Back Slope Cross Section. Excavation for the grassed back slope cross section shall be taken from the downhill side except where borrow from other locations is needed to enhance alignment or farmability. The back slope must be seeded to grass.

This type of terrace decreases the slope of the land that is farmed. Grassed back slope terraces are adaptable to all field slopes.

The back slope shall not be steeper than 2:1 for all soil types except Ida and Monona which may have the back slope constructed no steeper than 1½:1. The front slope shall not be steeper than 5:1 or shorter than 15 feet.

Narrow Base Cross Section. For narrow base terraces both the front slope and the back slope are seeded to grass and not farmed. Excavation for this type of terrace shall be taken from the downhill side except where borrow from other locations is needed to enhance alignment or farmability.

Neither the front slope nor the back slope shall be steeper than 2:1. Narrow base terraces shall not be left loose and uncompacted. Construction equipment shall be used on the terrace during construction to provide compactive effort and to provide a uniform cross section.

End Closures. Complete end closures will usually be made on level terraces and are required on basin terraces. End closures should be constructed to the terrace design height. If a partial end closure is designed lower that the design terrace height, a stable outlet shall be provided. Upper terraces in a system with partial end closures shall not discharge into lower terraces unless the lower terrace is designed to handle the additional water.

End closures shall be designed so that overtopping occurs over the end closure before overtopping the terrace ridge. Storage terraces with underground outlets shall be constructed so that overtopping, if it occurs, will take place at the ends of the storage section where ridge height is a minimum. This also applies to level and basin terraces where due to topography or layout considerations, an outlet is not possible at an end closure.

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

1. Maximum channel velocity for farmed channels shall be non-erosive for the soil and planned treatment. Maximum velocity for erosion-resistant soils is 2.5 fps; for average soils, 2.0 fps; and for easily erodible soils, 1.5 fps. Velocity shall be computed by Manning's formula using an "n" value of 0.025. Chapter 8 of the Engineering Field Handbook provides solutions to Manning's formula.
2. Maximum channel velocities for vegetated channels shall not exceed those used for grassed waterways.

Channel grades may be uniform or variable.

Channel velocity shall not be erosive 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.

Level terraces shall have level channel grades and ridge tops, except that channels of terraces on Ida or Monona soils need not be leveled if the temporary ponding is acceptable to the landowner. For short reaches near the end of the terrace, graded channels may be used if adequate storage is provided in the storage sections. Channel grades shall not exceed those specified for gradient terraces.

Except as noted for Ida and Monona soils, storage for runoff must be provided over a sufficient length of the terrace to prevent ponding unless an underground outlet is used. When an underground outlet is used, steeper grades may be permitted near the outlet below the elevation attained by the design storage volume.

Basin terrace channels and ridges shall be constructed level over the entire length of the terrace, except that channels of basin terraces on Ida or Monona soils need not be leveled if the temporary ponding is acceptable to the landowner.

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 2,000 feet unless the channel is blocked at intervals not exceeding 2,000 feet. Blocks may also be used to separate adjacent level terrace reaches with different elevations. Blocks for this purpose shall be built to the full design height of the terrace with side slopes flat enough to easily accommodate farm machinery. Normally, the gradient terrace length is controlled by the capacity and the non-erosive velocity requirements.

Outlets. All terraces must have adequate 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 that crops are not significantly damaged by standing water.

Vegetated outlets may be used for gradient or partial 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 existing, or installed and vegetated before the terrace is constructed, if necessary, to provide a stable non-erodible 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.

Terraces shall not outlet on the right-of-way of a public road or highway or other public utility without approval of proper authorities. State drainage or water laws shall be adhered to in the diversion and disposal of drainage water.

Underground outlets may be used on gradient or level terraces. The outlet consists of an inlet and an underground conduit. An orifice plate, reduction in size of offset line or other features, shall be installed as needed to control the release rate and prevent pressure pipe flow. The discharge, when combined with the storage, shall be such that runoff from a 10-year frequency, 24-hour rainfall 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 soil 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. If the front slope is farmed, the inlet shall be located an adequate distance uphill from the front slope to permit passage of farm machinery.

