TECHNICAL NOTES

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ESTIMATING SHEET-RILL EROSION AND SEDIMENT YIELD ON DISTURBED WESTERN FOREST AND WOODLANDS

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0.0 INTRODUCTION

The objectives of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) are to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. The goal of the Act is to eliminate the discharge of pollutants into navigable waters by 1985. An interim goal of water quality which provides for the protection and propagation of fish, shell fish, and wildlife, and provides for recreation in and on the water is to be achieved by July 1, 1983. To this end, Section 208 of the Act provides for a continuing planning process which documents existing problems that occur from point and nonpoint sources. Management procedures to eliminate the problems found and proper controls to see that the needed actions are carried out are an integral part of all forest planning.

Soil erosion has been a constant concern of the Department of Agriculture. Methods and procedures to evaluate the erosion process as well as preventive measures have been developed over many years of research and practical experience.

A procedure to evaluate sheet and rill erosion on disturbed forest lands has been developed. This procedure, which uses the Universal Soil Loss Equation (USLE), could be of value to those working on the evaluation of nonpoint pollution problems in Section 208 planning. It could also be a valuable tool in general forest management. Experience with river basin and small watershed planning has indicated the value of being able to estimate erosion and sediment from forest land in a manner comparable for all participating units.

0.1 History

Both the Soil Conservation Service and Forest Service are using the Universal Soil Loss Equation (USLE) for estimating the average annual sheet and rill erosion on agricultural and forested lands throughout the United States. The development of factors for the use in USLE has increased the interest and usefulness of this equation in a broad range of activities beyond the original agricultural applications. These include forestry, highway construction, building sites, and other disturbed areas.

0.2 Purpose

The following procedures detail the process of evaluating accelerated sheet erosion and sediment yield from forested land, and assure their compatibility with estimating methods used for agricultural lands by the Soil Conservation Service. Procedures for evaluating sheet and rill erosion on undisturbed forested lands are found in SCS Technical Release 51, revised 1977.

0.3 Capabilities and Limitations

The USLE is useful in making estimates of erosion from disturbed forest land. It can estimate erosion from skid trails, temporary roads, landings, burns, grazing, game and recreation areas, and planting sites on forested lands. Other opportunities to utilize this procedure may develop.

There are definite limitations to the use of this equation. First, the USLE was primarily developed for agricultural use. Its application to a forest involves different considerations from the agricultural area. Many forest slopes and slope lengths may exceed the limits of the equations base data. Also, K[1/] factors for areas without soil surveys need to be approached with the assistance of a soil scientist. On roadways compaction, rock, and engineering processes give the estimator additional trouble evaluating K.

It is important to recognize that the USLE is designed to predict long-term average soil loss for specific combinations of factor values. Short-term losses are influenced by random fluctuations of variables. These fluctuations over narrow time periods are not reflected by the equation.

0.4 Associated Publications

This material is to be used in conjunction with Conservation Agronomy Technical Note No. 32 prepared by SCS West Technical Service Center, Portland, Oregon, dated September 1974 (Rev. March 1975), SCS Technical Release No. 51 (Rev.) Geology, July 1977, and factors developed locally. In addition, consult USDA Agricultural Handbook No. 282.

1.0 UNIVERSAL SOIL LOSS EQUATION

The evaluation of factors for use in the USLE must be a team effort. It requires the knowledge of soil scientists, foresters, geologists, meteorologists, and hydrologists. Where erosion estimates from various land uses are needed, the scientists must understand the erosion processes in each situation.

The USLE as used in this report is applied to forest areas that have been disturbed. This is taken as a forest site with erodible soil exposed because of man's activity. All other forested areas are considered to be at or near the geologic norm for erosion. Thus, only accelerated sheet and rill erosion caused by man is addressed. Mass movement, gully, and stream channel erosion must be considered separately and becomes additive to sheet and rill erosion.

The complete USLE is A = RKLSCP[2/]. The version for use on forested lands is modified as follows:

$$A = R_T KLSC$$

1/ K is defined on page 5.

2/ The P factor is not evaluated for forest conditions.

Where:

A is the computed soil loss (sheet and rill erosion) in tons per acre per year. A is not sediment yield. It represents onsite erosion rather than delivered sediment at some point within a stream system.

R_T is the total annual rainfall factor R plus R_S, if it applies.

R_S, the snowmelt factor, is the amount of snowmelt water that contributes to the erosive force of overland flow (Cons. Agron. Tech. Note 32).

R, the rainfall factor, is the sum of energy-intensity (EI) for a normal year's rain.

K, the soil-erodibility factor, is the erosion rate per unit of erosion index for a specific soil in cultivated continuous fallow, on a 9 percent slope 72.6 feel long (USDA Agric. Handbook No. 282).

L, the slope-length factor, is the ratio of the soil loss from the field (disturbed soil) slope length to that from a 72.6 foot length on the same soil type and gradient.

S, the slope-gradient factor, is the ratio of soil loss from the erodible surface gradient to that from a 9 percent slope.

C, the vegetative management factor, is the ratio of soil loss from disturbed forest areas to that from a fallow condition of a comparable soil.

1.1 Rainfall Factor (R)

The energy of moving water detaches and transports soil materials. The energy-intensity parameter Erosion Index (EI) measures total raindrop energy of a storm and its relation to the maximum 30-minute intensity[1/]. Soil losses are linearly proportional to the number of EI units. Storm EI values are summed to obtain an annual rainfall-erosivity index for a given location (Wischmeir & Smith 1958). This annual index serves as the R factor; an example is given in figure 3.1-4. The procedures used in Technical Note, Conservation Agronomy No. 32, September 1974 (Rev. March 1975) are used to compute R. When R is needed for less than one year, use the EI distribution curves provided by the Soil Conservation Service state or field office.

1.2 Snowmelt Factor (R_S)

Snowmelt water that does not infiltrate the soil becomes overland flow and contributes to the volume of water available to detach the transport soil particles. A compensating effect of energy absorption by the presence of snow to reduce the effect of falling rain also exists (Brooks et al, 1975).

1/ Maximum 30-minute intensity is twice the greatest amount of rain occurring in any 30 consecutive minutes.

1.3 Soil-Erodibility Factor (K)

The capability of a soil surface to resist erosion is a function of its physical and chemical properties. The most significant soil characteristics affecting soil erodibility are texture, organic matter content, soil structure, and permeability. The average K values are assigned to named soils and may be obtained from soil scientists, technical guides, published lists or estimated using table 3.2-2, display 3.2-2.

1.4 Slope Length (L) and Slope Gradient (S)

Soil loss is affected by both length and percent of slope. For convenience in the field application of these factors, they are combined into a single topographic factor, LS.

The LS factor for gradients up to 60 percent and slope lengths to 2,000 feet may be obtained from the Slope-Effect tables 3.2-4 and 3.2-5. Values shown on the tables for slopes of less than 3 percent, greater than 20 percent, or longer than 400 feet, represent extrapolations of the formula beyond the range of research data, as shown on figures 3.1-6 and 3.1-7.

Present conditions are evaluated to develop an LS factor for use in the USLE. The future LS for example would reflect changes in the general slope of new temporary roads and skid trails as well as the spacing of waterbars or culverts due to improved management procedures.

1.5 Plant Cover Factor (C)

The C factor values relate the effect of ground cover to the computation of erosion. Forest land cover factors for the USLE are generated from field data and procedure recommended by W. H. Wischmeir (Unpub. Paper, 1971).

The C factor is based upon three separate and distinct but interrelated effects: Type (I), the vegetative cover in direct contact with the soil surface; Type (II), canopy cover; and Type (III), effects at and beneath the surface; figures 3.1-1, 3.1-2., and 3.1-3. Where satisfactory C factors have been developed, they may be used. An example is provided in table 3.2-1.

2.0 USE OF THE UNIVERSAL SOIL LOSS EQUATION

This is a procedure to evaluate sheet and rill erosion and sediment yield on disturbed forest land. There also should be a sampling procedure that will meet your objectives. This latter element is not discussed, but needs careful attention for a successful estimate.

2.1 Field Procedure

The methods for collecting and manipulating the data suggested in this paper are designed to provide reasonable estimates of the erosion and sediment from disturbed

forest land. Because some of the elements recorded are estimated, there will be variance between individual results. This can be reduced by care in the data collection and analysis.

It is suggested that areas of similar characteristics be sampled and analyzed together. Thus slope ranges, soil, disturbance type, aspect and other attributes which are meaningful to the analysis can serve as sampling strata to reduce the variation of the estimate.

Equipment needed for the fieldwork includes a data recording and computation sheet, and an instrument to measure slope.

Data are collected on the site using a pace transect. If there is insufficient space to complete the 100 pace transect, it may be folded back and forth across the slope.

At each two steps (one pace) evaluate a square inch or other suitable area at the tip of your boot. Note the location of the point. Separate trails, roads, landings, log paths, recreation zones, and other areas of interest in the field tallys. Next, record if the point is bare ground or protected ground.

2.1-1 Definitions

Bare Ground - Unprotected soil surface that will erode from the impact of rain.

Buffer - An area of porous forest soil with a protective cover of humus and litter or other medium that has a nonerodible surface which intercepts runoff from sheet flow and filters out suspended materials. The assumed optional buffer width is 50+ (4x% Slope) feet (Trimble 1957). To avoid bias, do not record buffers wider than the optimal. It should be noted that on large storms having high volume of runoff the effectiveness of buffer strips may be reduced.

Canopy Cover - The percent of canopy closes to the ground that is most effective in intercepting rainfall. Percent of canopy is computed as viewed in the vertical projection.

Effective Canopy Height - The average fall height in meters from the canopy to the ground.

Functioning Channel - A well-defined channel that clears itself at least once a year of small debris and litter.

Percent Slope - (the measure of), Display 3.3-5

(1) For Erosion Computation

The slope in percent along which water travels during overland runoff.

