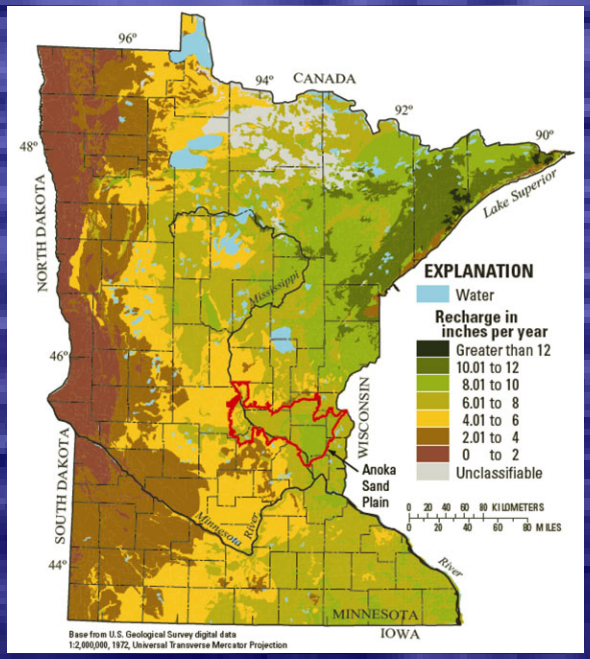
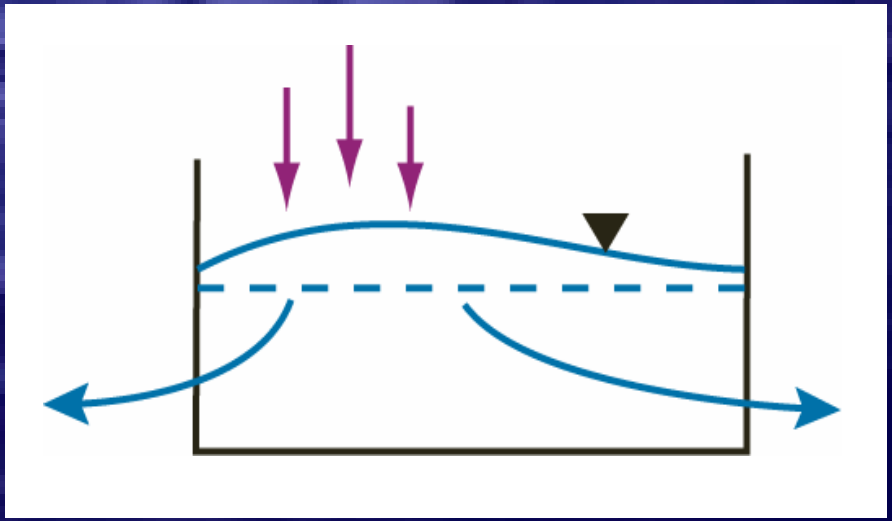
Overview of Recharge to Surficial Ground Water Systems in Minnesota



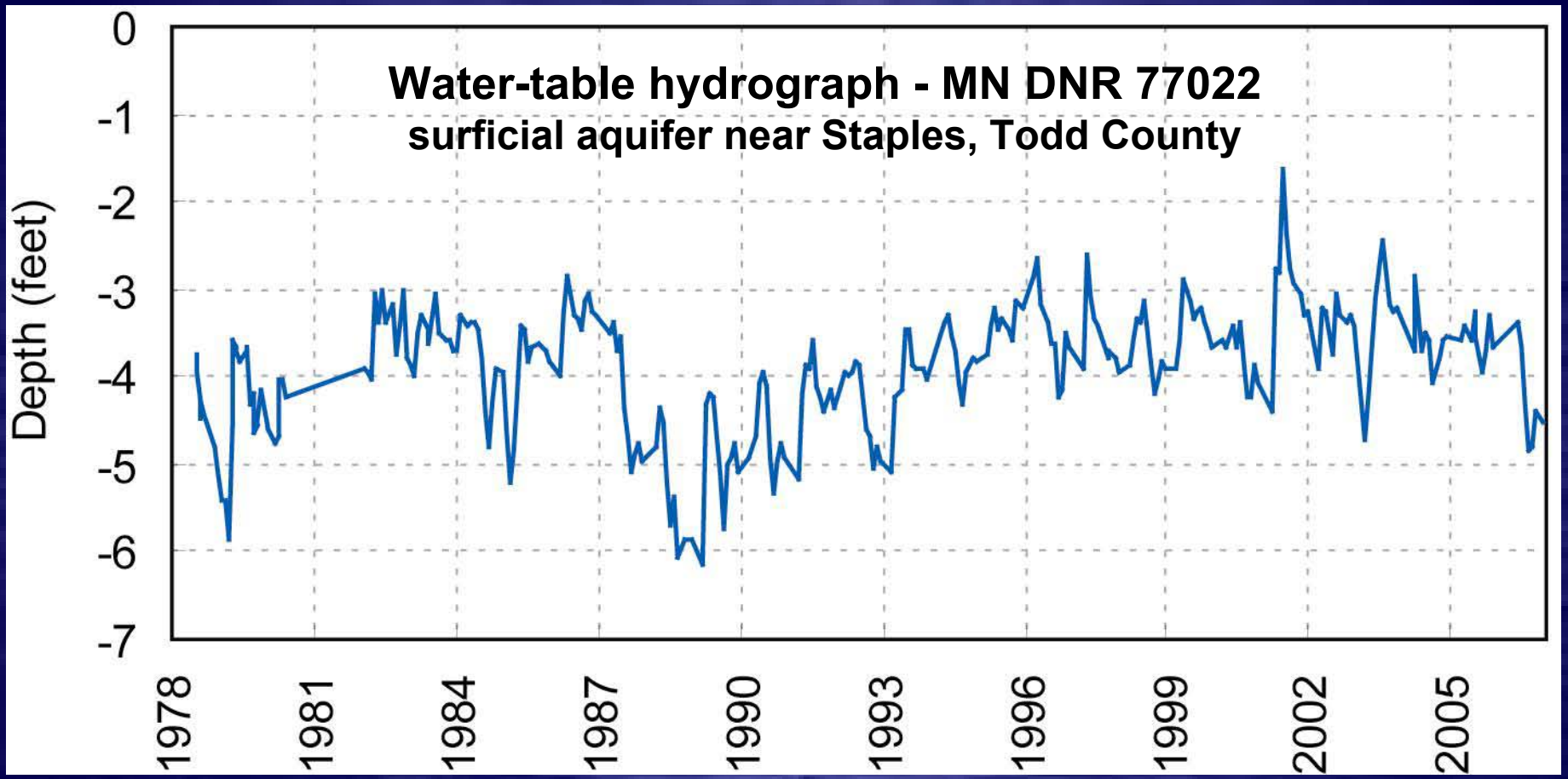
Jan Falteisek
Minnesota Department of Natural Resources
Waters Division

What is ground water recharge?

The entry into the saturated zone of water made available at the water-table surface and the associated movement away from the area.



DNR Waters


Water-table hydrograph - MN DNR 77022
surficial aquifer near Staples, Todd County
Depth (feet)
0
-1
-2
-3
-4
-5
-6
-7
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005