The inlet shall be offset from the main conduit. Only the top inlet in the terrace system can be placed directly on the main conduit. At least 8 feet of non-perforated conduit shall be installed as the offset between the inlet and the main conduit.

If the topmost inlet is placed directly on the main conduit, the conduit shall be non-perforated from the inlet to the toe of the terrace back slope. All inlets shall be fabricated so that an orifice can easily be installed. When corrugated plastic tubing is used under terrace fills, it shall meet the requirements for "heavy duty" tubing.

The conduit shall be designed to discharge the runoff from a 10-year frequency, 24-hour rainfall event without overtopping the terrace, but shall not be designed for less than 1 inch of runoff per acre per day. It must be installed deep enough to prevent damage by machinery for both present and future operations.

Conduits used specifically to outlet the terrace system should usually extend only to the closest satisfactory surface or underground outlet with no reduction of the required design discharge. When the distance to a satisfactory outlet for a subsurface conduit is excessive, a surface relief well may be installed downstream from the toe of the bottom terrace, and the

capacity of the conduit reduced to that needed for subsurface drainage of the area served by the conduit.

The terrace outlet conduit may discharge into an existing subsurface drain with a discharge capacity of less than 1 inch per acre per day providing:

1. The capacity of the existing subsurface drain is adequate for subsurface drainage of the watershed area at the point of connection, and
2. A surface relief well is installed between the bottom terrace and the point of connection into the existing line.

Where the discharge enters an open channel, the outlet pipe shall be equipped with a flapgate type rodent guard.

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 to grass as soon as practicable after construction. Seeding shall be done in accordance with the Critical Area Planting (342) Standard. Sod shall be maintained and trees and brush controlled by chemical or mechanical means.

CONSIDERATIONS

All terrace systems should be designed as part of a resource management system.

Terrace systems should be combined with planned cultural and management practices, including residue management systems and crop rotations, that will adequately reduce soil loss in the interval between terraces to permissible limits. Soil loss on each terrace system must be checked to determine needed resource management systems. When the terraces alone do not reduce soil loss to permissible limits, the landowner will be informed of additional system components needed.

Water Quantity

1. Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
2. Variability effects caused by seasonal or climatic changes.
3. Effects of snowcatch and melt on water budget components.
4. Potential for a change in plant growth and transpiration because of changes in the volume of soil water.
5. Effects on downstream or aquifer flows could affect other water uses and users.
6. The effect on the water table of the field to ensure that it will provide a suitable rooting depth, field wide, for anticipated land uses.
7. Potential for water management to supply alternative uses.

Water Quality

1. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.
2. Effects of nutrients and pesticides on surface and ground water quality.
3. Effects on the visual quality of onsite and downstream water.
4. Short-term and construction-related effects on the quality of onsite and downstream water.
5. Potential for development of saline seeps or other salinity problems resulting from increased infiltration in soils that have restrictive layers.
6. Potential for uncovering or redistributing toxic materials such as saline soils.
7. Effects on the movement of dissolved substances below the root zone and to the ground water.
8. Effects on wetlands and water-related wildlife habitats.

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.

SAFETY

Terrace ridges, especially those with steep back slopes, can be very hazardous. For this reason, some landowners/users 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 operate safely. Any hazards must be brought to the attention of the responsible person.

OPERATION AND MAINTENANCE

1. Establish a program for maintaining terrace capacity, storage, ridge height, and outlets.
2. Keep inlets clean and redistribute sediment build-up so that the inlet is in the lowest point in the terrace channel.
3. Repair or replace any damaged surface inlets.
4. Remove trash from around and inside the surface inlet.
5. Control weeds, brush, and trees by mechanical methods or chemicals.
6. Re-seed and fertilize as needed to maintain good vegetation.