



## Best Management Practices

# SOIL EROSION BY WATER

Soil erosion by water is the detachment, transport and deposition of soil particles by flowing water. After intense rainfall and runoff events, it can take the form of concentrated flow. The effects are less conspicuous following regular rainfall events, where small amounts of soil are removed.

Soil erosion is a key form of soil degradation. Left unchecked, it can lead to other forms of soil health problems such as loss of fertility, degraded seedbed structure, and lower infiltration rates.

Water erosion takes three forms: sheet (or inter-rill), rill and gully. This infosheet describes a set of diagnostic tools used to determine the form, nature and extent of erosion by water of Ontario agricultural soils. Proper diagnosis is essential to identify the most effective remedial measures for a given field.

### THE ROLE OF HEALTHY SOIL IN A CHANGING CLIMATE

Agriculture and climate are directly linked – anything that has a significant effect on our climate will influence farm production. Greenhouse gas (GHG) emissions and climate change are global concerns, and agriculture can be part of the solution.

BMPs that improve soil health can also help lower GHG emissions, reduce phosphorus loss from fields to surface water, and improve resilience to drought or excessively wet conditions. Healthy soil – an essential component of a healthy environment – is the foundation upon which a sustainable agriculture production system is built.



# What happens in an erosion-prone soil during a storm event

- Past tillage has pulverized the soil and accelerated the decomposition of soil organic matter.
- If no manure or plant material has been added, soil organic levels drop more quickly.
- Surface seedbed structure weakens and breaks down.
- Surface seals and forms crusts, topsoil compacts, and infiltration rates decrease.
- If soils in this weakened condition are not covered, a rain event will instigate soil erosion.
- Soil particles – usually silts, very fine sands and organic matter – are shed from chunks of soil (peds).
- Loose detached particles become suspended and move with flowing water, or settle gradually in ponded water in depressional areas with reduced infiltration rates.
- Sediment-laden water moving across the soil landscape will follow the path of least resistance downslope.
- If unchecked, finger-like rills are formed, following the downslope direction.
- Unimpeded, finger-sized rills become larger rills and large rills can develop into channels of concentrated flow or gullies.

By removing excess gravitational waters, agricultural drainage systems help cropland soils accommodate precipitation and reduce overland runoff. However, without good infiltration characteristics made possible by a healthy soil, water can't enter the soil, making tile drainage systems less effective in their role.

## THE IMPACT OF SOIL EROSION AND RUNOFF

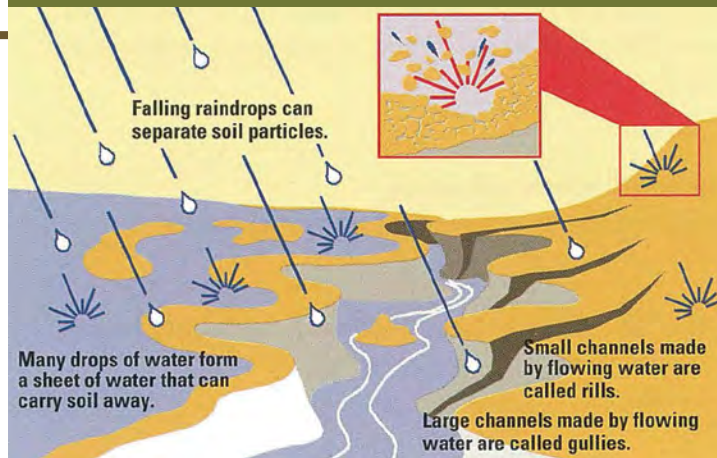
### Loss of topsoil on the farm:

- decreases crop yields
- increases cost of production
- degrades topsoil
- increases runoff and reduces water storage.

### Off the farm, sediment or eroded soil can:

- increase the cost of maintaining drains and shipping channels
- destroy fish habitat and spoil recreational waters
- contaminate surface water, through runoff carrying pathogens, pesticide residues and soil nutrients (e.g. phosphorus).

### SOIL AND SOIL QUALITY LOSSES THROUGH EROSION





# Conditions where soil erosion is likely

All **soil types** can become eroded. Silt loams, very fine sandy loams, and loams are most erosion-prone.

In terms of **topography**, long, steep and irregular slopes can be most acutely affected.

**Past field practices** can contribute to risk of soil erosion by water:

- soils are ploughed and left uncovered each fall
- tillage is up and down slope

- row crops are grown with no or little crop residue returned to the soil or left on the soil surface
- cover crops are not planted
- a fine seedbed is prepared that may have been packed or rolled.