(2) For Sediment Yield Computation

The slope in percent from the beginning point of a buffer to a functioning channel.

Protected Ground - A covered surface that will not erode from the impact of rain.

Root Net - The relationship of the root structures in the area of investigation to that of a mature forest or sod. Percent root net is taken as approximately the same as percent forest or grass cover.

Sediment Delivery Ratio - The percentage of eroded material that is yielded or delivered to a point. The formula is DR= Y/E

Where:

DR = Sediment delivery ratio (DR less than 1)

Y = Sediment yield (tons/unit area/year)

E = Erosion (tons/unit area/year)

Slope Length - Display 3.3-5

(1) Erosion Computation

Slope length is defined as the distance from the point of origin of overland flow to one of the following, whichever is limiting: (1) the point where the slope decreases to the extent that deposition begins; (2) the point where runoff enters a functioning channel that may be part of a drainage network of a construction channel such as a ditch, waterbar, or diversion.

(2) For Sediment Yield Computation

The slope length in feet from the point that runoff enters a buffer area to a functioning channel.

2.2 Computations (Example)

2.2-1 Present Conditions

A highlead logging operation was sampled and the data recorded (display 3.3-1).

Recorded elements are totaled and averaged. Slope and length of water travel are properly weighted to reflect the area in various disturbances. The buffer data pertains to the distance and slope between a given disturbance and the functioning channel.

These elements are used to develop a simple sediment delivery ratio. The cover factors are averaged and recorded.

In the example used for this discussion, 22 percent of the transect paces fell on log paths, roads, or fire trails. All other hits were on forest duff. Elements are recorded in a simple way. Display 3.3-1.

Percent Slope and Length Feet

1. The percent area based on transect hits for each disturbance class is recorded in display 3.3-1. For log paths this is 5 + 3.7 = 8.7 percent.

2. Bare ground in this example is 5 + 3.0 + 5.3 = 13.3 or 13 percent.

3. Weighted averages of percent slope and lengths are developed for each disturbance class.

   Weighted % Slope = [(34)(8.7) + (5)(5.0) + (30)(8.3)]/22 = 26 percent

   Weighted Slope Length Feet = [(133)(8.7) + (40)(5.0) + (55)(8.3)]/22 = 82 ft.

LS Factor - The slope length factor is provide in table format, tables 3.2-4, and 3.2-5, or figures 3.1-6 and 3.1-7.

For the example, display 3.3-1, the present slope and length were calculated to be 26 and 82 respectively. Using figure 3.1-5 the area for the sample is located in the Xeric moisture regime and Mesic and Thermic temperature zone requiring the use of table 3.2-5 for the estimate of LS. The LS factor is computed to be 4.1. Enter the LS into the erosion computation (see pages 8 and 9).

Cover Factor (C)

Type I effect - figure 3.1-1 percent protected ground for the whole operation is 100 less the percent bare ground. Enter bottom of figure with 100 -13 = 87 and read 0.08.

Type II effect - figure 3.1-2. The Type II effect is the product of rainfall energy intercepted by the canopy (RE_C) and the decimal percent bare ground minus 1.

$$\text{Type II} = 1 - [(RE_C)\ (\%\ \text{Br. Gr.})]$$

1/ Percent canopy cover is 60 percent. Enter figure at bottom with 60 and read from 1 meter line 42 percent on the right side of figure. Enter 0.42, the gross reduction in energy by the canopy (RE_C), in equation.

2/ Percent bare ground is thirteen hundredths and entered into the equation.

$$\text{Type II} = 1 - [(0.42)(0.13)] = 0.95$$

Type III effect - figure 3.1-3. Since this is a forest floor, the forest duff curve is used. The root network was estimated in 70 percent. Enter with 70 at bottom of figure and read 0.13. Enter 0.13 into the equation.

The C factor is the product of Types I, II, and III effects. (See graphic description display 3.3-4.) C= (0.08)(0.95)(0.13) = 0.01.

Additional C factors are available for consideration in table 3.2-1.

<u>K Factor</u> - The erodibility of the soil is taken from soil survey information, developed by the soil scientist on the project, or estimated using table 3.2-2. This table requires the use of a wetting bottle and the procedure outlined on display 3.3-2. For the example, use a K of 0.32.

<u>R Factor</u> - Where no R value charts are available, use the procedures outlined in Technical Note, Conservation Agronomy No. 32, dated September 1974 (Rev. March 1975), to compute the total R factor (R_T). For our example the R factor was taken from a map provided by the Oregon State Conservationist, Soil Conservation Service, figure 3.1-4. The R of 47 was entered into the Erosion Computation, page 14. It should be noted that if snowmelt adds to the water available for erosive activity, a snowmelt R_S must be added to the R to form the total R_T.

For forested lands there are few areas where R_S is a problem. These are isolated on those sites where concrete frost develops or other factors prevent the melt waters from percolating into the soil. Where this does occur, it is suggested that the R_T be weighted for the site in proportion to its occurrence, or erosion and sediment calculation be kept separate.

The procedure for developing EI factors for individual storms is presented in the Appendix. A sample of the procedure is shown in display 3.3-3.

<u>Erosion Estimate</u>

Rate per Acre

$$\begin{aligned} A &= R_T KLSC \\ &= (47)(0.32)(4.1)(0.01) \\ &= 0.62 \text{ tons/acre/year} \end{aligned}$$

For the 80-Acre Highlead Operation

$$\begin{aligned} A &= (0.62)(80) \\ &= 49.6 \text{ tons/year} \end{aligned}$$

Sediment Yield Estimate

Where:

Sediment Delivery Ratio = 1 – {L/ [50 + (4)(% S)]}

= 1 – {200/ [50 + (4)(42)]}

= 0.08

L = Slope length of buffer strip to channel.

S = percent slope of the buffer strip.

Estimated Sediment Yield = (0.62)(0.80)

= 0.05 tons/acre/year

Sediment Yield for Highlead Operation

= (0.05)(80)

= 4.0 tons/year

The sediment yield estimated by this procedure takes the material only as far as a functioning channel. Routing sediment through the stream system is not considered. It should also be noted that permanent road, slide, gully, stream bank, and channel sediments must be added where necessary to complete the sediment picture.

2.2-2 Future Conditions

Seven elements within the computation process allow for anticipated change. These are in order of their appearance in the USLE: K, L, S, C. The three remaining are the total acres of disturbance type, percent bare ground within the disturbed area, and the changes expected in the buffer widths.

The following elements in the example are adjusted for the new estimates:

Bareground: reduced from 13 to 9 percent by improved management.

Rootnet: increased from 70 to 91 percent by new plant growth.

Slope Length: all changes are due to improved management.

Log paths from 133 to 107 feet - a better highlead setting

Road and Landings from 40 to 30 feet - increased drainage

Fire trails from 55 to 20 feet - by increasing waterbars

Percent Slope: No changes anticipated.

Buffer: a 220-foot wide strip is set to assure there would be little or no sediment yield.

Introducing these changes then will give a new estimate of the erosion and sediment yield for this example as follows:

Cover Factor (C)

Type I effect: (100-2) = 98 percent protected soil. Enter figure 3.1-1 with 91 and read a 0.06 soil surface factor.

Type II effect: $= 1 – [(RE_C)\ (\%\ Br.\ Gr.)]$

$= 1 – (0.42)(0.09) = 0.96$

Type III effect: for a 91 percent protected soil, read form figure 3.1-3 a root network factor of 0.10.

The new computed future C factor is then:

$C = (TI)(TII)(TIII)$

$C = 0.06\ [1 – (0.42)(0.09)]\ (0.10) = 0.006$

This is entered in the erosion computation as before.

K Factor - For this example the K factor is assumed to remain the same. Under some situations the K may change due to management. An example of this would be where compacted soils are ripped for planting.

R Factor - No change.

LS Factor - Future estimates for our example are based on the factors given. Percent slope did not change in this example, but it could.

With the new estimates of bare ground and L factors, re-calculate the average weighted percent slope and length. These are found to be 25 and 55 respectively.

Weighted % Slope = [(34)(6.7) + (5)(4.5) + (30)(6.5)] / 17.7 = 25 percent.

Weighted Slope Length Feet = [(0.07)(6.7) + (30)(4.5) + (20)(6.5)] / 17.7 = 55 ft.

A new LS factor 3.5 is computed and entered into the erosion computation.

Compute the estimated tons of erosion per acre as before. Acreage of highlead logging remains the same, 80. The new estimate of total erosion then is 25.3 tons per year.

Future Erosion Estimate

Rate per Acre

$A = R_T KLSC$

$= (47)(0.32)(3.5)(0.006)$

$= 0.32$ tons/acre/year

For the Highlead Operation

$A = (0.32)(80)$

$= 25.3$ tons/year

Future Sediment Yield Estimate

Sediment Delivery Ratio = 1 – {L/ [50 + (4)(%S)]}

= 1 – {220/ [50 + (4)(42)]}

= 1 – {1.01}

= 0.0

Estimated Sediment Yield = (25.3)(0.0)

= 0.0 tons/acre/year

Sediment Yield for Highlead Operation

= (0.00)(80)

= 0.0 tons/year

2.3 Projections

Future estimates of erosion and sediment yield have just been discussed. Another slightly different procedure can be used for predicting the change in erosion or sediment yield rates in the future. This usually is a decay function.

To establish these rates, separate disturbance type into suitable strata and plot the computed rates against Time Since Disturbance. A sample of one hypothetical data plot is shown in display 3.3-6.

SELECTED REFERENCES

1974 Brooks, F. L., J. W. Turelle, et al., Universal Soil Loss Equation, Cons. Agron. Tech. Note, No. 32. West Technical Service Center (Rev. March 1975).

1977 Soil Conservation Service. Procedure for Computing Sheet and Rill Erosion on Project Areas. SCS Technical Release No. 51 (Rev. 2).

