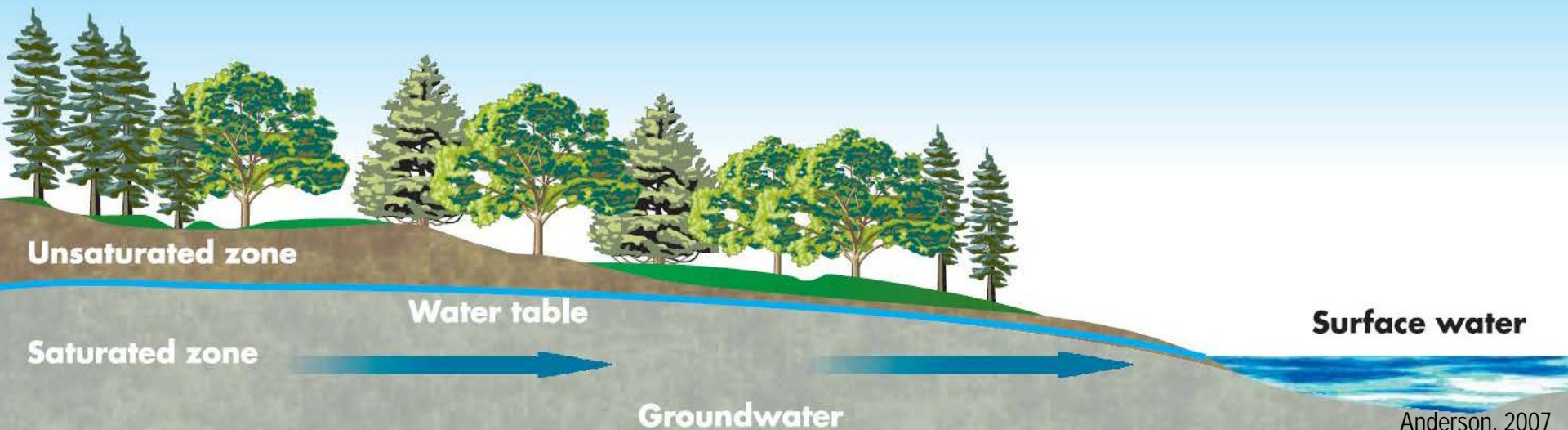


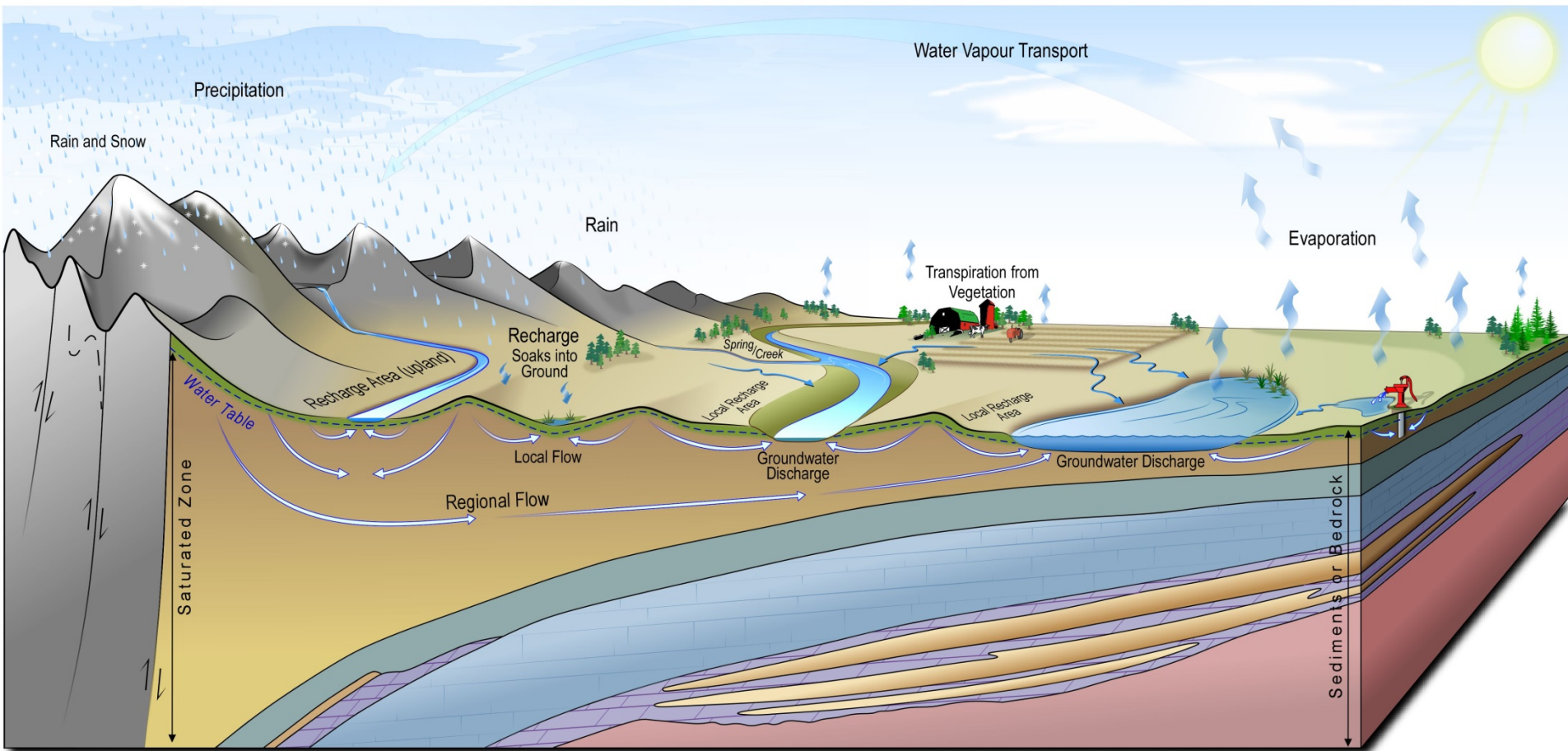
# A Primer on Groundwater

Brian Smerdon, *Alberta Geological Survey*

North Saskatchewan Watershed Alliance  
Groundwater Forum, 27 February 2019



# Groundwater: Part of the water cycle



Barker et al., 2011

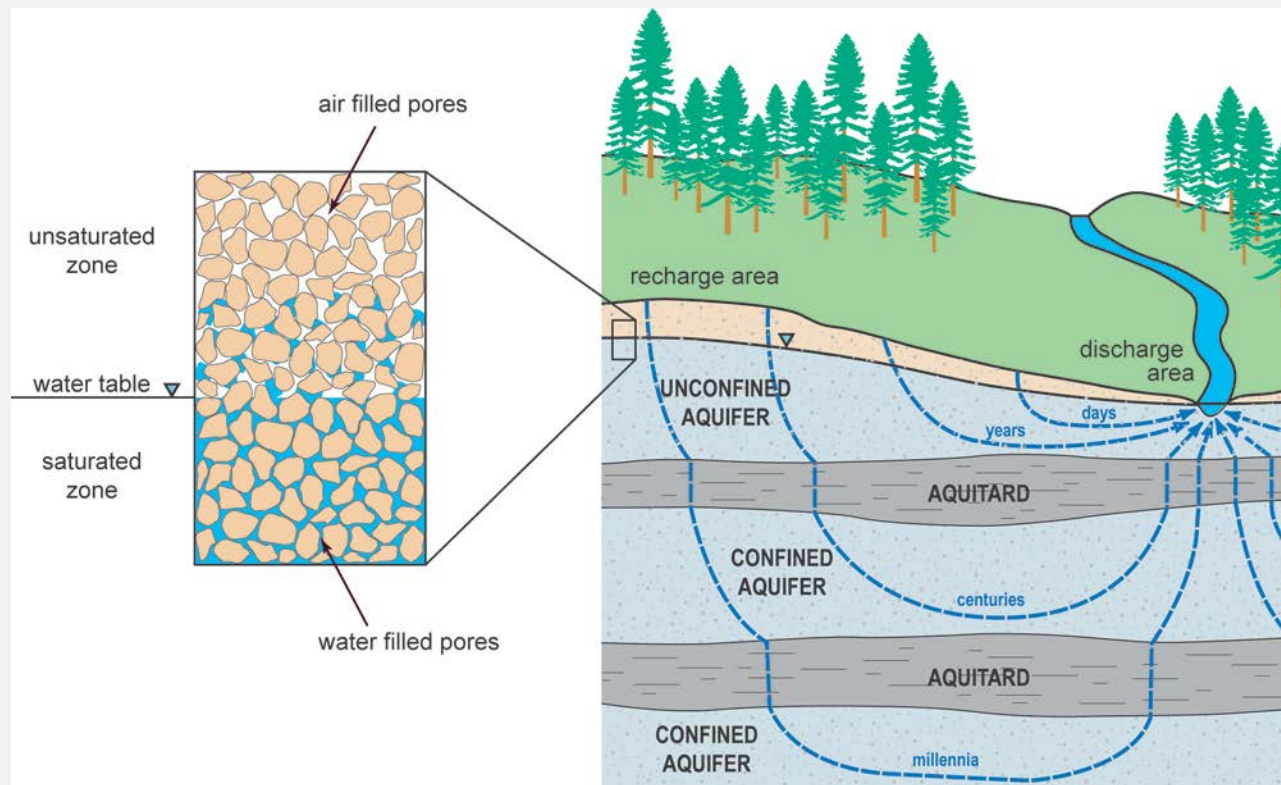
**AGS**

- » Science → Concepts and processes
- » Management → Policies and regulations

# Groundwater:

## More than *‘water below the ground’*

- » Water within the zone of saturation beneath the Earth's surface
- Liquid that completely fills pore spaces
  - Water table is the uppermost surface

