# ALABAMA SUPPLEMENTS TO THE

# NATIONAL ENGINEERING FIELD HANDBOOK

## CHAPTER 8. TERRACES

### Contents

**PAGE**

**Terrace Spacing** ........ **AL8-21(1)**

**Spacing Affected by Cross Section** ........ **AL8-24(1)**

**Layout** ........ **AL8-33(1)**
  **Truck method of Parallel Terrace Layout** ........ **AL8-33(1)**

**Design** ........ **AL8-55(1)**
  **Graded Terraces with Underground Outlets** ........ **AL8-55(1)**
    Detention Time ........ **AL8-55(1)**
    Terrace Storage Capacity ........ **AL8-55(1)**
    Risers, Size, and Locations ........ **AL8-55(1)**
    Detachable Plastic or Rigid Metal Risers for Underground Outlets ........ **AL8-55(2)**
    Outlet Section of Pipe ........ **AL8-55(2)**
    Materials ........ **AL8-55(4)**
    Runoff Storage ........ **AL8-55(4)**
    Sediment Storage ........ **AL8-55(6)**
    Design Procedure-All Terraces With Underground Outlets ........ **AL8-55(6)**
    Design Procedure-Unstable Bypass ........ **AL8-55(6)**
    Design Procedure-Stable Bypass ........ **AL8-55(7)**
    Design of the Underground Outlet Conduit ........ **AL8-55(7)**
    Underground Outlet Installation ........ **AL8-55(8)**
    Intake or Riser ........ **AL8-55(8)**

**Design Example-Storage Terrace with Underground Outlet** ........ **AL8-55(15)**

**Records and Maintenance** ........ **AL8-55(18)**

### FIGURES

**Figure AL8-1 Cross section of effective cultivated length of slope.** ........ **AL8-24(1)**
**Figure AL8-2 Concrete culvert stilling well for underground outlet.** ........ **AL8-55(3)**
**Figure AL8-3 A method of backfilling the underground conduit trench.** ........ **AL8-55(8)**
**Figure AL8-4 Terrace system with underground outlets survey notes and design.** ... **AL8-55(19)**
**Figure AL8-5 Terrace system survey notes and design.** ........ **AL8-55(25)**

<u>TABLES</u>

**Table AL8-1.  Terrace spacing for different farming equipment widths. ........................ AL8-24(1)**
**Table AL8-2.  Runoff for 10-year, 24-hour rainfall. ........................................................... AL8-55(5)**
**Table AL8-3.  Sediment storage for terraces and sediment basins. ............................... AL8-55(6)**
**Table AL8-4.  Per cent storage factor. ................................................................................ AL8-55(7)**
**Table AL8-5a.  Natural storage above terrace for 14-foot front slopes. ......................... AL8-55(9)**
**Table AL8-5b.  Natural storage above terrace for 28-foot front slopes. ......................... AL8-55(10)**
**Table AL8-5c.  Natural storage above terrace for 3 to 1 front slopes. ............................ AL8-55(11)**
**Table AL8-5d.  Natural storage above terrace for 2½ to 1 front slopes. ........................ AL8-55(13)**

## TERRACE SPACING

The maximum spacing of terraces for erosion control shall be determined by one of the following methods but does not have to be less than 90 feet:

1. Equations: $V.I. = xs + y$ or $H.I. = x(100) + \frac{y(\ 100\ )}{s}$

   Where: V.I. = vertical interval in feet.  
   H.I. = horizontal interval in feet (See Conservation Practice Standard, Terraces – Code 600.  
   x = a variable with values from 0.4 to 0.5. South of a line struck from south Cleburne County to the southern border of Lamar County, use 0.4. Above this line use x = 0.5.  
   s = land slope in feet per 100 feet.  
   y = a variable with values from 1.0 to 4.0.

   The values of “Y” generally are as follows:  
   y = 1.0 for soils with below average intake rates and cropping systems that provide little cover during intense rainfall periods.  
   y = 4.0 for soils with average or above intake rates and cropping systems that provide good cover during periods of intense rainfall.  
   y = 2.5 where one of the above factors is favorable and the other unfavorable.

With parallel terraces the horizontal interval is important in order to fit equipment and trips through the field. The vertical interval is used only as a means to determine horizontal interval. The vertical interval equation VI = XS = Y can be arranged to determine the horizontal interval.

For example, if the value of X is 0.5 and Y is 4, then the equation becomes VI = 0.5 S + 4.

The equation for HI can be rearranged as:

$$HI = X(100) + Y\frac{(100)}{S}$$

For the above case of X and Y, the equation for horizontal interval is

$$HI = 0.5(100) + \frac{4(100)}{S} = 50 + \frac{400}{S}$$

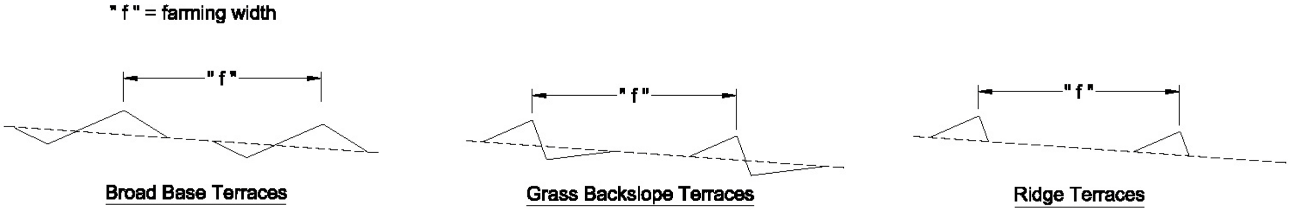
If the slope is 5 percent, then VI = 0.5(5) + 4 = 6.5 feet, and the

$$HI = 50 + \frac{400}{5} = 130 \text{ feet (use 130 feet)}$$

2. Table AL8-1 should be used to determine parallel terrace spacing. The horizontal spacing should not exceed 450 feet for land slopes up to 2%, 300 feet for land slopes of 2% to 4%, 200 feet for slopes of 4% to 6%, and 150 feet for slopes of 6% and over.

## SPACING AFFECTED BY CROSS SECTION

The effective cultivated length of slope (Figure AL8-1) between terraces varies with the type of cross section. Spacing can be increased 10 percent for alignment or location to adjust for farm machinery and an additional 10% with underground outlets.



Broad Base Terraces

Grass Backslope Terraces

Ridge Terraces

**Figure AL8-1. Cross section of effective cultivated length of slope.**

| **Width of One Trip Across Field** | | | | | | |
|---|---|---|---|---|---|---|
| **No. of Rows** | **Width of Row (inches)** | | | | | |
| | **30** | **32** | **34** | **36** | **38** | **40** |
| **4** | 10’ - 0” | 10’ - 8” | 11’ - 4” | 12’ - 0” | 12’ - 8” | 13’ - 4” |
| **6** | 15’ - 0” | 16’ - 0” | 17’ - 0” | 18’ - 0” | 19’ - 0” | 20’ - 0” |
| **8** | 20’ - 0” | 21’ - 4” | 22’ - 8” | 24’ - 0” | 25’ - 4” | 26’ - 8” |
| **12** | 30’ - 0” | 32’ - 0” | 34’ - 0” | 36’ - 0” | 38’ - 0” | 40’ - 0” |
| **16** | 40’ - 0” | 42’ - 8” | 45’ - 4” | 48’ - 0” | 50’ - 8” | 53’ - 4” |

| **FARMING WIDTHS “f” FOR DIFFERENT MACHINERY SIZES (rows)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **No. of Trips** | **4 Rows** | | | | **6 Rows** | | | | **8 Rows** | | | |
| | **30”** | **36”** | **38”** | **40”** | **30”** | **36”** | **38”** | **40”** | **30”** | **36”** | **38”** | **40”** |
| **4** | | | | | | 72’-0” | 76’-0” | 80’-0” | 80’-0” | 96”-0” | 101’-4” | 106’-8” |
| **5** | | | | 66’-8” | 75’-0” | 90’-0” | 95’-0” | 100’-0” | 100’-0” | 120’-0 | 126’-8” | 133’-4” |
| **6** | | | 76’-0” | 80’-0” | 90’-0” | 108’-0” | 114’-0” | 120’-0” | 120’-0” | 114’-0” | 152’-0” | 160’-0” |
| **7** | | 84’-0” | 88’-8” | 93’-4” | 105’-0” | 126’-0” | 133’-0” | 140’-0” | 140’-0” | 168’-0” | 177’-4” | 186’-8” |
| **8** | 80’-0” | 96’-0” | 101’-4” | 106’-8” | 120’-0” | 144’-0” | 152’-0” | 160’-0” | 160’-0” | 192’-0” | 202’-8” | 213’-4” |
| **9** | 90’-0” | 108’-0” | 114’-0” | 120’-0” | 135’-0” | 162’-0” | 171’-0” | 180’-0” | 180’-0” | 216’-0” | 228’-0” | 240’-0” |
| **10** | 100’-0” | 120’-0” | 126’-8” | 133’-4” | 150’-0” | 180’-0” | 190’-0” | 200’-0” | 200’-0” | 240’-0” | 253’-4” | 266’-8” |
| **11** | 110’-0” | 132’-0” | 139’-4” | 146’-8” | 165’-0” | 198’-0” | 209’-0” | 220’-0” | 220’-0” | 264’-0” | 278’-8” | 293’-4” |
| **12** | 120’-0” | 144’-0” | 152’-0” | 160’-0” | 180’-0” | 216’-0” | 228’-0” | 240’-0” | 240’-0” | 288’-0” | 304’-0” | 320’-0” |
| **13** | 130’-0” | 156’-0” | 164’-8” | 173’-4” | 195’-0” | 234’-0” | 247’-0” | 260’-0” | 260’-0” | 312’-0” | 324’-4” | 346’-8” |
| **14** | 140’-0” | 168’-0” | 177’-4” | 186’-8” | 210’-0” | 252’-0” | 266’-0” | 280’-0” | 280’-0” | 336’-0” | 354’-8” | 373’-4” |
| **15** | 150’-0” | 180’-0” | 190’-0” | 200’-0” | 225’-0” | 270’-0” | 285’-0” | 300’-0” | 300’-0” | 360’-0” | 380’-0” | 400’-0” |
| **16** | 160’-0” | 192’-0” | 202’-8” | 213’-4” | 240’-0” | 288’-0” | 304’-0” | 320’-0” | 320’-0” | 384’-0” | 405’-4” | 426’-8” |
| **17** | 170’-0” | 204’-0” | 215’-4” | 226’-8” | 255’-0” | 306’-0” | 323’-0” | 340’-0” | 340’-0” | 408’-0” | 430’-8” | |
| **18** | 180’-0” | 216’-0” | 228’-0” | 240’-0” | 270’-0” | 324’-0” | 342’-0” | 360’-0” | 360’-0” | 432’-0” | | |
| **19** | 190’-0” | 228’-0” | 240’-8” | 253’-4” | 285’-0” | 342’-0” | 361’-0” | 380’-0” | 380’-0” | | | |
| **20** | 200’-0” | 240’-0” | 253’-4” | 266’-8” | 300’-0” | 360’-0“ | 380’-0“ | 400’-0” | 400’-0” | | | |

**Table AL8-1. Terrace spacing for different farming equipment widths.**

## LAYOUT

### Truck Method for Parallel Terrace for Contour Strip Layout (Optional Method)

After the key terrace is established, a truck is used to drive along that terrace with a person walking along the new parallel terrace line to be staked. One end of the tape is fastened to the truck at the front of the bed on the driver's side. The person holding the other end of the tape at the terrace interval distance starts out a few steps ahead of the truck and walks 100 feet along the new parallel terrace and stops. The driver keeps the left side of the truck following the key terrace alignment. When daylight can be seen between the truck cab and bed by the person on the new terrace, the truck is stopped. The terrace interval, perpendicular to the truck, will be correct and a station on the new terrace can be set. When fields are too wet for a truck, a small tractor or four wheeler can be used. The frame or any suitable upright reference posts can be used to get alignment. Rotation of truck driver and person on the new terrace will minimize fatigue. See Alternate Methods 1 and 2.

Alternate Method 1:

Visible 3 ft. post can be placed in the two truck bed holes at the cab or tailgate for alignment purposes. One end of the windless tape is fastened to the appropriate post, the walker then at the correct distance for the new terrace or contour strip line, walks, and marks the line keeping the tape tight and the posts in line so the terrace or contour line is laid out in perpendicular. The walker using flags marks the stations and the farmer follows the walker and marks the line with a tractor plowing with a subsoil shank. Rod readings are then taken on the new terrace or plowed strip lines as soon as two lines are staked or marked.