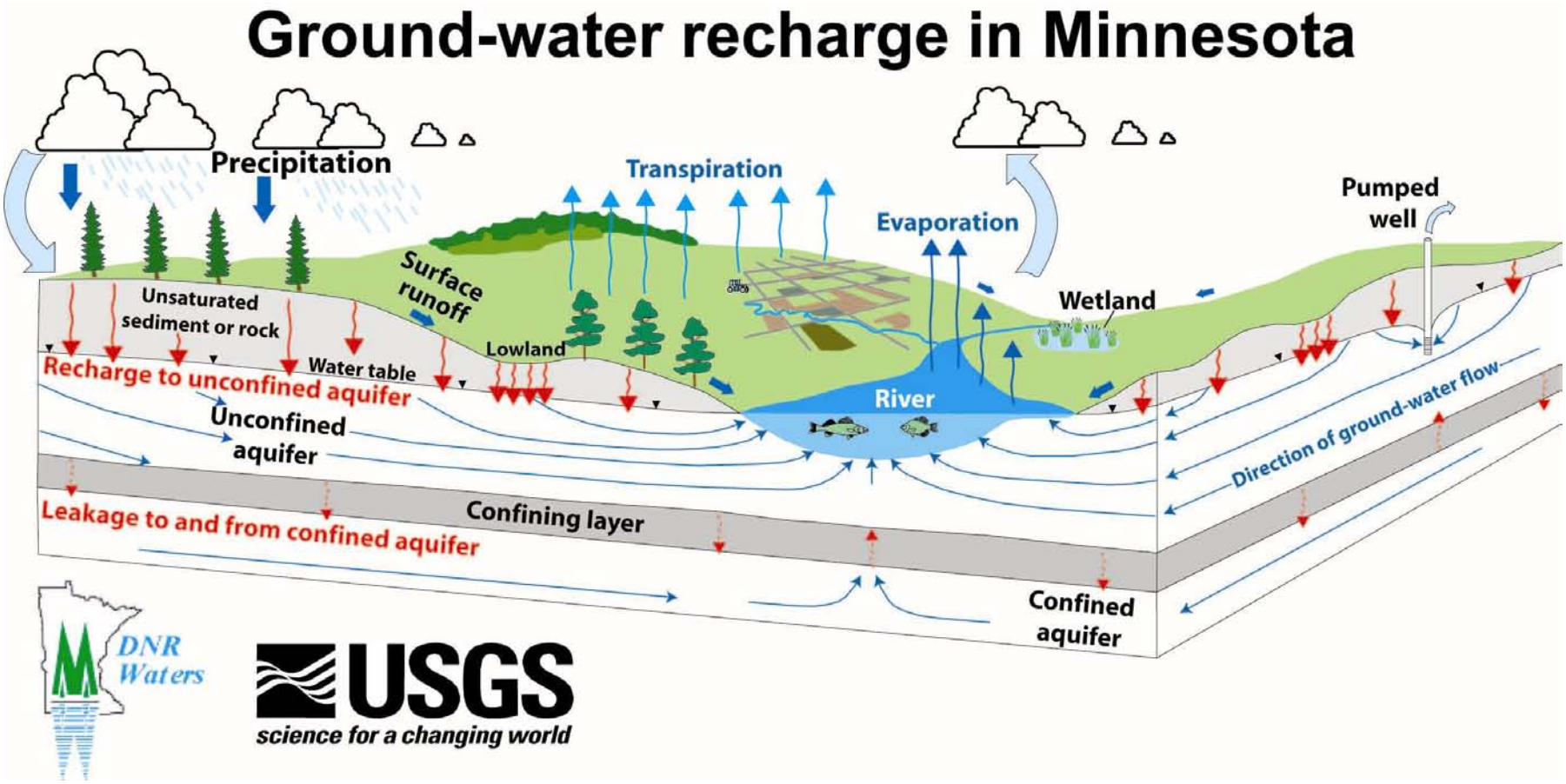
DNR Waters

Recharge is one component of the water balance of the ground water system

Inputs include:
Precipitation or net WT recharge, surface-water losses, ground-water inputs from outside the area or other aquifers

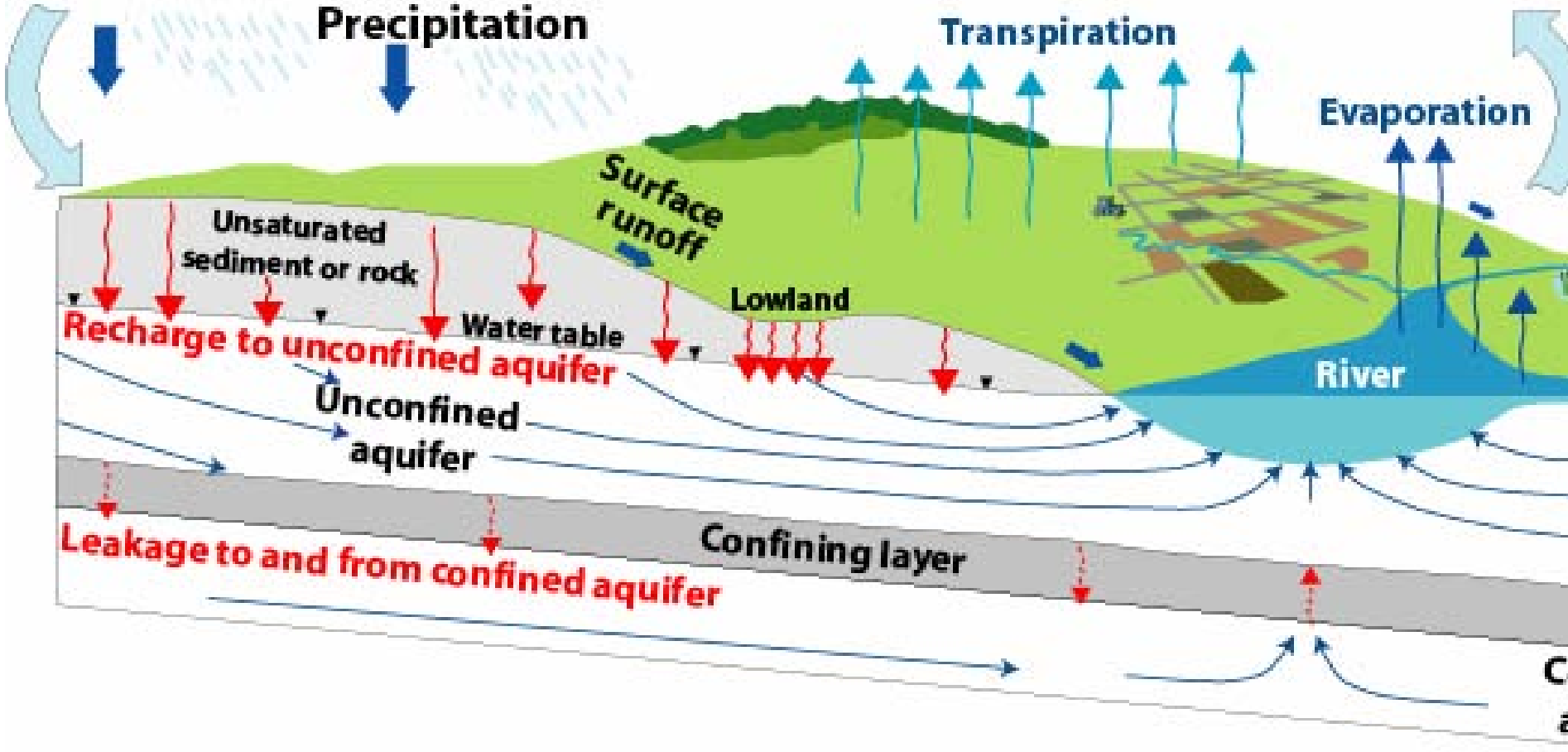
Outputs include:
Evapotranspiration, surface-water returns, pumping, ground-water losses to outside the area or other aquifers