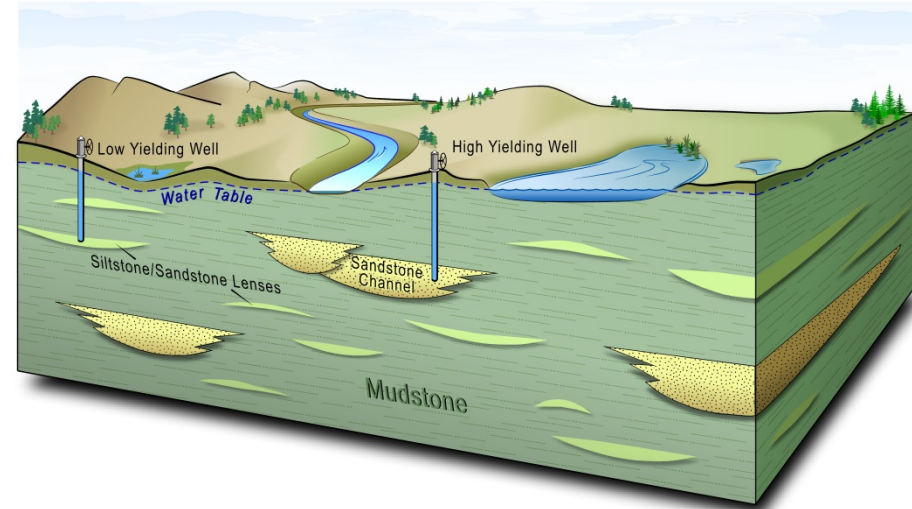




# Geological Framework

## Aquifers

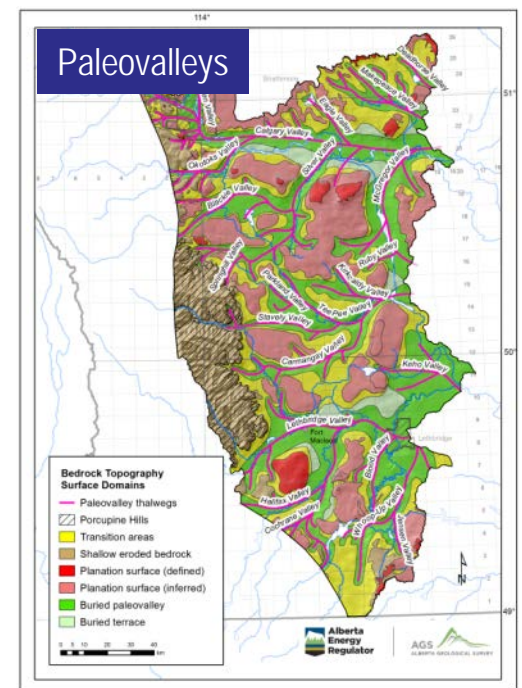
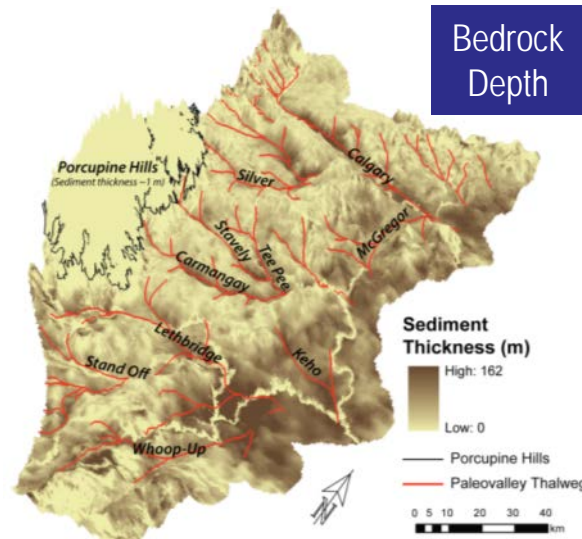
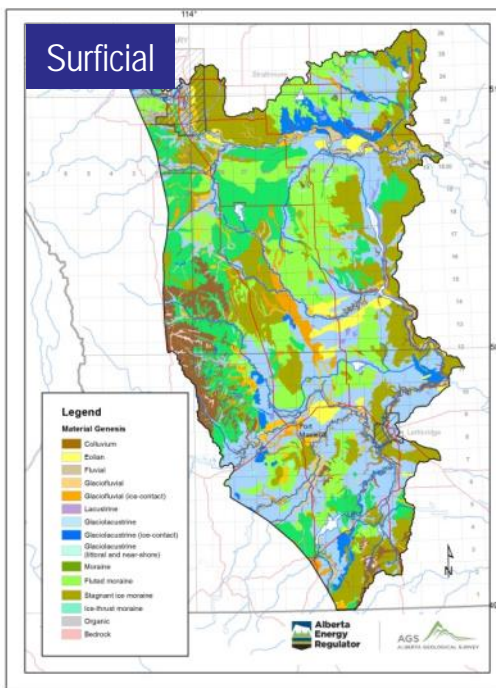
- » Permeable geological unit that transmits appreciable quantities of water
- » Sand, gravel, sandstone bedrock



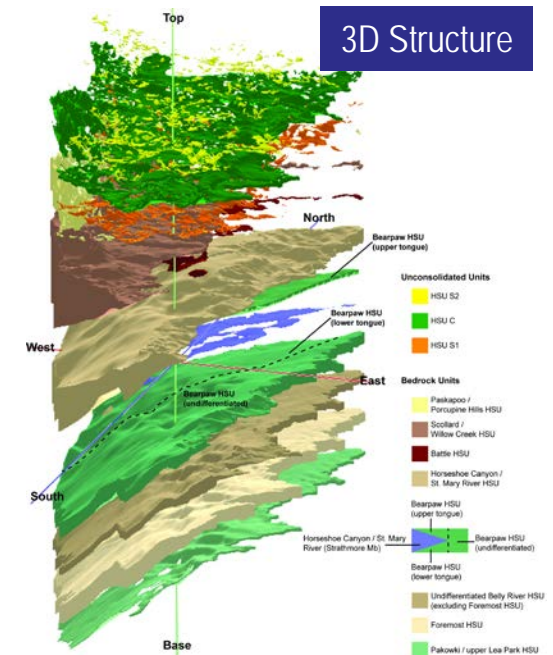
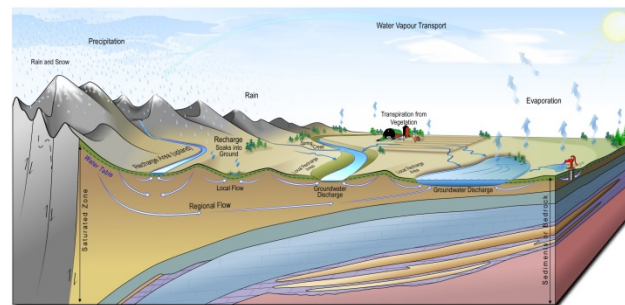
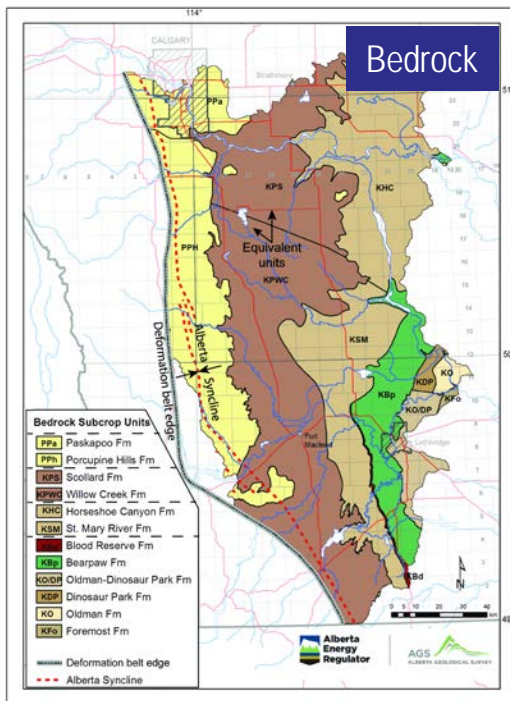
## Aquitards

- » A less permeable unit that is incapable of transmitting useful quantities of water
- » Silt, clay, shale/mudstone bedrock