1973 Ports, M. A. Use of the Universal Soil Loss Equation as a Design Standard. ASCE Wtr. Res. Engr. Mtg., Washington, D. C.

1957 Trimble, G. R., Jr., and R. S. Sartz. How Far From a Stream Should a Logging Road be Located. J. For., Vol. 55, pp. 339-341.

1975 Vile, Charles. A Procedure to Evaluate Erosion and Sedimentation Hazards, Vermont Dept. For. Wtrs. Montpelier, Vermont.

1971 Wischmeir, Walter H. Approximating the Erosion Equation's Factor C for Uncultivated Land Areas. Form Unpub. Rpt. of ARS-SCS Tech. Conf., Des Plaines, Ill. Nov. 22-24

1976 Wischmeir, Walter H. Use and Misuse of the Universal Soil Loss Equation. Jour. Soil Wtr. Cons. pp. 5-9.

1958 Wischmeier, W. H. and D. D. Smith. Rainfall Energy and its Relation to Soil Loss. Trans. AGU, Vol. 39, No. 2 pp 285-291.

1965 Wischmeier, Walter H. and D. D. Smith. Predicting Rainfall-Erosion Losses from Cropland East of the Rocky Mountains. USDA ARS. Agr. Hdbk. No. 282.

1971 Wischmeier, W. H., C. B. Johnson and B. V. Cross. A Soil Erodibility Nomograph for Farmland and Construction Sites. J. Soil Wtr. Conc. 26(5): 189-193.

1975 Wischmeier, W. H. Estimating the Soil Loss Equation's Cover and Management Factor for Undisturbed Areas. Present and Prospective Technology for Predicting Sediment Yields and Sources, ARS-S-40, June, pp. 118-124.

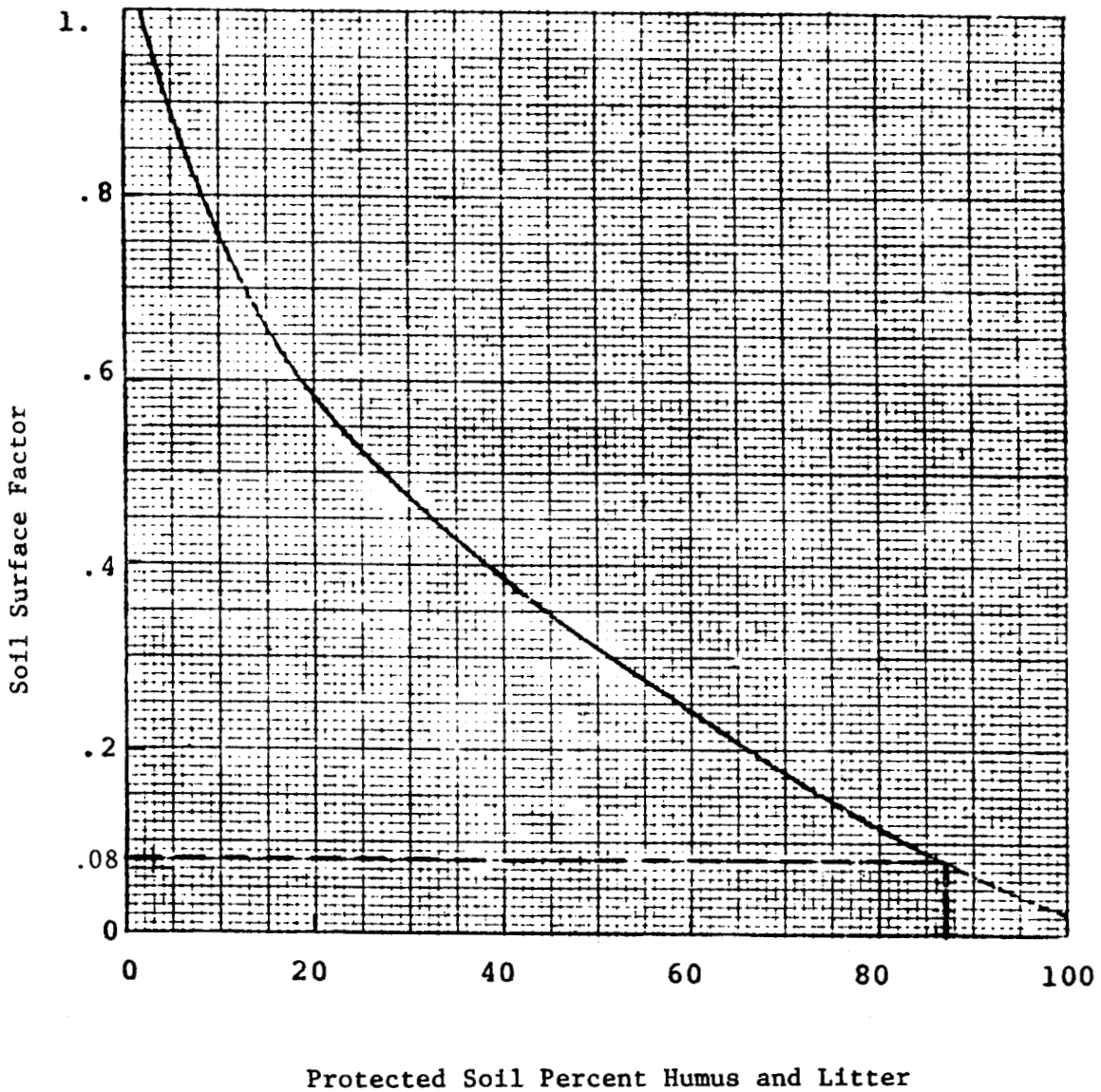


Figure 3.1-1

Cover in Direct Contact with the Soil Surface, Type I Effect

W.H. Wischmeier. Approximating the Erosion Equation's Factor C for Undisturbed Land Areas, USDA, Agricultural Research Service, Unpublished Report

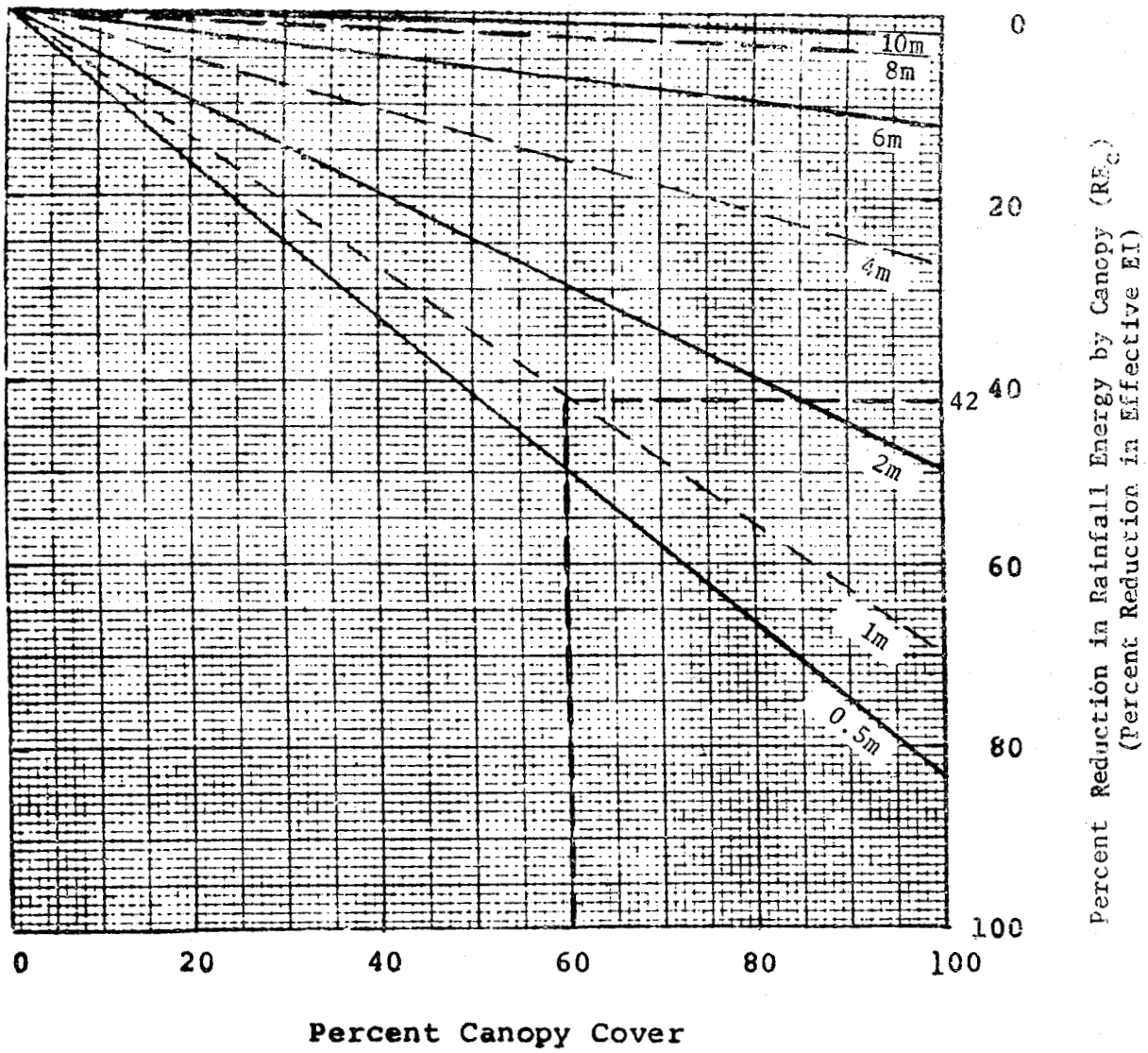


Figure 3.1-2

Reduction in Rainfall Energy (RE_c) by Effective Canopy Cover Above the Soil Surface

Adapted from W. H. Wischmeier, Approximating the Erosion Equation's Factor C for Undisturbed Land Areas, USDA Agricultural Research Service, Unpublished Report

