HYDRIC SOILS

SOIL, LANDSCAPE, HYDROLOGY RELATIONSHIPS

Mark Bramstedt
Certified Professional Soil Scientist/Soil Classifier

INTRODUCTION

- GEOMORPHOLOGY IS STUDY OF LANDSCAPE HISTORY
- INTEGRATES BOTH LANDSCAPE AND TIME TO PREDICT WHERE SOILS OCCUR, INCLUDING HYDRIC SOILS
- SOILS CAN OCCUR AS DISTINCT ENTITIES AND AS TRANSITIONAL SOILS GRADING TO ANOTHER

SOIL-LANDSCAPE MODEL

SOIL = f(CL, O, *<u>R</u>*, PM, T)

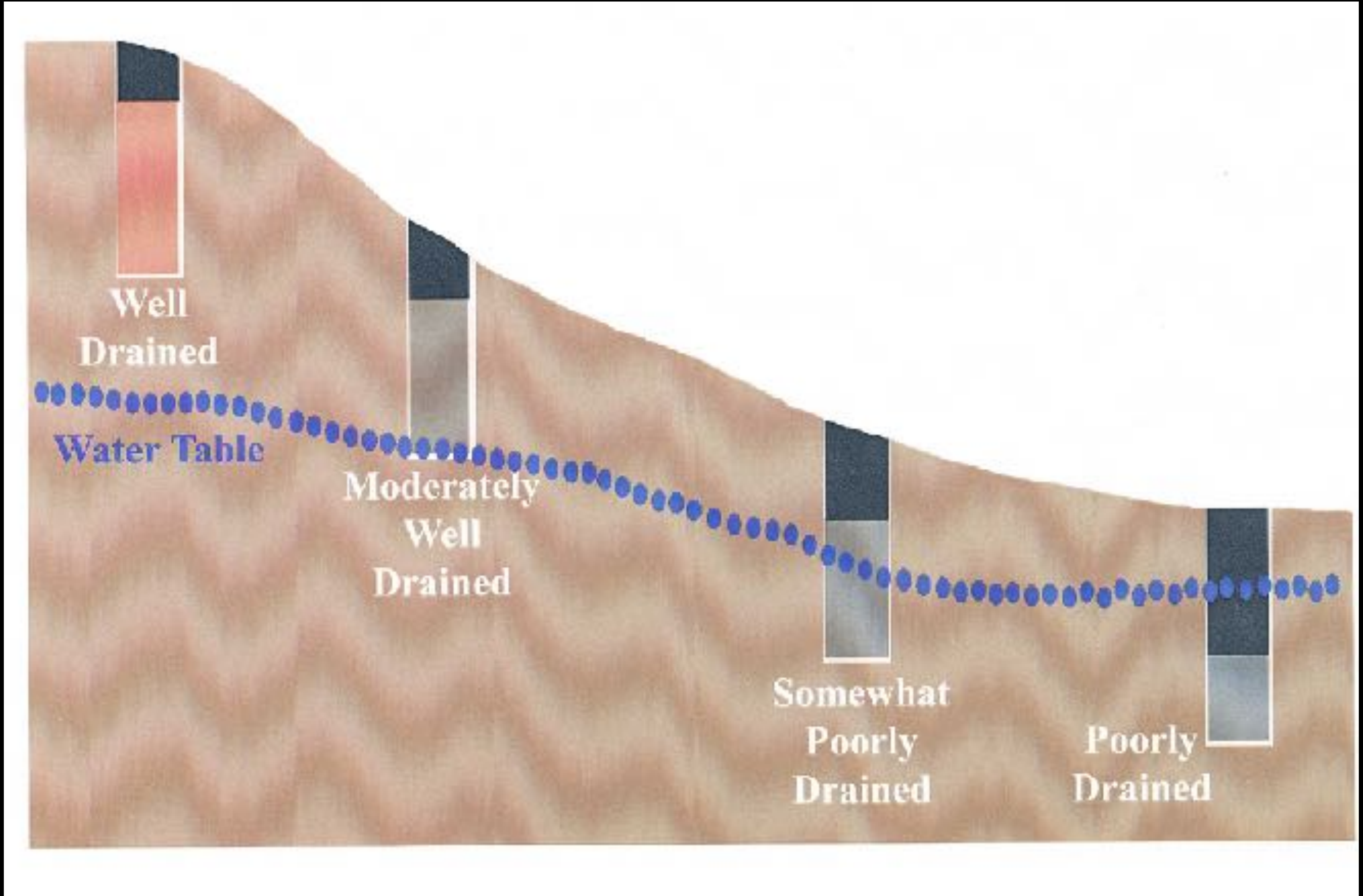
- **EQUATION IMPLIES THAT:**
  - **SOILS ARE NATURAL BODIES**
  - **DISTRIBUTED IN A PREDICTABLE WAY**
  - **AND IN RESPONSE TO A SYSTEMATIC INTERACTION OF ENVIRONMENTAL FACTORS**
- **EQUATION IMPLIES THAT:**
  - **BY LOOKING FOR CHANGES IN ONE OR MORE OF THESE FACTORS, ONE CAN ACCURATELY LOCATE BOUNDARIES BETWEEN DIFFERENT BODIES OF SOIL**

SOIL-LANDSCAPE MODEL

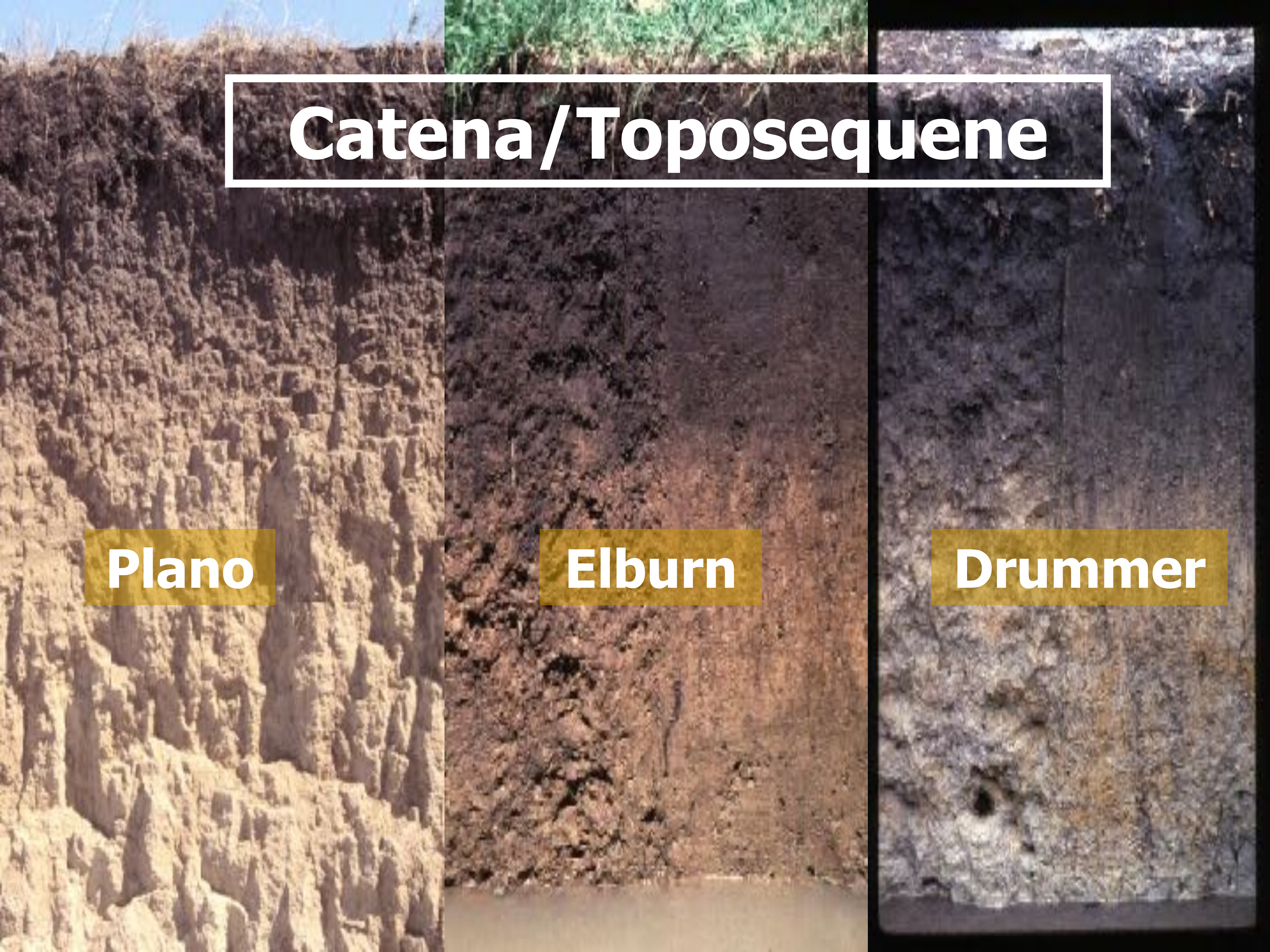
THIS RESULTS IN A SEQUENCE OF SOILS ON THE LANDSCAPE – SOIL CATENA OR TOPOSEQUENCE