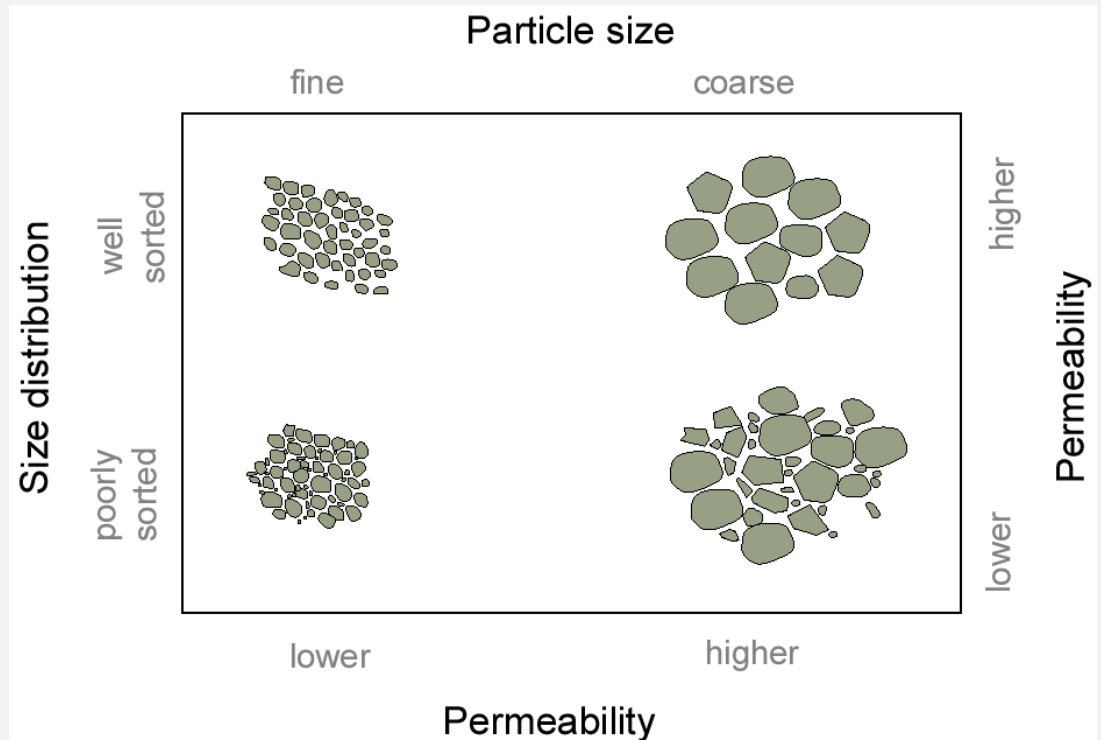
## Geological Framework



# Hydraulic Properties

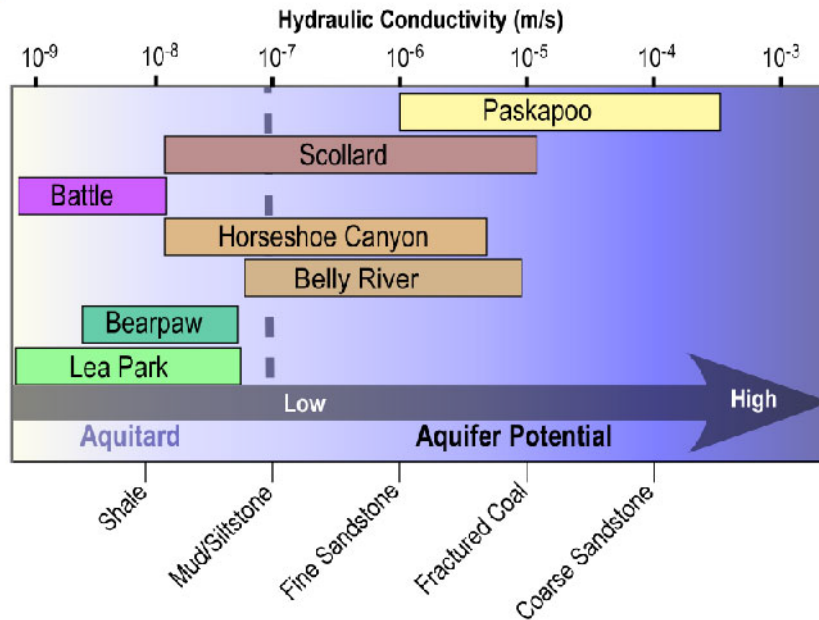
## Groundwater movement depends on:

- 》 Amount of available pore space (porosity, storage)
- 》 Size and connectivity of pores (permeability, transmission)
- 》 Material Properties
  - Grain size and shape
  - Sorting and consolidation

