# 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 is the most insidious form of soil erosion in that it 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 there 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 concave slopes, at the upper edge of grass strips, and in terrace channels and impoundments. 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 relatively uniform erosion 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 as it runs off the soil. Gully erosion occurs when rills converge into larger channels. Gully erosion is further identified as “ephemeral” or “classic” depending on whether or not the gully can be crossed by farm equipment. General characteristics of rills, ephemeral gullies, and classic gullies are given below. However, differentiating among them will still require careful judgment.

## Characteristics of Rills

Rills may be any size, but are usually less than 4 inches deep. Rills 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 cropland gullies.

--They usually end at a concentrated flow channel, a terrace, or an area where the slope flattens and deposition occurs.

--They are on the same portion of the slope that is used to determine the length of slope factor (L) for the RUSLE2.

--The amount of soil lost by rill erosion is included in soil loss estimates using RUSLE2.

Conservation practices such as a conservation crop rotation which includes one or more soil conserving crops, tillage and residue management systems such as no-till and mulch till, contour farming, contour stripcropping, and use of a cover crop may be sufficient to control sheet and rill erosion to acceptable levels. RUSLE2 calculations will indicate if additional practices are necessary.

**Characteristics of Ephemeral Gullies**

In general, an ephemeral gully is larger than a rill and smaller than a gully. It usually results from the junction of rills that form a dendritic (branching or tree-like) pattern of channels. It appears on a cultivated field during the planting or growing season and is erased by cultivation. After an ephemeral gully has been in existence for a few years, the area from which soil has been moved can be 100 feet wide or more. Within this area, soil deterioration greater than that caused by sheet erosion has taken place; tillage has moved soil into the ephemeral gully. This loose material is readily available for transport by runoff from the next rain. During the next season or after the next rain, the ephemeral gully reappears in approximately the same place and pattern.

Ephemeral gullies may be of any size but are usually larger than rills. They 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 in natural drainage ways.

--They tend to occur in the upper reaches of a drainage network, where average slopes are greater.

--They generally occur in the direction of field slope perpendicular to field contour, but may have other patterns caused by row alignment or other characteristics of field operations.

--They are generally wider, deeper, and longer than the rills on the field.

--They can occur in depressions into which rows or tillage marks lead.

--They can form along sloping rows or tillage marks.

--They are partially or totally erased and filled by tillage operations. The filling results in soil deterioration over a larger area than the gully itself.

--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 bottom of gradient terraces.

--The amount of soil lost by ephemeral gully erosion is not included in RUSLE2 soil loss estimates.

**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 temporary (by definition) nature. However, control of ephemeral gully erosion is necessary to achieve resource quality criteria (and, hence, 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 (landscape depressions with a drainage pattern) are likely to develop ephemeral gully erosion if control measures are not implemented. Grassed waterways are the most effective treatment for this type of ephemeral gully erosion. Planners with sufficient local knowledge and experience will generally be able to determine when control measures should be included in conservation plans by identifying concentrated flow areas using aerial imagery, on-site observation and comparing site conditions with nearby cropped fields with similar topographic features (and soils).

In some cases, the need for control measures may not be obvious to the planner due to small drainages, mild or undulating slopes, poorly defined drainage patterns, etc… 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 and 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) and it's not mandatory for use and does not supplant good judgment. Refer to the Ephemeral Gully Erosion Prediction Worksheet Instructions for information regarding its use and limitations.

Ephemeral gully erosion can also occur where no concentrated flow areas are obvious. This can occur 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 down slope concentration of rill erosion. 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 analyze on-site conditions to determine if ephemeral gully erosion is likely to occur on slopes where concentrated flow is not obvious, is to compare the measured slope length to the terrace spacing interval that would be indicated for that slope and soil (FOTG Sec. IV – 600 – Terraces). If the existing slope length is considerably longer than the indicated terrace spacing interval, then it would be reasonable to predict that down slope ephemeral gully erosion is likely to occur. Another method is comparative analysis referencing a nearby cropped field with similar topographic features and soils. Conditions include watershed area, peak discharge, and slope of drainage course, cross section of channel, soils, vegetative cover (most erosive condition), crop rotation and residue management.

Terraces are the most effective type of control measure for this type of ephemeral gully erosion. Adding associated management practices such as Residue Management and Contour Farming will maximize the effectiveness of the erosion control system.

Diversions, Contour Stripcropping and Contour Buffer Strips may also be effective structural/vegetative practices for controlling ephemeral gully erosion. Ephemeral gully erosion can also be controlled by converting cropland to perennial vegetation.

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”. The control measures are not necessary, unless ephemeral gully erosion is likely to occur in the future with rainfall events that do not exceed the 10 yr – 24 hr storm.

**Classic Gullies**

Permanent gullies are channels too deep for normal tillage operations to erase. Special operations are required to fill them. Gullies also have one or more of the following characteristics:

--They may grow or enlarge from year to year by head cutting and lateral widening.

--They may also occur in depressions and natural drainage ways.

--They may begin as an ephemeral gully that was left in the field and not erased by tillage or other operations.

--They may become partially stabilized by grass, weeds, or woody vegetation.

-- Erosion from permanent gullies is not calculated by the RUSLE2. It can be estimated by measuring the voided areas caused by head cutting and lateral widening.

Grade Stabilization Structures are the most effective form of control measure for this type of erosion.