SOIL-LANDSCAPE MODEL

CATENA IN LOESS

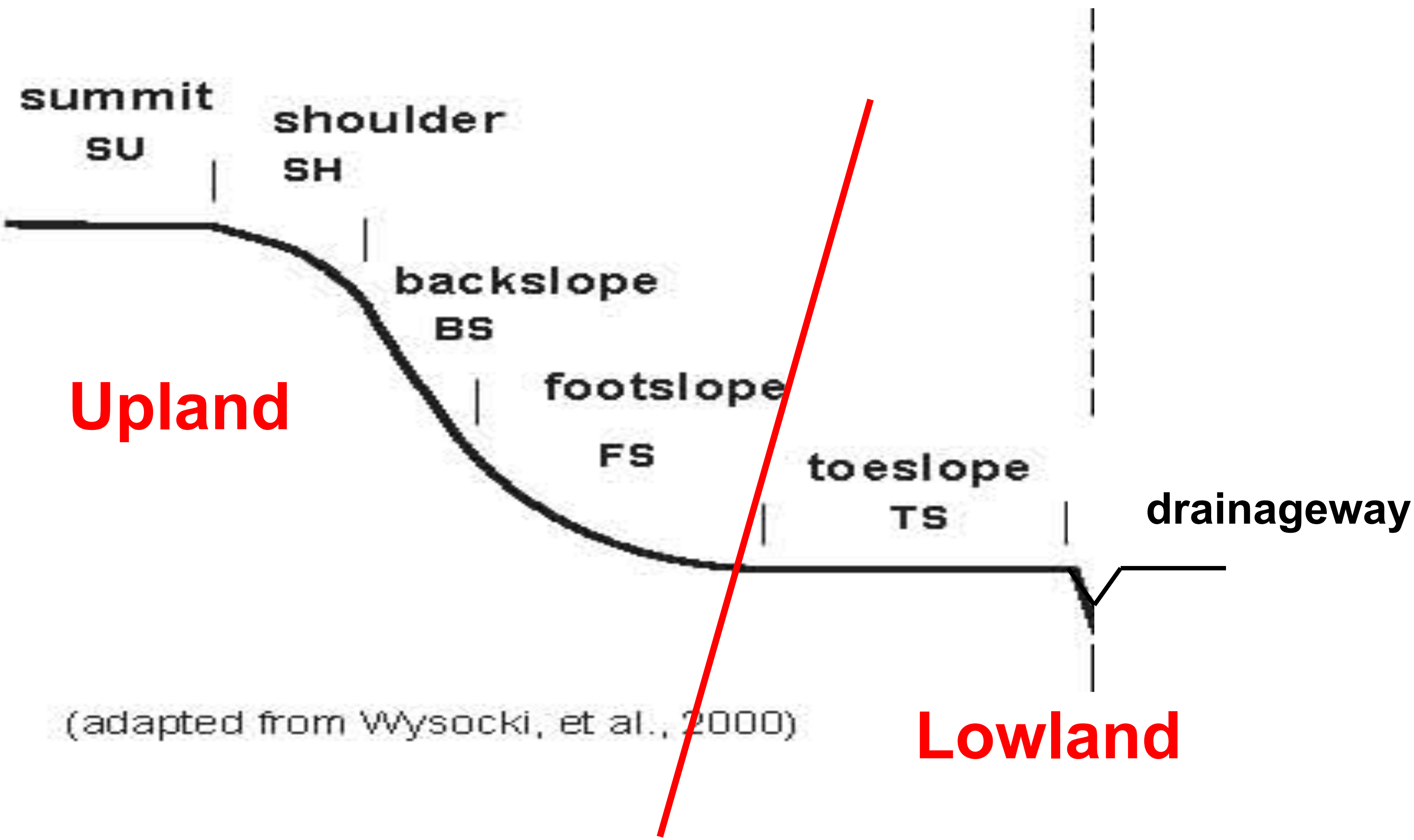


Catena/Toposequene

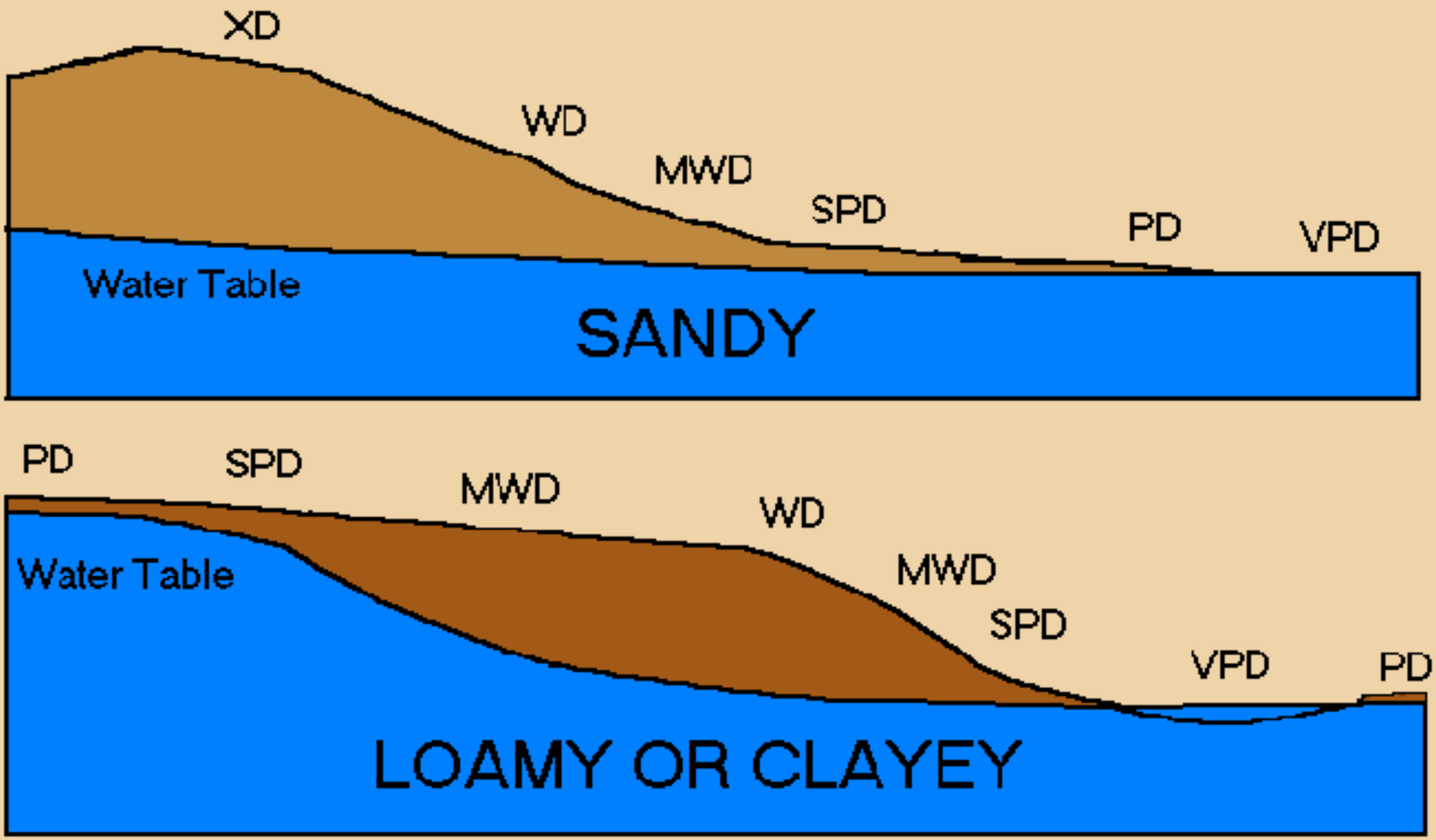


SOIL-LANDSCAPE MODEL

HILLSLOPE ELEMENTS



Hillslope Elements & Water Table



SOIL-LANDSCAPE MODEL

SUMMIT

- Relatively flat
- Usually convex upland
- “Watershed divide”, “Top of the World” view
- Often referred to as the “interfluve”
- If wide, can have hydric soils!

SOIL-LANDSCAPE MODEL

SHOULDER

- RAPID RUNOFF
- CONVEX SLOPE
- SHALLOW SOILS, LESS DEVELOPED
- SHEDS WATER

SOIL-LANDSCAPE MODEL

BACKSLOPE

- "Side slope"
- Rapid runoff
- Linear trending to concave area
- Sheds water

SOIL-LANDSCAPE MODEL

FOOTSLOPE

- Concave near base
- Runoff water slows
- Transition zone between eroding and deposition
- <u>Transition zone hydric to non-hydric</u>

SOIL-LANDSCAPE MODEL

TOESLOPE

- Base of slope
- Linear, with depositional surface
- Grades from slope to flat valley floor
- Can contain hydric soils

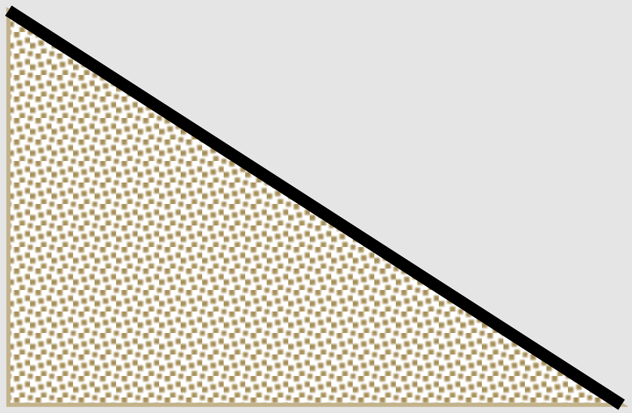
SOIL-LANDSCAPE MODEL

LANDSCAPE MORPHOLOGY

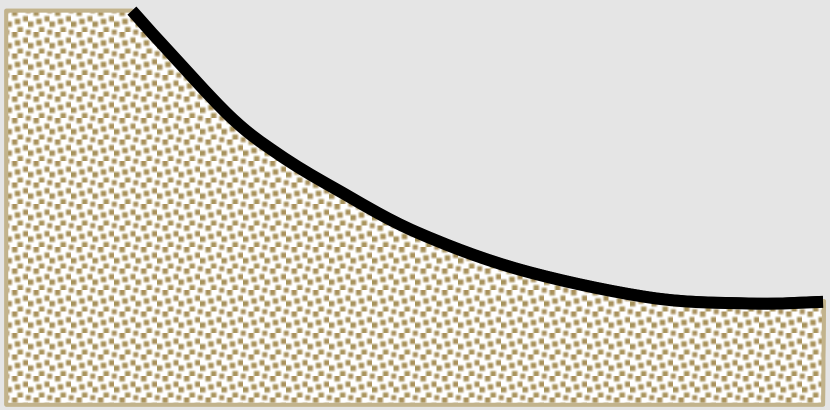
- **Gradient – The Slope**
  (land surface, subsurface stratigraphy, water table)
- **Aspect – Compass Direction**
  (can affect degree of soil development)
- **Vertical Curvature – Longitudinal**
  (perpendicular to contour, helps to funnel or scatter water)
- **Horizontal Curvature – Latitudinal**
  (parallel to contour. Shape is linear if contours are straight)

SOIL-LANDSCAPE MODEL-SHAPES

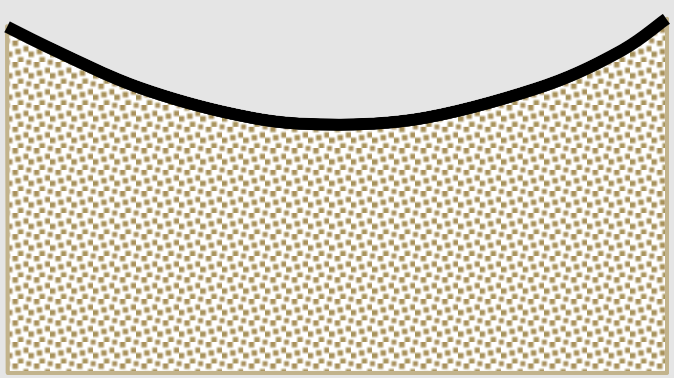
Linear



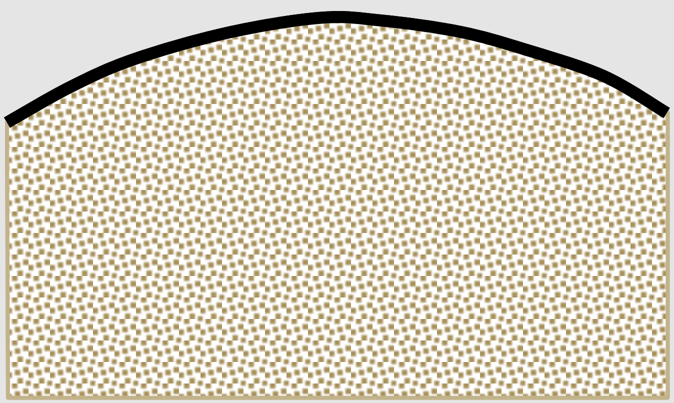
Hyperbolic Concave



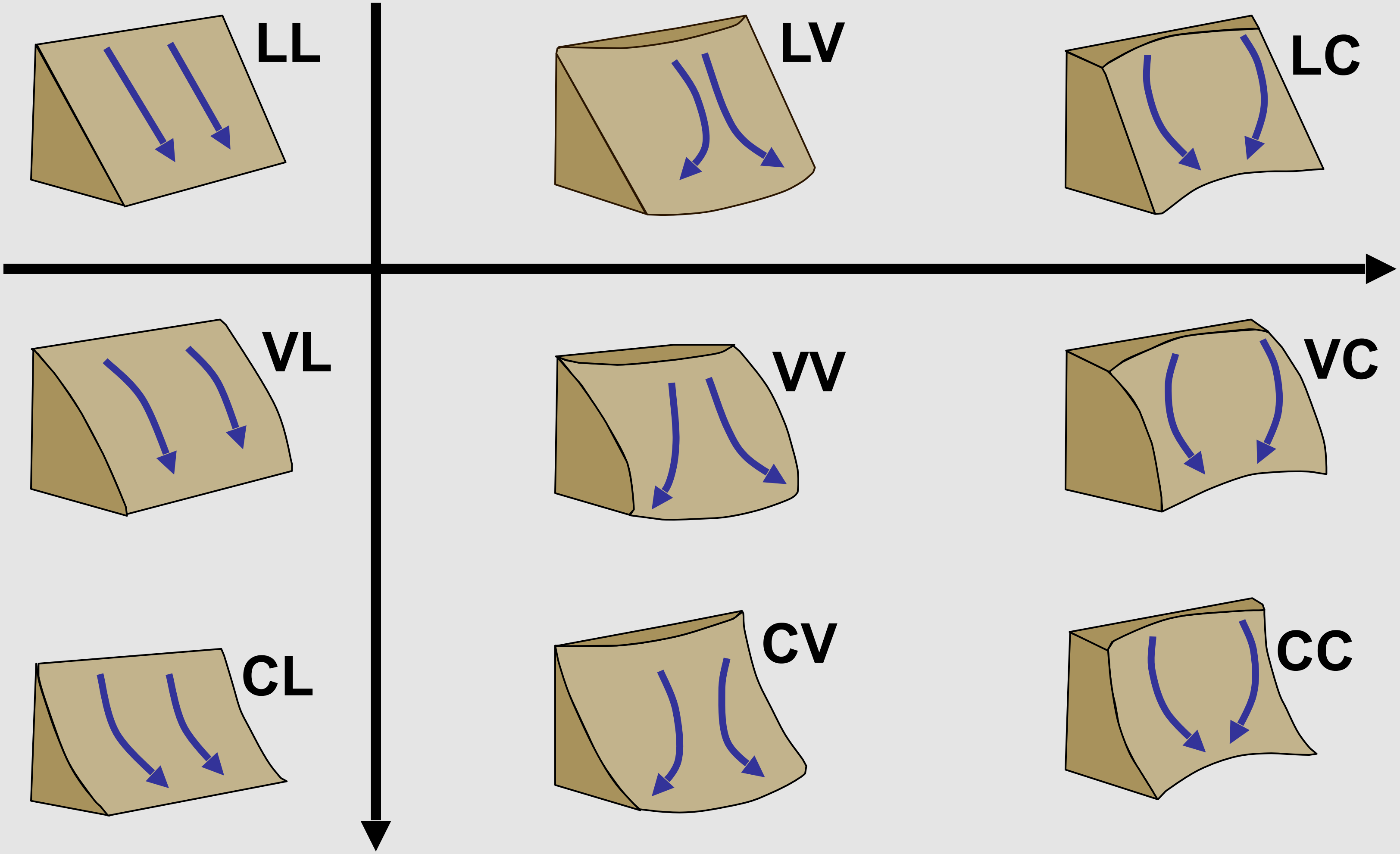
Concave



Convex



SOIL-LANDSCAPE MODEL
HILL SLOPE ELEMENTS AND CURVATURE



L = Linear   V = Convex   C = Concave

Ruhe, 1975

WATER MOVEMENT

WATER MOVEMENT ON LANDSCAPES ARE 3-DIMENSIONAL

- **SURFACE COMPONENTS (HORIZONTAL & VERTICAL)**
- **LANDSCAPE POSITION (ELEVATION)**
- **INTERNAL SUBSURFACE LATERAL COMPONENT**

Groundwater will move in response to BOTH gravitational gradients and pressure (suction) gradients

WATER MOVEMENT, BOTH SURFACE & SUBSURFACE, IMPACT SOIL GENESIS & LANDSCAPE EVOLUTION

WATER MOVEMENT

RUNOFF

- Water moves across the surface
- In most areas, more water enters the soil than runs off
- Generally, less soil development occurs with more runoff

