Estimating Soil Loss From Gully Erosion

ESTIMATING SOIL LOSS FROM GULLY EROSION - EPHEMERAL OR CLASSIC

Definitions

Ephemeral Gully - a shallow channel cut by concentrated runoff where soil loosened by mechanical operations is removed, generally between tillage operations. An ephemeral gully typically erodes to the tilled depth. If untreated, the ephemeral gully may develop into a classic gully over time. In general, this type of gully can be crossed with farm equipment and obliterated with tillage. Although tillage removes the visible erosion, tillage moves soil into the voided area and loosens soil material for the next rainfall event.

Classic Gully - a channel or miniature valley cut by concentrated runoff into the earth, but through which water commonly flows only during and immediately after rains or during the snow melt period. A gully may be either branching or linear (long, narrow, and of uniform width) with a width and depth that prevents normal tillage operations across the gully.

Procedures

When an ephemeral gully is actively eroding:

Ephemeral gullies are shallow cuts (often less than 1 foot deep) and generally have nearly vertical sides. Therefore, a difference in the top width and bottom width is not significant. Refer to Tables 1, 2, 3, and 4 for estimated erosion rates associated with different depth, width, and length combinations. For ephemeral gully dimensions (width, depth or length) that exceed the increments shown in these tables, combine the erosion rates from two or more columns that equate to the actual size.

The tables are based on the following formula. This formula may be used to estimate the ephemeral gully soil loss in lieu of using the tables (see Figure 1):

$$\mathbf{L \times W \times D_i / 12 = V}$$

Where: **L** is the total length in feet;
W is the average width in feet;
$\mathbf{D_i}$ is the average depth measured in inches; and
V is the displaced volume in cubic feet.

To convert this calculated volume into a weight of soil lost since the last tillage operation, use the following formula:

$$(V \times 90 / 2000) \times N / Y = E$$

Where: **V** is the volume in cubic feet calculated above;
90 is the average weight of soil in pounds per cubic foot;
2000 is the weight in pounds per ton;
N is the number of similar ephemeral gullies;
Y is the number of years the gully has been active; and
E is the current soil loss in tons per year.

NOTE: Ephemeral gully erosion occurs between seasonal tillage operations. The number of years (Y) that the gully has been active will always be equal to 1 for an ephemeral gully. On intensively tilled cropland, ephemeral gullies may form and reform between tillage operations in any given year. The formula above calculates the erosion that occurred since the most recent tillage operation.

When the entire classic gully is actively eroding:

Use the following direct computation method where the entire classic gully is actively eroding due to a lack of vegetation or surface armor. The following formula will be used to estimate the soil loss of the entire voided area in cubic feet:

$$L \times [(W_t + W_b) / 2] \times D_f = V$$

Where: **L** is the total length in feet;
W_t is the average top width in feet;
W_b is the average bottom width in feet;
D_f is the average depth measured in feet; and
V is the displaced volume in cubic feet.

To convert this calculated volume into a weight of soil lost over time (tons per year), use the following formula:

$$[(V \times 90 / 2000) / Y] \times N = E$$

Where: **V** is the volume in cubic feet calculated above;
90 is the average weight of soil in pounds per cubic foot;
2000 is the weight in pounds per ton;
Y is the number of years the gully has been active;
N is the number of similar classic gullies; and
E is the soil loss in tons per year.

NOTE: The number of years the gully has been actively eroding is important in gauging the severity of the total erosion. A determination of the beginning date is critical (use aerial photos, producer knowledge, etc. to estimate the year erosion started).

When portions of a classic gully are actively eroding:

This procedure is for use where major portions of the gully are stabilized with vegetation or surface armor, but erosion is occurring either as downward cutting or headward progression and enlargement of the gully in defined areas. This erosion may be visible as any of the following processes:

a) overfall erosion at a headcut;
b) mass sloughing of the gully sides or headcut.

Estimate annual soil loss in cubic feet from the actively eroding areas within the gully. Active areas may be:

a. Headcuts where:

Vertical Depth* x Average Width* x Estimated Annual Progression* = V

b. Bank Sloughing where:

Height* x Length* x Annual Sloughing Section Thickness* = V

.

NOTE: Any measurement designated with an asterisk (*) must be in units of "feet" and representative of an average value.

Add all individual erosion estimates (V) calculated for items a and b above to determine a total sum of the soil loss in cubic feet. Determine the annual loss by the following formula:

(V x 90) / 2000 = E

Where: **V** is the total volume in cubic feet of soil loss;
90 is the average weight of soil in pounds per cubic foot;
2000 is the weight in pounds per ton; and
E is the soil loss in tons per year.

NOTE: Soil loss estimates will be rounded and reported as whole numbers. A decimal number of .50 or greater will be rounded up to the nearest whole number. A decimal number less than .50 will be rounded down to the nearest whole number.