Alternate Method 2:

After the key terrace is established, the farmer with his tractor and planter or cultivator can simulate planting or cultivating the field above and/or below the key terrace until the spacing is reached for the next terrace. Then this terrace can be marked with terracing flags and rod reading made to determine acceptability. This procedure can be continued as long as terrace or contour line grade is acceptable.

## DESIGN

### Graded Terraces with Underground Outlets

An emergency bypass should be provided when possible at the edge of the field or away from the riser to reduce possibility of terrace over-topping and failure.

#### Detention Time

A detention time of 24 hours is recommended for most fields.

#### Terrace Storage Capacity

Many terraces have both natural and excavated storage. However, if sediment storage is not added to the total design storage requirements, only natural storage should be computed to determine the ridge height. The additional storage excavated during construction will compensate for the lack of sediment storage in most situations.

#### Risers, Size, and Locations

The riser shall be located at the lowest spot on the terrace profile, or the terrace must be graded to the riser in order to drain all the terrace channel. The riser shall be placed uphill from the terrace ridge a distance equal to a multiple of the equipment width (min. 8-row) so that all equipment used will pass. Spacing of the risers shall be as recommended for terrace spacing in Table 8-1 and emphasis will be on spacing for multiple of round trips. The riser should be 6 in. in diameter or larger with openings in the 5 ft. riser above ground and holes for subsurface drainage in the first four beet below ground. These holes shall be rectangular or drilled uniformly smooth and round for hydraulic efficiency using a round hole saw. The openings shall be sufficiently numerous to pass the required flow even if some are obstructed. A minimum of 12 1-in. diameter holes per linear foot or equivalent is recommended. Flexible risers should be guarded by a post (or two) in line with the rows and be marked for visibility. Risers should be attached to the post using a figure-eight wrap of galvanized wire or strap that in turn is secured to the post. The riser should be surrounded by a gravel drain fill to improve drainage. The gravel drain material needs to surround the riser in a 24-in. diameter or square column from the riser bottom to the ground surface. In “B”, “C”, and “D” soils, drain material is essential. Artificial filter material such as spun fiberglass, bonded nylon fabric, and plastic filter cloth will suffice in “A” soils.

An orifice plate will usually be installed to meter the desired discharge into a common conduit outlet when there are two or more terraces involved. However, since actual field conditions will impact the hydraulics of these structures, systems may be designed without orifice plates by experienced personnel with guidance from the resource engineer.

Subsurface drainage pipe should be used through wet soils for the outlet conduit, with flow in the intake risers restricted with an orifice so as to prevent pressure flow in the conduit. If sealed or continuous pipe or tubing is used for the conduit, flow shall be controlled in the risers in the upper terraces to prevent reverse flow in the risers of the lower terraces. Flow will be controlled by the use of an orifice located near the bottom of the intake riser by sizing the outlet conduit or by sizing the intake lateral. The diameter of the orifices can be determined from the following formula as shown in the design example:

Orifice Size Formula $A = Q/[C \times (2gH)^{0.5}]$

Where:
$A$ = area of orifice in $ft^2$
$Q$ = discharge rate of orifice in cfs
$C$ = coefficient = 0.60
$g$ = 32.2 ft./sec2
$H = (0.5 \times d1) + d2$
d1 = water depth in feet
d2 = depth of orifice below ground level in feet

Note: 1 cfs = 23.802 ac.in./24 hr.

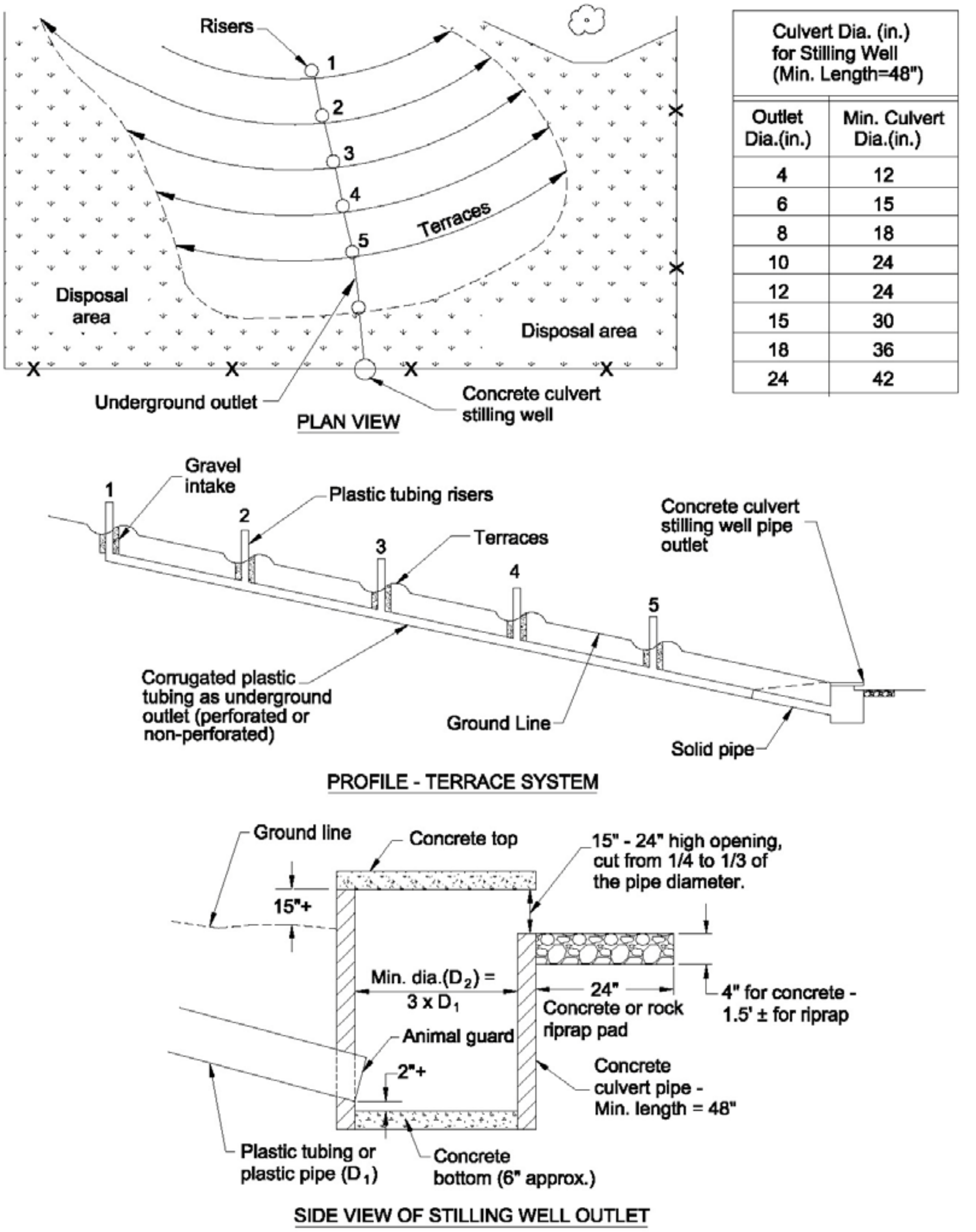
## Detachable Plastic or Rigid Metal Risers for Underground Outlets

Risers for the terrace underground outlets are damaged by cattle, farm equipment and fire. Installation of detachable PVC sewer pipe risers or metal risers will limit the damage from most sources. For moving and maintenance activities the upper riser portion can be removed and then replaced. The following and installation details are required:

1. Thin wall PVC sewer pipe meeting ASTM D-2729 or SDR-26 PVC pipe are acceptable materials.
2. Above-ground risers will have a minimum 12-1 in. holes/foot for length of pipe.
3. Below ground riser will have 12- ¼ in. holes/foot and be surrounded by 2 ft. of concrete gravel.
4. PVC coupling is glued to below ground section only. Above ground section is inserted about 1 inch for ease of removal.
5. Joint filler or tape maybe needed between pipe and orifice plate.

## Outlet Section of Pipe

The outlet shall be protected against erosion, undermining of the conduit, damage by equipment, damage during periods of submergence, and entry of rodents or other animals. A continuous 10-ft. section of non-perforated rigid pipe (plastic not recommended) with an animal guard or flap gate will be used at the outlet end of the line. The outlet should be at least 1 ft. above the normal elevation or low flow in the waterway or ditch. When satisfactory pipe cover or outlet is not available, the stilling well should be used.
(See Figure AL8-2.) The diameter of the stilling well will normally be a minimum 3X barrel diameter. If the outlet is stable for concentrated flow and a stilling well is only being installed to maintain pipe cover, the stilling well will be a minimum 2x barrel diameter. The cutout in the well will normally be 1/3 diameter and 15 in. high but may be designed using the weir flow formula: $Q = 3.1 \times L \times H^{1.5}$ where L is the length of the weir and H is the head.



| Culvert Dia. (in.) for Stilling Well (Min. Length=48") | |
|---|---|
| Outlet Dia.(in.) | Min. Culvert Dia.(in.) |
| 4 | 12 |
| 6 | 15 |
| 8 | 18 |
| 10 | 24 |
| 12 | 24 |
| 15 | 30 |
| 18 | 36 |
| 24 | 42 |

Note: There are a number of instances where, due to soil cover, underground outlets can not be safely emptied into a waterway, edge of field, at the property line, etc. unless carried a long distance. The concrete culvert pipe outlet can be used to safely discharge this flow as long as there are 15 inches or more of culvert pipe above normal ground. The underground plastic pipe should be solid pipe where pressure flow could develop and should enter the culvert 2 inches or more above the culvert bottom.

Drawing Number
Sheet no. of

PROJECT:
__________________COUNTY, __

U.S. DEPARTMENT OF AGRICULTURE - NATURAL RESOURCES CONSERVATION SERVICE

Date
Designed__________
Drawn__________
Checked__________
Approved__________

NRCS

Figure AL8-2. Concrete Culvert Stilling Well for Underground Outlet.

The pipe and its installation shall conform to the following requirements:

1. Where there is a hazard of vegetation burning at the outlet, the outlet pipe shall be fabricated from fire resistant material. Where the hazard of burning is high, the riser outlet also shall be fire resistant.
2. Two-thirds or more of the 10-ft. outlet section shall be buried in the ditch bank and the cantilevered section shall extend to the toe of the ditch side slope or the side slope shall be protected from erosion.
3. Where floating debris may damage the outlet pipe, the outlet shall be recessed to the extent that the cantilevered portion of the pipe will be protected from the current in the ditch.
4. Headwalls which are used at subsurface drain outlets shall be adequate in strength and design to avoid washouts and other failures. To protect against trench erosion, use a mound of soil over the pipe.

Watertight conduit strong enough to withstand the loads upon it shall be used where outlets cross under roadways or ditches.

### Materials

Pipe for the riser will be limited to corrugated or smooth plastic, steel, or aluminum. Durable smooth plastic pipe may be used provided it will withstand severe weather and temperature conditions and wear and tear from farm equipment and livestock. If corrugated plastic tubing is used for the riser, it shall be supported and protected from damage by livestock and farm equipment. When livestock is a problem, the answer may be three post set in a triangular pattern and wrapped with barbed wire. Pipe for outlet conduit section shall be clay or concrete sewer pipe, smooth steel pipe, corrugated metal pipe, asbestos cement pipe, or plastic pipe that will withstand loads applied by earth cover and heavy farm equipment. Materials shall meet strength and durability requirements of the site. Pipe materials shall conform to the specifications set forth in Conservation Practice Standard, Subsurface Drain – Code 606.

Orifice plates shall be made of metal or durable plastic that will withstand the pressure and flow of water through the riser.

### Runoff Storage

Sufficient storage will be provided to protect the terrace from overtopping. The amount of storage is generally based on a 10-year frequency 24-hour storm. Calculate the runoff or use values found in Table AL8-2.

