# TECHNIQUES FOR CONTROLLING SHORELAND EROSION PART 1

# WHAT ARE YOU DEALING WITH?

2017 Wisconsin Lakes Partnership Convention

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# OUTLINE

- Calculating Slopes
- Soil Types
- Erosion Factors – Active / Passive
- Drainage Area Calculation

- Slope is measured by rise over run or vertical over horizontal distance and is expressed as a percentage. Slopes greater than 20%  are not suitable for a Healthy Lakes practice.


$$\text{Slope Percent} = \frac{\text{Rise}}{\text{Run}} \times 100$$

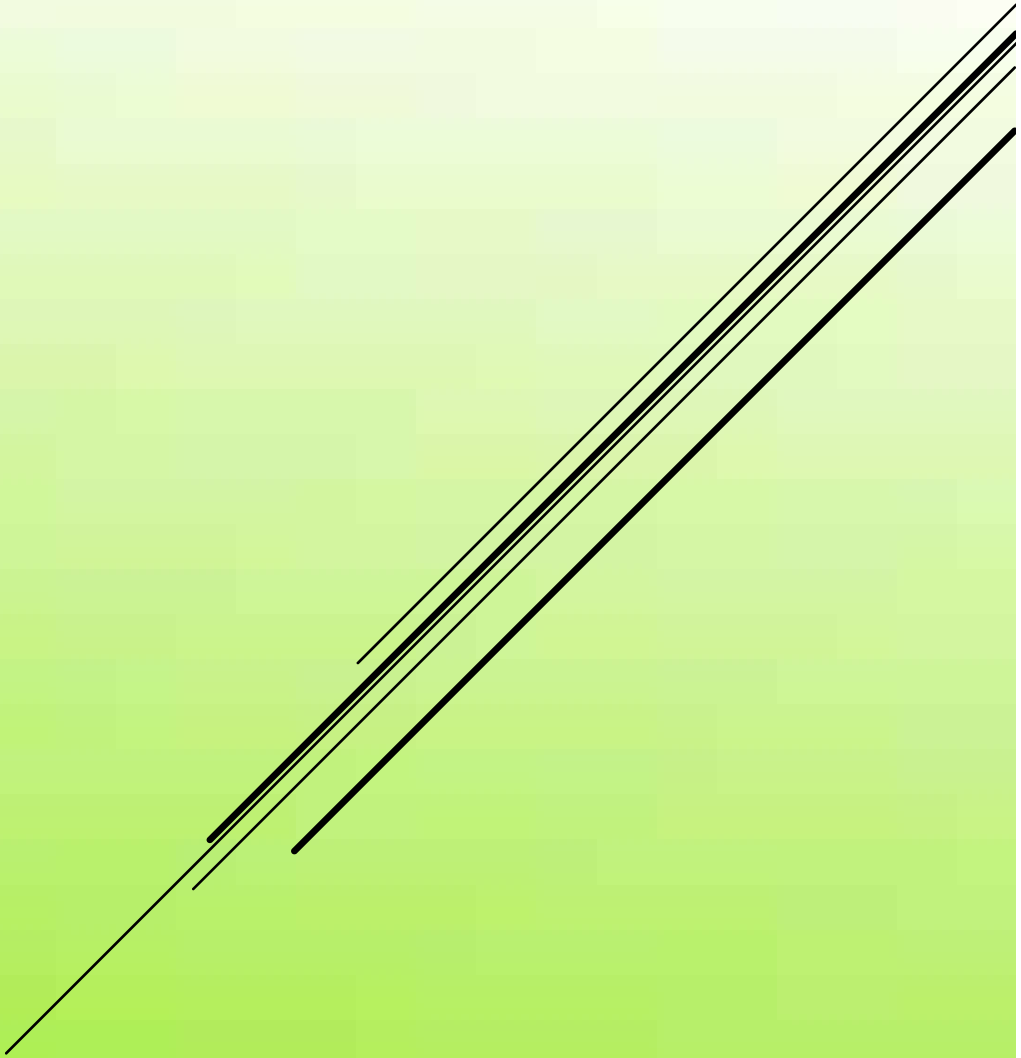
# HOW STEEP IS YOUR SLOPE?

# GRADUAL SLOPE

# STEEP, UNSTABLE, SLOPE

# SOIL TYPES

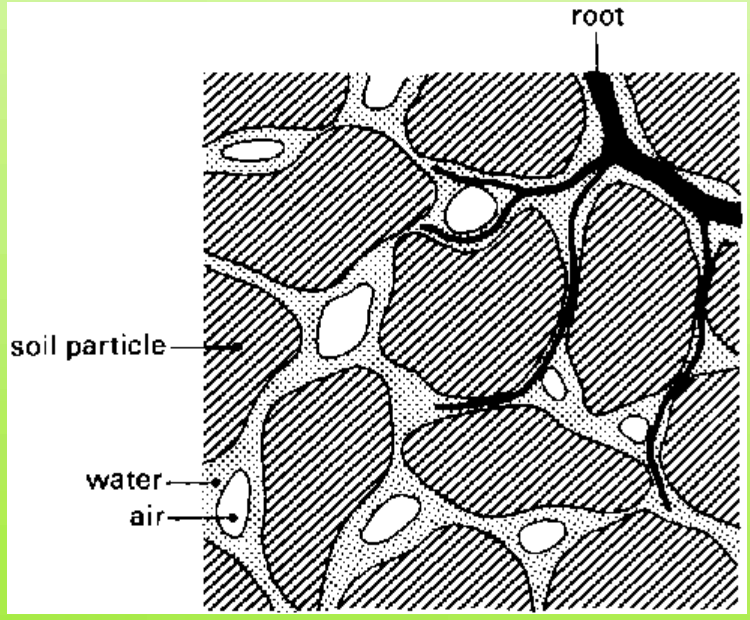
Ability to resist erosion forces

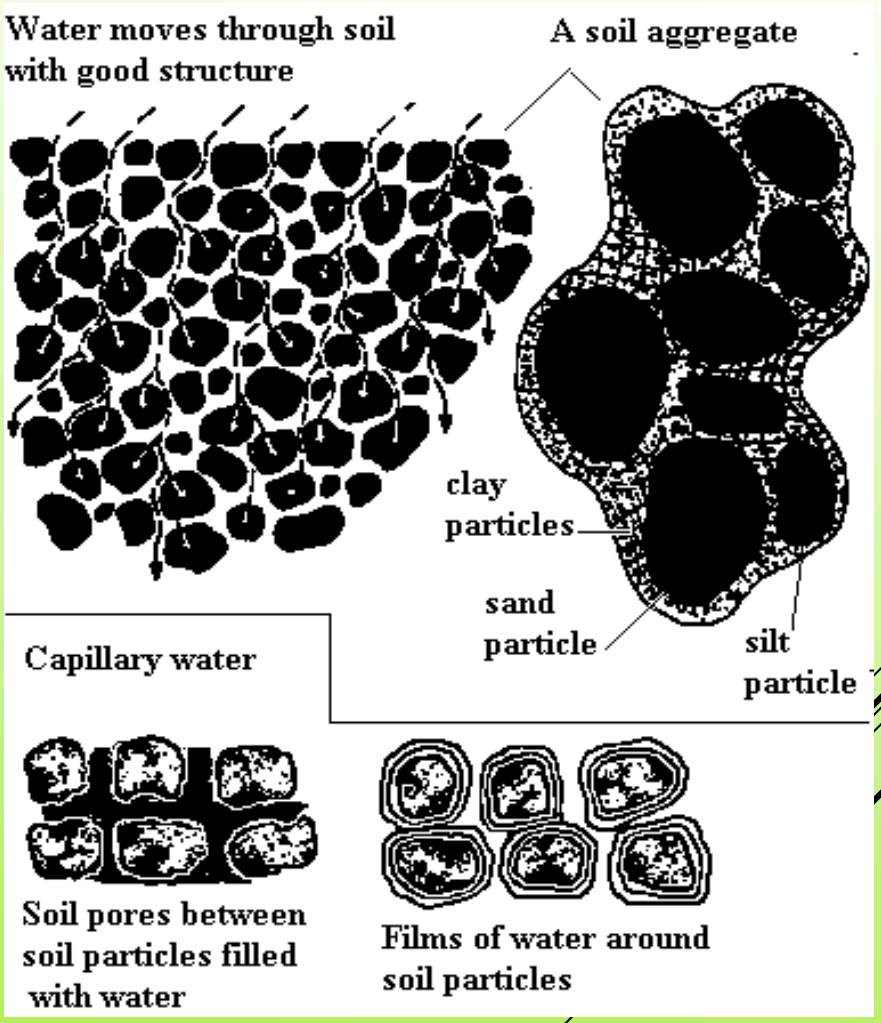


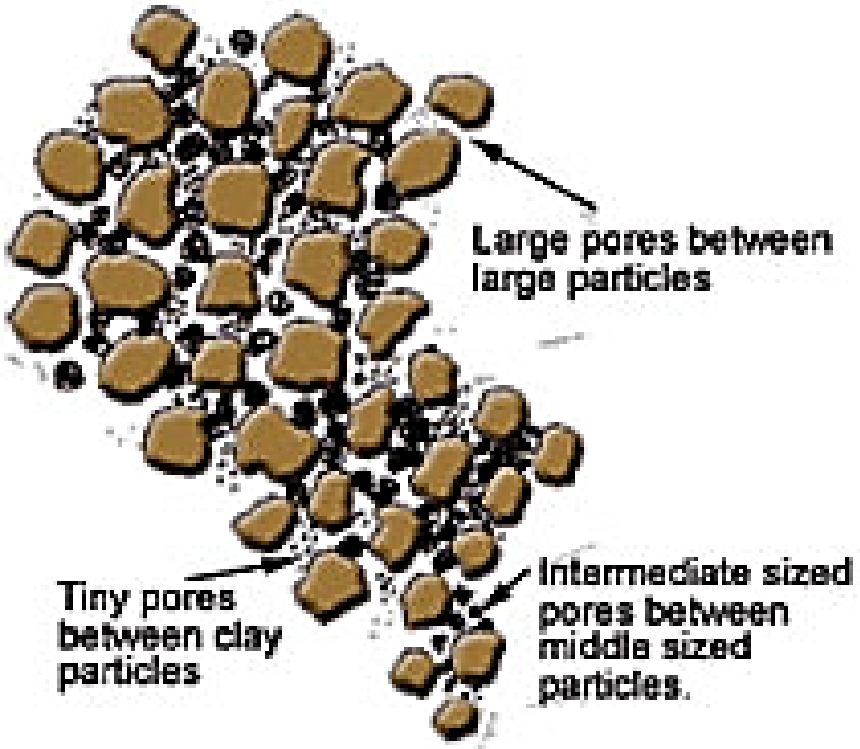
# Soil Has Different Properties Based on:

- Geologic Origin
- Composition
- Chemical and Physical
- Erosion based on:
  - Cohesive (clay) vs. Non cohesive (sand)
  - Density and Particle Size
  - Permeability and Change due to COMPACTION
  - Strength – Tensile, Shear, Bearing Capacity
  - Water Table and Saturation

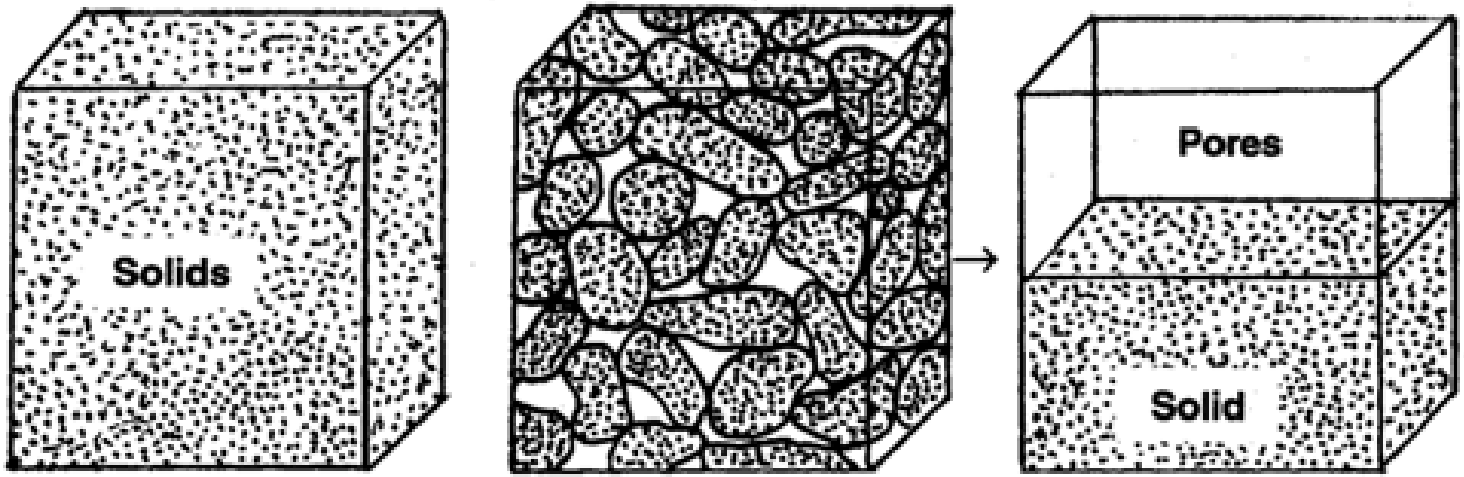

Sand
Silt
Clay


root
soil particle
water
air


Water moves through soil with good structure
A soil aggregate
clay particles
sand particle
silt particle
Capillary water
Soil pores between soil particles filled with water
Films of water around soil particles




| Soil Type | Average Bulk Density ($g/cm^3$) |
|---|---|
| sand | 1.2 - 1.8 |
| silt | 1.0 – 1.3 |
| clay | 0.51 – 1.2 |