ESTIMATED TONS OF EPHEMERAL GULLY EROSION*

TABLE 1 - DEPTH OF EROSION EQUALS ***2 INCHES***

L (ft) \ W (ft)	1	2	3	4	5	6	7	8	9	10
25	**	**	1	1	1	1	1	2	2	2
50	**	1	1	2	2	2	3	3	3	4
75	1	1	2	2	3	3	4	5	5	6
100	1	2	2	3	4	5	5	6	7	8
125	1	2	3	4	5	6	7	8	8	9
150	1	2	3	5	6	7	8	9	10	11
175	1	3	4	5	7	8	9	11	12	13
200	2	3	5	6	8	9	11	12	14	15
225	2	3	5	7	8	10	12	14	15	17
250	2	4	6	8	9	11	13	15	17	19
275	2	4	6	8	10	12	14	17	19	21
300	2	5	7	9	11	14	16	18	20	23

TABLE 2 - DEPTH OF EROSION EQUALS ***4 INCHES***

L (ft) \ W (ft)	1	2	3	4	5	6	7	8	9	10
25	**	1	1	2	2	2	3	3	3	4
50	1	2	2	3	4	5	5	6	7	8
75	1	2	3	5	6	7	8	9	10	11
100	2	3	5	6	8	9	11	12	14	15
125	2	4	6	8	9	11	13	15	17	19
150	2	5	7	9	11	14	16	18	20	23
175	3	5	8	11	13	16	18	21	24	26
200	3	6	9	12	15	18	21	24	27	30
225	3	7	10	14	17	20	24	27	30	34
250	4	8	11	15	19	23	26	30	34	38
275	4	8	12	17	21	25	29	33	37	41
300	5	9	14	18	23	27	32	36	41	45

* Based on 0.00048 ac-ft/ton, Engineering Field Handbook, pg. MO-10-3, Table 3
** Insignificant amount (less than 1 ton)

ESTIMATED TONS OF EPHEMERAL EROSION*

TABLE 3 - DEPTH OF EROSION EQUALS ***6 INCHES***

W (ft) / L (ft)	1	2	3	4	5	6	7	8	9	10
25	1	1	2	2	3	3	4	5	5	6
50	1	2	3	5	6	7	8	9	10	11
75	2	3	5	7	8	10	12	14	15	17
100	2	5	7	9	11	14	16	18	20	23
125	3	6	8	11	14	17	20	23	25	28
150	3	7	10	14	17	20	24	27	30	34
175	4	8	12	16	20	24	28	32	35	39
200	5	9	14	18	23	27	32	36	41	45
225	5	10	15	20	25	30	35	41	46	51
250	6	11	17	23	28	34	39	45	51	56
275	6	12	19	25	31	37	43	50	56	62
300	7	14	20	27	34	41	47	54	61	68

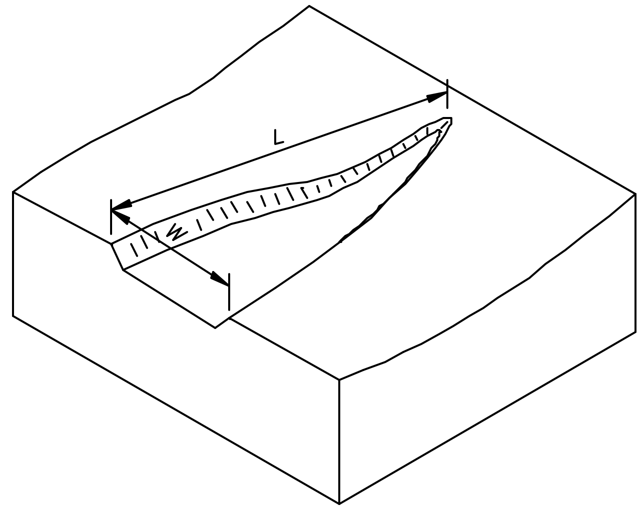
TABLE 4 - DEPTH OF EROSION EQUALS ***8 INCHES***

W (ft) / L (ft)	1	2	3	4	5	6	7	8	9	10
25	1	2	2	3	4	5	5	6	7	8
50	2	3	5	6	8	9	11	12	14	15
75	2	5	7	9	11	14	16	18	20	23
100	3	6	9	12	15	18	21	24	27	30
125	4	8	11	15	19	23	26	30	34	38
150	5	9	14	18	23	27	32	36	41	45
175	5	11	16	21	26	32	37	42	47	53
200	6	12	18	24	30	36	42	48	54	60
225	7	14	20	27	34	41	47	54	61	68
250	8	15	23	30	38	45	53	60	68	75
275	8	17	25	33	41	50	58	66	74	83
300	9	18	27	36	45	54	63	72	81	90

* Based on 0.00048 ac-ft/ton, Engineering Field Handbook, pg. MO-10-3, Table 3
** Insignificant amount (less than 1 ton)

EXAMPLE EROSION CALCULATIONS

Example 1: Ephemeral Gully Erosion:

