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SECTION I - WATER EROSION PREDICTION

INTRODUCTION

SECTION I - WATER EROSION PREDICTION

This section describes use of the Revised Universal Soil Loss Equation (RUSLE) in South Dakota. The RUSLE is the management tool used in conservation planning to estimate soil losses by sheet and rill erosion on cropland, pastureland, rangeland, woodland, idle land, and in some instances, urban areas. The equations quantify the effects of natural factors, cultural management, and cropping practices in soil loss.

The purpose of the RUSLE is to predict long-term average soil losses from specific field areas under specified cropping and management systems. Because of unpredictable short-time fluctuations in the values of influential variables, they are less accurate in predicting specific events than for predicting average soil losses over the entire cropping sequence.

The effectiveness of a particular land treatment alternative can be evaluated when the predicted soil loss for that treatment is compared with the soil loss tolerance "T" for the specific soil.

T = soil loss tolerance. "T" is not part of RUSLE but is used with RUSLE to establish a benchmark for evaluating the predicted erosion rate from an existing or planned conservation system. "T" is the average annual erosion rate that can occur with little or no long-term degradation of the soil resource on the field. When the computed soil erosion rate is less than the "T" value, control of sheet and rill erosion is assumed to be adequate. When the computed soil erosion rate exceeds the "T" value, sheet and rill erosion is considered to be excessive and additional conservation treatment is needed. Soil loss tolerance values ("T") are assigned to each soil map unit by the Natural Resources Conservation Service (NRCS).

By using the RUSLE, numerous crop and tillage alternatives can be developed for a particular field or farm. These alternatives can be compared on the basis of predicted soil loss and they can also be evaluated for effectiveness using "T." This allows the operator to select his or her system based on the effectiveness to reduce soil loss, feasibility, and economics.

Occasionally, small portions of fields identified during the planning process cannot be completely treated to meet "T" due to topography or physical limitations. In these situations, when water courses or sensitive areas are located down slope, either offsite protection from siltation must be provided or additional land treatment must be utilized to minimize siltation. Some practices, such as crop residue management hay in rotation and the use of cover crops, may compensate for the lack of other treatment.

Even when meeting "T," cropland immediately upslope (above) water courses or sensitive areas may require additional treatment during periods of low residue or crop cover. This is especially true during the part of a crop sequence when crops with high "C" values are utilized. This additional treatment could include the use and management of crop residues, cover crops, intercropping, or by allowing a natural or seeded filter strip between the cropland and the water course or other sensitive area.

In summary, RUSLE is an important tool in developing conservation plans which keep soil losses to acceptable levels which will be sustainable over time. This tool is also important in treating surface water quality problems where nonpoint source sediment is an identified problem.

PREDICTING RAINFALL EROSION LOSSES
Revised Universal Soil Loss Equation

RUSLE replaces the Universal Soil Loss Equation (USLE) for predicting soil loss from interrill (sheet) and rill erosion caused by rainfall and associated overland flow. RUSLE retains the equation structure of USLE, but each of its factor relationships has been either updated with recent data or new relationships have been derived based on modern erosion theory and data.

RUSLE is an erosion prediction model that enables conservation planners to predict the long-term average annual rate of interrill (sheet) and rill soil erosion on a landscape as described by the factor values assigned by the planner. The factors represent the effect of climate, soil, topography, conservation practice, and land use on interrill (sheet) and rill erosion. Based on assigned factor values for site specific conditions, RUSLE computes soil erosion rates to guide planning conservation systems for individual fields by evaluating the impact of present and/or planned land use and management.

The soil loss computed by RUSLE is the rate of soil erosion from the landscape profile represented by the particular RUSLE computation; not the amount of sediment leaving a field or watershed. A landscape profile is defined by a slope length. Erosion rate varies along the slope profile and the erosion rate at the end of the slope length is greater than the average erosion rate for the entire slope length. The calculated soil loss is an average erosion rate for the landscape profile.

The DOS computer version of RUSLE (version 1.05) was used to develop the values in these erosion prediction tables. To compute the average annual erosion rate on a field slope, select appropriate values from the figures and tables for R, K, LS, C, and P and multiply the values together.

The equation is expressed as follows: A = RKLSCP

A = the predicted average annual soil loss from interrill (sheet) and rill erosion from rainfall and associated overland flow. Units for factor values are usually selected so that "A" is expressed in tons per acre per year.

R = the factor for climatic erosivity. "R" factor values represent the average storm EI value from a 22-year record period. "R" accounts for the amount of rainfall and the peak intensity sustained over an extended period of time and is the number of rainfall erosion index (EI) units in an average years rainfall.

K = the factor for soil erodibility. "K" values represent the susceptibility of soil to erosion and the amount and rate of runoff, as measured under the standard plot condition. "K" is a measure of the soil loss rate per erosion unit for a specified soil as measured on a unit plot. The unit plot is an erosion plot 72.6 feet long on a uniform 9 percent slope managed in continuous clean till fallow.

L = the factor for slope length. "L" represents the effect of slope length on erosion. "L" is the ratio of soil loss from the field slope length to that from a plot slope 72.6 feet long under otherwise identical conditions. Slope length is the distance from the origin of overland flow along its flow path to the location of either concentrated flow or deposition. Computed soil loss values are not as sensitive to slope length as to slope steepness, thus differences in slope length of + or - 10 percent are not important on most slopes. This is especially true in flatter landscapes.

S = the factor for slope steepness. "S" represents the effect of slope steepness on erosion. "S" is the ratio of soil erosion from the field slope gradient to that from a nine percent slope under otherwise identical conditions. Computed soil erosion rates are more sensitive to slope steepness than to slope length.

LS = The slope length "L" and steepness "S" factors are combined into the "LS" factor in the RUSLE equation. An "LS" value represents the relationship of the actual field slope condition to the unit plot. An "LS" value of 1.0 represents the unit plot condition of 72.6 feet in length and 9 percent slope steepness.

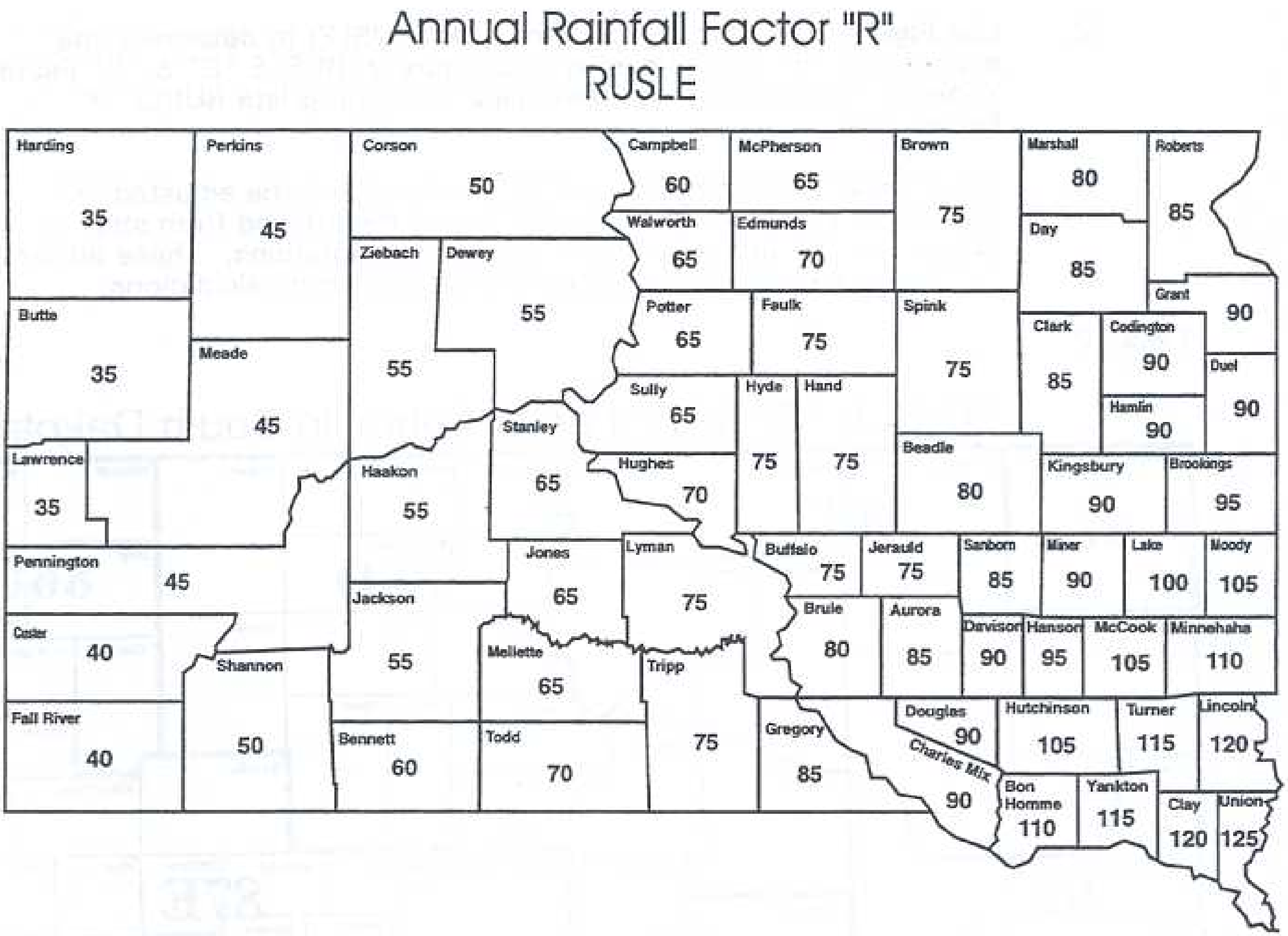
C = the factor for cover and management. "C" represents the effect of plants, soil cover, soil biomass, and soil disturbing activities on soil erosion. "C" is the ratio of soil loss from an area with specified cover and management to that from an identical area under tilled continuous fallow management.

P = the factor for support practices. "P" represents the impact of support practices on erosion rates. "P" is the ratio of soil loss from an area with supporting practices in place to that from an identical area without any supporting practices. Supporting practices include contour farming, cross-slope farming, buffer strips, stripcropping, and terraces.

