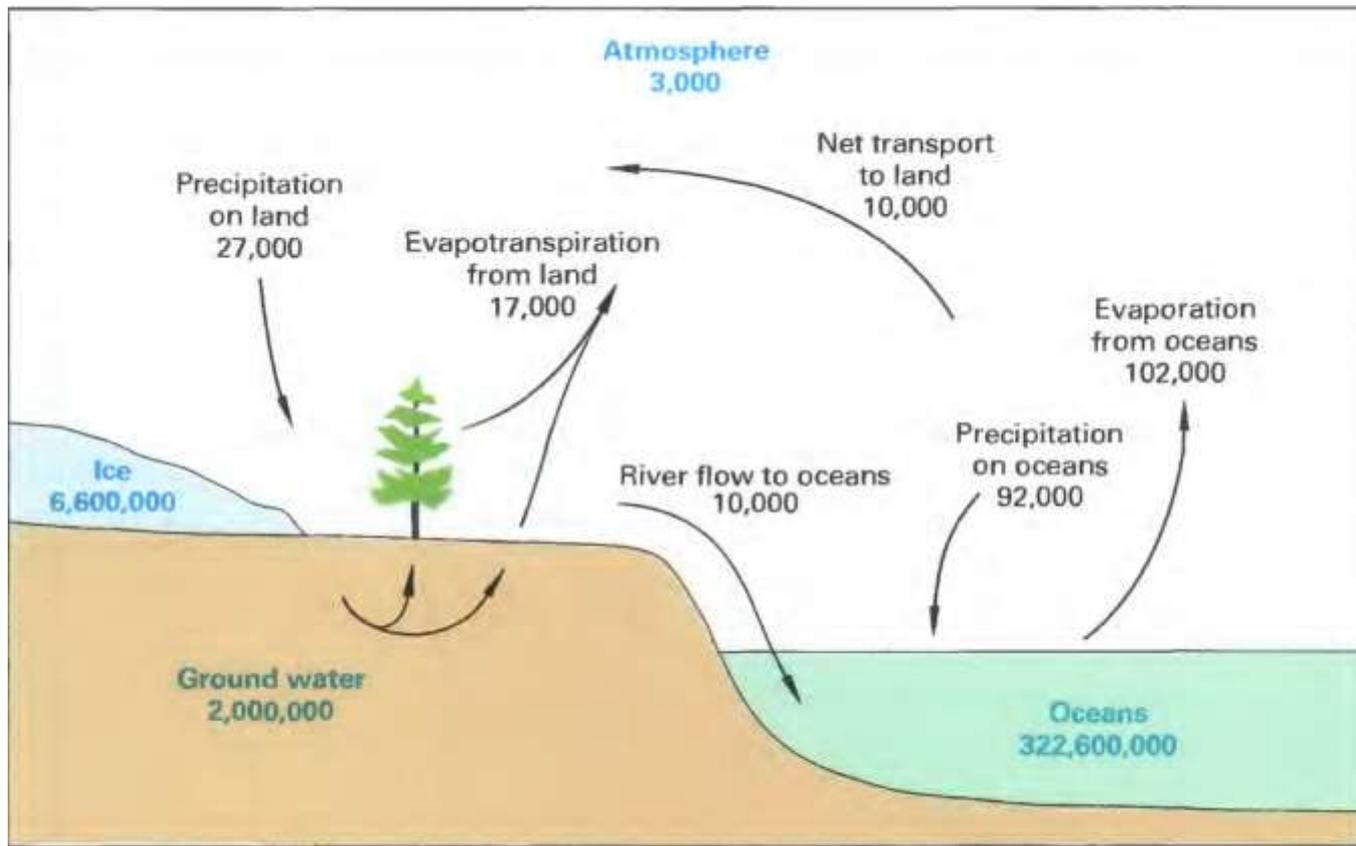


**Select Slides from  
U.S. Geological Survey  
Circular 1139  
“Ground Water and  
Surface Water  
A Single Resource”**

Assembled by: Lynn Rasmussen  
Center for Watershed Science and Education  
UWSP/UWEX, January, 2016



Pools are in cubic miles  
Fluxes are in cubic miles per year

Figure 1. Ground water is the second smallest of the four main pools of water on Earth, and river flow to the oceans is one of the smallest fluxes, yet ground water and surface water are the components of the hydrologic system that humans use most.

(Modified from Schelesinger, W.H., 1991, Biogeochemistry-An analysis of global change: Academic Press, San Diego, California.) (Used with permission.)

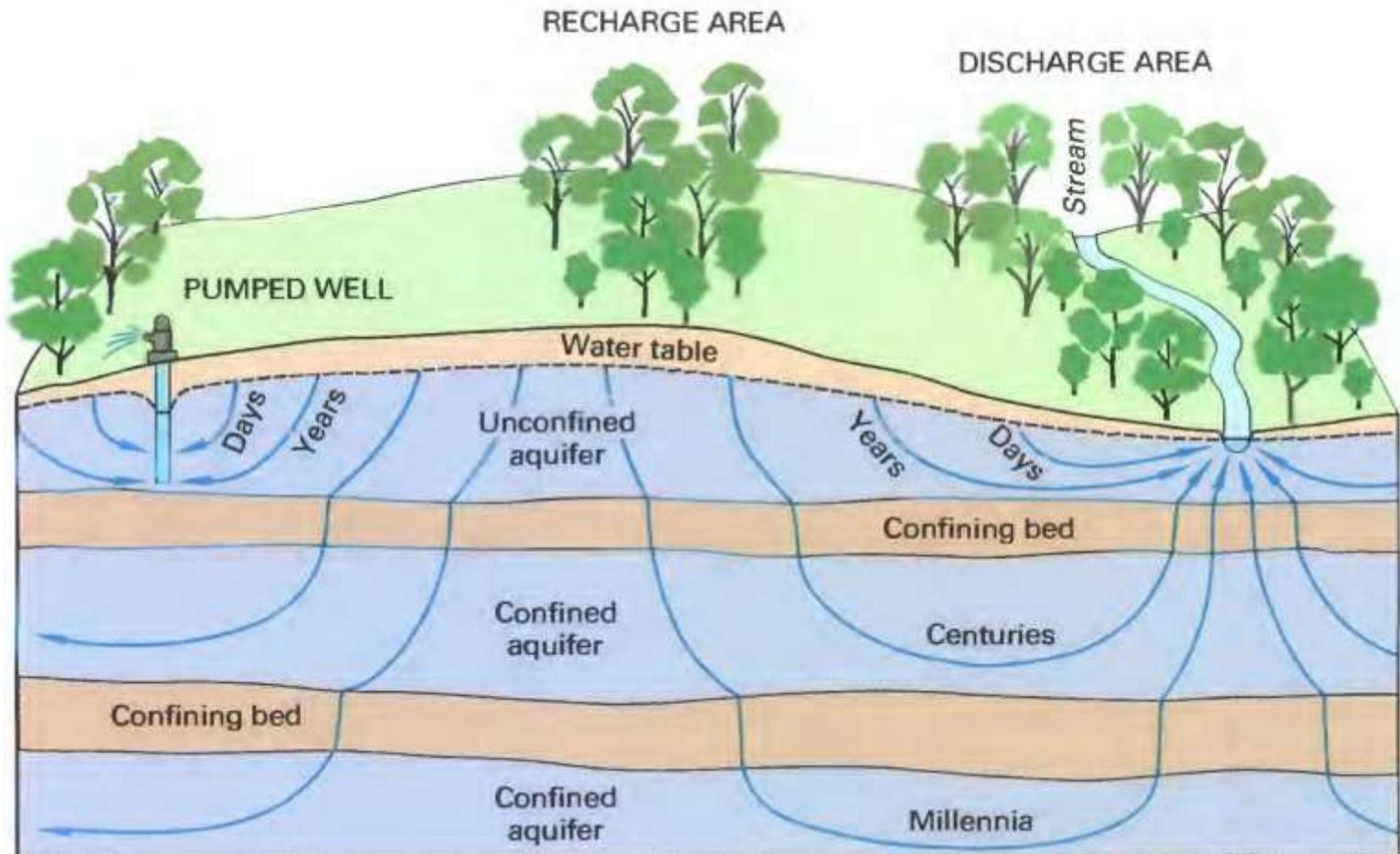


Figure 3. Ground-water flow paths vary greatly in length, depth, and travel time from points of recharge to points of discharge in the groundwater system.

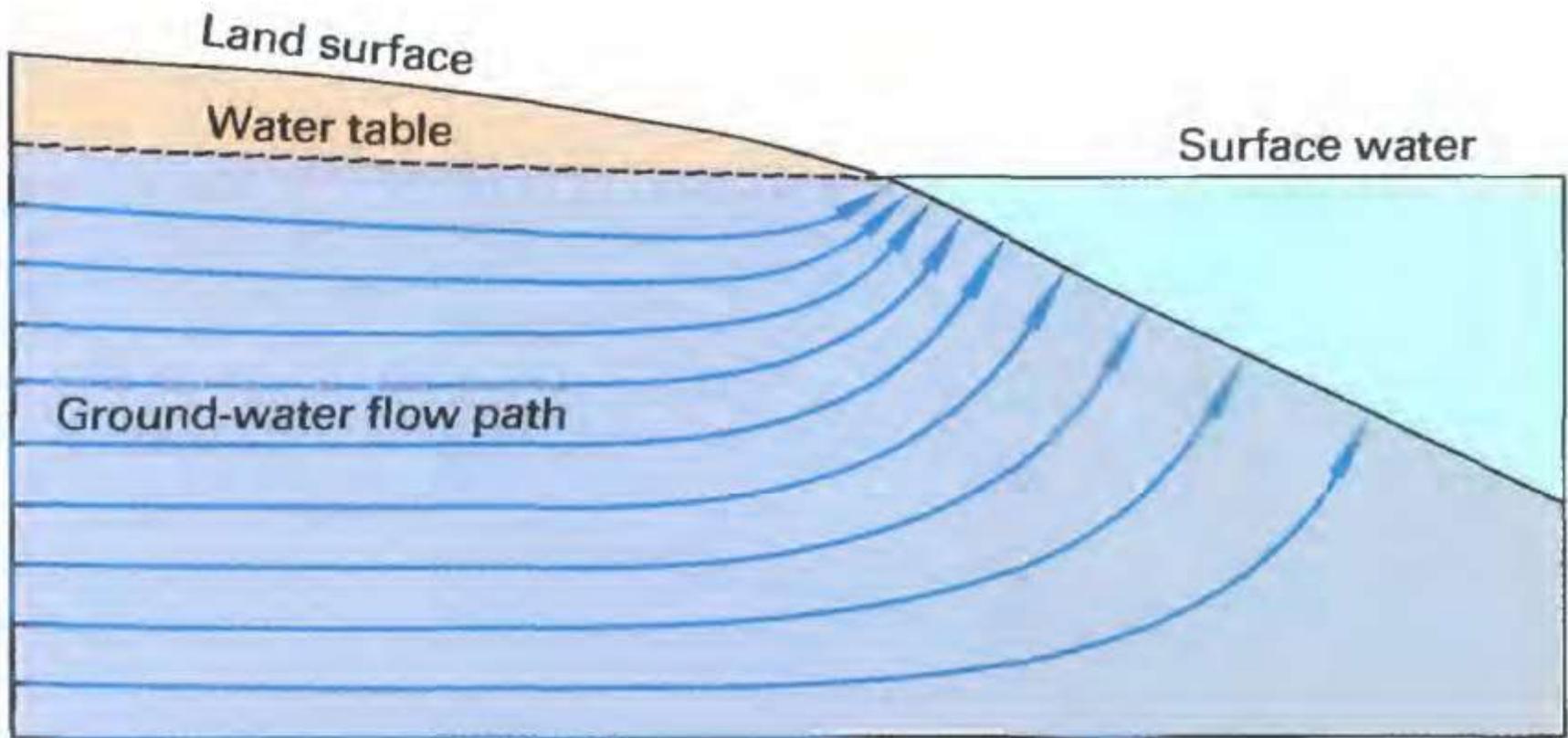


Figure 4. Ground-water seepage into surface water usually is greatest near shore. In flow diagrams such as that shown here, the quantity of discharge is equal between any two flow lines; therefore, the closer flow lines indicate greater discharge per unit of bottom.

