GROUNDWATER STORAGE

UNIVERSITY OF CALGARY

GROUNDWATER CONNECTION FACT SHEET SERIES

RECHARGE:

- **Addition of water to the water table as a result of the infiltration of rain and snowmelt.**

DISCHARGE

- **The movement of groundwater from the subsurface to the surface.**

GROUNDWATER STORAGE:

- **The amount of groundwater in an aquifer.**

The natural system

Researchers use the groundwater budget equation to explain the change in storage. Groundwater storage is determined by examining the amount of water entering the system (recharge) compared to the amount of water leaving the system (discharge). As recharge and discharge fluctuate, so does the change in groundwater storage. This change can be seen in groundwater levels increasing and decreasing. The long-term average (about 10-20 years) of a natural system is in a balanced state, which means recharge minus discharge equals approximately zero on average (Figure 1).

The groundwater budget is expressed as:

Recharge (Input) – Discharge (Output) = Change in Storage

In a relatively undisturbed system, long-term average recharge and discharge are balanced.

Recharge – Discharge ≈ 0

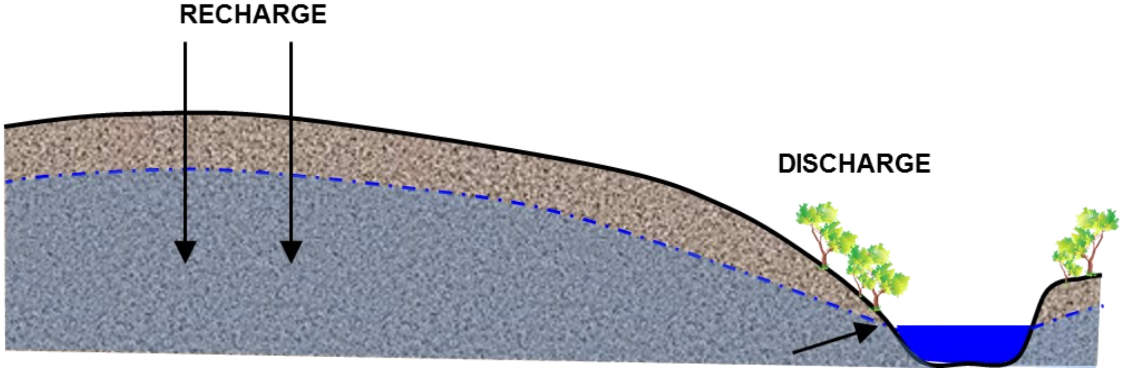

Figure 1: The natural water balance. Recharge - Discharge ≈ 0 over the long-term average

What is the impact of humans on the water balance?

When the natural system is interrupted by human activities it can alter the groundwater storage. The addition of pumping water for domestic, commercial and industrial uses adds a new variable to the groundwater balance equation. This addition of pumping increases the amount of water being extracted from the aquifer, which generally increases the output of water from the aquifer (Figure 2).

Recharge (Input) – Discharge (Output) – Pumping (Output) = Change in Storage

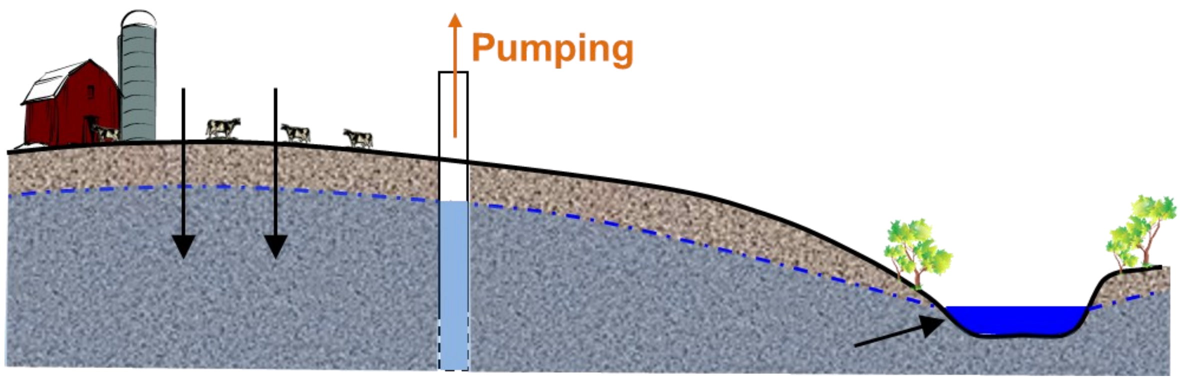

Figure 2: The addition of a well pumping from an aquifer disturbs the water balance.

This addition of human activity on an aquifer requires the system to adjust and find a new revised balance. However, for a groundwater system to remain sustainable the change in storage must not continuously decrease. Therefore a new balance must be achieved balancing groundwater inputs and outputs.

This new water balance equation with pumping, written for long-term average is:

Recharge (Input) – Discharge (Output) – Pumping (Output) ≈ 0

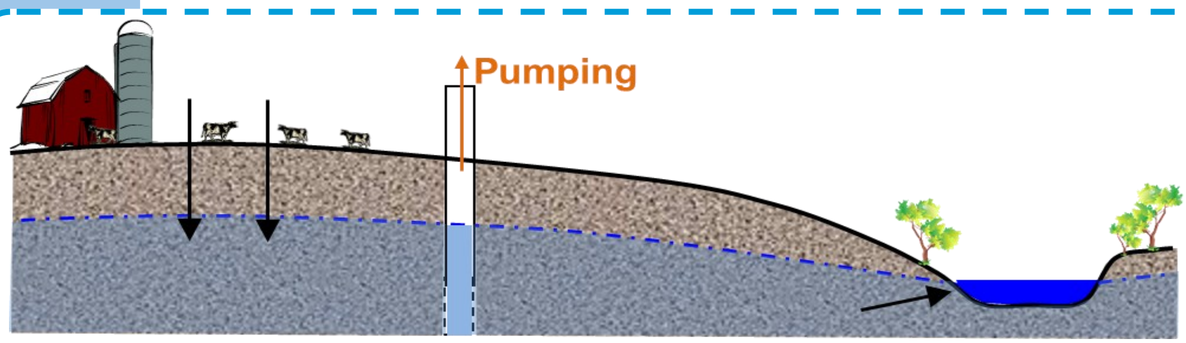

Figure 3: A new water balance with pumping. This new balance occurs when pumping remains smaller than recharge and there is a reduction in the amount of natural discharge.