I. RAINFALL AND RUNOFF FACTOR (R)

The numerical values for "R" in South Dakota range from 35 in northwest South Dakota to 125 in southeast South Dakota. Values are assigned for each county in South Dakota. Use **Figure 1** below to select the appropriate "R" value for the geographic location of the land being evaluated.

Figure 1



II. SOIL ERODIBILITY FACTOR (K)

Soil erodibility varies during the year. Erodibility tends to be high early in the spring during and immediately following thawing and during periods when the soil tends to be wetter than during other periods. "K" values tend to be lower in the fall. RUSLE accounts for these variations and an adjusted "K" has been computed for locations where climate has a significant impact.

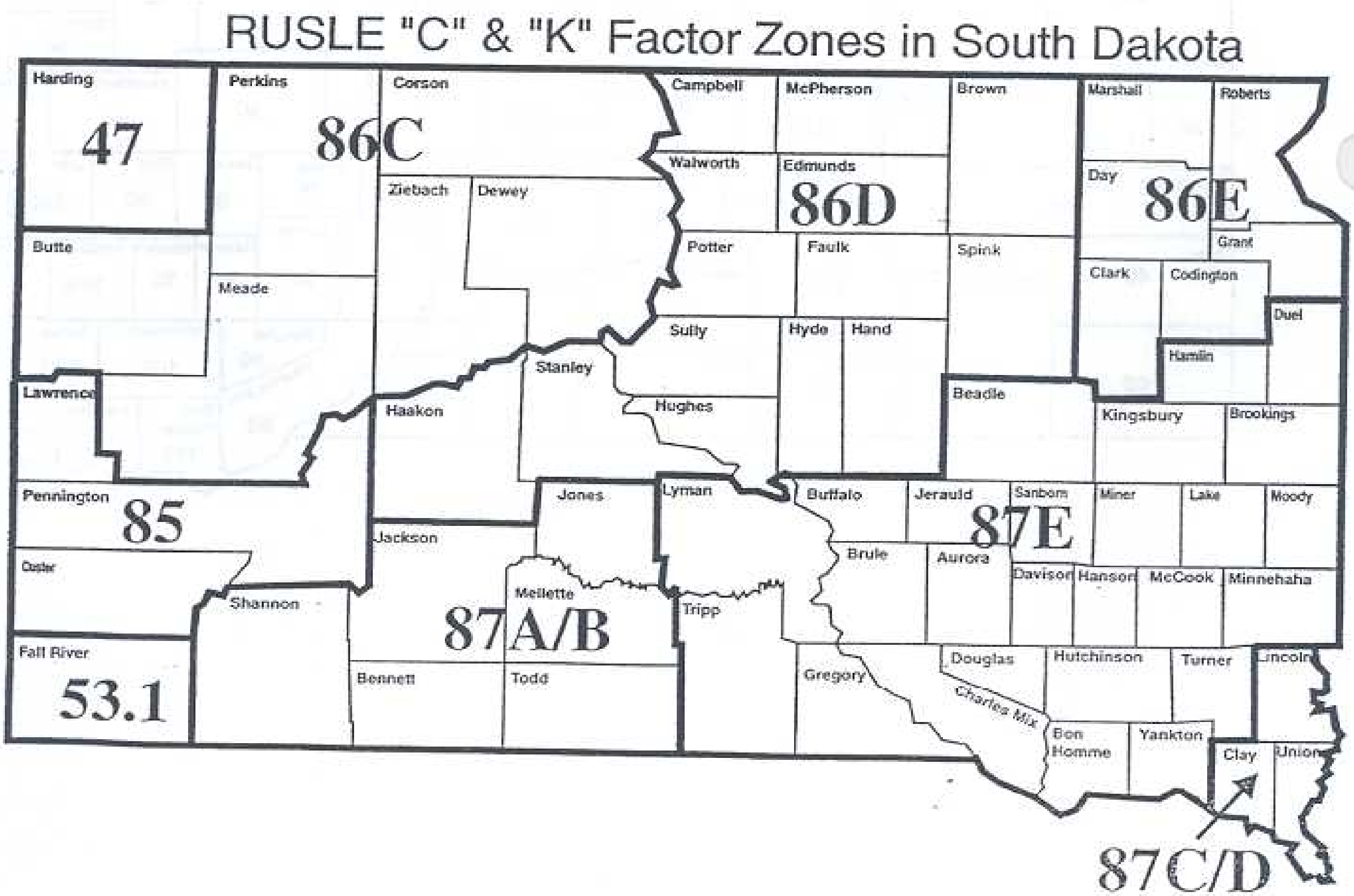
"K" factor adjustments for all counties are made by:

1. Obtain the assigned "K" factor for the soil map unit from the Interpretative Groupings Table found in Section II - Soil Legends of the SDTG.

2. Use **Figure 1** (Annual rainfall Factor "R" RUSLE) to determine the appropriate "R" for the county and **Figure 2** (RUSLE "C" & "K" Factor Zones in South Dakota) to determine the appropriate RUSLE "K" Factor Zone.

3. From **Table 1** (Average Annual "K" Factors) find the adjusted "K" factor that corresponds to the "K" factor determined from step 1. This is the "K" factor to use in RUSLE computations. These adjusted "K" factor values are for use only in RUSLE hand calculations.

Figure 2



AVERAGE ANNUAL 'K' FACTOR
FOCS RUSLE

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 47 (Wibaux, MT)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
35	.02	.17	.20	.22	.26	.32	.35	.40	.49

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 53.1 (Redbird, WY)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
40	.02	.17	.20	.24	.28	.32	.37	.43	.49

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 85 (Rapid City AP, SD)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
35	.02	.17	.20	.22	.28	.32	.37	.43	.49
40	.02	.17	.20	.22	.28	.32	.37	.43	.49
45	.02	.17	.20	.22	.28	.32	.37	.43	.49

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 86C (Bismarck, ND)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
35	.02	.15	.17	.22	.26	.30	.35	.40	.46
40	.02	.15	.17	.22	.26	.30	.35	.40	.46
45	.02	.15	.17	.22	.26	.30	.35	.40	.46
50	.02	.15	.17	.22	.26	.30	.35	.40	.46
55	.02	.15	.17	.22	.26	.30	.35	.40	.46

Zone 86D

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
55	.02	.17	.17	.22	.26	.30	.35	.40	.46
60	.02	.17	.17	.22	.26	.30	.35	.40	.46
65	.02	.15	.17	.20	.24	.30	.32	.40	.46
70	.02	.15	.17	.20	.24	.28	.32	.37	.43
75	.02	.15	.17	.20	.24	.28	.32	.37	.43

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 86E (Fergus Falls, MN)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
80	.02	.15	.17	.20	.24	.28	.32	.37	.43
85	.02	.15	.17	.20	.24	.28	.32	.37	.43
90	.02	.15	.17	.20	.22	.26	.30	.35	.40

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 87A\B (Valentine, NE)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
50	.02	.17	.20	.24	.28	.32	.37	.43	.49
55	.02	.17	.20	.24	.28	.32	.37	.43	.49
60	.02	.17	.20	.24	.28	.32	.37	.43	.49
65	.02	.17	.20	.24	.28	.32	.37	.43	.49
70	.02	.17	.20	.22	.26	.32	.35	.43	.49

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 87C\D (Norfolk, NE)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
120	.02	.15	.15	.20	.22	.26	.30	.35	.40
125	.02	.15	.15	.17	.22	.26	.30	.35	.40

TABLE 1
AVERAGE ANNUAL K FACTORS
Climatic Zone: 87E (Mitchell, SD)

R\K	.02	.15	.17	.20	.24	.28	.32	.37	.43
75	.02	.17	.20	.22	.28	.32	.37	.43	.49
80	.02	.17	.20	.22	.26	.30	.35	.40	.49
85	.02	.17	.17	.22	.26	.30	.35	.40	.46
90	.02	.15	.17	.20	.26	.30	.35	.40	.46
95	.02	.15	.17	.20	.24	.28	.32	.37	.43
100	.02	.15	.17	.20	.24	.28	.32	.37	.43
105	.02	.15	.17	.20	.24	.28	.30	.35	.43
110	.02	.15	.15	.20	.22	.26	.30	.35	.40
115	.02	.15	.15	.17	.22	.26	.30	.35	.40

III. SLOPE LENGTH AND SLOPE STEEPNESS (LS)

Slope length in feet and slope steepness in percent are combined into the "LS" factor using Table 3. **Table 2** is used for **Cropped Agricultural Land** with moderately consolidated soil conditions and moderate to little cover.

Table 2: Cropped Agricultural Land

"LS" values for the topographic factor for land with a moderate ratio of rill to interrill erosion. This includes land in agricultural crop rotations and other land uses with moderately consolidated soil conditions and moderate to little cover.