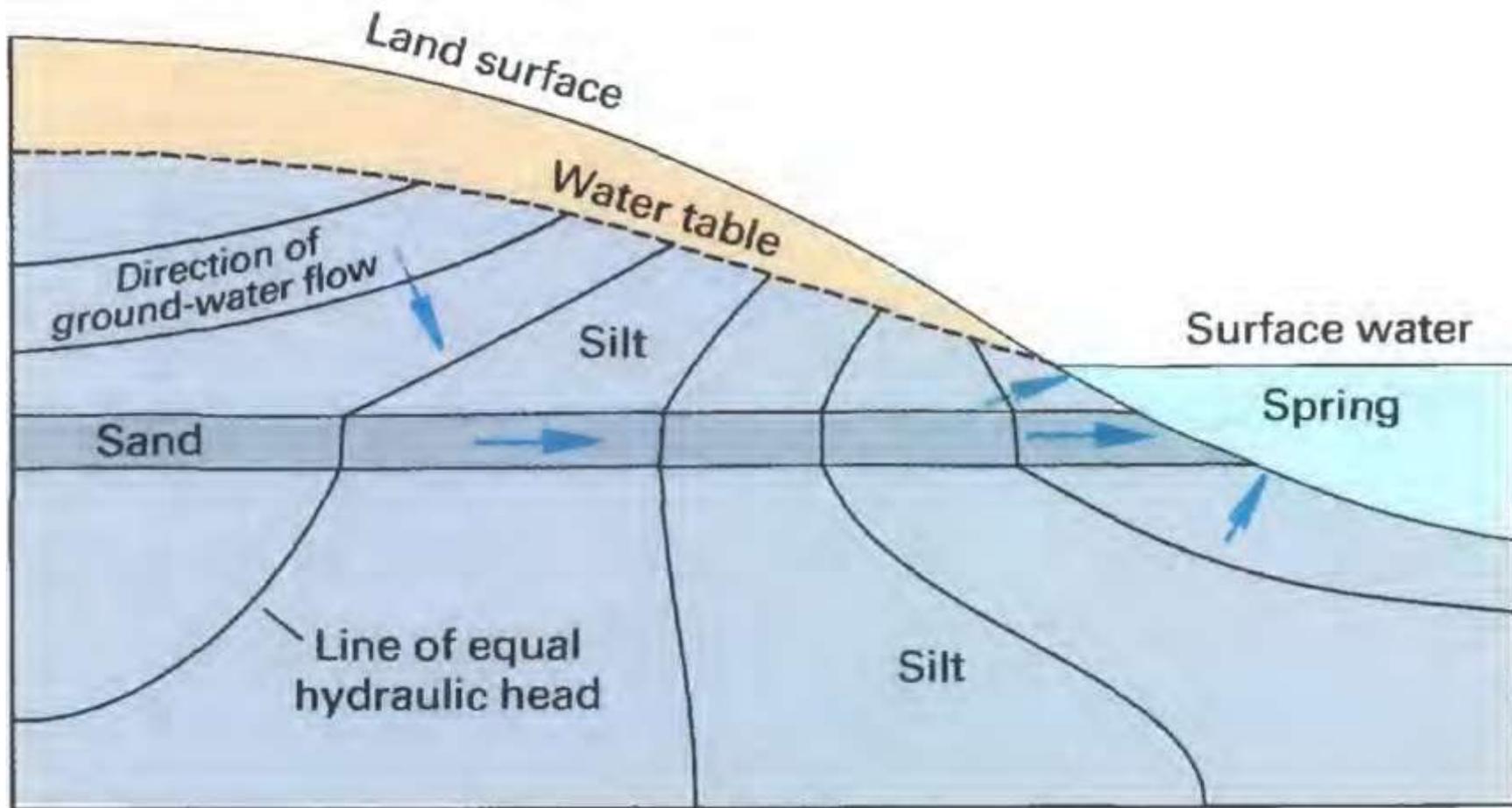


Figure 5. Subaqueous springs can result from preferred paths of ground-water flow through highly permeable sediments.

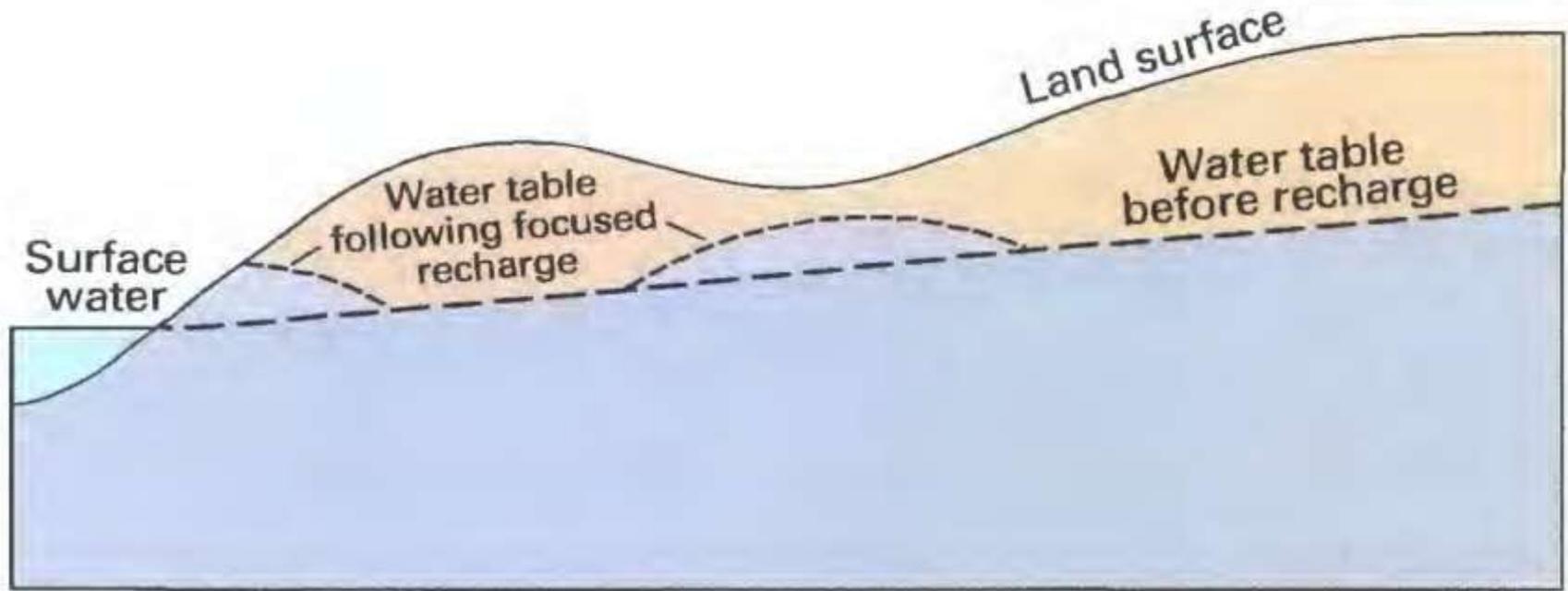


Figure 6. Ground-water recharge commonly is focused initially where the unsaturated zone is relatively thin at the edges of surface-water bodies and beneath depressions in the land surface.

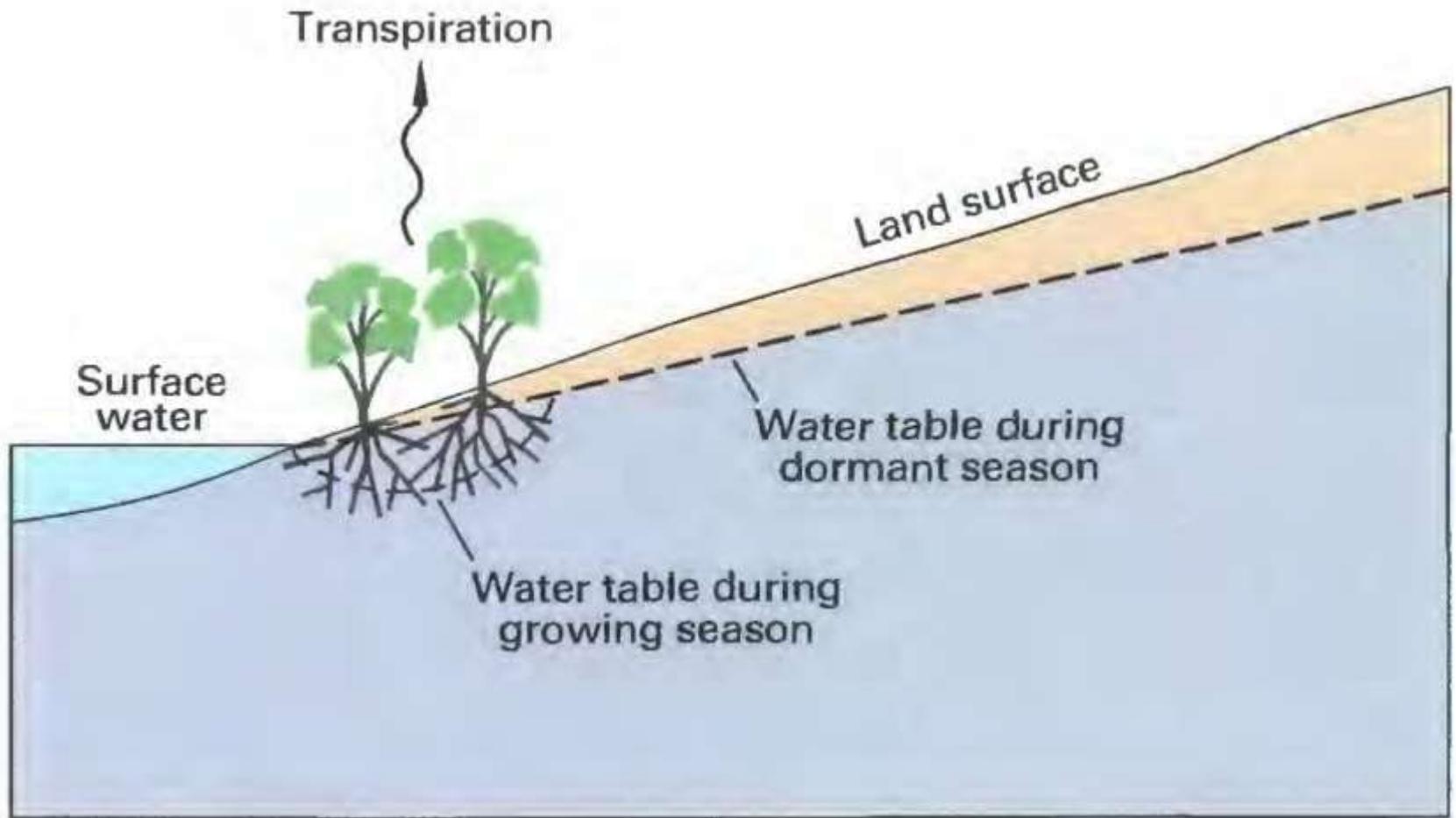


Figure 7. Where the depth to the water table is small adjacent to surface-water bodies, transpiration directly from ground water can cause cones of depression similar to those caused by pumping wells. This sometimes draws water directly from the surface water into the subsurface.

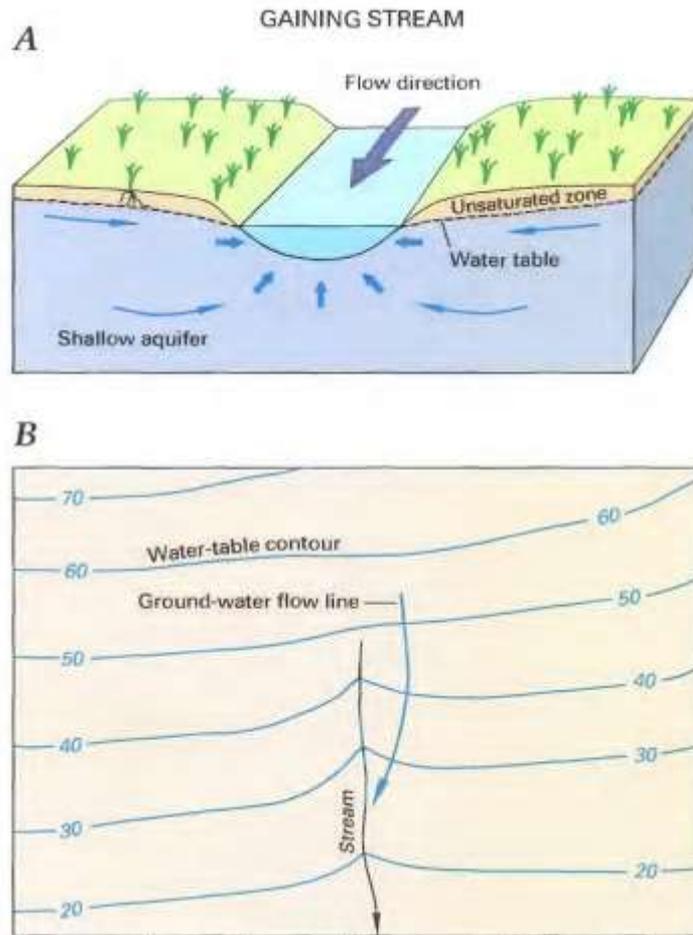


Figure 8. Gaining streams receive water from the ground-water system (A). This can be determined from water-table contour maps because the contour lines point in the upstream direction where they cross the stream (B).