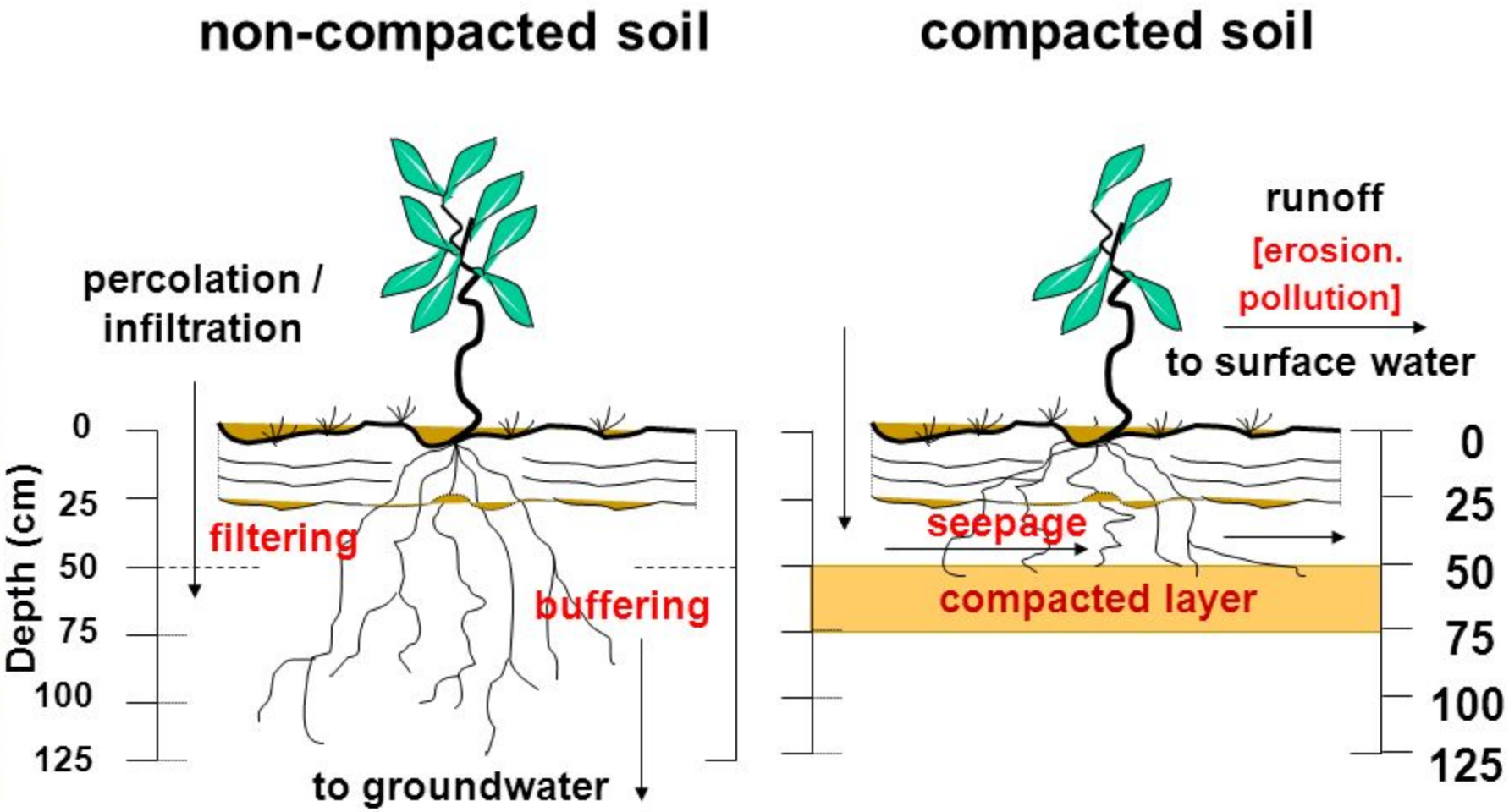



**Particle Density**

100% solid
Weight = 2.66 g
Volume = 1 $cm^3$

**Bulk Density**

50% solid, 50% pore space
Weight = 1.33 g
Volume = 1 $cm^3$




Bulk density higher than 1.9 g.cm$^{-3}$ stops the ability of plant roots to grow

# Geologic Origin

- Parent Material
  - character and chemical composition of the parent material plays an important role in determining soil properties

- Glaciers, Floods, and Water Movement
  - As glaciers pushed, they act like giant bulldozers pushing soil ahead of them. Glacial ‘till’ or ‘drift’ deposits resulted many tens or even hundreds of miles from where the soils were first formed.
  - Water is also very important in moving soils. As rivers flow, they transport soil particles along. If soil is washed into a river, the smallest particles will be carried the furthest by the water as they weigh the least. Heavier particles, such as sand, will be dropped earlier. Soils dropped around streams are termed ‘alluvial’. Soils deposited in lakes are called 'lacustrine', soils deposited by rivers 'riverine' and by sea 'marine' alluvial soils

# Composition

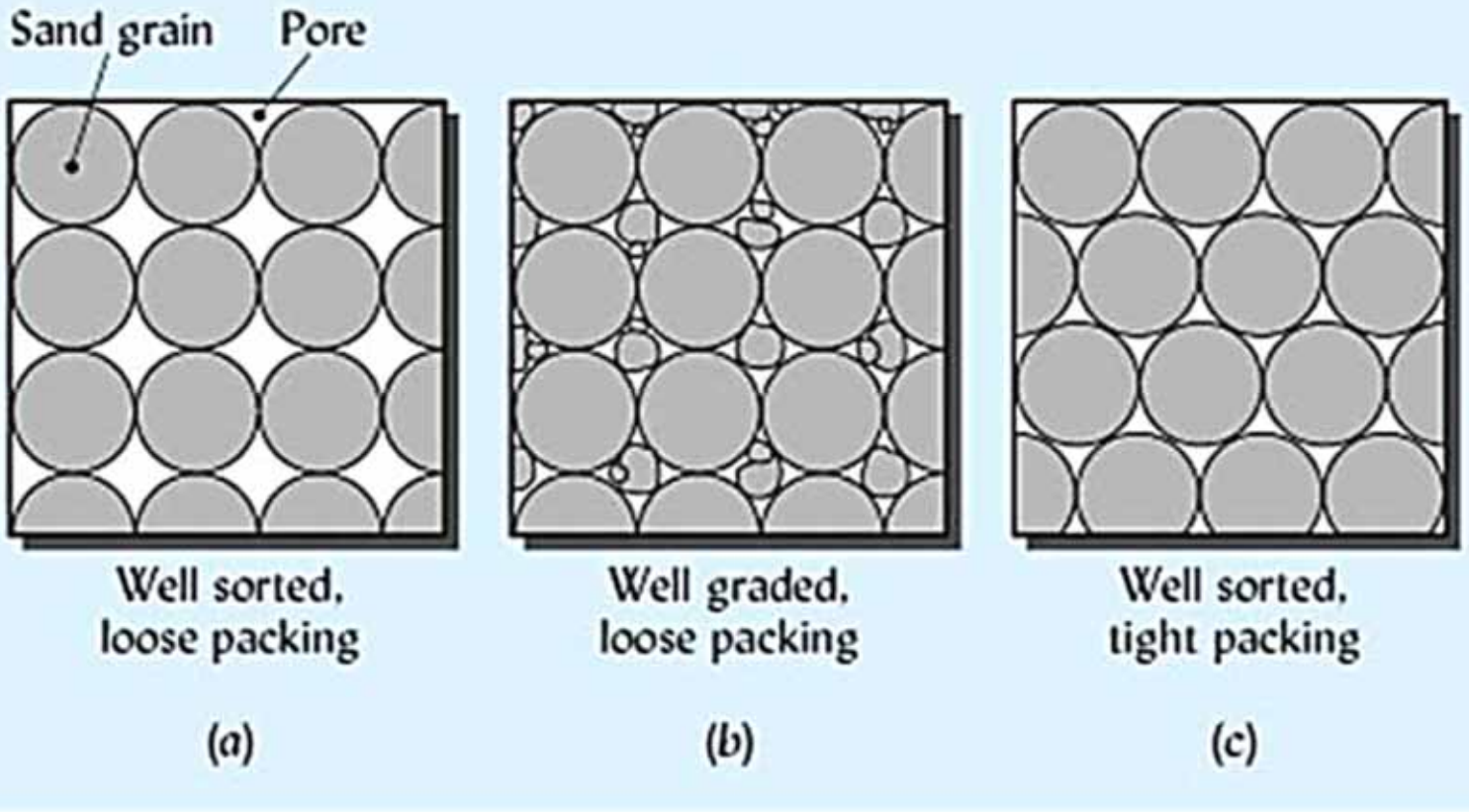
Percent Silt, Clay, Sand, Gravel

Uniform or Poorly Graded

Layered Horizontally or Diagonally

Densely Packed or Loose

Particle Sizes


Sand grain
Pore
Well sorted, loose packing
(a)
Well graded, loose packing
(b)
Well sorted, tight packing
(c)


Sandy Soil
Clay Soil
Chalky Soil
Silty Soil
Peaty Soil
Loamy Soil

Most Erodible $\longrightarrow$ Least Erodible

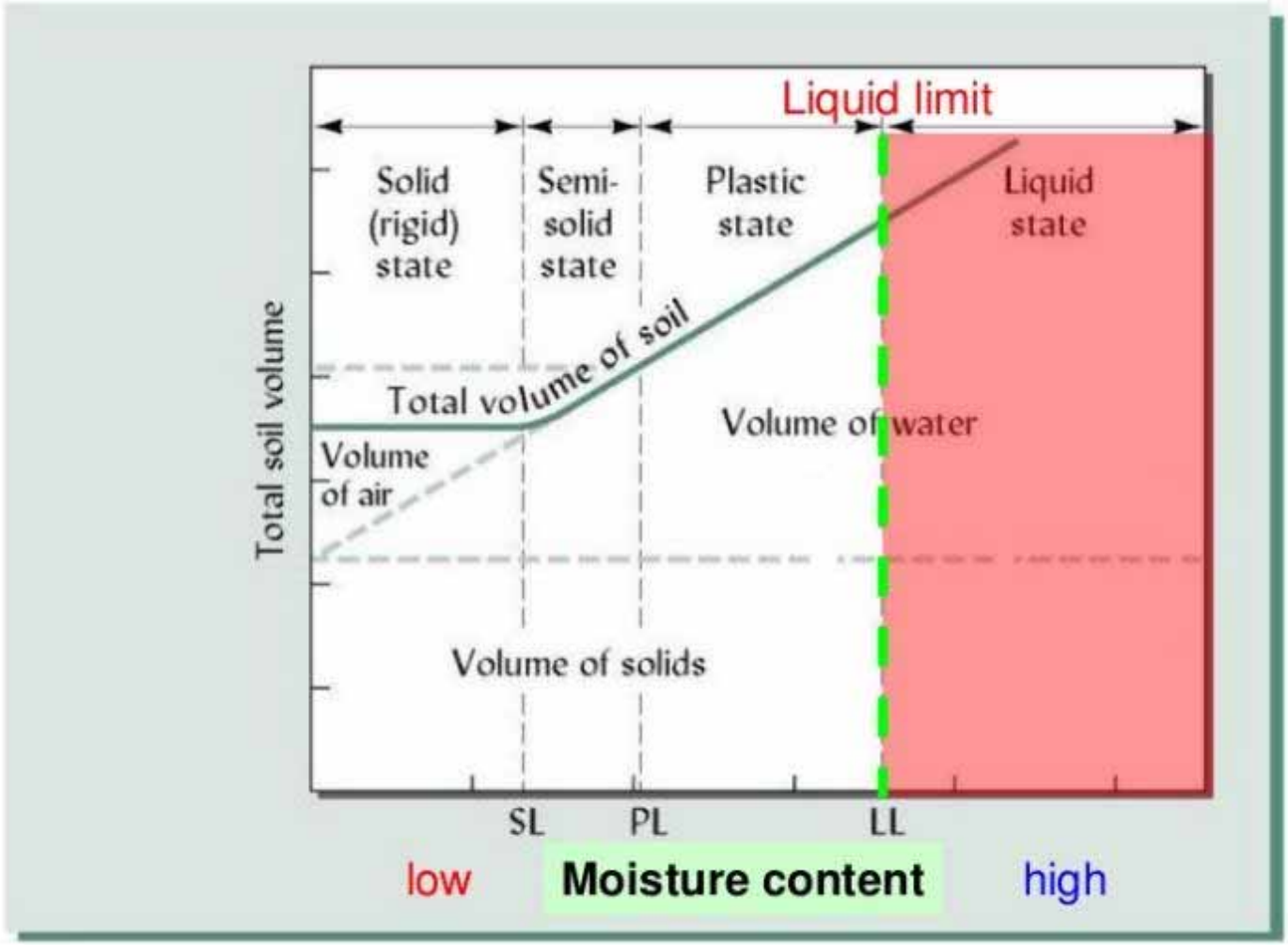
$$ML > SM > SC > MH > OL \gg CL > CH > GM > SW > GP > GW$$

where:

GW = well graded gravel
GP = poorly graded gravel
GM = silty gravel
SW = well graded sand
SM = silty sand
SC = clayey sand
ML = low plasticity silt
MH = high plasticity silt
CL = low plasticity clay
CH = high plasticity clay
OL = low plasticity organic soil

This erodibility hierarchy is simple, but based on gradation and plasticity indices of remolded or disturbed soils. Accordingly, it fails to take into account effects of soil structure, void ratio, and antecedent moisture content. Wischmeir

# Engineering properties of soil




Brady and Weil, 2002

**When moistened to its liquid limit, a soil starts to flow.**

# Chemical and Physical Properties

pH, Conductivity, Calcium Carbonate and plant survival

Soil Structure

Susceptibility of soil to sheet and rill erosion by water

Plasticity Index

Water Content

# Types of Soil Erosion

- **Rain drop or splash erosion:**
  - Erosion preceded by the destruction of the crumb structure due to the impact of falling raindrop on the surface of soil is termed as splash erosion.
- **Sheet erosion:**
  - It is the fairly uniform removal of soil in thin layers from the land surface, often scarcely perceptible, especially when caused by wind. Areas where loose, shallow topsoil overlies compact soil are most susceptible to sheet erosion.
- **Rill erosion:**
  - A form of water erosion in which numerous very small and more or less straight channels are produced; the channels get obliterated by ordinary use. It can be removed by normal tillage operations.
- **Gully erosion:**
  - A form of water erosion in which gullies are produced by combination of unattended rills.
- **Stream bank erosion:**
  - Stream banks are eroded by water either flowing over the sides of a stream or scouring at the base. It is aggravated by removal of vegetation, over grazing or cultivation near the stream banks.