WATER MOVEMENT

INFILTRATION

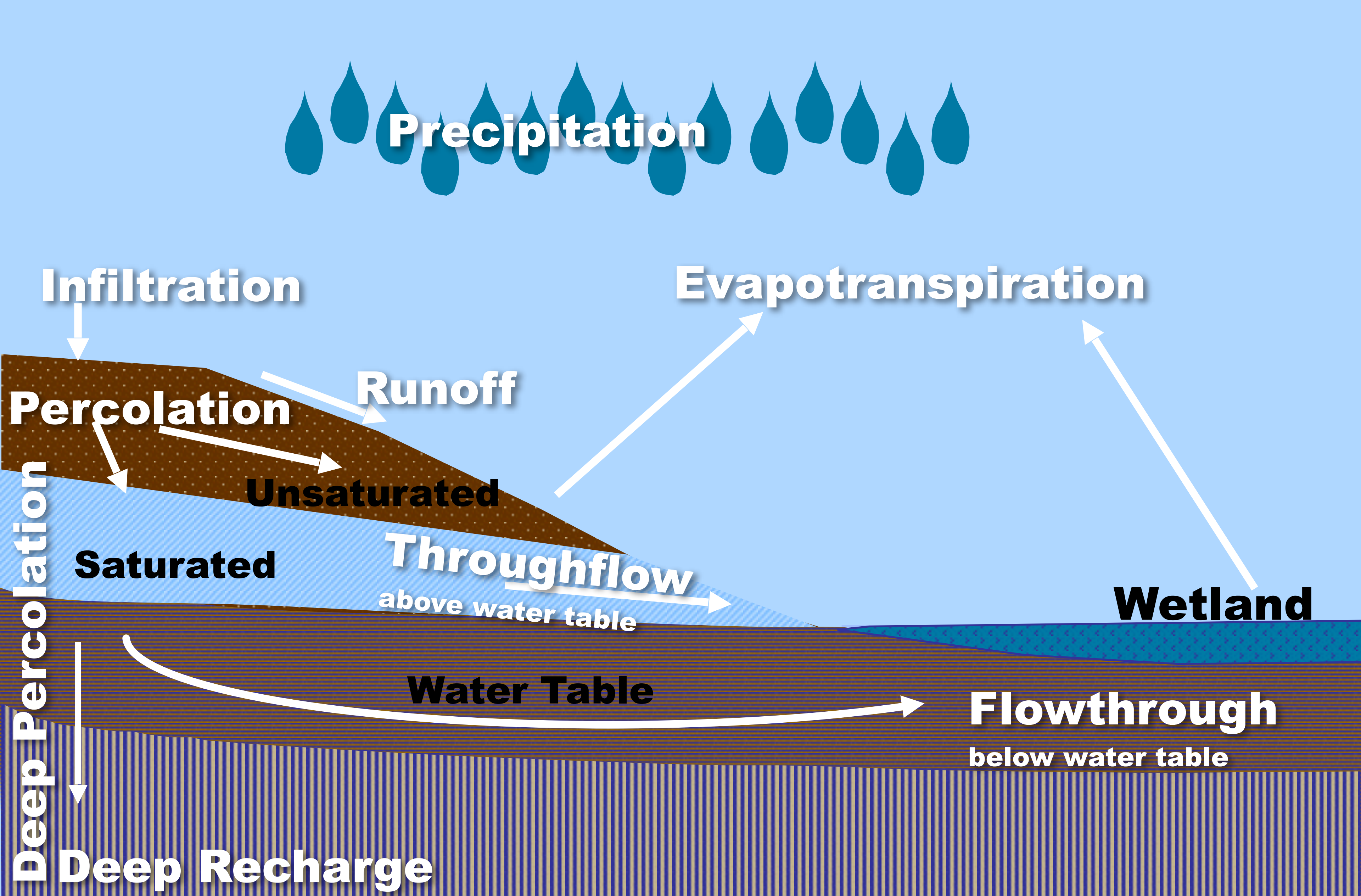
- Water that enters the soil
- more water infiltrating the soil generally implies more soil development
- "Effective rainfall" concept

WATER MOVEMENT

PERCOLATION / PERMEABILITY / KSAT

- SOILS ARE LAYERED IN MOST CASES
- WATER MOVES LATERALLY AND DOWNWARD
- DIFFERENCE IN HYDRAULIC CONDUCTIVITY AS LAYERS CHANGE IN SOIL PROFILE
- LAYERING CAN CAUSE WATER TO MOVE "SIDEWAYS"

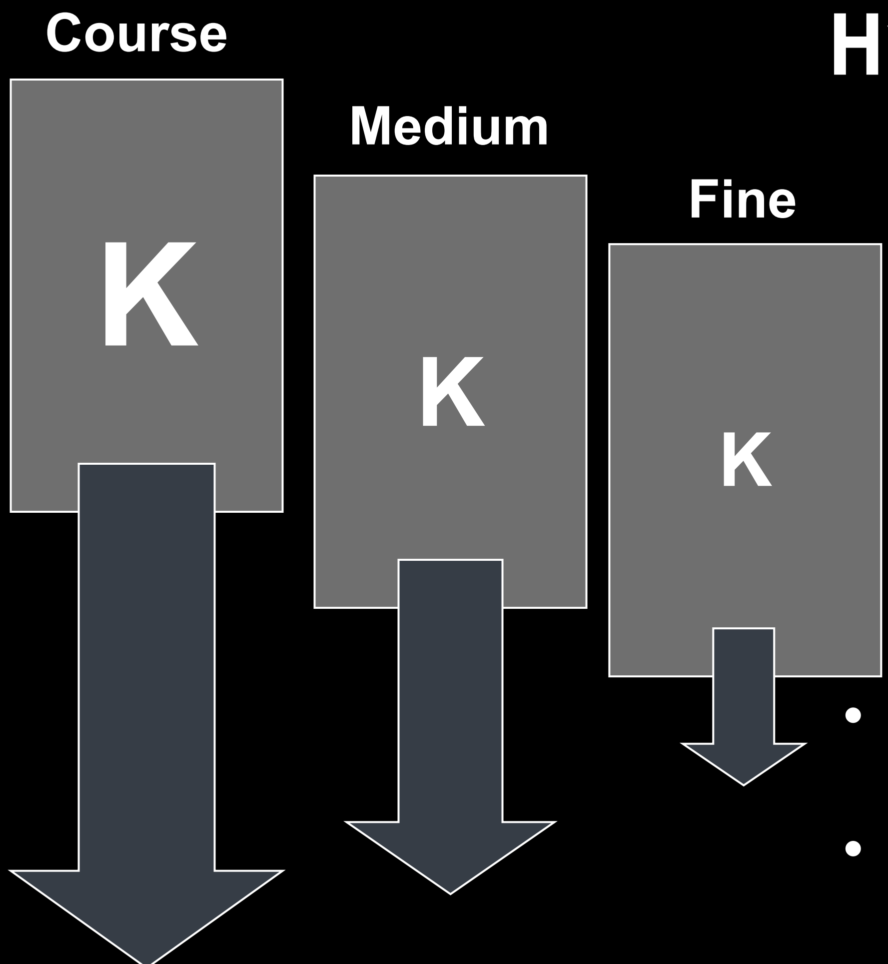
Soil Hydrologic Cycle



WATER MOVEMENT

GROUNDWATER FLOW

$K = J / (\Delta H / L)$



Hydraulic Conductivity

(K) Related to:

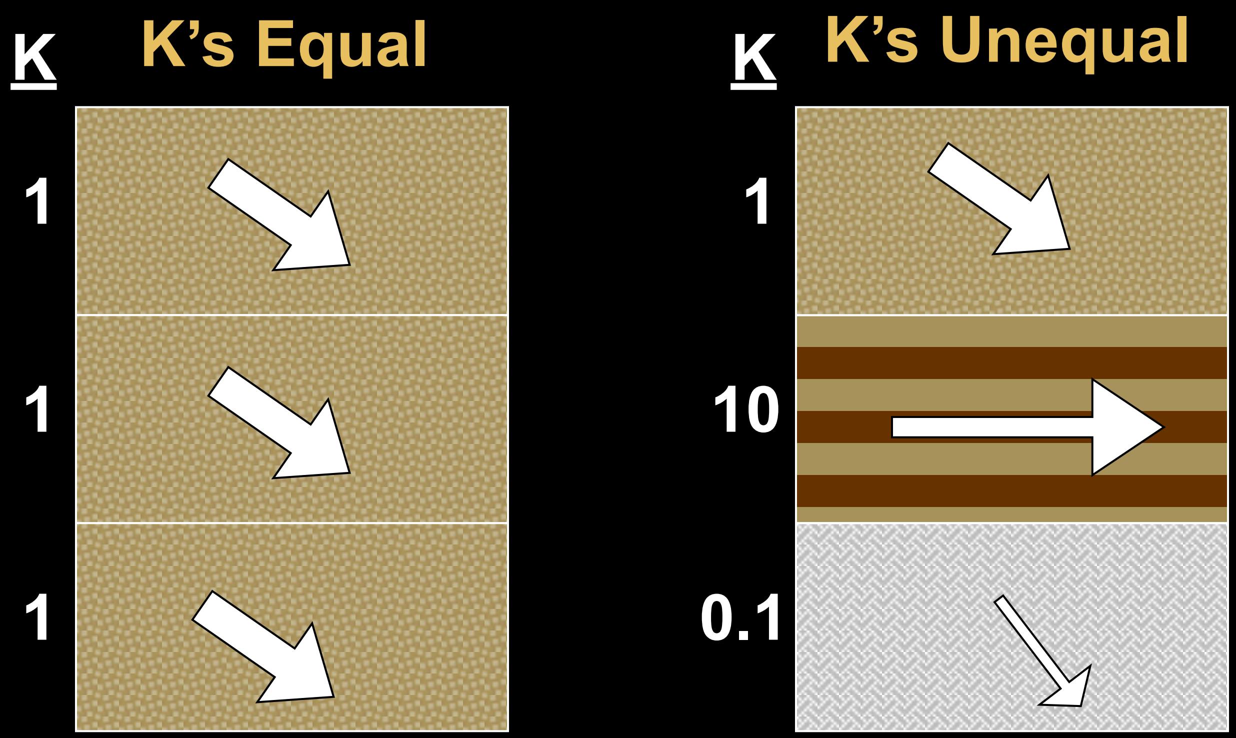
- Texture
- Structure

- K in a profile is determined by the overall slowest layer
- K occurs in saturated and unsaturated conditions, but Ksat refers to Saturated Hydraulic Conductivity