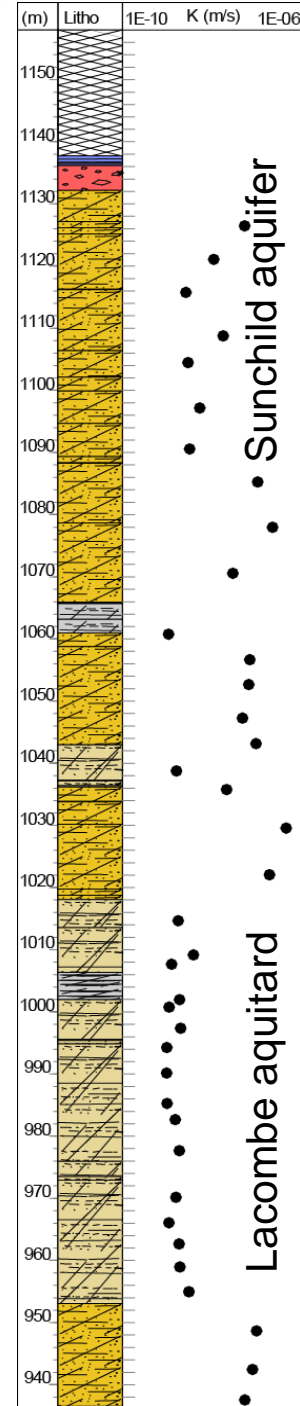




# Hydraulic Properties



- › Lab testing on rock cores
- › Field testing with wells

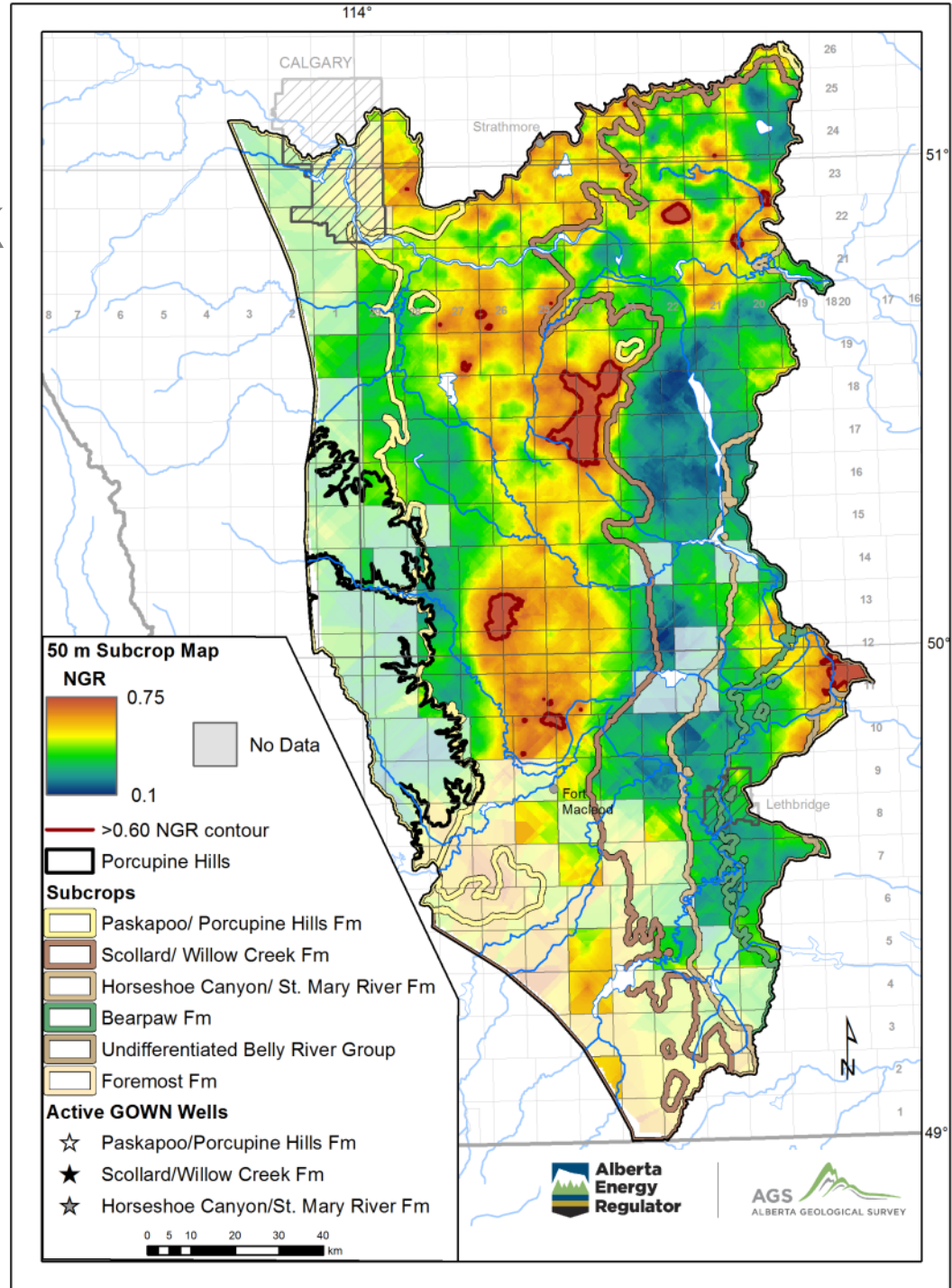


# Distribution of Permeable Bedrock

➤ Identify major sandstone trends → *aquifer potential*

AGS

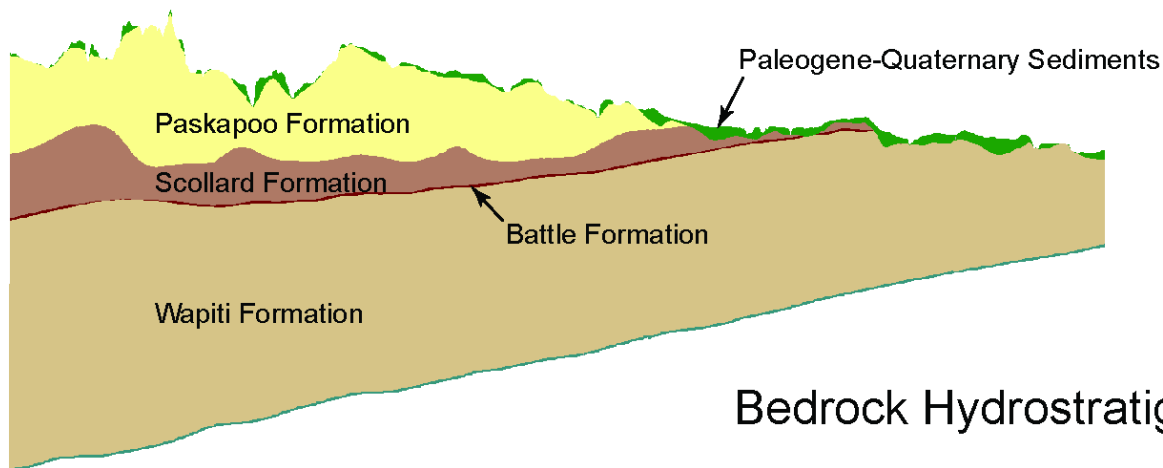
Atkinson et al., 2017



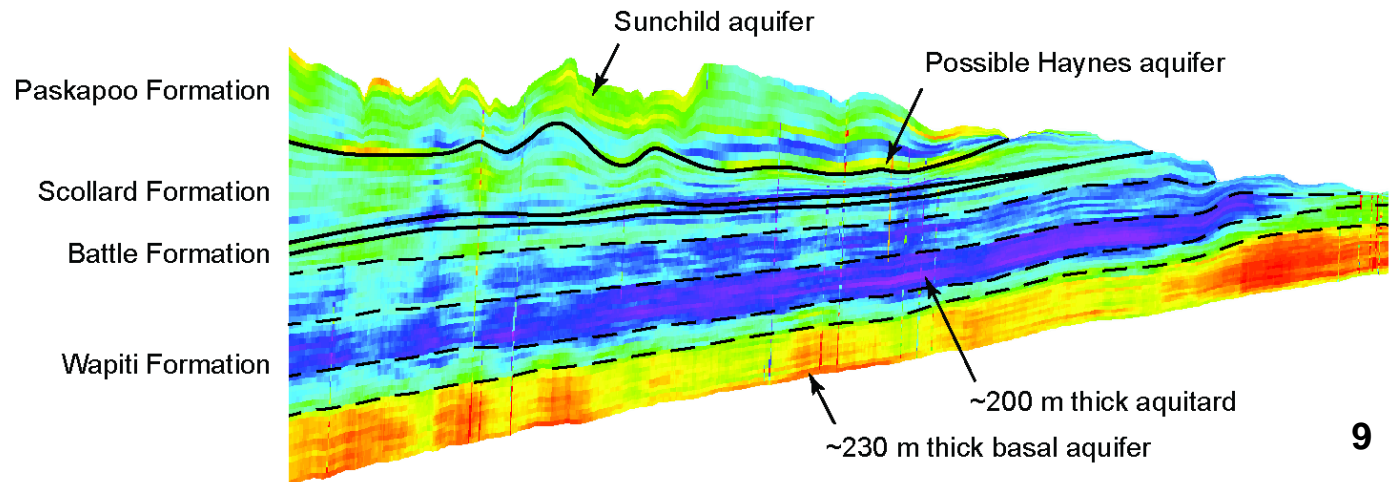


# Distribution of Permeable Bedrock

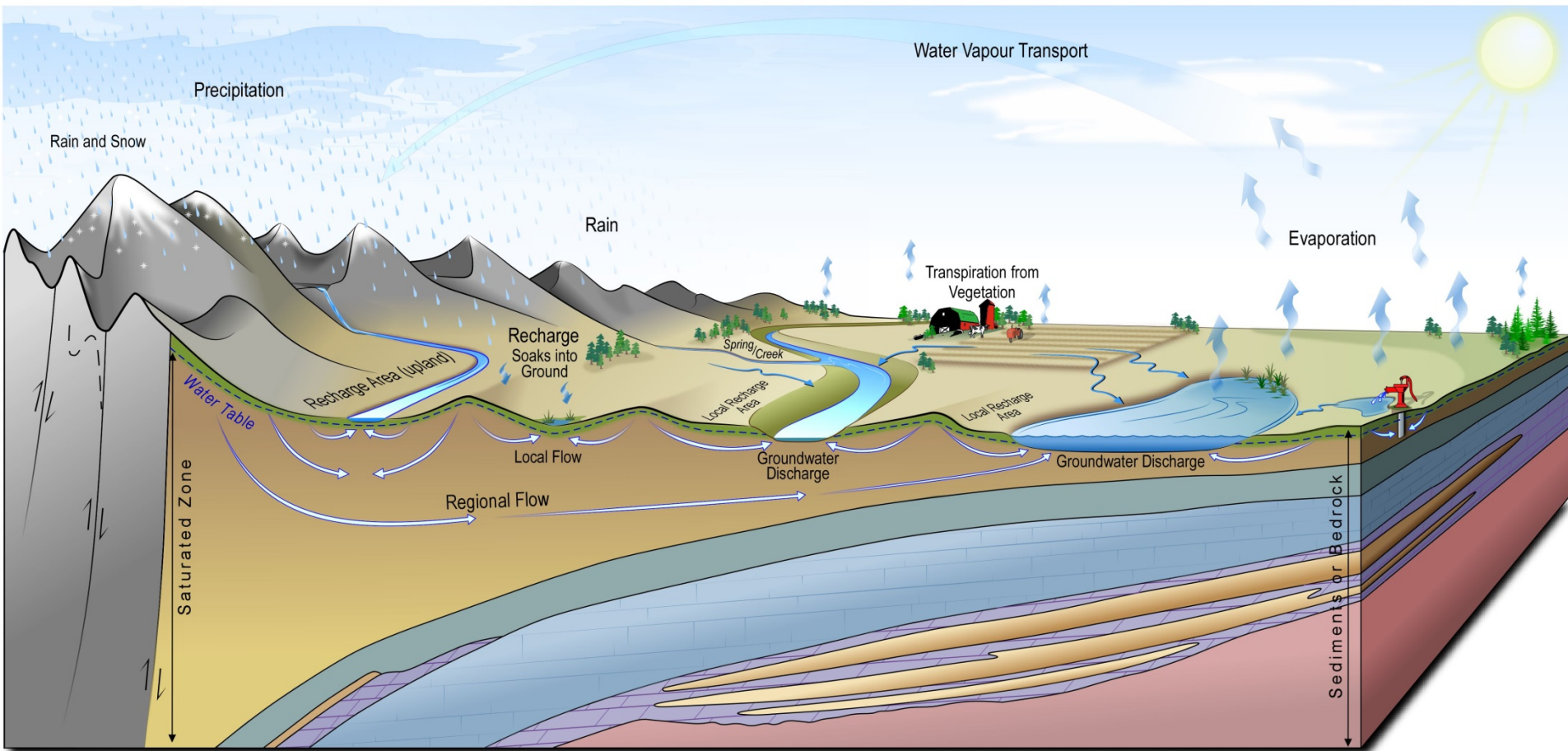
## Bedrock Geology



## Bedrock Hydrostratigraphy



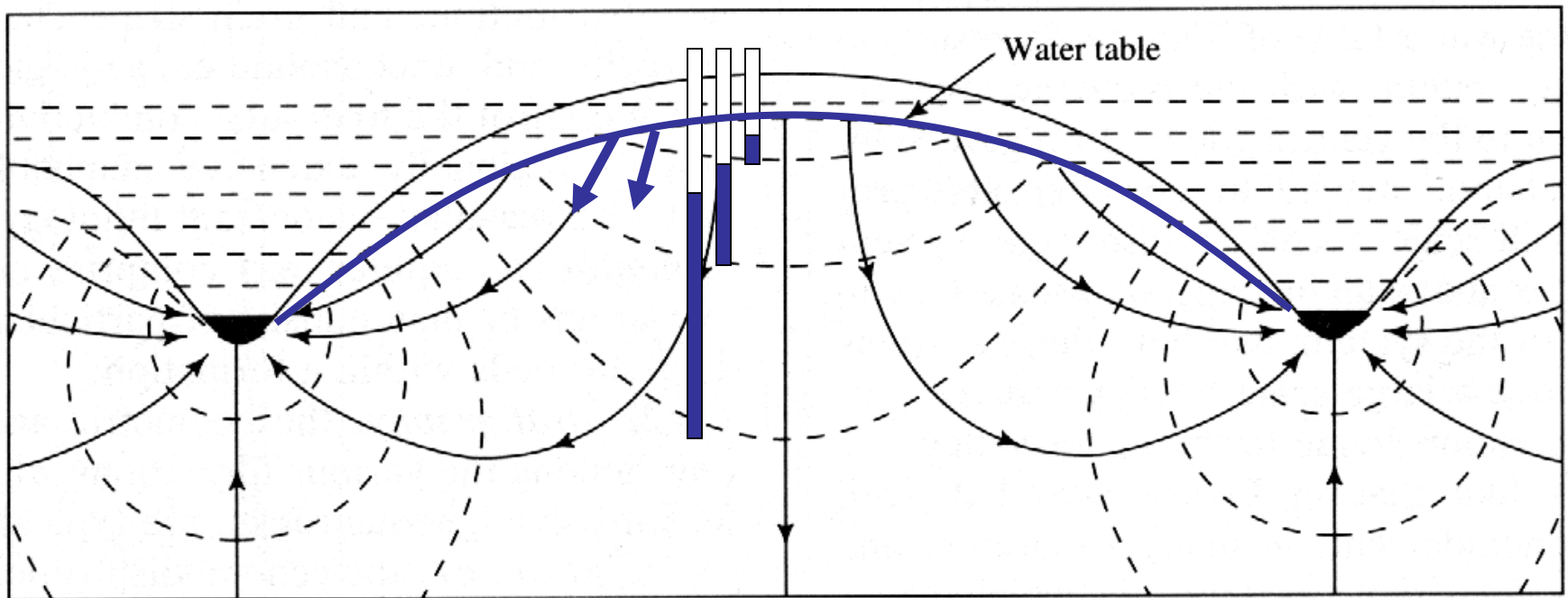
# How does groundwater move?