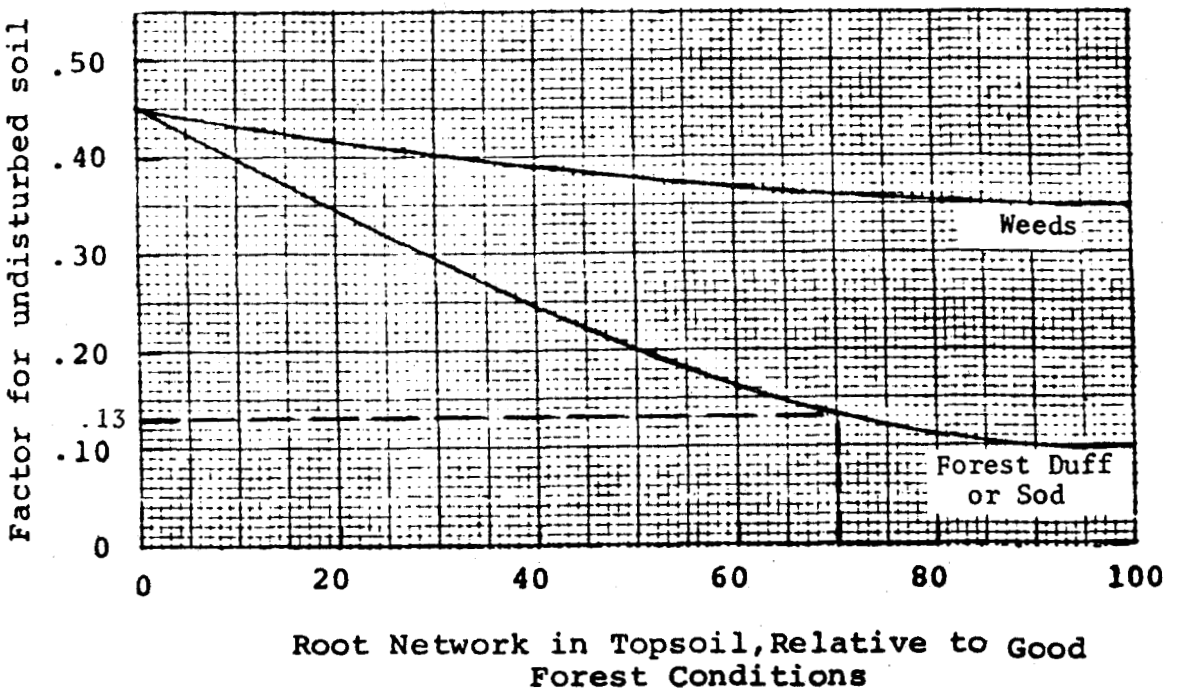


Figure 3.1-3

Effect of No Soil Disturbance for at Least 10 Years, Root Accumulation in the Upper Layer of Soil, and other Related Factors, Type III Effect

W.H. Wischmeier, Approximating the Erosion Equation's Factor C for Undisturbed Land Areas, USDA Agricultural Research Service, Unpublished Report

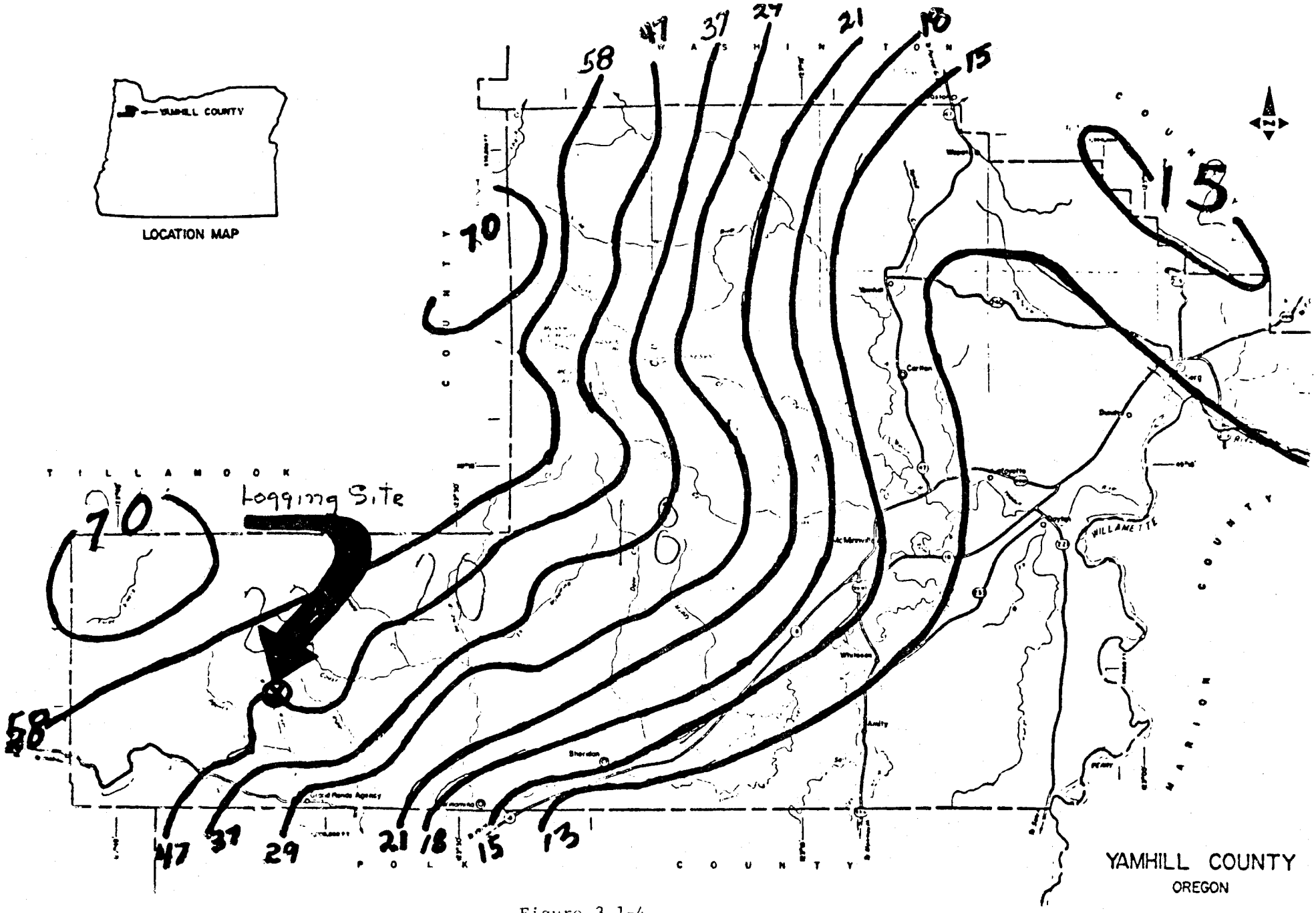
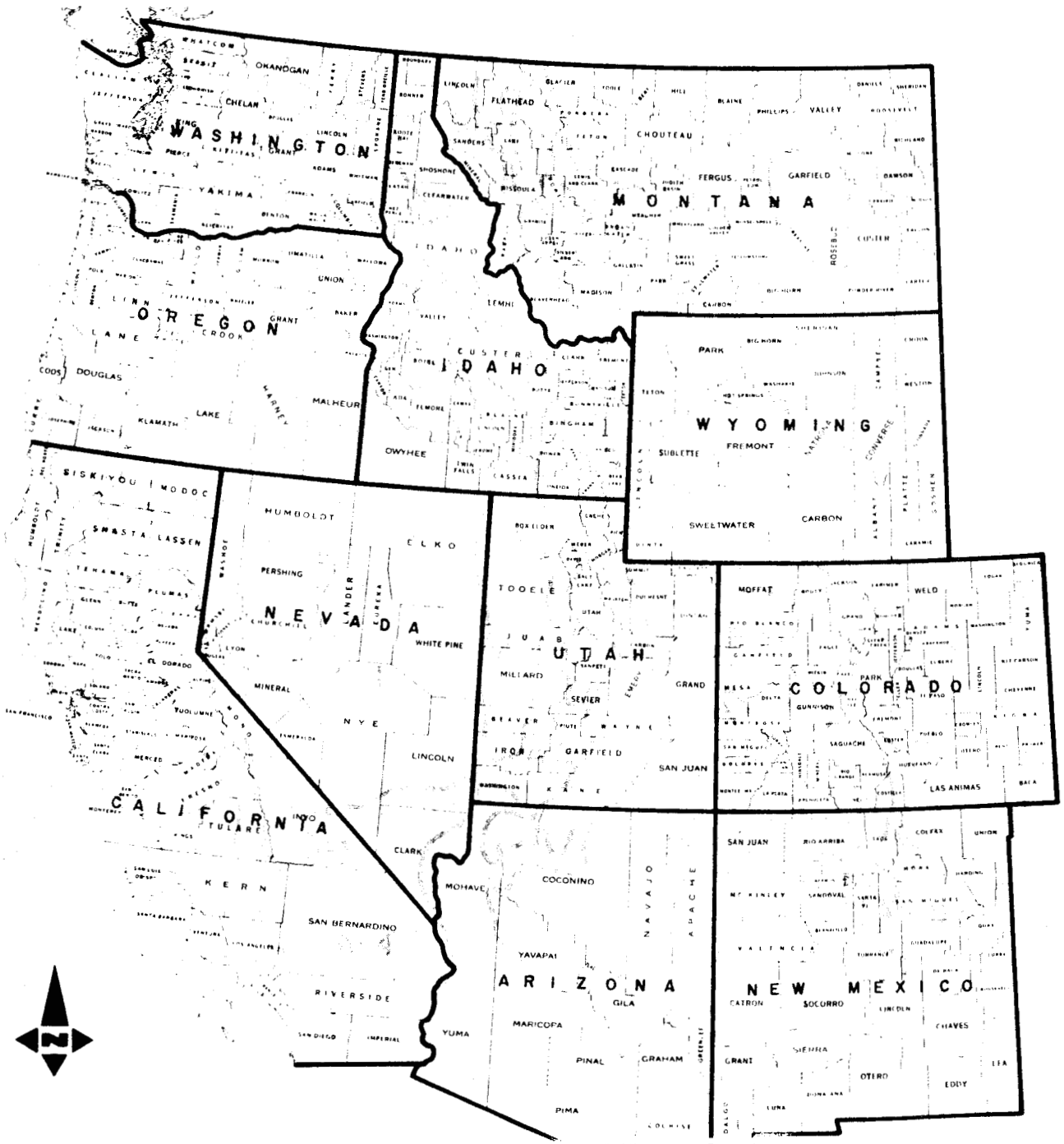