WATER MOVEMENT

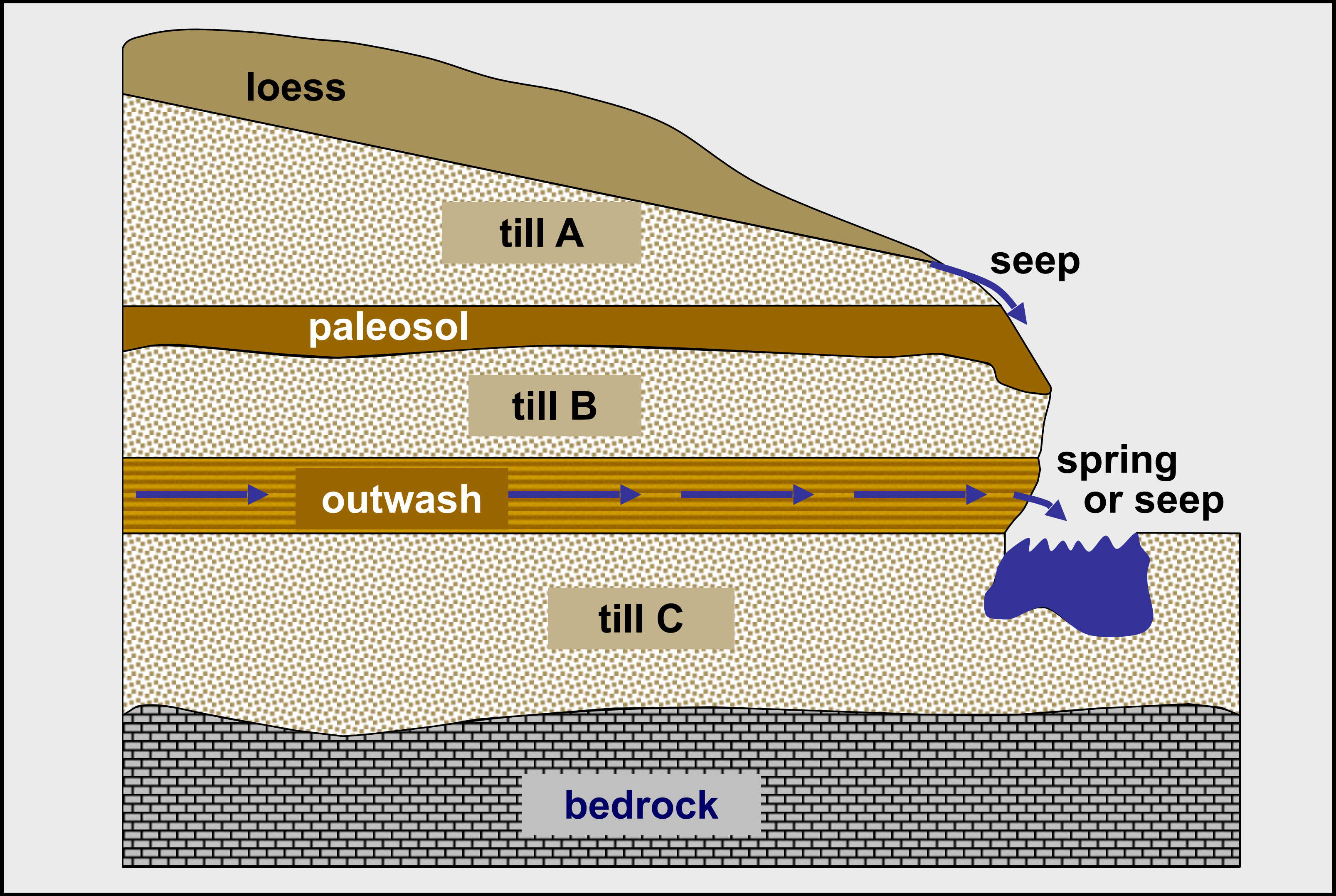
EFFECTS OF SEDIMENT LAYERING

Flow Cross-sections



Layering Favors Lateral Flow

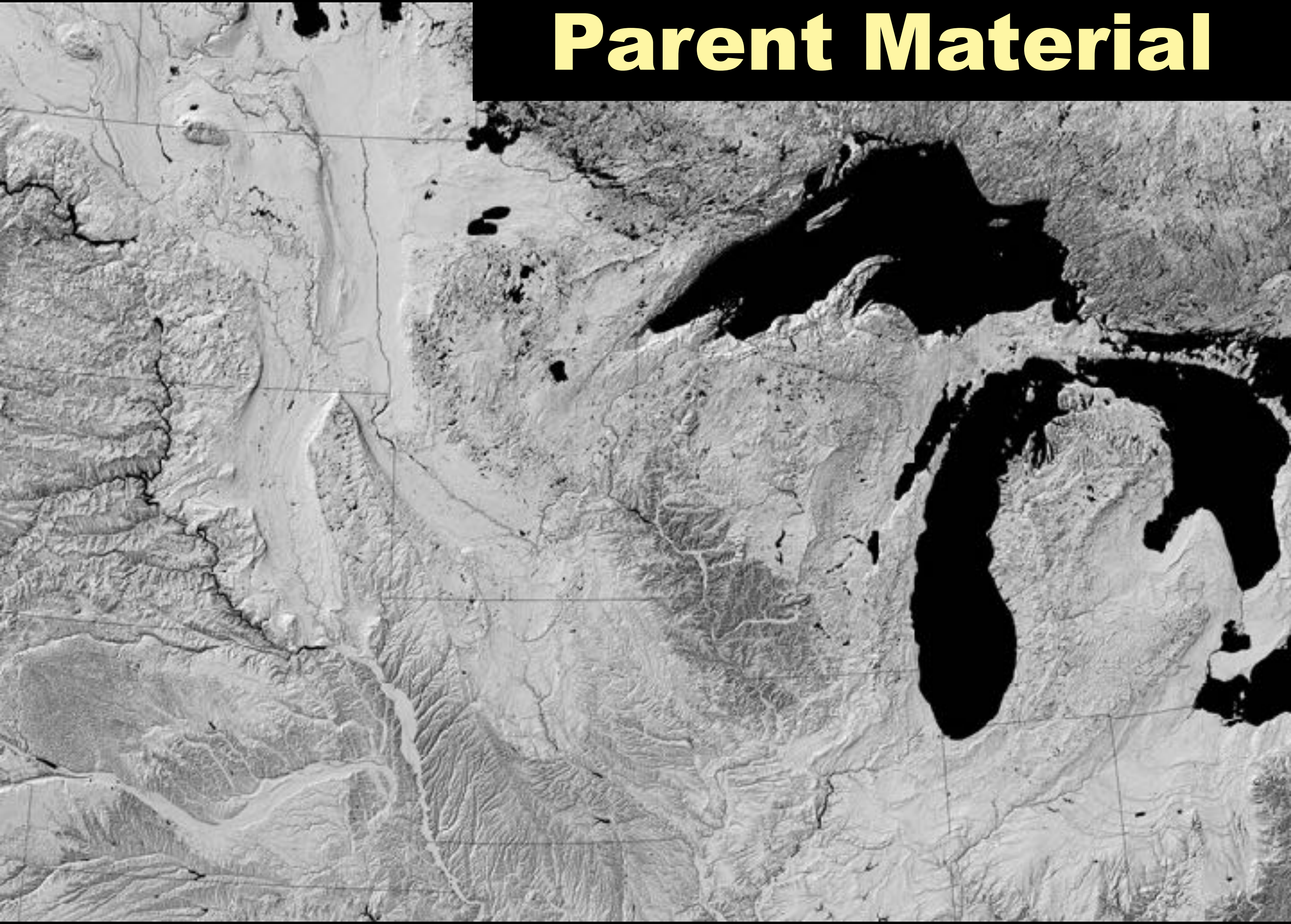
WATER MOVEMENT



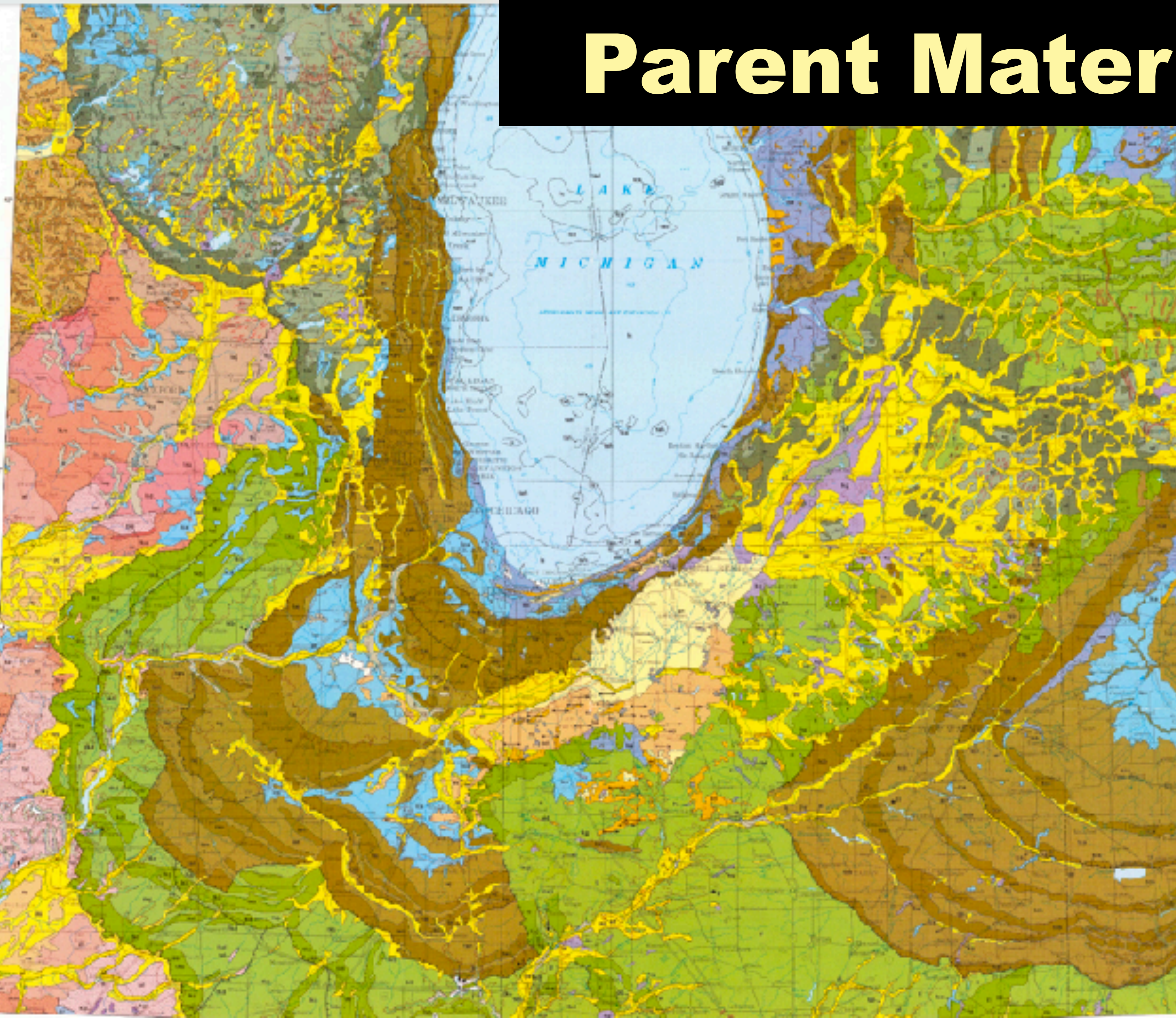
WATER MOVEMENT

SEEPS

Parent Material



Parent Material



Parent Material

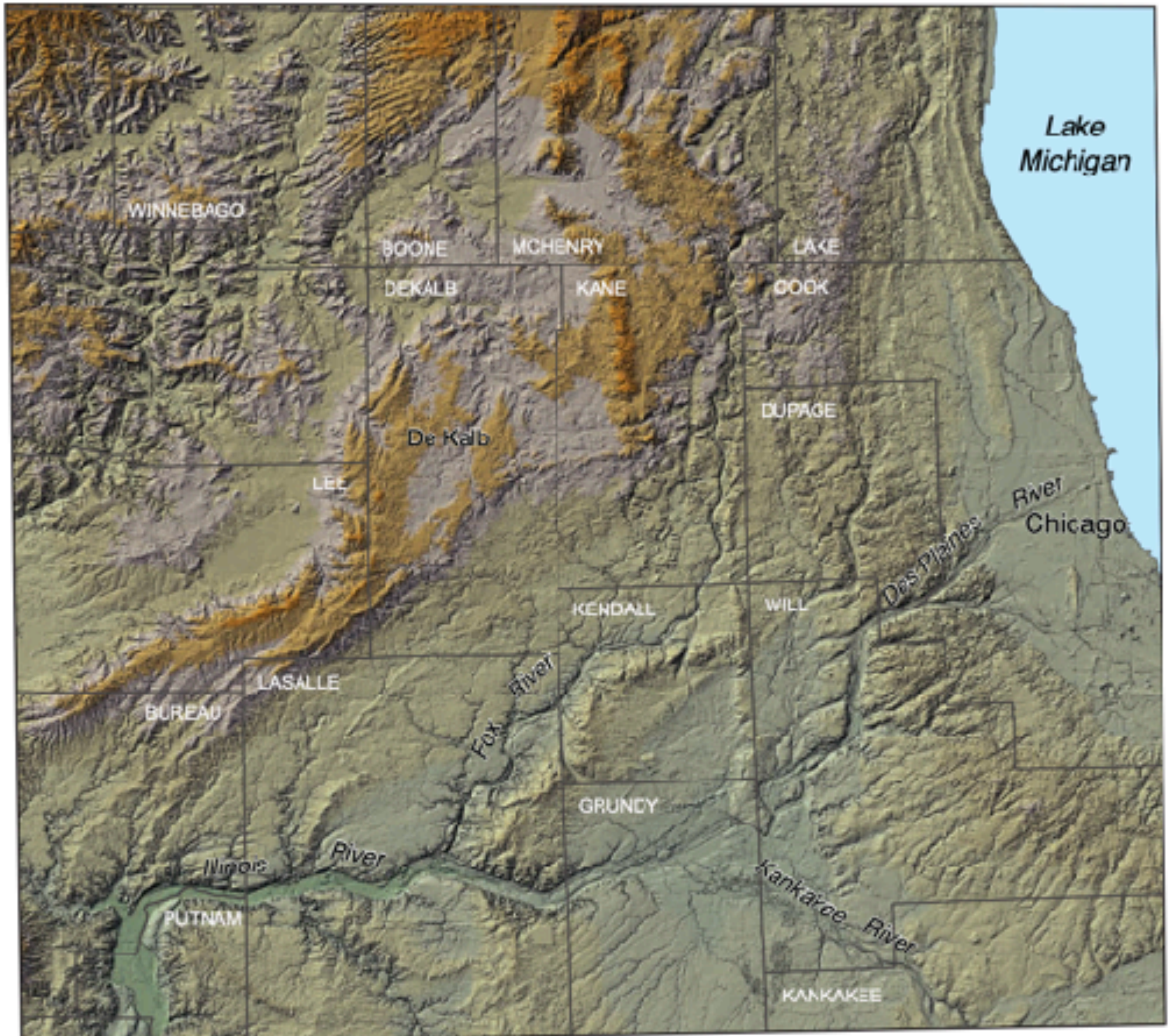


Figure 2 Painted relief map of northeastern Illinois; modified from Luman et al. (2003)