Cropland soils with a high silt and very fine sand content on long, steep slopes are at the highest risk of erosion by water.



Cropping and field practices can put soil at greater risk of erosion. Systems that involve several passes of tillage equipment and leave minimal residue from previous crops (overwinter and after planting) increase erosion risk. Fewer passes and continuous cover of the soil surface protect soil.



Ploughing up and down slope increases the risk of erosion.

# Diagnostic tool to predict soil erosion – USLE / RUSLE2

The Universal Soil Loss Equation (now the Revised Universal Soil Loss Equation, or RUSLE2) is a tool that helps predict soil erosion. Risk factors considered in the equation include:

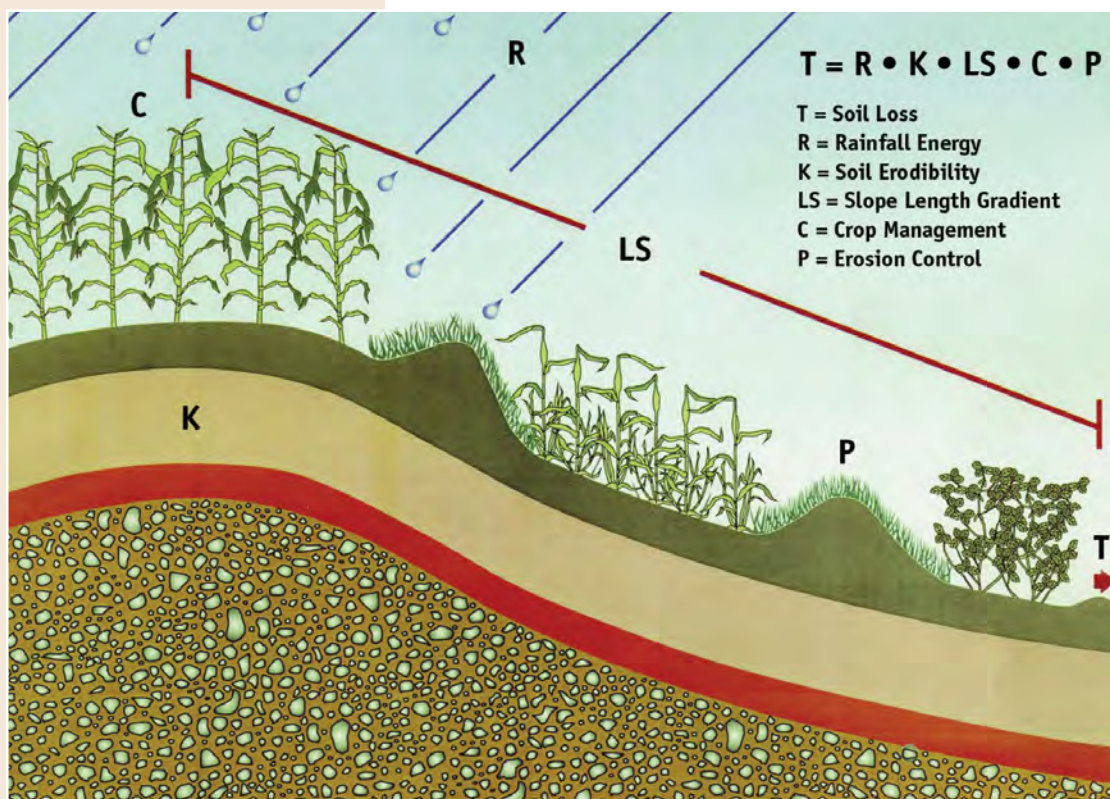
- severity and patterns of precipitation and associated runoff (R)
- the erodibility of the soil particles (K)
- the land's topography, expressed in terms of hill slope length (L) and grade or steepness (S)
- the nature and extent of crop cover, residue cover, and tillage practices (C)
- presence of selected soil conservation practices that shorten slope length and disrupt overland water flow, e.g. contour cropping, terracing (P).

## USLE, RUSLE1, RUSLE2

Since its introduction in 1965, the USLE has undergone many revisions and refinements. In 1978, data from 10,000 plot years of field-measured erosion data collected across North America were incorporated. With the benefit of research findings and rainfall simulation studies to help fill in data gaps, it was revised and released in the 1990s as the Revised Universal Soil Loss Equation (RUSLE). In 2004 it was updated again as RUSLE2 – this time in a computer software format.

Today's RUSLE2 takes the best we have in erosion prediction science to try to evaluate the effect specific field management practices have on the water erosion rates experienced daily, seasonally and annually along a given hill slope within a field.