**Table AL8-2. Runoff for 10-year, 24-hour rainfall.**

| County | Hydrologic Soil Group | | | |
|---|---|---|---|---|
| | A | B | C | D |
| AUTAUGA | 2.70 | 3.80 | 4.54 | 4.87 |
| BALDWIN | 4.76 | 6.14 | 7.01 | 7.38 |
| BARBOUR | 2.85 | 3.97 | 4.73 | 5.06 |
| BIBB | 2.55 | 3.63 | 4.36 | 4.68 |
| BLOUNT | 2.12 | 3.11 | 3.80 | 4.11 |
| BULLOCK | 2.78 | 3.89 | 4.64 | 4.97 |
| BUTLER | 3.15 | 4.33 | 5.10 | 5.44 |
| CALHOUN | 2.12 | 3.11 | 3.80 | 4.11 |
| CHAMBERS | 2.41 | 3.45 | 4.17 | 4.49 |
| CHEROKEE | 2.05 | 3.03 | 3.71 | 4.02 |
| CHILTON | 2.55 | 3.63 | 4.36 | 4.68 |
| CHOCTAW | 3.00 | 4.15 | 4.92 | 5.25 |
| CLARKE | 3.31 | 4.50 | 5.29 | 5.64 |
| CLAY | 2.33 | 3.37 | 4.08 | 4.40 |
| CLEBURNE | 2.12 | 3.11 | 3.80 | 4.11 |
| COFFEE | 3.31 | 4.50 | 5.29 | 5.64 |
| COLBERT | 1.98 | 2.94 | 3.62 | 3.93 |
| CONECUH | 3.54 | 4.77 | 5.58 | 5.92 |
| COOSA | 2.55 | 3.63 | 4.36 | 4.68 |
| COVINGTON | 3.62 | 4.86 | 5.67 | 6.02 |
| CRENSHAW | 3.08 | 4.24 | 5.01 | 5.35 |
| CULLMAN | 2.12 | 3.11 | 3.80 | 4.11 |
| DALE | 3.08 | 4.24 | 5.01 | 5.35 |
| DALLAS | 2.85 | 3.97 | 4.73 | 5.06 |
| DEKALB | 1.91 | 2.86 | 3.53 | 3.83 |
| ELMORE | 2.63 | 3.71 | 4.45 | 4.78 |
| ESCAMBIA | 4.02 | 5.31 | 6.15 | 6.50 |
| ETOWAH | 2.05 | 3.03 | 3.71 | 4.02 |
| FAYETTE | 2.26 | 3.28 | 3.99 | 4.30 |
| FRANKLIN | 2.05 | 3.03 | 3.71 | 4.02 |
| GENEVA | 3.46 | 4.68 | 5.48 | 5.83 |
| GREENE | 2.63 | 3.71 | 4.45 | 4.78 |
| HALE | 2.63 | 3.71 | 4.45 | 4.78 |
| HENRY | 2.93 | 4.06 | 4.82 | 5.16 |
| HOUSTON | 3.23 | 4.41 | 5.20 | 5.54 |
| JACKSON | 1.85 | 2.78 | 3.44 | 3.74 |
| JEFFERSON | 2.33 | 3.37 | 4.08 | 4.40 |
| LAMAR | 2.19 | 3.20 | 3.90 | 4.21 |
| LAUDERDALE | 1.91 | 2.86 | 3.53 | 3.83 |
| LAWRENCE | 1.98 | 2.94 | 3.62 | 3.93 |
| LEE | 2.48 | 3.54 | 4.26 | 4.59 |
| LIMESTONE | 1.91 | 2.86 | 3.53 | 3.83 |
| LOWNDES | 2.85 | 3.97 | 4.73 | 5.06 |
| MACON | 2.63 | 3.71 | 4.45 | 4.78 |
| MADISON | 1.91 | 2.86 | 3.53 | 3.83 |
| MARENGO | 2.85 | 3.97 | 4.73 | 5.06 |
| MARION | 2.12 | 3.11 | 3.80 | 4.11 |
| MARSHALL | 1.98 | 2.94 | 3.62 | 3.93 |
| MOBILE | 4.59 | 5.95 | 6.81 | 7.18 |
| MONROE | 3.46 | 4.68 | 5.48 | 5.83 |
| MONTGOMERY | 2.78 | 3.89 | 4.64 | 4.97 |
| MORGAN | 1.98 | 2.94 | 3.62 | 3.93 |
| PERRY | 2.70 | 3.80 | 4.54 | 4.87 |
| PICKENS | 2.48 | 3.54 | 4.26 | 4.59 |
| PIKE | 2.93 | 4.06 | 4.82 | 5.16 |
| RANDOLPH | 2.26 | 3.28 | 3.99 | 4.30 |
| RUSSELL | 2.63 | 3.71 | 4.45 | 4.78 |
| SHELBY | 2.41 | 3.45 | 4.17 | 4.49 |
| ST. CLAIR | 2.19 | 3.20 | 3.90 | 4.21 |
| SUMTER | 2.78 | 3.89 | 4.64 | 4.97 |
| TALLADEGA | 2.33 | 3.37 | 4.08 | 4.40 |
| TALLAPOOSA | 2.48 | 3.54 | 4.26 | 4.59 |
| TUSCALOOSA | 2.48 | 3.54 | 4.26 | 4.59 |
| WALKER | 2.19 | 3.20 | 3.90 | 4.21 |
| WASHINGTON | 3.54 | 4.77 | 5.58 | 5.92 |
| WILCOX | 3.00 | 4.15 | 4.92 | 5.25 |
| WINSTON | 2.12 | 3.11 | 3.80 | 4.11 |

Runoff for 10-yr., 24-hr. rainfall
Curve Nos. 64,75,82 and 85 for soil hydr. groups

## Sediment Storage

Sediment storage needs may be estimated using the following table AL8-3 after the average annual soil loss in tons per acre has been determined for the terrace interval. Where large areas of the terrace interval will be disturbed during construction, additional sediment storage may be added to allow for the high first year accumulation. However, if construction is performed from the front and natural storage design tables are used, additional sediment storage is not required.

**Table AL8-3. Sediment Storage for Terraces and Basins.**

| Soil Loss Tons per acre per year | Estimated 10-year Sediment Yield Inches per Unit of Drainage Area (in.) |
|---|---|
| 1 | .07 |
| 2 | .14 |
| 3 | .21 |
| 4 | .28 |
| 5 | .34 |
| 7 | .48 |
| 10 | .69 |
| 12 | .83 |
| 15 | 1.03 |
| 18 | 1.24 |

## Design Procedure – All Terraces With Underground Outlets

1. Determine the design area of the terrace and the required inches of storage. (See Table AL8-2.) If the available storage will be calculated using excavated plus natural storage, sediment storage must be added to the required storage. Multiply these figures to obtain the maximum volume of storage required in acre-inches.
2. Analyze the rod readings and determine the maximum bypass elevation that would be practical to construct. If the maximum elevation will not result in a channel (stable) bypass, the unstable bypass design procedure will be used.

## Design Procedure – Unstable Bypass

If the terrace being designed will bypass over the top or onto an unstable area, the terrace should contain a 10-year, 24-hour storm. The terrace may be designed to store 100% of the storm with the pipe designed only to dewater this storage within the specified detention time (usually 24 hours) or the storage requirement may be reduced by increasing the pipe size. However, the minimum storage for a terrace with an unstable bypass shall be 33%. For terraces with less than 100% storage, the pipe shall be designed to carry the volume of storage required multiplied by a factor from Table AL8-4.

A. If the unstable bypass design must be used, compute the natural storage in cu.ft./ft. from Table AL8-5a, b, c, or d, multiply by the distance between rod readings and divide by 3,630 to obtain the available storage in acre-inches.

B. Compute the % stored by dividing the available storage by the volume of storage required

C. Compute the % stored by dividing the available storage by the volume of storage required. If less than 33%, the bypass will have to be raised.

D. Size the outlet pipe by multiplying the maximum required storage by the appropriate multiplier factor from Table AL8-4 to obtain the volume to be dewatered in 24 hours.

**Table AL8-4. Percent storage factor.**

| % Storage | Multiplier Factor |
|---|---|
| 33 | 3.0 |
| 35 | 2.9 |
| 40 | 2.5 |
| 45 | 2.2 |
| 50 | 2.0 |
| 55 | 1.8 |
| 60 | 1.7 |
| 65 | 1.5 |
| 70 | 1.4 |
| 75 | 1.3 |
| 80 | 1.3 |
| 85 | 1.2 |
| 90 | 1.1 |
| 95 | 1.1 |
| 100 | 1.0 |

## Design Procedure – Stable Bypass

If the terrace being designed will bypass along the channel onto a stable area, the constructed terrace ridge height will be increased by 0.5 ft. plus 10% settlement. The pipe may be designed only to dewater the available storage within the specified detention time (usually 24 hours). However, it is highly recommended that all pipes be sized to remove the maximum required storage in 24 hours.

A. The capacity will be based on the available storage. Compute the natural storage in cu.ft./ft. from Table AL8-5a, b, c, or d, multiply by the distance between rod readings and divide by 3,630 to obtain the available storage in acre-inches.

B. Size the outlet pipe.

## Design of the Underground Outlet Conduit

The underground outlet conduit is designed to remove the calculated volume of terrace storage in a specified time interval. The outlet conduit can be designed by either a computer program or the formula below. The underground outlet should be designed for open channel flow. The design procedure is to start with the top terrace and accumulate the volume or discharge rate of each terrace, moving downhill. The pipe sizes can be determined from the following formula as shown in the design example:

Pipe Size Formula $D = (K \times Q^{0.375}) / S^{0.1875}$

Where: D = pipe diameter in inches
K = 3.4007 for corrugated tubing
K = 2.9208 for smooth
Q = design outflow in cfs
S = slope of pipe in ft./ft.

Note: 1 cfs = 23.802 ac.in./24 hr.

## Underground Outlet Installation

Underground outlets used to dispose of impounded water from terraces are, in fact, mechanical spillways through earthen embankments. In order for these spillways to function properly and not be washed out, proper material selection, adequate moisture and good construction techniques are required. Figure AL8-3 shows details of underground conduit installation and backfill.

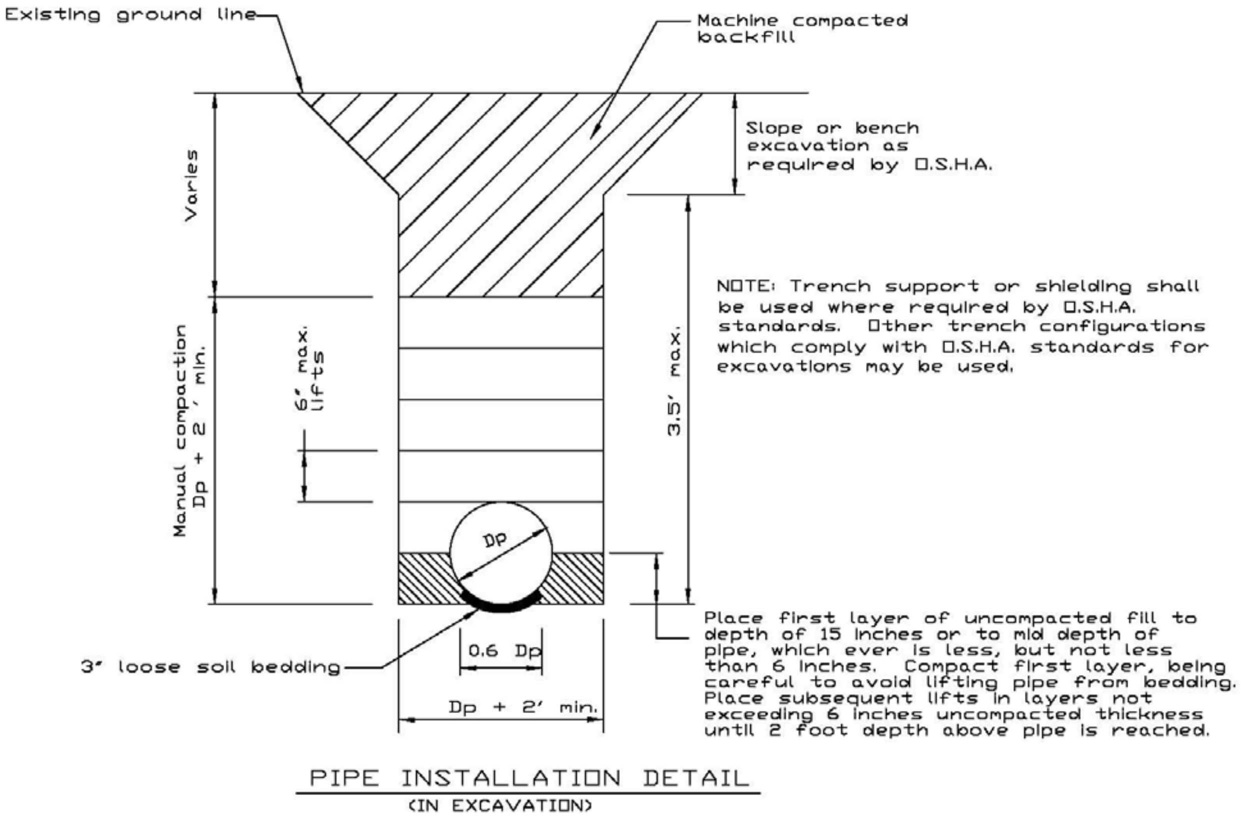


**Figure AL8-3. A method of backfilling the underground conduit trench.**

## Intake or Riser

The riser extends above the ground and directs the flow into the underground outlet. Intakes or risers may be placed on a lateral leading to the main line. The main conduit and lateral may be of perforated conduit. The intake should be of sturdy construction and securely connected to the lateral conduit. The riser should extent to the top elevation of the terrace ridge or minimum of 3 feet. This gives a factor of safety against plugging by trash and permits operators of equipment to see them. It also permits sediment to build up gradually over the years without having to raise the riser.