What happens if pumping exceeds recharge?

As water is pumped from an aquifer, there is a greater amount of water extracted from groundwater storage. If recharge remains the same, there is a reduction in the amount of water available to discharge into the natural environment (springs and streams). Therefore, it is important that the rate of pumping remains smaller than the amount of recharge to the system. If pumping and natural discharge exceed the recharge rate of the aquifer, there will be a decrease in groundwater storage (Figure 4). A slight decrease in storage will not necessarily impact the aquifer negatively, especially if it is short-term. However, if there is a continuous reduction of stored water in the aquifer it could have an impact on humans (well would go dry) and the natural ecosystem (decrease baseflow to streams) (Figure 4). Therefore pumping must remain less than recharge over the long-term in order to be sustainable (Sophocleous, 2000).

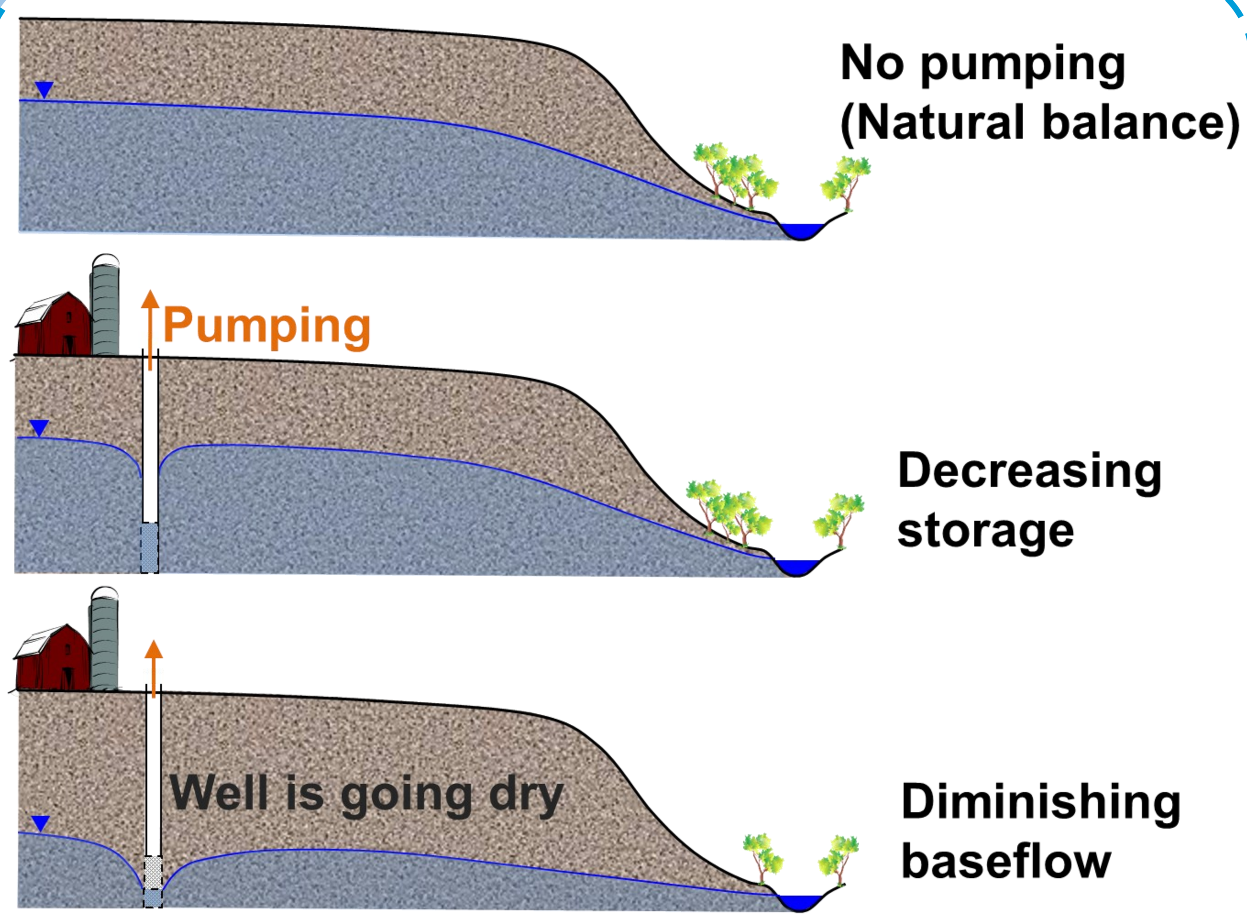

Figure 4: Cross section illustrating the impact of pumping on the water table. The top diagram shows the natural balance (no pumping). As pumping increases (middle) there is a decrease in storage. If pumping continues at an unsustainable rate, the water level drops to a point where the well will be dry and stream baseflow will be impacted.

REFERENCES

Sophocleous, M. 2000. From safe yield to sustainable development of water resources – the Kansas experience. *Journal of Hydrology* 235: 27-43.

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