The factors that affect erosion and runoff relate to rainfall amount and intensity, the length and steepness of the field's hill slopes, soil type, crop management practices in place, and the implementation of physical measures to control erosion.





# What to look for in the field

## SHEET OR INTER-RILL EROSION

Sheet (sometimes called inter-rill) erosion occurs where water begins to flow off the land. Sheet erosion is difficult to see because the soil is lost in a way similar to a few sheets of paper being peeled from a pad. Over time the soil loss affects crop growth.

You have excessive sheet erosion if you see:

- sedimentation at the bottom of the slope with no apparent rills or gullies
- light-coloured knolls or higher stone content on knolls (could also indicate tillage erosion)
- variable crop development and yields across a field, with knolls having lower populations and stunted plants
- in drought conditions, crops on knolls show first signs of stress before the rest of field
- low yields on shoulder slopes and knolls
- in the spring, fall-tilled soil seems to flow together
- ditchbank grass cover is buried with soil
- runoff into surface waters or wetlands.

Loamy soil types are the most vulnerable to sheet erosion, but any soil with poor water infiltration capacity stemming from poor soil health will also be vulnerable. Long gradual slopes or short steep slopes are prone to sheet erosion.

The risk of sheet erosion in Ontario is highest on clean-tilled, steeply sloping fields with saturated medium-textured (e.g. silty) soils – and without intentional practices like terracing or contour ploughing in place to help check water runoff.

One of the clearest diagnostics for erosion by water is the deposition of sediment in lower slope positions after a major rain event.

Eroded knolls are degraded growing sites. The combined moisture stress and nutrient deficiency symptoms shown by these crops are clear indicators of lower fertility and lower water-holding capacities found on eroded knoll landscape positions.



Sediment found on grassed buffers and the top of ditchbanks indicates runoff from upslope cropland.



## GULLY EROSION

Gully erosion may develop further downslope of where sheet and rill erosion is happening and where runoff waters begin to concentrate.

You have gully erosion when:

- rills (eroded channels in field) are so large and deep (i.e. 30–60 cm or 1–2 ft) that you cannot cross them with your tractor and most implements
- eroded channels have to be filled in with tractor (and bucket or blade) or heavy equipment.

Gullies are essentially large rills that form channels that are too wide and deep for equipment to pass over or cover up.



## RILL EROSION

Rill erosion leaves distinct paths where the soil has been washed away, as water concentrates in natural drainage channels and flows down the slope.

The potential for rill erosion is greater with larger contributing watersheds, steeper slopes and confined drainageways.

You are experiencing rill erosion if:

- rills or cuts are formed on the soil surface after a rain or snowmelt
- there is an obvious path where water has been flowing
- you need to slow down when crossing a natural drainageway due to soil erosion
- you see finger-like patterns on sloping fields after runoff events
- seed is exposed in seed trench following intense rain
- crops are buried with soil.

In many cases, rills are filled in each year as part of tillage operations. Don't fool yourself – there is a problem.



Rills can form in the channels formed by tillage tools or wheel tracks, followed by concentrated flow across bare soils.



Rills may form on long, gently sloping (<2% slopes) cropland where erodible soils are not covered following the growing season.

Erosion from concentrated flow can form **rills**. When the rills develop into channels large enough to prevent crossing by farm machinery, these channels are known as **gullies**.



Rill erosion forms clearly visible yet small channels on sloping, erodible cropland.



Gullies that outlet directly into surface waters carry considerable loads of sediment, organic material and crop inputs. Such gullies can also accelerate the rate of bank erosion along watercourses.



# Best management practices

- ✓ Use crop rotations that alternate row crops with solid-seeded crops.
- ✓ Work cover crops and green manure crops into the rotation.
- ✓ Use strip cropping and buffer strips.
- ✓ Till and plant crops across the slope where possible or use a system of contour cropping.
- ✓ Use reduced tillage systems – no-till, minimum tillage or ridge tillage.
- ✓ Use residue management – aim to leave at least 30% crop residue on the soil surface after planting.
- ✓ Improve subsurface drainage throughout field or to areas prone to ponding.
- ✓ Construct erosion control structures and/or surface water management devices where needed once agronomic measures have been considered to help improve soil infiltration and reduce runoff.
- ✓ Consider retirement of erosion-prone lands to trees, shrubs, pollinating species and other habitat-enhancing plants.

## CROP ROTATIONS

Rotating row crops with solid stand cereals, cover crops or forages improves soil health and covers the soil during the off-season. For more information, refer to one of these BMPs for Soil Health factsheets: *Rotation of Agronomic Crops* and *Crop Rotation for Vegetable Crops*.