**Table AL8-5a. Natural Storage Above Terrace for 14-ft. Front Slopes (cu.ft./lin.ft.).**

| d | Land Slope, $S_L$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1%** | **2%** | **3%** | **4%** | **5%** | **6%** | **8%** | **10%** | **12%** | **14%** |
| 0.1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 0.3 | 7 | 4 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| 0.4 | 11 | 7 | 6 | 5 | 4 | 4 | 4 | 4 | 4 | 3 |
| 0.5 | 16 | 10 | 8 | 7 | 6 | 6 | 5 | 5 | 5 | 4 |
| 0.6 | 22 | 13 | 10 | 9 | 8 | 7 | 6 | 6 | 6 | 6 |
| 0.7 | 29 | 17 | 13 | 11 | 10 | 9 | 8 | 7 | 7 | 7 |
| 0.8 | 38 | 22 | 16 | 14 | 12 | 11 | 10 | 9 | 8 | 8 |
| 0.9 | 47 | 27 | 20 | 16 | 14 | 13 | 11 | 10 | 10 | 9 |
| 1.0 | 57 | 32 | 24 | 20 | 17 | 15 | 13 | 12 | 11 | 11 |
| 1.1 | 68 | 38 | 28 | 23 | 20 | 18 | 15 | 14 | 13 | 12 |
| 1.2 | 80 | 44 | 32 | 26 | 23 | 20 | 17 | 16 | 14 | 14 |
| 1.3 | 94 | 51 | 37 | 30 | 26 | 23 | 20 | 18 | 16 | 15 |
| 1.4 | 108 | 59 | 43 | 34 | 29 | 26 | 22 | 20 | 18 | 17 |
| 1.5 | 123 | 67 | 48 | 39 | 33 | 29 | 25 | 22 | 20 | 19 |
| 1.6 | 139 | 75 | 54 | 43 | 37 | 33 | 27 | 24 | 22 | 20 |
| 1.7 | 156 | 84 | 60 | 48 | 41 | 36 | 30 | 26 | 24 | 22 |
| 1.8 | 175 | 94 | 67 | 53 | 45 | 40 | 33 | 29 | 26 | 24 |
| 1.9 | 194 | 104 | 74 | 58 | 49 | 43 | 36 | 31 | 28 | 26 |
| 2.0 | 214 | 114 | 81 | 64 | 54 | 47 | 39 | 34 | 31 | 28 |
| 2.1 | 235 | 125 | 88 | 70 | 59 | 51 | 42 | 37 | 33 | 30 |
| 2.2 | 257 | 136 | 96 | 76 | 64 | 56 | 46 | 40 | 36 | 32 |
| 2.3 | 281 | 148 | 104 | 82 | 69 | 60 | 49 | 43 | 38 | 35 |
| 2.4 | 305 | 161 | 113 | 89 | 74 | 65 | 53 | 46 | 41 | 37 |
| 2.5 | 330 | 174 | 122 | 96 | 80 | 70 | 57 | 49 | 44 | 40 |
| 2.6 | 356 | 187 | 131 | 103 | 86 | 75 | 60 | 52 | 46 | 42 |
| 2.7 | 383 | 201 | 140 | 110 | 92 | 80 | 65 | 55 | 49 | 45 |
| 2.8 | 412 | 216 | 150 | 117 | 98 | 85 | 69 | 59 | 52 | 48 |
| 2.9 | 441 | 231 | 161 | 125 | 104 | 90 | 73 | 62 | 55 | 50 |
| 3.0 | 471 | 246 | 171 | 134 | 111 | 96 | 77 | 66 | 58 | 53 |
| 3.1 | 502 | 262 | 182 | 142 | 118 | 102 | 82 | 70 | 62 | 56 |
| 3.2 | 534 | 278 | 193 | 150 | 125 | 108 | 86 | 74 | 65 | 59 |
| 3.3 | 568 | 295 | 205 | 159 | 132 | 114 | 91 | 78 | 68 | 62 |
| 3.4 | 602 | 313 | 216 | 168 | 139 | 120 | 96 | 82 | 72 | 65 |
| 3.5 | 637 | 331 | 229 | 178 | 147 | 127 | 101 | 86 | 76 | 68 |
| 3.6 | 673 | 349 | 241 | 187 | 155 | 133 | 106 | 90 | 79 | 71 |
| 3.7 | 710 | 368 | 254 | 197 | 163 | 140 | 111 | 94 | 83 | 75 |
| 3.8 | 749 | 388 | 267 | 207 | 171 | 147 | 117 | 99 | 87 | 78 |
| 3.9 | 788 | 408 | 281 | 217 | 179 | 154 | 122 | 103 | 91 | 82 |
| 4.0 | 828 | 428 | 295 | 228 | 188 | 161 | 128 | 108 | 95 | 85 |
| 4.1 | 869 | 449 | 309 | 239 | 197 | 169 | 134 | 113 | 99 | 89 |
| 4.2 | 911 | 470 | 323 | 250 | 206 | 176 | 140 | 118 | 103 | 92 |
| 4.3 | 955 | 492 | 338 | 261 | 215 | 184 | 146 | 123 | 107 | 96 |
| 4.4 | 999 | 515 | 353 | 273 | 224 | 192 | 152 | 128 | 111 | 100 |
| 4.5 | 1044 | 538 | 369 | 285 | 234 | 200 | 158 | 133 | 116 | 104 |
| 4.6 | 1090 | 561 | 385 | 297 | 244 | 209 | 164 | 138 | 120 | 108 |

**Table AL8-5b. Natural Storage Above Terrace for 28-ft. Front Slopes (cu.ft./lin.ft.).**

| d | Land Slope, $S_L$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1% | 2% | 3% | 4% | 5% | 6% | 8% | 10% | 12% | 14% | 16% | 18% |
| 0.1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.2 | 5 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| 0.3 | 9 | 6 | 6 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | 4 |
| 0.4 | 14 | 10 | 8 | 8 | 7 | 7 | 7 | 6 | 6 | 6 | 6 | 6 |
| 0.5 | 20 | 13 | 11 | 10 | 10 | 9 | 9 | 8 | 8 | 8 | 8 | 8 |
| 0.6 | 26 | 17 | 14 | 13 | 12 | 11 | 11 | 10 | 10 | 10 | 10 | 9 |
| 0.7 | 34 | 22 | 18 | 16 | 15 | 14 | 13 | 12 | 12 | 12 | 11 | 11 |
| 0.8 | 43 | 27 | 22 | 19 | 18 | 17 | 15 | 14 | 14 | 13 | 13 | 13 |
| 0.9 | 53 | 33 | 26 | 23 | 21 | 19 | 18 | 17 | 16 | 15 | 15 | 15 |
| 1.0 | 64 | 39 | 31 | 26 | 24 | 22 | 20 | 19 | 18 | 18 | 17 | 17 |
| 1.1 | 76 | 46 | 36 | 31 | 28 | 25 | 23 | 21 | 20 | 20 | 19 | 19 |
| 1.2 | 89 | 53 | 41 | 35 | 31 | 29 | 26 | 24 | 23 | 22 | 21 | 21 |
| 1.3 | 103 | 60 | 46 | 39 | 35 | 32 | 29 | 27 | 25 | 24 | 23 | 23 |
| 1.4 | 113 | 69 | 52 | 44 | 39 | 36 | 32 | 29 | 28 | 27 | 26 | 25 |
| 1.5 | 134 | 77 | 58 | 49 | 44 | 40 | 35 | 32 | 30 | 29 | 28 | 27 |
| 1.6 | 150 | 86 | 65 | 54 | 48 | 44 | 38 | 35 | 33 | 32 | 30 | 30 |
| 1.7 | 168 | 96 | 72 | 60 | 53 | 48 | 42 | 38 | 36 | 34 | 33 | 32 |
| 1.8 | 187 | 106 | 79 | 66 | 58 | 52 | 45 | 41 | 39 | 37 | 35 | 34 |
| 1.9 | 207 | 117 | 87 | 72 | 63 | 57 | 49 | 45 | 42 | 40 | 38 | 37 |
| 2.0 | 228 | 128 | 95 | 78 | 68 | 61 | 53 | 48 | 45 | 42 | 40 | 39 |
| 2.1 | 250 | 140 | 103 | 85 | 74 | 66 | 57 | 51 | 48 | 45 | 43 | 42 |
| 2.2 | 273 | 152 | 111 | 91 | 79 | 71 | 61 | 55 | 51 | 48 | 46 | 44 |
| 2.3 | 297 | 164 | 120 | 98 | 85 | 76 | 65 | 59 | 54 | 51 | 49 | 47 |
| 2.4 | 322 | 178 | 130 | 106 | 91 | 82 | 70 | 62 | 58 | 54 | 52 | 50 |
| 2.5 | 348 | 191 | 139 | 113 | 98 | 87 | 74 | 66 | 61 | 57 | 54 | 52 |
| 2.6 | 374 | 205 | 149 | 121 | 104 | 93 | 79 | 70 | 65 | 61 | 58 | 55 |
| 2.7 | 402 | 220 | 159 | 129 | 111 | 99 | 83 | 74 | 68 | 64 | 61 | 58 |
| 2.8 | 431 | 235 | 170 | 137 | 118 | 105 | 88 | 78 | 72 | 67 | 64 | 61 |
| 2.9 | 461 | 251 | 181 | 146 | 125 | 111 | 93 | 83 | 76 | 71 | 67 | 64 |
| 3.0 | 492 | 267 | 192 | 154 | 132 | 117 | 98 | 87 | 80 | 74 | 70 | 67 |
| 3.2 | 557 | 301 | 215 | 173 | 147 | 130 | 109 | 96 | 87 | 81 | 77 | 73 |
| 3.4 | 626 | 337 | 240 | 192 | 163 | 144 | 120 | 105 | 96 | 89 | 84 | 80 |
| 3.6 | 698 | 374 | 266 | 212 | 180 | 158 | 131 | 115 | 104 | 97 | 91 | 86 |
| 3.8 | 775 | 414 | 294 | 234 | 198 | 174 | 143 | 125 | 113 | 105 | 98 | 93 |
| 4.0 | 856 | 456 | 323 | 256 | 216 | 189 | 156 | 136 | 123 | 113 | 106 | 100 |
| 4.2 | 941 | 500 | 353 | 279 | 235 | 206 | 169 | 147 | 132 | 122 | 114 | 108 |
| 4.4 | 1030 | 546 | 384 | 304 | 255 | 223 | 183 | 158 | 142 | 131 | 122 | 115 |
| 4.6 | 1122 | 593 | 417 | 329 | 276 | 241 | 197 | 170 | 153 | 140 | 131 | 123 |
| 4.8 | 1219 | 643 | 451 | 355 | 298 | 259 | 211 | 182 | 163 | 150 | 139 | 131 |
| 5.0 | 1320 | 695 | 487 | 382 | 320 | 278 | 226 | 195 | 174 | 159 | 148 | 139 |

1. Storage shown in natural storage, storage above natural ground on uphill side of the terrace. Does not include any storage which might result from excavation.
2. $S_L$ – slope of the land where the terrace is built.
3. d – depth of water in the completed terrace, measured from the natural ground at the flag line to the designed bypass elevation..
4. This table is based entirely on a flag line placed 28 ft. uphill from the completed terrace ridge. Stated another way, peak of the terrace ridge is always built 28 ft. downhill from the flag line. These footnotes also apply to Table AL8-3a.