%	Horizontal slope length (ft)															
Slope	<3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10
1.0	0.11	0.11	0.11	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17	0.17	0.18	0.19	0.20	0.20
2.0	0.17	0.17	0.17	0.17	0.17	0.19	0.22	0.25	0.27	0.29	0.31	0.33	0.35	0.37	0.41	0.44	0.47
3.0	0.22	0.22	0.22	0.22	0.22	0.25	0.32	0.36	0.39	0.44	0.48	0.52	0.55	0.60	0.68	0.75	0.80
4.0	0.26	0.26	0.26	0.26	0.26	0.31	0.40	0.47	0.52	0.60	0.67	0.72	0.77	0.86	0.99	1.10	1.19
5.0	0.30	0.30	0.30	0.30	0.30	0.37	0.49	0.58	0.65	0.76	0.85	0.93	1.01	1.13	1.33	1.49	1.63
6.0	0.34	0.34	0.34	0.34	0.34	0.43	0.58	0.69	0.78	0.93	1.05	1.16	1.25	1.42	1.69	1.91	2.11
8.0	0.42	0.42	0.42	0.42	0.42	0.53	0.74	0.91	1.04	1.26	1.45	1.62	1.77	2.03	2.47	2.83	3.15
10.0	0.46	0.48	0.50	0.51	0.52	0.67	0.97	1.19	1.38	1.71	1.98	2.22	2.44	2.84	3.50	4.06	4.56
12.0	0.47	0.53	0.58	0.61	0.64	0.84	1.23	1.53	1.79	2.23	2.61	2.95	3.26	3.81	4.75	5.56	6.28
14.0	0.48	0.58	0.65	0.70	0.75	1.00	1.48	1.86	2.19	2.76	3.25	3.69	4.09	4.82	6.07	7.15	8.11
16.0	0.49	0.63	0.72	0.79	0.85	1.15	1.73	2.20	2.60	3.30	3.90	4.45	4.95	5.86	7.43	8.79	10.02
20.0	0.52	0.71	0.85	0.96	1.06	1.45	2.22	2.85	3.40	4.36	5.21	5.97	6.68	7.97	10.23	12.20	13.99
25.0	0.56	0.80	1.00	1.16	1.30	1.81	2.82	3.65	4.39	5.69	6.83	7.88	8.86	10.65	13.80	16.58	19.13
30.0	0.59	0.89	1.13	1.34	1.53	2.15	3.39	4.42	5.34	6.98	8.43	9.76	11.01	13.30	17.37	20.99	24.31
40.0	0.65	1.05	1.38	1.68	1.95	2.77	4.45	5.87	7.14	9.43	11.47	13.37	15.14	18.43	24.32	29.60	34.48
50.0	0.71	1.18	1.59	1.97	2.32	3.32	5.40	7.17	8.78	11.66	14.26	16.67	18.94	23.17	30.78	37.65	44.02
60.0	0.76	1.30	1.78	2.23	2.65	3.81	6.24	8.33	10.23	13.65	16.76	19.64	22.36	27.45	36.63	44.96	52.70

IV. COVER AND MANAGEMENT (C)

There are nine RUSLE "C" & "K" factor zones in South Dakota as shown in **Figure 2**. Each zone is represented by the climatic data base for a selected city. Those cities are: Wibaux, MT; Redbird, WY; Rapid City, SD; Fergus Falls, MN; Bismarck, ND; Eureka, SD; Valentine, NE; Norfolk, NE; and Mitchell, SD. "C" factor tables have been generated for each of these zones.

"C" factors are shown in **Table 3 (Appendix A)** in a family of tables that display the crop to be planted and the preceding crop. "C" factors are displayed by tillage type for several levels of residue cover after planting. Tables are available for three yield groups: high, average, and low. Yield information is presented in Table 3A (Appendix A).

"C" factor tables contained in the SDTG are relevant to each individual location throughout South Dakota. Table 3 will change from location to location depending on the climatic station used to generate the table.

Crop rotation "C" factors can be constructed by selecting the appropriate "C" factor for each crop in the rotation, adding these "C" factors together, and dividing the sum of "C" factors by the number of years in the rotation.

The residue cover value necessary for "C" factor development can be determined by estimating residue production and reduction for planning purposes or precisely measured in the field. Tables 4, 5, and 6 can be used to estimate residue quantities for planning purposes. Average crop yields and the corresponding residue value from Table 4 can be used to determine initial residue production at harvest. Estimations of residue reduction can be determined with Tables 5 and 6. The values in Table 6 were developed jointly by NRCS and the Equipment Manufacturers Institute, February 1992.

Each tillage or planting operation leaves a percent of the residue that was present just prior to that operation. The numbers in Table 6 represent the remaining percentages.

Crop residue has been generally classified as being either nonfragile or fragile in Table 5. This is a subjective classification based in part on the ease in which crop residues are decomposed by the elements or buried by tillage operations. Plant characteristics such as composition and size of leaves and stems; density of the residue and relative quantities produced were considered.

TABLE 4

RESIDUE PRODUCED BY CROP

Crop	Estimated Air Dry Residue Produced	
Barley	72	lbs./bu. grain
Buckwheat	1.5	lbs./lb. grain
Corn	56	lbs./bu. grain
Corn Silage Stubble	21	lbs. residue/ inch of stubble height/10,000 plants/acre
Dry Edible Beans	2.2	lbs./lb. grain
Field Peas (Dry)	1.2	lbs./lb. grain
Flax	80	lbs./bu. grain
Lentil	1.2	lbs./lb. grain
Millet	80	lbs./bu. grain
Oats	64	lbs./bu. grain
Potatoes	6	lbs./cwt.
Rape Seed	2	lbs./lb. grain
Rye	84	lbs./bu. grain
Rye (fall growth)	175-500	lbs./ac.
Safflower	1.5	lbs./lb. grain
Sorghum (Grain)	56	lbs./bu. grain
Sorghum silage stubble (Plant population/ac) <58,000	32	lbs./inch/10,000 plants/acre
>58,000	186	lbs./inch of stubble height
Soybeans	75	lbs./bu. grain
Spring wheat	78	lbs/bu. grain
Sunflowers	2.2	lbs./lb. grain
Winter wheat	102	lbs./bu. grain
Winter wheat (fall growth)	175-260	lbs./ac.

Many factors affect the amount of residue left after a pass with a tractor and tillage or planting machine. Residue levels are sensitive to depth and speed of equipment operation and to row spacing. When selecting values from the ranges in Table 9 for a specific machine, consider the following general rules of thumb. (1) At shallower operating depths greater amounts of residue are left on the surface, while at deeper operating depths more residue is buried. (2) Slower operating speeds tend to leave more residue on the surface, while at faster speeds more residue is buried. Under some conditions field cultivators and other finishing tools with field cultivator gangs and some planters and drills may return as much as 20 percent of the residue incorporated at shallow depths by recent previous operations. Excess wheel slippage caused by improper ballasting of tractor tires can destroy valuable residue in the wheel tracks. Higher retention values should be used when dealing with residue in excess of 2000 lbs. and the lower values when residue amounts are less than 2000 lbs.

Residue Estimation For Planning

The basic steps for estimating residue reduction are as follows:

1. Determine the total amount of residue produced using average crop yield and values provided in Table 4.

2. Convert the calculated residue value from item 1 to percent residue cover using Figure 3 or Table 7.

3. Using Tables 5 and 6 determine the residue value for the period of interest in percent residue cover.

Again, the values in Table 6 should only be used as a guide in conservation planning. Residue amounts left by each operation should be measured in the field to make necessary adjustments to table values.

TABLE 5

RESIDUE TYPES

Nonfragile	Fragile
Alfalfa or legume hay	Canola/rapeseed
Barley*	Dry beans
Buckwheat	Dry peas
Corn	Fall seeded cover crops
Flaxseed	Lentils
Forage Silage	Mustard
Grass Hay	Potatoes
Millet	Safflower
Oats*	Soybeans
Pasture	Sugar Beets
Popcorn	Sunflowers
Rye*	Vegetables
Sorghum	
Speltz*	
Triticale*	
Wheat*	

*If a combine is used with a straw chopper or otherwise cuts straw into small pieces in harvesting small grain then the residue should be considered as being fragile.

TABLE 6

RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining: Nonfragile Percent	Fragile Percent
Drills		
Hoe opener drills	50-80	40-60
Semi-deep furrow drill or press drill (7"-12" spacing)	70-90	50-80
Deep furrow drill with >12" spacing	60-80	50-80
Single disk opener drills	85-100	75-85
Double disk opener drills (conventional)	80-100	60-80
No-till drills and drills with the following attachments in standing stubble:		
Smooth no-till coulters	85-95	70-85
Ripple or bubble coulters	80-85	65-85
Fluted coulters	75-80	60-80
No-till drills and drills with the following attachments in flat residues:		
Smooth no-till coulters	65-85	50-70
Ripple or bubble coulters	60-75	45-65
Fluted coulters	55-70	40-60
Air Seeders: Refer to appropriate field cultivator or chisel plow depending on the type of ground engaging device used.		
Air drills: Refer to corresponding type of drill opener.		
Row Planters		
Conventional planters with:		
Runner openers	85-95	80-90
Staggered double disk openers	90-95	85-95
Double disk openers	85-95	75-85
No-till planters with:		
Smooth coulters	85-95	75-90
Ripple coulters	75-90	70-85
Fluted coulters	65-85	55-80
Strip till planters with:		
2 or 3 Fluted coulters	60-80	50-75
Row cleaning devices (8"-14" wide bare strip using brushes, spikes furrowing disks, or sweeps)	60-80	50-60
Ridge till planter	40-60	20-40

TABLE 6

RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining Nonfragile Percent	Fragile Percent
<u>Climatic Effects</u>		
Over winter weathering:**		
Following summer harvest	70-90	65-85
Following fall harvest	80-95	70-80
<u>Field Cultivators</u> (Including leveling attachments)		
Used as the primary tillage operation:		
Sweeps 12"-20"	60-80	55-75
Sweeps or shovels 6"-12"	35-75	50-70
Duckfoot points	35-60	30-55
Field cultivators as secondary operation following chisel or disk:		
Sweeps 12"-20"	80-90	60-75
Sweeps or shovels 6"-12"	70-80	50-60
Duckfoot points	60-70	35-50
<u>Finishing Tools</u>		
Combination finishing tools with:		
Disks, shanks, and leveling attachments	50-70	30-50
Spring teeth and rolling basket	70-90	50-70
Harrows:		
Springtooth (coil tine)	60-80	50-70
Spike tooth	70-90	60-80
Flex-tine tooth	75-90	70-85
Roller harrow (cultipacker)	60-80	50-70
Packer roller	90-95	90-95
Rotary tiller:		
Secondary operation 3" deep	40-60	20-40
Primary operation 6" deep	15-35	5-15
<u>Rodweeders</u>		
Plain rotary rod	80-90	50-60
Rotary rod with semi-chisels or shovels	70-80	60-70
<u>Strip Tillage Machines</u>		
Rotary tiller, 12" tilled on 40" rows	60-75	50-60

**In northern climates with long periods of snow cover and frozen conditions, weathering may reduce residue levels only slightly; while in warmer climates, weathering losses may reduce residue levels significantly.

