

INTRODUCTION TO WATER EROSION

Water Erosion Processes

Detachment – The primary mechanism of detachment in the water erosion process is raindrop impact. As raindrops strike the soil surface they dislodge soil particles and can destroy soil aggregates making the individual soil particles more susceptible to detachment and transportation. Suspended sediment in concentrated flow causes further soil loss by scouring the bottom and sides of the channel.

Transport – The primary mechanisms of transport in the water erosion process are raindrop splash and flowing water. Raindrop splash coupled with sheet flow contributes significantly to soil movement in the field but its short term effects are difficult to see. Concentrated flow areas such as rills and gullies generally contribute less to overall soil loss and movement in the field, but the impact is much more noticeable.

Deposition – Deposition occurs when the energy of the flowing water is no longer capable of carrying the suspended sediment. Sediment can be deposited near where it was detached in small depressions or between rows. This is called local deposition. Sediment can also be deposited some distance from where it was detached on foot slopes, along the upper edges of buffer strips, in terrace channels and grassed waterway, and in impoundments such as water and sediment control basins. This is known as remote deposition. Sediment can also leave the field entirely where it contributes to water quality degradation in streams, rivers, lakes and wetlands.

Types of Water Erosion

There are three types of water erosion: sheet, rill and gully. Sheet, or interrill, erosion is the relatively uniform loss of soil from the entire soil surface. Soil particles are detached by raindrop impact and transported down slope by raindrop splash and sheet flow. Rill erosion occurs when runoff is concentrated in small channels. Soil particles are detached by a combination of raindrop impact and channel scouring action associated with suspended sediment in the runoff water. Flowing water is the primary transport mechanism. Gully erosion occurs when rills converge into larger channels. Gullies are further classified as either “ephemeral” or “classic” depending on whether or not the gully can be crossed by farm equipment. Guidance for identifying and controlling sheet and rill erosion, ephemeral gully erosion and classic gully erosion is given below.

Sheet and Rill Erosion

Identification:

Sheet, or interrill, erosion is difficult to identify in the field especially in the absence of channels or areas of concentrated flow because of the relative uniformity of soil loss across the entire slope. Sometimes the only evidence of sheet erosion is the exposure of subsoil on the eroded slope or the accumulation of soil at the bottom of the field.

Rill erosion is much easier to identify. Rills are essentially small channels or gullies located at regular intervals across the slope that can be “erased” by normal tillage operations. Rills may be

any size, but are usually less than 4 inches deep and have one or more of the following characteristics:

- They are generally parallel on a slope, but may converge.
- They are generally of uniform spacing and dimension.
- They generally appear at different locations on the landscape from year to year.
- They are generally shorter than ephemeral gullies.
- They usually end at a concentrated flow channel, a terrace, or an area where the slope flattens and deposition occurs.
- They occur on the same portion of the slope used to determine the length and steepness of slope for the RUSLE2.

The RUSLE2 model is used to estimate the amount of soil loss from sheet and rill erosion.

Control:

Conservation practices which minimize runoff and protect the soil surface are most effective in controlling sheet and rill erosion. These practices include: a conservation crop rotation with one or more soil conserving crops; tillage and residue management systems which maximize the amount of crop residue remaining on the soil surface during critical erosion periods; and use of a cover crop. Additional practices such as contour farming, contour buffer strips, stripcropping and terraces may be required if cropping and residue management practices alone are not adequate to achieve soil loss objectives. RUSLE2 calculations will indicate if additional practices are necessary.

Ephemeral Gully Erosion

Identification:

In general, an ephemeral gully is larger than a rill but smaller than a classic gully. They occur when two or more rills converge to form a deeper and wider channel or in areas of concentrated flow. Ephemeral gullies can be crossed and filled by normal tillage operations but they usually cannot be totally “erased.” Regular filling of ephemeral gullies results in soil deterioration over a larger area than the gully itself because the loose material used to fill the gully is readily available for transport by runoff from the next rainfall event.

Ephemeral gullies have one or more of the following characteristics:

- They are seasonal in nature, occurring on cropland.
- They recur in the same area each time they form rather than randomly at different places on a slope.

- They frequently form in well-defined depressions or natural drainage ways.
- They tend to occur in the upper reaches of a drainage network, where average slopes are greater.
- They are generally wider, deeper, and longer than the rills.
- They can occur in depressions or drainage ways into which rows or tillage marks lead.
- They can form along sloping rows or tillage marks.
- They can occur on terraced fields where overtopping of the terraces occurs or where piping occurs below the terrace embankment.
- They can occur in the channel of gradient terraces.

The amount of soil lost by ephemeral gully erosion **is not** included in the RUSLE2 soil loss estimates. Refer to “Estimating Ephemeral Gully Erosion” on pages 24-26.

Predicting when Planning for Ephemeral Gully Erosion is needed:

Ephemeral gully erosion may not be identified as a resource concern by land users due to its seasonal nature. However, control of ephemeral gully erosion is necessary to achieve resource quality criteria and sustainability. For these reasons, it is important for the planner to be able to identify areas of potential ephemeral gully erosion during the planning process.