Figure 3.1-4
RAINFALL FACTOR R
(does not include R_c Values)



LEGEND

Moisture Regime	Temperature Zones
Xeric	Mesic and frigid
	Cryic and frigid
	Mesic and thermic
	Mesic, thermic and hyperthermic
Ustic	Mesic and frigid
	Mesic and frigid
	Mesic, thermic and hyperthermic
Udic	areas

Fig. 3.1-5 Soil Moisture-Soil Temperature Regimes

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

WEST TECHNICAL SERVICE CENTER AREA

SEPTEMBER 1977

50 0 50 100 150 200 250 300 MILES

SCALE 1:14,360,000

Table 3.2-1

Cover Index Factor C
Construction Sites

Type of Cover		Factor C
None (fallow ground)		1.0
Temporary Seeding (90 percent Stand):		
Ryegrass (perennial type)		0.05
Ryegrass (annuals)		0.1
Small grain		0.05
Millet or sudan graas		0.05
Field bromegrass		0.03
Permanent Seeding (90 Percent Stand):		0.01
Sod (laid immediately)		0.01
Mulch:		
Hay rate of application tons per acre:		
	1/2	0.25
	1	0.13
	1-1/2	0.07
	2	0.02
Small grain straw	2	0.02
Wood chips	6	0.06
Wood cellulose	1-3/4	0.1
Fiberglass	1/2	0.05
Asphalt emulsion (1250 gals/acre)		0.02

Fiber matting, excelsior, gravel, and stone may also be used as protective cover.

From Ports, 1973

Table 3.2-2

GUIDE FOR ESTIMATING ERODIBILITY (K) VALUES

Soil Surface Texture 1/	Permeability			
	Very Slow	Slow	Mod. Slow, Moderate	Mod. Rapid, Rapid, Very Rapid
c, sic, sc 2/	0.37	0.32	0.28	0.24
scl, sicl, cl	0.43	0.37	0.32	0.28
sil, l, vfsl	0.49	0.43	0.37	0.32
fsl, sl	0.37	0.32	0.24	0.20
ls, s, lcs, cls	0.28	0.24	0.20	0.17 or .15

1/ Gravelly, channery, shaly, slaty, cherty, cobbly, or flaggy phases of these textures are normally reduced one or two classes in K value.

2/ C, Clay; Si, Silt; S, Sand; l, loam; vf, very fine; f, fine

REFERENCE: Soil Conservation Service, 1969, Hydrologic Group K and T Factors of Series Having Type Locations in the South Region: South Regional Technical Service Center, Fort Worth, Texas

Table 3.2-3

KINETIC ENERGY OF NATURAL RAINFALL*
(Hundreds of foot tons per acre inch)

$Y = 9.16 + 3.31 \log Xr$ 1/

(Wischmeier and Smith, 1958)

Intensity in/hr	Intensity, inches/hr									
	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0	0	2.54	3.54	4.12	4.53	4.85	5.12	5.34	5.53	5.70
0.1	5.85	5.99	6.11	6.23	6.33	6.43	6.53	6.61	6.69	6.77
0.2	6.85	6.92	6.98	7.05	7.11	7.17	7.22	7.28	7.33	7.38
0.3	7.43	7.48	7.52	7.57	7.61	7.65	7.69	7.73	8.07	7.81
0.4	7.84	7.88	7.91	7.95	7.98	8.01	8.04	8.07	8.10	8.14
0.5	8.16	8.19	8.22	8.25	8.27	8.30	8.33	8.35	8.38	8.40
0.6	8.43	8.45	8.47	8.50	8.52	8.54	8.56	8.58	8.61	8.63
0.7	8.65	8.67	8.69	8.71	8.73	8.75	8.77	8.78	8.80	8.82
0.8	8.84	8.86	8.87	8.89	8.91	8.93	8.94	8.96	8.98	8.99
0.9	9.01	9.02	9.04	9.06	9.07	9.09	9.10	9.12	9.13	9.15
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1	9.16	9.30	9.42	9.54	9.64	9.74	9.84	9.92	10.00	10.08
2	10.16	10.23	10.29	10.36	10.42	10.48	10.53	10.59	10.64	10.69
3	10.74	10.79	10.83	10.88	10.92	10.96	11.00	11.04	11.08	11.12
4	11.15	11.19	11.22	11.26	11.29	11.32	11.35	11.38	11.41	11.44
5	11.47	11.50	11.53	11.56	11.58	11.61	11.64	11.66	11.69	11.71
6	11.74	11.76	11.78	11.81	11.83	11.85	11.87	11.89	11.92	11.94
7	11.96	11.98	12.00	12.02	12.04	12.06	12.08	12.09	12.11	12.13
8	12.15	12.17	12.18	12.20	12.22	12.24	12.25	12.27	12.29	12.30
9	12.32	12.33	12.35	12.37	12.38	12.40	12.41	12.43	12.44	12.46

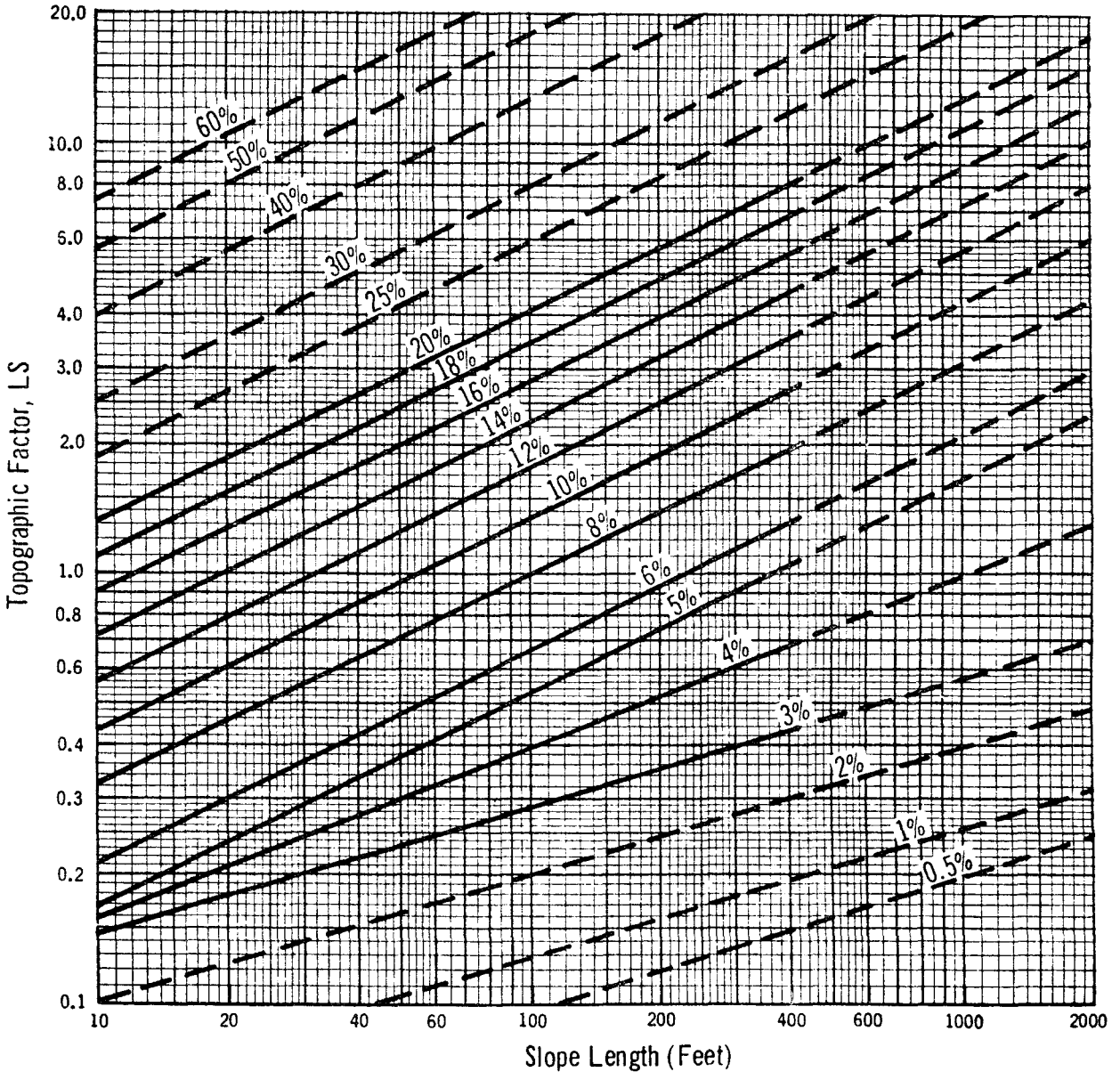
***Example;** Kinetic energy of rainfall of 0.57 in/hr = 8.35 hundreds of ft tons/cu in.

1/ Y = Kinetic Energy of Natural Rainfall, hundreds of foot tons per acre inch.

Xr = The rainfall intensity in inches per hour.

Figure 3.1-6 - Applicable to all Soil Moisture - Soil Temperature Regimes except A=3, and A-1 in WN, OR, and ID.