TABLE 6

RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining Nonfragile Percent	Fragile Percent
<u>Row Cultivators</u> (30" and wider)		
Single sweep per row	75-90	55-70
Multiple sweeps per row	75-85	55-65
Finger wheel cultivator	65-75	50-60
Rolling disk cultivator	45-55	40-50
Ridge till cultivator	20-40	5-25
<u>Unclassified Machines</u>		
Anhydrous applicator	75-85	45-70
Anhydrous applicator with closing disks	60-75	30-50
Subsurface manure applicator	60-80	40-60
Rotary Hoe	85-90	80-90
Bedders, listers, & hippers	15-30	5-20
Furrow diker	85-95	75-85
Mulch treader	70-85	60-75
<u>Plows</u>		
Moldboard plow	0-10	0-5
Moldboard plow-uphill furrow (Pacific Northwest Region only)	30-40	---
Disk plow	10-20	5-15
<u>Machines which fracture soil</u>		
Paratill/paraplow "V" ripper/subsoiler	80-90	75-85
12"-14" deep 20" spacing	70-90	60-80
Combination tools:		
Subsoil-chisel	50-70	40-50
Disk-subsoiler	30-50	10-20
<u>Chisel Plows with</u>		
Sweeps	70-85	50-60
Straight chisel spike points	40-80	30-60
Twisted points or shovels	35-70	20-40
<u>Combination Chisel Plows</u> Coulter chisel plows with:		
Sweeps	60-80	40-50
Straight chisel spike points	30-60	25-40
Twisted points or shovel	25-60	10-30
Disk chisel plows with:		
Sweeps	60-70	30-50
Straight chisel spike points	30-60	25-40
Twisted points or shovels	20-50	10-30

TABLE 6

RESIDUE REDUCTION BY TYPE OF ACTIVITY

Implement	Percent Residue Remaining Nonfragile Percent	Fragile Percent
Undercutters Stubble-mulch sweep or blade plows with:		
Sweep/"V"-blade >30" wide	75-95	60-80
Sweeps 20"-30" wide	70-90	50-75
Disk Harrows		
Offset		
Heavy plowing >10" spacing	25-50	10-25
Primary cutting >9" spacing	30-60	20-40
Finishing 7"-9" spacing	40-70	25-40
Tandem		
Heavy plowing >10" spacing	25-50	10-25
Primary cutting >9" spacing	30-60	20-40
Finishing 7"-9" spacing	40-70	25-40
Light tandem disk after harvest, before other tillage	70-80	40-50
One-way disk with:		
12-16" blade	40-50	20-40
18-30" blades	20-40	10-30
Single gang disk	50-70	40-60

TABLE 7
RELATIONSHIP OF RESIDUE WEIGHT TO PERCENT RESIDUE COVER

% Cover	Alfalfa, Bromegrass, Rye	Wheat, Oats Soybeans	Corn	Sorghum	Sunflower
	-----------------------lbs/ac 1/	-----------------------			
5	95	85	135	145	215
10	190	180	275	295	440
15	295	275	430	450	675
20	405	380	585	620	930
25	525	490	755	800	1200
30	650	605	940	990	1485
35	785	730	1135	1195	1795
40	930	865	1345	1420	2130
45	1085	1015	1575	1660	2490
50	1260	1175	1825	1925	2890
55	1450	1355	2100	2220	3325
60	1665	1555	2410	2545	3820
65	1910	1780	2765	2915	4375
70	2190	2040	3170	3345	5015
75	2520	2350	3650	3850	5775
80	2925	2730	4235	4470	6705
85	3450	3215	4990	5270	7905
90	4185	3905	6060	6395	9595

1/ Values listed for 30, 60, and 90 percent cover vary slightly from those listed in the RUSLE database due to rounding.

V. SUPPORT PRACTICE FACTOR (P)

A series of tables and charts are required to determine the appropriate "P" factor to credit the support practices (contour farming, cross-slope farming, buffer strips, strip cropping, and terraces) planned or applied to the field.

The "P" factor value used in the RUSLE equation is a combination of subfactors determined to represent the actual field conditions. After determining the contour on-grade "P" factor, adjustments with subfactors are made as appropriate. These adjustments may increase "P" due to ridge/furrow grade and/or when actual field slope length exceeds the critical slope length for effectiveness of contouring. Strip cropping, buffer strip, and terrace "P" subfactors reduce the "P" factor for on-grade contouring or as adjusted for ridge/furrow grade.

Determine the appropriate "P" factor using the instructions and tables presented in this section. Contents in this section include:

RUSLE "P" SUBFACTOR VALUES FOR CONTOURING

Step 1. Gather required information.

1. Identify the hydrologic soil group for the soil map unit(s) on the selected landscape profile.

2. Determine the slope length "L" and slope steepness "S" of the landscape profile, and grade along the ridges/furrows that result from tillage, planting and/or row cultivation operations.

3. Identify the 10-year storm erosivity (10-yr. "EI") value for the site from the map in **Figure 3.**

4. Select the Cover-Management Condition from **Table 8**, "Cover Management Conditions."

5. Select the appropriate ridge height using the guidelines shown in **Table 9.**

Step 2. Determine the "P" subfactor for contouring on-grade.

1. With 10-year "EI" value, ridge height, hydrologic soil group, and cover-management condition, select the appropriate part of **Table 10**, "RUSLE Contour "P" Subfactor Tables for On-Grade Condition."

2. Enter the selected table proceeding across the row for the hydrologic soil group and read the value in the column for the slope steepness. This value is the "P" subfactor value for contouring on-grade.

Step 3. Adjust contouring "P" subfactor for ridge/furrow grade.

1. Calculate the ratio of the field average ridge/furrow grade to the landscape profile slope used to describe the field topographic factor and round to the nearest 0.1. For ratio values <0.05, go to **Step 4** as no adjustment is required for off-grade contouring.

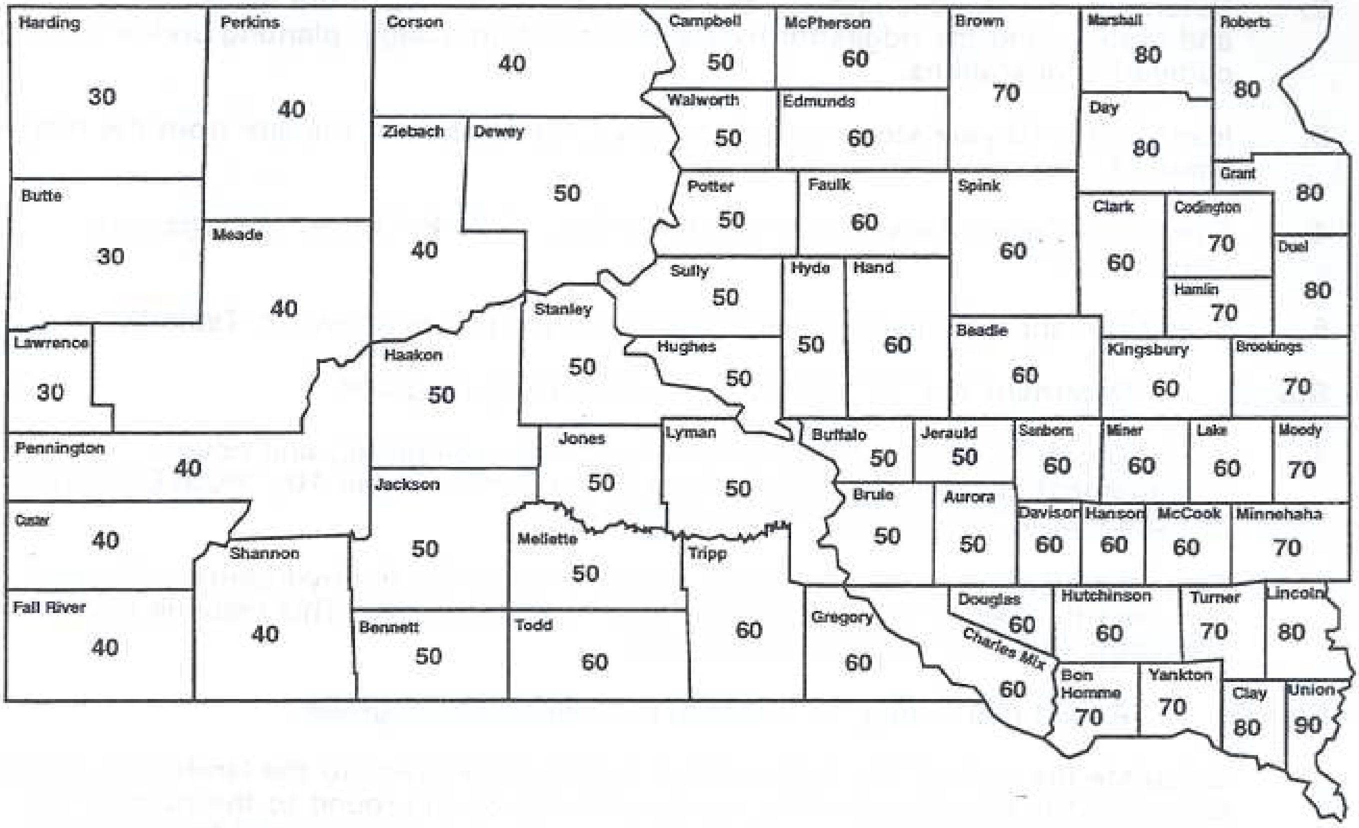
2. For ratio values of >0.05, go to **Table 11,** "Contouring "P" Subfactor Value Adjusted for Furrow Grade."

3. In the left column of **Table 11,** locate the "P" factor value for on-grade contouring obtained from **Step 2** above. If the "P" factor value is an odd number, round up or down to the nearest even number listed in **Table 11**. Round in the opposite direction from that used when rounding the ridge/turrow grade to landscape profile slope ratio to the nearest 0.1.

On the located row, move right to the column for the appropriate ratio of ridge/furrow grade to slope steepness of the landscape profile. This value is the RUSLE "P" subfactor value for off-grade contouring where the slope is less than the critical slope. Beyond the critical slope length, the practice effectiveness decreases quickly with increasing slope length.

Figure 3

10-Year Frequency, Single Storm EI Maps



Step 4. Determine the critical slope length.