# Types of Water Induced Erosion

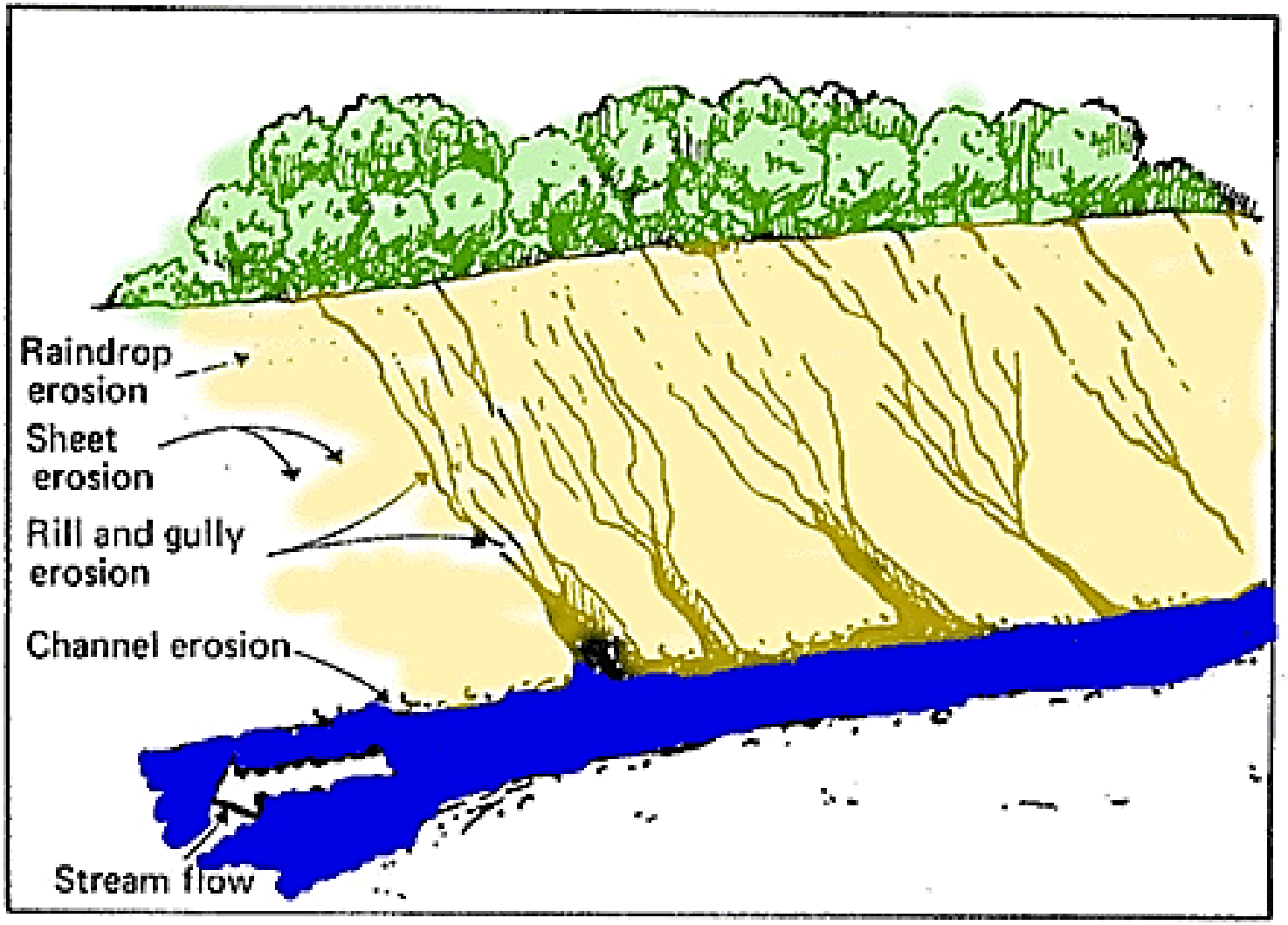


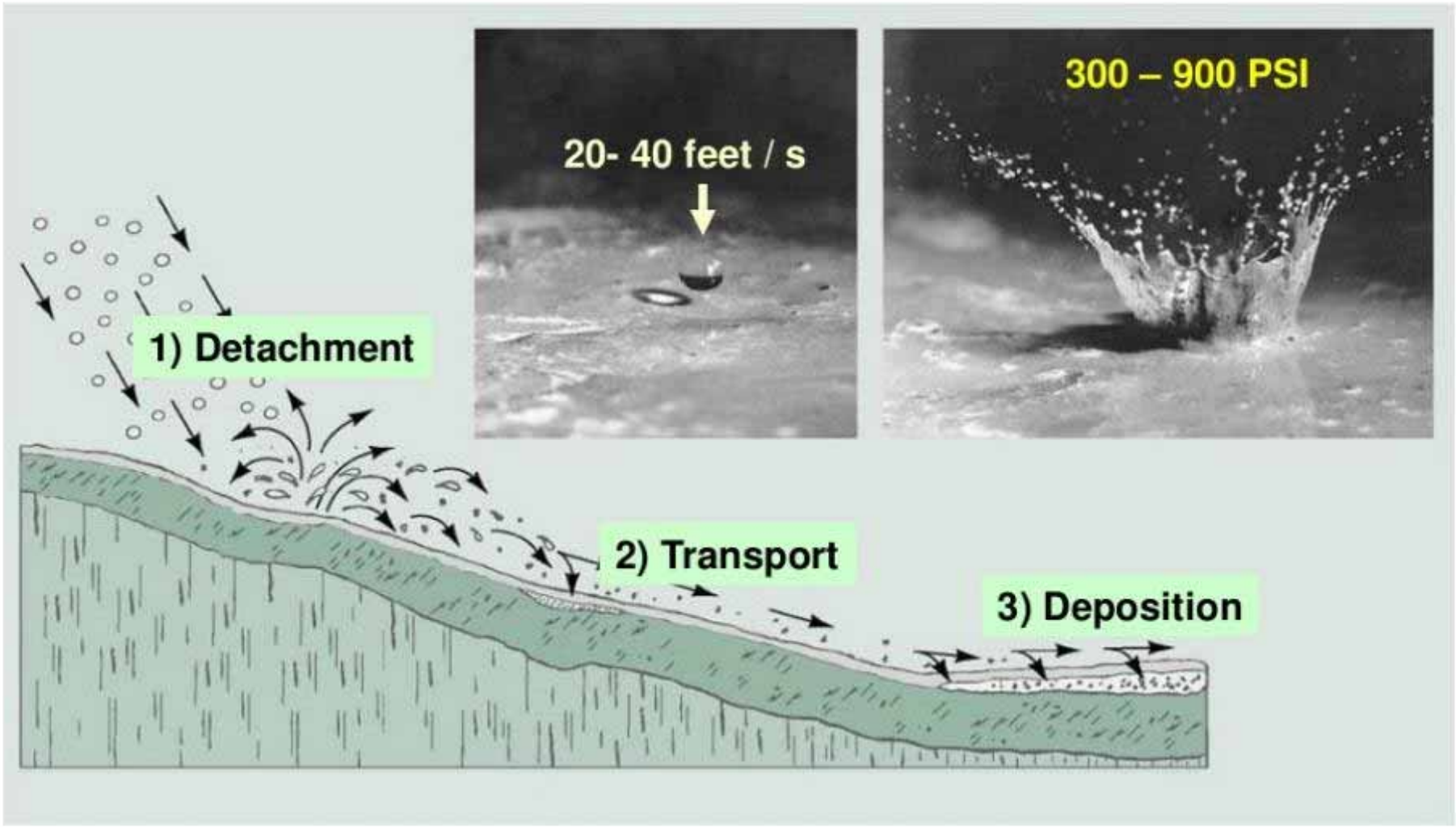

**Fig. 1.3** Types of erosion. (Adapted from 1)


Sheet Erosion


Rill Erosion
JUN 29 2004

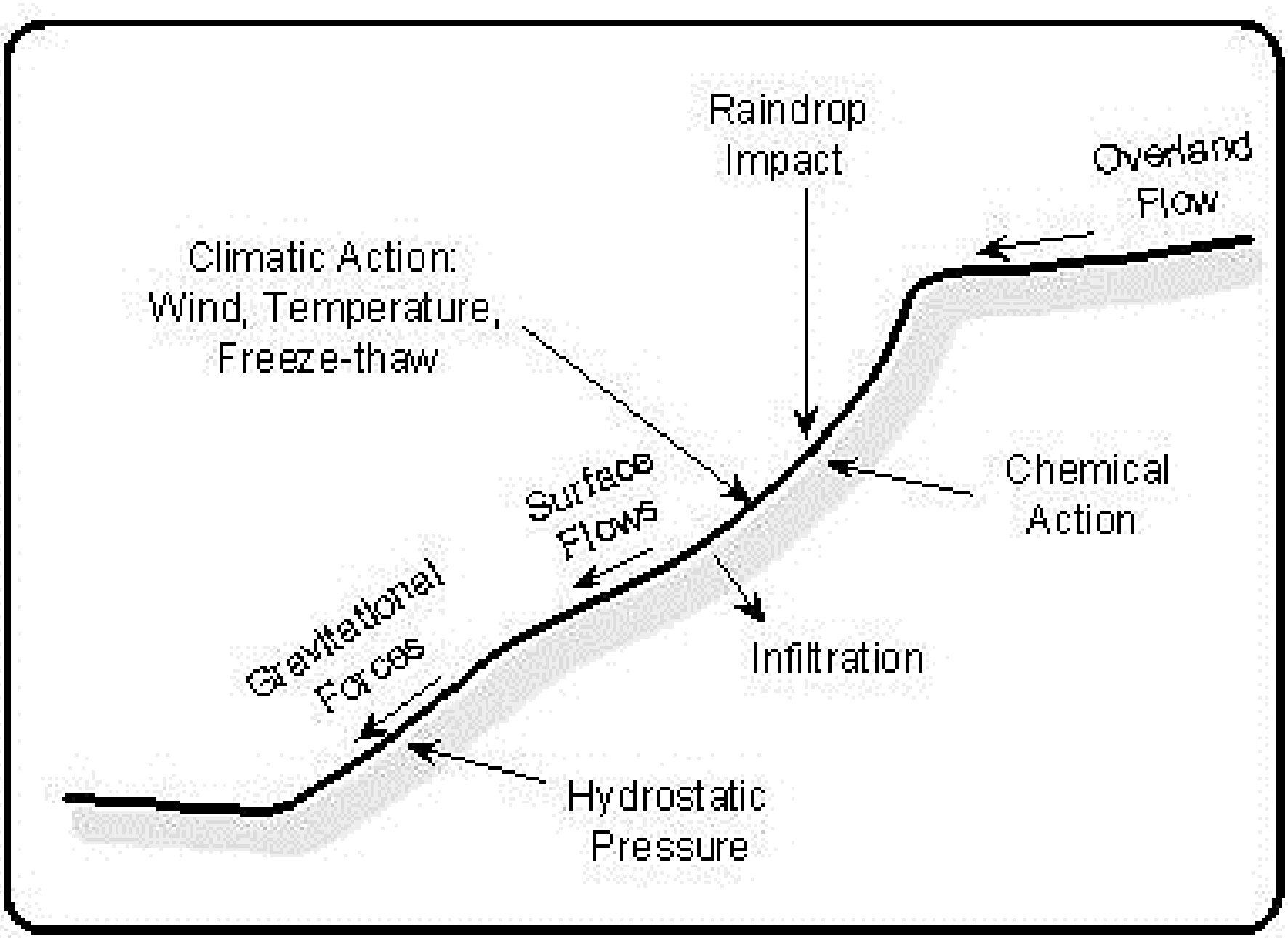
# Gully Erosion

# Understanding water erosion processes

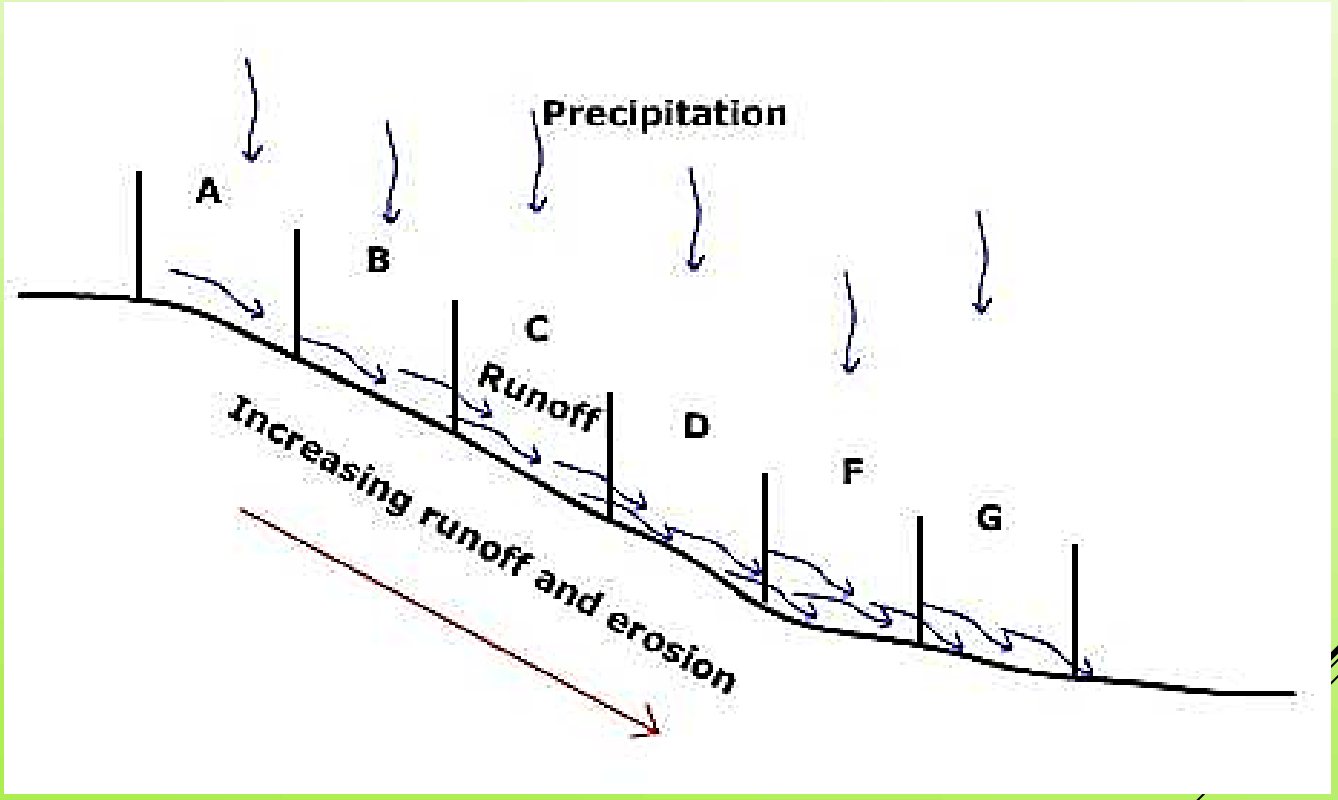



Brady and Weil (2002)

# What causes the soil particles to come loose?



Slope angle and length affects runoff generated when rain falls to the surface. Examine the diagram below showing the relationship between hill slope position, runoff, and erosion.