Parent Material

Lake County - Libertyville Quad

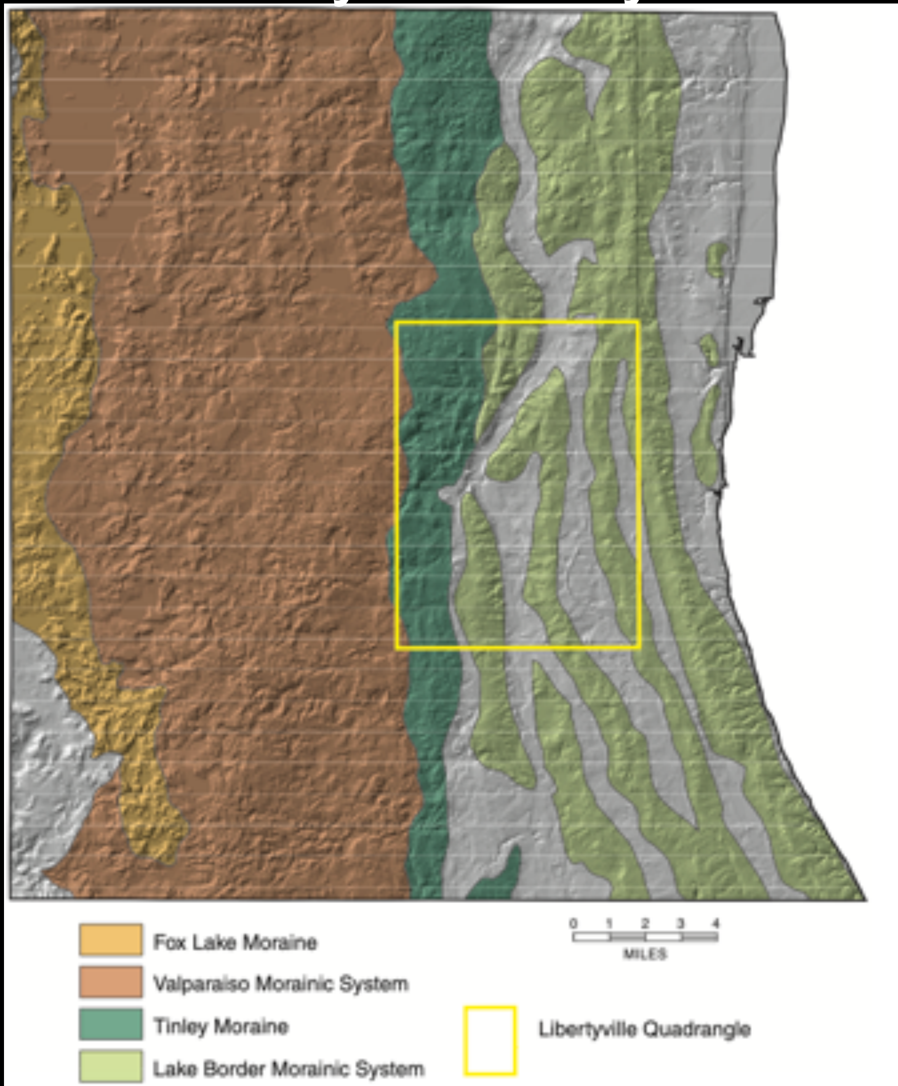
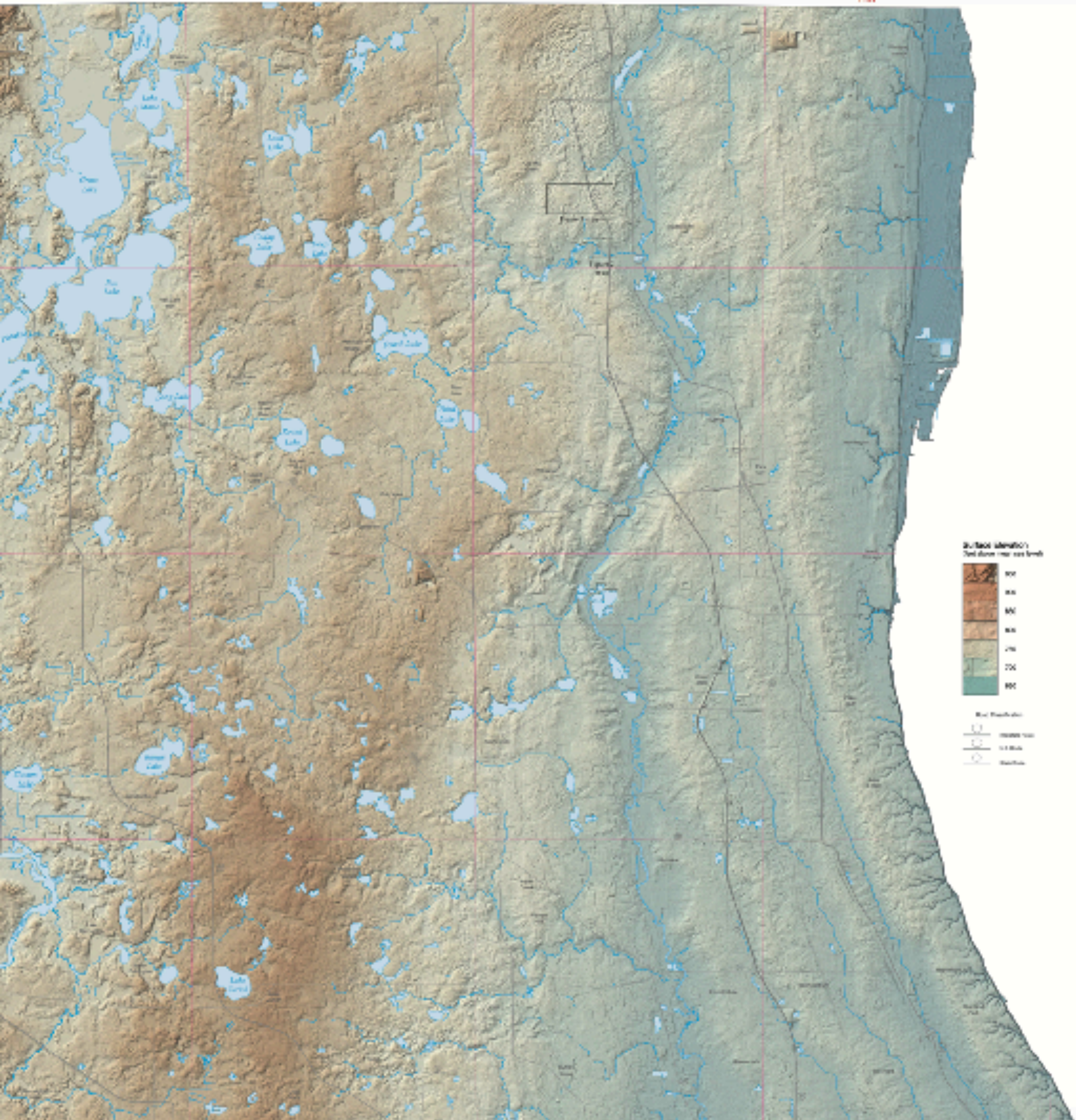


Figure 2 Surface topography and moraines of Lake County. After Willman and Frye 1970; Willman and Lineback 1970; Surface topography after Luman et al., 2003.

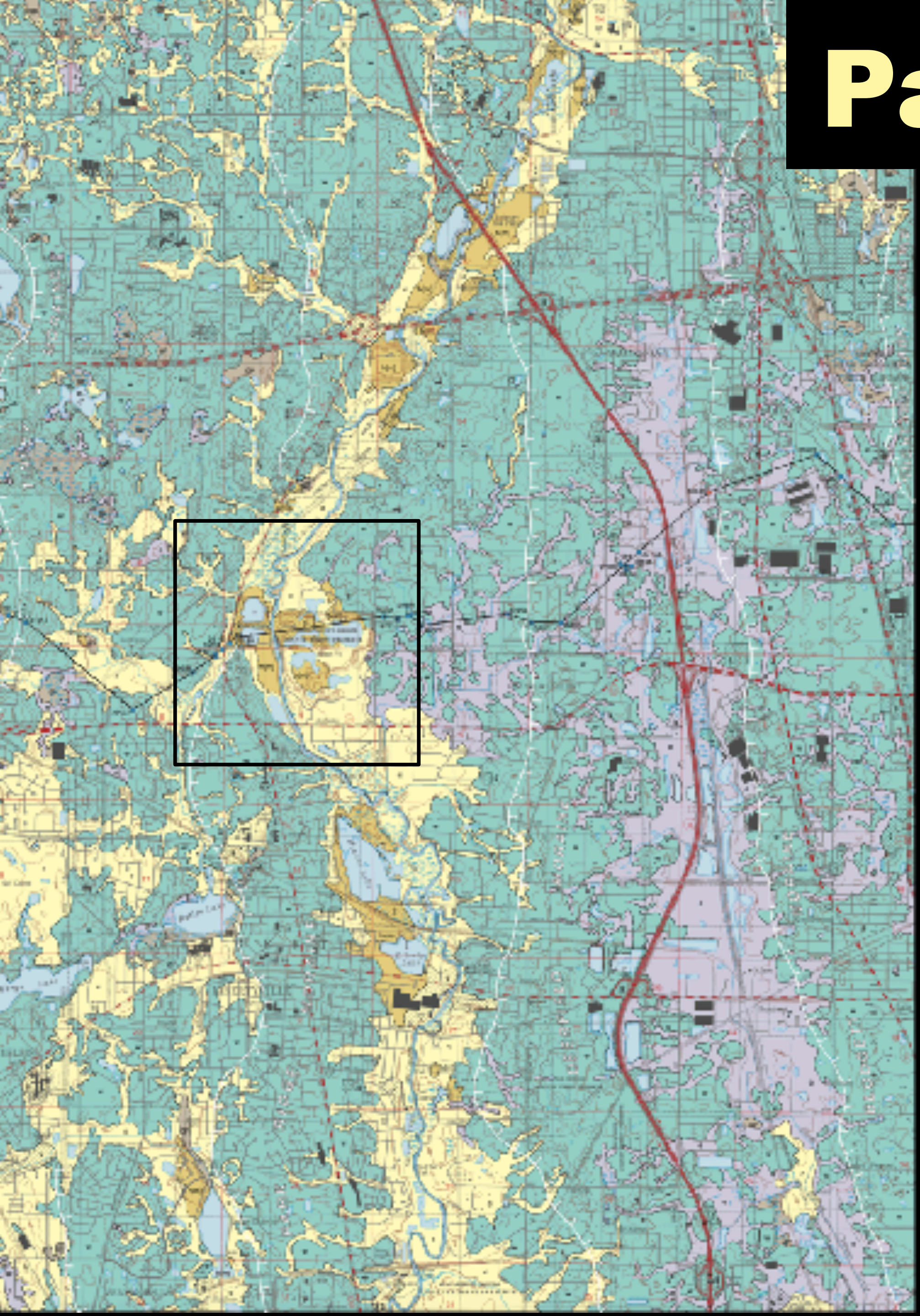


LiDAR

Lake County

Parent Material

Libertyville Quad
Independence Grove



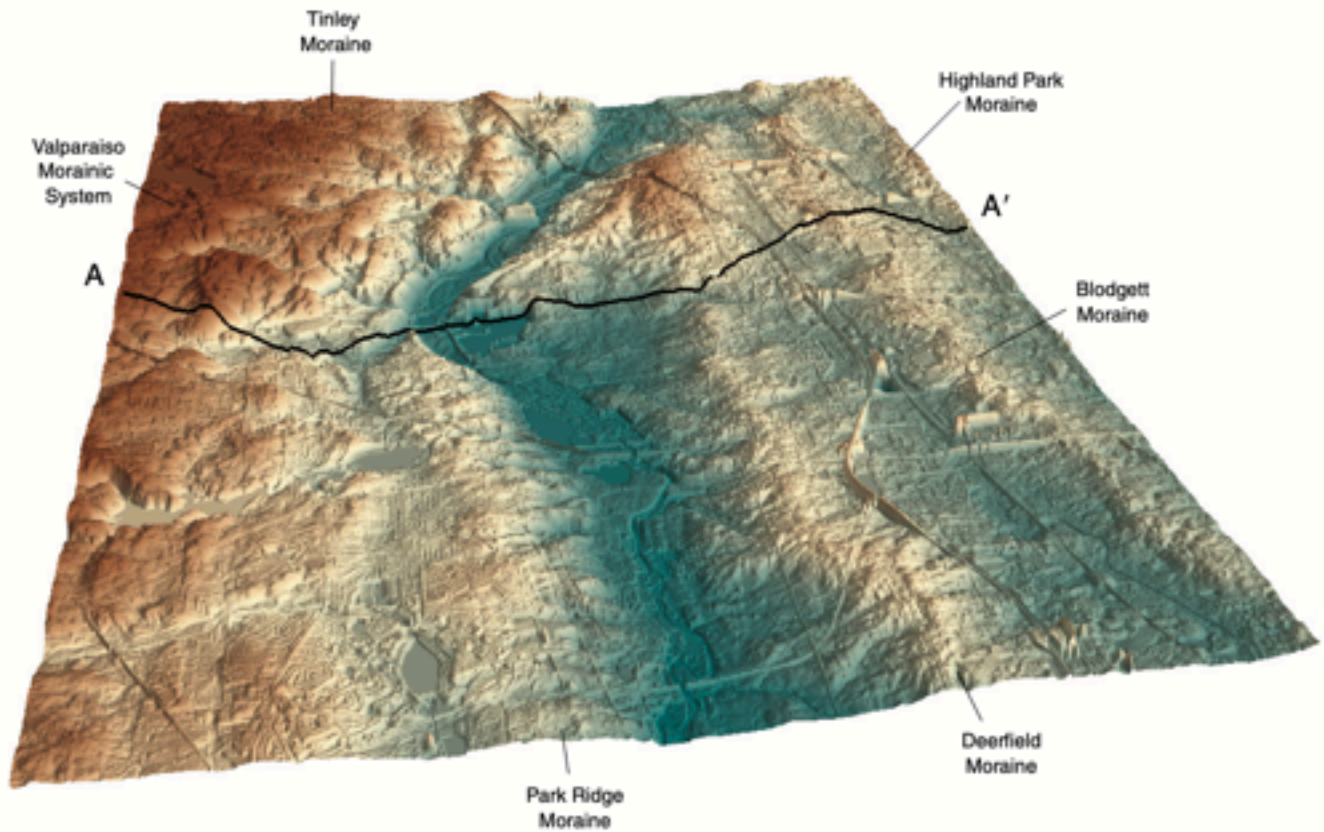
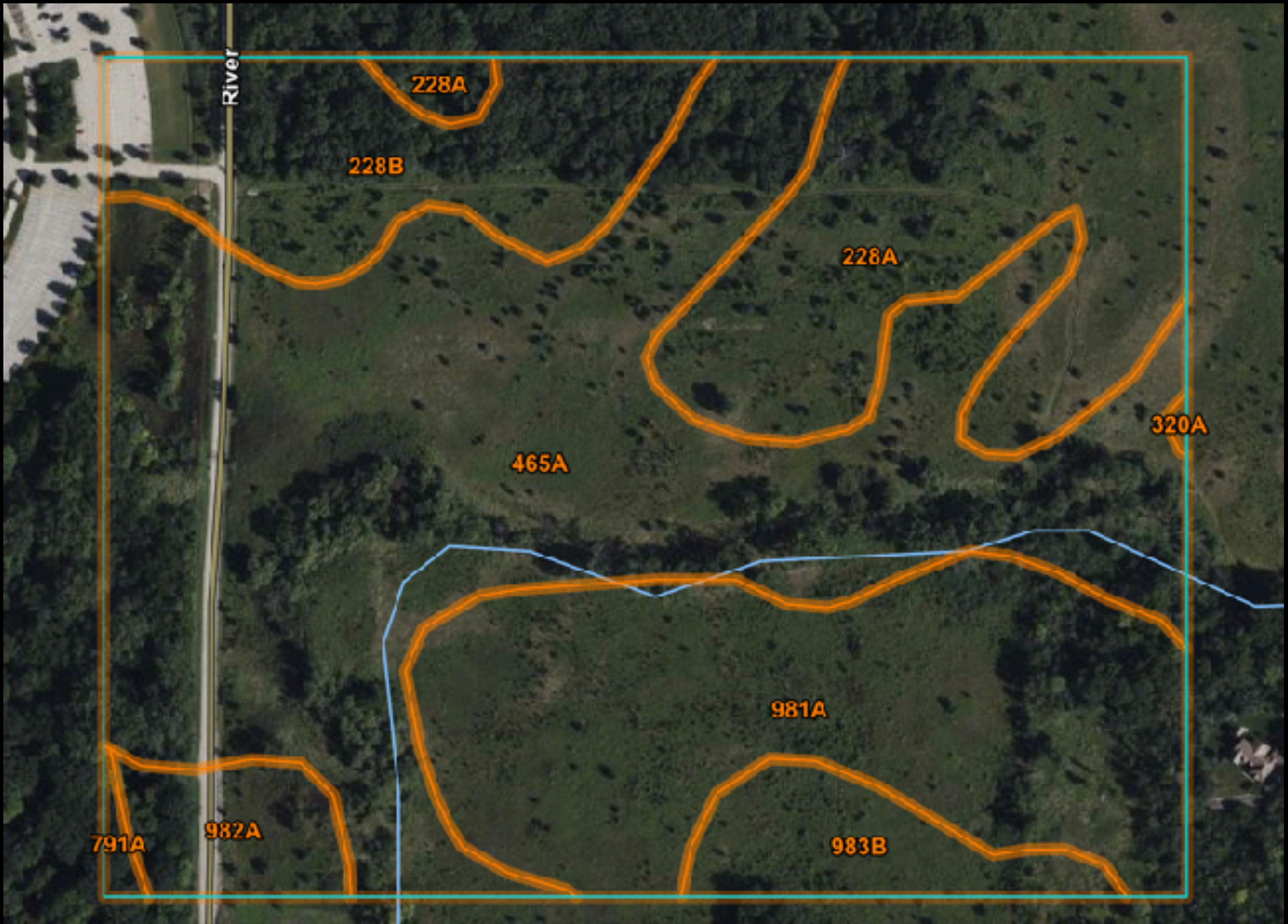