1. In South Dakota, exceeding the critical slope length is <u>usually</u> only a concern with cover management codes 5, 6, or 7.

2. Refer to **Figures 4-23** and select the applicable figure for the hydrologic soil group, and Cover-Management Condition.

3. Enter the selected figure at the landscape profile slope percent on the horizontal axis and project a vertical line up to intersect the 10-year "EI" value for the site. From that intersection project a horizontal line to the left and read the critical slope length. This is the critical slope length or the maximum slope length for which the previously determined "P" subfactor value applies. Use the previously determined "P" subfactor value for slopes less than the critical slope length.

4. Stripcropping increases the effectiveness of contouring. When used in conjunction with contouring, increase the critical slope length by multiplying the slope length from 3 above by 1.5.

Step 5. Adjust the contouring "P" subfactor where the landscape profile exceeds the critical slope length.

1. Where landscape profile slope length exceeds the critical slope length, calculate the slope actual length to critical slope length ratio by dividing the landscape profile slope length by the critical slope length. Increase the critical slope length before making this calculation if stripcropping applies.

2. Use the same rill/interrill ratio as previously used in determining the topographic "LS" factor at the site. Use **medium** for cultivated cropland and other land uses with moderately consolidated soil conditions.

3. Go to **Figures 28-30**. Select the appropriate figure for the land use rill/interrill ratio and the site slope steepness.

4. From the actual slope length/critical slope length ratio on the horizontal axis of the selected figure, project a vertical line to intersect the "P" subfactor value determined in **Step 2** or **3** above. From that intersection project a horizontal line to the left and read the effective "P" subfactor value. This subfactor value is the corrected "P" subfactor value for contouring and applies to the entire landscape profile slope length.

Step 6. Compute rotational contouring "P" subfactor where cover-management conditions and/or ridge heights change from year to year during the life of a crop rotation.

1. Calculate the contour "P" subfactor for each year in the crop rotation following the appropriate **Steps 1-5** above.

2. Add the contour "P" subfactor values for all years in the rotation and divide by the total years in the rotation to determine a weighted average annual contour "P" subfactor value.

RUSLE "P" SUBFACTOR VALUES FOR STRIPCROPPING

Step 1. Gather required information. Note that some of the information is the same as used for evaluating contouring.

1. Identify the hydrologic soil group for the soil map unit(s) on the selected landscape profile.

2. Determine the slope length "L" and slope steepness "S" of the landscape profile and grade along the ridges/furrows that result from tillage, planting, and/or row cultivation operations.

3. Identify the 10-year storm erosivity (10-yr. "EI") value for the site from the map in **Figure 3.**

4. Determine the number of strips that can be laid across the landscape profile slope length "L." A minimum of two full strip widths must fit on the slope.

5. For a strip pair, select the Cover-Management Conditions that will be opposite each other during the life of the crop rotation using **Table 8**, "Cover-Management Conditions." For sod based rotations, it is also important whether or not hay is established by direct seeding or seeding is done with a nurse crop. The seeding year with a nurse crop introduces a third cover-management condition.

6. Determine whether the support practice is:

   A. Contour stripcropping layout with strip boundaries as close to level as possible. Sediment retarding strips and erosion prone strips on contour layouts switch positions on the landscape profile during the crop rotation.

   B. A field stripcropping layout with strips boundaries markedly off-contour. Sediment retarding strips and erosion prone strips on field stripcropping layouts switch positions on the landscape profile during the life of the crop rotation.

   C. Buffer strip layout with narrow sod cross slope strips alternating with wider tilled strips. Sod strips are maintained in a permanent location.

7. For buffer strip layout, determine the percentage of landscape profile to be occupied by buffer strips at least 15 feet wide. **Table 14** is set up for 10 and 20 percent of the landscape profile. **Table 14** presents these as crop strip to buffer strip ratios of 9:1 and 4:1 respectively. Note from **Table 14** that there is little to be gained by going to 20 percent from a sheet and rill erosion standpoint. The minimum landscape profile length that can benefit from buffer strips is 150 feet.

Step 2. Determine the "P" subfactor for stripcropping.

1. Determine the type of stripcropping layout, number of strips on the slope length "L," cover-management condition pairings, and for buffer strips the percent of slope length "L" occupied by buffer strips. Select the appropriate table:

   A. **Table 12** for Contour Stripcropping Subfactors

   B. **Table 13** for Field Stripcropping Subfactors

   C. **Table 14** for Buffer Strip Subfactors

2. Locate the stripcropping subfactor value at the intersection of number of strips and the Cover-Management Conditions of the strips. For buffer strips, enter the correct column for ratio of cultivated crop strip to buffer strip. The value is the stripcropping "P" subfactor for slopes where the landscape profile slope length does not exceed the critical slope length.

Step 3. Determine critical slope length.

1. Refer to **Figures 4-23** and select the applicable figure for the hydrologic soil group and Cover-Management Condition.

   Use the most erosive cover-management condition of the opposing strip pairs on the slope to determine the critical slope length for stripcropping.

2. Enter the selected figure at the profile slope on the horizontal axis and project a vertical line up to intersect the 10-year "EI" value for the site. From that intersection project a horizontal line to the left and read the critical length. Stripcropping increases the effectiveness of the contouring. Therefore, adjust the critical slope length from the figure by multiplying the value by 1.5.

3. The adjusted critical length is the maximum slope length for which the previously determined stripcropping "P" subfactor value applies. Use the previously determined stripcropping "P" subfactor value where the landscape slope is equal to or less than the adjusted critical slope length.

Step 4. Adjust the stripcropping "P" subfactor where the landscape profile exceeds the critical slope length.

1. Where landscape profile slope length exceeds the critical slope length, calculate the slope actual length to critical slope length ratio by dividing the landscape profile slope length by the critical slope length. Increase the critical slope length before making this calculation for stripcropping.

2. Use the same rill/interrill ratio as previously used in determining the topographic "LS" factor at the site. Use **medium** for cultivated cropland and other land uses with moderately consolidated soil conditions.

3. Go to **Figures 28-30**. Select the appropriate figure for the land use rill/interrill ratio and the site slope steepness.

4. From the actual slope length/critical slope length ratio on the horizontal axis of the selected figure, project a vertical line to intersect the "P" subfactor value determined in **Step 2** above. From that intersection project a horizontal line to the left and read the effective "P" subfactor value. This subfactor value is the corrected "P" subfactor value for stripcropping and applies to the entire landscape profile slope length.

Step 5. Multiply the contour "P" subfactor times the stripcropping "P" subfactor to get the composite "P" factor for the sheet and rill erosion conservation management subsystem.

1. When the critical slope is not exceeded for stripcropping, use the unadjusted "L" for slope length contour "P" subfactor value determined earlier using the contour "P" subfactor instructions. Take the "P" subfactor for stripcropping times the contour "P" subfactor to get the composite "P" factor for the conservation management subsystem.

2. When the critical slope is exceeded for stripcropping, adjust the contour "P" subfactor value using the ratio determined by dividing the total slope length by the critical slope length for stripcropping. Go to Figures 28-30, enter appropriate figure with this ratio and determine adjusted contour "P" subfactor. Take this adjusted contour "P" subfactor times the adjusted "P" subfactor for stripcropping to get the composite "P" factor for the conservation management subsystem.

RUSLE "P" SUBFACTOR VALUES FOR TERRACING

Step 1. Gather required information.

1. Determine the slope steepness of the landscape profile. Will it change with construction of terrace? If yes, determine new slope steepness.

2. Determine what supporting conservation practice will accompany the terraces, contouring, cross-slope farming, buffer strips, or contour stripcropping.

3. Decide whether terrace will have an open or closed outlet.

4. If the terrace has an open outlet, determine the channel grade of terrace at outlet end. The terrace outlet for this determination is defined as the lesser of the 300 feet or 1/3 of the terrace closest to the outlet. If channel grade is 0.8 or greater, the practice factor equals 1.0. In this case, skip **Step 2** below and proceed with **Step 3** below.

Step 2. Determine terrace "P" subfactor.

1. From **Table 15** select the appropriate horizontal spacing interval. Read across the row to the selected outlet type. If an open outlet is used, then select the terrace channel grade range column that describes the design terrace channel grade. Read the "P" subfactor value at the row-column intersection.

Step 3. If terrace horizontal spacing interval is less than landscape profile slope length, recalculate the "LS" value to reflect a shorter sheet and rill erosion flow length.

1. If significant earth moving will cause a change in landscape profile slope, recompute landscape profile slope steepness and length and record for use in **Step 2.**

2. Determine new "LS" value from appropriate "LS" table. For cropped agricultural land use **Table 2.**

Step 4. Determine composite "P" factor for terracing when used in combination with contouring alone or with contouring and stripcropping.

1. When terraces are used in conjunction with contouring or cross-slope farming, multiply terrace "P" subfactor times the previously determined contouring "P" subfactor to get the composite "P" factor.

2. When terraces are used in conjunction with contouring, buffer strips, or stripcropping, multiply all applicable "P" subfactors together to get the composite "P" factor.

TABLE 8 - COVER MANAGEMENT CONDITIONS

Select the cover management condition that best describes the land surface condition during spring seedbed preparation and planting when rainfall and runoff are most erosive and the soil is most susceptible to erosion. Use the following descriptions of cropland cover-management conditions for estimating P-factor values.