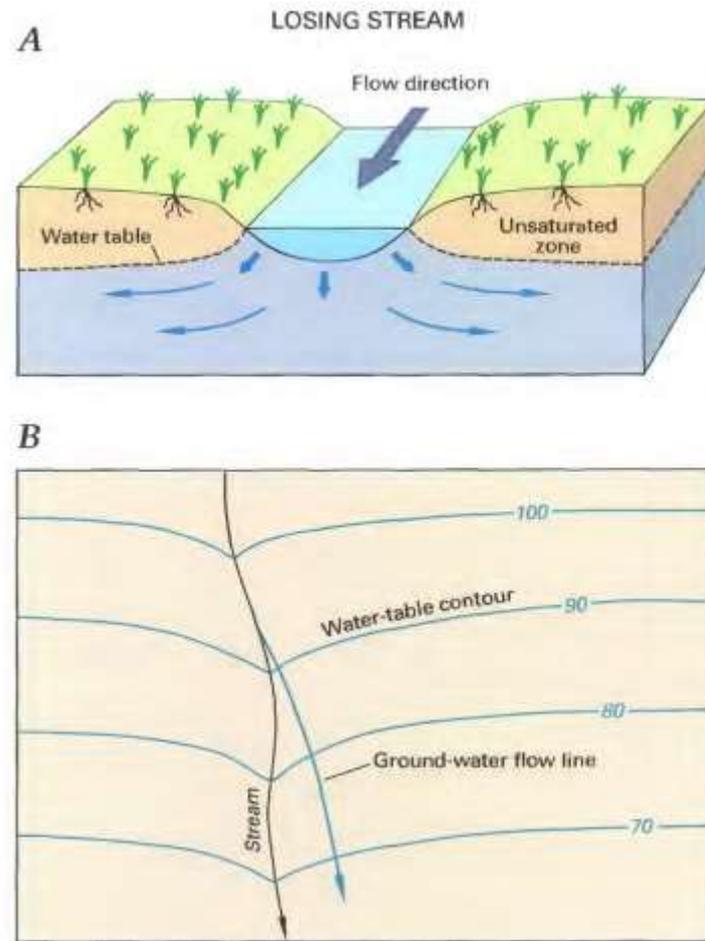


Figure 9. Losing streams lose water to the groundwater system (A). This can be determined from water table contour maps because the contour lines point in the downstream direction where they cross the stream (B).

# DISCONNECTED STREAM

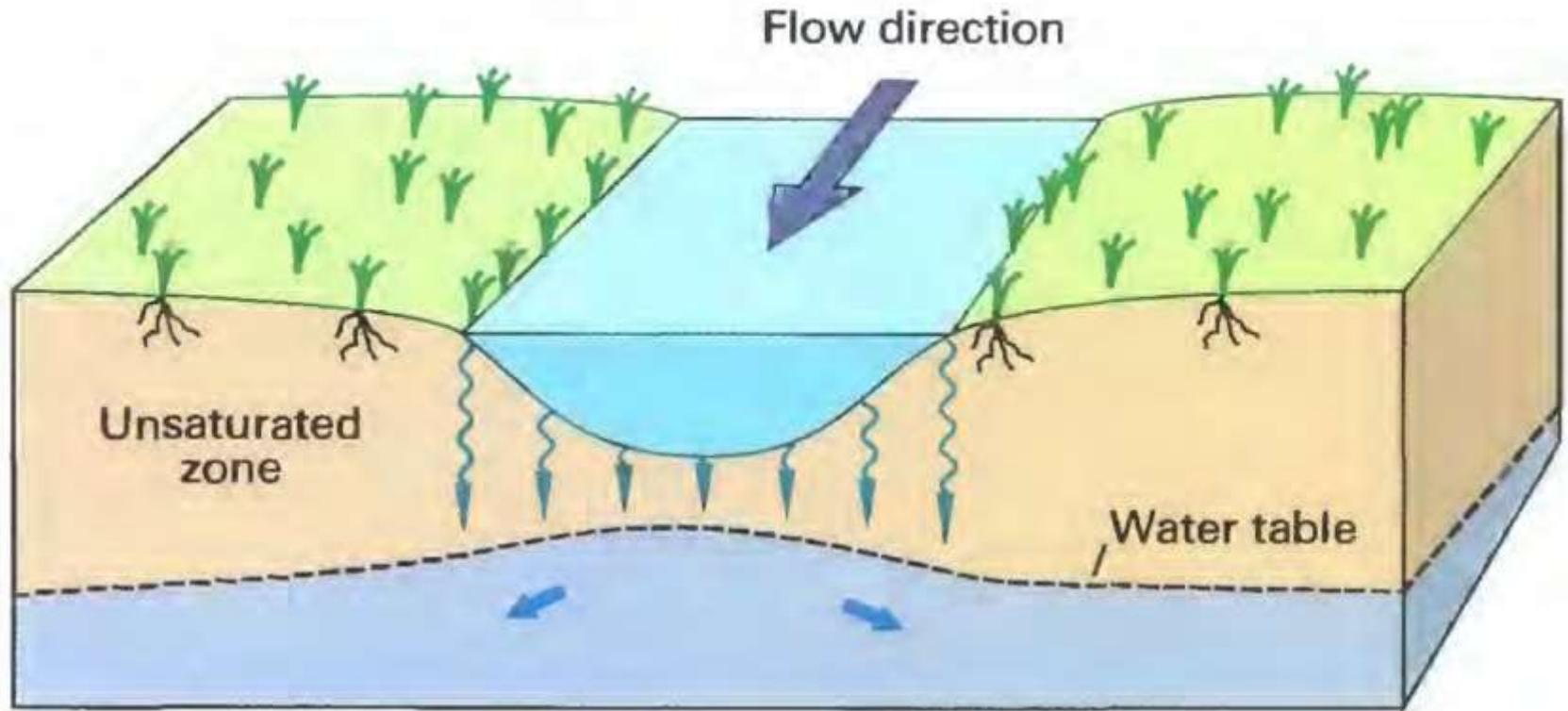


Figure 10. Disconnected streams are separated from the ground-water system by an unsaturated zone.

# BANK STORAGE

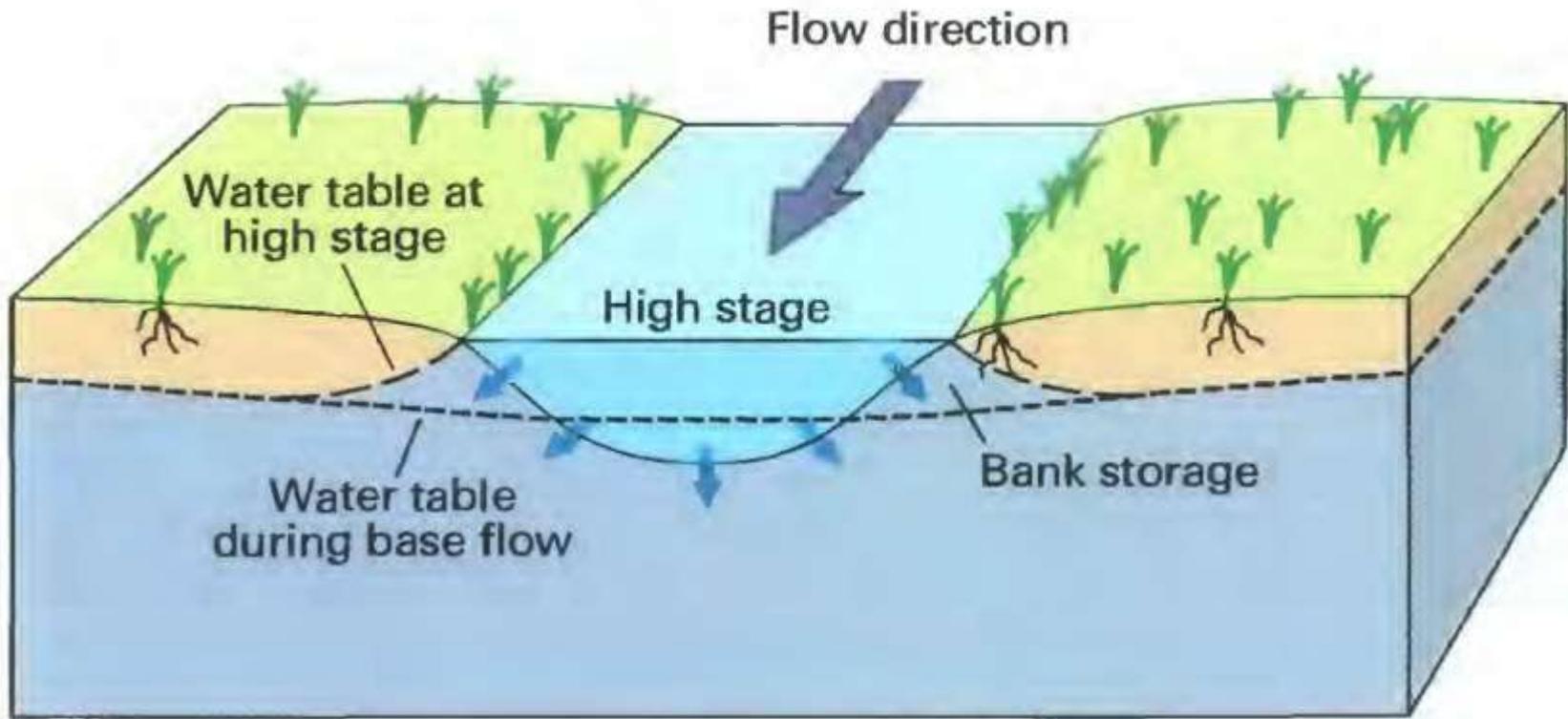
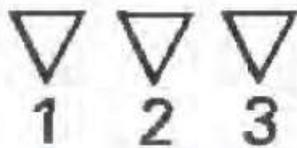
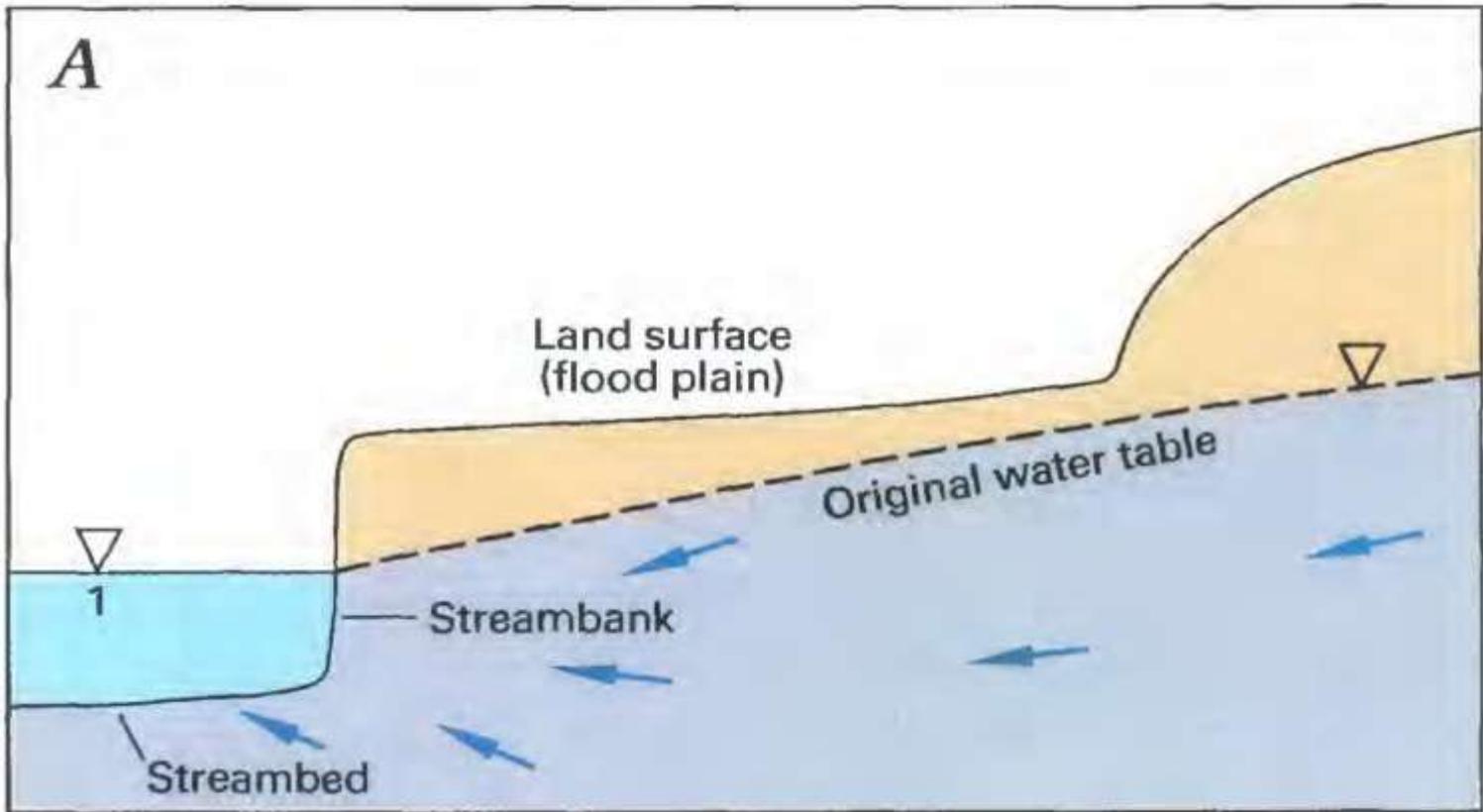


Figure 11. If stream levels rise higher than adjacent ground-water levels, stream water moves into the streambanks as bank storage.