SLOPE-EFFECT CHART (Topographic Factor, LS)*



*The dashed lines represent estimates for slope dimensions beyond the range of lengths and steepnesses for which data are available. The curves were derived by the formula:

$$LS = \left(\frac{\lambda}{72.6}\right)^m \left(\frac{430x^2 + 30x + 0.43}{6.57415}\right)$$

where λ = field slope length in feet and m = 0.5 if s = 5% or greater, 0.4 if s = 4%, and 0.3 if s = 3% or less; and $x = \sin\theta$. θ is the angle of slope in degrees.

Figure 3.1-7

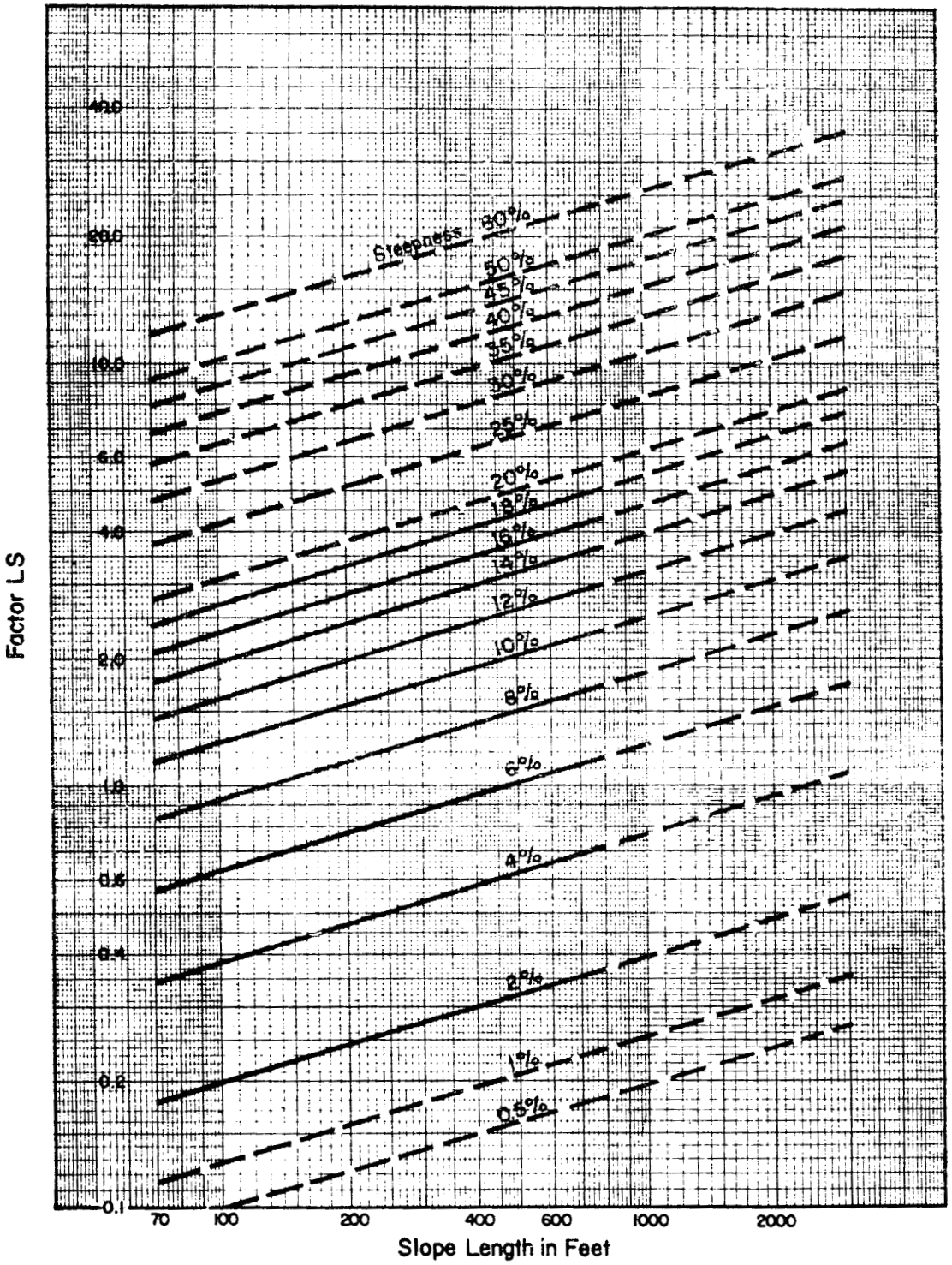


Figure 3.1-7 Applicable to Soil Moisture-Soil Temperature Regimes A-1 in WN, OR, and ID; and in A-3

Note: Dashed lines are extensions of LS Formulae beyond values tested in studies.

For slopes less than 9% $LS = \left(\frac{\ell}{72.6}\right)^{0.3} \left(\frac{0.43 + 0.30 + 0.043s^2}{6.613}\right)$

For slopes greater than 9% $LS = \left(\frac{\ell}{72.6}\right)^{0.3} \left(\frac{s}{9}\right)^{1.3}$

ℓ=length of slope
s=percent slope

Table 3.2-4 contintues

Percent Slope	Slope Length in Feet 300	400	500	600	700	800	900	1000	1100	1200	1300	1500	1700	2000
0.2	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.19	0.19	0.20
0.3	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.18	0.18	0.18	0.19	0.20	0.21	0.22
0.4	0.13	0.14	0.15	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.20	0.21	0.22	0.23
0.5	0.14	0.15	0.16	0.17	0.18	0.18	0.19	0.20	0.20	0.21	0.21	0.22	0.23	0.24
1.0	0.18	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.27	0.28	0.29	0.30	0.32
2.0	0.28	0.31	0.33	0.34	0.36	0.38	0.39	0.40	0.41	0.42	0.43	0.45	0.47	0.49
3.0	0.40	0.44	0.47	0.49	0.52	0.54	0.56	0.57	0.59	0.61	0.62	0.65	0.67	0.71
4.0	0.62	0.70	0.76	0.82	0.87	0.92	0.96	1.01	1.04	1.08	1.12	1.18	1.24	1.33
5.0	0.93	1.07	1.20	1.31	1.42	1.52	1.61	1.69	1.78	1.86	1.93	2.07	2.21	2.40
6.0	1.17	1.35	1.50	1.65	1.78	1.90	2.02	2.13	2.23	2.33	2.43	2.61	2.77	3.01
8.0	1.72	1.98	2.22	2.43	2.62	2.81	2.98	3.14	3.29	3.44	3.58	3.84	4.09	4.44
10.0	2.37	2.74	3.06	3.36	3.62	3.87	4.11	4.33	4.54	4.74	4.94	5.30	5.65	6.13
12.0	3.13	3.61	4.04	4.42	4.77	5.10	5.41	5.71	5.99	6.25	6.51	6.99	7.44	8.07
14.0	3.98	4.59	5.13	5.62	6.07	6.49	6.88	7.26	7.61	7.95	8.27	8.89	9.46	10.26
16.0	4.92	5.68	6.35	6.95	7.51	8.03	8.52	8.98	9.42	9.83	10.24	11.00	11.71	12.70
18.0	5.95	6.87	7.68	8.41	9.09	9.71	10.30	10.86	11.39	11.90	12.38	13.30	14.16	15.36
20.0	7.07	8.16	9.12	9.99	10.79	11.54	12.24	12.90	13.53	14.13	14.71	15.80	16.82	18.24
25.0	10.20	11.78	13.17	14.43	15.59	16.66	17.67	18.63	19.54	20.41	21.24	22.82	24.29	26.35
30.0	13.78	15.91	17.79	19.48	21.04	22.50	23.86	25.15	26.38	27.55	28.68	30.81	32.80	
40.0	21.92	25.31	28.30	31.00	33.48									
50.0	30.87													
60.0														

Table 3.2-4
APPLICABLE TO ALL SOIL MOISTURE - SOIL TEMPERATURE REGIMES EXCEPT A-3, AND A-1 IN WN, OR, AND ID.

Slope-Effect Table (Topographic Factor, LS)

Percent	Slope Length in Feet													
Slope	10	20	40	60	80	100	110	120	130	140	150	160	180	200
0.2	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10
0.3	0.04	0.05	0.07	0.08	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.11
0.4	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11
0.5	0.05	0.06	0.08	0.08	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
1.0	0.06	0.08	0.10	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.16
2.0	0.10	0.12	0.15	0.17	0.19	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.25
3.0	0.14	0.18	0.22	0.25	0.27	0.29	0.30	0.30	0.31	0.32	0.32	0.33	0.34	0.35
4.0	0.16	0.21	0.28	0.33	0.37	0.40	0.42	0.43	0.44	0.46	0.47	0.48	0.51	0.53
5.0	0.17	0.24	0.34	0.41	0.48	0.54	0.56	0.59	0.61	0.63	0.66	0.68	0.72	0.76
6.0	0.21	0.30	0.43	0.52	0.60	0.67	0.71	0.74	0.77	0.80	0.82	0.85	0.90	0.95
8.0	0.31	0.44	0.63	0.77	0.89	0.99	1.04	1.09	1.13	1.17	1.21	1.25	1.33	1.40
10.0	0.43	0.61	0.87	1.06	1.23	1.37	1.44	1.50	1.56	1.62	1.68	1.73	1.84	1.94
12.0	0.57	0.81	1.14	1.40	1.61	1.80	1.89	1.98	2.06	2.14	2.21	2.28	2.42	2.55
14.0	0.73	1.03	1.45	1.78	2.05	2.29	2.41	2.51	2.62	2.72	2.81	2.90	3.08	3.25
16.0	0.90	1.27	1.80	2.20	2.54	2.84	2.98	3.11	3.24	3.36	3.48	3.59	3.81	4.01
18.0	1.09	1.54	2.17	2.66	3.07	3.43	3.60	3.76	3.92	4.06	4.21	4.34	4.61	4.86
20.0	1.29	1.82	2.58	3.16	3.65	4.08	4.28	4.47	4.65	4.83	5.00	5.16	5.47	5.77
25.0	1.86	2.63	3.73	4.56	5.27	5.89	6.18	6.45	6.72	6.97	7.22	7.45	7.90	8.33
30.0	2.52	3.56	5.03	6.16	7.11	7.95	8.34	8.71	9.07	9.41	9.74	10.06	10.67	11.25
40.0	4.00	5.66	8.00	9.80	11.32	12.65	13.27	13.86	14.43	14.97	15.50	16.01	16.98	17.90
50.0	5.64	7.97	11.27	13.81	15.94	17.82	18.69	19.53	20.32	21.09	21.83	22.55	23.91	25.21
60.0	7.32	10.35	14.64	17.93	20.71	23.15	24.28	25.36	26.40	27.39	28.36	29.29	31.06	32.74