Cover-Management Condition	Description
Code 1. Established Grass/Legume Cover.	The grass cover is dense and runoff is very slow, the slowest under any vegetative condition. When mowed and baled, this condition is condition 2.
Code 2. Established Hay Under Harvest Management.	Hay is a mixture of grass and legume just before cutting. The vegetative cover is a good grass/legume stand and is harvested for hay. When harvested this cover condition becomes a condition 4 until regrowth occurs.
Code 3. Heavy cover and/or very rough.	Ground cover for this condition is about 65 to 95 percent as with no-till planting. Roughness depressions would have the appearance of being 7 inches deep and deeper.
Code 4. Moderate cover and/or rough.	The ground cover for this condition is about 40 to 65 percent. Roughness depressions would have the appearance of being about 4 to 6 inches deep.
Code 5. Light cover and/or moderate roughness.	Ground surface cover is between 10 to 40 percent. Roughness depressions would have the appearance of being on the order of 2 to 3 inches deep.
Code 6. No cover and/or minimal roughness.	This condition is very much like the condition typically found in row cropped fields after the field has been planted and exposed to a moderately intense rainfall. Ground cover is less than about 10 percent and the roughness is characteristic of a good seedbed for corn or soybeans. The surface is rougher than that of a finely pulverized seedbed for seeding vegetables or grass.
Code 7. Clean-tilled, smooth, fallow.	This condition is essentially bare, with a cover of 5 percent or less. The soil has not had a crop grown on it in the last 6 months or more. Much of the residual effects of previous cropping has disappeared. The surface is smooth, much like the surface that develops on a very finely pulverized seedbed exposed to several intense rainfalls. This condition is found in fallow and vegetable fields, or in newly seeded lawns.

TABLE 9 - GUIDELINES FOR SELECTING RIDGE HEIGHTS

Select the ridge height that best describes the condition during the spring seedbed preparation and planting when rainfall and runoff are most erosive and the soil is most susceptible to erosion.

1. VERY LOW (0.5 - 2 in.) RIDGES

- -Plants not closely spaced but with a slight ridge height
- -No-till planted row crops
- -Fields that have been rolled, pressed, or dragged after planting
- -Spring planted conventionally drilled crops
- -Direct seeded forage crops that leave a very low ridge

2. LOW (2 - 3 in.) RIDGES

- -No-till drilled crops
- -Mulch tilled row crops
- -Clean tilled row crops with no row cultivation
- -Transplanted crops, widely spaced

3. MODERATE (3 - 4 in.) RIDGES)

- -Clean tilled row crops with row cultivation
- -High yielding winter small grain crops when erosive rains are concentrated in the late spring after plants have developed a stiff, upright stem
- -Transplanted crops that are closely spaced and/or in narrow rows

4. HIGH (4 - 6 in.) RIDGES

- -Ridge tilled crops with high (4-6") ridges during periods of erosive rain

5. VERY HIGH (Greater than 6 in.) RIDGES

- -Ridge tilled crops with very high (6+") ridges during periods of erosive rains
- -Hipping, bedding, or ridging with very high ridges during periods of erosive rains

TABLE 11 - CONTOURING "P" SUBFACTOR VALUE ADJUSTED FOR RIDGE/FURROW GRADE

On Grade Contouring "P" SubFactor Value	Ratio of Furrow Grade to Profile Grade 0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.04	0.34	0.47	0.57	0.65	0.72	0.78	0.84	0.90	0.95	1.00
0.06	0.36	0.48	0.57	0.65	0.72	0.79	0.85	0.90	0.95	1.00
0.08	0.37	0.49	0.58	0.66	0.73	0.79	0.85	0.90	0.95	1.00
0.10	0.38	0.50	0.59	0.67	0.74	0.80	0.85	0.90	0.95	1.00
0.12	0.40	0.51	0.60	0.68	0.74	0.80	0.86	0.91	0.95	1.00
0.14	0.41	0.52	0.61	0.68	0.75	0.81	0.86	0.91	0.96	1.00
0.16	0.43	0.54	0.62	0.69	0.75	0.81	0.86	0.91	0.96	1.00
0.18	0.44	0.55	0.63	0.70	0.76	0.82	0.87	0.91	0.96	1.00
0.20	0.45	0.56	0.64	0.71	0.77	0.82	0.87	0.92	0.96	1.00
0.22	0.47	0.57	0.65	0.71	0.77	0.82	0.87	0.92	0.96	1.00
0.24	0.48	0.58	0.66	0.72	0.78	0.83	0.88	0.92	0.96	1.00
0.26	0.49	0.59	0.67	0.73	0.78	0.83	0.88	0.92	0.96	1.00
0.28	0.51	0.60	0.67	0.74	0.79	0.84	0.88	0.92	0.96	1.00
0.30	0.52	0.61	0.68	0.74	0.79	0.84	0.89	0.93	0.96	1.00
0.32	0.54	0.62	0.69	0.75	0.80	0.85	0.89	0.93	0.97	1.00
0.34	0.55	0.64	0.70	0.76	0.81	0.85	0.89	0.93	0.97	1.00
0.36	0.56	0.65	0.71	0.76	0.81	0.86	0.90	0.93	0.97	1.00
0.38	0.58	0.66	0.72	0.77	0.82	0.86	0.90	0.93	0.97	1.00
0.40	0.59	0.67	0.73	0.78	0.82	0.86	0.90	0.94	0.97	1.00
0.42	0.60	0.68	0.74	0.79	0.83	0.87	0.91	0.94	0.97	1.00
0.44	0.62	0.69	0.75	0.79	0.84	0.87	0.91	0.94	0.97	1.00
0.44	0.63	0.70	0.76	0.80	0.84	0.88	0.91	0.94	0.97	1.00
0.48	0.64	0.71	0.76	0.81	0.85	0.88	0.92	0.95	0.97	1.00
0.50	0.66	0.72	0.77	0.82	0.85	0.89	0.92	0.95	0.97	1.00
0.52	0.67	0.73	0.78	0.82	0.86	0.89	0.92	0.95	0.98	1.00
0.54	0.69	0.75	0.79	0.83	0.87	0.90	0.92	0.95	0.98	1.00
0.56	0.70	0.76	0.80	0.84	0.87	0.90	0.93	0.95	0.98	1.00
0.58	0.71	0.77	0.81	0.85	0.88	0.91	0.93	0.96	0.98	1.00
0.60	0.73	0.78	0.82	0.85	0.88	0.91	0.93	0.96	0.98	1.00
0.62	0.74	0.79	0.83	0.86	0.89	0.91	0.94	0.96	0.98	1.00
0.64	0.75	0.80	0.84	0.87	0.89	0.92	0.94	0.96	0.98	1.00
0.66	0.77	0.81	0.85	0.88	0.90	0.92	0.94	0.96	0.98	1.00
0.68	0.78	0.82	0.86	0.88	0.91	0.93	0.95	0.97	0.98	1.00
0.70	0.79	0.83	0.86	0.89	0.91	0.93	0.95	0.97	0.98	1.00
0.72	0.81	0.85	0.87	0.90	0.92	0.94	0.95	0.97	0.99	1.00
0.74	0.82	0.86	0.88	0.90	0.92	0.94	0.96	0.97	0.99	1.00
0.76	0.84	0.87	0.89	0.91	0.93	0.95	0.96	0.97	0.99	1.00
0.78	0.85	0.88	0.90	0.92	0.94	0.95	0.96	0.98	0.99	1.00
0.80	0.86	0.89	0.91	0.93	0.94	0.95	0.97	0.98	0.99	1.00

TABLE 11 (cont.) - CONTOURING "P" SUBFACTOR VALUE ADJUSTED FOR RIDGE/FURROW GRADE

On Grade Contouring "P" SubFactor Value	Ratio of Furrow Grade to Profile Grade									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
0.82	0.88	0.90	0.92	0.93	0.95	0.96	0.97	0.98	0.99	1.00
0.84	0.89	0.91	0.93	0.94	0.95	0.96	0.97	0.98	0.99	1.00
0.86	0.90	0.92	0.94	0.95	0.96	0.97	0.98	0.99	0.99	1.00
0.88	0.92	0.93	0.95	0.96	0.96	0.97	0.98	0.99	0.99	1.00
0.90	0.93	0.94	0.95	0.96	0.97	0.98	0.98	0.99	0.99	1.00
0.92	0.95	0.96	0.96	0.97	0.98	0.98	0.99	0.99	1.00	1.00
0.94	0.96	0.97	0.97	0.98	0.98	0.99	0.99	0.99	1.00	1.00
0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.00
0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

TABLE 12 CONTOUR STRIPCROPPING PRACTICE "P" SUBFACTOR TABLE

Tables based on an average row gradient of 0.5 percent, low ridge height (2-3 inches), 12 percent RUSLE slope gradient with the number of strips listed spanning 100 percent of the RUSLE slope length, and only 2 cover-management conditions being on the RUSLE slope at any given time.

CONTOUR STRIPCROPPING "P" SUBFACTOR VALUES FOR SOD BASED ROTATIONS 1/

	CLEAR, SPRING SEEDED HAY 2/					WITH SMALL GRAIN SEEDING 3/			
CMC*	2-3	2-4	2-5	2-6	2-7	2-(4,5)	2-(5,5)	2-(6,5)	2-(7,5)
NUMBER STRIPS									
2	1.0	.86	.82	.78	.77	.84	.81	.79	.77
4	1.0	.81	.72	.69	.66	.77	.71	.69	.67

CONTOUR STRIPCROPPING "P" SUBFACTOR VALUES FOR RESIDUE-SURFACE ROUGHNESS OR SMALL GRAIN BASED ROTATIONS 4/

	HIGH RES., VERY ROUGH FALLOW 5/				MOD. RES., ROUGH FALLOW & SMALL GRAIN 6/				
CMC*	3-4	3-5	3-6	3-7	4-5	4-6	4-7	5-6	5-7
NUMBER STRIPS									
2	.97	.87	.81	.79	.92	.85	.81	.91	.86
4	.95	.83	.75	.70	.88	.78	.73	.87	.80

* **COVER-MANAGEMENT CONDITION PAIRINGS**

1/ Rotations where cross-slope sod strips are alternated with cross-slope cultivated strips down the slope. Sediment deposition is induced by the sod.

2/ Sod-based rotations where hay crop is established in the spring without a nurse or companion crop of small grain. Half of the strips are always in hay, which is condition 2.

3/ Sod-based rotations where a companion crop of small grain is sown with hay seed, or hay crop is sown in stubble after small grain harvest. Half of the strips are always in hay.

4/ Rotations where cross-slope strips of contrasting residue amounts or surface roughness are alternated down the slope or strips of small grain alternate with clean tilled row crops. Sediment deposition is induced by a strip that is either rougher surfaced or more residue covered or has standing small grain or small grain stubble. Seasonal shifts in location of the sediment trapping versus sediment producing strip during the cropping year are acceptable as long as the contrasting cover strip types alternate at all times.