*"Streams interact with ground water in three basic ways: streams gain water from inflow of ground water through the streambed (gaining stream), they lose water to ground water by outflow through the streambed (losing stream), or they do both, gaining in some reaches and losing in other reaches"*



Sequential stream stages



Approximate direction of groundwater flow or recharge through the unsaturated zone

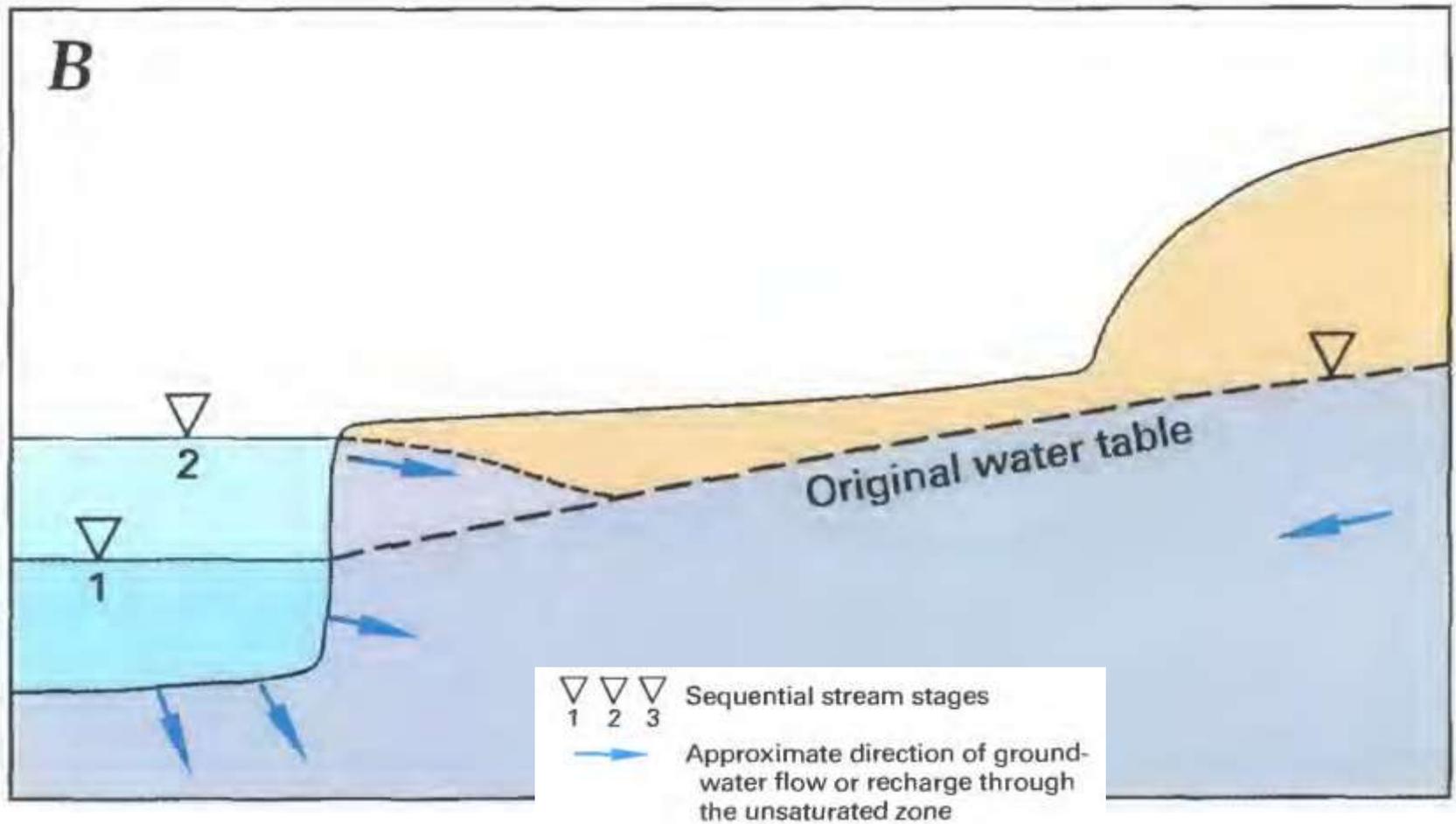


Figure 12. Rises in stream stage can cause the direction of flow through the streambed to reverse and lead to bank storage (B) and to ground-water recharge throughout the flooded area (C).

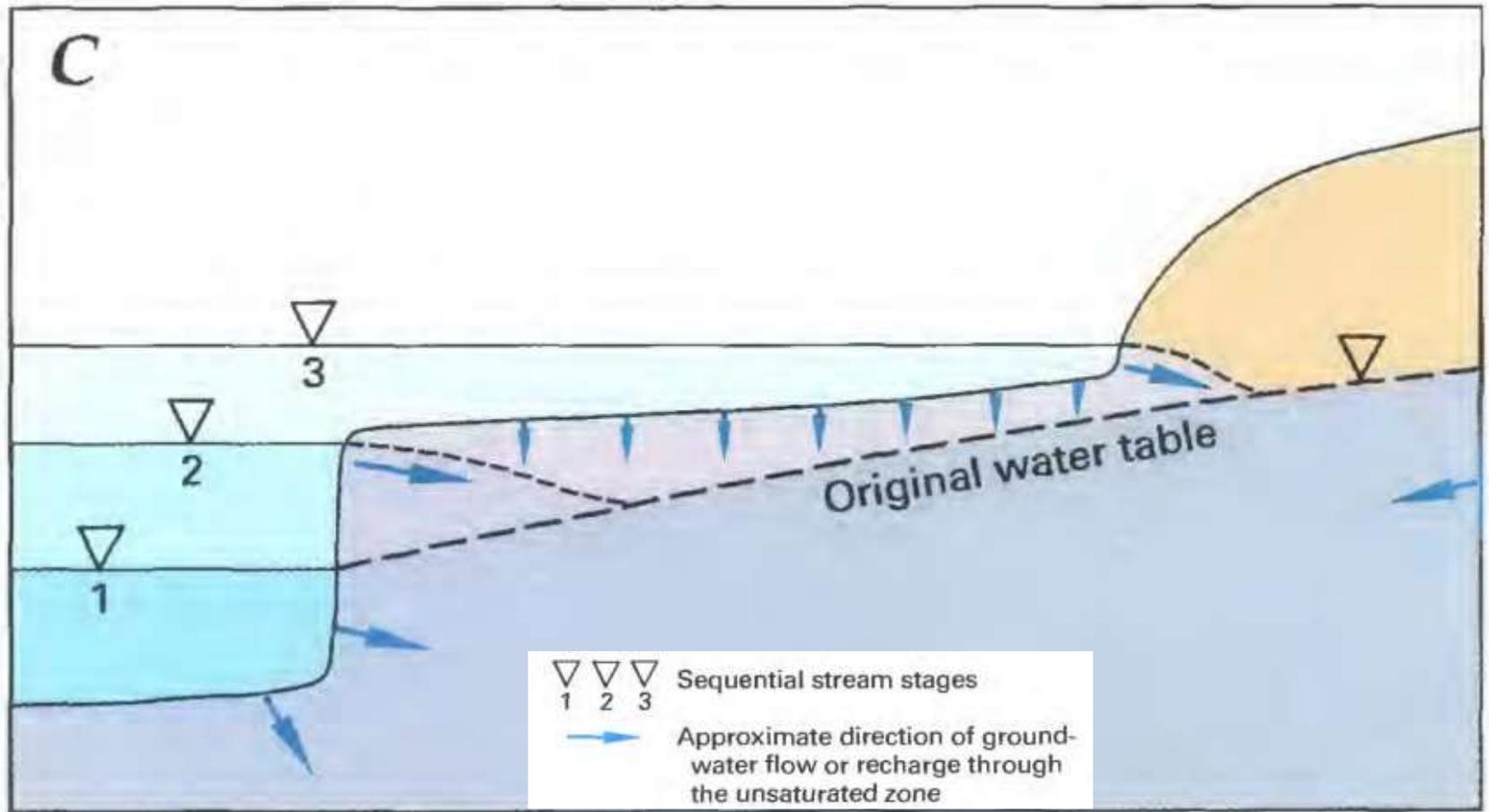


Figure 12. Rises in stream stage can cause the direction of flow through the streambed to reverse and lead to bank storage (B) and to ground-water recharge throughout the flooded area (C).