Barker et al., 2011

# Recharge Areas

- › Water table is below the ground surface
- › Groundwater flow is downward

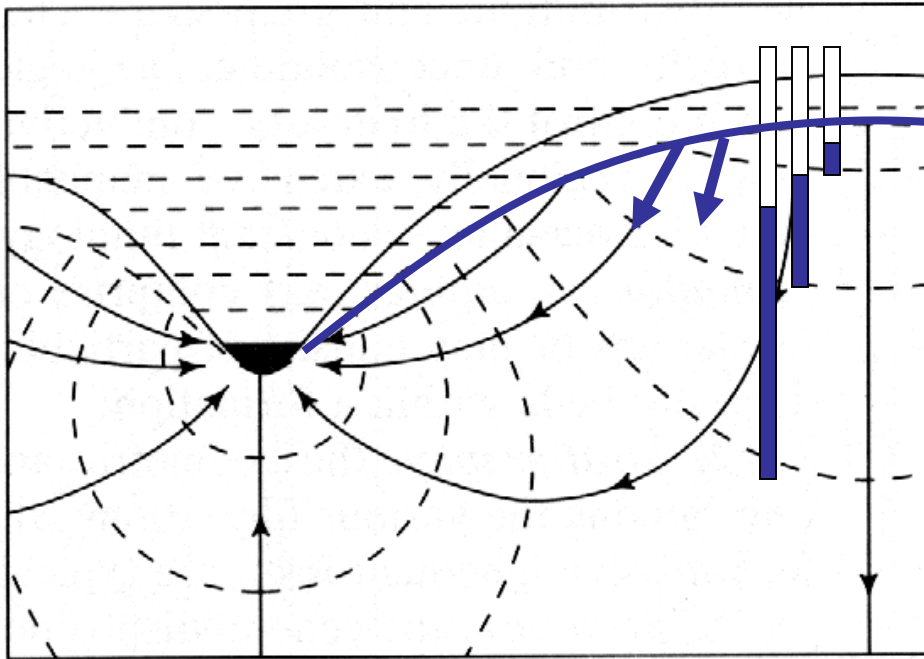


Hubbert, 1940



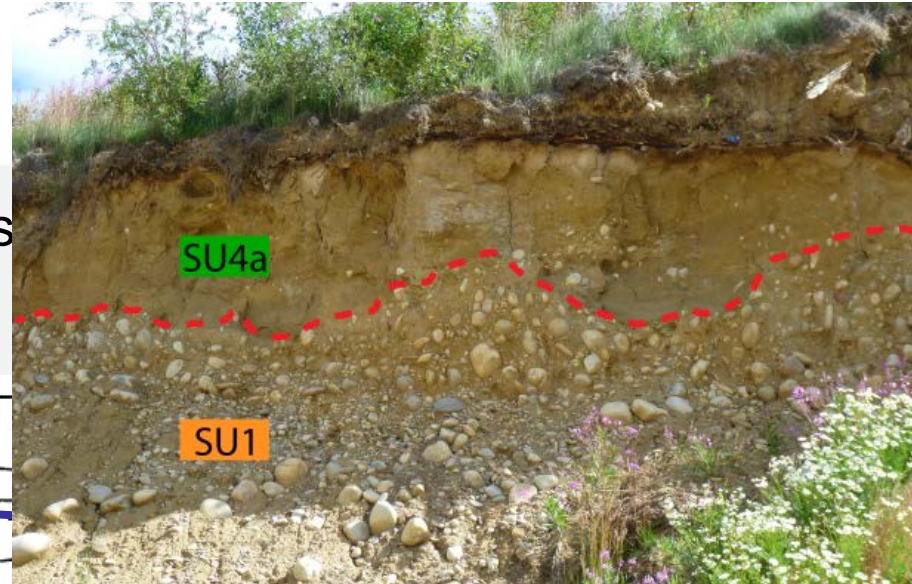
# Recharge Areas

- › Water table is below the ground surface
- › Groundwater flow is downward



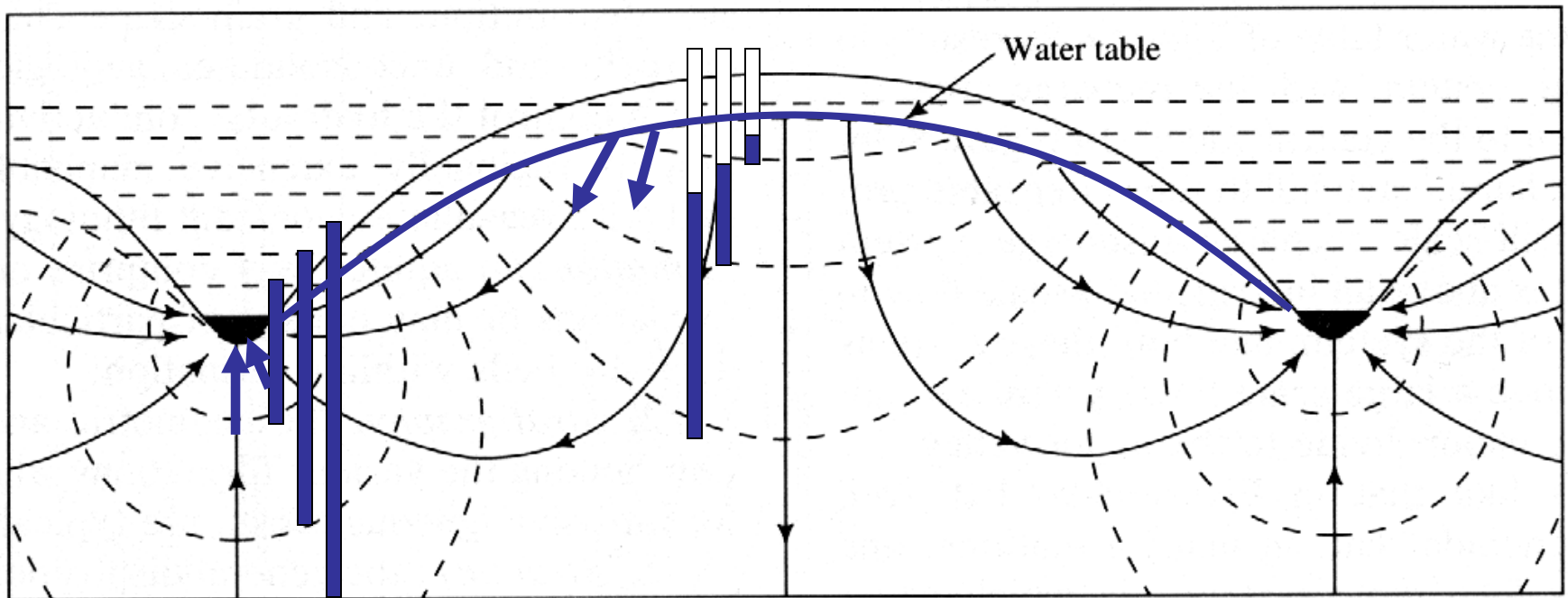
Hubbert, 1940

AGS



# Discharge Areas

- › Water table can be above the ground surface
- › Groundwater flow is upward

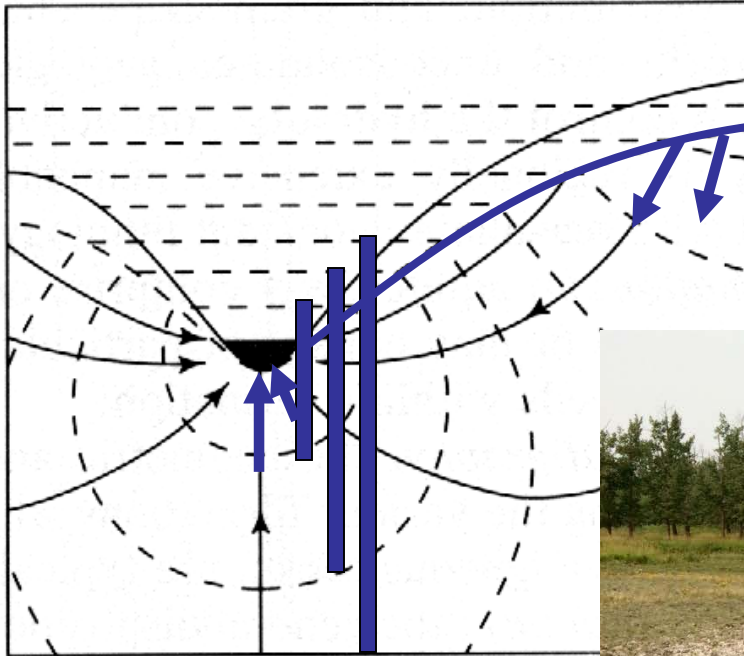


Hubbert, 1940



# Discharge Area

- › Water table can be above
- › Groundwater flow is upwa



Hubbert, 1940