**Hill slope position, runoff & erosion**

# SURFACE RUNOFF FACTORS:

- **SOILS**
  - **INFILTRATION RATE**
  - **INFILTRATION CAPACITY**
  - **FROZEN / THAWED**
  - **ANTECEDENT (PRIOR) MOISTURE CONTENT**

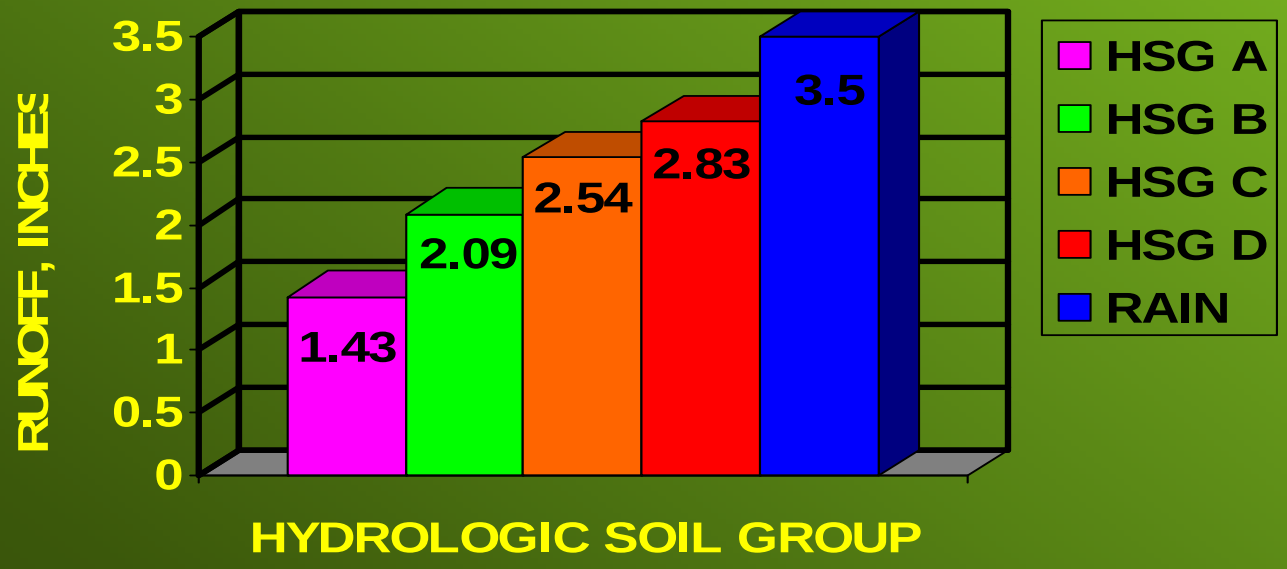
# SOIL FACTORS:

- **INFILTRATION**
  - **4 HYDROLOGIC SOIL GROUPS**
    - **HSG A - > 0.30 IN/HR**
    - **HSG B - 0.15 - 0.30 IN/HR**
    - **HSG C - 0.05 - 0.15 IN/HR**
    - **HSG D - < 0.05 IN/HR**
- **RUNOFF DECREASES WITH INCREASING INFILTRATION RATE**

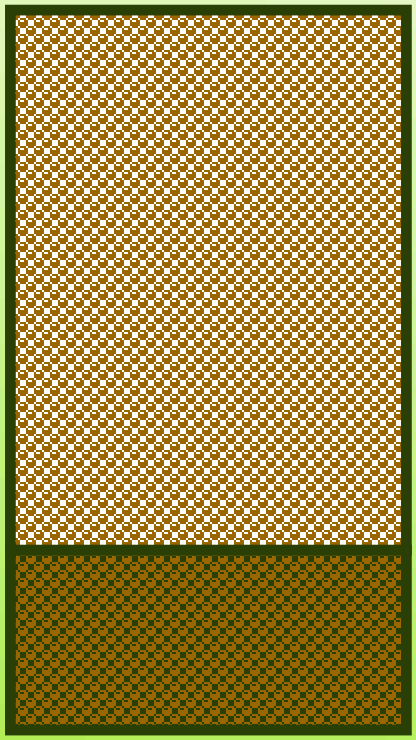
# RUNOFF COMPARISON

RUNOFF DOUBLES

**BARE SOIL**

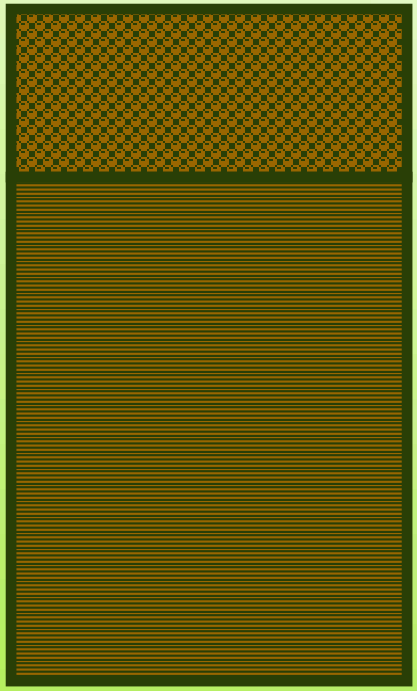


# HSG A



- DEEP (THICK)
- SANDS
- GRAVELS
- WELL TO EXCESSIVELY DRAINED
- DRAINED MUCK
- HIGH INFILTRATION RATE WHEN THOROUGHLY WETTED

# HSG D



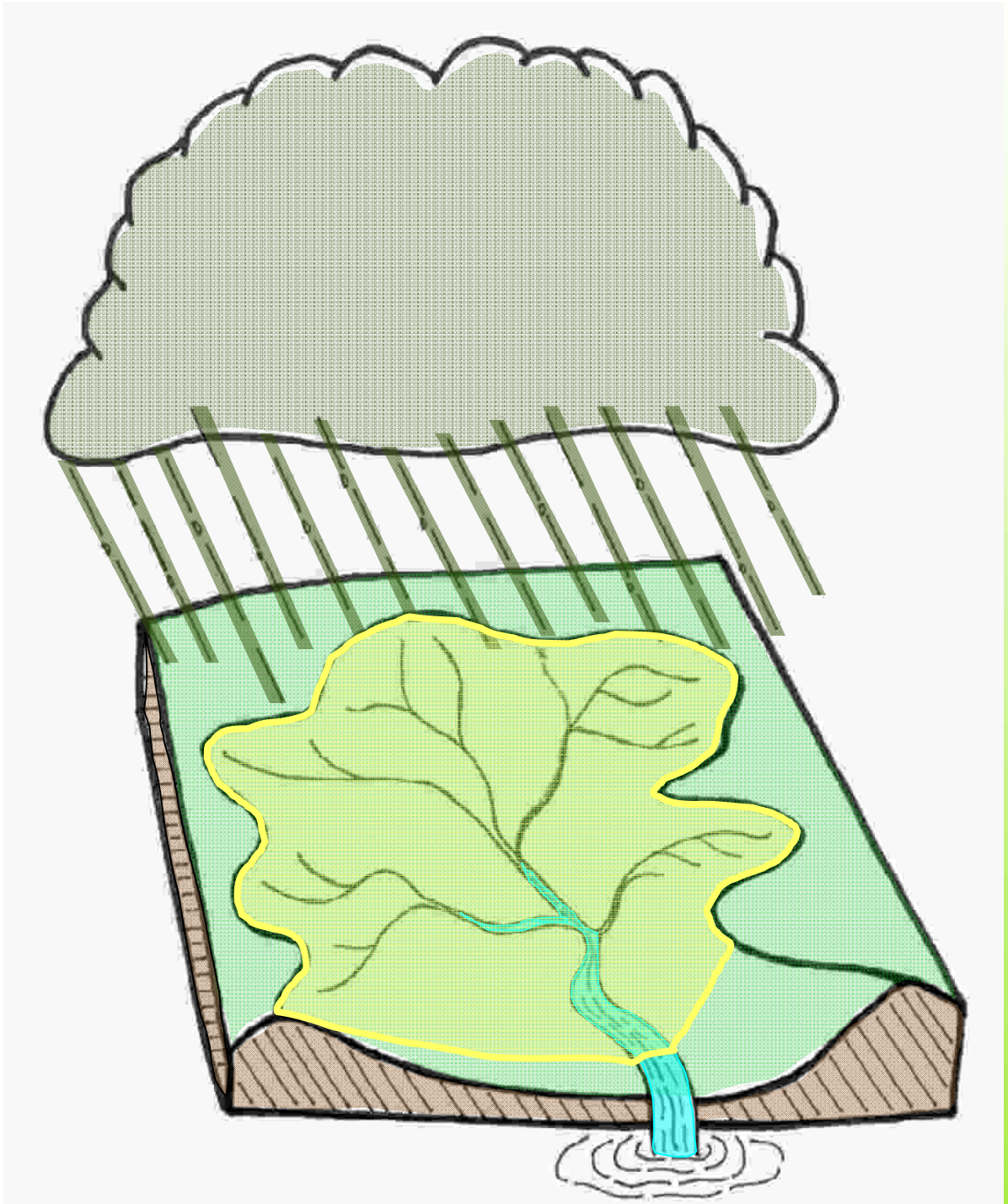
- PERMANENT HIGH WATER TABLE
- SHALLOW SOILS OVER NEARLY IMPERVIOUS MATERIAL
  - BEDROCK
  - CLAY FRAGIPAN
- CLAY SOILS
- VERY LOW INFILTRATION RATE WHEN THOROUGHLY WETTED

# SOIL FACTORS:

- FROZEN SOIL
  - IMPERMEABLE LAYER CREATED
    - ICE LAYER AT SOIL SURFACE.
    - SOIL PORES ICE FILLED.
  - WINTER, SPRING THAW.
  - RAIN ON FROZEN GROUND OR QUICK THAW CAN RESULT IN EWP.

# SOIL FACTORS:

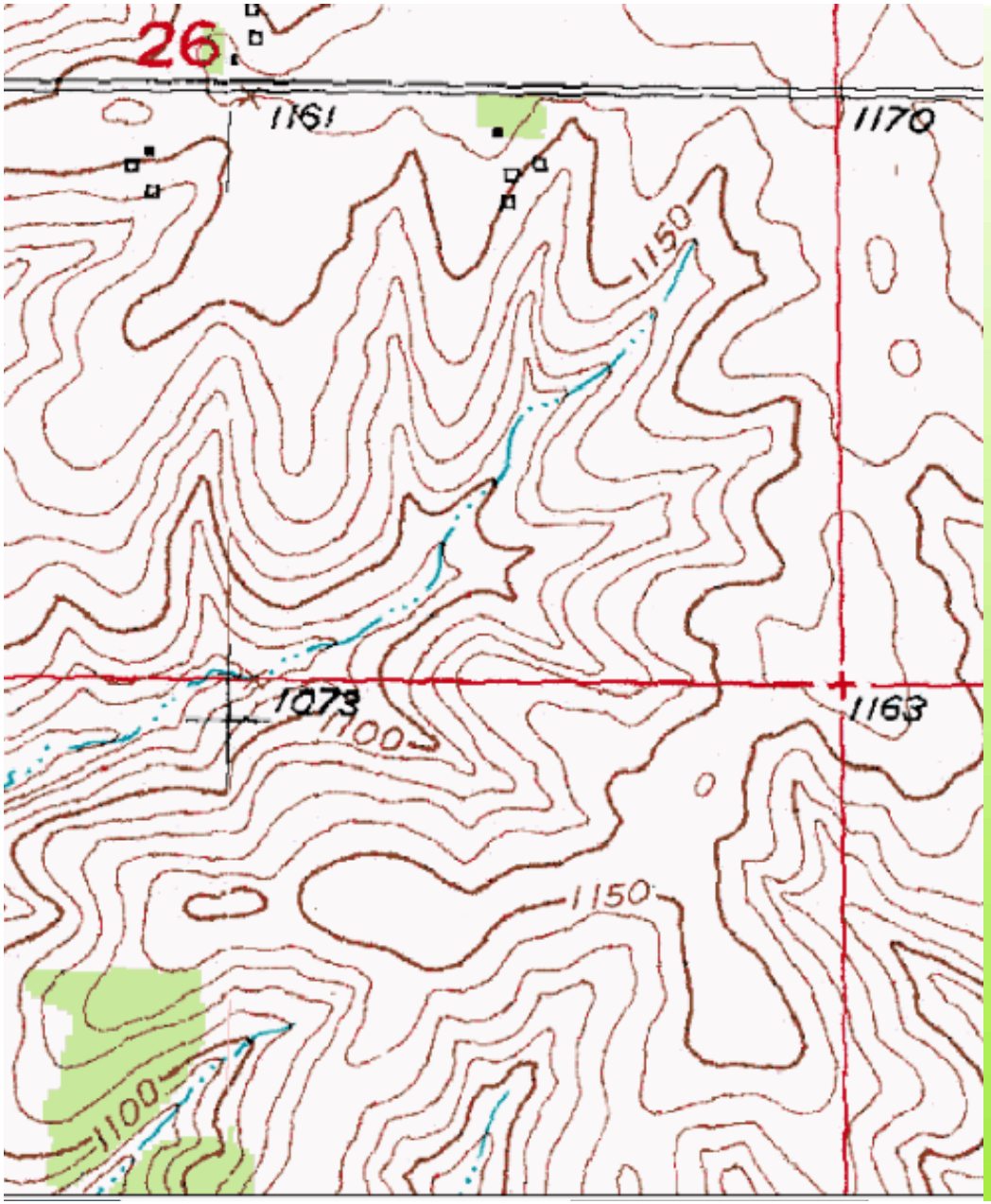
- **ANTECEDENT MOISTURE CONDITION**
  - "WETNESS" OF WATERSHED AT BEGINNING OF STORM
    - DRY CONDITION - LESS RUNOFF
    - MOIST - TYPICAL ASSUMPTION FOR OUR WORK
  - WET OR SATURATED CONDITION - INCREASED RUNOFF
  - INDICATOR OF AVAILABLE SOIL-WATER STORAGE CAPACITY