**Table AL8-5c. Natural Storage Above Terrace for 3 to 1 Front Slopes (cu.ft./lin.ft.).**

| d | Land Slope, $S_L$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1% | 2% | 3% | 4% | 5% | 6% | 8% | 10% | 12% | 14% |
| 0.1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.3 | 5 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.4 | 8 | 4 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 0.5 | 13 | 7 | 5 | 4 | 3 | 2 | 2 | 2 | 1 | 1 |
| 0.6 | 19 | 13 | 17 | 5 | 4 | 4 | 3 | 2 | 2 | 2 |
| 0.7 | 25 | 13 | 9 | 7 | 6 | 5 | 4 | 3 | 3 | 2 |
| 0.8 | 33 | 17 | 12 | 9 | 7 | 6 | 5 | 4 | 4 | 3 |
| 0.9 | 42 | 21 | 15 | 11 | 9 | 8 | 6 | 5 | 5 | 4 |
| 1.0 | 52 | 27 | 18 | 14 | 12 | 10 | 8 | 7 | 6 | 5 |
| 1.1 | 62 | 32 | 22 | 17 | 14 | 12 | 9 | 8 | 7 | 6 |
| 1.2 | 74 | 38 | 26 | 20 | 17 | 14 | 11 | 9 | 8 | 7 |
| 1.3 | 87 | 45 | 31 | 24 | 19 | 17 | 13 | 11 | 10 | 9 |
| 1.4 | 101 | 52 | 36 | 27 | 23 | 19 | 15 | 13 | 11 | 10 |
| 1.5 | 116 | 60 | 41 | 32 | 26 | 22 | 17 | 15 | 13 | 11 |
| 1.6 | 132 | 68 | 47 | 36 | 29 | 25 | 20 | 17 | 15 | 13 |
| 1.7 | 149 | 77 | 53 | 40 | 33 | 28 | 22 | 19 | 16 | 15 |
| 1.8 | 167 | 86 | 59 | 45 | 37 | 32 | 25 | 21 | 18 | 16 |
| 1.9 | 186 | 96 | 66 | 51 | 42 | 35 | 28 | 23 | 20 | 18 |
| 2.0 | 206 | 106 | 73 | 56 | 46 | 39 | 31 | 26 | 23 | 20 |
| 2.1 | 227 | 117 | 80 | 62 | 51 | 43 | 34 | 29 | 25 | 22 |
| 2.2 | 249 | 128 | 88 | 68 | 56 | 48 | 38 | 31 | 27 | 25 |
| 2.3 | 272 | 140 | 96 | 74 | 61 | 52 | 41 | 34 | 30 | 27 |
| 2.4 | 297 | 153 | 105 | 81 | 66 | 57 | 45 | 37 | 33 | 29 |
| 2.5 | 322 | 166 | 114 | 88 | 72 | 61 | 48 | 41 | 35 | 32 |
| 2.6 | 348 | 179 | 123 | 95 | 78 | 66 | 52 | 44 | 38 | 34 |
| 2.7 | 375 | 193 | 132 | 102 | 84 | 72 | 56 | 47 | 41 | 37 |
| 2.8 | 404 | 208 | 142 | 110 | 90 | 77 | 61 | 51 | 44 | 40 |
| 2.9 | 443 | 223 | 153 | 118 | 97 | 83 | 65 | 55 | 48 | 43 |
| 3.0 | 464 | 239 | 164 | 126 | 104 | 89 | 70 | 59 | 51 | 46 |
| 3.1 | 495 | 255 | 175 | 135 | 111 | 94 | 74 | 62 | 54 | 49 |
| 3.2 | 527 | 271 | 186 | 143 | 118 | 101 | 79 | 67 | 58 | 52 |
| 3.3 | 561 | 289 | 198 | 152 | 125 | 107 | 84 | 71 | 62 | 55 |
| 3.4 | 595 | 306 | 210 | 162 | 133 | 114 | 90 | 75 | 66 | 59 |
| 3.5 | 631 | 325 | 223 | 172 | 141 | 120 | 95 | 80 | 69 | 62 |
| 3.6 | 667 | 343 | 235 | 181 | 149 | 127 | 100 | 84 | 73 | 66 |
| 3.7 | 705 | 363 | 249 | 192 | 157 | 135 | 106 | 89 | 78 | 69 |
| 3.8 | 744 | 383 | 262 | 202 | 166 | 142 | 112 | 94 | 82 | 73 |
| 3.9 | 783 | 403 | 276 | 213 | 175 | 150 | 118 | 99 | 86 | 77 |
| 4.0 | 824 | 428 | 291 | 224 | 184 | 157 | 124 | 104 | 91 | 81 |
| 4.2 | 908 | 467 | 320 | 247 | 203 | 173 | 137 | 115 | 100 | 82 |
| 4.4 | 997 | 513 | 352 | 271 | 223 | 190 | 150 | 126 | 110 | 98 |
| 4.6 | 1090 | 561 | 384 | 296 | 243 | 208 | 164 | 138 | 120 | 107 |
| 4.8 | 1187 | 611 | 419 | 323 | 265 | 227 | 179 | 150 | 131 | 117 |

Storage = $d^2$ x [(50 ÷ $S_L$) + 1.50] where d = depth in feet
$S_L$ = land slope in %

**Table AL8-5c. Natural Storage Above Terrace for 3 to 1 Front Slopes (cu.ft./lin.ft.). (con't)**

| d | Land Slope, $S_L$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1%** | **2%** | **3%** | **4%** | **5%** | **6%** | **8%** | **10%** | **12%** | **14%** |
| 5.0 | 1288 | 663 | 454 | 350 | 288 | 246 | 194 | 168 | 142 | 127 |
| 5.2 | 1393 | 717 | 491 | 379 | 311 | 266 | 210 | 176 | 153 | 137 |
| 5.4 | 1502 | 773 | 530 | 408 | 335 | 287 | 226 | 190 | 165 | 148 |
| 5.6 | 1615 | 831 | 570 | 439 | 361 | 308 | 243 | 204 | 178 | 159 |
| 5.8 | 1732 | 891 | 611 | 471 | 387 | 331 | 261 | 219 | 191 | 171 |
| 6.0 | 1854 | 954 | 654 | 504 | 414 | 354 | 279 | 234 | 204 | 183 |
| 6.2 | 1980 | 1019 | 698 | 538 | 442 | 378 | 298 | 250 | 218 | 195 |
| 6.4 | 2109 | 1085 | 744 | 573 | 471 | 403 | 317 | 266 | 232 | 208 |
| 6.6 | 2243 | 1154 | 791 | 610 | 501 | 428 | 338 | 283 | 247 | 221 |
| 6.8 | 2381 | 1225 | 840 | 647 | 532 | 455 | 358 | 301 | 262 | 235 |
| 7.0 | 2524 | 1229 | 890 | 686 | 564 | 482 | 380 | 319 | 278 | 249 |
| 7.2 | 2670 | 1374 | 942 | 726 | 596 | 510 | 402 | 337 | 294 | 263 |
| 7.4 | 2820 | 1451 | 995 | 767 | 630 | 538 | 424 | 356 | 310 | 278 |
| 7.6 | 2975 | 1531 | 1049 | 809 | 664 | 568 | 448 | 375 | 327 | 293 |
| 7.8 | 3133 | 1612 | 1105 | 852 | 700 | 598 | 472 | 395 | 345 | 309 |
| 8.0 | 3296 | 1696 | 1163 | 896 | 736 | 629 | 496 | 416 | 363 | 325 |
| 8.2 | 3463 | 1782 | 1222 | 941 | 773 | 661 | 521 | 437 | 381 | 341 |
| 8.4 | 3634 | 1870 | 1282 | 988 | 811 | 694 | 547 | 459 | 400 | 358 |
| 8.6 | 3809 | 1960 | 1344 | 1035 | 851 | 727 | 573 | 481 | 419 | 375 |
| 8.8 | 3988 | 2052 | 1407 | 1084 | 891 | 761 | 600 | 503 | 439 | 393 |
| 9.0 | 4172 | 2147 | 1472 | 1134 | 932 | 797 | 628 | 527 | 459 | 411 |
| 9.2 | 4359 | 2243 | 1538 | 1185 | 973 | 832 | 656 | 550 | 480 | 429 |
| 9.4 | 4551 | 2342 | 1605 | 1237 | 1016 | 869 | 685 | 574 | 501 | 448 |
| 9.6 | 4746 | 2442 | 1674 | 1290 | 1060 | 906 | 714 | 599 | 522 | 467 |
| 9.8 | 4946 | 2545 | 1745 | 1345 | 1104 | 944 | 744 | 624 | 544 | 487 |
| 10.0 | 5150 | 2650 | 1817 | 1400 | 1150 | 983 | 775 | 650 | 567 | 507 |
| 10.2 | 5358 | 2757 | 1800 | 1457 | 1196 | 1023 | 806 | 676 | 590 | 528 |
| 10.4 | 5570 | 2866 | 1965 | 1514 | 1244 | 1064 | 838 | 703 | 613 | 543 |
| 10.6 | 5787 | 2978 | 2041 | 1576 | 1292 | 1105 | 871 | 730 | 637 | 570 |
| 10.8 | 6001 | 3091 | 2119 | 1633 | 1341 | 1147 | 904 | 758 | 661 | 592 |
| 11.0 | 6232 | 3207 | 2198 | 1694 | 1392 | 1190 | 938 | 787 | 686 | 614 |
| 11.2 | 6460 | 3324 | 2279 | 1756 | 1443 | 1233 | 972 | 815 | 711 | 636 |
| 11.4 | 6693 | 3444 | 2361 | 1819 | 1495 | 1278 | 1007 | 845 | 136 | 659 |
| 11.6 | 6930 | 3566 | 2445 | 1884 | 1547 | 1323 | 1043 | 875 | 763 | 682 |
| 11.8 | 7171 | 3690 | 2530 | 1949 | 1601 | 1369 | 1079 | 905 | 789 | 706 |
| 12.0 | 7416 | 3816 | 2616 | 2016 | 1656 | 1416 | 1116 | 936 | 816 | 730 |
| 12.2 | 7665 | 3944 | 2704 | 2084 | 1712 | 1464 | 1154 | 967 | 846 | 755 |

**Table AL8-5d. Natural Storage Above Terrace for 2½ to 1 Front Slopes (cu.ft./lin.ft.).**

| d | Land Slope, $S_L$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1%** | **2%** | **3%** | **4%** | **5%** | **6%** | **8%** | **10%** | **12%** | **14%** |
| 0.1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.3 | 5 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 0.4 | 8 | 4 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 0.5 | 13 | 7 | 4 | 3 | 3 | 2 | 2 | 2 | 1 | 1 |
| 0.6 | 18 | 9 | 6 | 5 | 4 | 3 | 3 | 2 | 2 | 2 |
| 0.7 | 25 | 13 | 9 | 7 | 6 | 5 | 4 | 3 | 3 | 2 |
| 0.8 | 33 | 17 | 11 | 9 | 7 | 6 | 5 | 4 | 3 | 3 |
| 0.9 | 42 | 21 | 15 | 11 | 9 | 8 | 6 | 5 | 4 | 4 |
| 1.0 | 52 | 26 | 18 | 14 | 11 | 10 | 8 | 6 | 5 | 5 |
| 1.1 | 62 | 32 | 22 | 17 | 14 | 12 | 9 | 8 | 7 | 6 |
| 1.2 | 74 | 38 | 26 | 20 | 16 | 14 | 11 | 9 | 8 | 7 |
| 1.3 | 87 | 44 | 30 | 23 | 19 | 16 | 13 | 11 | 9 | 8 |
| 1.4 | 100 | 51 | 35 | 27 | 22 | 19 | 15 | 12 | 11 | 9 |
| 1.5 | 115 | 59 | 40 | 31 | 25 | 22 | 17 | 14 | 12 | 11 |
| 1.6 | 131 | 67 | 46 | 35 | 29 | 25 | 19 | 16 | 14 | 12 |
| 1.7 | 148 | 76 | 52 | 40 | 33 | 28 | 22 | 18 | 16 | 14 |
| 1.8 | 166 | 85 | 58 | 45 | 36 | 31 | 24 | 20 | 18 | 16 |
| 1.9 | 185 | 95 | 65 | 50 | 41 | 35 | 27 | 23 | 20 | 17 |
| 2.0 | 205 | 105 | 72 | 55 | 45 | 38 | 30 | 25 | 22 | 19 |
| 2.1 | 226 | 116 | 79 | 61 | 50 | 42 | 33 | 28 | 24 | 21 |
| 2.2 | 248 | 127 | 87 | 67 | 54 | 46 | 36 | 30 | 26 | 23 |
| 2.3 | 271 | 139 | 95 | 73 | 60 | 51 | 40 | 33 | 29 | 26 |
| 2.4 | 295 | 151 | 103 | 79 | 65 | 55 | 43 | 36 | 31 | 28 |
| 2.5 | 320 | 164 | 112 | 86 | 70 | 60 | 47 | 39 | 34 | 30 |
| 2.6 | 346 | 177 | 121 | 93 | 76 | 65 | 51 | 42 | 37 | 33 |
| 2.7 | 374 | 191 | 131 | 100 | 82 | 70 | 55 | 46 | 39 | 35 |
| 2.8 | 402 | 206 | 140 | 108 | 88 | 75 | 59 | 49 | 42 | 38 |
| 2.9 | 431 | 221 | 151 | 116 | 95 | 81 | 63 | 53 | 46 | 41 |
| 3.0 | 461 | 236 | 161 | 124 | 101 | 86 | 38 | 56 | 49 | 43 |
| 3.1 | 493 | 252 | 172 | 132 | 108 | 92 | 72 | 60 | 52 | 46 |
| 3.2 | 525 | 269 | 183 | 141 | 115 | 98 | 77 | 64 | 55 | 49 |
| 3.3 | 558 | 286 | 195 | 150 | 123 | 104 | 82 | 68 | 59 | 53 |
| 3.4 | 592 | 303 | 207 | 159 | 130 | 111 | 87 | 72 | 63 | 56 |
| 3.5 | 628 | 322 | 219 | 168 | 138 | 117 | 92 | 77 | 66 | 59 |
| 3.6 | 664 | 340 | 232 | 178 | 146 | 124 | 97 | 81 | 70 | 62 |
| 3.7 | 702 | 359 | 245 | 188 | 154 | 131 | 103 | 86 | 74 | 66 |
| 3.8 | 740 | 379 | 259 | 199 | 162 | 138 | 108 | 90 | 78 | 70 |
| 3.9 | 780 | 399 | 273 | 209 | 171 | 146 | 114 | 95 | 82 | 73 |
| 4.0 | 820 | 420 | 287 | 220 | 180 | 153 | 120 | 100 | 87 | 77 |