**AGS**

Big Hill Springs Provincial Park

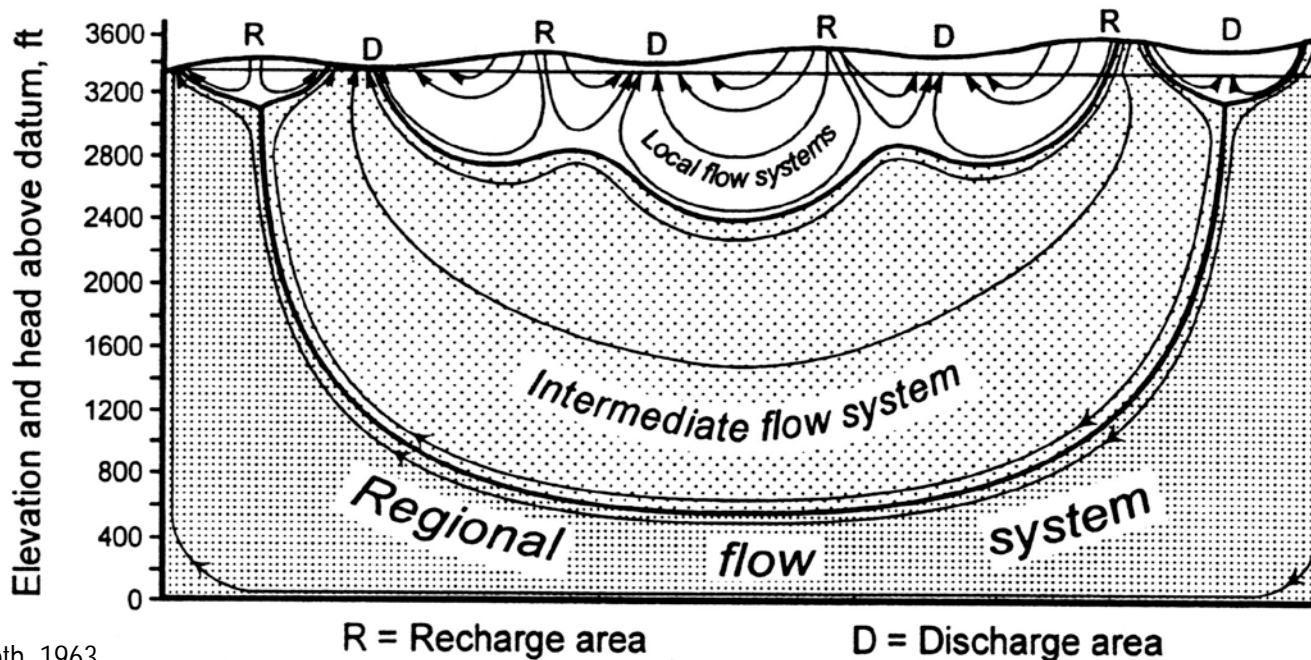


Elk Island Soap Holes



# Groundwater Flow System

- › Recharge + Discharge = Groundwater Flow System
- › Variation in ground topography creates nested flow systems
- › Concept helps understand water resource potential



Tóth, 1963

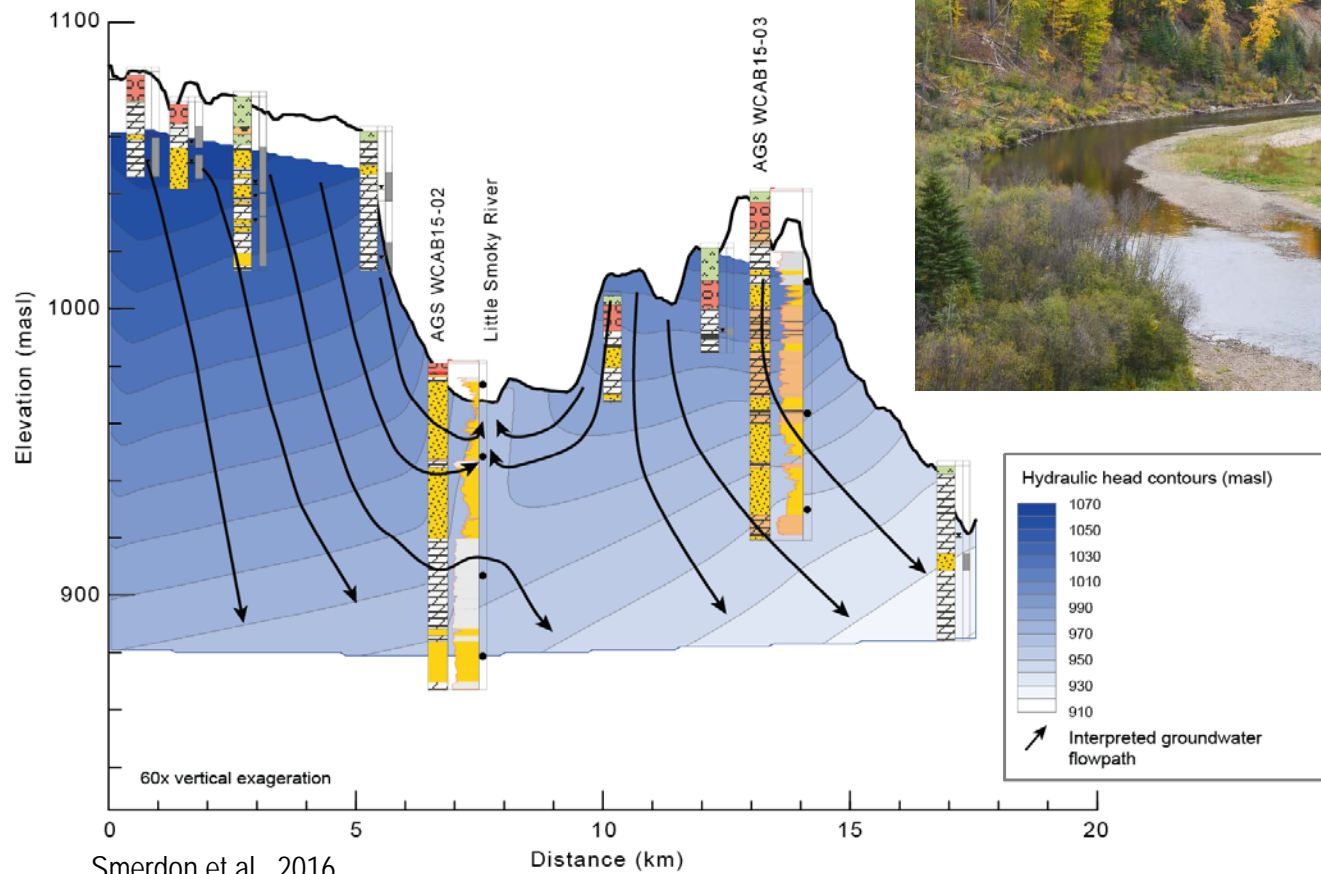
## Local

Seasonal or annual variation & faster turnover time

## Regional

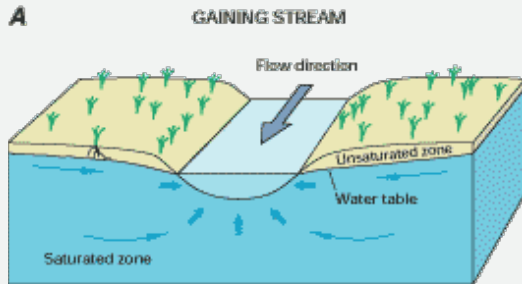
Limited temporal variation & very slow turnover time

# Interaction with Surface Water



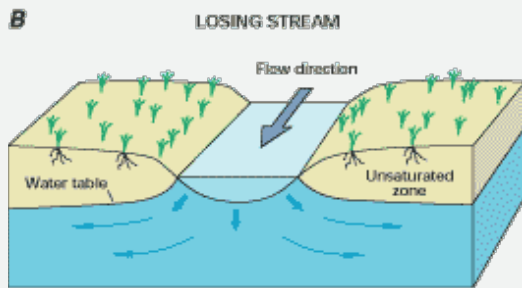
Groundwater maintains many of Alberta's rivers and lakes