SLOPE-EFFECT USING TOPOGRAPHIC FACTOR LS

TABLE 3.2-5

APPLICABLE TO SOIL MOISTURE - SOIL TEMPERATURE REGIMES A-3 AND A-1 IN WN, OR, AND ID,

PERCENT SLOPE	SLOPE LENGTH IN FEET 10	20	40	60	80	100	110	120	130	140	150	160	180	200
0.2	0.04	0.05	0.06	0.07	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.10	0.10
0.3	0.04	0.05	0.07	0.07	0.08	0.09	0.09	0.09	0.09	0.10	0.10	0.10	0.10	0.11
0.4	0.05	0.06	0.07	0.08	0.09	0.09	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11
0.5	0.05	0.06	0.07	0.08	0.09	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.12	0.12
1.0	0.06	0.08	0.10	0.11	0.12	0.13	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.16
2.0	0.10	0.12	0.15	0.17	0.19	0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24	0.25
3.0	0.14	0.18	0.22	0.25	0.27	0.29	0.29	0.30	0.31	0.32	0.32	0.33	0.34	0.35
4.0	0.19	0.24	0.29	0.33	0.36	0.39	0.40	0.41	0.42	0.43	0.44	0.44	0.46	0.48
5.0	0.25	0.31	0.38	0.43	0.47	0.50	0.51	0.53	0.54	0.55	0.56	0.58	0.60	0.62
6.0	0.32	0.39	0.48	0.54	0.59	0.63	0.65	0.66	0.68	0.70	0.71	0.72	0.75	0.77
8.0	0.47	0.57	0.71	0.80	0.87	0.93	0.96	0.98	1.01	1.03	1.05	1.07	1.11	1.14
10.0	0.63	0.78	0.96	1.08	1.18	1.26	1.30	1.33	1.37	1.40	1.43	1.45	1.51	1.55
12.0	0.80	0.99	1.22	1.37	1.50	1.60	1.65	1.69	1.73	1.77	1.81	1.84	1.91	1.97
14.0	0.98	1.21	1.49	1.68	1.83	1.96	2.01	2.07	2.12	2.16	2.21	2.25	2.33	2.41
16.0	1.17	1.44	1.77	2.00	2.18	2.33	2.39	2.46	2.52	2.57	2.63	2.68	2.77	2.86
18.0	1.36	1.67	2.06	2.33	2.54	2.71	2.79	2.86	2.93	3.00	3.06	3.12	3.23	3.34
20.0	1.56	1.92	2.36	2.67	2.91	3.11	3.20	3.28	3.36	3.44	3.51	3.58	3.71	3.83
25.0	2.08	2.56	3.16	3.56	3.89	4.15	4.28	4.39	4.49	4.60	4.69	4.78	4.96	5.11
30.0	2.64	3.25	4.00	4.52	4.92	5.27	5.42	5.56	5.70	5.83	5.95	6.06	6.28	6.48
40.0	3.84	4.72	5.81	6.57	7.16	7.65	7.88	8.08	8.28	8.47	8.64	8.81	9.13	9.42
50.0	5.13	6.31	7.77	8.78	9.57	10.23	10.53	10.80	11.07	11.32	11.55	11.78	12.20	12.59
60.0	6.50	8.00	9.85	11.12	12.13	12.97	13.34	13.69	14.03	14.34	14.64	14.93	15.47	15.96

TABLE 3.2-5 (Continued)

PERCENT SLOPE	SLOPE LENGTH IN FEET 300	400	500	600	700	800	900	1000	1100	1200	1300	1500	1700	2000
0.2	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.20
0.3	0.12	0.13	0.14	0.15	0.16	0.16	0.17	0.17	0.18	0.18	0.19	0.20	0.20	0.21
0.4	0.13	0.14	0.15	0.16	0.17	0.17	0.18	0.18	0.19	0.20	0.20	0.21	0.22	0.23
0.5	0.14	0.15	0.16	0.17	0.18	0.18	0.19	0.20	0.20	0.21	0.21	0.22	0.23	0.24
1.0	0.18	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.26	0.27	0.28	0.29	0.30	0.32
2.0	0.28	0.30	0.32	0.34	0.36	0.37	0.39	0.40	0.41	0.42	0.43	0.45	0.47	0.49
3.0	0.40	0.43	0.46	0.49	0.51	0.53	0.55	0.57	0.59	0.60	0.62	0.64	0.67	0.70
4.0	0.54	0.58	0.63	0.66	0.69	0.72	0.75	0.77	0.79	0.81	0.83	0.87	0.90	0.95
5.0	0.70	0.76	0.81	0.86	0.90	0.93	0.97	1.00	1.03	1.05	1.08	1.13	1.17	1.23
6.0	0.87	0.95	1.02	1.08	1.13	1.17	1.22	1.25	1.29	1.33	1.36	1.42	1.47	1.54
8.0	1.29	1.41	1.51	1.59	1.67	1.73	1.80	1.85	1.91	1.96	2.01	2.09	2.17	2.28
10.0	1.76	1.91	2.05	2.16	2.26	2.36	2.44	2.52	2.59	2.66	2.73	2.84	2.95	3.10
12.0	2.22	2.43	2.59	2.74	2.87	2.99	3.09	3.19	3.29	3.37	3.45	3.61	3.74	3.93
14.0	2.72	2.96	3.17	3.35	3.51	3.65	3.78	3.90	4.01	4.12	4.22	4.41	4.57	4.80
16.0	3.23	3.53	3.77	3.98	4.17	4.34	4.50	4.64	4.78	4.90	5.02	5.24	5.44	5.71
18.0	3.77	4.11	4.39	4.64	4.86	5.06	5.24	5.41	5.57	5.71	5.85	6.11	6.34	6.66
20.0	4.32	4.71	5.04	5.32	5.57	5.80	6.01	6.20	6.38	6.55	6.71	7.00	7.27	7.64
25.0	5.78	6.30	6.73	7.11	7.45	7.75	8.03	8.29	8.53	8.76	8.97	9.36	9.72	10.21
30.0	7.32	7.98	8.53	9.01	9.44	9.83	10.18	10.51	10.81	11.10	11.37	11.87	12.32	12.94
40.0	10.64	11.60	12.40	13.10	13.72	14.28	14.80	15.27	15.71	16.13	16.52	17.25	17.91	18.80
50.0	14.22	15.51	16.58	17.51	18.34	19.09	19.78	20.41	21.00	21.56	22.08	23.05	23.93	25.13
60.0	18.03	19.65	21.01	22.19	23.24	24.20	25.07	25.87	26.62	27.32	27.99	29.22	30.33	31.85

Table 3.2-6

APPROXIMATE WEIGHTS OF SOILS IN LBS. PER CUBIC FT. AND CONVERSION FACTORS

Soils	Volume Wt. lb./cu. ft.	Conversion Factors Ac. Inches	Ac. Ft.	Tons to Cu. Yds.
Sands and loamy sands	110	0.005	0.00042	0.67
Sandy loam	105	0.0052	0.00044	0.71
Fine sandy loam	100	0.0055	0.00046	0.74
Loam	90	0.0061	0.00051	0.82
Silt loam	85	0.0065	0.00054	0.87
Silty clay loam	80	0.0069	0.00057	0.93
Clay loam	75	0.0073	0.00061	0.99
ilty, sandy clay and clay	70	0.0079	0.00066	1.06
Aerated Sediment	80*	0.0069	0.00057	0.93
Saturated Sediment	60*	0.0092	0.00077	1.24

*These are the approximate aerated and saturated weights tc be used at damage sites (Streams or reservoirs)

Display 3.3-1
Transect
Highlead Logging Data

Location and Size

Acres	80
County	Yamhill
Lat. N	45°00'
Long. W	123°30'

Average Buffer Data

Percent Slope to Channel	42
Slope length to channel	200
Future Slope length/channel	220

Average C Factor Elements

	Present	Future
Effective Canopy Cover Percent	60	60
Effective Canopy Height feet	4	4
Root Network Percent	70	91

Average Transect Data

Transect Elements	Present				Future			
	Log paths	Road Land	Fire Trail	Un-dist.	Log paths	Road Land	Fire Trail	Un-dist.
% Bare Ground	5.0	3.0	5.3	-	3.0	2.5	3.5	-
% Protected Ground	3.7	2.0	3.0	78.0	3.7	2.0	3.0	81.3
% Slope	34	5	30	-	34	5	30	-
Slope Length	133	40	55	-	107	30	20	-
% Area	8.7	5.0	8.3	78.0	6.7	5.5	6.5	81.3

Display 3.3-2

U.S. DEPT. AGRICULTURE HANDBOOK 18

FIELD DETERMINATION OF SOIL TEXTURE CLASS

The determination of soil class is still made in the field mainly by feeling of the soil with the fingers, sometimes supplemented by examination under the hand lens. This requires skill and experience, but good accuracy can be had if the field scientist frequently checks against laboratory results, especially for each soil varying widely from other soils of the area in structure, consistence, and content of organic matter. Moist soil feels different to the fingers than dry soil. Frequently clay particles are grouped into small hard aggregates that give a feel of silt or sand when dry. Because of differences in relative size within the clay fraction itself, soil horizons of similar total clay content vary in physical properties. Variations in kind of clay or in other constituents may give a soil unusual hardness, suggesting a high amount of clay, or an unusual granulation, suggesting a low amount of clay. The soil must be well moistened and rubbed vigorously between the fingers for a proper designation of textural class by feel.