# WHAT IS A WATERSHED?

*An Area of Land that Drains to a given location*

# CONTOUR MAP FEATURES

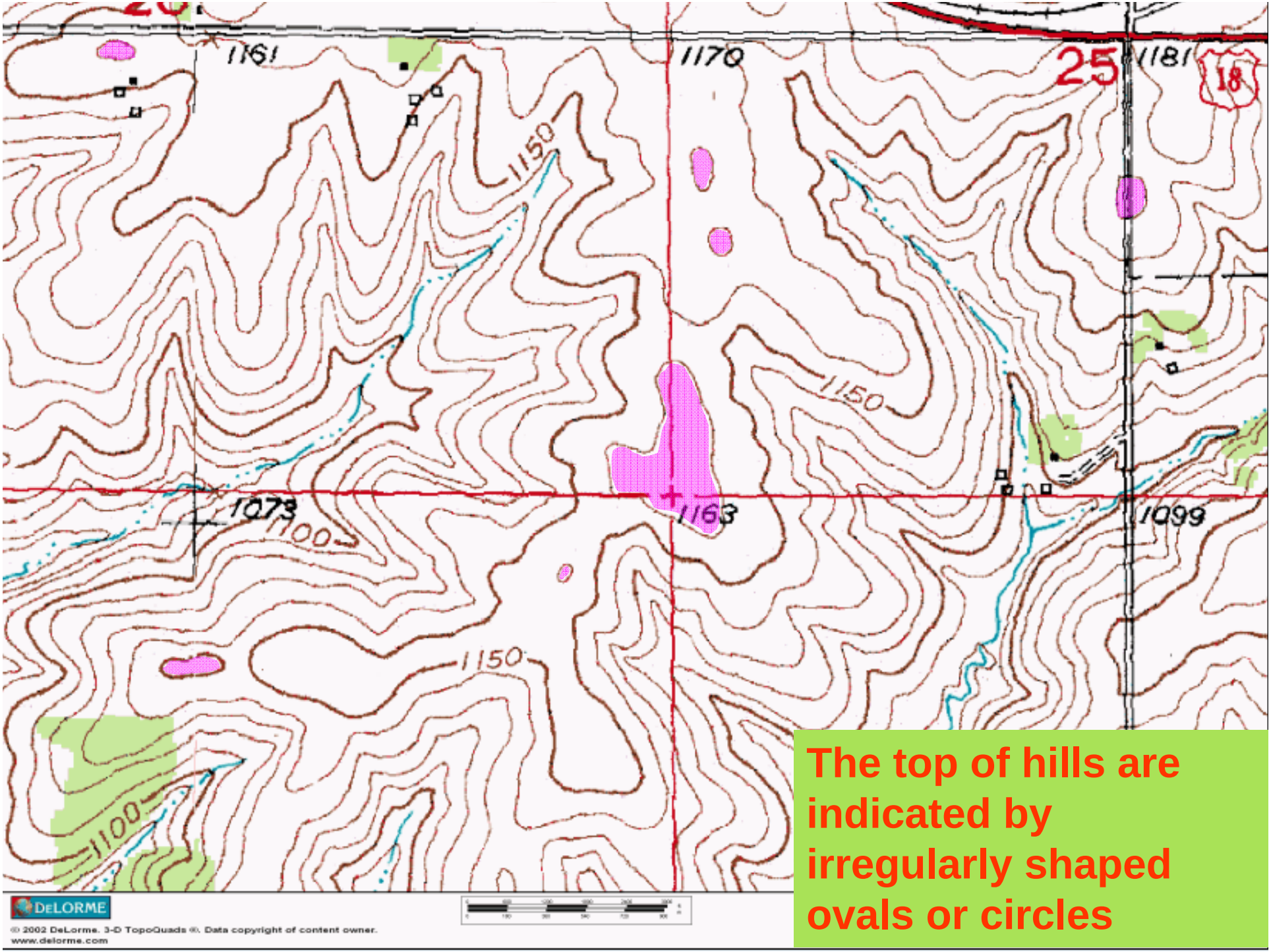



**Contour Maps:**

**Represent 3-D Landscape**

**Contour Lines:**

- Connect points of equal elevation
- Always close back on themselves
- Do not cross
- Darker lines represent the 50’ or 100’ contour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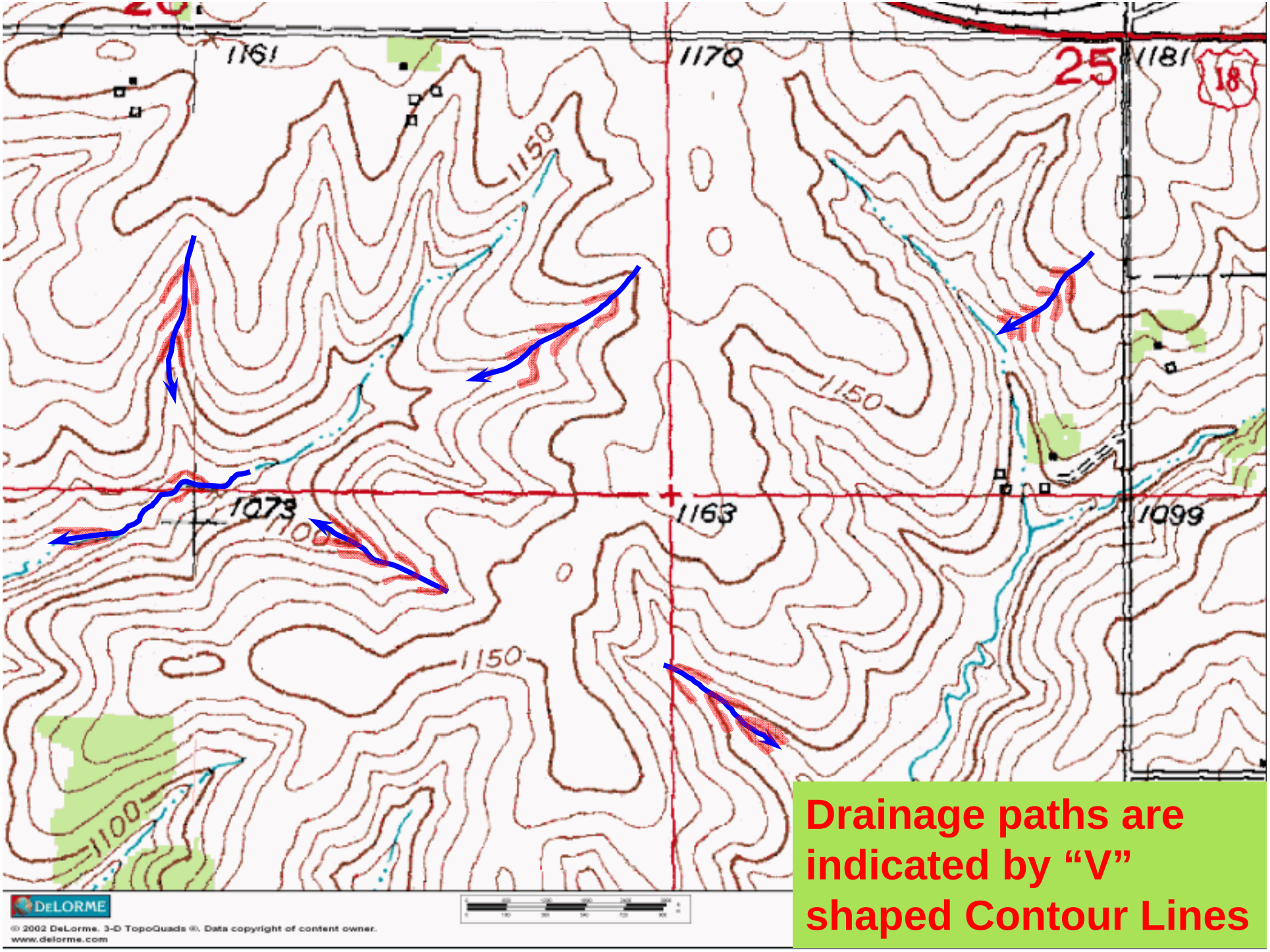
The top of hills are indicated by irregularly shaped ovals or circles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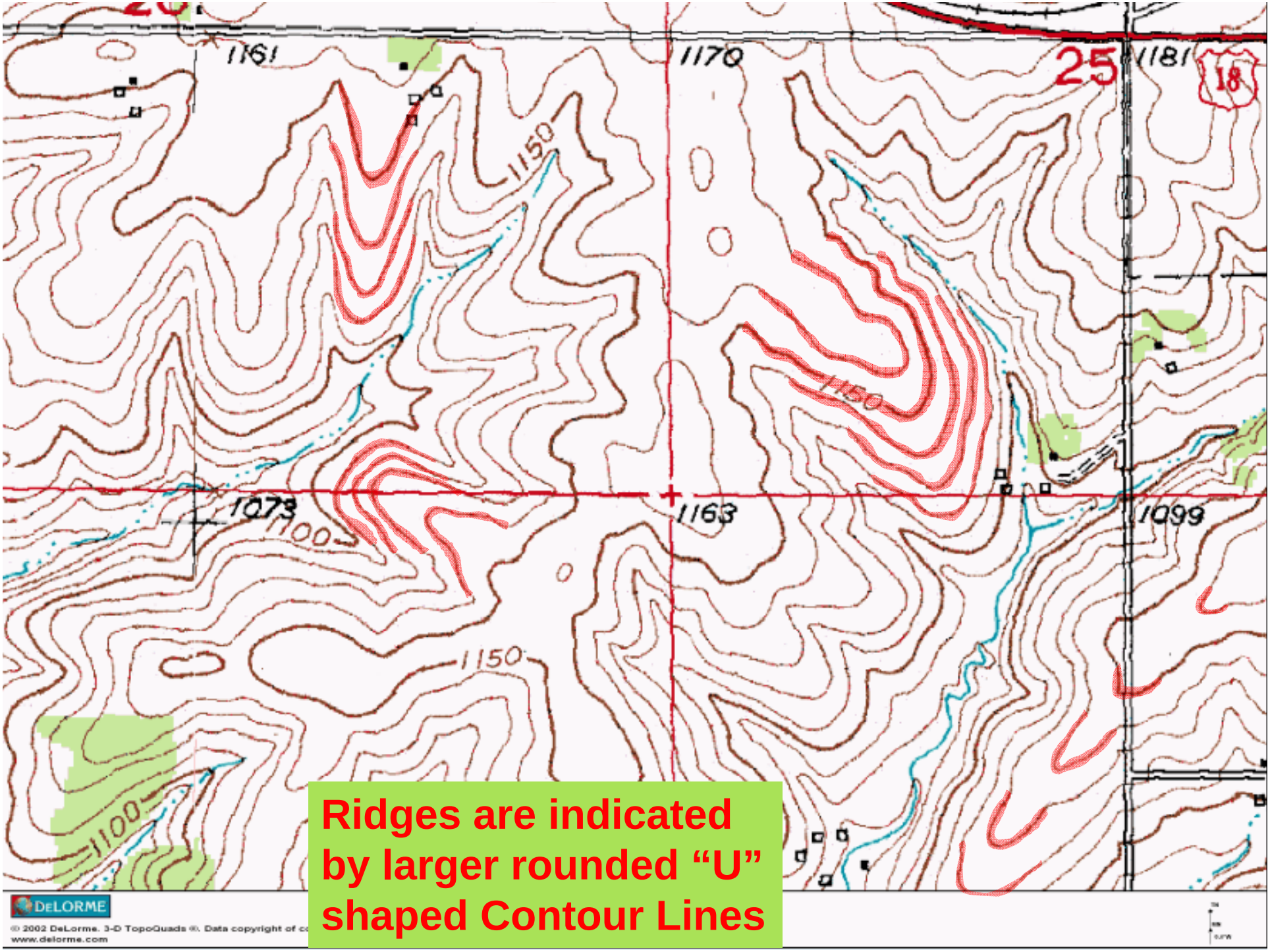
Drainage paths are indicated by “V” shaped Contour Lines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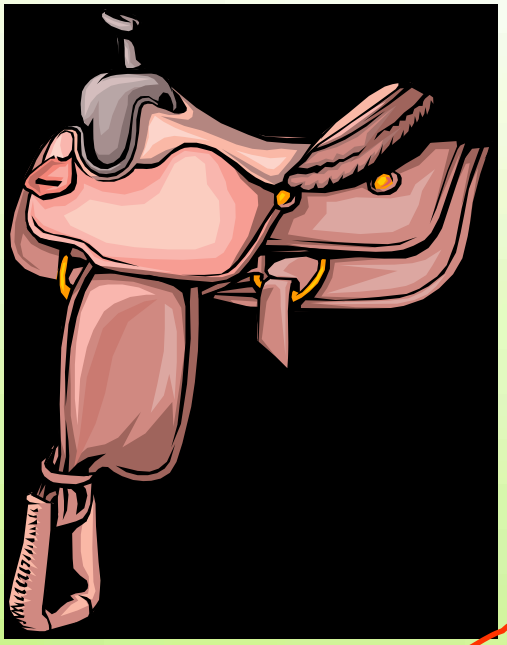
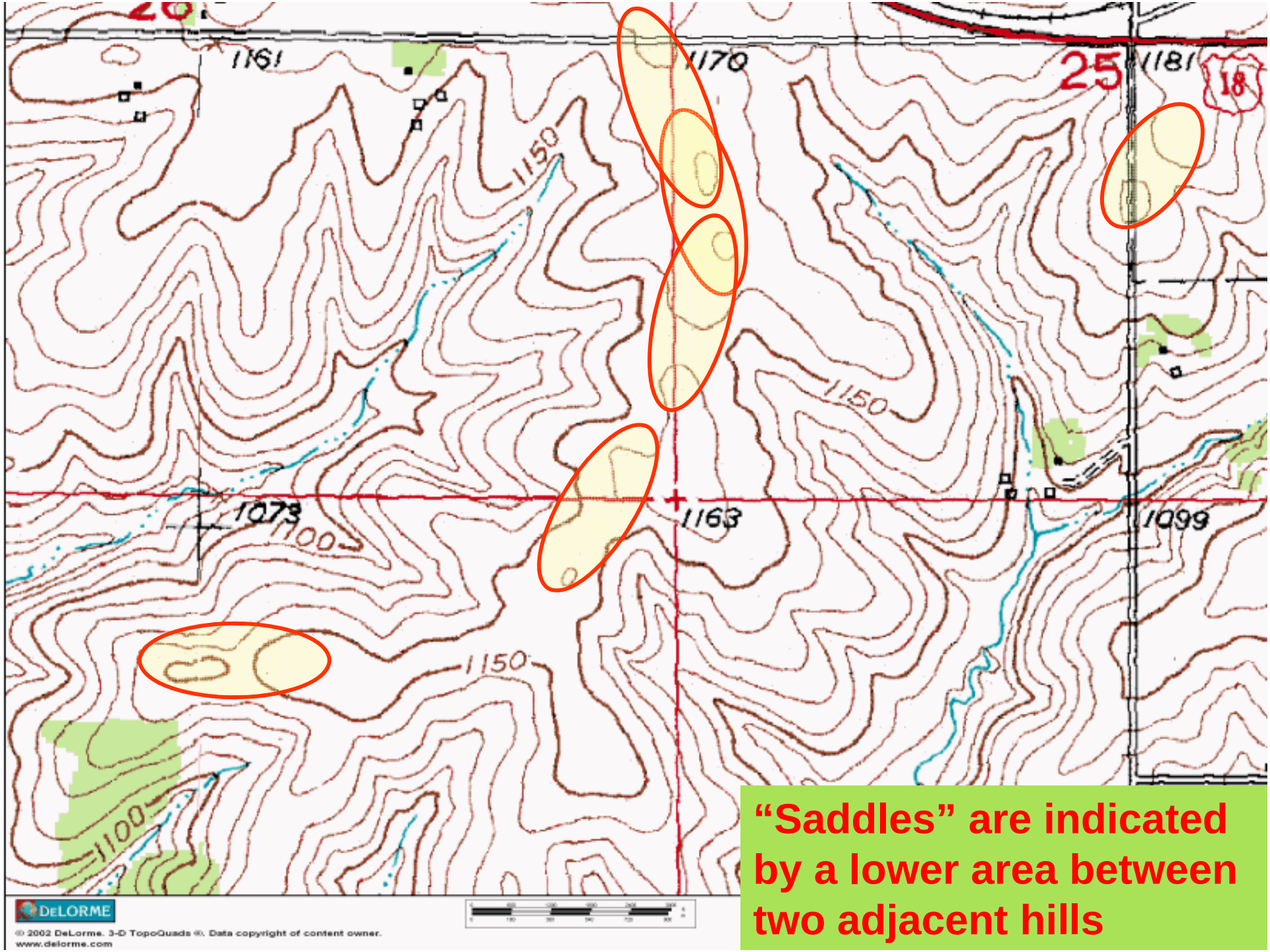
Ridges are indicated by larger rounded “U” shaped Contour Lines

# CONTOUR MAP FEATURES (CONTINUED)

On a Contour Map A “Saddle” is indicated by a lower area between two adjacent hills