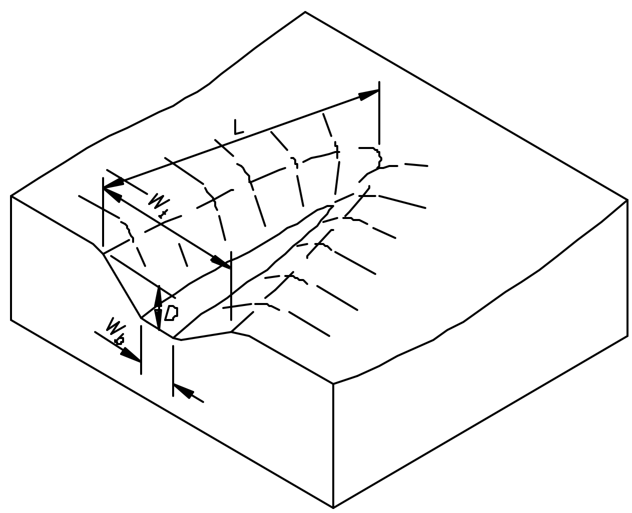


If: W = 8 feet
D_i = 6 inches
L = 125 feet
Then:
125 x 8 x 6 / 12 = 500 ft^3

And:
(500 x 90 / 2000) / 1 = 22.5

Round this value to 23 tons per year.

Example 2: Classic Gully Erosion



If: W_t = 20 feet
W_b = 8 feet
D_f = 7 feet
L = 125 feet

Then:

125 x [(20 + 8) / 2] x 7 = 12,250 ft^3

And erosion occurred over a 10 year period:

[(12,250 x 90) / 2000] / 10 = 55.13 tons per year

Round this value to 55 tons per year.

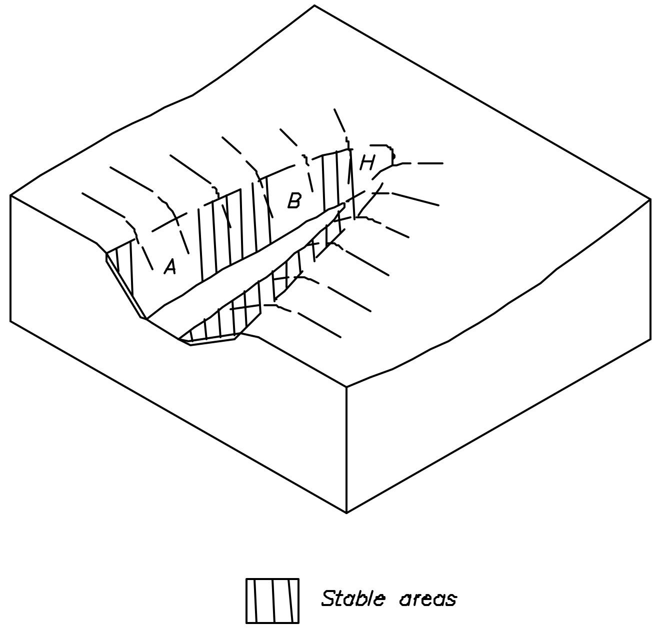
Example 3: Classic Gully Portions Actively Eroding

H (headcut): 3 ft. vertical depth
6 ft. wide
5 ft. annual regression
V = 3 x 6 x 5
V = 90 ft^3

A (sloughing): 8 ft. high
20 ft. long
1 ft. thick
V = 8 x 20 x 1
V = 160 ft^3

B (sloughing): 4 ft. high
15 ft. long
0.5 ft. thick
V = 4 x 15 x 0.5
V = 30 ft^3

Total V = 90 + 160 + 30 or 280 ft^3



And: 280 x 90 / 2000 = 12.6 tons per year (use 13 tons)

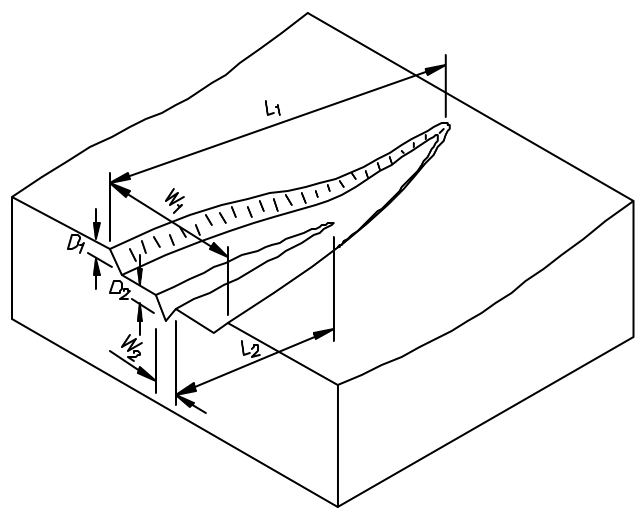
Example 4: Ephemeral and Classic Gully Combination:

Ephemeral Gully Erosion:

If: W_1 = 10 feet
D_1 = 8 inches
L_1 = 150 feet

Then: V = 150 x 10 x 8 / 12
V = 1000 ft^3

And: E = (1000 x 90 / 2000) / 1
E = 45 tons per year



Classic Gully Erosion:

If: W_2 = 3 feet
D_2 = 3 feet
L_2 = 90 feet

Then: V = 90 x (3 + 0 / 2) x 3
V = 405 ft^3

And: E = (405 x 90 / 2000) / 1
E = 18.23 tons per year (use 18 tons)

Total Erosion = 45 tons per year + 18 tons per year = 63 tons per year