# Interaction with Surface Water



## › Gaining streams

- › Groundwater discharge
- › Baseflow
- › Critical for ecosystem function

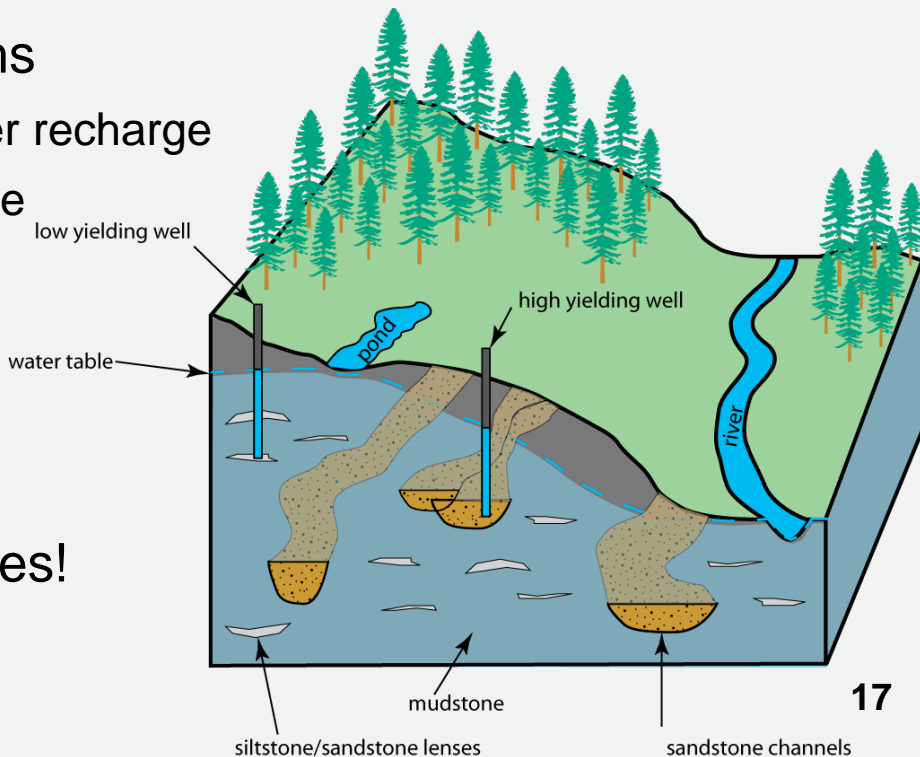


## › Losing streams

- › Groundwater recharge
- › Bank storage

Winter et al., 1998

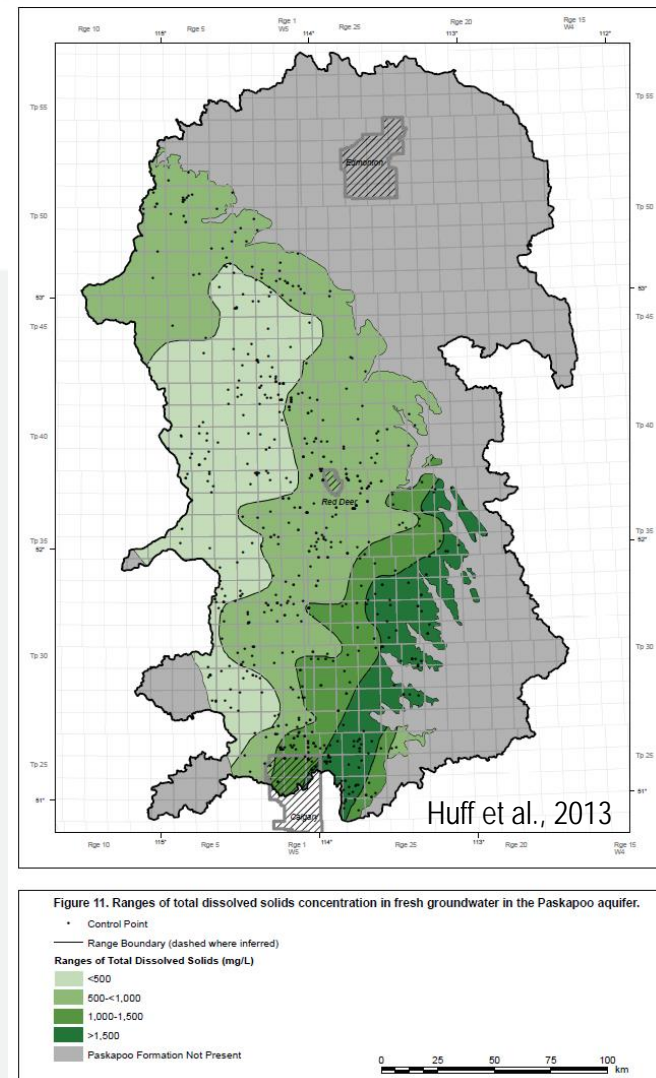
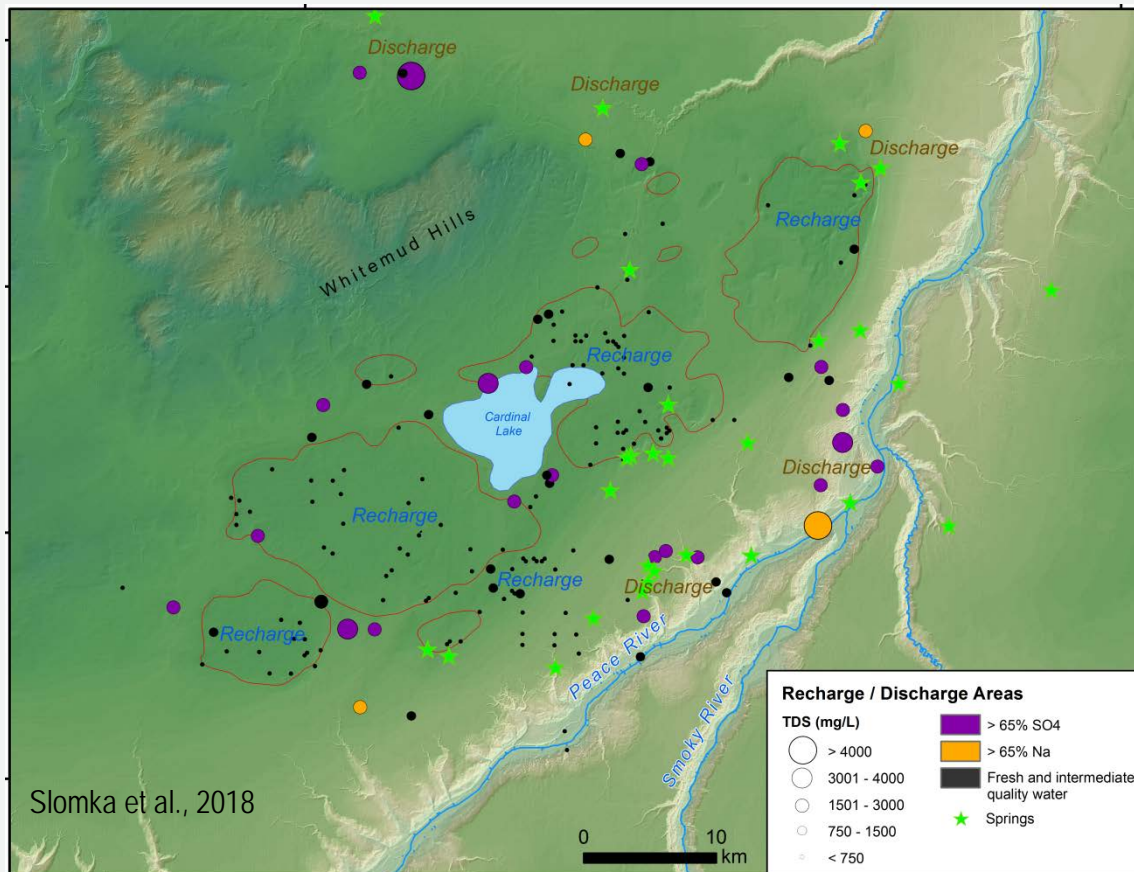
› Connected water resources!





# Groundwater Quality

- » Groundwater chemistry depends on:
- Geological materials it passes through
  - Length and time of travel



- » Interaction with geological materials adds dissolved solids (salts, metals)

# AEPHIN

## Water Quality

[Home](#) [About](#) [Contact](#)
[Suitability for Drinking](#) [Household Use](#) [Human Activity & Health](#) [Trace Elements](#)