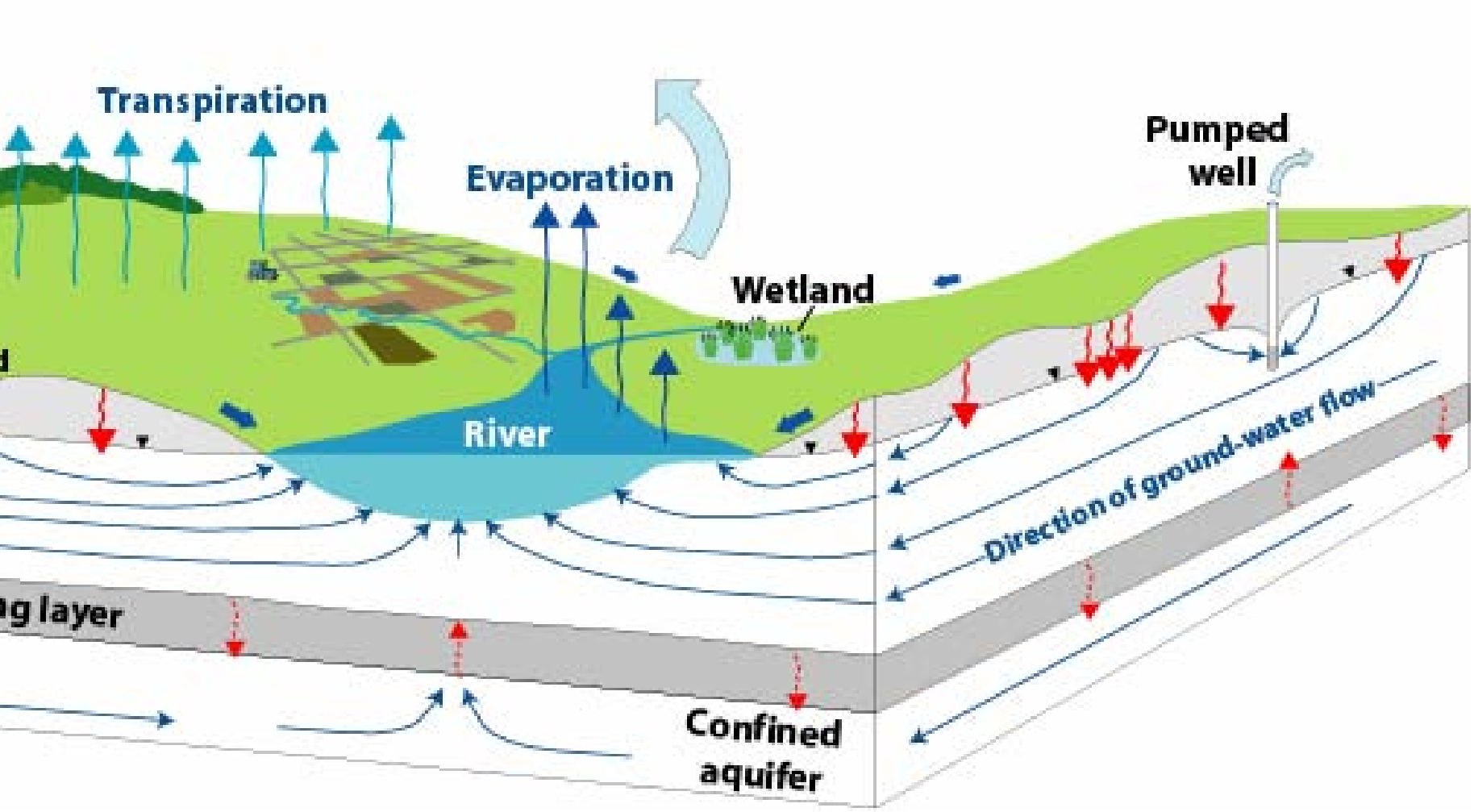
Ground-water recharge in Minnesota



DNR Waters

USGS
science for a changing world


Precipitation
Transpiration
Evaporation
Surface runoff
Unsaturated sediment or rock
Water table
Lowland
Recharge to unconfined aquifer
River
Unconfined aquifer
Confining layer
Leakage to and from confined aquifer


Transpiration
Evaporation
Pumped well
Wetland
River
Direction of ground-water flow
Confined aquifer