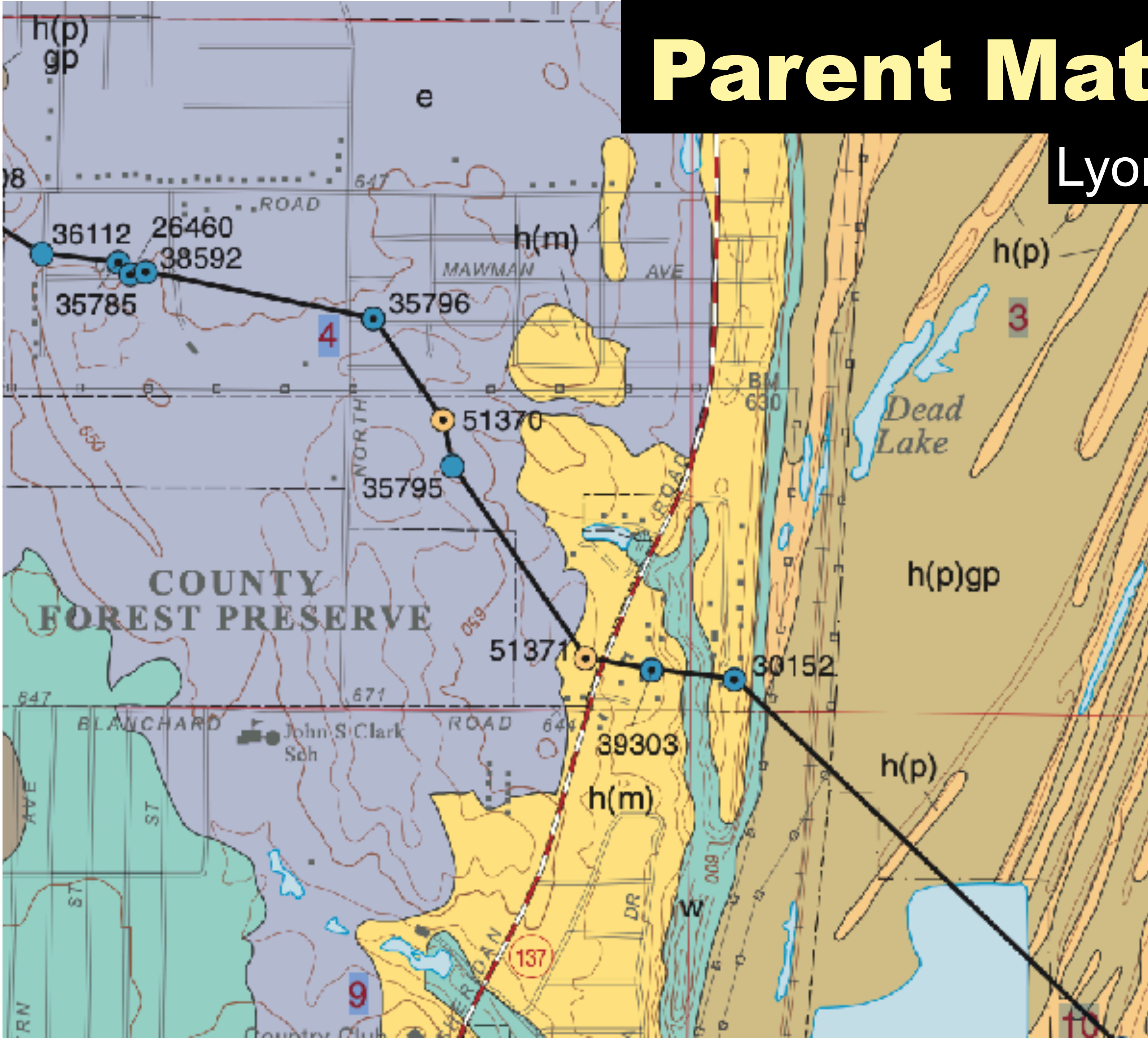
Figure 3 Surface topography of Libertyville Quadrangle with cross section A–A′. Digital elevation model generated from 2-foot resolution LIDAR, courtesy Lake County, Illinois GIS (2004).

Soil Map - Independence Grove

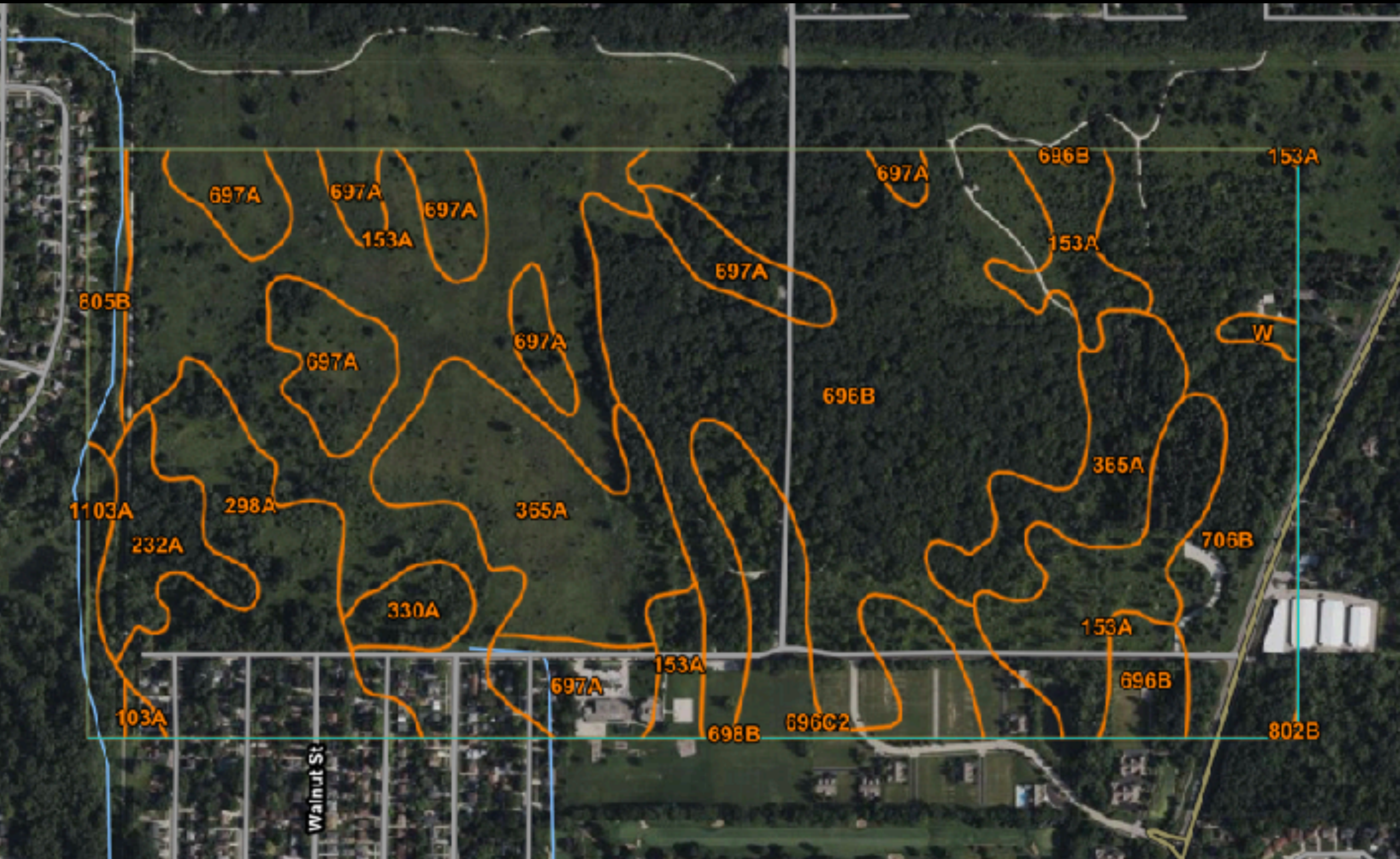


Parent Material

Lyons Woods



Soil Map - Lyons Woods



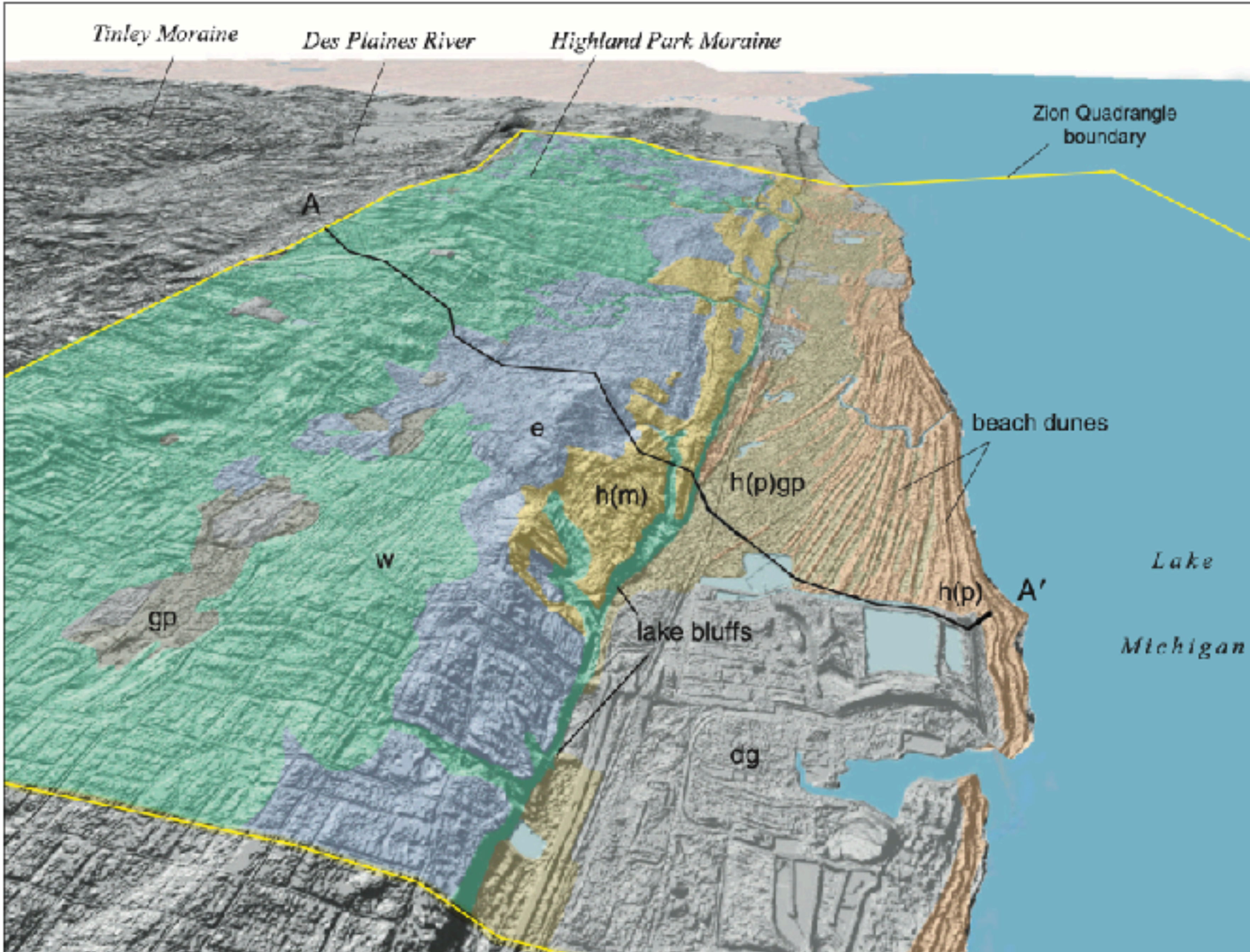


Figure 4 Surficial geology over topography of Zion Quadrangle.