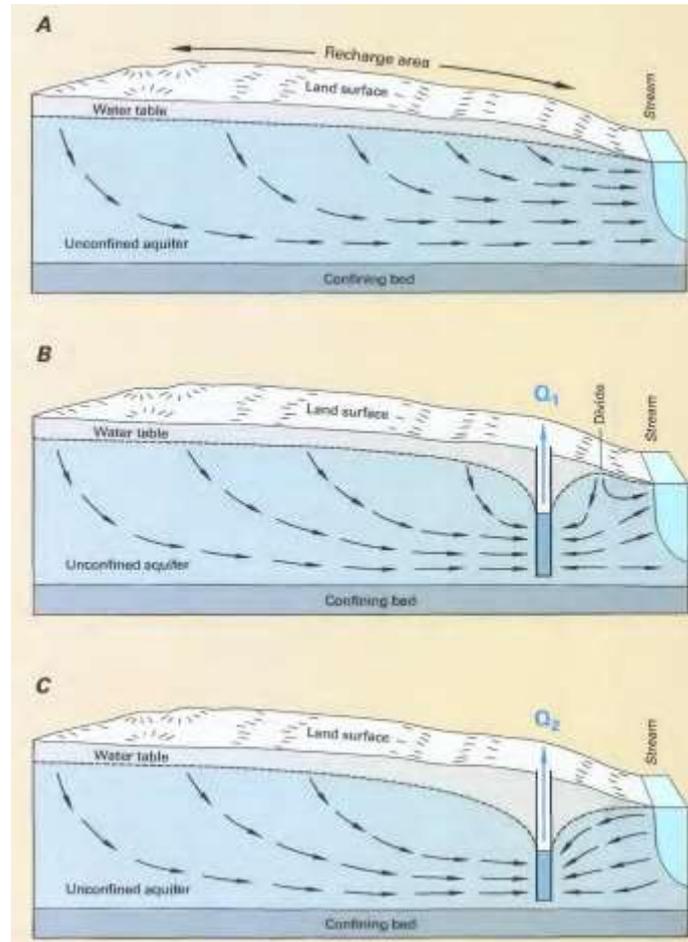
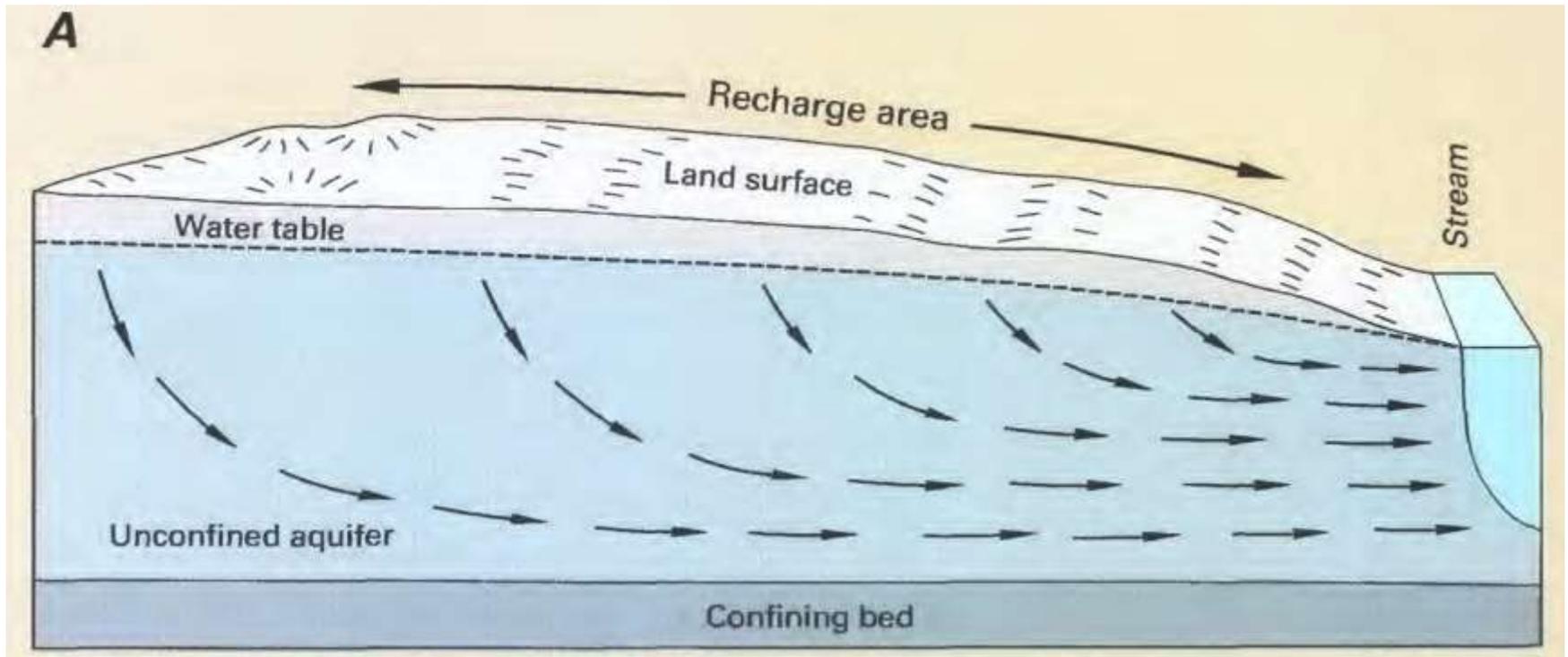
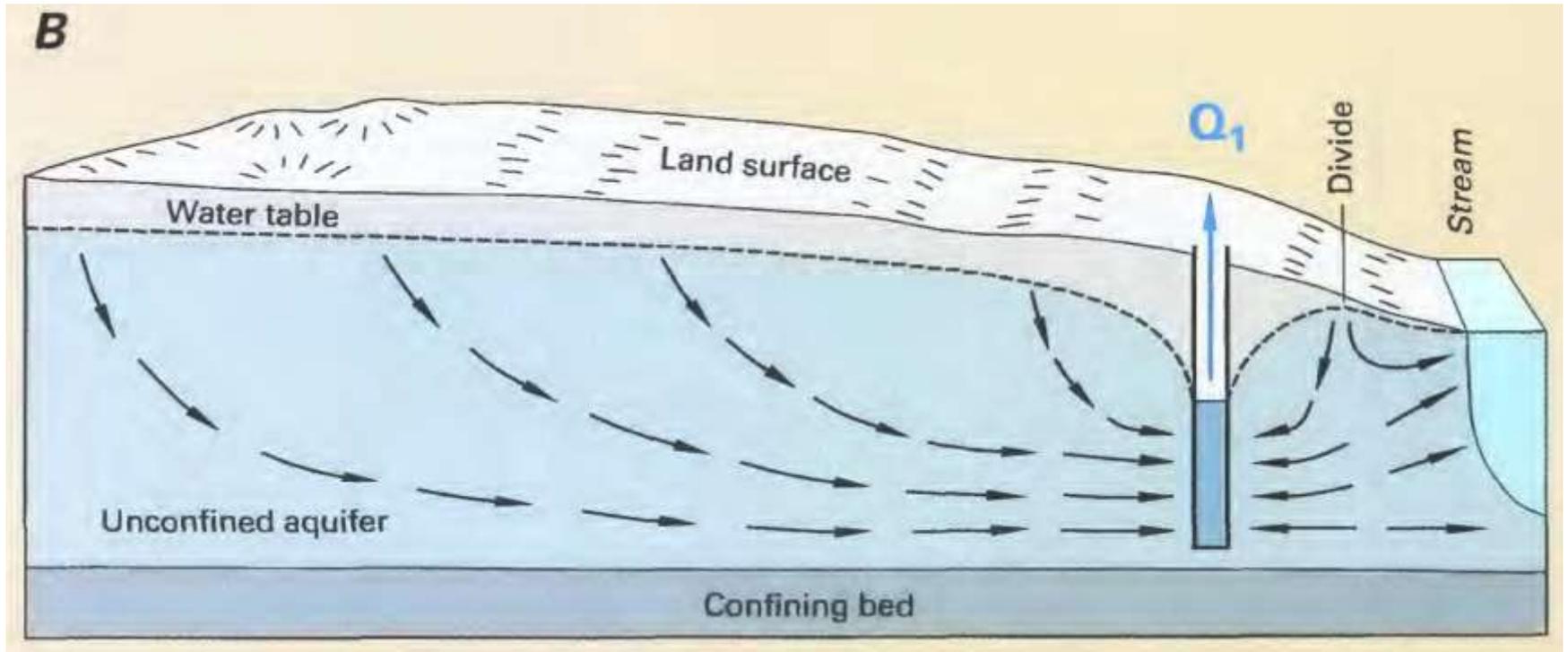


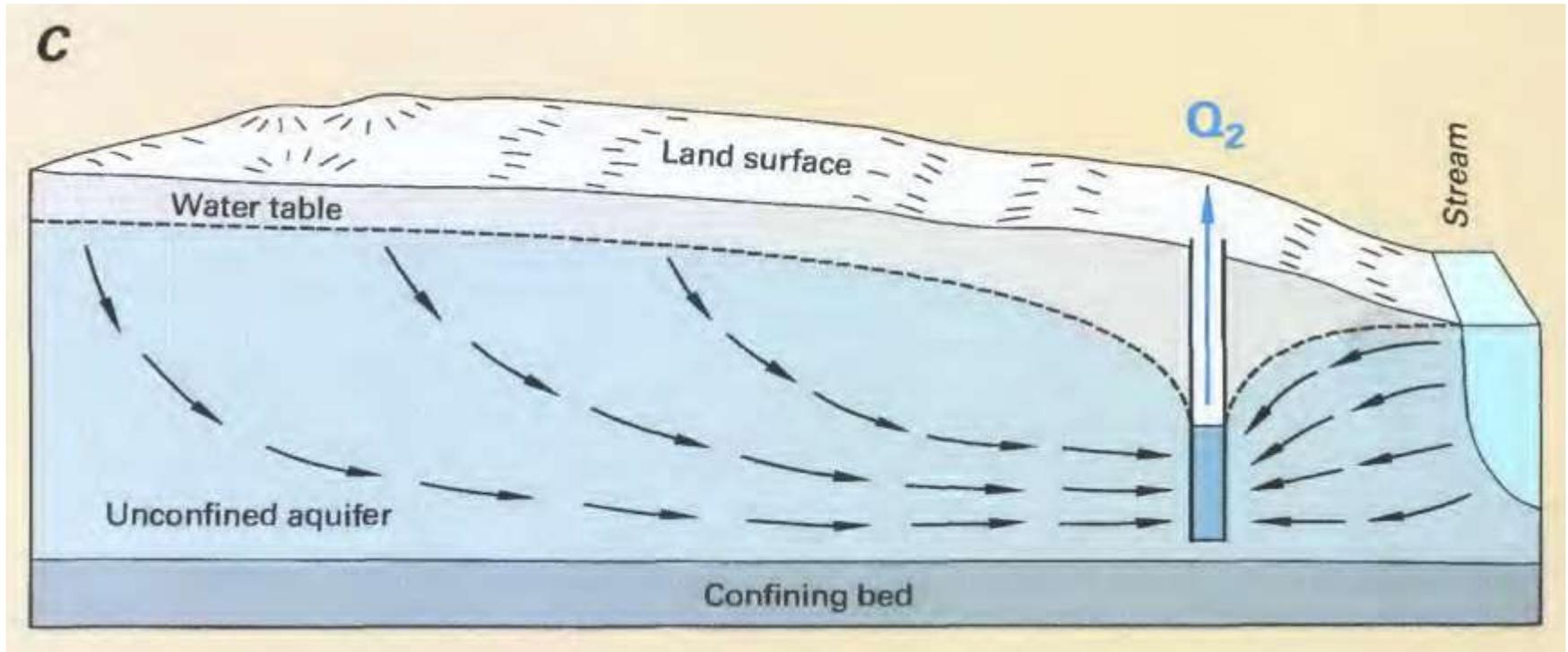
Figure C-1. In a schematic hydrologic setting where ground water discharges to a stream under natural conditions (A), placement of a well pumping at a rate ( $Q_1$ ) near the stream will intercept part of the ground water that would have discharged to the stream (B). If the well is pumped at an even greater rate ( $Q_2$ ), it can intercept additional water that would have discharged to the stream in the vicinity of the well and can draw water from the stream to the well (C).



*In a schematic hydrologic setting where ground water discharges to a stream under natural conditions (A),*



Placement of a well pumping at a rate ( $Q_1$ ) near the stream will intercept part of the ground water that would have discharged to the stream (B).



If the well is pumped at an even greater rate ( $Q_2$ ), it can intercept additional water that would have discharged to the stream in the vicinity of the well and can draw water from the stream to the well (C).

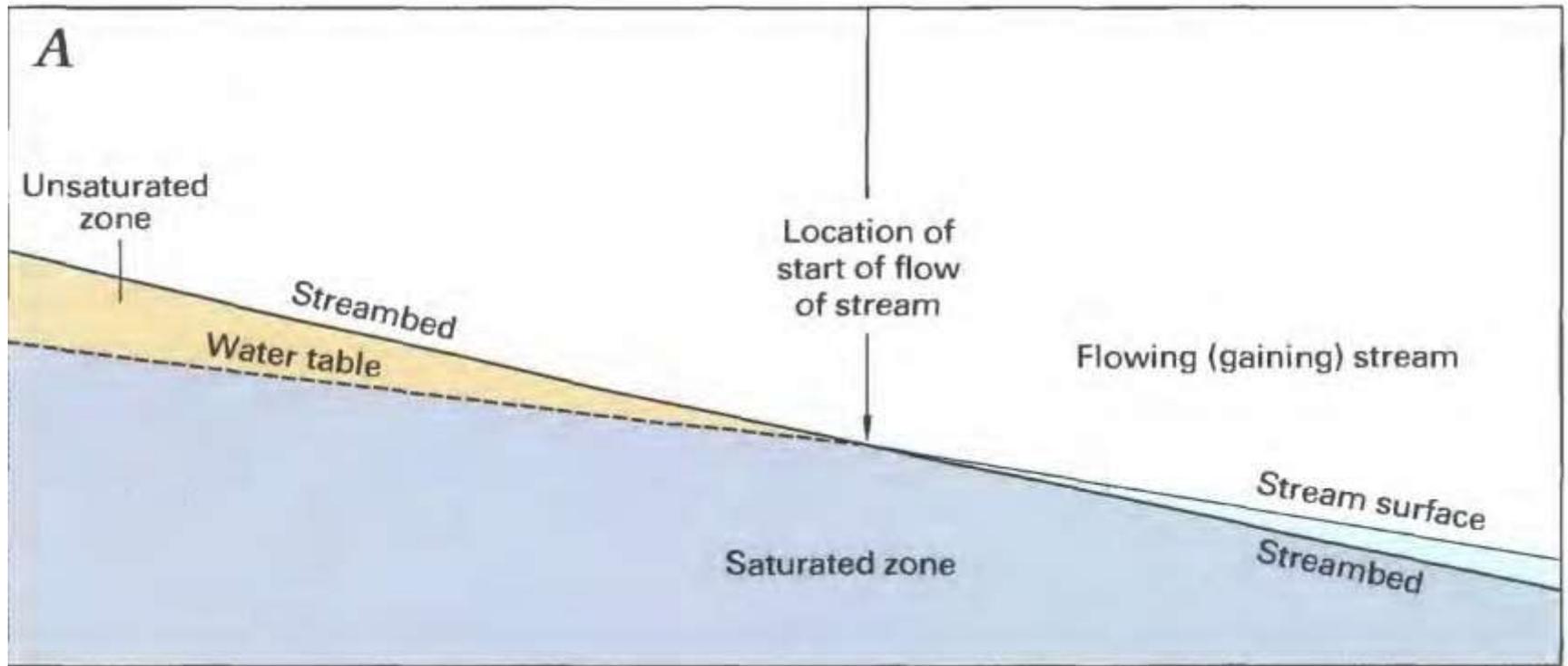


Figure 13. The location where perennial streamflow begins in a channel can vary depending on the distribution of recharge in headwaters areas. Following dry periods (A)