Any change to a component results in system changes

Inputs = Outputs

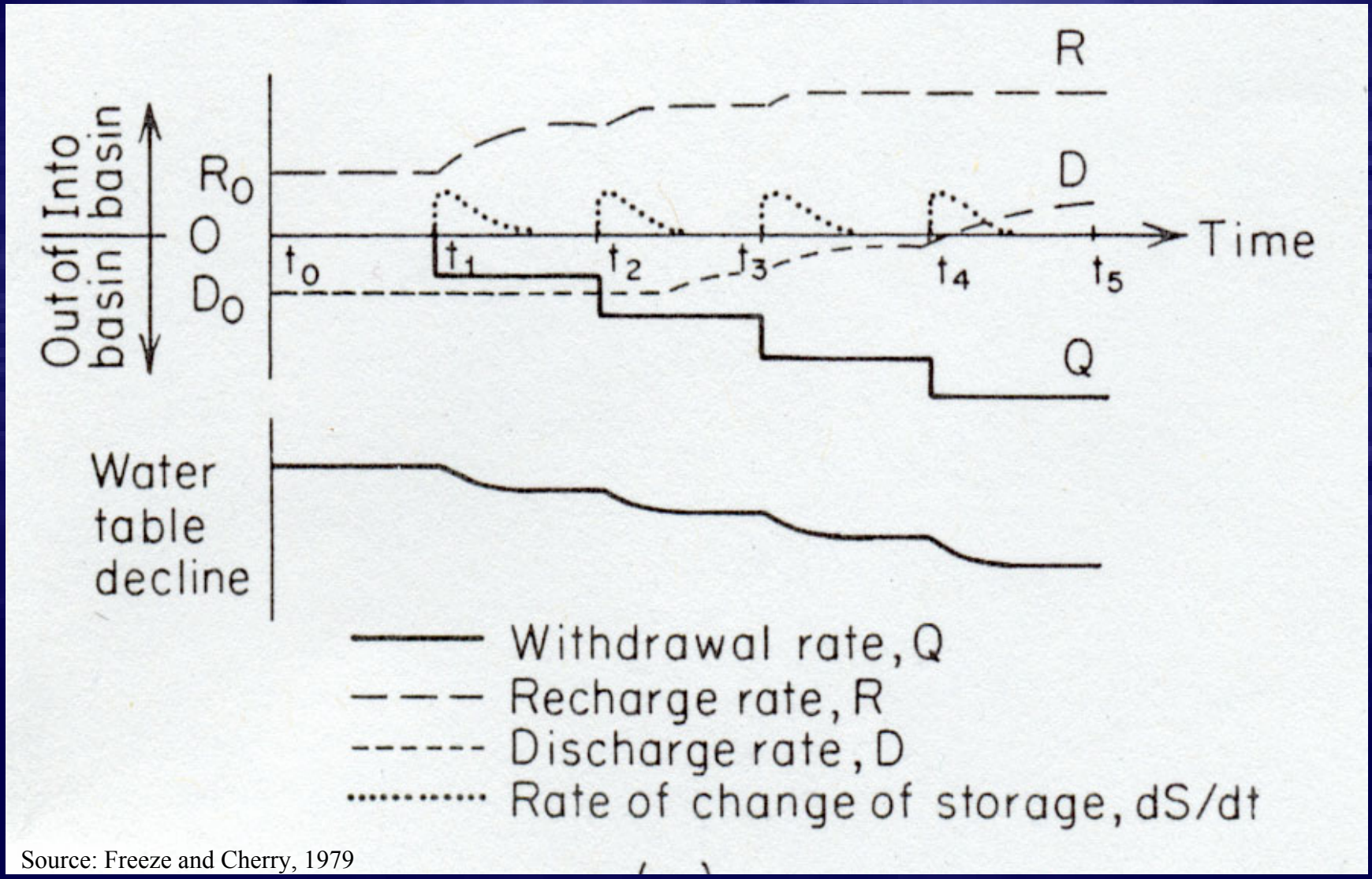
Ground water storage stable

Any change to a component results in system changes

Inputs = Outputs
Ground water storage stable

Ground water withdrawal balanced by other component changes

Water balance component rate changes in response to pumping

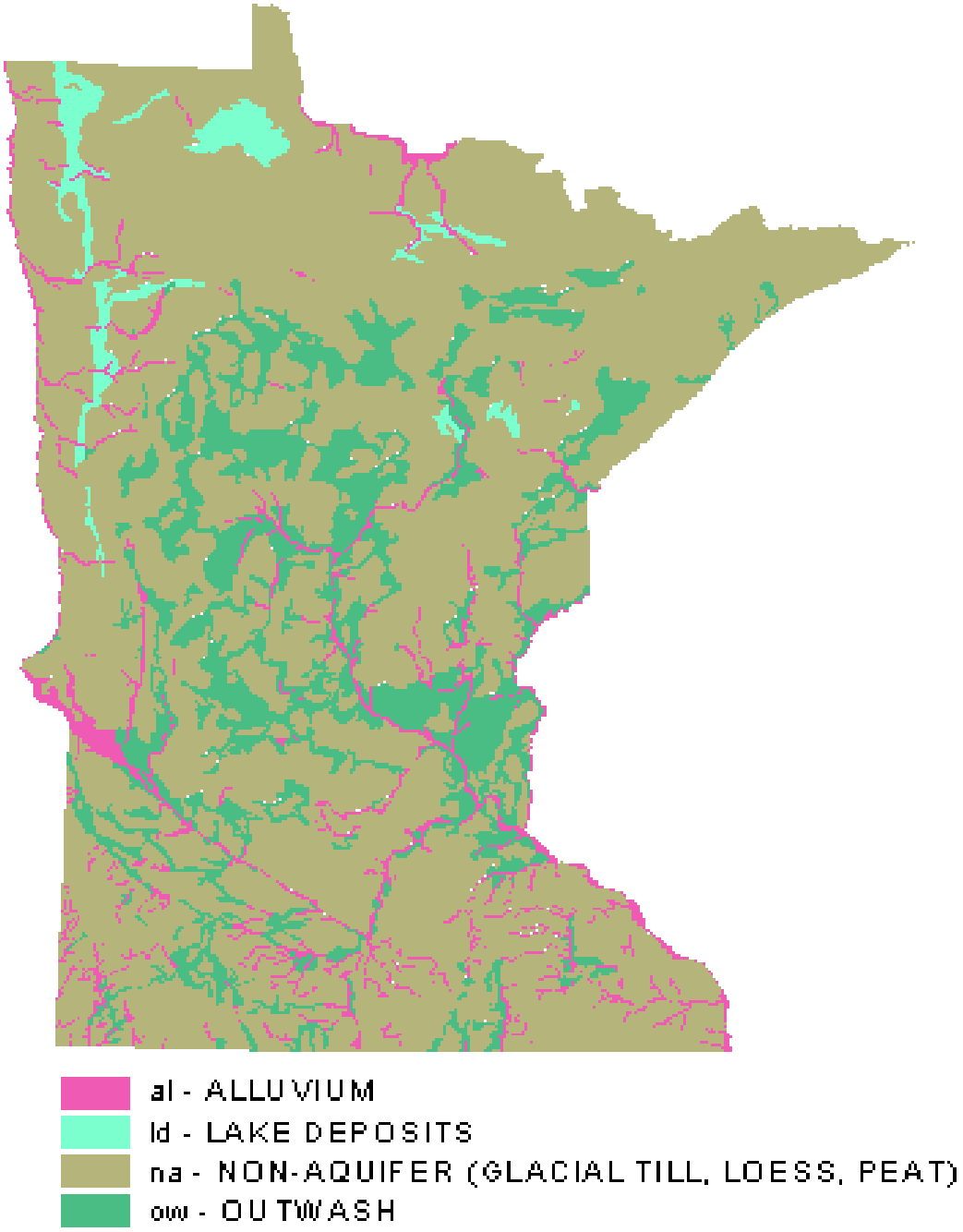


Source: Freeze and Cherry, 1979

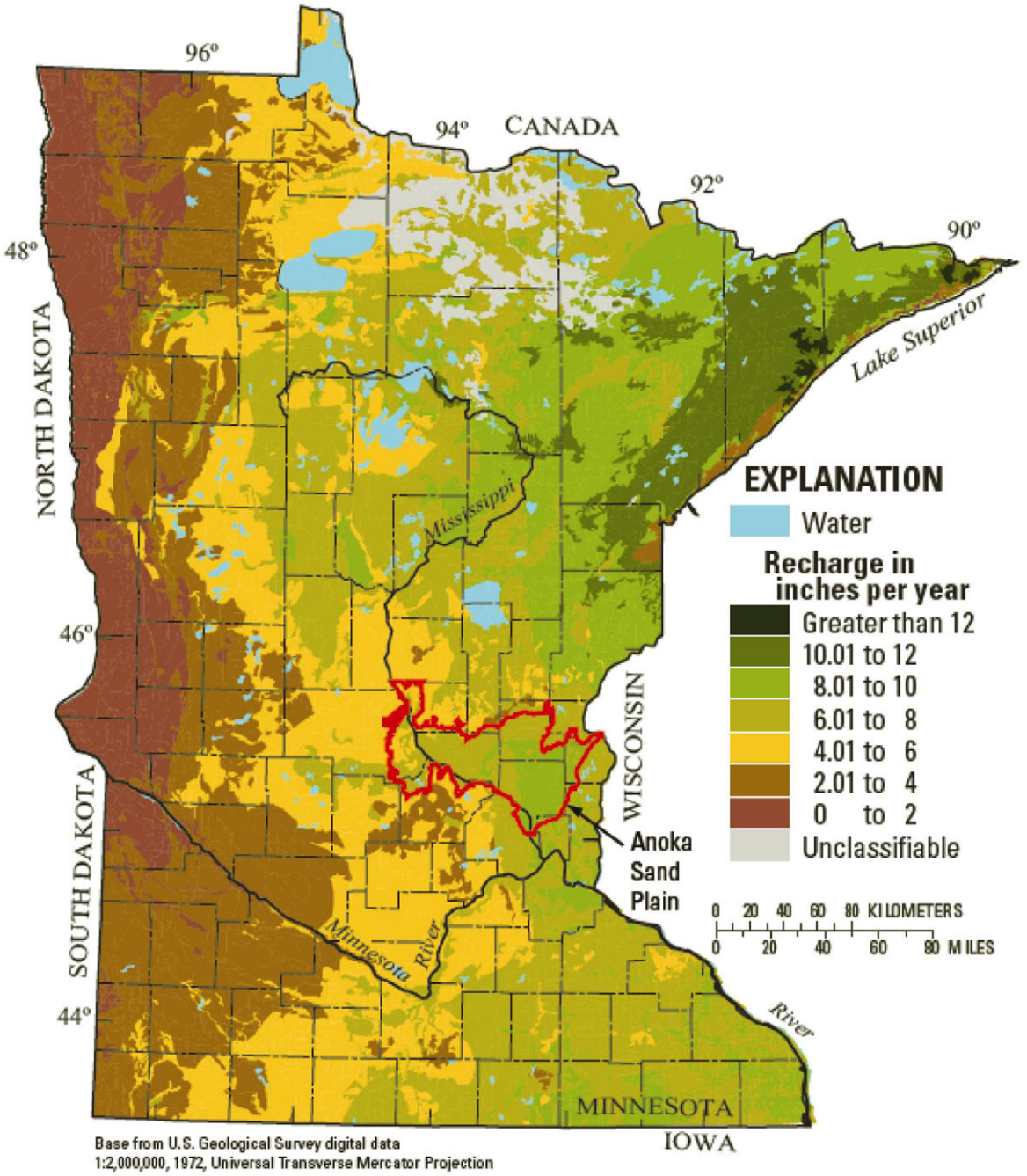
Recharge to the water table in Minnesota

- Amounts variable, but approximately
  - 20-25 percent of precipitation in surficial aquifer areas
  - Less than 10 percent of precipitation in clay/till areas
- Increases from west to east across the state
- Most recharge from spring melt
- Generally reaches water table in a year or less
- Most recharged water exits the ground water system relatively quickly
- Typically little of recharged water transferred to deeper system by leakage (<1%)

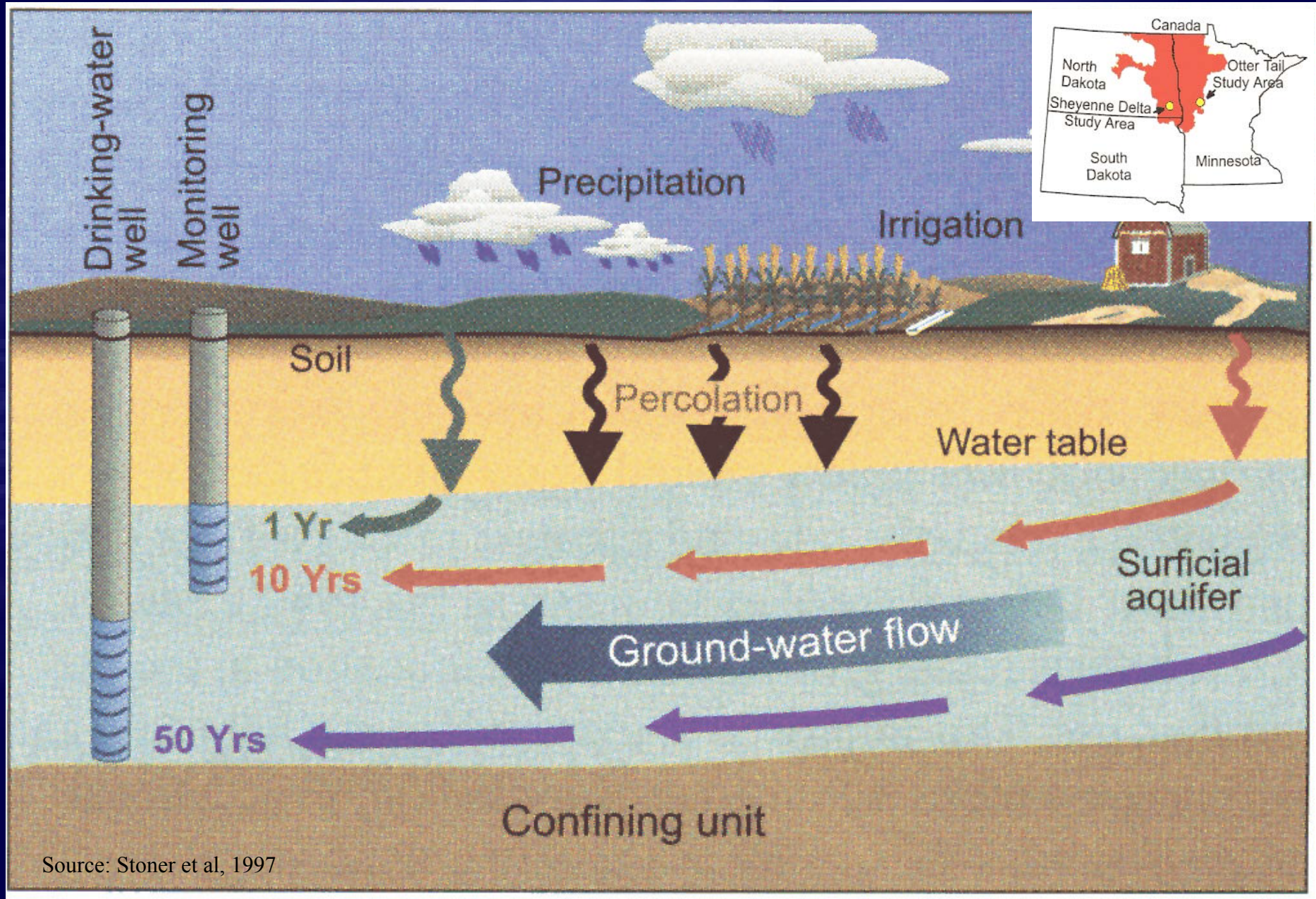
Surficial Quaternary aquifers and non-aquifers