Spring Bluff Forest Preserve - 1939

Spring Bluff Forest Preserve - 1974

Spring Bluff Forest Preserve - 1993

Ridge and swale topography

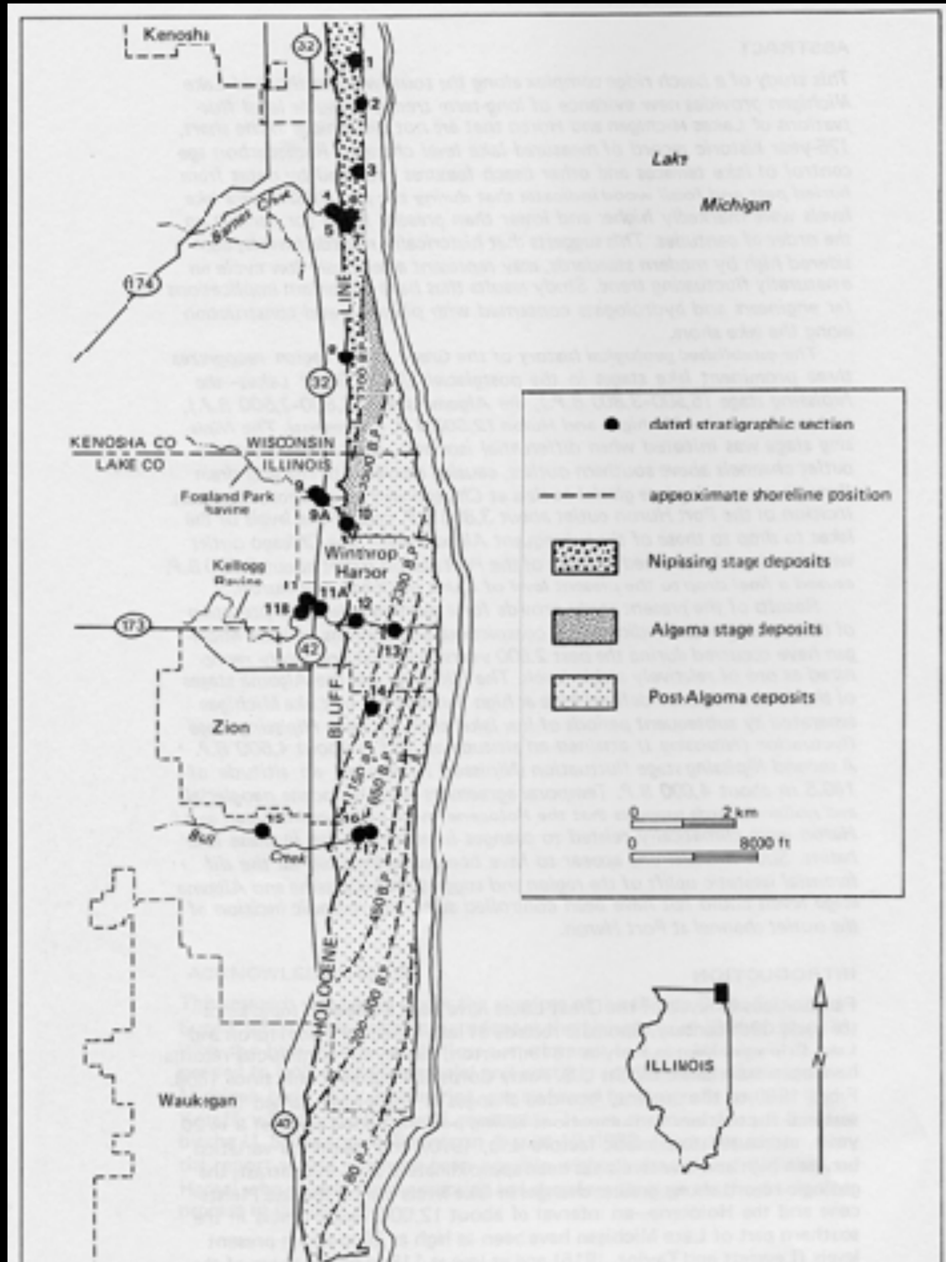


FIGURE 1. Beach ridge progradation sequence and study area.

Ridge and swale topography

Ridge and swale topography

creates a variety of habitats

Desert -like

Wetland

Karner Blue
Butterfly

Coastal wetlands

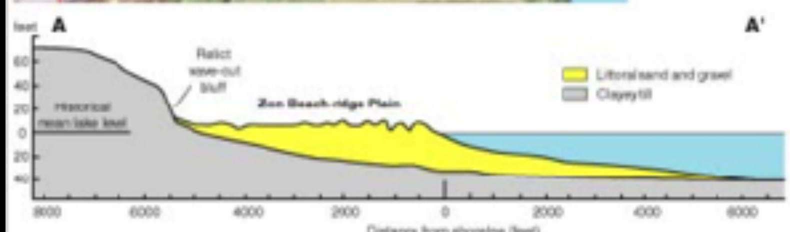
Blandings turtle

Ridge and swale topography

Stop 1

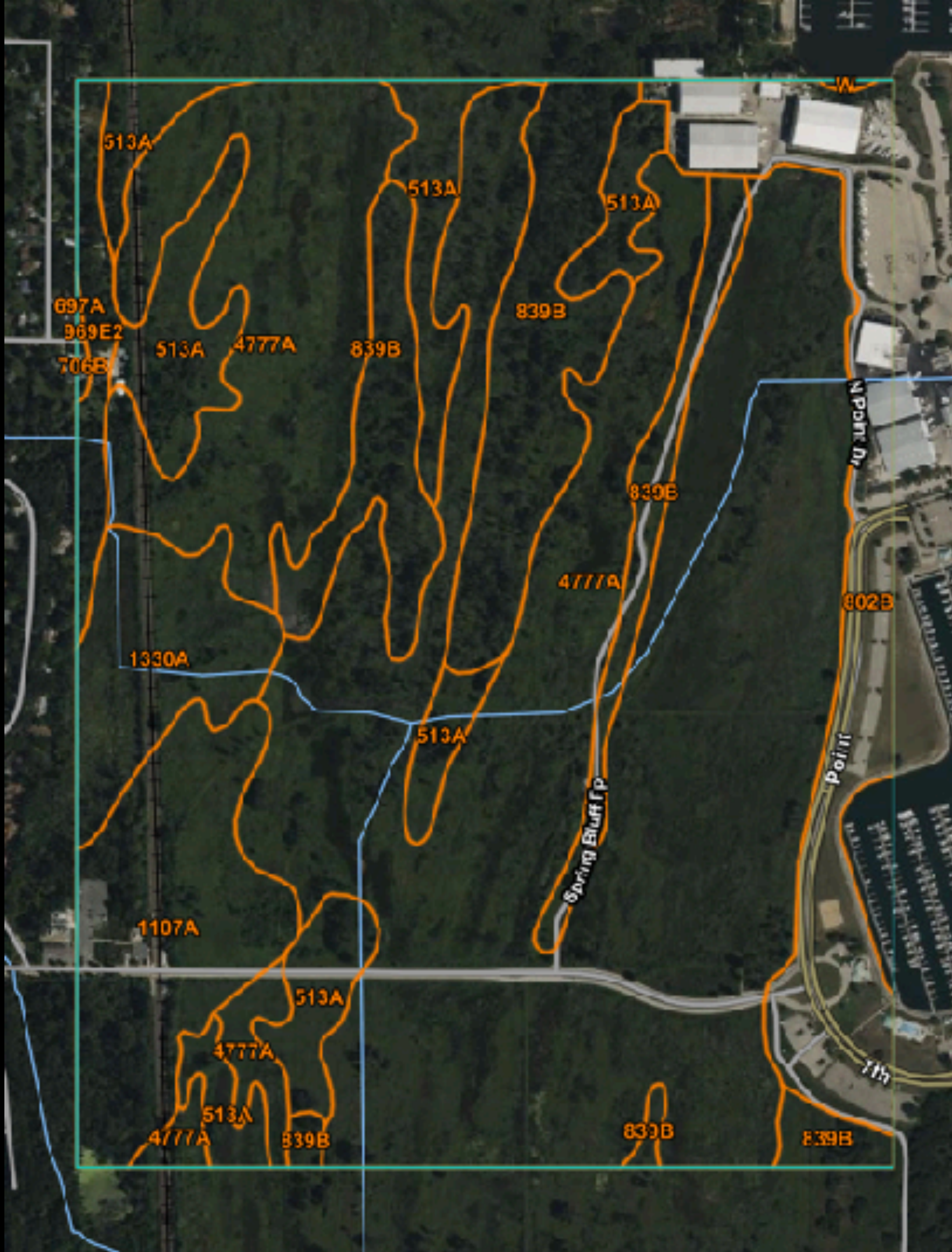
Beach and dune ridges in the South Unit of Illinois Beach State Park record the southward translation and lakeward progradation of the sand plain.

(LIDAR data courtesy of Lake County)



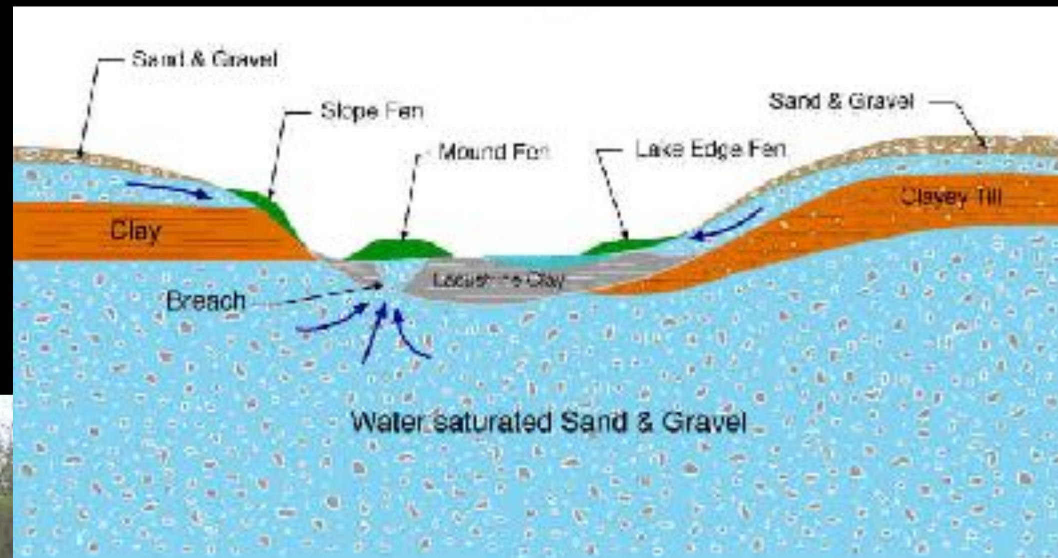
Generalized cross section showing the beach ridge sediments overlying a relict nearshore profile eroded in till.
(modified from Chrzastowski and Trask 1995)