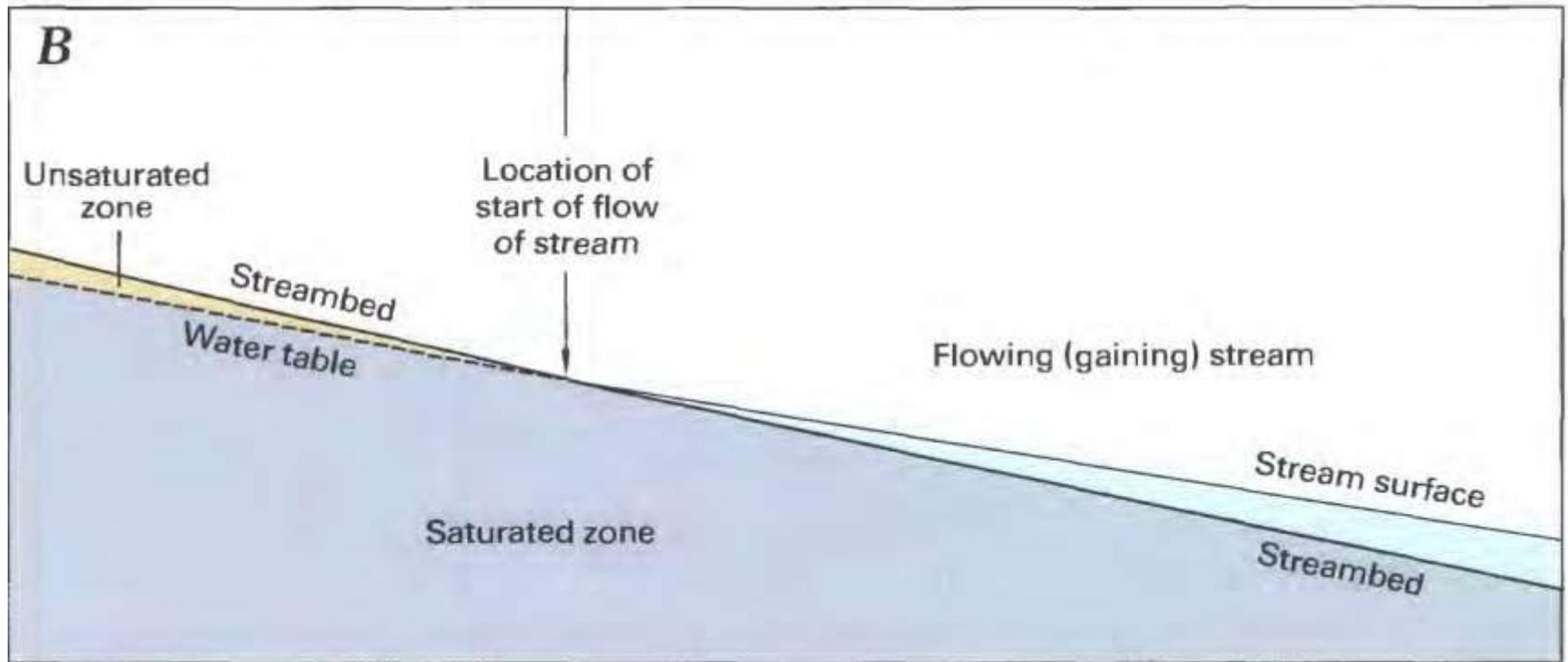


Figure 13. The location where perennial streamflow begins in a channel can vary depending on the distribution of recharge in headwaters areas. The start of streamflow will move upchannel during wet periods as the ground-water system becomes more saturated (B).

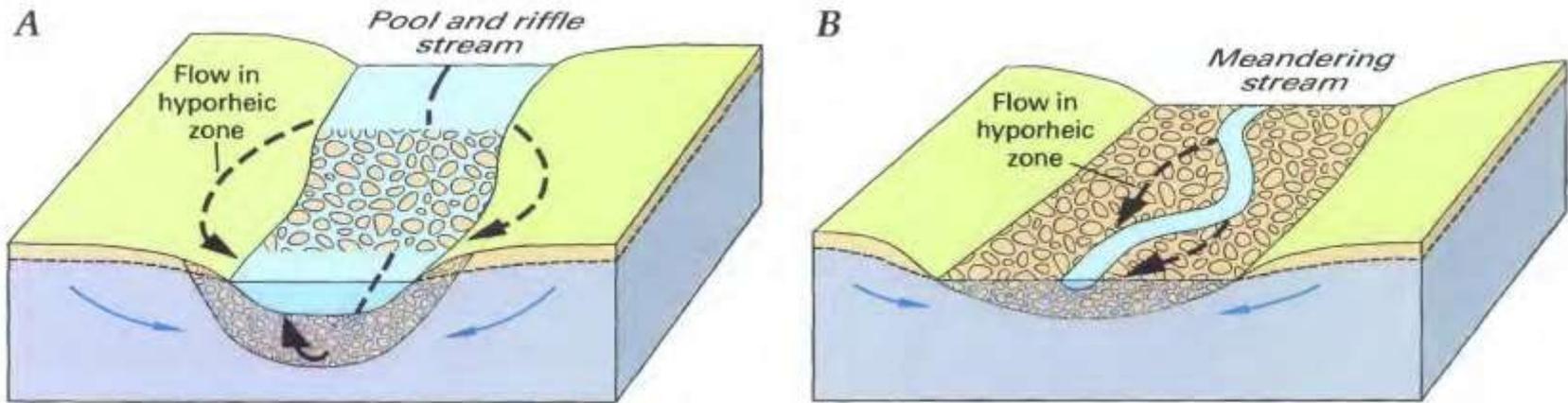


Figure 14. Surface-water exchange with ground water in the hyporheic zone is associated with abrupt changes in streambed slope (A) and with stream meanders (B).

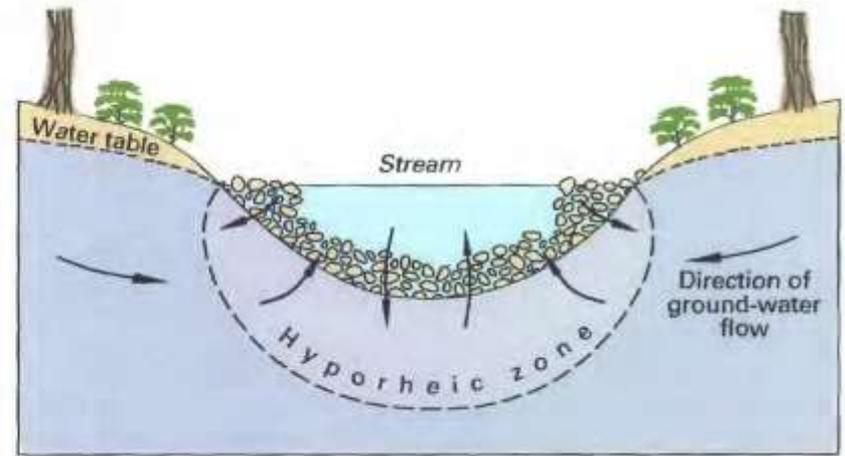
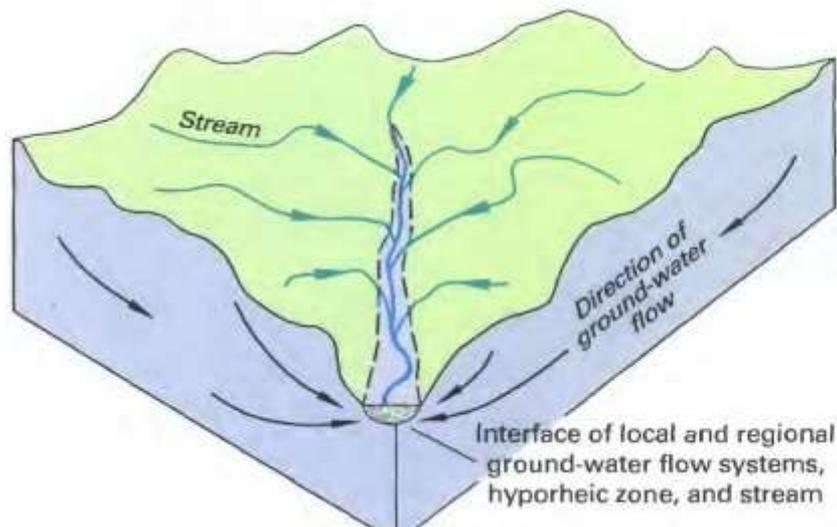


Figure 15. Streambeds and banks are unique environments because they are where ground water that drains much of the subsurface of landscapes interacts with surface water that drains much of the surface of landscapes.