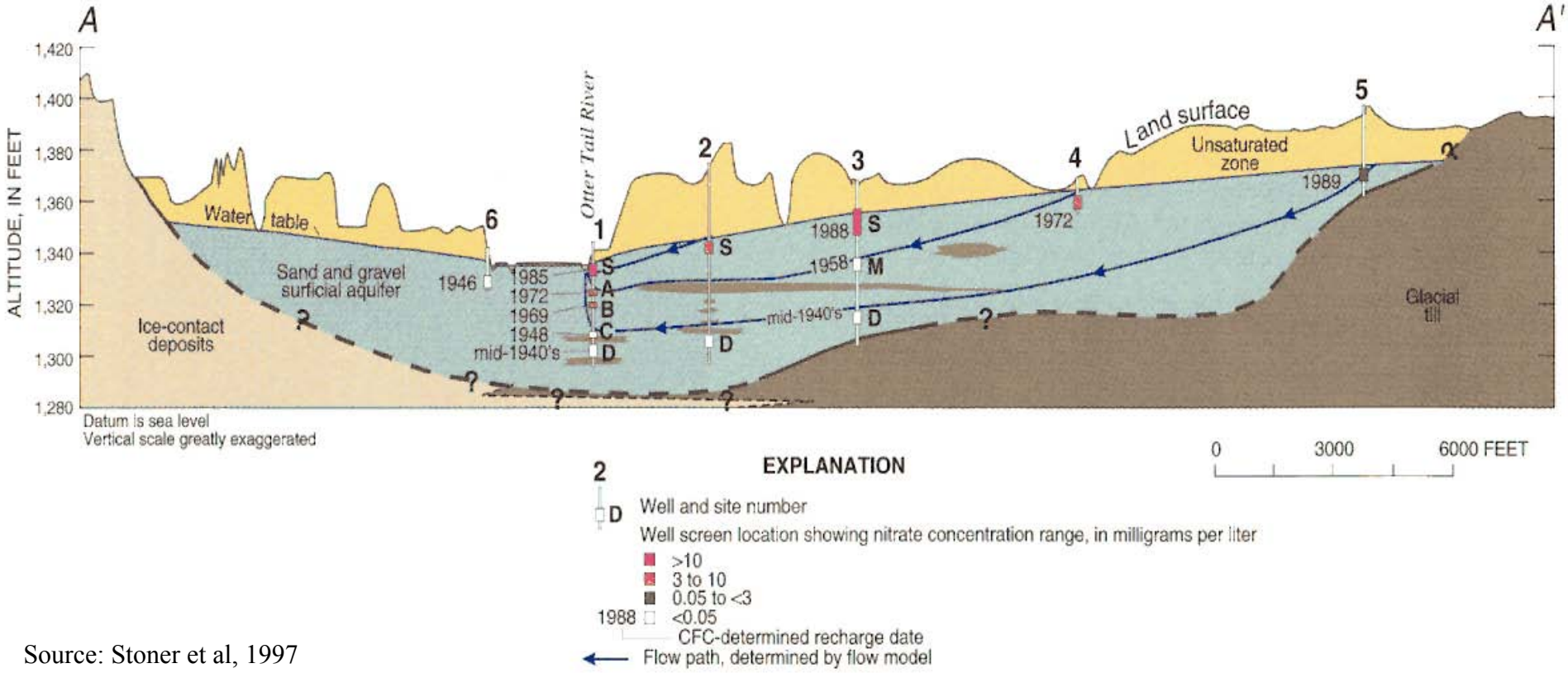
Source: Minnesota Geological Survey, 1979. Geologic Map of Minnesota – Quaternary Hydrogeology State Map Series S-3 digital data available: http://www.lmic.state.mn.us/chouse/metadata/hydqgeo.html