5/ Rotations where strips with greater than 75 percent residue cover or roughness depressions 7 inches or deeper alternate with strips of lesser cover or shallower tillage depressions at all times.

6/ Rotations where strips with greater than 40 percent but less than 75 percent residue cover or surface roughness depressions, 4-6 inches deep, or strips of growing small grain or small grain stubble, alternate with strips of lesser cover or shallower tillage depressions at all times.

TABLE 13
FIELD STRIPCROPPING PRACTICE "P" SUBFACTOR TABLE

STRIPCROPPING "P" SUBFACTOR VALUES FOR SOD BASED ROTATIONS 1/

CLEAR, SPRING SEEDED HAY 2/						WITH SMALL GRAIN SEEDING 3/			
CMC*	2-3	2-4	2-5	2-6	2-7	2-(4,5)	2-(5,5)	2-(6,5)	2-(7,5)
NUMBER STRIPS									
2	1.0	.91	.88	.86	.85	.89	.87	.86	.86
4	1.0	.83	.81	.80	.79	.82	.81	.80	.79

STRIPCROPPING "P" SUBFACTOR VALUES FOR SMALL GRAIN BASED ROTATIONS 4/

HIGH RES., VERY ROUGH FALLOW 5/					MOD. RES., ROUGH FALLOW & SMALL GRAIN 6/				
CMC*	3-4	3-5	3-6	3-7	4-5	4-6	4-7	5-6	5-7
NUMBER STRIPS									
2	.97	.92	.88	.87	.95	.90	.89	.94	.92
4	.95	.88	.84	.82	.91	.86	.84	.92	.89

* COVER-MANAGEMENT CONDITION PAIRINGS

Tables based on an average row gradient of 3.0 percent, low ridge height (2-3 inches), 12 percent RUSLE slope gradient with the number of strips listed spanning 100 percent of the RUSLE slope length, and only 2 cover-management conditions being on the RUSLE slope at any given time.

1/ Rotations where cross-slope sod strips are alternated with cross-slope cultivated strips down the slope. Sediment deposition is induced by the sod.

2/ Sod-based rotations where hay crop is established in the spring without a nurse or companion crop of small grain. Half of the strips are always in hay which is condition 2.

3/ Sod-based rotations where a companion crop of small grain is sown with hay seed or hay crop is sown in stubble after small grain harvest. Half of the strips are always in hay.

4/ Rotations where cross-slope strips of contrasting residue amounts or surface roughness are alternated down the slope or strips of small grain alternate with clean tilled row crops. Sediment deposition is induced by a strip that is either rougher surfaced or more residue covered or has standing small grain or small grain stubble. Seasonal shifts in location of the sediment trapping versus sediment producing strip during the cropping year are acceptable as long as the contrasting cover strip types alternate at all times.

5/ Rotations where strips with greater than 75 percent residue cover or roughness depressions 7 inches or deeper alternate with strips of lesser cover or shallower tillage depressions at all times.

6/ Rotations where strips with greater than 40 percent but less than 75 percent residue cover or surface roughness depressions, 4-6 inches deep, or strips of growing small grain or small grain stubble, alternate with strips of lesser cover or shallower tillage depressions at all times.

TABLE 14 BUFFER STRIPCROPPING PRACTICE "P" SUBFACTOR TABLES

CMC*	3-1		4-1		5-1		6-1		7-1	
CBSR 1/	9:1	4:1	9:1	4:1	9:1	4:1	9:1	4:1	9:1	4:1
NO. OF STRIPS										
2	.90	.77	.89	.77	.90	.77	.90	.78	.92	.79
3	.72	.70	.72	.70	.72	.70	.73	.70	.75	.70
4	.74	.64	.71	.64	.73	.64	.74	.65	.80	.67
5	.65	.64	.65	.64	.65	.64	.68	.64	.73	.64

* COVER-MANAGEMENT CONDITION PAIRINGS, **UNHARVESTED BUFFERS**

CMC**	3-2		4-2		5-2		6-2		7-2	
CBSR 1/	9:1	4:1	9:1	4:1	9:1	4:1	9:1	4:1	9:1	4:1
NO. OF STRIPS										
2	.99	.99	.93	.86	.92	.82	.92	.80	.94	.82
3	.98	.98	.82	.82	.78	.77	.76	.74	.78	.73
4	.98	.98	.81	.76	.79	.72	.78	.70	.83	.72
5	.98	.98	.75	.73	.74	.70	.73	.69	.77	.70

** COVER-MANAGEMENT CONDITION PAIRINGS, **HARVESTED BUFFERS**

Tables based on an average row gradient of 0.5 percent, low ridge height (2-3 inches), 12 percent RUSLE slope gradient with the number of strips listed spanning 100 percent of the RUSLE slope length, a continuous cover-management condition on all cultivated crop strips, and the position of the buffer/crop strips on the slope as shown below. Use upper table for buffer strips that are left in an unharvested condition, condition 1. They may be mowed for maintenance purposes. Use lower table for buffer strips that are mowed and harvested for forage, condition 2.

1/ CROP-BUFFER STRIP RATIOS - Ratio of cultivated crop strip to perennial sod (buffer) strip; 9-1 ratio means 10 percent of the RUSLE slope length is in buffer strip(s); 4-1 ratio is 20 percent of the RUSLE slope length in buffer strip(s).

Figure 31 - BUFFER STRIP SYSTEMS

TWO STRIP SYSTEM
POSITION OF STRIPS ON RUSLE SLOPE
(TOP OF SLOPE)

CROP

BUFFER

(BOTTOM OF SLOPE)

THREE STRIP SYSTEM
POSITION OF STRIPS ON RUSLE SLOPE
(TOP OF SLOPE)

CROP

BUFFER

CROP

(BOTTOM OF SLOPE)

FOUR STRIP SYSTEM
POSITION OF STRIPS ON RUSLE SLOPE
(TOP OF SLOPE)

CROP

BUFFER

CROP

BUFFER

(BOTTOM OF SLOPE)

FIVE STRIP SYSTEM
POSITION OF STRIPS ON RUSLE SLOPE
(TOP OF SLOPE)

CROP

BUFFER

CROP

BUFFER

CROP

(BOTTOM OF SLOPE)

NOTE: Some deviation from the relative position of the strips as shown here is to be expected and is allowed.

Table 15 Terrace "P" Subfactor							
Horizontal Interval[1/] (ft)	Closed outlets[2/]	Open Outlets, With Percent Grade of[3/] 0.1	0.2	0.4	0.6	0.8	>0.8
<100	.48	.52	.54	.61	.72	.90	1.00
105	.51	.55	.57	.63	.73	.91	1.00
120	.58	.62	.63	.69	.77	.92	1.00
135	.64	.67	.69	.73	.81	.94	1.00
150	.70	.72	.74	.77	.84	.94	1.00
180	.78	.80	.81	.84	.88	.96	1.00
210	.84	.86	.86	.88	.92	.97	1.00
240	.89	.90	.90	.92	.94	.98	1.00
270	.92	.93	.93	.94	.96	.99	1.00
300	.94	.95	.95	.96	.97	.99	1.00
400	.98	.98	.98	.99	.99	1.00	1.00
500	.99	.99	.99	1.00	1.00	1.00	1.00

1/ Refer to Section IV, SDTG, Terrace (600), for horizontal interval.

2/ Applies to terraces with underground outlets, to level terraces with open outlets, and to water and sediment control basins. (Sediment control basins that do not have a contour factor should not be given a terrace "P" subfactor.)

3/ The average channel grade is calculated from 300 feet or 1/3 of the terrace length closest to the outlet, whichever is less.

Example A: CONTOUR "P" FACTOR DETERMINATION

Step 1. Gather information.

1. Hydrologic Soil Group B.
2. Landscape profile slope steepness = 6 percent slope length = 250 feet, and ridge/furrow grade = 1 percent.
3. The 10-year "EI" = 100 from **Figure 3.**
4. The crop rotation is continuous corn using conventional clean tillage. From **Table 8** this is Cover-Management Condition 6.
5. Ridges and furrows created during corn planting are 2-3 inches in depth or low ridges from **Table 9.**

Step 2. Determine the "P" subfactor for contouring on-grade.

1. From **Table 10**, 10-Year "EI" = 100 and Cover-Management Condition 6, select the table for low ridge height (2-3" ridges).
2. Find the row for Hydrologic Soil Group B and the value in the intersect column for six percent slope. Read the "P" subfactor value of 0.53 for on-grade contouring.

Step 3. Adjust contouring "P" subfactor for ridge/furrow grade.

1. The ridge/furrow to field slope steepness ratio is calculated as 1%/6% = 0.167 rounded up to 0.2.

2. Go to **Table 11** as ridge/furrow to field slope ratio >0.05 indicates a correction applies.

3. Since **Table 11** does not have an on-grade contour line for 0.53, round the value up or down to 0.52 or 0.54. Since the ridge/furrow to slope grade ratio was rounded up, round down this time to 0.52. Enter **Table 11** with the on-grade contouring "P" subfactor value of 0.52 and read across to the ridge/furrow to slope grade ratio of 0.2. The value is 0.73. This is the "P" subfactor value for off-grade contouring where the slope is less than the critical slope.

Step 4. Determine the critical slope length.

1. From **Figure 11** for Hydrologic Soil Group B, Cover-Management Condition 6, at the 6 percent slope "EI"-10 = 100 intersect, read a critical length of 300 feet. The critical slope exceeds the 250 foot slope length at the site so the "P" subfactor value of 0.73 applies to the entire landscape profile slope length.

Example B: CONTOUR "P" FACTOR DETERMINATION WHEN ACTUAL SLOPE LENGTH EXCEEDS CRITICAL SLOPE LENGTH

Step 1. Gather information.

1. Hydrologic Soil Group C.

2. Landscape profile slope = 6 percent slope length = 450 feet, and ridge/furrow grade = 1 percent.

3. The 10-year "EI" = 80 from **Figure 3.**

4. The crop rotation is corn-soybeans produced using conventional clean tillage. From **Table 8** this is Cover-Management Condition 6.