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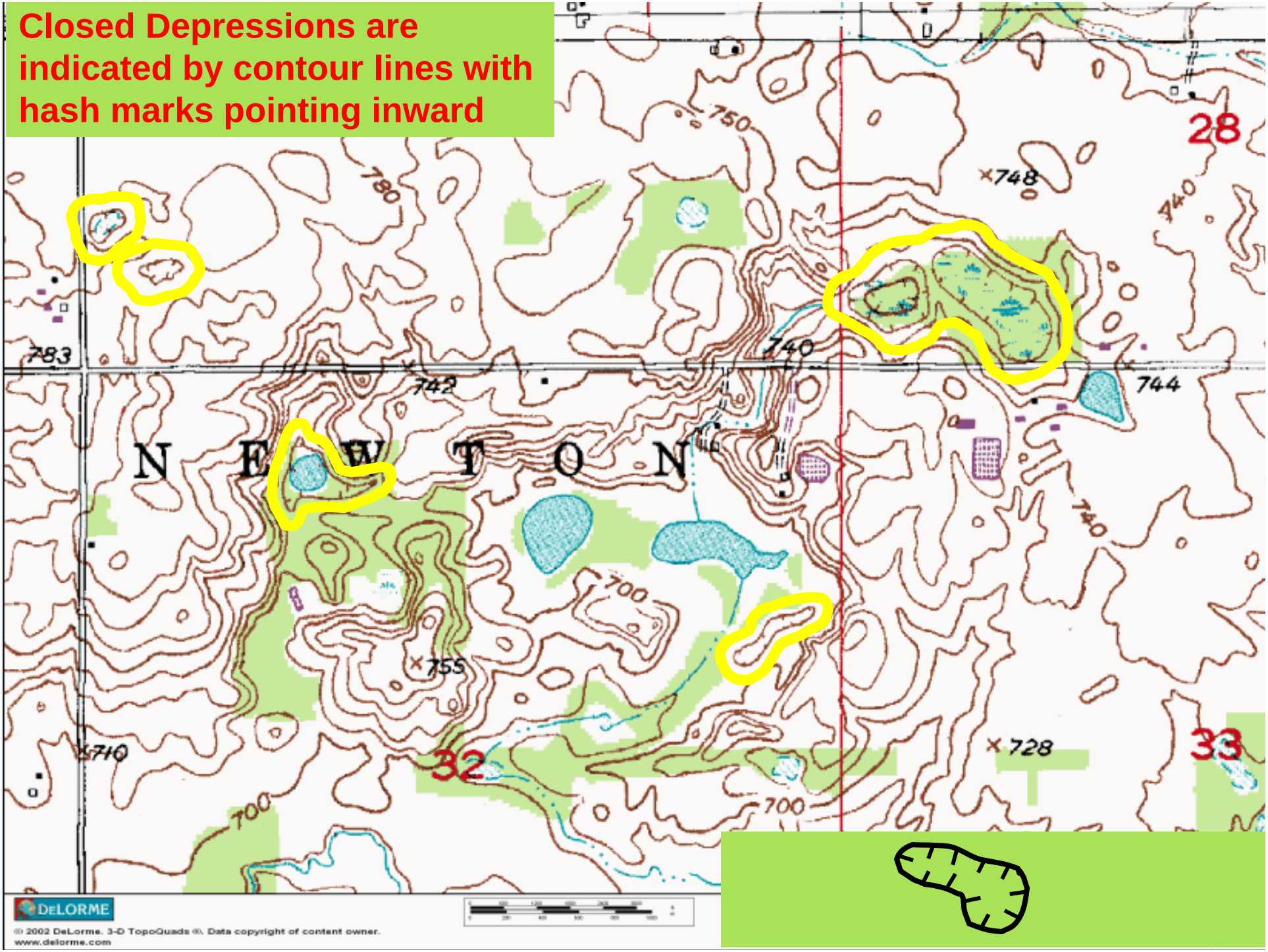
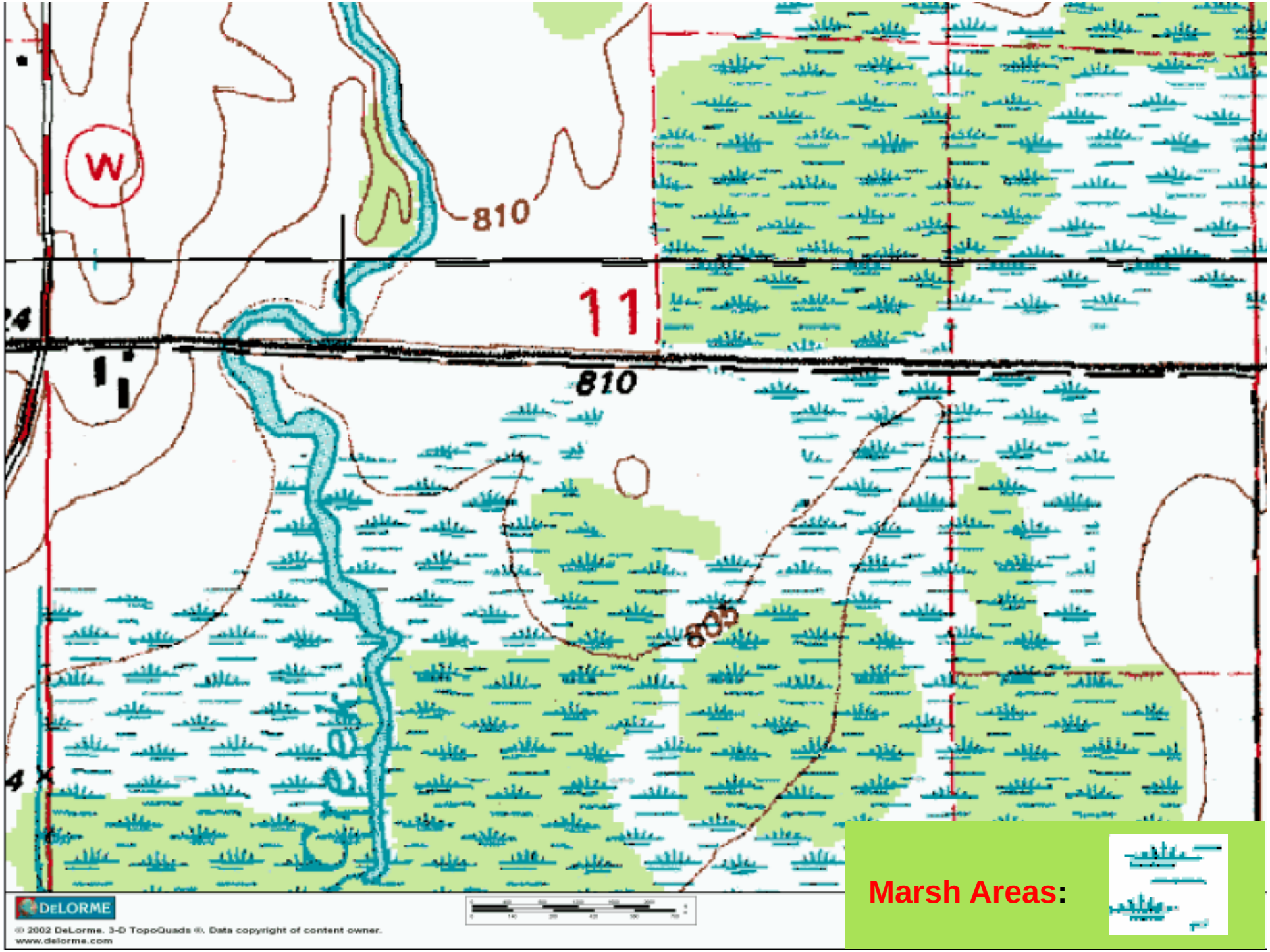
"Saddles" are indicated by a lower area between two adjacent hills

**Closed Depressions are indicated by contour lines with hash marks pointing inward**

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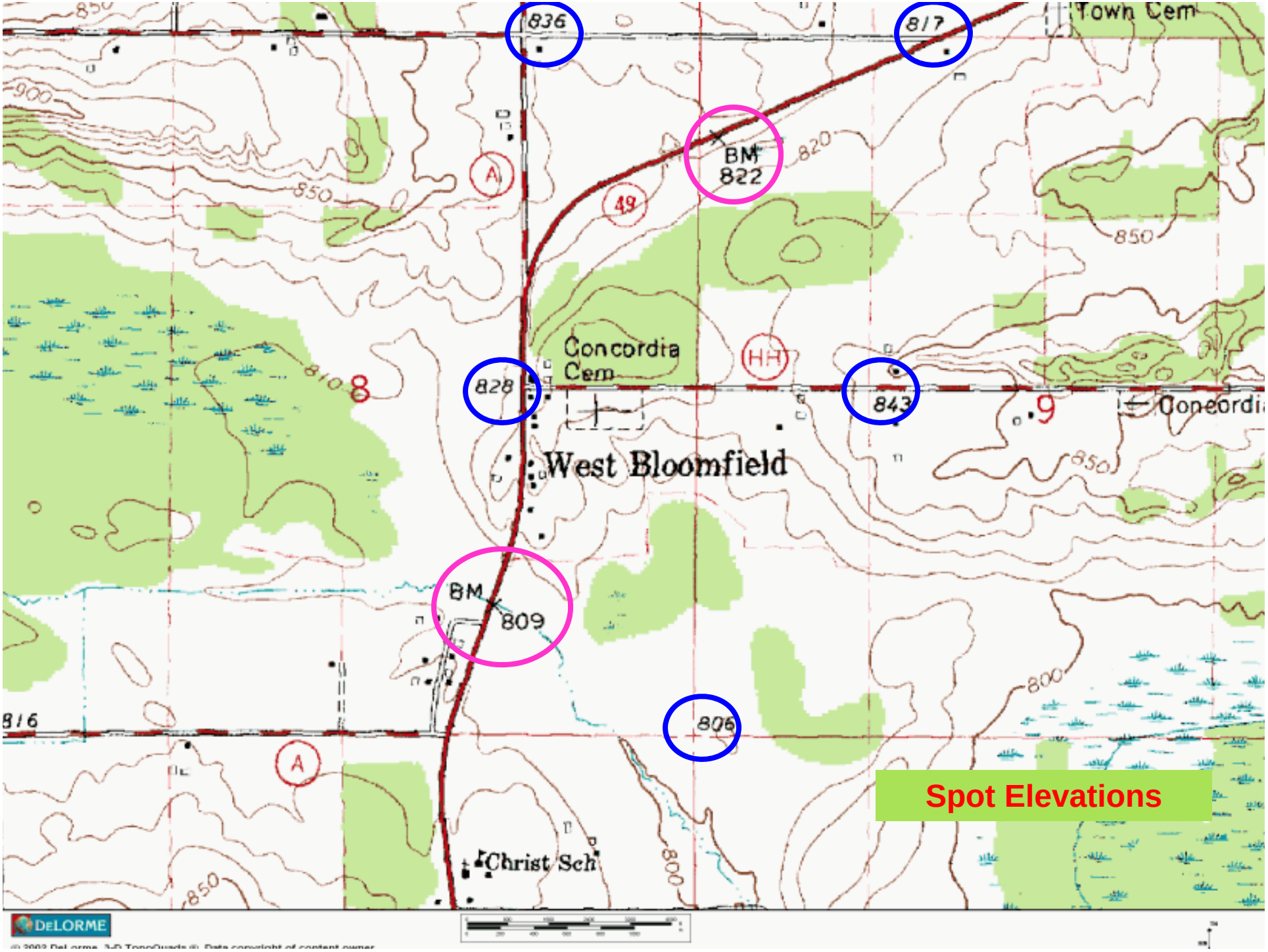
Marsh Areas: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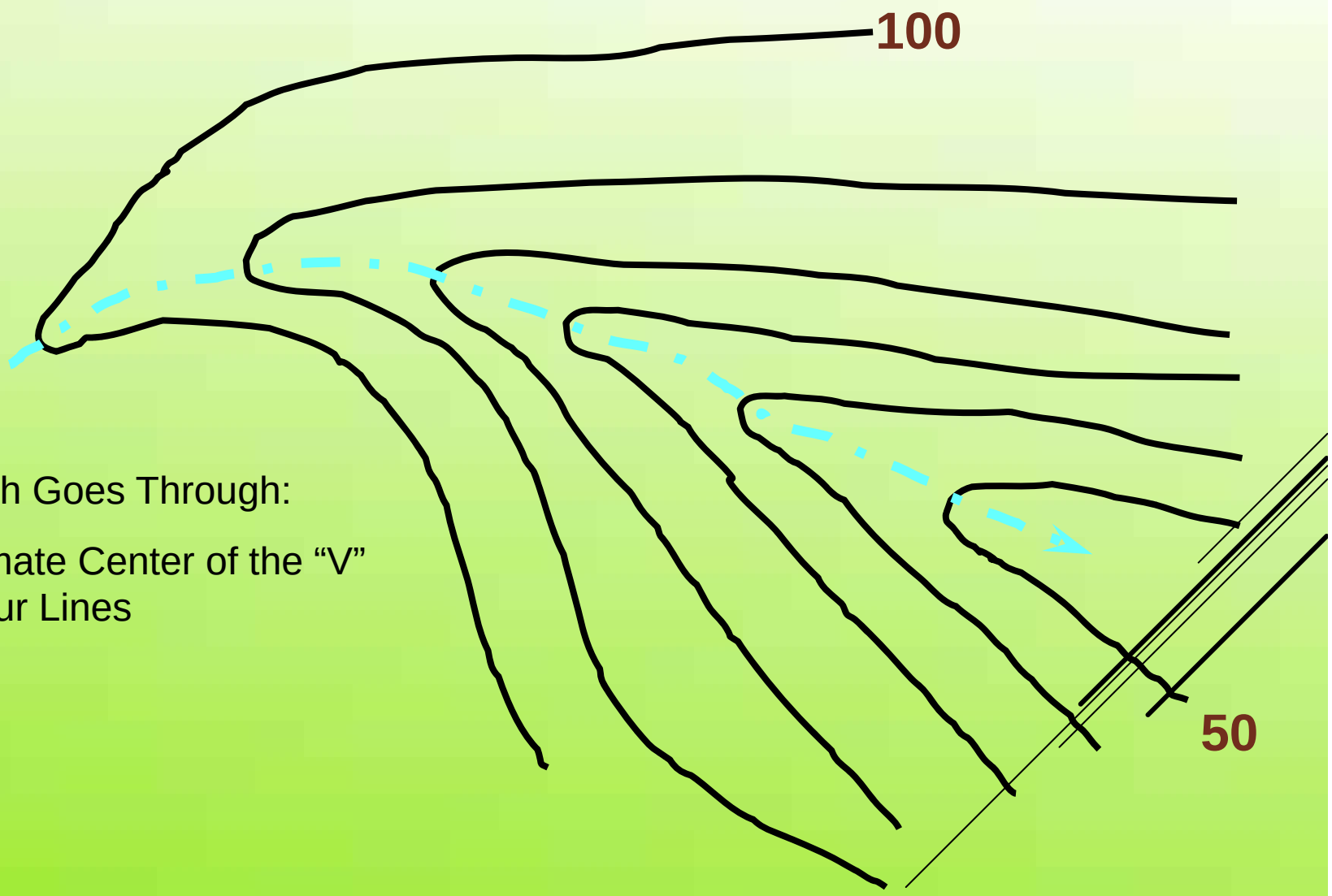
- Basic Concepts:
  - Water Flows Downhill (i.e. Perpendicular to Contour Lines)
  - Tops of Hills and Ridges are the Boundaries of Watersheds
  - Start By Noting Unique Features in the Mapping of the Area that you are studying

