Introduction to Groundwater Resources

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Maine Geological Survey

Commission To Study the Role of Water, Sept. 12, 2022

Main Topics

1. The water cycle in Maine
2. Human groundwater use
3. Distribution of water resources
4. Effects of human activities
5. Future challenges

Outline of Main Points

1. Groundwater in Maine is an abundant, renewable resource.
2. Human groundwater use is a very small component of the overall water budget.
3. Usable water is not evenly distributed across the landscape.
4. The effects of pumping wells are localized.
5. Groundwater levels in Maine are stable through time.

The Hydrologic Cycle

...begins with precipitation.

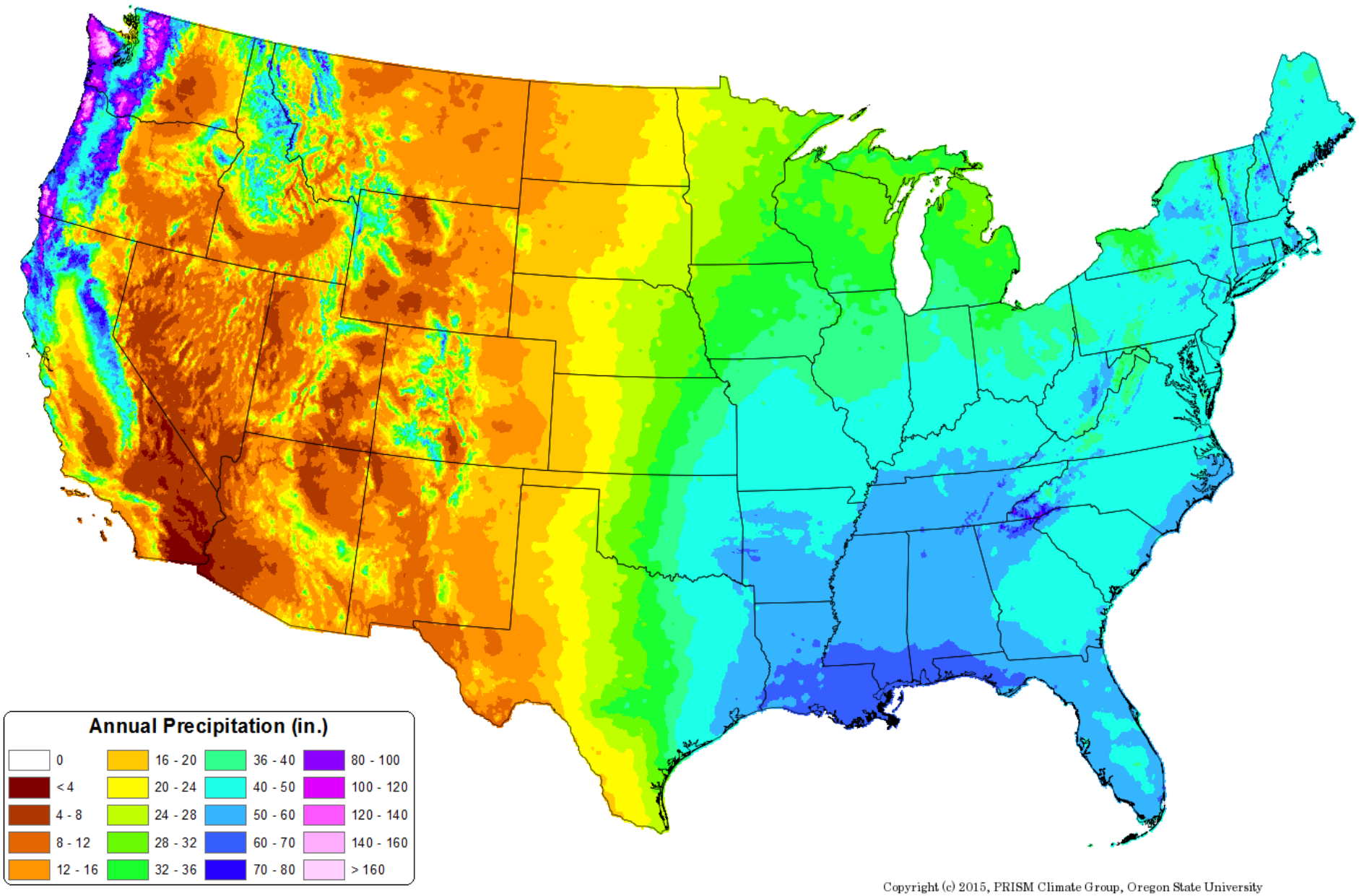
The source of all water in Maine

Rain

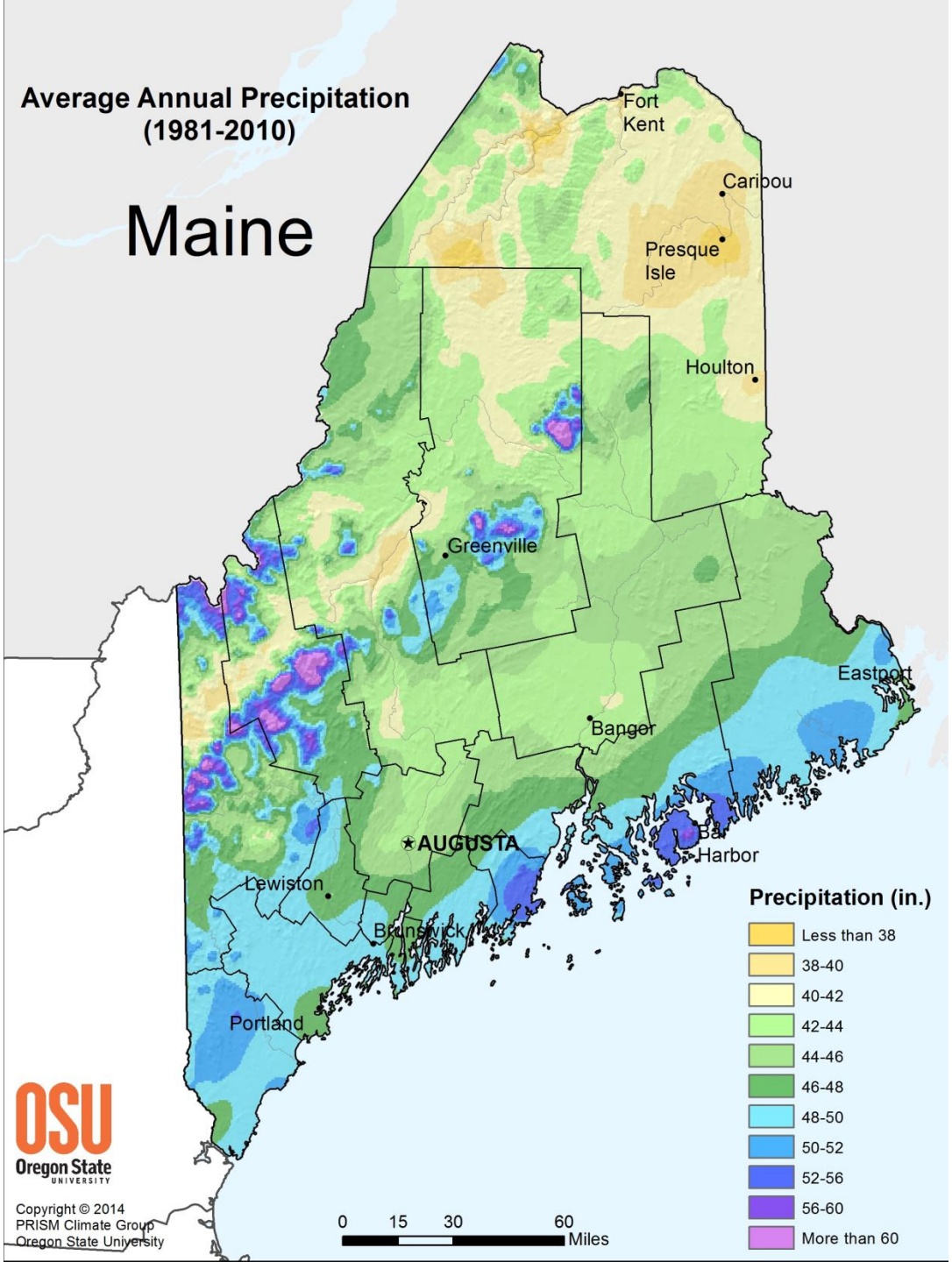
Snow

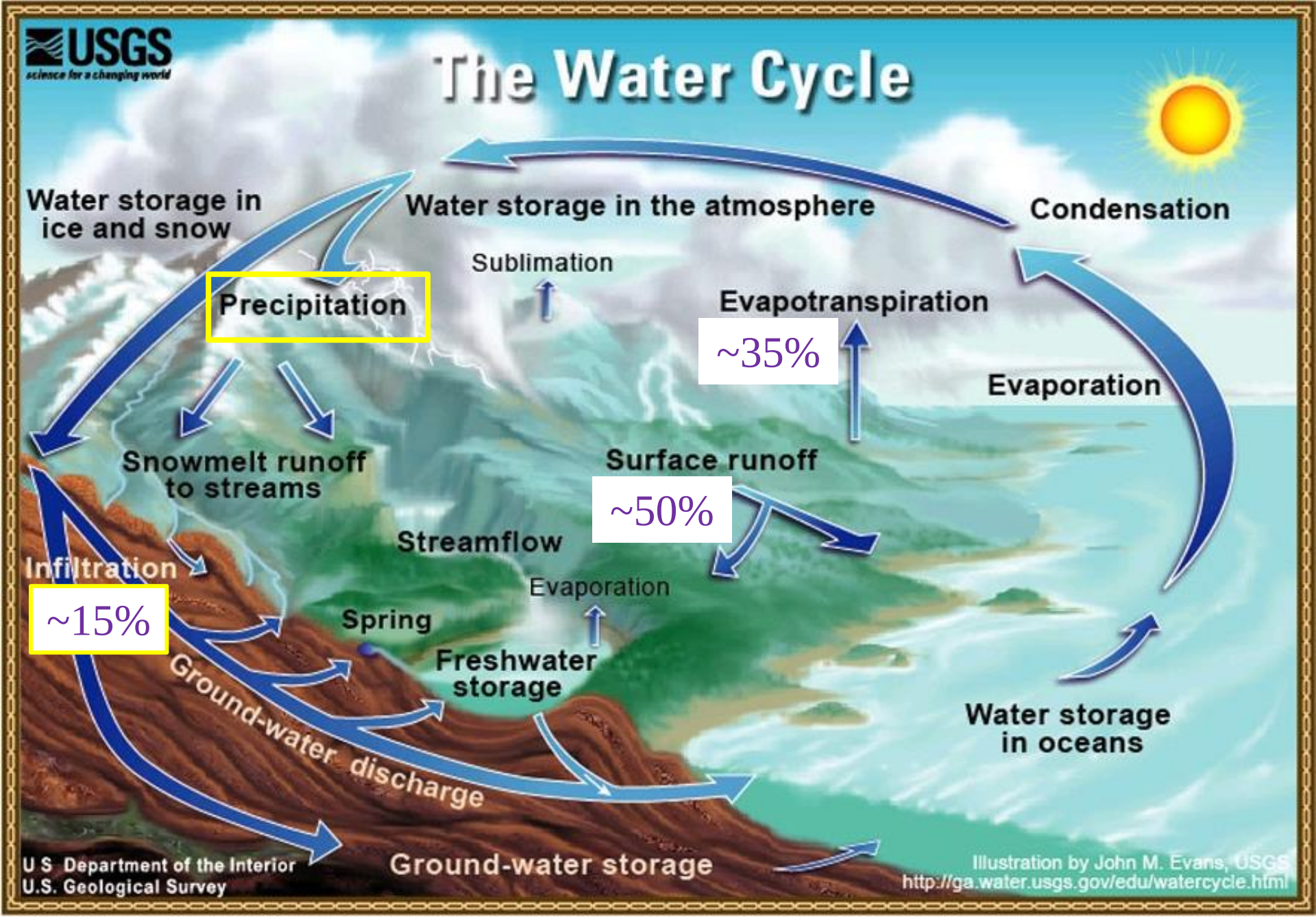
30-yr Normal Precipitation: Annual

Period: 1981-2010

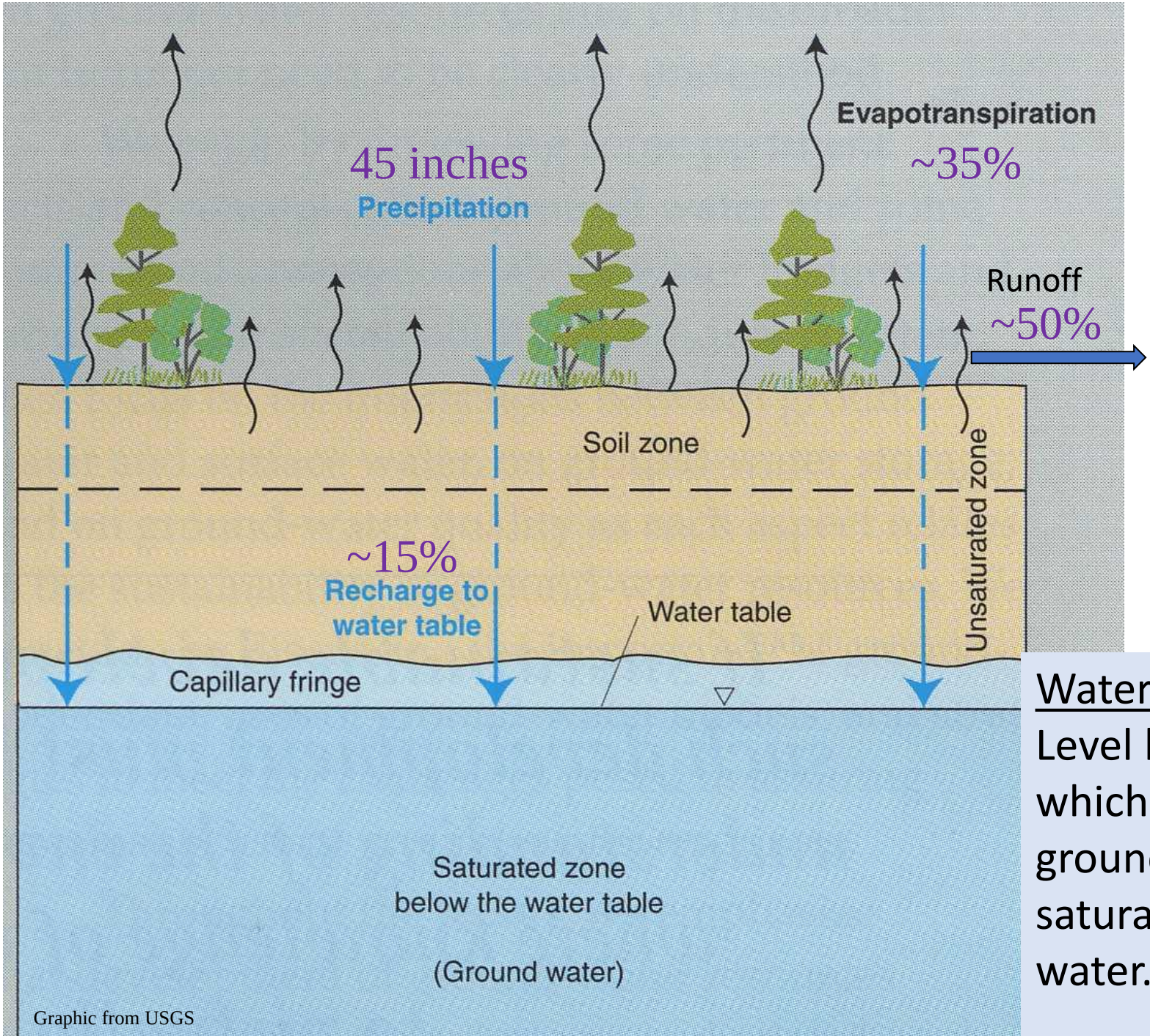


Maine Average:
45 inches/year





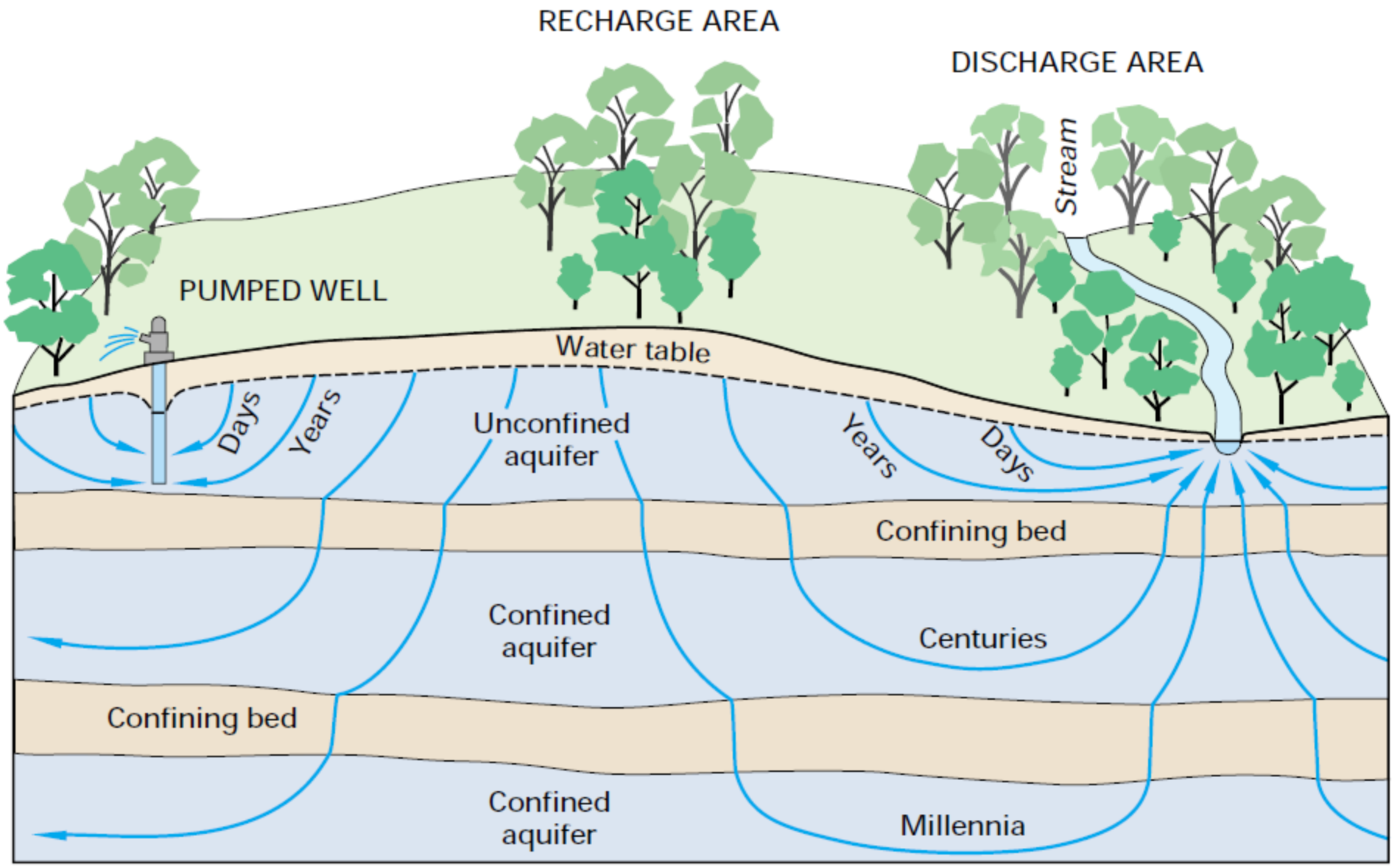
For areas of fractured rock with little cover, infiltration ~2-5%



Graphic from USGS

Water table: Level below which the ground is fully saturated with water.

Groundwater flow



USGS Circular 1139

Groundwater is:

- Water that fell as precipitation,
  that is being stored in the earth for some time,
  and is on its way to somewhere else.
- A renewable resource.

Groundwater in Maine is not:

- From faraway places
- An underground river or lake
- A “fossil” resource

Maine Water Facts

- How much water are we talking about?
- How much do humans use?

Let's talk about volume.

How Much Water?

Moosehead is Maine's largest lake

(118 square miles)

How many gallons are in the top inch of this lake?