For many years, the field determination of soil textural class actually took precedence over the results of mechanical analyses, which served only as general guides. Some 25 years ago the late Professor C. F. Shaw[5/] worked out the following definitions of the basic soil textural classes in terms of field experience and feel:

Sand: Sand is loose and single-grained. The individual grains can readily be seen or felt. Squeezed in the hand when dry it will fall apart when the pressure is released. Squeezed when moist, it will form a cast, but will crumble when touched.

Sandy Loam: A sandy loam is a soil containing much sand but which has enough silt and clay to make it somewhat coherent. The individual sand grains can readily be seen and felt. Squeezed when dry, it will form a cast which will readily fall apart, but if squeezed when moist a cast can be formed that will bear careful handling without breaking.

Loam: A loam is a soil having a relatively even mixture of different grades of sand and of silt and clay. It is mellow with a somewhat gritty feel, yet fairly smooth and slightly plastic. Squeezed when dry, it will form a cast that will bear careful handling, while the cast formed by squeezing the moist soil can be handled quite freely without breaking.

Silt Loam: A silt loam is a soil having a moderate amount of the fine grades of sand and only a small amount of clay, over half of the particles being of the size called "silt." When dry it may appear cloddy but the lumps can be readily broken, and when pulverized it feels soft and floury. When wet the soil readily runs together and puddles. Either dry or moist it will form casts that can be freely handled without breaking, but when moistened and squeezed between thumb and finger it will not "ribbon" but will give a broken appearance.

Clay Loam: A clay loam is a fine textured soil which usually breaks into clods or lumps that are hard when dry. When the moist soil is pinched between the thumb and finger it will form a thin "ribbon" which will break readily, barely sustaining its own weight. The moist soil is plastic and will form a cast that will bear much handling. When kneaded in the hand it does not crumble readily but tends to work into a heavy compact mass.

Clay: A clay is a fine textured soil that usually forms very hard lumps or clods when dry and is quite plastic and usually sticky when wet. When the moist soil is pinched out between the thumb and fingers it will form a long, flexible "ribbon." Some fine clays very high in colloids are friable and lack plasticity in all conditions of moisture (does not apply to soils that have oxidic mineralogy).

5/ Shaw, C.F. A Definition of Terms Used in Soil Literature. 1st Intl Cong. Soil Sci. Proc. & Papers 5:38-64. Washington. 1928

DISPLAY 3.3-3

COMPUTING INDIVIDUAL STORM EI FROM RECORDING RAINGAGE READINGS[1/]

. . . 1 . . . 2 . . . 3 . . . 4 . . . 5 . . . 6 . . . 7 . . . 8 . . .

Time	Time Interval	Accumulated Depth	Depth for the Interval	$\frac{④ \times 60}{②}$ Internal Intensity	Table 3.2-3 Energy Per Inch	④ x ⑥ Energy Increment	⑦ + ⑧ Accumulated Energy
	Min.	Inches	Inches	In/Hr	Hundreds Ft - Tons	Hundreds Ft - Tons	Hundreds Ft - Tons
3:51p	0	0					
			.04	.60	8.43	.34	.34
3:55	4	.04					
			.35	4.20	11.22	3.93	4.27
4:00	5	.39					
			.10	3.00	10.74	1.07	5.34
4:02	2	.49					
			.02	.60	8.43	.17	5.51
4:04	2	.51					
			.02	.20	6.85	.14	5.65
4:10	6	.53					
			.01	.12	6.11	.06	5.71
4:15	5	.54					

MAXIMUM 30 MINUTE INTENSITY: 2 x .54 = 1.08 Inches Per Hour

EI INTERACTION TERM: 5.71 x 1.08 = 6.17 or 6

1/Wischmeier, W.H., File Report, West Tech. Serv. Ctr., SCS.

DISPLAY 3.3-4

EVALUATION OF C

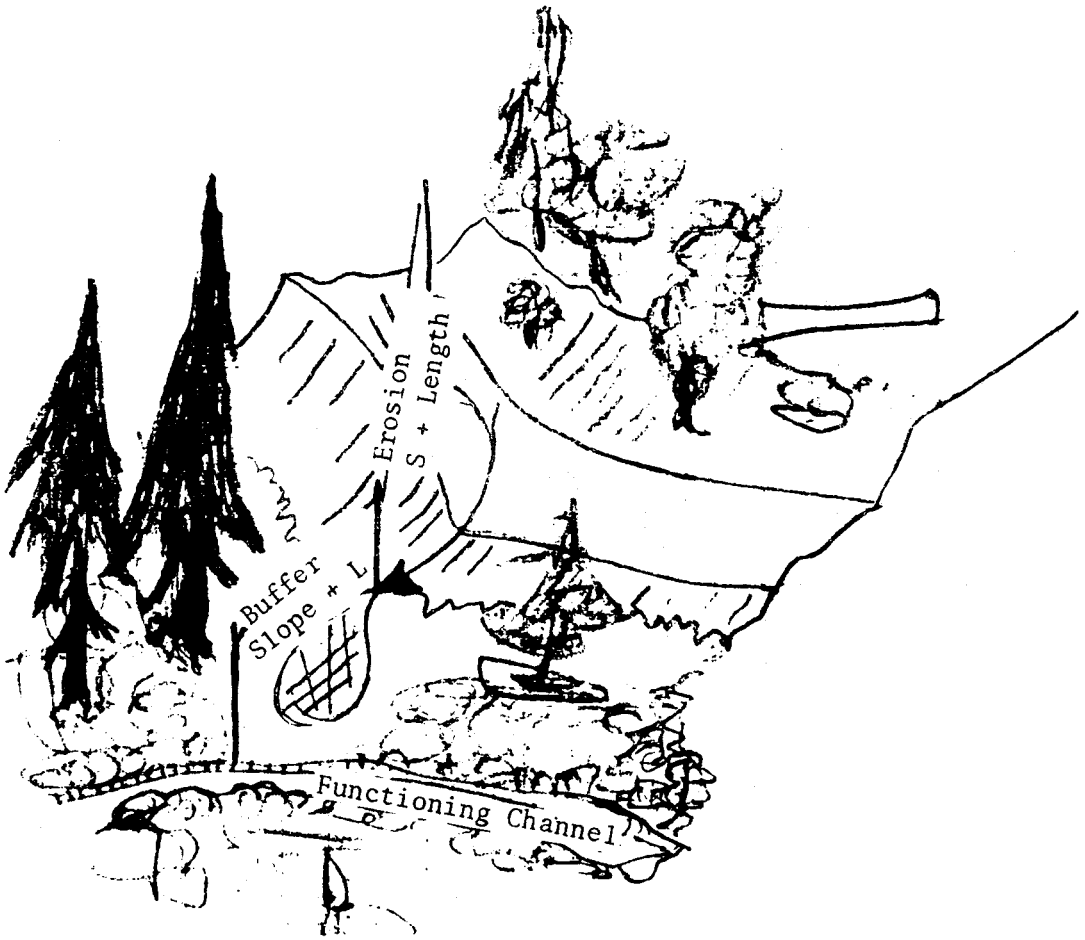
TYPE 1	TYPE II = [1 - (RE_C)(BR. GRD.)]	TYPE III
87% PROT. GR.	TOTAL RAINFALL ENERGY 60% CANOPY (FROM FIG. 3.1-2 42 REDUCTION)	70% FOREST ROOT
	.13 BR. G. | .87 DUFF	
.08	[1-(.42)(.13)] = .95	.13
	C = (.08)(.95)(.13) = .01	

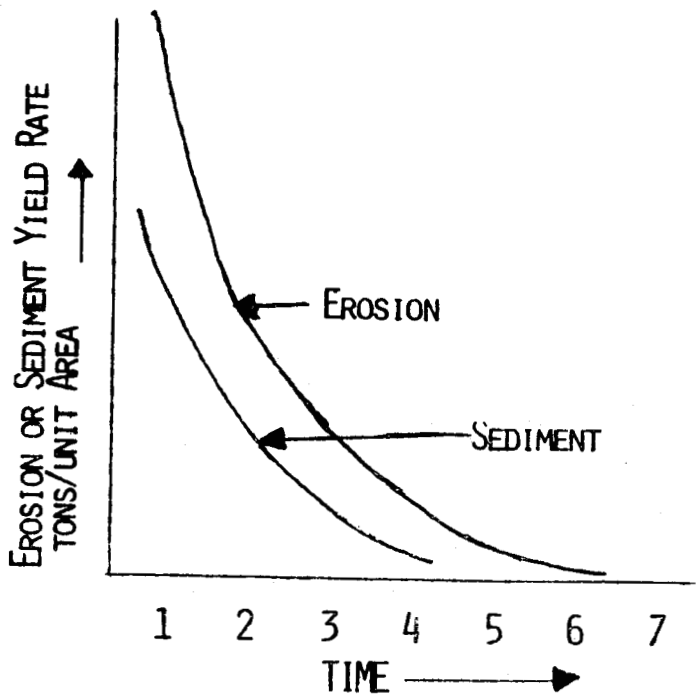
NOTE: (.42)(.13) = .05 ENERGY REDUCTION

ENERGY = 1-(.05) = .95

DISPLAY 3.3-5

SLOPE LENGTH MEASUREMENTS



DISPLAY 3.3-6

PROJECTION OF EROSION AND SEDIMENT YIELD RATES