Storage = $d^2 \times [(50 \div S_L) + 1.25]$ where d = depth in feet

$S_L$ = land slope in %

**Table AL8-5d. Natural Storage Above Terrace for 2½ to 1 Front Slopes (cu.ft./lin.ft.). (con't)**

| d | Land Slope, $S_L$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1%** | **2%** | **3%** | **4%** | **5%** | **6%** | **8%** | **10%** | **12%** | **14%** |
| 4.2 | 904 | 463 | 316 | 243 | 198 | 169 | 132 | 110 | 96 | 85 |
| 4.4 | 992 | 508 | 347 | 266 | 218 | 186 | 145 | 121 | 105 | 98 |
| 4.6 | 1084 | 555 | 379 | 291 | 238 | 203 | 159 | 132 | 115 | 102 |
| 4.8 | 1181 | 605 | 413 | 317 | 259 | 221 | 173 | 144 | 125 | 111 |
| 5.0 | 1281 | 656 | 448 | 344 | 281 | 240 | 188 | 156 | 135 | 121 |
| 5.2 | 1385 | 710 | 484 | 372 | 304 | 259 | 203 | 169 | 146 | 130 |
| 5.4 | 1494 | 465 | 522 | 401 | 328 | 279 | 219 | 182 | 158 | 141 |
| 5.6 | 1607 | 823 | 562 | 431 | 353 | 301 | 235 | 196 | 170 | 151 |
| 5.8 | 1724 | 883 | 603 | 463 | 378 | 322 | 252 | 210 | 182 | 162 |
| 6.0 | 1845 | 945 | 645 | 495 | 405 | 345 | 270 | 225 | 195 | 174 |
| 6.2 | 1970 | 1009 | 689 | 529 | 432 | 368 | 288 | 240 | 208 | 185 |
| 6.4 | 2099 | 1075 | 734 | 563 | 461 | 393 | 307 | 256 | 222 | 197 |
| 6.6 | 2232 | 1143 | 780 | 599 | 490 | 417 | 327 | 272 | 236 | 210 |
| 6.8 | 2370 | 1214 | 828 | 636 | 520 | 443 | 347 | 289 | 250 | 223 |
| 7.0 | 2511 | 1286 | 878 | 674 | 551 | 470 | 368 | 306 | 265 | 236 |
| 7.2 | 2657 | 1361 | 929 | 713 | 583 | 497 | 389 | 324 | 281 | 250 |
| 7.4 | 2806 | 1437 | 981 | 753 | 616 | 525 | 411 | 342 | 297 | 264 |
| 7.6 | 2960 | 1516 | 1035 | 794 | 650 | 554 | 433 | 361 | 313 | 278 |
| 7.8 | 3118 | 1597 | 1090 | 837 | 684 | 583 | 456 | 380 | 330 | 293 |
| 8.0 | 3280 | 1680 | 1147 | 880 | 720 | 613 | 480 | 400 | 347 | 309 |
| 8.2 | 3446 | 1765 | 1205 | 925 | 756 | 644 | 504 | 420 | 364 | 324 |
| 8.4 | 3616 | 1852 | 1264 | 970 | 794 | 676 | 529 | 441 | 382 | 340 |
| 8.6 | 3790 | 1941 | 1325 | 1017 | 832 | 709 | 555 | 462 | 401 | 357 |
| 8.8 | 3969 | 2033 | 1387 | 1065 | 871 | 742 | 581 | 484 | 419 | 373 |
| 9.0 | 4151 | 2126 | 1451 | 1114 | 911 | 776 | 608 | 506 | 439 | 391 |
| 9.2 | 4338 | 2222 | 1516 | 1164 | 952 | 811 | 635 | 529 | 458 | 408 |
| 9.4 | 4528 | 2319 | 1583 | 1215 | 994 | 847 | 663 | 552 | 479 | 426 |
| 9.6 | 4723 | 2419 | 1651 | 1267 | 1037 | 883 | 691 | 576 | 499 | 444 |
| 9.8 | 4922 | 2521 | 1721 | 1321 | 1080 | 920 | 720 | 600 | 520 | 463 |
| 10.0 | 5125 | 2625 | 1792 | 1375 | 1125 | 958 | 750 | 625 | 542 | 482 |
| 10.2 | 5332 | 2731 | 1864 | 1481 | 1170 | 997 | 780 | 650 | 564 | 502 |
| 10.4 | 5543 | 2839 | 1938 | 1487 | 1217 | 1037 | 811 | 676 | 586 | 521 |
| 10.6 | 5758 | 2949 | 2013 | 1545 | 1264 | 1077 | 843 | 702 | 609 | 542 |
| 10.8 | 5978 | 3062 | 2090 | 1604 | 1312 | 1118 | 875 | 729 | 632 | 562 |
| 11.0 | 6201 | 3176 | 2168 | 1664 | 1361 | 1160 | 908 | 756 | 655 | 583 |
| 11.2 | 6429 | 3293 | 2247 | 1725 | 1411 | 1202 | 941 | 784 | 679 | 605 |
| 11.4 | 6660 | 3411 | 2328 | 1787 | 1462 | 1245 | 975 | 812 | 704 | 627 |
| 11.6 | 6896 | 3532 | 2411 | 1850 | 1514 | 1290 | 1009 | 841 | 729 | 649 |
| 11.8 | 1736 | 3655 | 2495 | 1915 | 1566 | 1334 | 1044 | 870 | 754 | 671 |
| 12.0 | 7380 | 3780 | 2580 | 1980 | 1620 | 1380 | 1080 | 900 | 780 | 694 |
| 12.2 | 7628 | 3907 | 2667 | 2047 | 1674 | 1426 | 1116 | 930 | 806 | 718 |

## DESIGN EXAMPLE - STORAGE TERRACE WITH UNDERGROUND OUTLET

Determine the total required storage and the capacity of the underground outlet for a storage type terrace in Coffee County, Alabama. The land slope is 4 percent. Easily erodible soil with good cover and cropping system. Soils are hydrologic group B. Terrace will bypass over the top.

### Step 1

Determine horizontal interval:

Existing Field Slope = 4%

Broadbase and Grassed Ridge Backslope. $HI = X(100) + y\left(\frac{100}{s}\right)$

Use a "Y" factor of 4.0 with a good cropping system and good cover.

x = 0.4 for South Alabama, HI = 140 ft. or select from Table AL8-1.

### Step 2

A. Determine present and future equipment row widths and number of rows (conference with landowner or operator.)

B. Determine farming width between terraces (See Table AL8-1).

NOTE: Broadbase Terraces - The farming width is from the top of the upper terrace ridge to the top of the lower terrace ridge.

Grassed Steep Backslope Terraces - The farming width is from the toe of the backslope of the upper terrace to the top of the ridge of the lower terrace.

For grassed steep front and backslope terraces, use a minimum front slope of 1.5:1. Farming width will be measured from backslope toe of the upper terrace to toe front slope of the lower terrace.

C. Determine the width of the terrace front slope.

NOTE: The width of the terrace front slope should be equal to 1 or 2 passes of future farming equipment.

Solution:

1. Equipment width (conference with owner and operator).
    a. Existing equipment - 6 rows, 30 in. wide
    b. Future equipment - 8 rows, 30 in. wide

| **Number of Equipment Trips** | **Present Equipment 6 row, 30 in. width (ft.)** | **Future 8 row, 30 in. width (ft.)** |
|---|---|---|
| 1 | 15 | 20 |
| 2 | 30 | 40 |

2. Farming widths (See Table 8-1).

   A farming width of 120 ft. fits present and future equipment for 4 or 3 round trips.

3. Use a front slope = 20 ft. (1 pass of future farming equipment)

### Step 3

Determine terrace spacing.

A. Broadbase terrace spacing (HI) is equal to the farming width. See Figure AL8-1.

B. Grassed steep backslope terrace spacing (HI) is equal to the farming width plus the width of the backslope. See Figure AL8-1.

C. Grassed steep front and backslope terrace spacing (HI) is equal to the farming width plus the frontslope and backslope. See Figure AL-1.

   NOTE: The HI can be increased or decreased up to 10% to fit future farm machinery and an additional 10% with underground outlets.

Solution:

1. Broadbase Terraces (farming width) from Table AL8-1 = 120 feet.

2. Grassed steep backslope terraces

   Farming width = 120 ft.
   Adjust to fit equipment = 0 ft.
   Backslope width (approx.) = 6 ft.
   Terrace spacing (HI) = 126 ft.

3. Grassed steep front and backslope terraces.

   Farming width = 120 ft.
   Adjust to fit equipment = 0 ft.
   Front slope width = 6 ft.
   Backslope width (approx.) = 6 ft.
   Terrace spacing (HI) = 132 ft.

### Step 4

Determine storage requirements.

Total storage for terrace 500 ft. long, spacing of 120 ft.

A. Compute drainage area.

   500 ft. terrace length
   120 ft. terrace spacing

   Area = 500 ft. x 120 ft. / 43,560 sf/ac = 1.38 ac.

B. Find runoff storage from Table AL8-2, to be 4.50 in. per unit of area.

C. 100% storage = 1.38 ac. x 4.50 in. = 6.21 ac.in.

D. Assume a unstable bypass design with the minimum 33% storage.

Required minimum storage = 0.33 x 6.21 ac.in. = 2.05 ac.in.

Step 5 - Determine the bypass elevation that will provide the required minimum storage.

A. Assume a bypass elevation and compute the available natural storage in cu.ft./ft. by summing the values from Table AL8-5a, b, c, or d, multiply by the distance between rod readings and divide by 3,630 to obtain the available storage in acre-inches.

B. If less than 2.05 ac.in., the bypass will have to be raised, repeat step A.

Step 6 - Determine pipe size.

A. Calculate the required discharge in cfs for the pipe.

Using the multiplier factor of 3.0 from Table AL8-4, Q = 3.0 x 6.21 ac.in. = 18.63 ac.in. / 24 hr.

Since 1 cfs = 23.802 ac.in. / 24 hr. Q = 18.63 / 23.802 = 0.78 cfs

B. Calculate the smooth pipe size from the formula on page 8-?.

$D = (K \times Q^{0.375}) / S^{0.1875} = (2.9208 \times 0.78^{0.375})/0.04^{0.1875} = 4.87"$ Use minimum 6" pipe.

Step 7 – Determine orifice size (if used).

Use Formula $A = Q/[C \times (2gH)^{0.5}]$ $A = 0.78/[0.6 \times (64.4 \times 3)^{0.5}] = 0.0935 \text{ sf} \times 144 = 13.46 \text{ in}^2$

Calculate a round opening with area = 13.46 $\text{in}^2$

13.46 $\text{in}^2$ / PI = 4.28 $R = 4.28^{0.5} = 2.07"$ D = 2.07 x 2 = 4.14 in. Use 4 1/4 " Orifice

Step 8 - Note

This is an "over the top" unstable bypass terrace. The ridge elevation would be 0.5 ft.freeboard plus 10% settlement added to the bypass elevation. The ridge elevation would only be required for a short distance on either side of the pipe line. The remainder of the terrace could be built to the bypass elevation plus 10% settlement.

## RECORDS AND MAINTENANCE

Engineering notes for terraces are to be recorded on Form SCE-ENG-29. Notes for storage terraces should be in accord with Figure AL8-4. When computer programs are used to design terraces, underground outlets and waterways, the printouts should be filed with the conservation plan. Notes for terraces with grassed waterways, field borders, and filter strip should be in accord with Figure AL8-5.