Areas where concentrated flow will occur are likely to develop ephemeral gully erosion if control measures are not implemented. Identifying concentrated flow areas using aerial imagery and on-site observation or comparing site conditions with nearby cropped fields with similar topographic features and soils can aid the experienced planner in determining when control measures should be included in conservation plans.

In some cases, the need for control measures may not be obvious to the planner due to small drainages, mild or undulating slopes, or poorly defined drainage patterns. For this reason, an ephemeral gully erosion prediction tool has been developed to estimate whether erosive flow rates can be anticipated for both the existing condition and for the planned crop management system. The [Ephemeral Gully Erosion Prediction Worksheet](#) and instructions for its use are found in the eFOTG Section IV, C. Tools. The worksheet is only a guide to be used when the experience of the planner is insufficient and/or field conditions are marginal as described above. It is not mandatory for planners to use this tool and its use does not supplant good judgment. Refer to the Ephemeral Gully Erosion Prediction Worksheet Instructions for information regarding its use and limitations.

An alternative to using the Ephemeral Gully Erosion Prediction Worksheet is to use the [Ephemeral Erosion Look-up Tool](#) which are also located in the eFOTG Section IV, C. Tools. The look-up tables were developed to provide a “quick” method for analyzing concentrated flow areas to determine if ephemeral erosion treatment practices beyond the planned residue

management system are needed. These tables were developed using the Ephemeral Gully Erosion Prediction Worksheet with the hydrology computed in the background using assumed watershed characteristics.

Due to the general nature of the watershed assumptions used and the broadness of the channel parameters chosen to populate these tables, the user should understand that the results are not precise to a given channel, field or location. If field observation seems to contradict results from the Ephemeral Gully Erosion Look-up Tables, the Look-up table results should be rejected in favor of common sense, planner's experience, and/or calculations done using the Ephemeral Gully Erosion Prediction Worksheet based on hydrology computed using actual watershed characteristics. **These tables are not to be used for any engineering design applications.**

Ephemeral gully erosion can also occur where no concentrated flow areas are obvious due to tillage patterns, row direction or excessive land slope and/or slope length. Excessive slope and slope length can result in ephemeral gully erosion due to the convergence of rills on the lower portion of the slope. The ability to predict this type of ephemeral gully erosion will, once again, depend on the planners experience and local knowledge.

One possible method to determine if ephemeral gully erosion is likely to occur on slopes where concentrated flow is not obvious is also to compare the measured slope length to the terrace spacing interval which would be indicated for the slope and soil (FOTG Sec. IV – 600 – Terraces). If the existing slope length is considerably longer than the indicated terrace spacing interval, it would be reasonable to predict down slope ephemeral gully erosion is likely to occur.

Another method is to compare site conditions with nearby cropped fields with similar slopes, soils, drainage areas and crop management practices. In determining if ephemeral gully erosion is likely to be a problem it is important to always consider the most erosive condition in terms of crop residue cover.

Control:

Grassed waterways are the most effective erosion control practice when ephemeral gully erosion occurs in concentrated flow areas while terraces are the most effective practice when ephemeral gully erosion is associated with excessive slope or slope length. Diversions, water and sediment control basins, contour stripcropping and contour buffer strips are also effective practices for controlling ephemeral gully erosion. Associated management practices such as a conservation crop rotation with one or more soil conserving crops and tillage and residue management systems which maximize the amount of crop residue remaining on the soil surface during critical erosion periods will maximize the effectiveness of the erosion control system.

Sometimes a continuous no-till system which includes one or more soil conserving crops may be sufficient to control ephemeral gully erosion. Refer to Nebraska Agronomy Tech Note 109 "Planning Considerations for Establishing Continuous No-till Cropping Systems on Highly Erodible Land."

http://efotg.nrcs.usda.gov/references/public/NE/Nebraska_Agronomy_Technical_Note-109_Planning_Considerations_for_Establishing_Continuous_No-Till.pdf

When ephemeral gully erosion occurs on areas due to excessive rainfall events, which exceed the 10 yr – 24 hr storm, it is considered an “Act of Nature.” Control measures are not necessary unless ephemeral gully erosion is likely to occur in the future with rainfall events which do not exceed the 10 yr – 24 hr storm.

Classic Gullies

Identification:

Classic gullies are channels that are generally too deep to be crossed by farm equipment or filled using normal tillage operations. Some type of earth moving equipment is generally required to fill them. Gullies also have one or more of the following characteristics:

- They generally occur in depressions and natural drainage ways.
- They may grow or enlarge from year to year by head cutting and lateral widening.
- They may begin as an ephemeral gully that was left untreated and not filled by tillage or other operations.
- They may become partially stabilized by grass, weeds, or woody vegetation.

Soil loss from classic gully erosion is not calculated by the RUSLE2. It can be estimated by measuring the voided areas caused by head cutting and lateral widening. Refer to “Estimating Channel and Gully Erosion” on pages 27-31. “[Gully Erosion Worksheet](#)” is a spreadsheet which is available to estimate the amount of gully erosion

Control:

Grade stabilization structures are the most effective control measure for this type of erosion.