# WATERSHED BOUNDARY DELINEATION

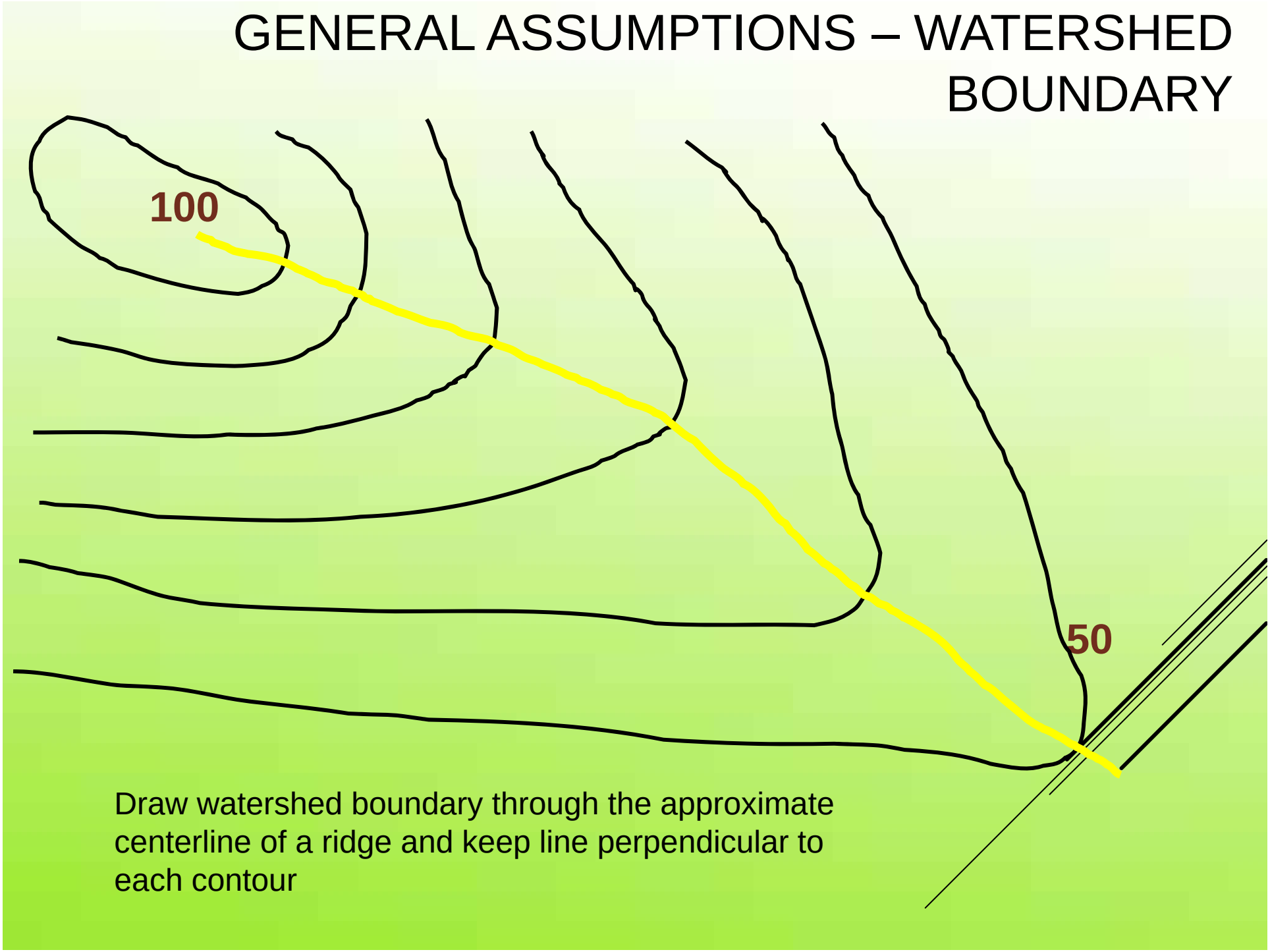
# GENERAL ASSUMPTIONS – FLOW PATH




Flow Path Goes Through:

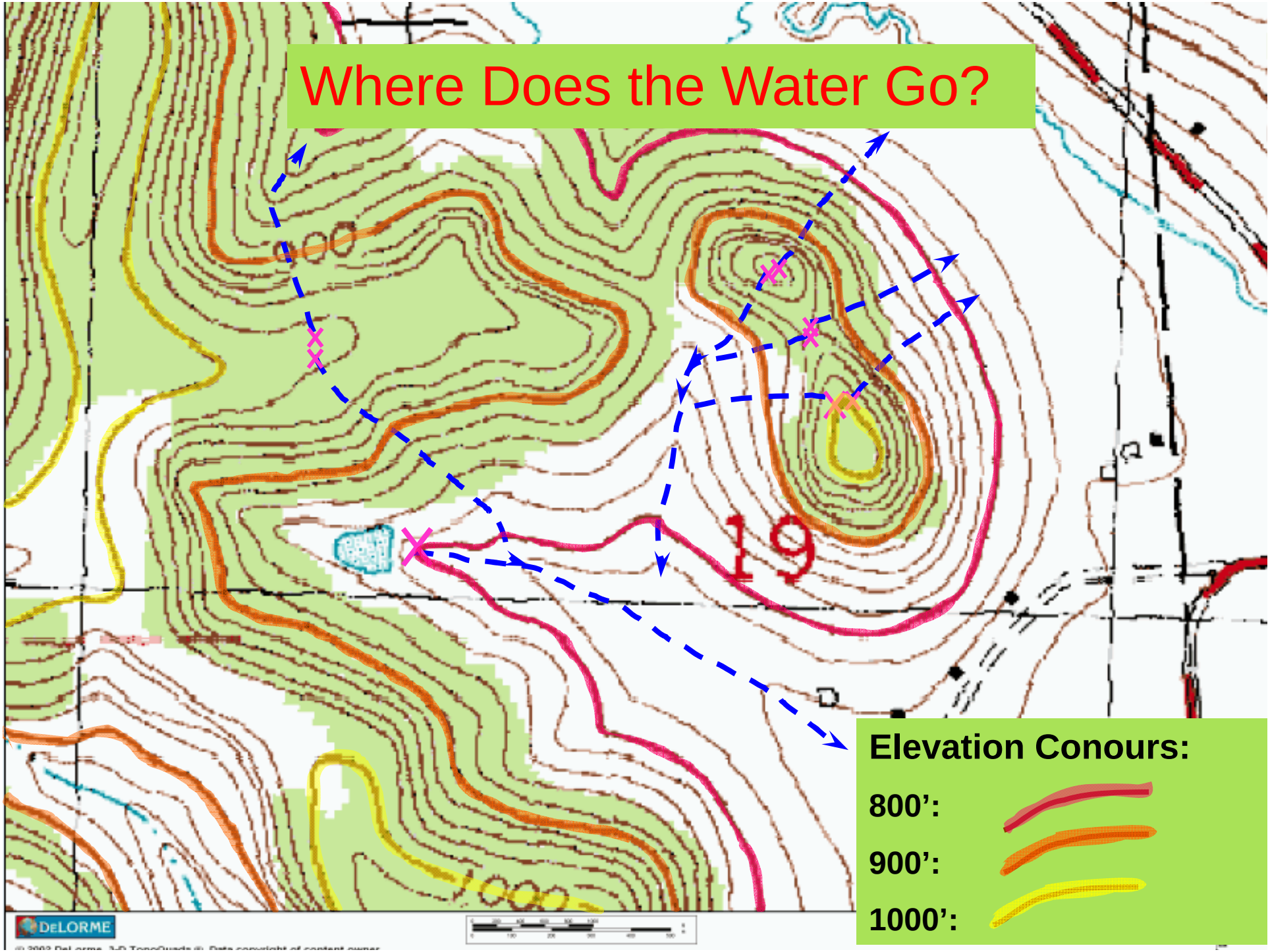
Approximate Center of the “V” in Contour Lines

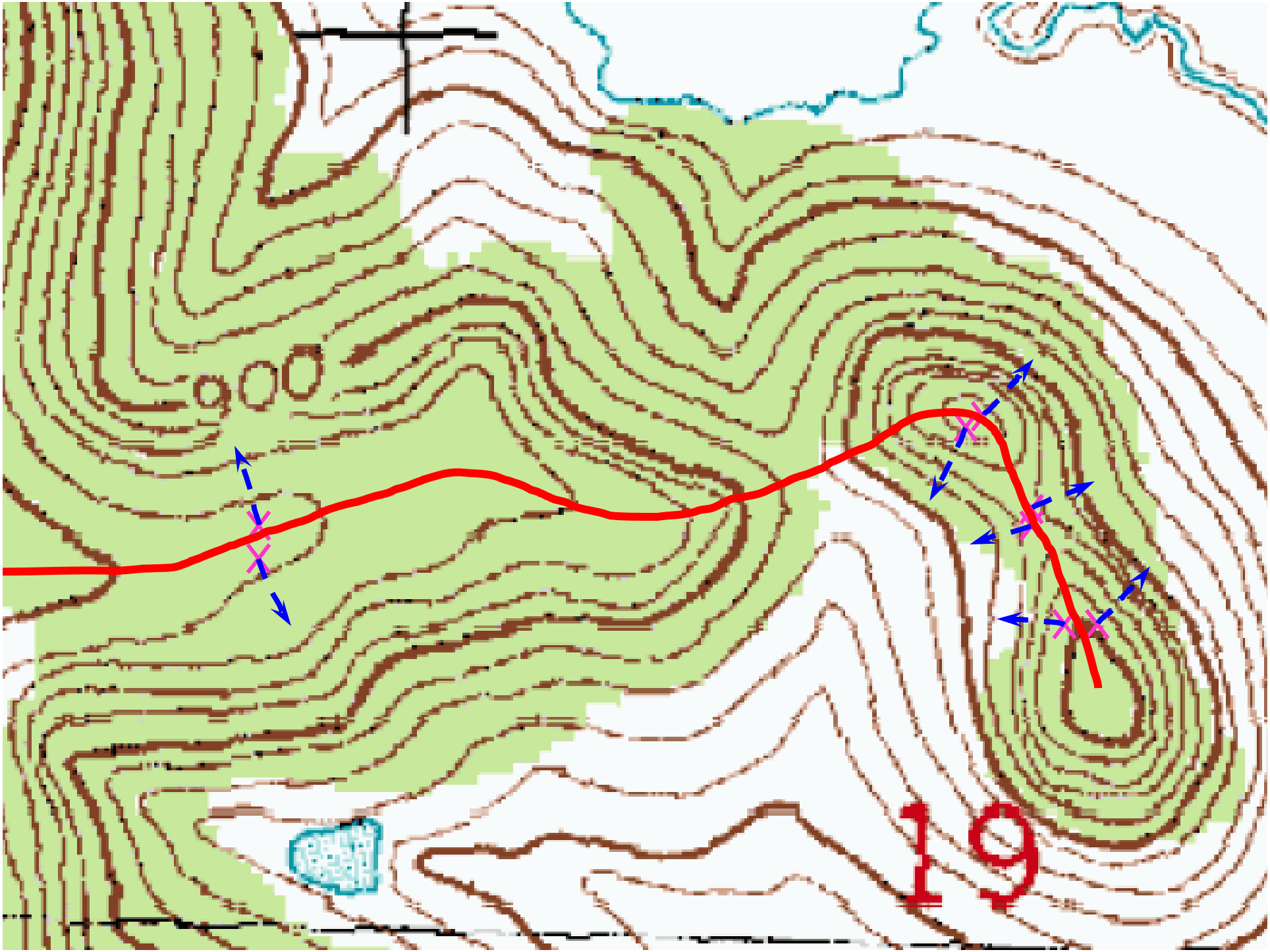
# GENERAL ASSUMPTIONS – WATERSHED BOUNDARY




Draw watershed boundary through the approximate centerline of a ridge and keep line perpendicular to each contour