Source: Lorenz and Delin, 2006



Source: Stoner et al, 1997



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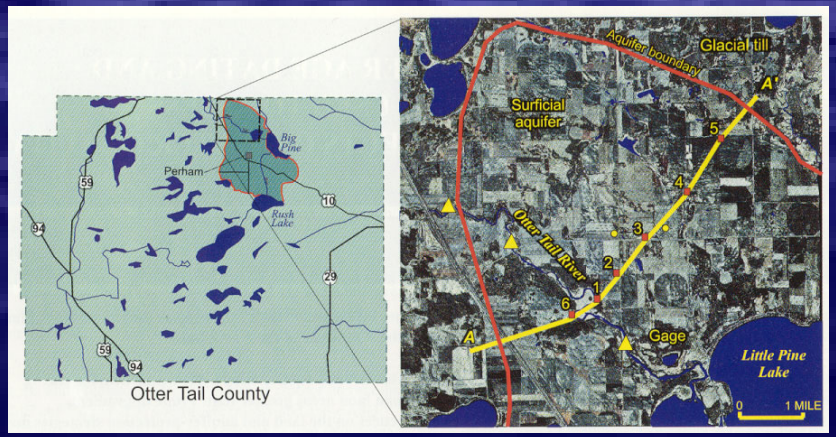
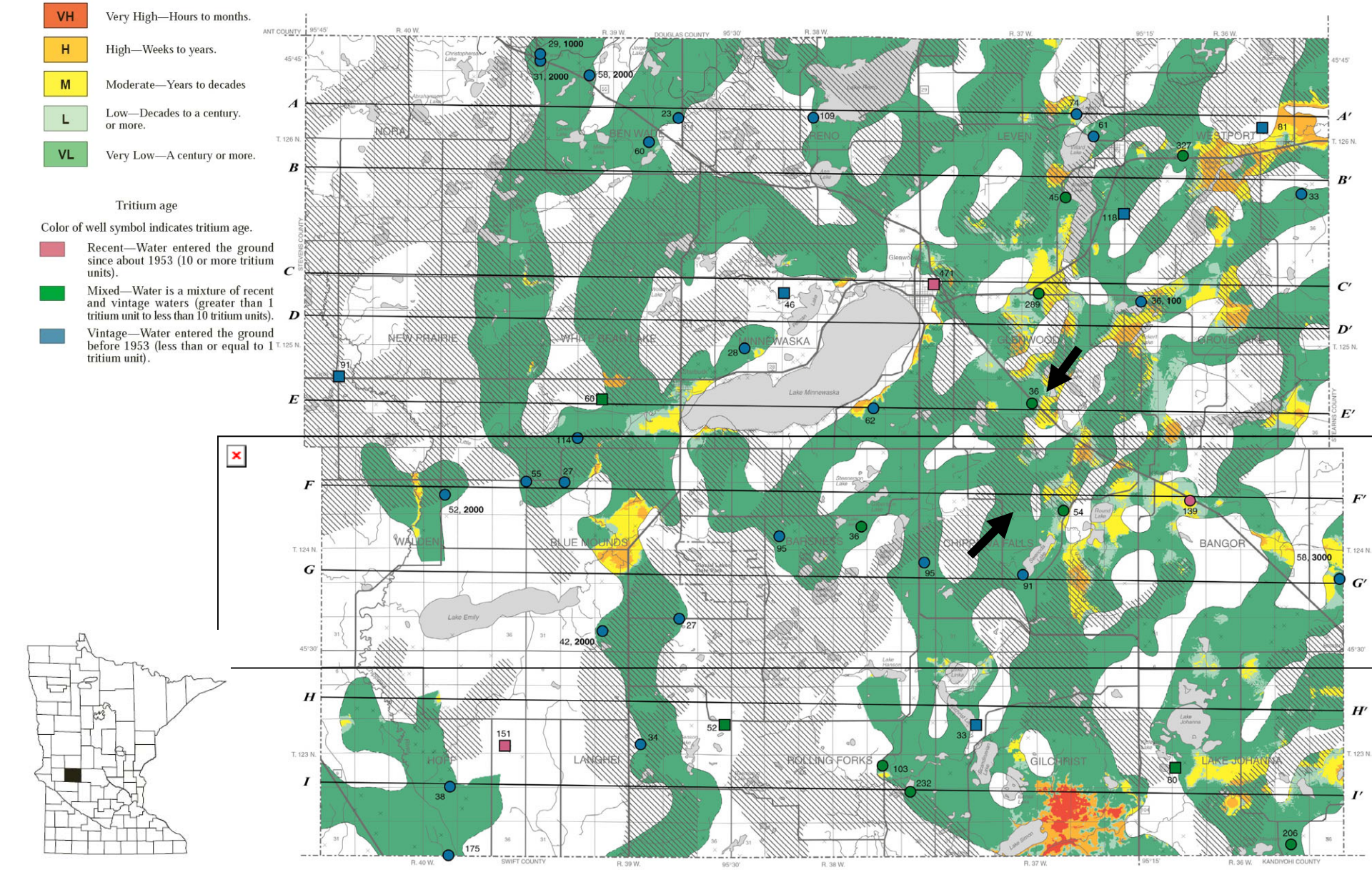
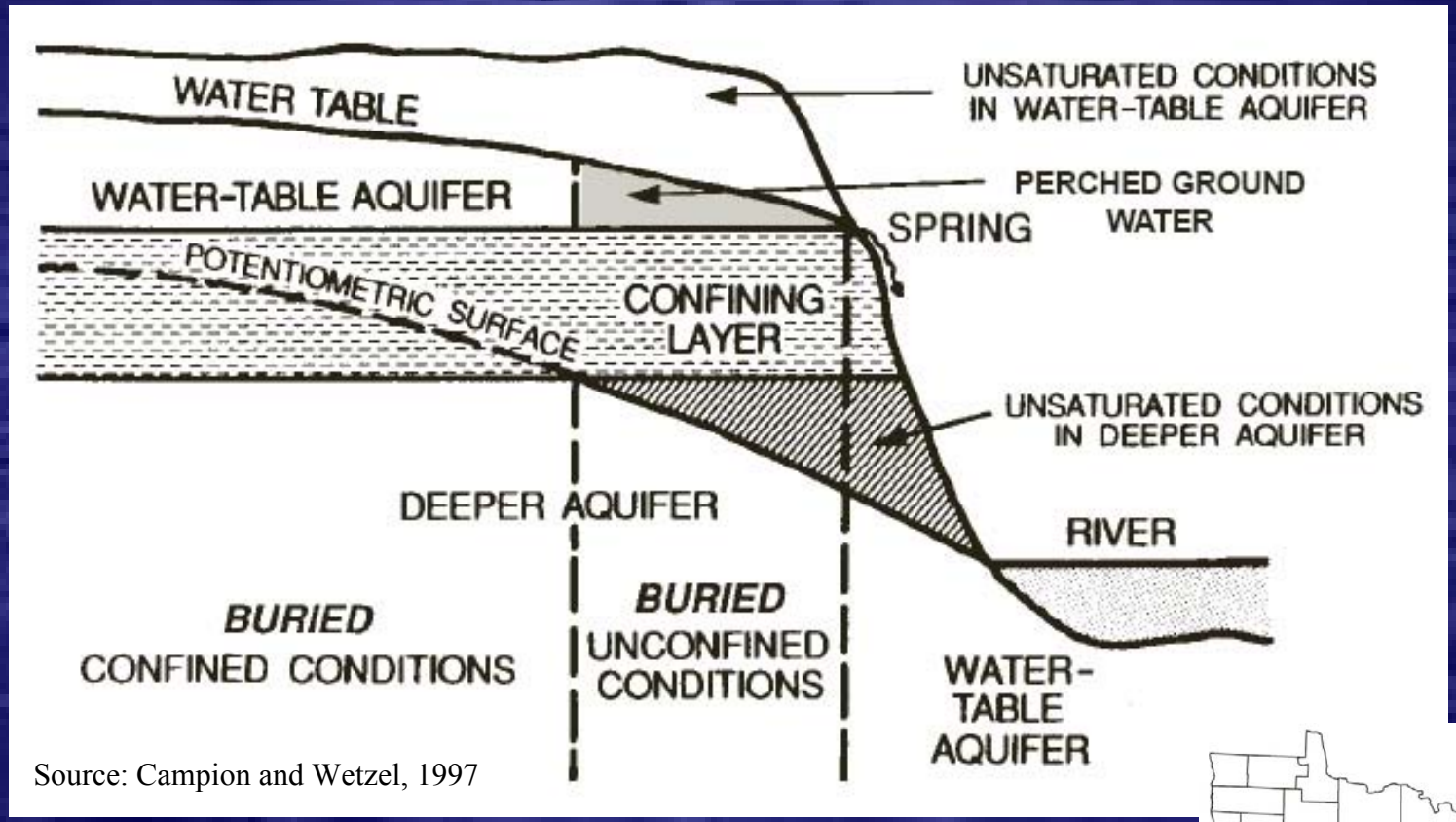


Pope County buried drift aquifers - BROW



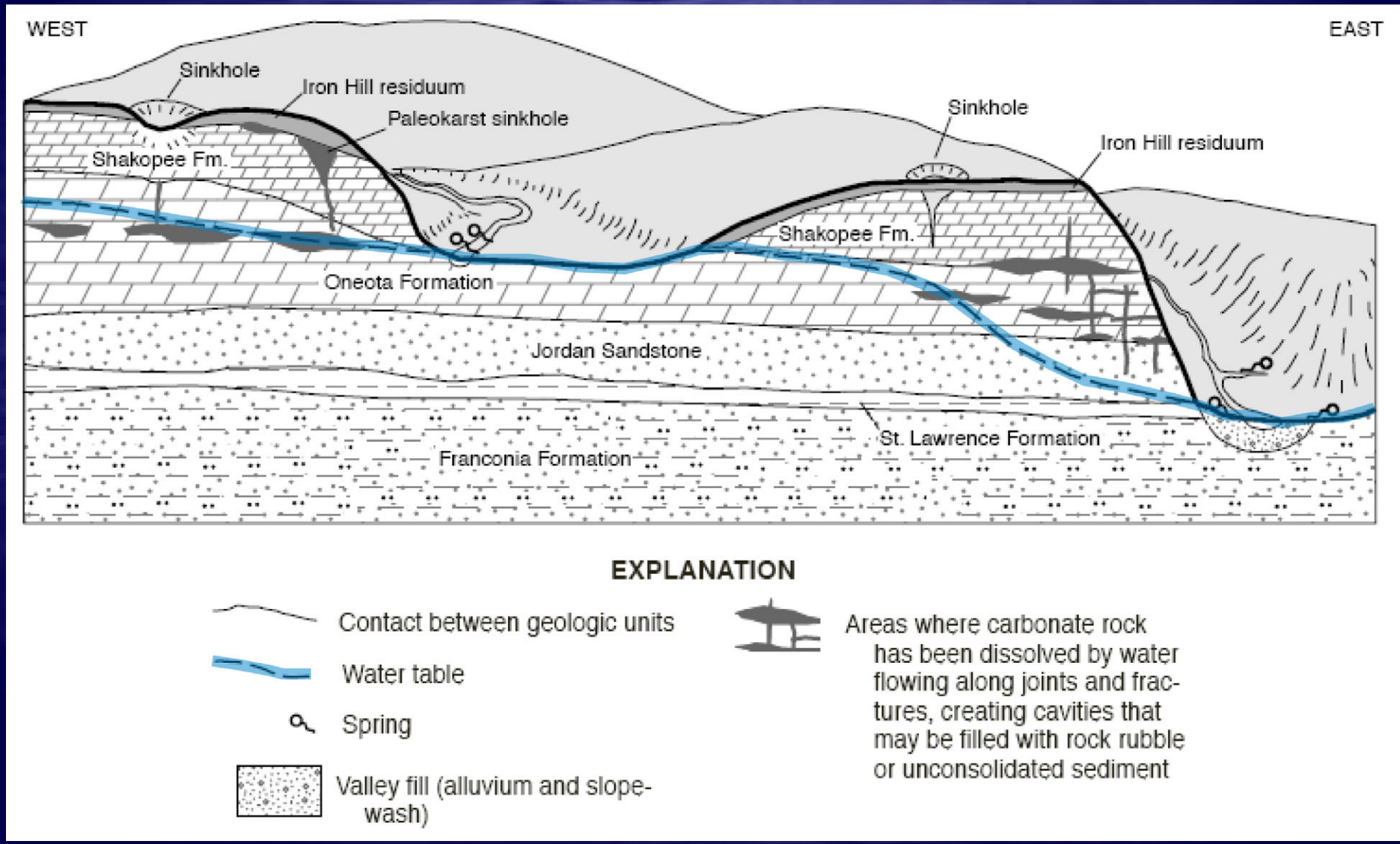
Complex water table and confined conditions, southeastern Minnesota