5. A ridge height of 2-3 inches is formed by tillage and planting equipment on this soil. From **Table 9** this is a low ridge.

Step 2. Determine the "P" subfactor for contouring on-grade.

1. In **Table 10,** "EI" = 80 and Condition 6, select the table for low ridge height (2-3" ridges).

2. Find the row for Hydrologic Soil Group C and the value in the intersect column for 6 percent slope. Read the "P" subfactor value of 0.53

Step 3. Adjust contouring "P" subfactor for ridge/furrow grade.

1. Calculate the ridge/furrow to field slope steepness ratio by dividing 1%/6% = 0.167, round to 0.2.

2. Go to **Table 11** as ridge/furrow to field slope ratio >0.05 indicates a correction applies.

3. Since **Table 11** does not have a line for 0.53, round the value up or down to 0.52 or 0.53. Since the ridge/furrow to slope grade ratio was rounded up, round down this time to 0.52. Enter **Table 11** with the on-grade contouring "P" subfactor value of 0.52 and read across to the ridge/furrow to slope grade ratio of 0.2. The value is 0.73. This is the "P" subfactor value for off-grade contouring where the slope is less than the critical slope.

Step 4. Determine the critical slope length.

1. Select **Figure 16** for Hydrologic Soil Group C and Cover-Management Condition 6.

2. Enter with the 6 percent slope, read up to intersection of "EI"-10 = 80 and across to find a critical length of 300 feet. The profile slope length of 450 feet exceeds the critical slope length so adjust the "P" subfactor value of 0.73.

Step 5. Adjust the contouring "P" subfactor for critical slope length.

1. The actual slope length/critical slope length ratio is 450/300 = 1.5.

2. Select **Figure 29** that applies to the slope range (4.1%-12%) and the medium rill/interrill ratio used to describe cropped agricultural land.

3. Find the slope length/critical length ratio of 1.5 on the horizontal axis, project a vertical line to intersect the previously determined "P" subfactor value of 0.73 for the site. From that intersection project a horizontal line to the left and read the "P" effective subfactor value of 0.85. The value of 0.85 is the contouring "P" subfactor value that applies to the entire landscape profile slope length.

EXAMPLE C: CONTOUR "P" FACTOR DETERMINATION FOR A CROP ROTATION WITH VARYING RIDGE HEIGHT

Step 1. Assemble information about the crop rotation. Include the crops grown, ridge height as applicable, and the cover management condition for each year in the rotation. Select ridge height and cover management condition based on those conditions during the seedbed and planting period.

A. Crop rotation is six years (Cg-Cg-Og-H-H-H).

B. Crops and tillage practices are moldboard plow corn after hay; mulch till corn after corn, 50 percent cover; mulch till oats after corn, 30 percent cover; followed by three years of alfalfa-intermediate wheatgrass hay production. Corn after hay is row cultivated within 30 days of planting.

C. Landscape profile is 10 percent slope steepness; slope length = 400 feet; ridge/furrow grade = 1 percent; 10-year "EI" = 90; and Hydrologic Soil Group is B.

D. Ridge height = 3-4" for corn after hay; 2-3" for mulch till corn after corn; 0.5-2" for oats after corn; and 3 years of alfalfa-wheatgrass hay = no ridges.

E. Cover management condition of corn after hay = 6; corn after corn = 4; oats after corn = 5; and alfalfa-wheatgrass hay/haylage = 2.

Step 2. **Calculate the "P" subfactor for each year where cover management condition or ridge height change. Make adjustments as needed when actual slope length exceeds the critical slope length.**

A. Ridge/furrow to profile grade = 1%/10% = 0.1 for all annual crops where ridges are formed.

B. Corn after hay, on-grade "P" = 0.37 from **Table 10.** Off-grade "P" = 0.56 from **Table 11**. Critical slope length = 190 feet from **Figure 11**. Corrected contour "P" subfactor = 0.85 from **Figure 29** for exceeding critical slope length where actual slope length/critical slope length is 400/190 = 2.1.

C. Corn after corn, on-grade "P" = 0.46 from **Table 10.** Off-grade "P" = 0.63 from **Table 11.** Critical slope length = >1000 feet from **Figure 10** thus no adjustment for exceeding critical slope length is required.

D. Oats after corn, on-grade "P" = 0.70 from **Table 10.** Off-grade "P" = 0.79 from **Table 11.** Critical slope length = 420 feet from **Figure 10** thus no adjustment for exceeding critical slope length is required.

E. Alfalfa-intermediate wheatgrass hay. No ridges present. Contour "P" subfactor = 1.0.

Step 3. **Calculate the weighted average annual contour "P" subfactor for the rotation.**

A. Add the values in **Step 2** and divide by the number of years in the crop rotation. The result is the weighted average annual contour "P" subfactor for the crop rotation.

0.85 + 0.63 + 0.79 + 1.0 + 1.0 + 1.0 = 5.27/6 Yrs = 0.88

Example D: STRIPCROPPING "P" FACTOR DETERMINATION

Step 1. **Gather required information.**

A. Landscape profile = 10 percent slope steepness; slope length = 400 feet; 10-yr. "EI" = 90; Hydrologic Soil Group is B; and strip boundary grade = 1 percent.

B. Four contour strips are planned with alternating Cover-Management Condition 2 for established hay that was seeded with a nurse crop and six for clean tilled corn. Acreage of corn and hay is nearly equal in every year of the crop rotation.

Step 2. **Determine stripcropping "P" subfactor.**

A. From **Table 12**, select the contour stripcropping practice "P" subfactor table for sod based rotations, hay established with a nurse crop. This table has a ridge/furrow grade of 0.5 percent (close to the 1 percent actual row grade).

B. Locate the intersection of 4 strips and Cover-Management = 2-(6,5). The value of 0.69 is the stripcropping "P" subfactor that applies for slopes less than or equal to the critical slope length.

Step 3. Determine critical slope length.

A. From **Figure 11** for 10-Yr. "EI" = 90, Cover-Management Condition 6, Hydrologic Soil Group B, and the 10 percent slope, read the critical length is 190 feet.

B. Multiply 1.5 X 190 to calculate the stripcropping critical length of 285 feet. The 400 foot slope length at the site is greater than the critical length.

Step 4. Adjust the stripcropping "P" subfactor for critical slope length.

A. Actual slope length/critical slope length is 400/285 = 1.4. From **Figure 29** the corrected stripcropping "P" subfactor for exceeding the critical slope length is 0.83.

Step 5. Multiply contour "P" subfactor times stripcropping "P" subfactor to get composite "P" factor.

A. From Example C, the contouring "P" subfactor was determined to be 0.56 + 0.63 = 0.60. This is an average of the contour "P" subfactors for the two corn years of the crop rotation.

Note that this is the contour "P" subfactor for the corn with appropriate cover-management condition before adjustment for critical slope and not a weighted average "P" subfactor for corn and hay cover-management conditions. Corn cover management conditions are present on the field profile a majority of the time and alternate positionally back and forth between strip pairs.

B. From this example, the contour stripcropping "P" subfactor was 0.83.

C. Multiply the two subfactors together, 0.60 X 0.83 = 0.50. The "P" factor for this field's contour stripcropping system is 0.50.

Example E: TERRACE "P" FACTOR DETERMINATION

Step 1. Gather required information.

A. Landscape profile = 6 percent slope steepness; slope length = 450 feet; 10-yr. "EI" = 80; and Hydrologic Soil Group is C.

B. The crop rotation is corn-soybeans produced using conventional clean tillage. This is Cover-Management Condition 6 from **Table 8.** A ridge height of 2-3 inches is formed by tillage and planting equipment on this soil. This is a Low Ridge from **Table 9.** Contouring will be used. Row grades will parallel terrace channel.

C. Landscape profile (slope steepness) will not change with terrace construction.

D. Horizontal spacing interval selected is 150 feet to split original landscape profile slope length (450 feet) into thirds.

E. Open outlet design with terrace channel grade at 0.4 percent.

Step 2. Determine "P" subfactor for Terracing.

A. In **Table 15** find horizontal interval range (terrace spacing) 150 feet and read across to Open Outlets, with percent grade of 0.4. Read the terrace "P" subfactor value of 0.77.

Step 3. Adjust "LS" value.

A. Slope length after terrace installation is 150 feet. Adjust "LS" factor value and re-enter new value into the general RUSLE equation.

B. Enter **"LS" Table 2** for Cropped Agricultural Land. Find the column for 150 feet of slope length and the value in the intersected row for 6 percent slope. Read the new "LS" value of 0.93. Enter this new value into the general RUSLE equation.

Step 4. Adjust contouring "P" subfactor for ridge/furrow grade.

A. Contour "P" subfactor is based on a low ridge (2-3 inch), 6 percent slope, 10-yr. "EI" = 80, and Hydrologic Soil Group of C. On-grade "P" = 0.53.

B. For 0.4 percent row grade calculate the ridge/furrow to field slope steepness ratio by dividing 0.4%/6% = 0.066, round to 0.1. Go to **Table 11** as ridge/furrow to field slope ratio >0.05 indicates a correction applies.

C. Since **Table 11** does not have a line for 0.53, round the value up or down to 0.52 or 0.54. Since the ridge/furrow to slope grade ratio was rounded up, round down this time to 0.52. Enter **Table 11** with the on-grade contouring "P" subfactor value of 0.52 and read across to the ridge/furrow to slope grade ratio of 0.1. The adjusted "P" subfactor value is 0.67. This is the "P" subfactor value for off-grade contouring where the slope is less than the critical slope.

Step 5. Determine the critical slope length.

A. Select **Figure 16** for Hydrologic Soil Group C and Cover-Management Condition 6.

B. Enter with the 6 percent slope, read up to intersection of 10-yr. "EI" = 80 and across to find a critical length of 300 feet. The new profile slope length of 150 feet with terraces does not exceed the critical slope length so no adjustment of the "P" subfactor is needed.

Step 6. Determine composite "P" factor.

A. Multiply terrace "P" subfactor 0.77 times off-contour "P" subfactor 0.67. Composite "P" factor = 0.52.