# Where Does the Water Go?

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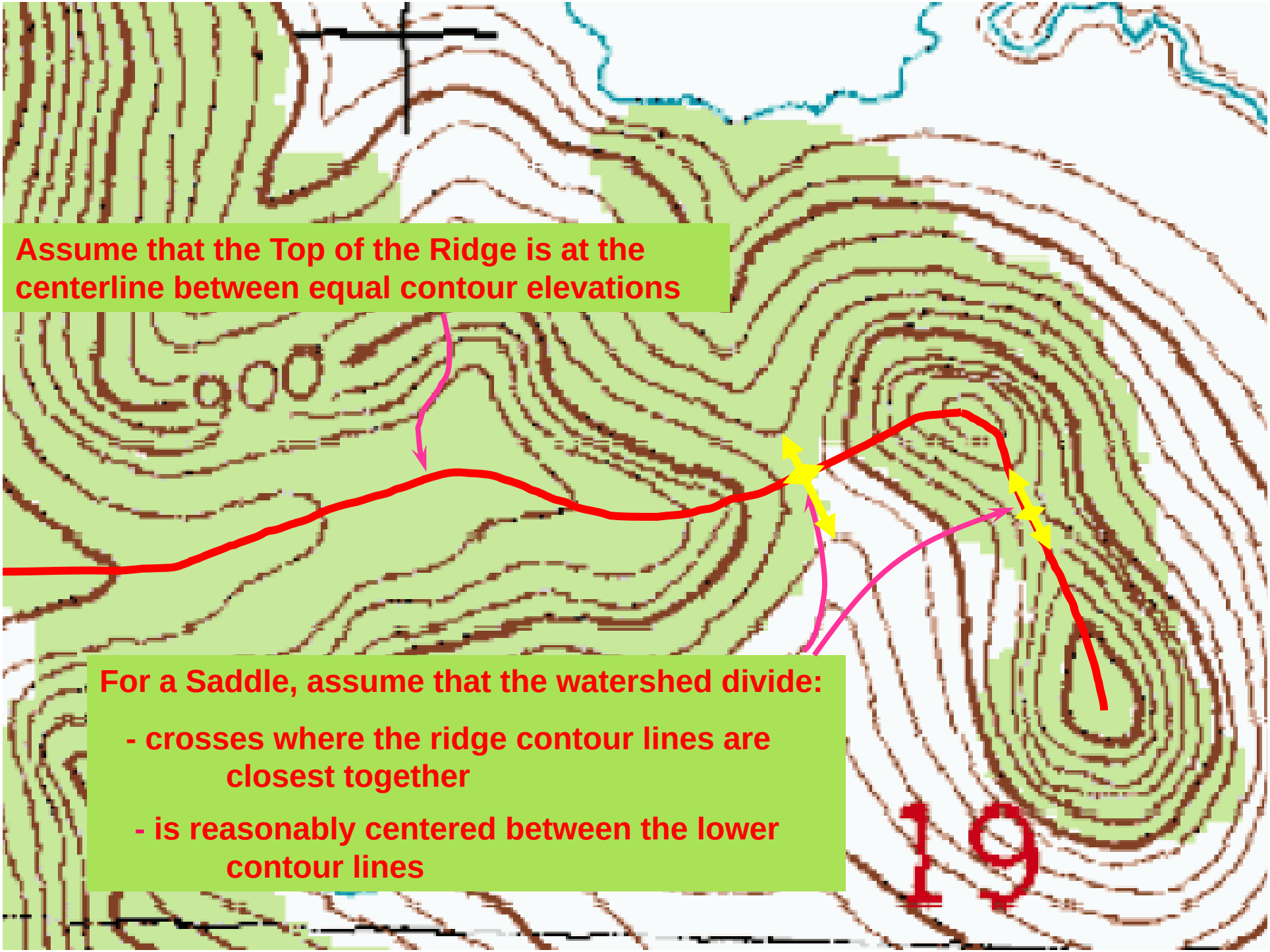
Assume that the Top of the Ridge is at the centerline between equal contour elevations
900
For a Saddle, assume that the watershed divide:
- crosses where the ridge contour lines are closest together
- is reasonably centered between the lower contour lines
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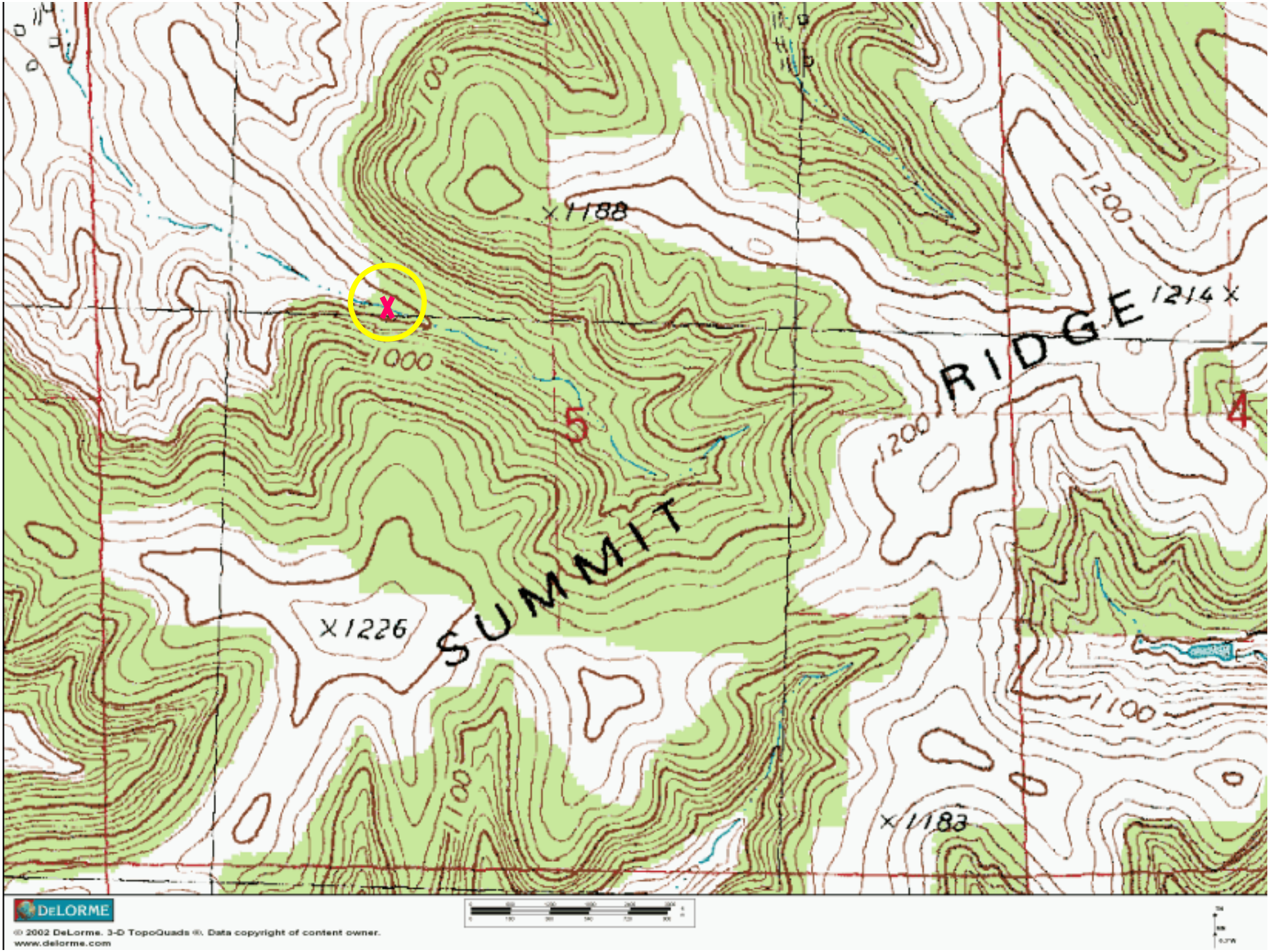
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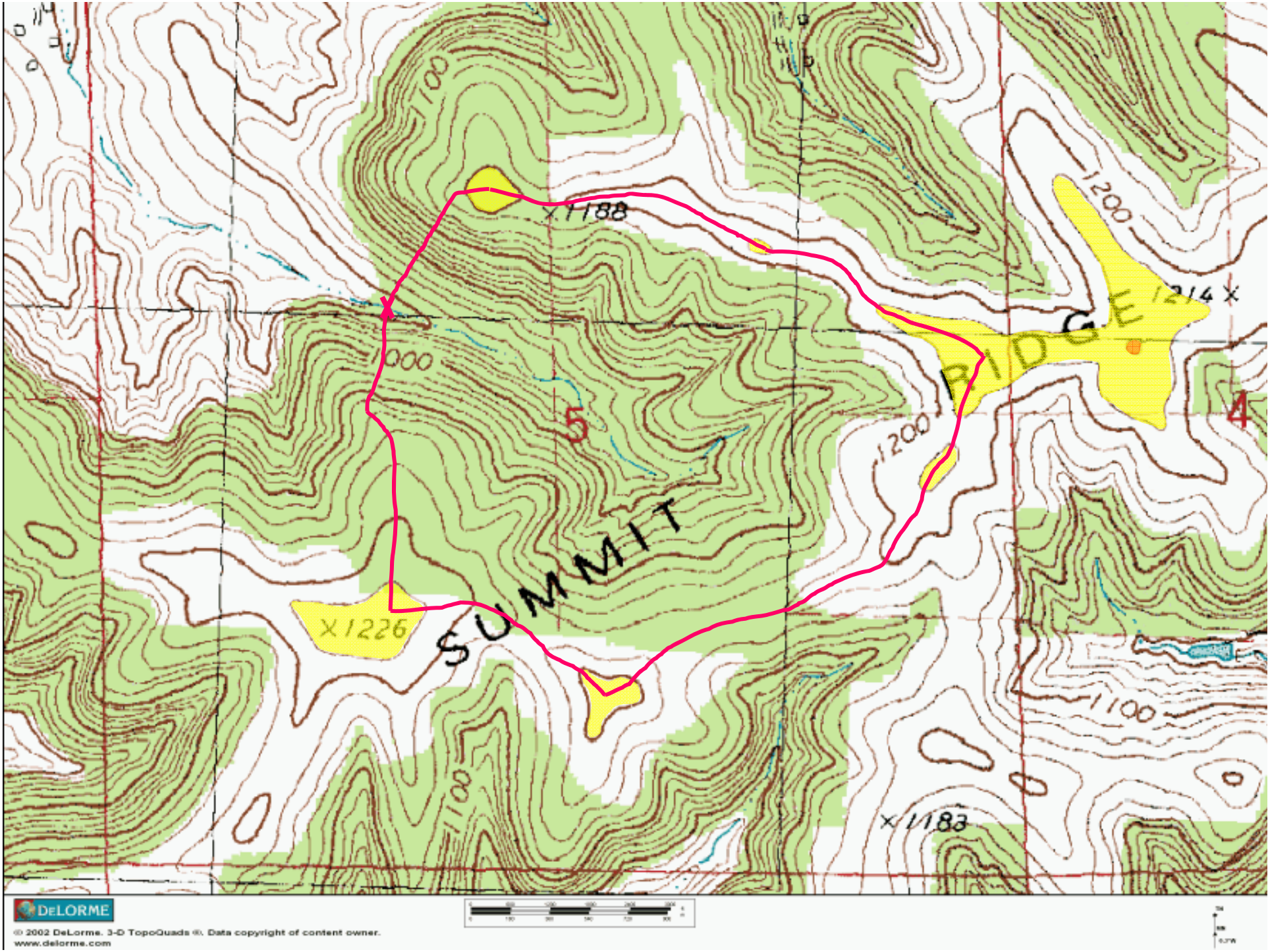
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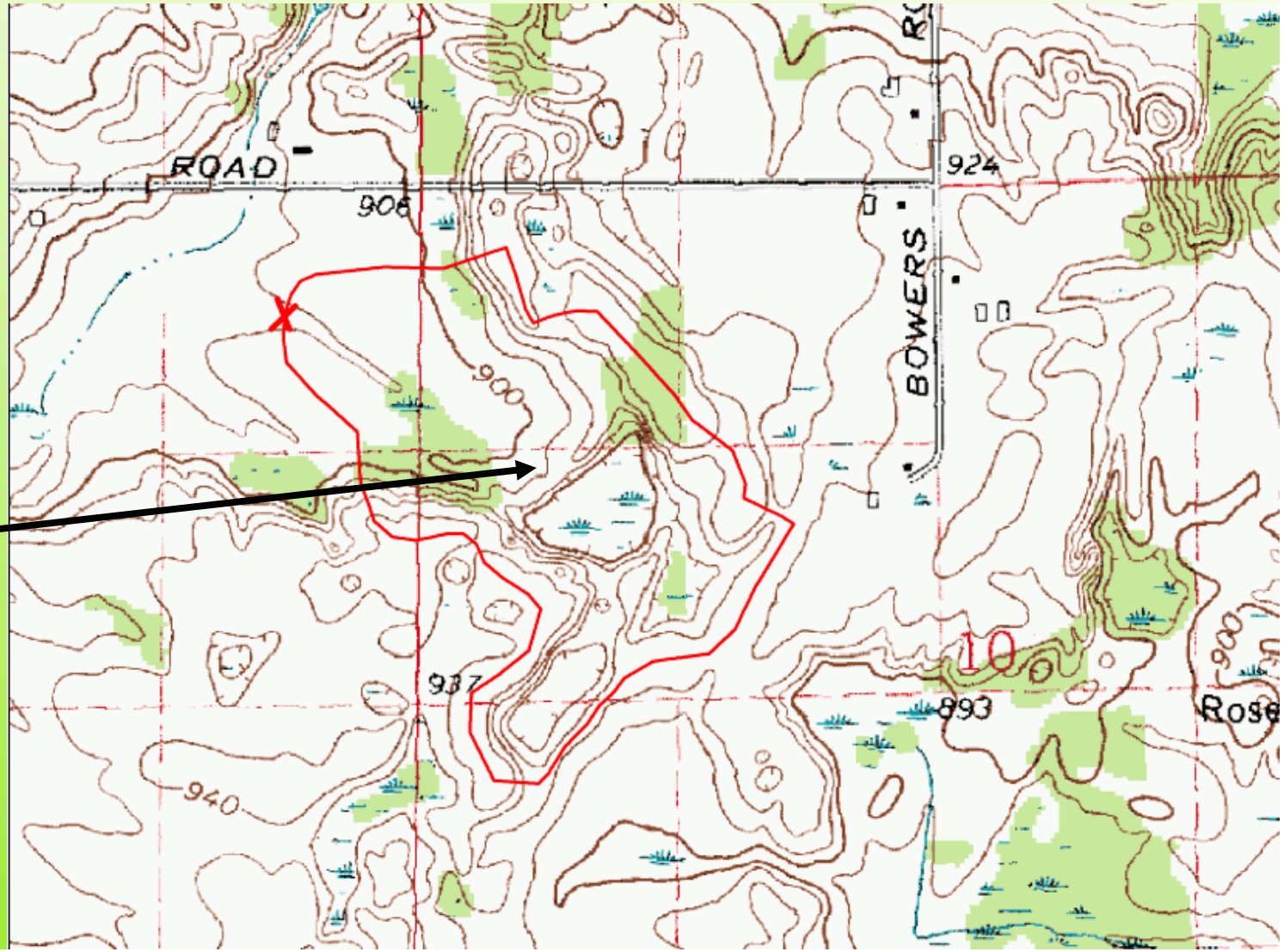
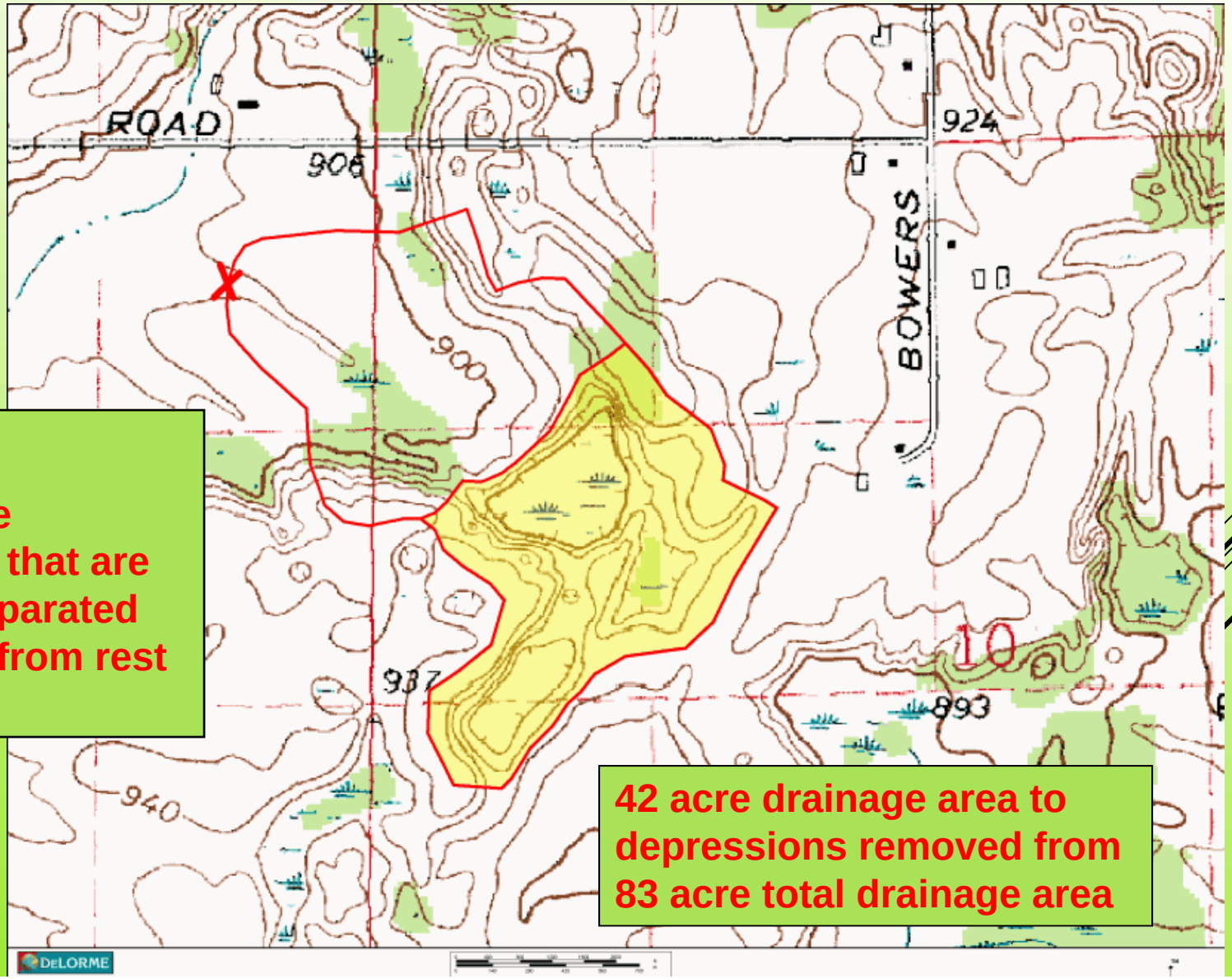
# WATERSHED WITH DEPRESSIONAL AREA



# WATERSHED WITH DEPRESSIONAL AREA




**Caution!!**

**Only Remove Depressions that are Deep and Separated (by a Ridge) from rest of Area!**

**42 acre drainage area to depressions removed from 83 acre total drainage area**