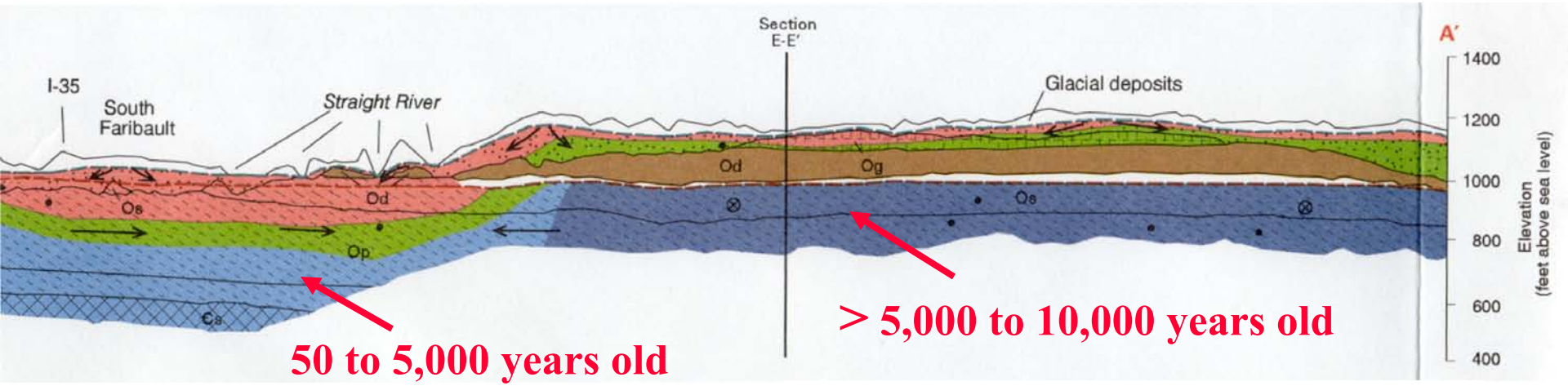
Source: Campion and Wetzel, 1997

- Water table
- Perched water table
- Buried unconfined conditions
- "Edge" effects

Karst landscape -- Wabasha County



Source: Tipping, 2002, RI 59, MGS

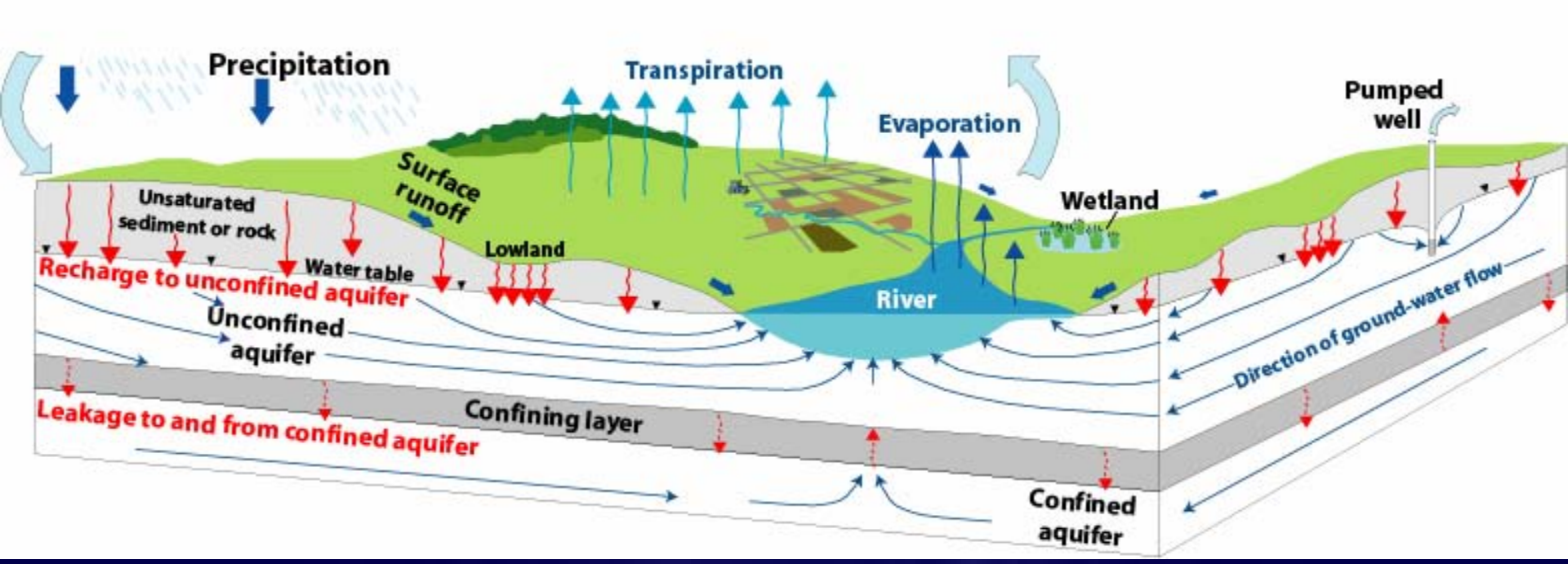


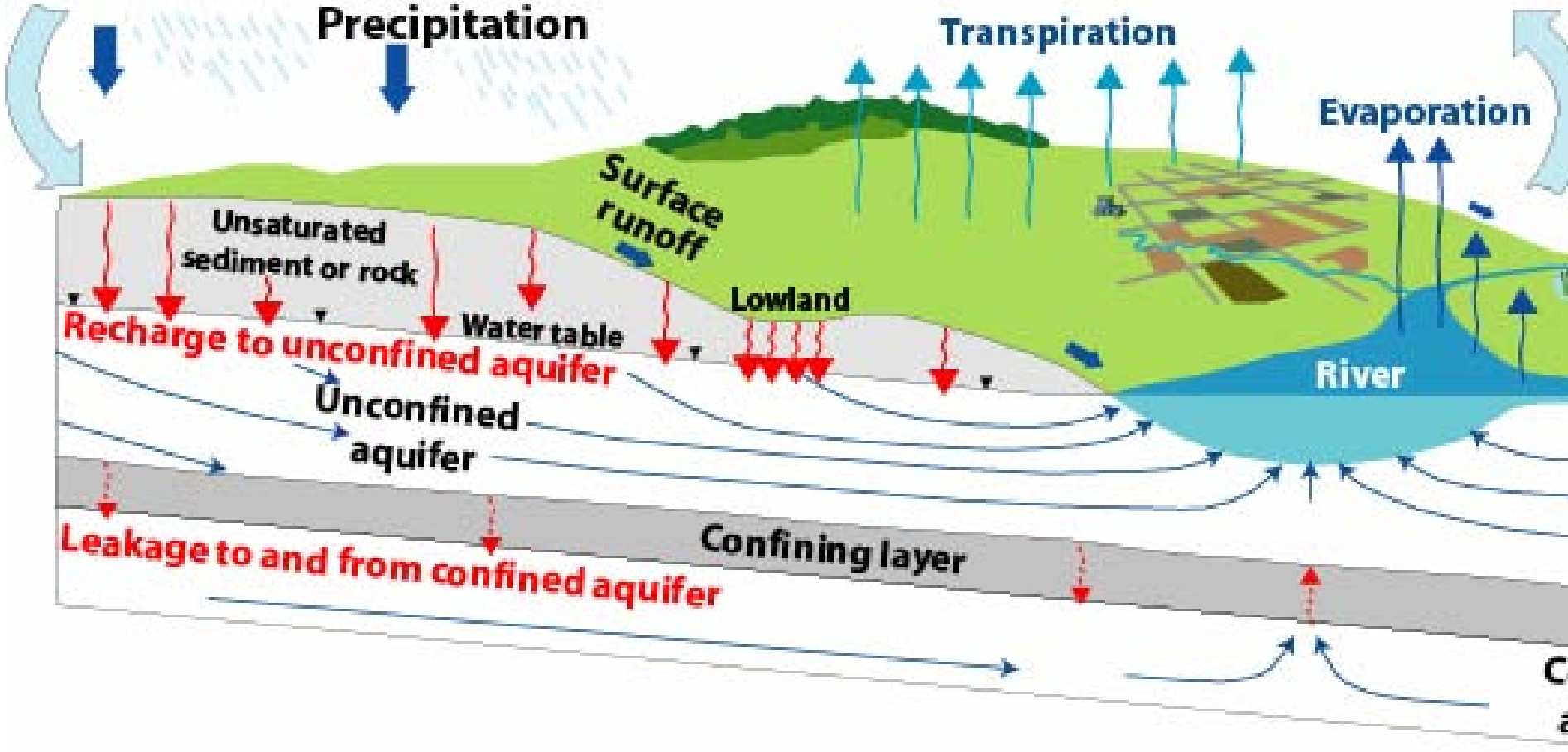
- Unsaturated sediment or rock
- Leaky, semi-confined Quaternary sediment
- Galena aquifer
- St. Peter-Prairie du Chien-Jordan aquifer
- St. Lawrence-Franconia low-yield aquifer
- Confining unit
- Water table
- St. Peter-Prairie du Chien-Jordan aquifer potentiometric surface
- General direction of ground-water flow
- ⊗ Ground-water flow direction perpendicular to plane of cross section