### Suitability for Drinking

#### Total Dissolved Solids

#### Conductivity

#### Sodium

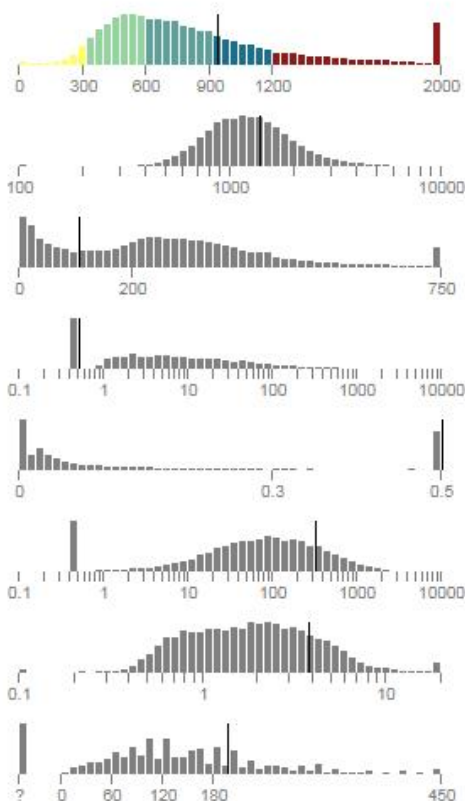
#### Chloride

#### Iron

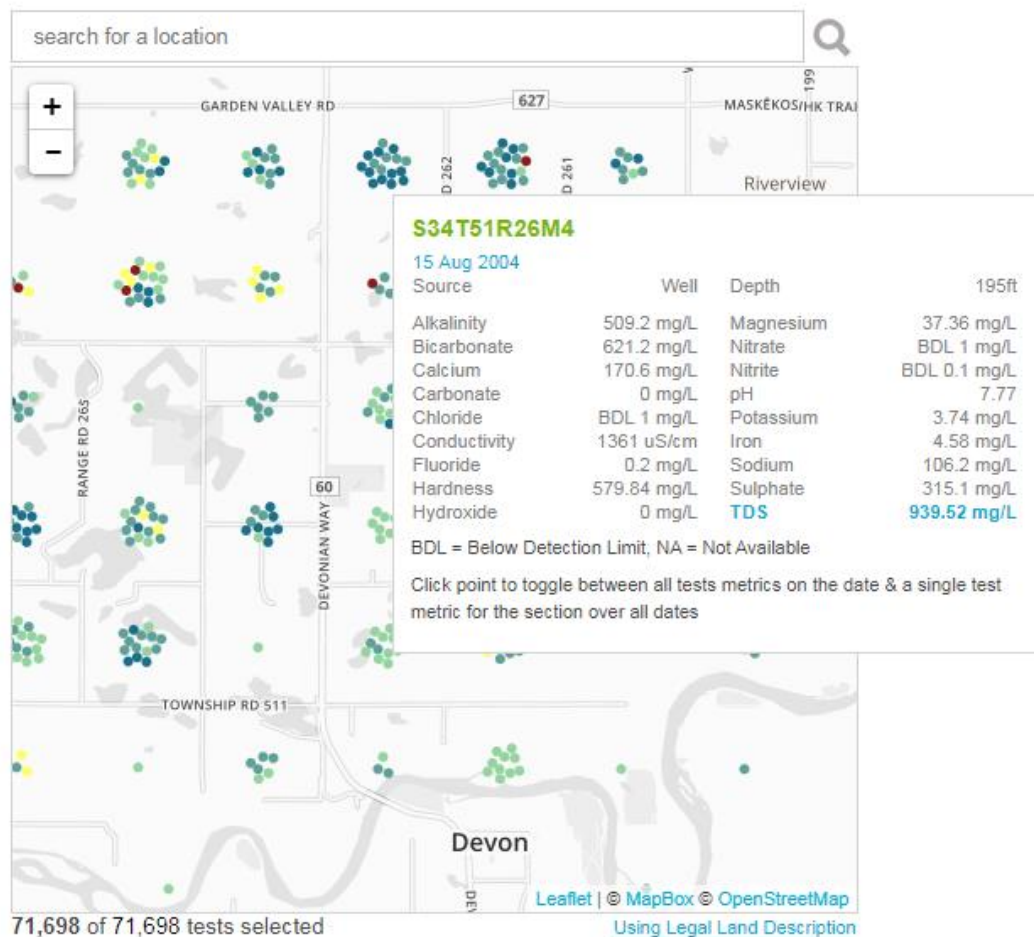
#### Sulphate

#### Potassium

#### Well Depth

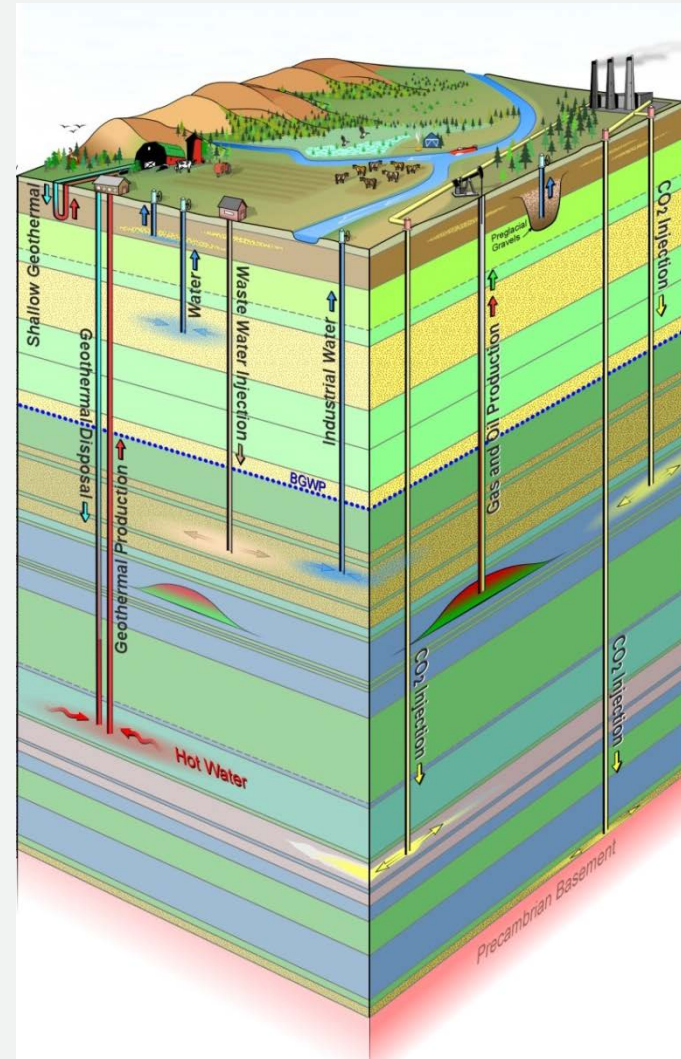
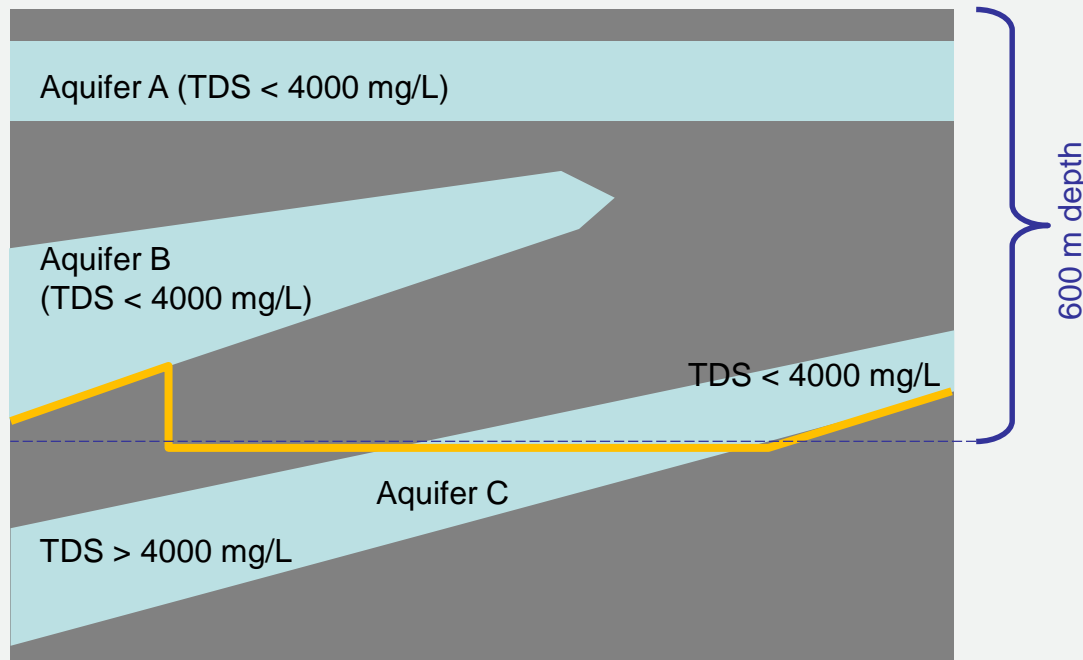


### Total Dissolved Solids Map



# Base of Groundwater Protection

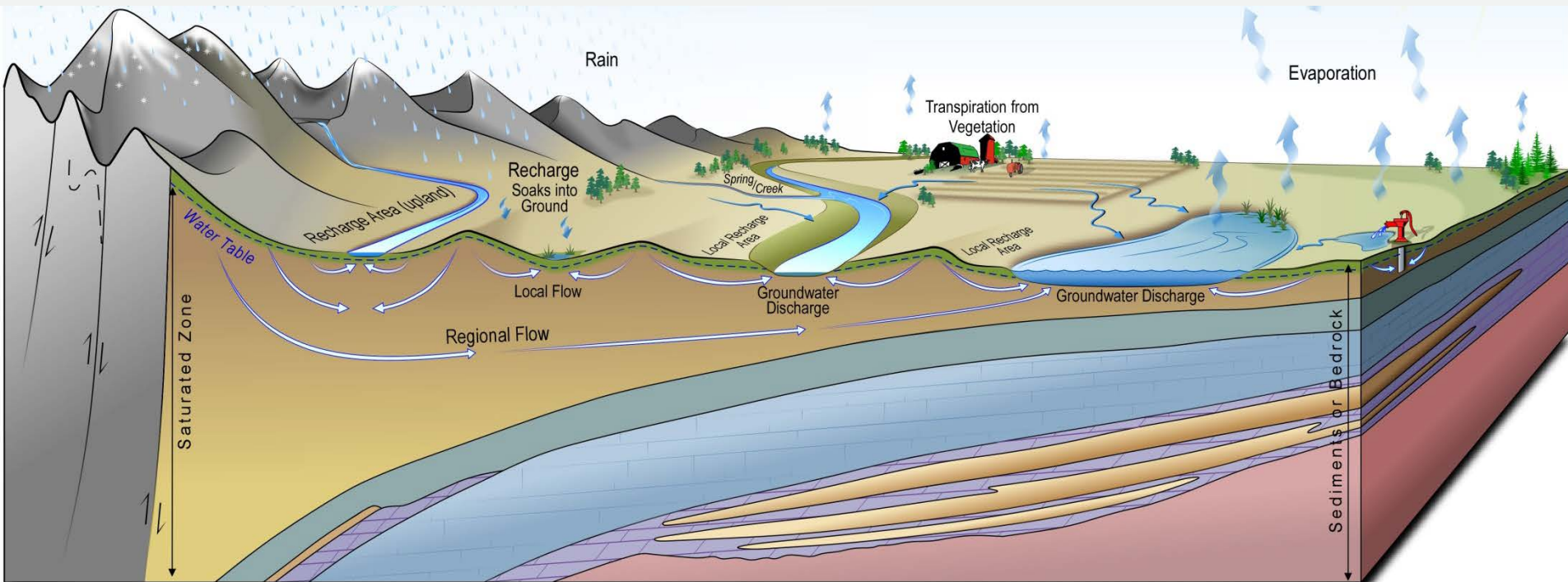
- › Best estimate of the maximum depth at which groundwater transitions from nonsaline to saline (TDS > 4000 mg/L)
- › Maximum depth of 600 m
- › AER hosts online BGWP tool (township based results)





# Groundwater in Watersheds

- » Movement and quality depend on geological properties
- » Organized into systems of recharge and discharge areas
- » Interacts dynamically with surface water
- » Has a different boundary than topographic catchment





**Thank you**