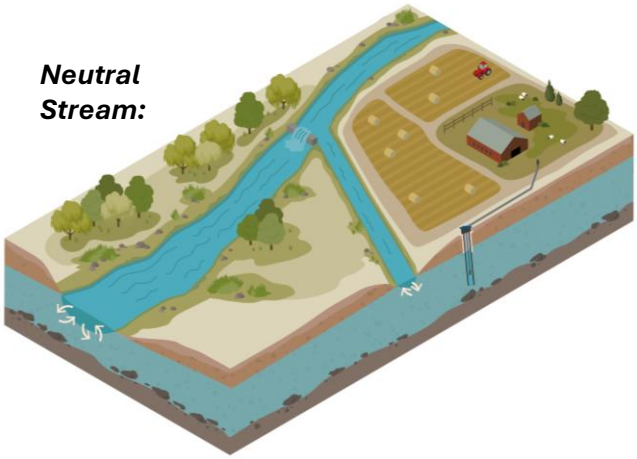
Groundwater and Surface Water Interactions

Groundwater and surface water can be connected in different ways. Depending on the type of aquifer, surface water can enter, or recharge, groundwater on scales as short as days, or as long as thousands of years. Groundwater can flow into surface water through seeps and springs. These connections are critical to understanding the water cycle and groundwater resources within our communities. Based on groundwater interactions, streams are classified as gaining, losing, neutral, or disconnected, describing whether they receive groundwater, lose water to it, do neither, or are hydraulically separated. These connections can vary from place to place along the stream and can also change over time.

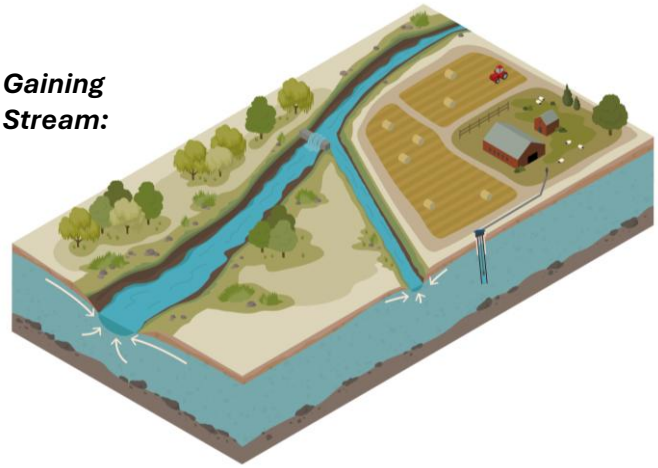
Pumping from a well can turn a gaining reach into a neutral or losing reach, a neutral reach into a losing reach, or increase losses in an already losing reach.

Neutral Stream:



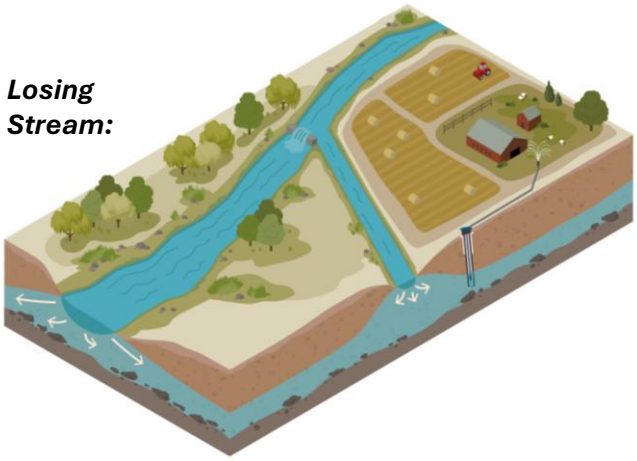
A stream where water exchange with the aquifer is minimal. This occurs when the groundwater level is the same as the stream level. A well next to a neutral stream may cause it to become a losing stream by lowering nearby groundwater levels.

Gaining Stream:



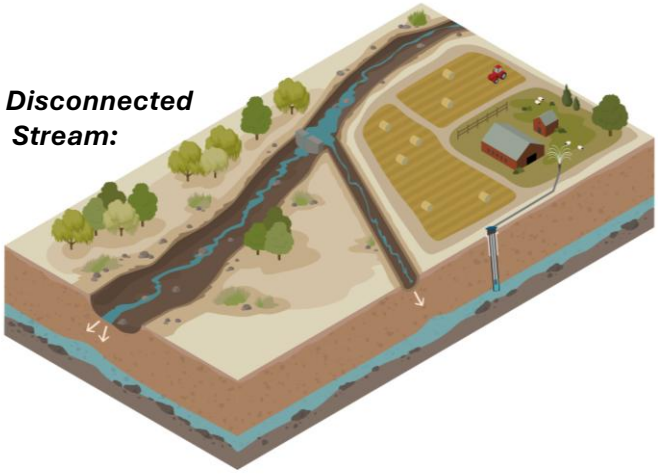
A stream where groundwater flows into the stream, increasing streamflow. This occurs when the groundwater level is higher than the stream. A shallow well near a gaining stream can capture or intercept groundwater that feeds the stream.

Losing Stream:



A stream where water flows from the stream into the aquifer, recharging groundwater. This occurs when the groundwater level is lower than the stream. A well next to a losing stream may receive water from the stream and increase losses from that stream.

Disconnected Stream:



A stream where the water is no longer in direct hydraulic connection with the aquifer. This occurs when the stream is separated from the aquifer by an unsaturated zone. Infiltration losses from the stream into the unsaturated zone can occur, however pumping from a well near a disconnected stream generally does not directly affect the stream.

How are groundwater-surface water interactions evaluated?

Surface water flows are measured and compared between two locations along the stream in a short time frame, typically within the same day or even the same hour (also known as **synoptic measurements**). These measurements take into account any diversions or inflows between the locations, such as irrigation ditches leaving or streams entering the flow.

The approach is referred to as a **seepage run**, which is a method to account for any gains or losses along a stream. Seepage run measurements are made during stable, non-changing flow conditions. Measurements involve stretching a surveyor's tape across the width of the stream or river and measuring the depth of water across the stream width and how fast the water is flowing. These measurements are known as **wading discharge measurements**.

When multiple surface water measurements are taken along a stream or river, scientists can use the changes in the amount of water flowing between surface water and groundwater.

FLOW LOSS (OR GAIN) = (Downstream Measurement + Any Diversions)
- (Upstream Measurement + Any Surface Water Inflows)

Decreasing flow downstream *is a "flow loss" and implies recharges the groundwater system.*
Increasing flow downstream *is a "flow gain" and implies discharge the groundwater system.*

Why are groundwater-surface water interactions important for communities?

Oregon apple orchard, irrigated by groundwater.

Understanding interactions between surface water and groundwater is essential for communities because many rivers, wetlands, and drinking water supplies depend on the exchange of water between these systems. This information also helps water managers with conjunctive management of groundwater and surface water resource, since using water from either one will affect the other.

Groundwater recharge, such as rain and snowmelt soaking into soils and aquifers, sustains long-term water supplies, while discharge from aquifers helps maintain streamflow in rivers during dry periods. Quantifying these flows helps communities manage water use, protect aquatic habitats, and ensure reliable water availability for people and agriculture. It also supports better planning for drought and climate change while protecting recharge areas from contamination.

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