- Recent waters with tritium greater than ten tritium units.
- Mixed waters with tritium less than ten but greater than one tritium units.
- Vintage waters with tritium less than one tritium unit. Age-dating results of widely spaced ^{14}C samples suggest water more than 50 but less than 5,000 years old.
- Vintage waters with tritium less than one tritium unit and ^{14}C age date of greater than five to ten thousand years before present.
- Ground-water sample analyzed for tritium or ^{14}C age

Ground-water recharge *is not…*

- …equivalent to *"infiltration"*
- …the process of *"percolation"*
- …to be confused with *"aquifer yield"*
- …the same as *"sustainable yield"*

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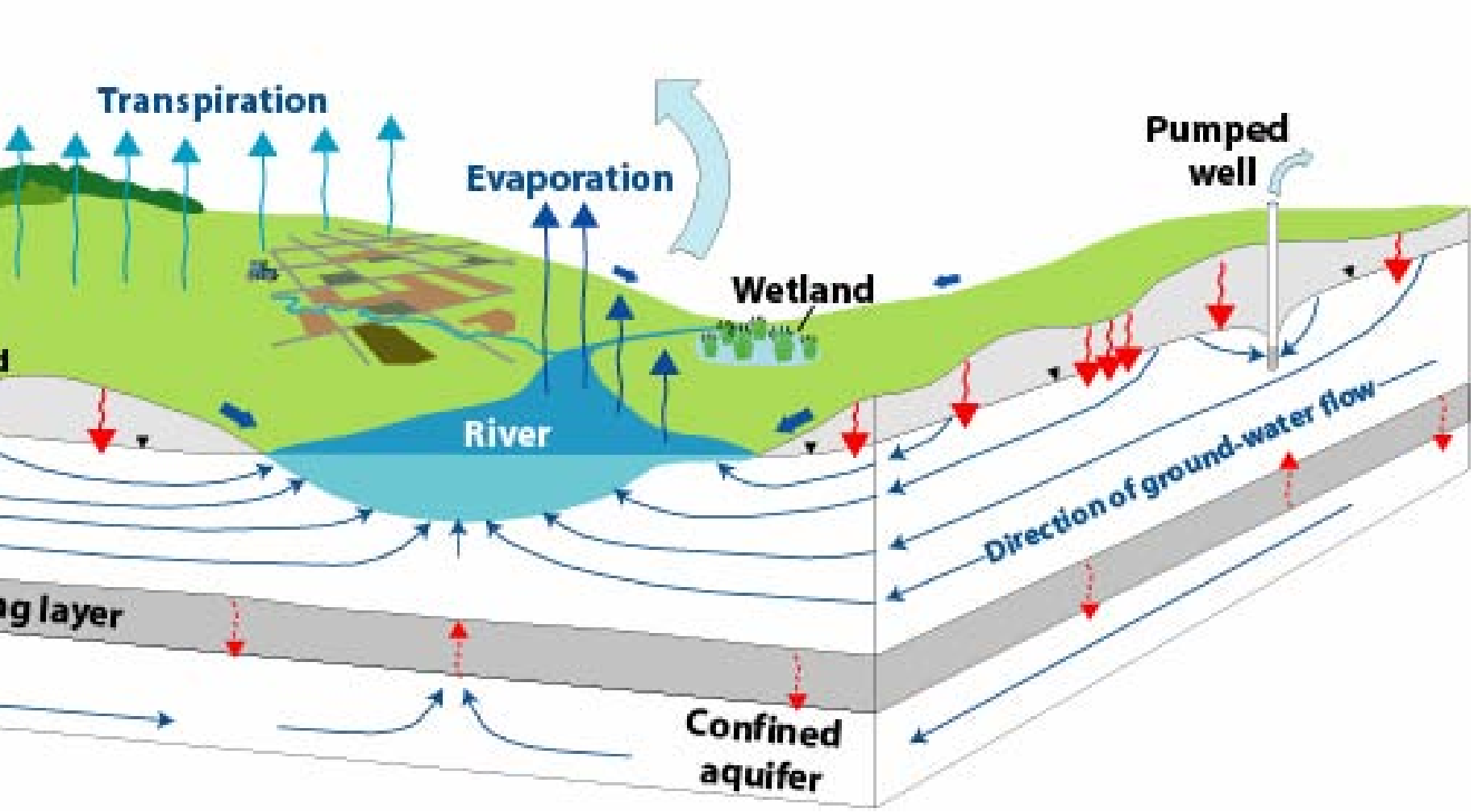
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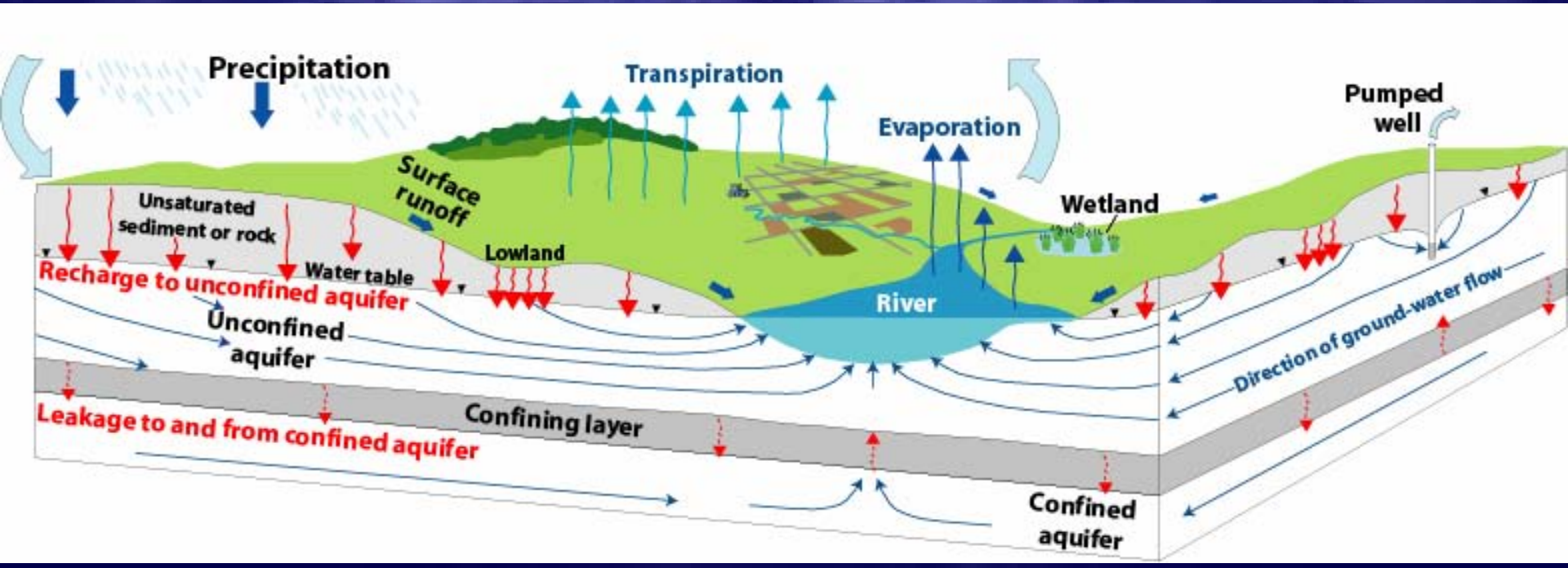
Direction of ground-water flow
Confined aquifer

Ground-water recharge versus *leakage*

- …the process by which water moves through a confining unit is called "leakage"
- Leakage rates generally much less than recharge rates



Reliable estimates of recharge are needed for:

- Assessment of ground water supply potential
- Accurate calibration of ground water flow models
- Development of wellhead protection programs
- Determination of flushing rates for contaminated ground water
- Delineation of contributing areas to wells designed to capture contaminated ground water
- Evaluation of the role of recharge in the regional ground water flow system