## RESIDUE MANAGEMENT

Properly managed residue from the previous crop will protect soils from erosion if left on cropland over the winter. For more information, refer to these BMPs for Soil Health factsheets: *No-Till*, *Mulch Tillage*, and *Residue Management*.



## CONTOUR CROPPING

Cropping and tillage across long steep slopes can help reduce the energy of flowing water and lower the risk of erosion. For more information, see the BMPs for Soil Health factsheet *Contour Farming and Strip Cropping*.



## LAND RETIREMENT

Severely eroded areas such as knolls or very steeply sloping hills (<10% slope) may be better-suited to growing trees and shrubs. For more information, refer to the BMPs for Soil Health factsheet *Cropland Retirement*.

## WASCoBS

Well-planned and well-designed water and sediment control basins (WASCoBs) will control erosion and runoff by halting concentrated surface flow, temporarily ponding water to permit sediments to settle, and then safely discharging the water to a subsurface cropland drainage system. For more information, refer to the BMPs for Soil Health factsheet *Erosion Control Structures*.



# For more information

## ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS

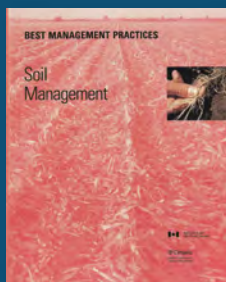
Many sources of supplementary information are available.

Below are some suggestions to get you started. Most can be found online at [ontario.ca/omafra](http://ontario.ca/omafra) or ordered through ServiceOntario.

- Publication 811, *Agronomy Guide for Field Crops*
- Publication 832, *Agricultural Erosion Control Structures*

### Best Management Practices Series

- *Buffer Strips*
- *Controlling Soil Erosion on the Farm*
- *Cropland Drainage*
- *Establishing Tree Cover*
- *Field Crop Production*
- *Soil Management*
- *Water Management*



### Environmental Farm Plan (4<sup>th</sup> ed.) and EFP Infosheets

- #15, *Soil Management*
- #19, *Field Crop Production*
- #21, *Stream, Ditch and Floodplain Management*

### Inquiries to the Ontario Ministry of Agriculture, Food and Rural Affairs

Agricultural Information Contact Centre  
Ph: 1-877-424-1300

Email: [ag.info.omafra@ontario.ca](mailto:ag.info.omafra@ontario.ca)

Web: [ontario.ca/omafra](http://ontario.ca/omafra)

## ORDER THROUGH SERVICEONTARIO

Online at ServiceOntario Publications – [ontario.ca/publications](http://ontario.ca/publications)

By phone through the ServiceOntario Contact Centre

Monday–Friday, 8:30 am–5:00 pm  
416-326-5300

416-325-3408 TTY

1-800-668-9938 Toll-free across Ontario

1-800-268-7095 TTY Toll-free across Ontario

## ACKNOWLEDGEMENTS

This factsheet was developed by the OMAFRA Soils Team: Adam Hayes (Chair), Doug Aspinall, Andrew Barrie, Dave Bray, Christine Brown, Adam Gillespie, Christoph Kessel, Kevin McKague, Jake Munroe, Deanna Nemeth, Nicole Rabe, Jim Ritter, Daniel Saurette, Stewart Sweeney, Ted Taylor, Anne Verhallen

**Technical Coordinators:** H.J. Smith, Ted Taylor

**Research and Writing:** Ann Huber, Don King, Margaret Ribey, Soil Research Group (SRG)

**Editorial Coordinator:** Alison Lane

**Design:** Neglia Design

AF191

ISBN 978-1-4606-9610-1 (Print)

ISBN 978-1-4606-9612-5 (HTML)

ISBN 978-1-4606-9614-9 (PDF)

### BMPs for Soil Health Factsheet Series:

Adding Organic Amendments

Buffer Strips

Contour Farming and Strip Cropping

Cover Crops and Manure

Crop Rotation for Vegetable Crops

Cropland Retirement

Erosion Control Structures

Field Windbreaks

Inter-Seeding Cover Crops

Mulch Tillage

No-Till for Soil Health

Perennial Systems

Pre-plant Cover Crops

Residue Management

Rotation of Agronomic Crops

Soil Remediation

Subsurface Drainage

Wind Strips

Winter Cover Crops

### BMPs for Soil Health Diagnostic Infosheet Series:

Cold and Wet Soils

Contaminated Soils

Droughtiness

Excessive Fertility

Low Fertility

pH Extremes

Salinity

Soil Erosion by Water

Subsidence

Subsurface Compaction

Surface Crusting

Tillage Erosion

Wind Erosion