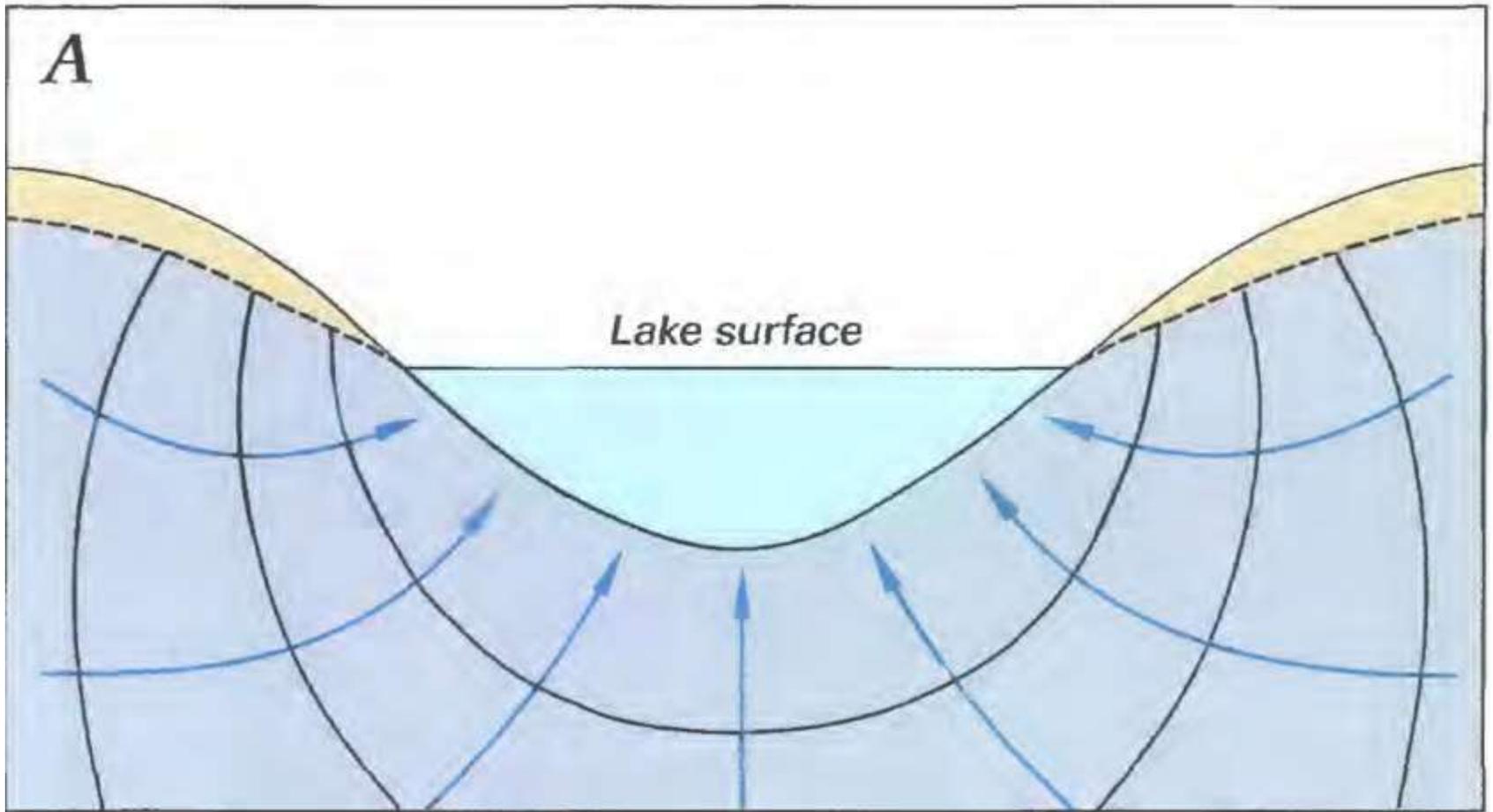
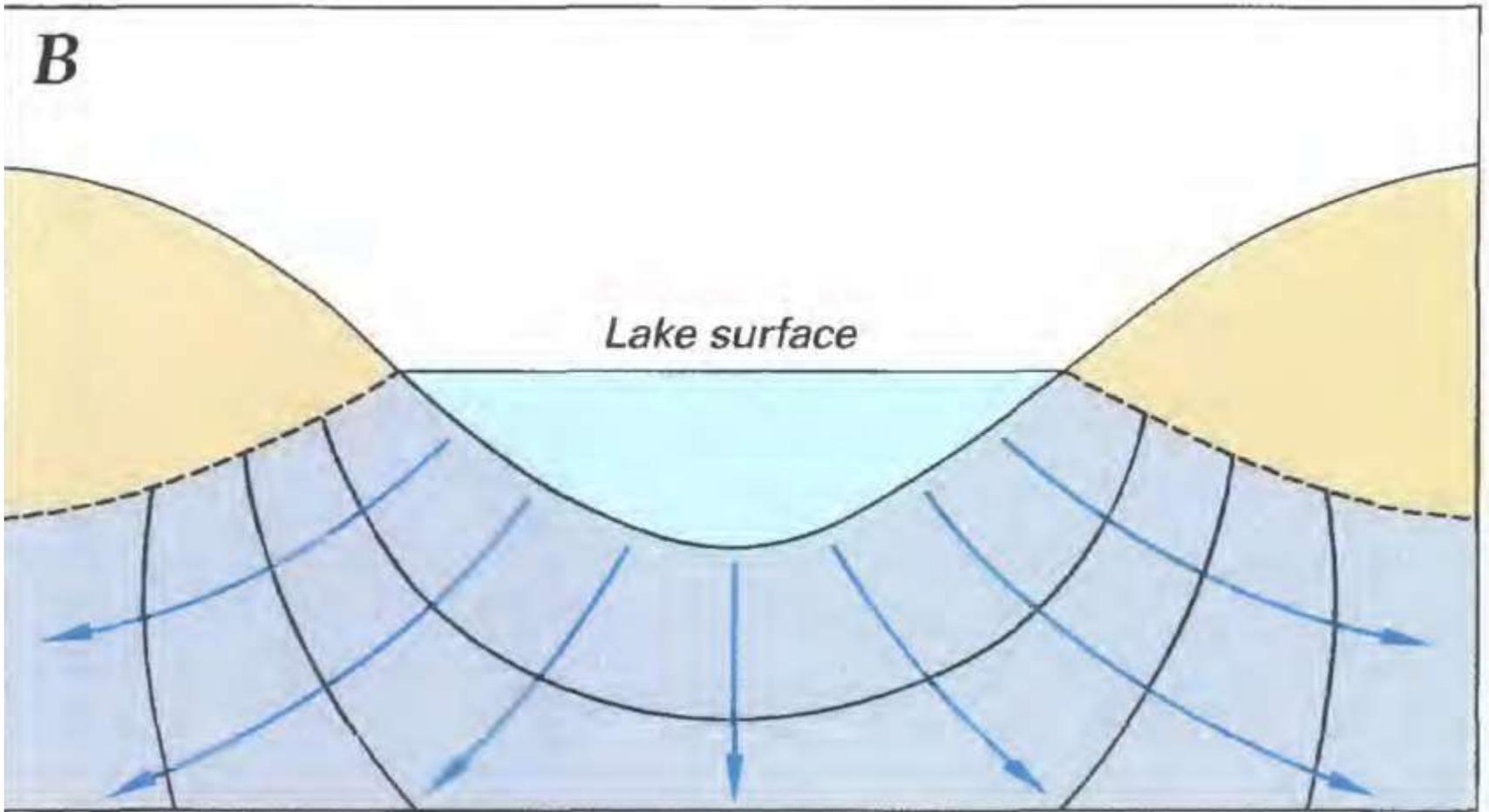
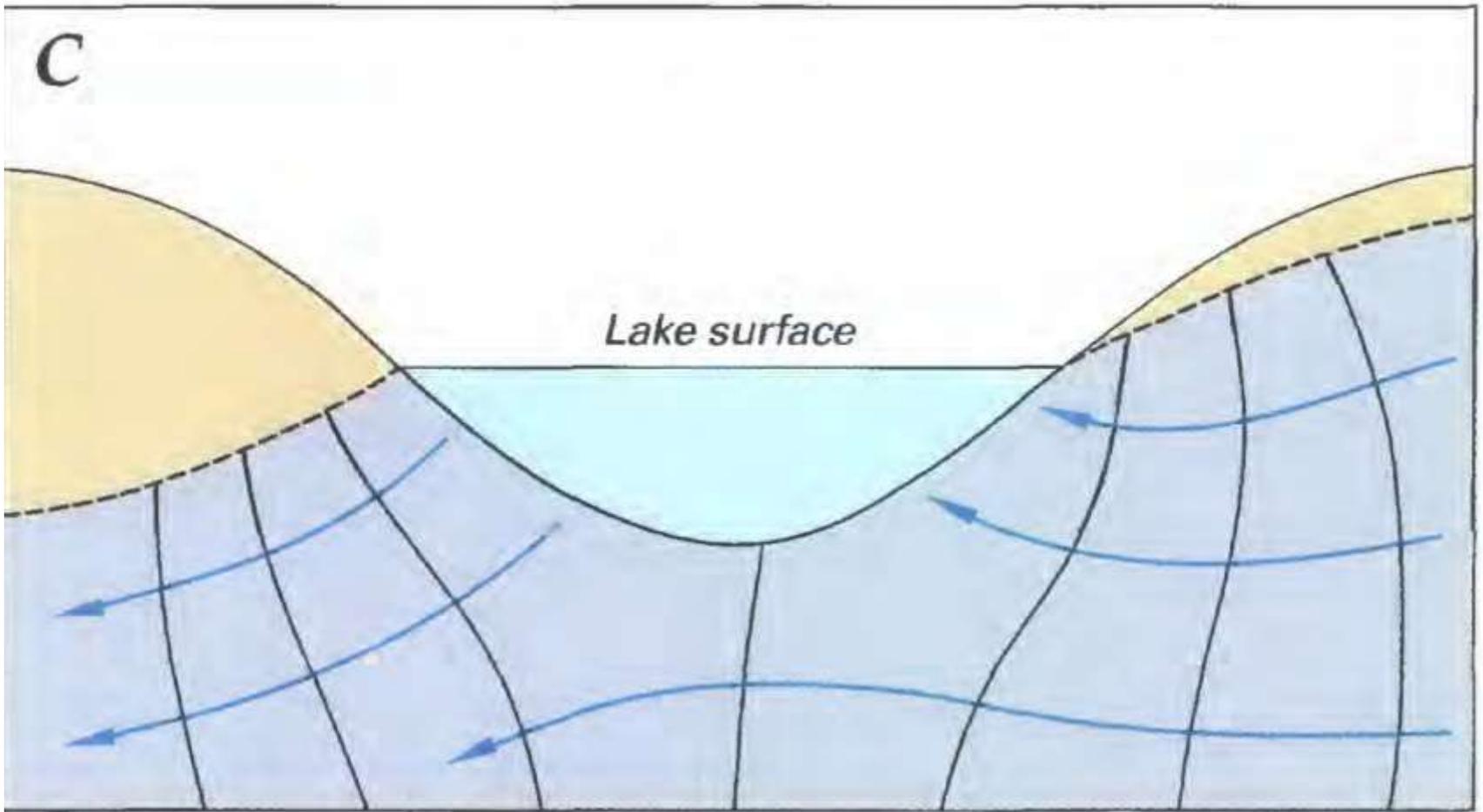