Terrace capacity can be maintained generally by routine plowing. There is really no satisfactory way to plow terraced land except with the two-way (reversible) plow. With this plow, soil can be thrown either to the right or to the left depending upon choice. To maintain the cross section of the terraces and the terrace interval as it was after construction, most of the area should be plowed uphill.

With the two-way plow, the front slope of each terrace should be plowed toward the ridge. The remaining area of the channel to the ridge of the next terrace generally should be plowed uphill.

Maintenance of grassed ridge and grass back terraces is much easier than conventional terraces. Trees, brush, and grass can be controlled by spraying, mowing, or burning. Grass should be fertilized occasionally to maintain vigorous sod. Heavy equipment can also be used to perform terrace construction and maintenance.

## Terraces with Underground Outlets

### A. Engineering Surveys for Design and Construction Layout

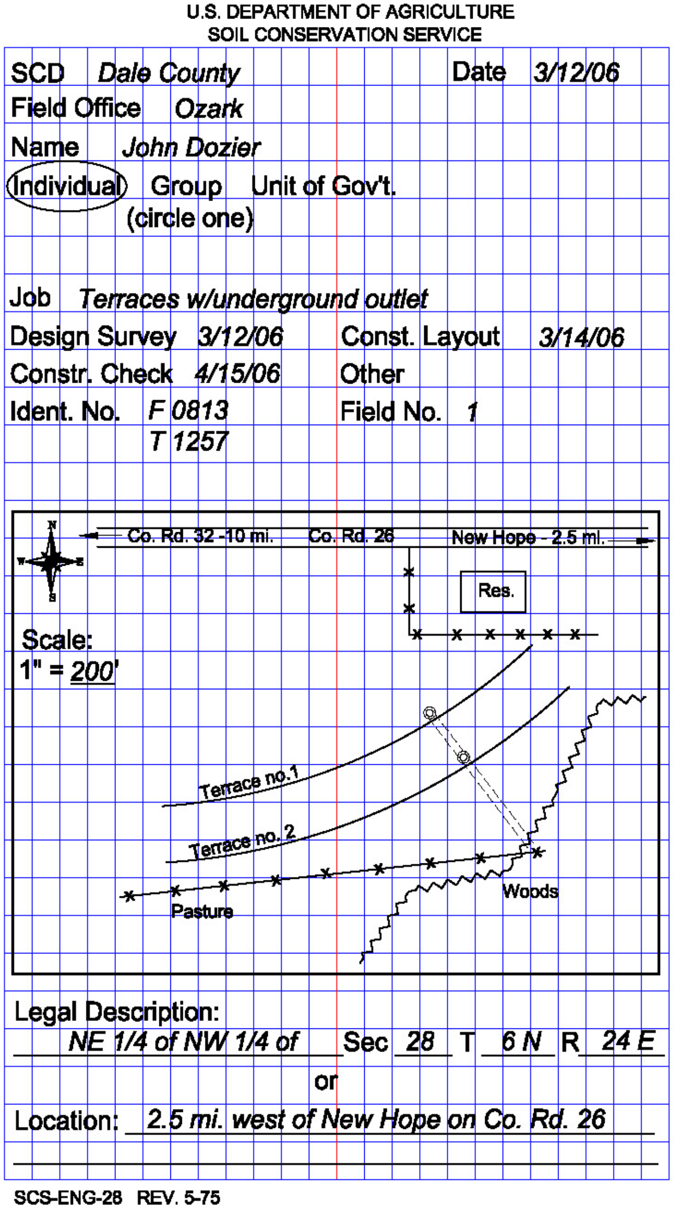
(SCS-ENG-191 Engineering Field Book) or (SCS-ENG-29)

1. Complete title page with sketch of practice location.
2. Show at beginning of survey; farmer's name, purpose of survey, name of practice, party members, duties, and date.
3. Sketch showing location of each terrace with appropriate outlets.
4. Profile of proposed channel of each terrace, one terrace per page.
5. Profile of proposed pipe.
6. Concrete AL-ENG-21 or equivalent computer design for each terrace.
7. Table showing required discharge, pipe slope, and pipe size for each terrace.

### B. Construction and Performance Checks

(SCS-ENG-191 Engineering Field Book) or (SCS-ENG-29)

1. All terraces will be surveyed to determine that elevations are according to design.
2. A complete profile of the channel and ridge on at least one terrace per underground outlet will be recorded. Cross-section survey of at least one terrace in the system is required. A hand level survey is acceptable for this. Critical elevations and any potential problem areas should be checked and documented prior to approval of the system.
3. Table showing the constructed length of each terrace and total length of all terraces if the terraces are constructed at locations other than that laid out.
4. Supporting statements.
    a. condition of outlets.
    b. General remarks about construction meeting plans and specifications along with signature and dates.



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SCD *Dale County* Date *3/12/06*
Field Office *Ozark*
Name *John Dozier*
[✓ Individual] Group Unit of Gov't.
(circle one)

Job *Terraces w/underground outlet*
Design Survey *3/12/06* Const. Layout *3/14/06*
Constr. Check *4/15/06* Other
Ident. No. *F 0813*
*T 1257* Field No. *1*

Scale:
1" = *200'*

Legal Description:
*NE 1/4 of NW 1/4 of* Sec *28* T *6 N* R *24 E*
or
Location: *2.5 mi. west of New Hope on Co. Rd. 26*

SCS-ENG-28 REV. 5-75

Figure AL8-4. Terrace system with underground outlets survey notes and design. (Sheet 1 of 6)

| Station | B. S. | H. I. | F. S or grade rod | Elev. or planned elev. | |
|---|---|---|---|---|---|
| | | | | | |
| *TBM no.1* | *6.01* | *106.01* | | *100.00* | |
| | | | | | |
| | Rod Reading | Water depth | Storage | | |
| | | | | | |
| *0+00* | *7.7* | | | | |
| *0+50* | *7.5* | | | | |
| *1+00* | *9.0* | | | | |
| *1+50* | *9.5* | | | | |
| *2+00* | *10.0* | *0.3* | *3* | | |
| *2+50* | *10.5* | *0.8* | *14* | | |
| *3+00* | *11.0* | *1.3* | *30* | | |
| *3+50* | *12.1* | *2.4* | *89* | | |
| *4+00* | *11.0* | *1.3* | *30* | | |
| *4+50* | *10.5* | *0.8* | *14* | | |
| *5+00* | *10.0* | *0.3* | *3* | | |
| *5+50* | *9.5* | | *183 cu. ft. / ft.* | | |
| *6+00* | *9.0* | | | | |
| *6+50* | *8.0* | | | | |
| *7+00* | *8.3* | | | | |

SCS-ENG-29
(2-80)

*John Dozier* | ⊼ - *C. Wise* | *3/12/06*
*Terraces w/undergrnd. outlet* | Φ - *T. Nabors*
*Dale Co., AL*

*Nail in 6" Cherry tree in corner of fence*

*Terrace No. 1*

U.S. Dept. of Agriculture
Natural Resources Conservation Service

AL-ENG-21
Rev. 5/06

## DESIGN OF UNDERGROUND OUTLET

(NOTE: References to tables and exhibits are found in the Alabama Engineering Field Design Manual, Chapter 8.)

LAND SLOPE = 4 % AVG TERR SPACING = 120 FT.

TERR FRONT SLOPE = 14 FT. TYPE CHANNEL V

D.A. = $\frac{\text{TER SP 120 FT. X CHAN LGTH 600 FT.}}{43560}$ = 1.65 AC.

REQ STORAGE(RS) = 4.24 IN. (From Table AL8-2)

VOL STO REQ(VSR) = 4.24 IN. X D.A. 1.65 AC. = 7.00 AC. IN.

AVAIL STO(AS) = $\frac{\text{183 FT}^3\text{/FT. X 50 STA FT.}}{3630}$ = 2.52 AC. IN.

BYPASS: ALONG CHAN ________ OVER TERRACE X

% STOR = AS 2.52 AC. IN. ÷ VSR 7.00 AC. IN. = 36 %

BYPASS EL = HI 106.0 - WL 9.7 = 96.3

RIDGE EL = BYPASS EL 96.3 + F'BRD 0.5 = 96.8

PIPE CAP = RS 4.24 IN. X 2.78 FACTOR = 11.79 IN.
[“FACTOR” from Table AL8-4 for unstable bypass or % storage (expressed as decimal) for channel bypass.]

PIPE SIZE = 6 IN. MIN. DIA. NO. OF 1 IN. DIA. HOLES/FT =

$\frac{\text{D.A. 1.65 AC. X PIPE CAP. 11.79 IN.}}{0.67}$ = 29 USE 30

H = 2.2 FT., Q 0.82 CFS, ORIFICE DIA = 4.18 IN.

DESIGNED BY C. Wise CHECKED BY T. Nabors

Figure AL8-4. Terrace system with underground outlets survey notes and design. (Sheet 2 of 6)

| Station | B. S. | H. I. | F. S or grade rod | Elev. or planned elev. | |
|---|---|---|---|---|---|
| | | | | | |
| | | 106.01 | | | |
| | | | | | |
| | Rod Reading | Water depth | Storage | | |
| | | | | | |
| 0+00 | 12.3 | | | | |
| 0+50 | 12.2 | | | | |
| 1+00 | 12.0 | | | | |
| 1+50 | 12.3 | | | | |
| 2+00 | 12.8 | 0.1 | 1 | | |
| 2+50 | 13.2 | 0.5 | 7 | | |
| 3+00 | 13.5 | 0.8 | 14 | | |
| 3+50 | 13.7 | 1.0 | 20 | | |
| 4+00 | 14.0 | 1.3 | 30 | | |
| 4+50 | 13.5 | 0.8 | 14 | | |
| 5+00 | 13.0 | 0.3 | 3 | | |
| 5+50 | 12.8 | 0.1 | 1 | | |
| 6+00 | 12.7 | | 90 cu. ft. / ft. | | |
| 6+50 | 13.1 | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| SCS-ENG-29 (2-80) | | | | | |

John Dozier
(Continued)
Same party and date

Terrace No. 2

U.S. Dept. of Agriculture
Natural Resources Conservation Service

AL-ENG-21
Rev. 5/06

## DESIGN OF UNDERGROUND OUTLET

(NOTE: References to tables and exhibits are found in the Alabama Engineering Field Design Manual, Chapter 8.)

LAND SLOPE = __4____ % AVG TERR SPACING = ___120____ FT.

TERR FRONT SLOPE = __14__ FT. TYPE CHANNEL____V_______

D.A. = TER SP 120 FT. X CHAN LGTH 500 FT. / 43560 = __1.38_ AC.

REQ STORAGE(RS) = _____4.24________ IN. (From Table AL8-2)

VOL STO REQ(VSR) = _4.24_ IN. X D.A. _1.38 AC. = 5.84__ AC. IN.

AVAIL STO(AS) = _90__FT$^3$/FT. X _50 STA FT. / 3630 = __1.24___ AC. IN.

BYPASS: ALONG CHAN ___X____ OVER TERRACE___________

% STOR = AS _1.24_ AC. IN. ÷ VSR _5.84___ AC. IN. =__21_____ %

BYPASS EL = HI ___106.0_ - WL__12.7______ = ____93.3_________

RIDGE EL = BYPASS EL _93.3___ + F'BRD__0.5___ = __93.8______

PIPE CAP = RS__4.24___ IN. X __0.21___ FACTOR = ___0.89__ IN.
[“FACTOR” from Table AL8-4 for unstable bypass or % storage (expressed as decimal) for channel bypass.]

PIPE SIZE = __8_ IN. MIN. DIA. NO. OF 1 IN. DIA. HOLES/FT =

D.A. 1.38 AC. X PIPE CAP. 4.21 IN. / 0.67 = _8.7_ USE_12_____

H = _2.6__FT., Q__0.34_ CFS, ORIFICE DIA =__2.66___ IN.

DESIGNED BY____C. Wise______ CHECKED BY__T. Nabors_____

Note: Pipe size includes Q from Terrace No. 1, used 100% of RS to size pipe.