Soil Map
Spring Bluff

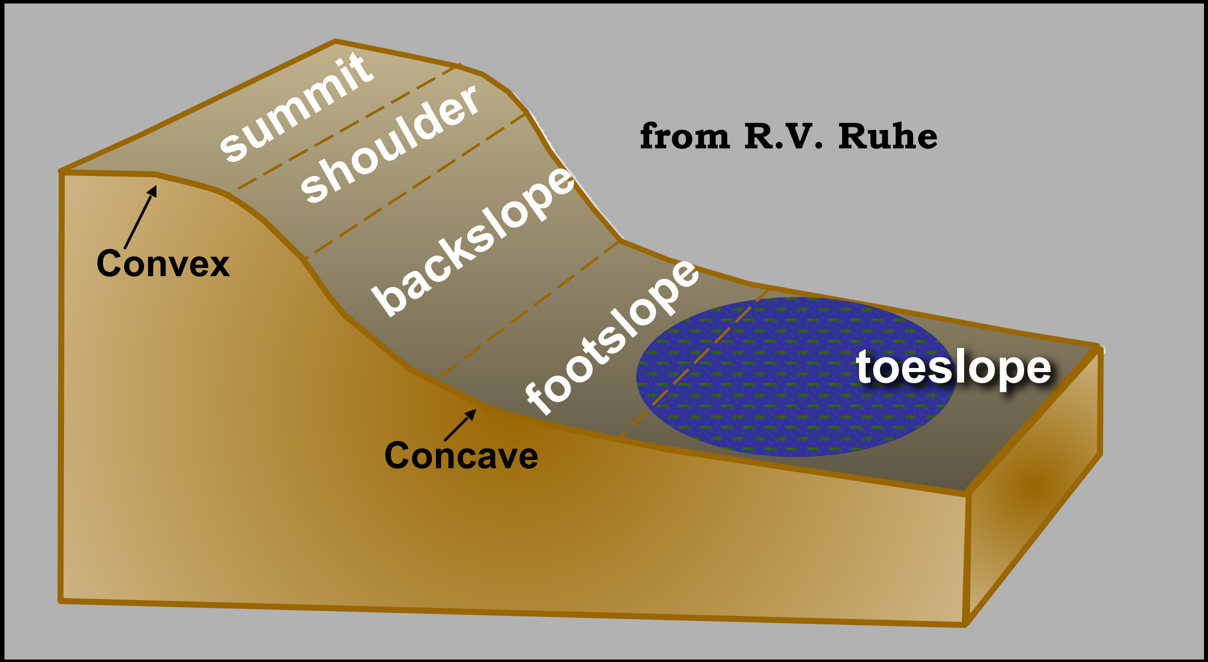


WATER MOVEMENT

FENS



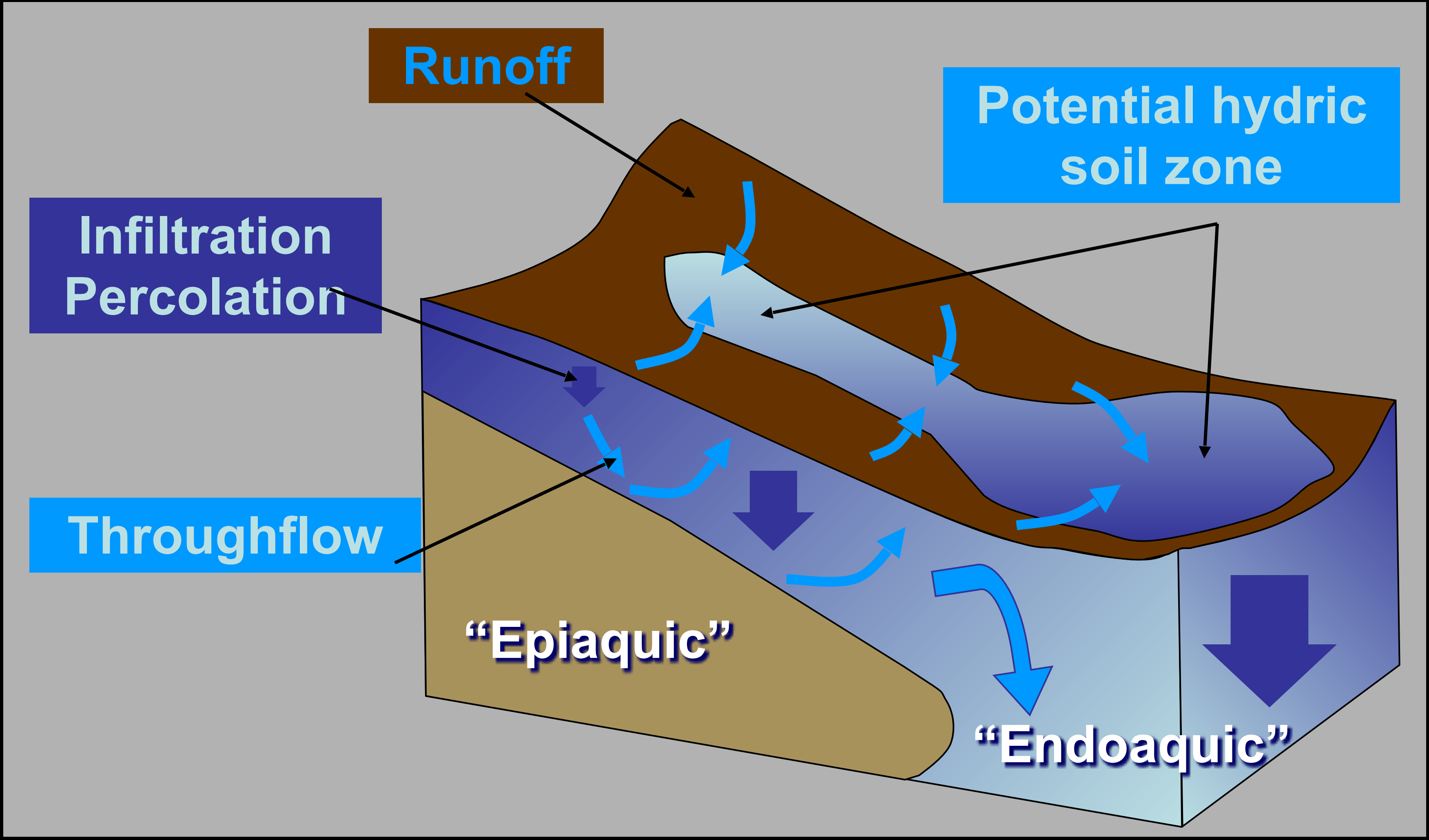
SLOPE MORPHOLOGY



- WHERE IS THE MAXIMUM WATER AND MINIMUM GRADIENT?
  - THIS IS WHERE INFILTRATION IS MAXIMIZED
- LOGICAL WETLAND LOCATIONS ARE ON FOOTSLOPES AND TOESLOPES

After Ruhe, 1975

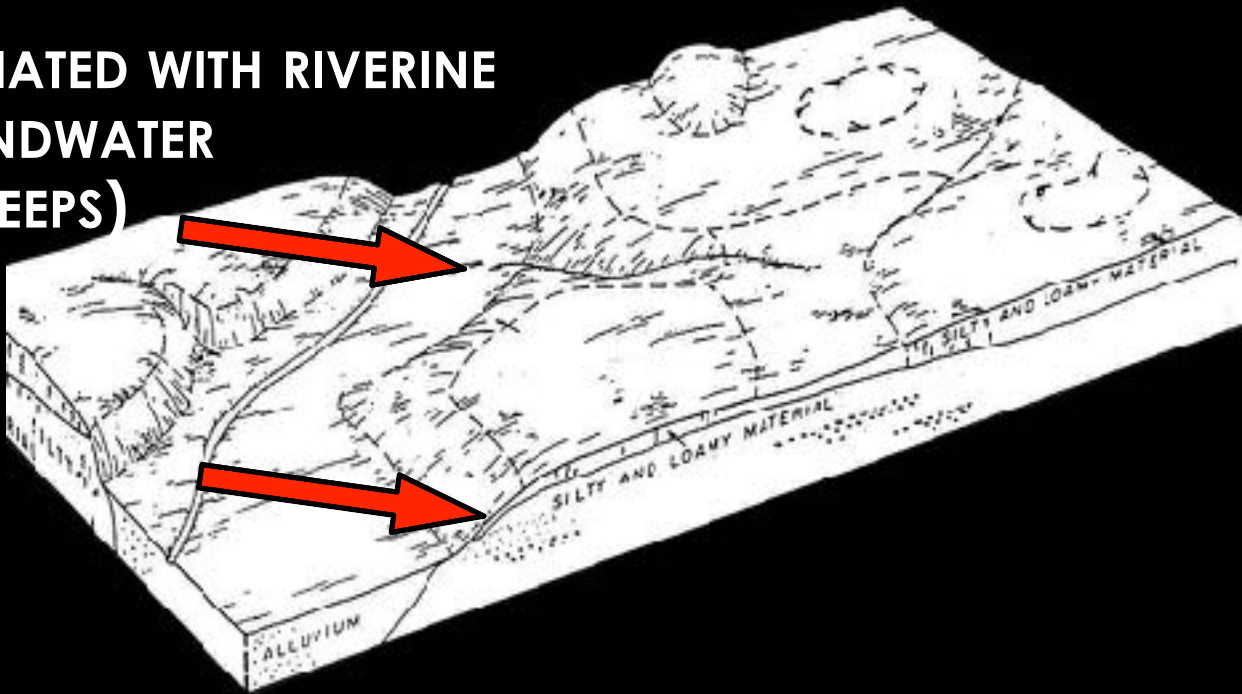
OVERLAND AND THROUGHFLOW:
CONVERGENT LANDSCAPES

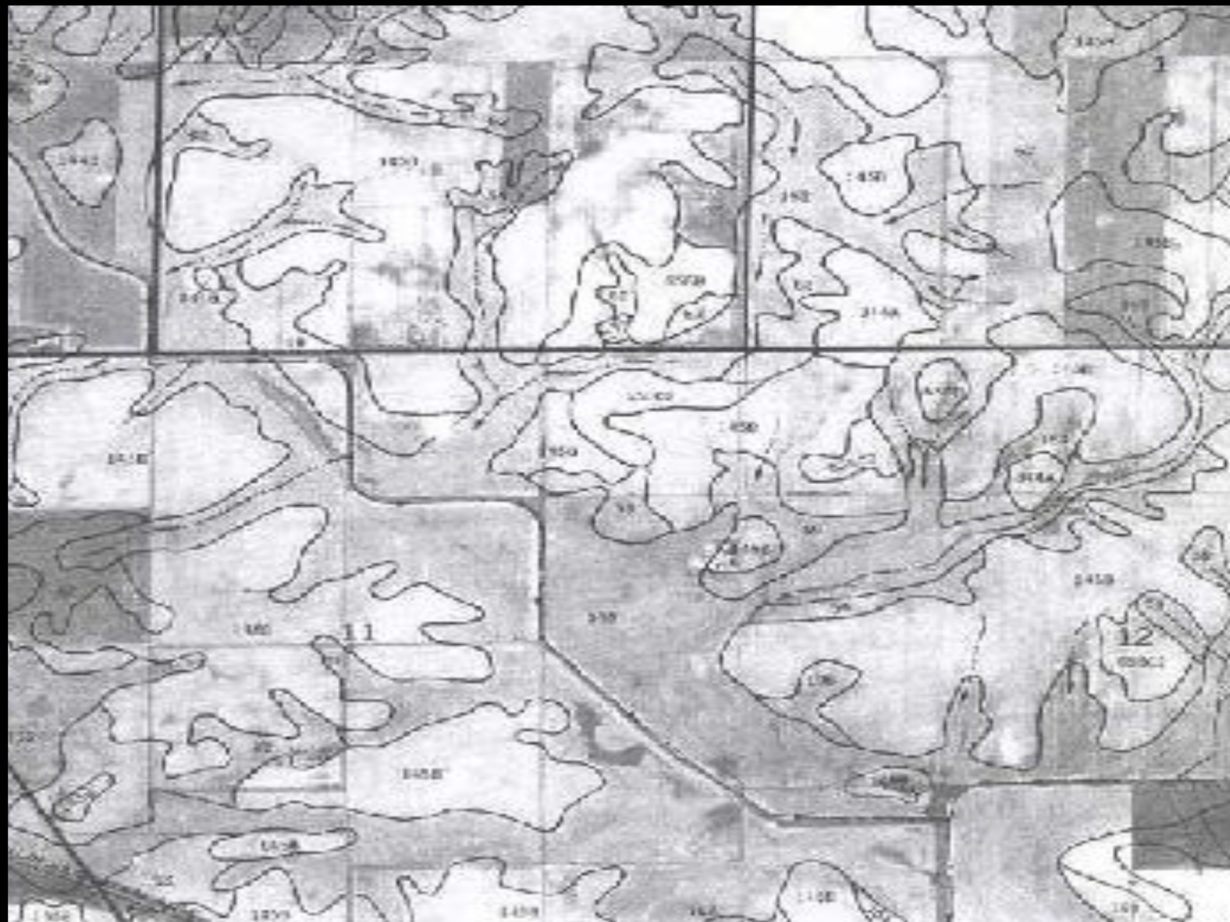


Modified from Peanock et al. 1987

OPEN SYSTEMS

- Water "leaves"
- Soil Map Units are linear and "continuous"
- Well-developed drainage system – Mature Landscape
- Some open systems can have broad interfluves or drainage divides
- Hydric Soils associated with riverine processes or groundwater discharge points (seeps)

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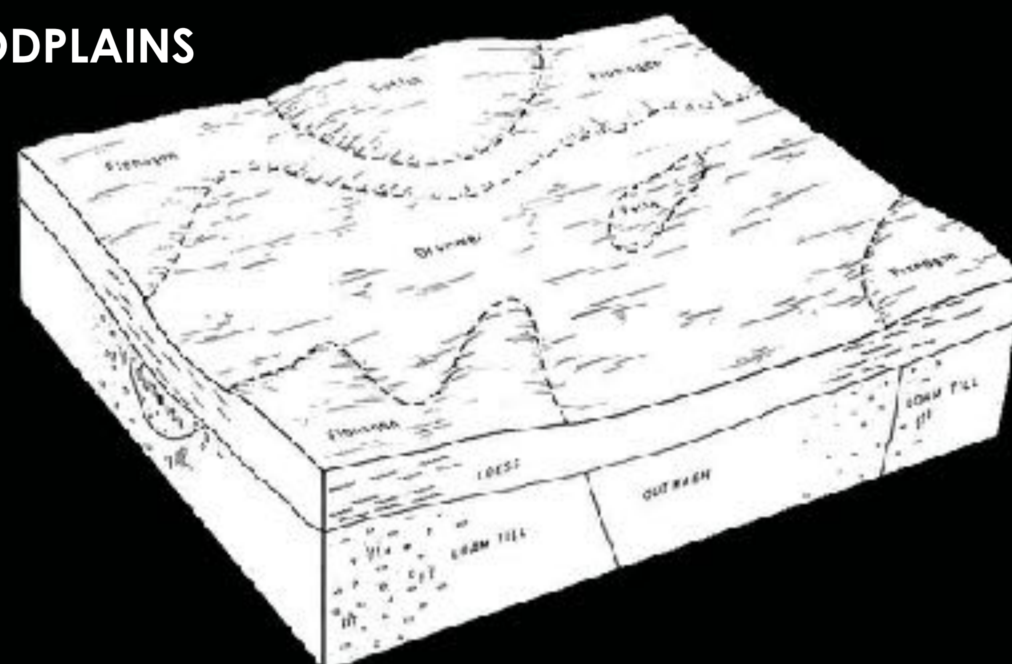
CLOSED SYSTEM

- Usually young landscapes, i.e. Prairie Potholes in Midwest
- Drainage poorly integrated to non-existent, little runoff
- Gather water from surrounding slopes
- Large percentage of wetlands occur in closed systems (more gleying & iron segregation)
- Can occur on broad floodplains

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REVIEW

- Catena Concept
  - Soils occur in predictable patterns on the landscape
- Water Movement
  - Most water infiltrates and moves laterally below the earth's surface
- Hillslope Terminology
- Open or Closed Landscape

" WHEN THE SOIL IS GONE, MEN MUST GO; AND THE PROCESS DOESN'T TAKE LONG."
-THEODORE ROOSEVELT

Questions?