Figure 16. Lakes can receive ground-water inflow

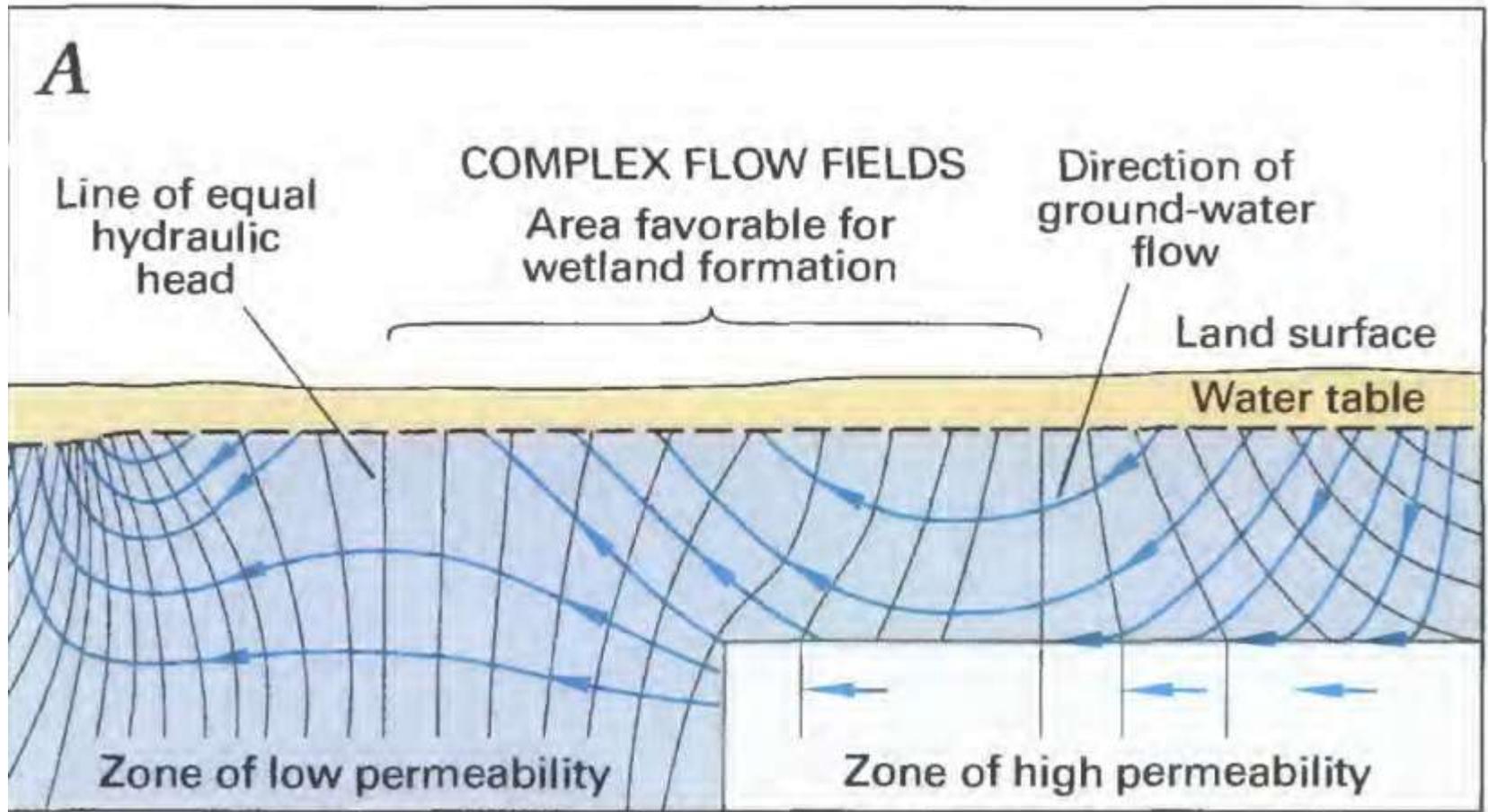


lose water as seepage to ground water

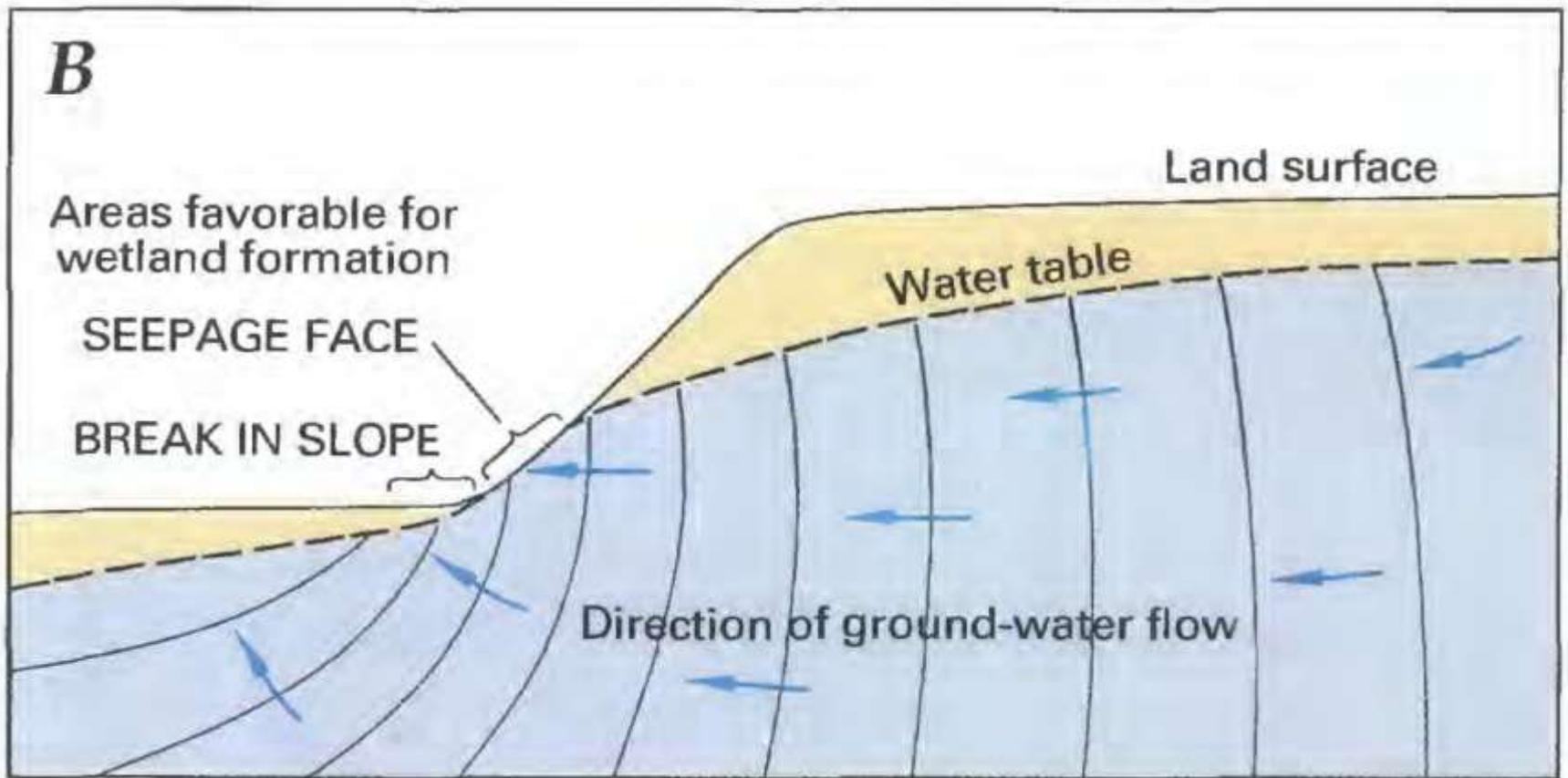


Lakes can both receive ground-water inflow and lose water as seepage to ground water.

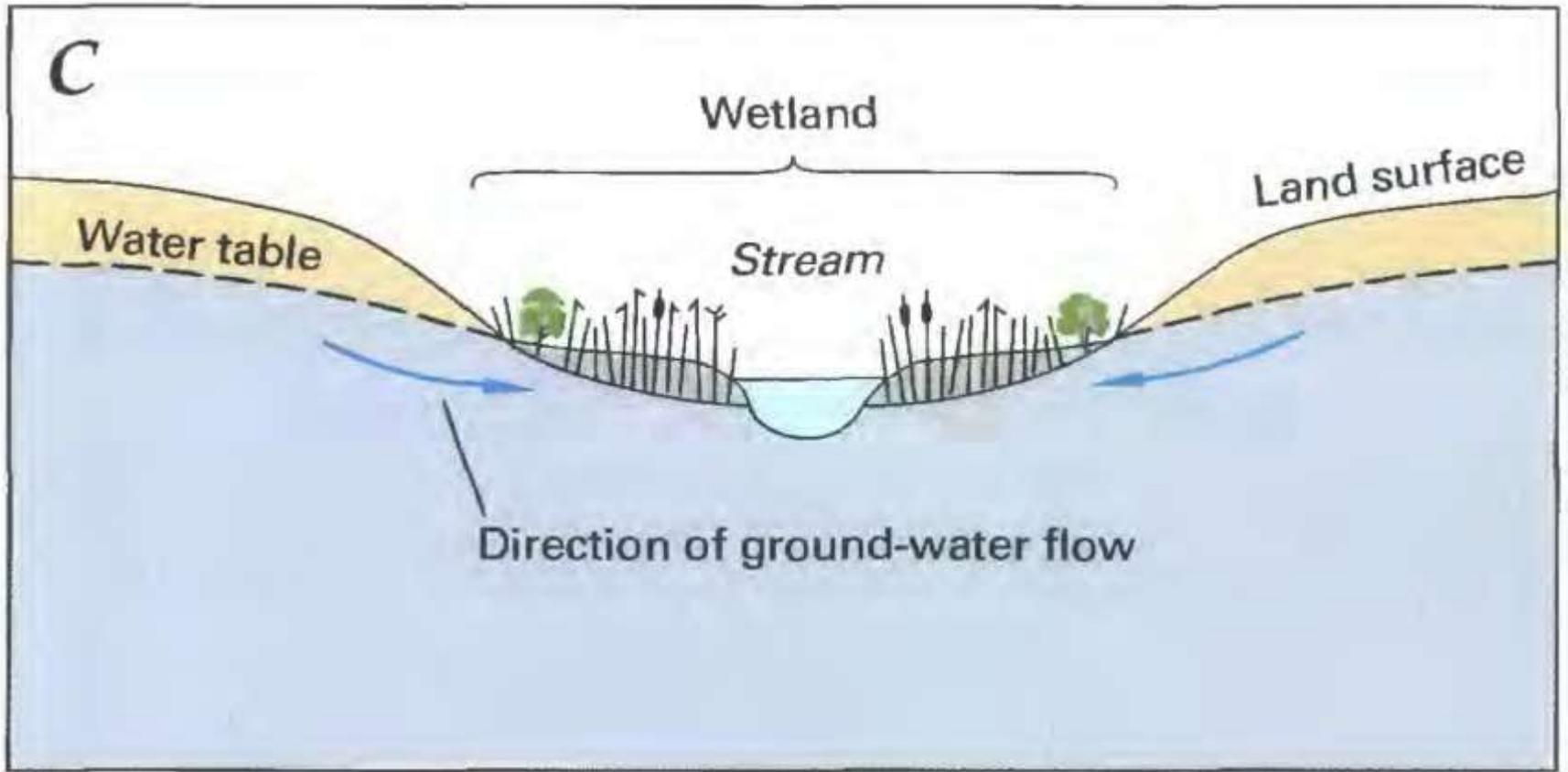
Figure 17. The source of water to wetlands can be from ground-water discharge where the land surface is underlain by complex ground-water flow fields (A), from ground-water discharge at seepage faces and at breaks in slope of the water table (B) from streams (C), and from precipitation in cases where wetlands have no stream inflow and ground-water gradients slope away from the wetland (D).



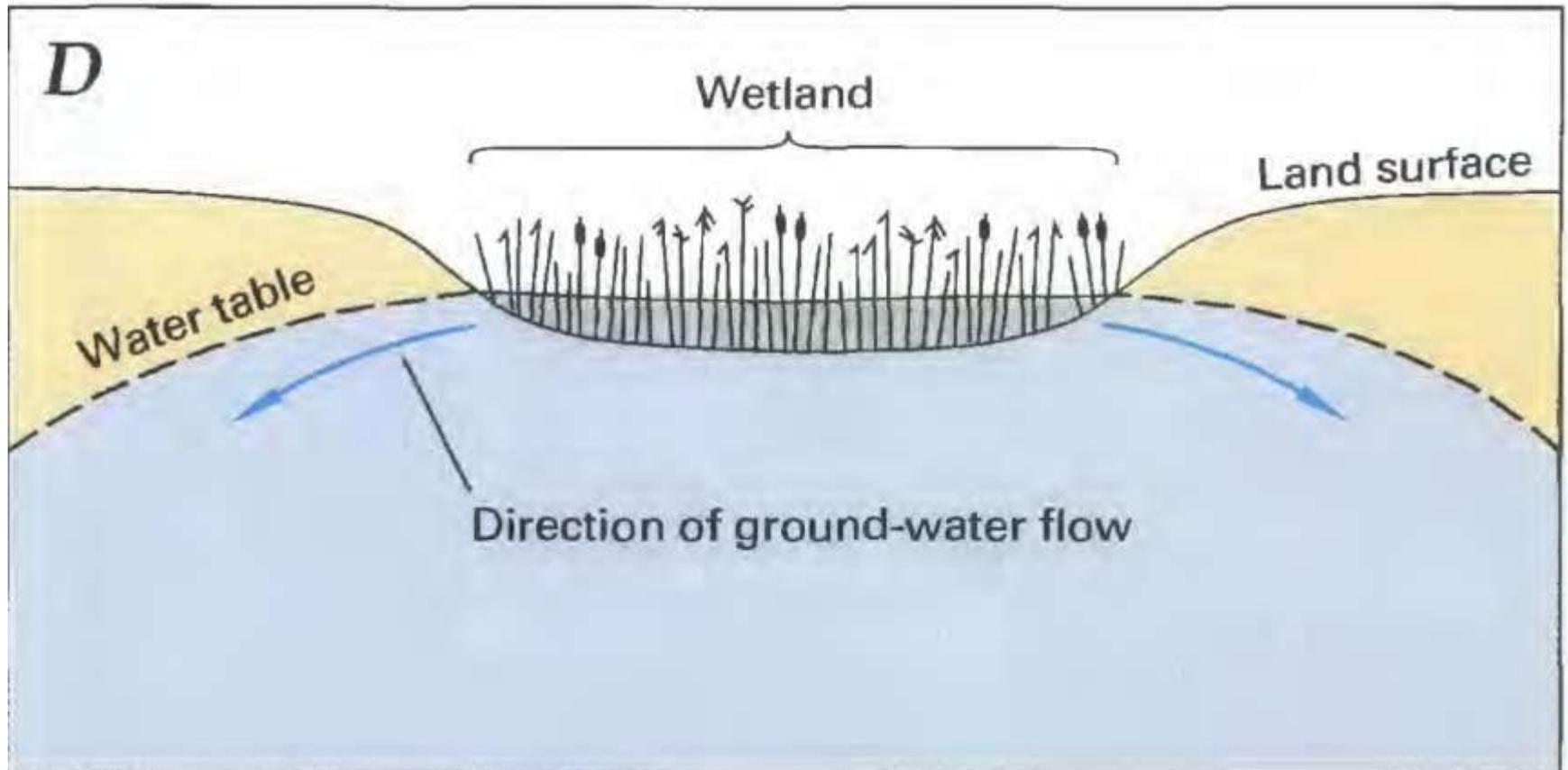
The source of water to wetlands can be ground-water discharge where the land surface is underlain by complex ground-water flow fields



From ground-water discharge at seepage faces and at breaks in slope of the water table



From streams



From precipitation in cases where wetlands have no stream inflow and ground-water gradients slope away from the wetland