Figure AL8-4. Terrace system with underground outlets survey notes and design. (Sheet 3 of 6)

| Station | B. S. | H. I. | F. S or grade rod | Elev. or planned elev. | |
|---|---|---|---|---|---|
| | | 106.01 | | | |
| | | | | | |
| Pipe Profile | | | | | |
| 0+00 | | | | | |
| | | | | | |
| 0+50 | Terrace no. 1 | | +14.6 | 91.4 | |
| | | | | | |
| 1+00 | | | +16.6 | 89.4 | |
| | | | | | |
| 1+70 | Terrace no. 2 | | +19.4 | 86.6 | |
| | | | | | |
| 2+00 | | | +20.6 | 85.4 | |
| | | | | | |
| 2+50 | | | +22.6 | 83.4 | |
| | | | | | |
| TBM no.1 | | | 6.01 | 100.00 | 100.00 |
| | | | | | o.k. C.Wise |

PIPE SIZE REQUIRED

| Terrace No. | Ac.- In. | CFS | Accum. CFS | Slope | Size |
|---|---|---|---|---|---|
| 1 | 19.5 | 0.82 | 0.82 | 4% | 6" |
| 2 | 5.9 | 0.34 | 1.16 | 4% | 8" |
| Outlet | | | 1.16 | 4% | 8" |

SCS-ENG-29
(2-80)

John Dozier (cont'd.) Same party and date

Pipe Profile

10.1

12.1

14.1

16.9

18.1

22.6

| Terrace No. | Layout Length |
|---|---|
| 1 | 700' |
| 2 | 650' |
| Total | 1350' |

Bill of Materials

2 - 6" Hickenbottom risers
120' - 6" dia. CPP
80' - 8" dia. CPP
10' - 8" dia. PVC pipe
1 - 8" animal guard

1 cu. yd. gravel
1 - 6" x 8" reducer
1 - 6" dia. tee
1 - 8" dia. tee

Figure AL8-4. Terrace system with underground outlets survey notes and design. (Sheet 4 of 6)

| Station | B. S. | H. I. | F. S or grade rod | Elev. or planned elev. | |
|---|---|---|---|---|---|
| | | | | | |
| TBM no.1 | 7.71 | 107.71 | | 100.00 | |
| | | | | | |
| | | | | | |
| | | | | | |
| 0+00 | Ridge | | +13.9 | 93.8 | |
| 0+50 | | | | | |
| 1+00 | | | | | |
| 1+50 | | | | | |
| 2+00 | | | | | |
| 2+50 | | | | | |
| 3+00 | | | | | |
| 3+50 | | | | | |
| 4+00 | | | | | |
| 4+50 | | | | | |
| 5+00 | | | | | |
| 5+50 | | | | | |
| 6+00 | Bypass | | +14.4 | 93.3 | |
| 6+50 | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| SCS-ENG-29 (2-80) | | | | | |

*John Dozier* ⊼ & ◫ - *C. Wise*
*Terraces w/undergrnd. outlet* ϕ - *T. Nabors 4/15/06*
*Construction check summary*
*Dale Co., AL - Terrace No. 2*

| Channel Rod | Ridge Rod |
|---|---|
| 14.0 | 13.0 |
| 13.9 | 12.9 |
| 13.7 | 12.7 |
| 14.0 | 13.0 |
| 14.5 | 13.4 |
| 14.9 | 13.5 |
| 15.2 | 13.7 |
| 15.4 | 13.7 |
| 15.7 | 13.7 |
| 15.2 | 13.8 |
| 14.7 | 13.8 |
| 14.5 | 13.8 |
| 14.4 | 13.8 |
| 14.8 | 13.8 |

Figure AL8-4. Terrace system with underground outlets survey notes and design. (Sheet 5 of 6)

| Station | B. S. | H. I. | F. S or grade rod | Elev. or planned elev. | |
|---|---|---|---|---|---|
| | | 107.71 | | | |
| Distance | Rod | Rod diff. | Distance | Rod | Rod diff. |
| 0 | 4.6 | 0 | 28 | 7.2 | 2.6 |
| 4 | 4.8 | 0.2 | 32 | 5.8 | 1.2 |
| 8 | 5.3 | 0.7 | 36 | 4.8 | 0.2 |
| 12 | 5.8 | 1.2 | 40 | 4.6 | 0 |
| 16 | 6.6 | 2.0 | 44 | 5.9 | |
| 20 | 7.0 | 2.4 | 48 | 6.8 | |
| 24 | 7.6 | 3.0 | 52 | 7.9 | 13.5 sq.ft.<br>x 4 |
| | | | | | = 54 sq. ft. |
| TBM no.1 | | | 7.71 | 100.00 | 100.00 |
| | | | | 0.00 O.K. | C. Wise |

SCS-ENG-29
(2-80)

John Dozier — Same party and date

Underground outlet terrace

Construction check terrace #2

Cross section survey

210 ft. of pipe installed as planned.
Filter strip planted. Construction meets
plans and specifications.

C. Wise - Soil Cons. Tech.
4/15/06

Figure AL8-4. Terrace system with underground outlets survey notes and design. (Sheet 6 of 6)

## Terraces

### A. Engineering Surveys for Design and Construction Layout

(SCS-ENG-191 Engineering Field Book) or (SCS-ENG-29)

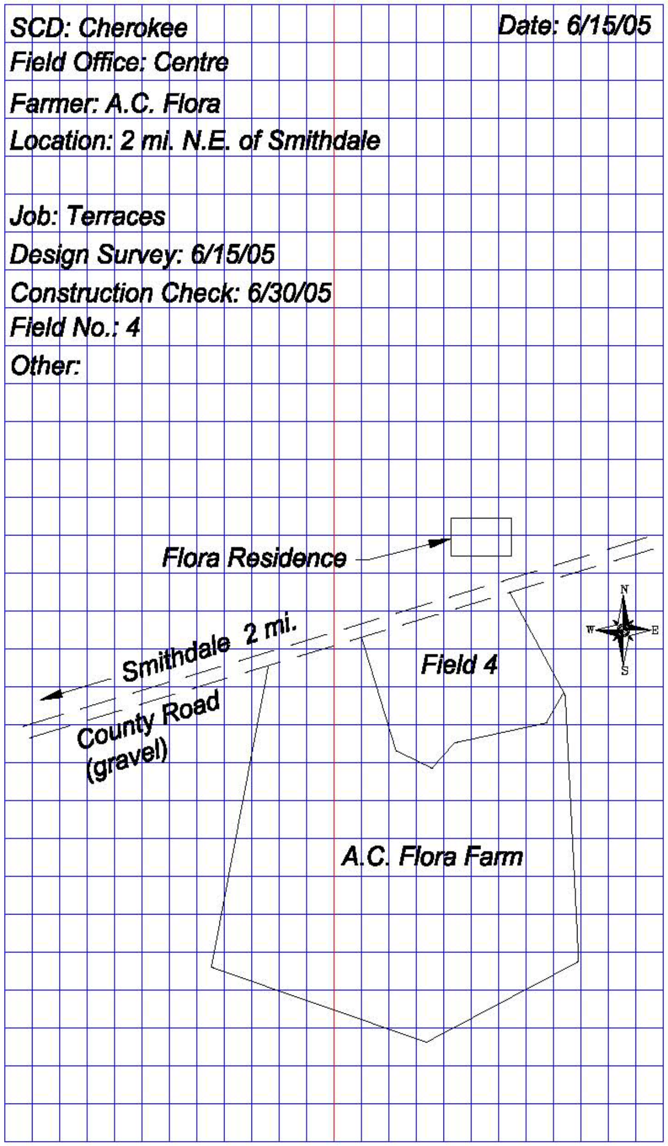
1. Complete title page with sketch of practice location.
2. Show at beginning of survey; farmer's name, purpose of survey, name of practice, party members, duties, and date.
3. Table showing terrace number, land slope, vertical or horizontal interval and layout length of each terrace.
4. Sketch showing location of each terrace with appropriate outlets.

### B. Construction and Performance Checks

(SCS-ENG-191 Engineering Field Book) or (SCS-ENG-29)

1. Normal survey check-out procedures are to make a profile and cross-section survey and record notes on at least one terrace in each group of terraces in each field.

   Experienced technicians may be approved by the engineer to make visual construction approval of the terrace profiles. It is recommended that visual approval be done after a runoff event. Cross-section survey of at least one terrace in the system is required. A hand level survey is acceptable for this. Critical elevations and any potential problem areas should be checked and documented prior to approval of the system.
2. Table showing the constructed length of each terrace and total length of all terraces if the terraces are constructed at locations other than that laid out.
3. Supporting statements.
   - a. condition of outlets.
   - b. General remarks about construction meeting plans and specifications along with signature and dates.



SCD: Cherokee
Date: 6/15/05
Field Office: Centre
Farmer: A.C. Flora
Location: 2 mi. N.E. of Smithdale

Job: Terraces
Design Survey: 6/15/05
Construction Check: 6/30/05
Field No.: 4
Other:

Figure AL8-5. Terrace system survey notes and design.

(Sheet 1 of 3)

| Terr. No. | Land Slope % | Vert. Int. | Horiz. Int. | Layout Length | |
|---|---|---|---|---|---|
| 1 | 3 | | 80 | 175 | |
| 2 | 5 | | 60 | 225 | |
| 3 | 8 | | 47 | 200 | |
| 4 | 6 | | 54 | 150 | |
| 5 | 3 | | 80 | 230 | |
| 6 | 5 | | 60 | 325 | |
| 7 | 7 | | 54 | 335 | |
| 8 | 5 | | 60 | 460 | |
| 9 | 4 | | 54 | 285 | |
| 10 | 3 | | 80 | 150 | |
| 11 | 5 | | 60 | 125 | |
| | | | Total = | 2660 | |

A.C. Flora ⊼ - H.R. Smith
Terraces ϕ - A.D. Scruggs
Design and Construction Layout 6/15/05

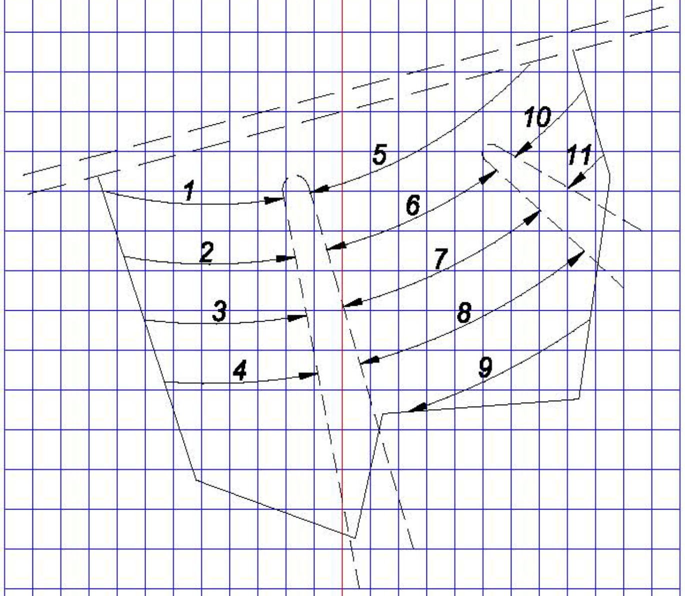


Figure AL8-5. Terrace System Survey Notes and Design.

(Sheet 2 of 3)

Cross Section Terrace No. 7 - Sta. 2+00

| Distance | Rod | Rod diff. | Distance | Rod | Rod diff. |
|---|---|---|---|---|---|
| 0 | 4.8 | 0 | 18 | 5.1 | |
| 2 | 4.9 | 0.1 | 20 | 5.3 | |
| 4 | 5.3 | 0.5 | 22 | 5.7 | |
| 6 | 5.7 | 0.9 | 24 | 6.0 | |
| 8 | 5.9 | 1.1 | 26 | 6.3 | |
| 10 | 5.8 | 1.0 | 28 | 6.6 | |
| 12 | 5.4 | 0.6 | | | |
| 14 | 5.0 | 0.2 | | | |
| 16 | 4.8 | 0 | | | |

Note: For cross section, multiply by distance between stations.

X-Section = 4.4 x 2 = 8.8 sq. ft.

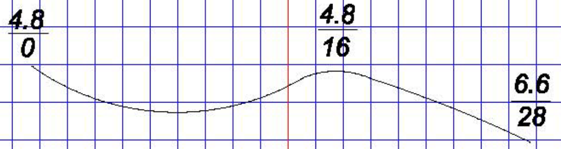
Profile Terrace No. 7

| Station | Channel Rod | Ridge Rod |
|---|---|---|
| 0+00 | 7.3 | 6.4 |
| 0+50 | 6.9 | 5.9 |
| 1+00 | 6.6 | 5.6 |
| 1+50 | 6.3 | 5.2 |
| 2+00 | 5.9 | 4.8 |
| 2+50 | 6.2 | 5.2 |
| 3+00 | 6.6 | 5.6 |
| 3+34 | 6.7 | 5.0 |

SCS-ENG-29
(2-80)

A.C. Flora
Terraces
Construction Check Survey

⊼ - A.D. Scruggs
ϕ - A.C. Flora
6/30/05



Cross Section Terrace No. 7 - Sta. 2+00

Terraces constructed at locations laid out.

A.D. Scruggs
S.C.T.

Construction meets plans and specs.
Waterway has adequate stand of Fescue grass this date.

A.D. Scruggs
Cons. Tech
6/30/05

Figure AL8-5. Terrace System Survey Notes and Design. (Sheet 3 of 3)