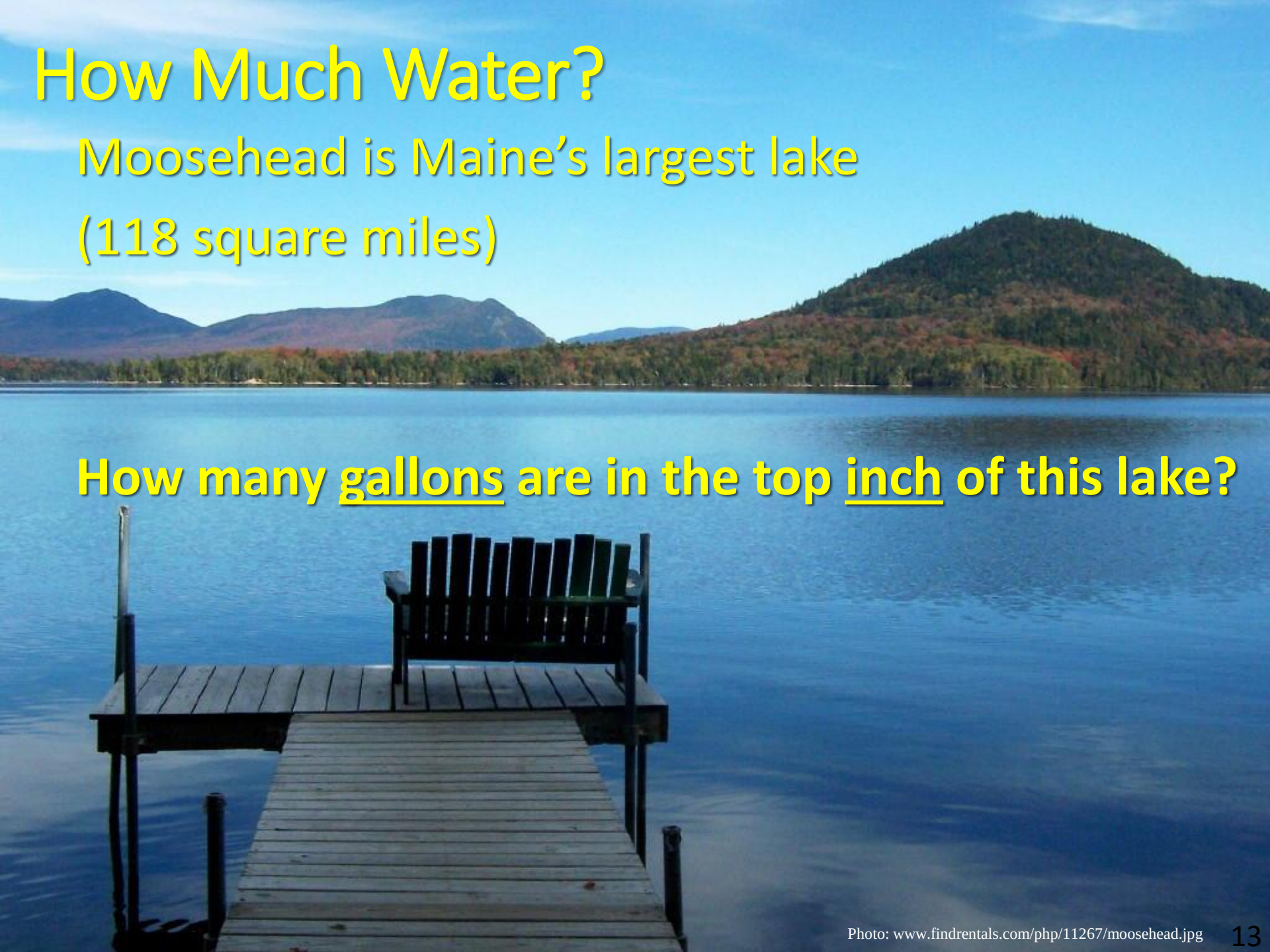


Photo: www.findrentals.com/php/11267/moosehead.jpg

Maine Water Facts

- Average annual rainfall: 45 inches per year
  = 26 trillion gallons
- Run-off: (50% of precipitation)
  = 13 trillion gallons
- Evaporation/transpiration: (35%)
  = 9 trillion gallons
- Infiltration to groundwater (“recharge”): (15%)
  = 4 trillion gallons

Humans in the Water Cycle

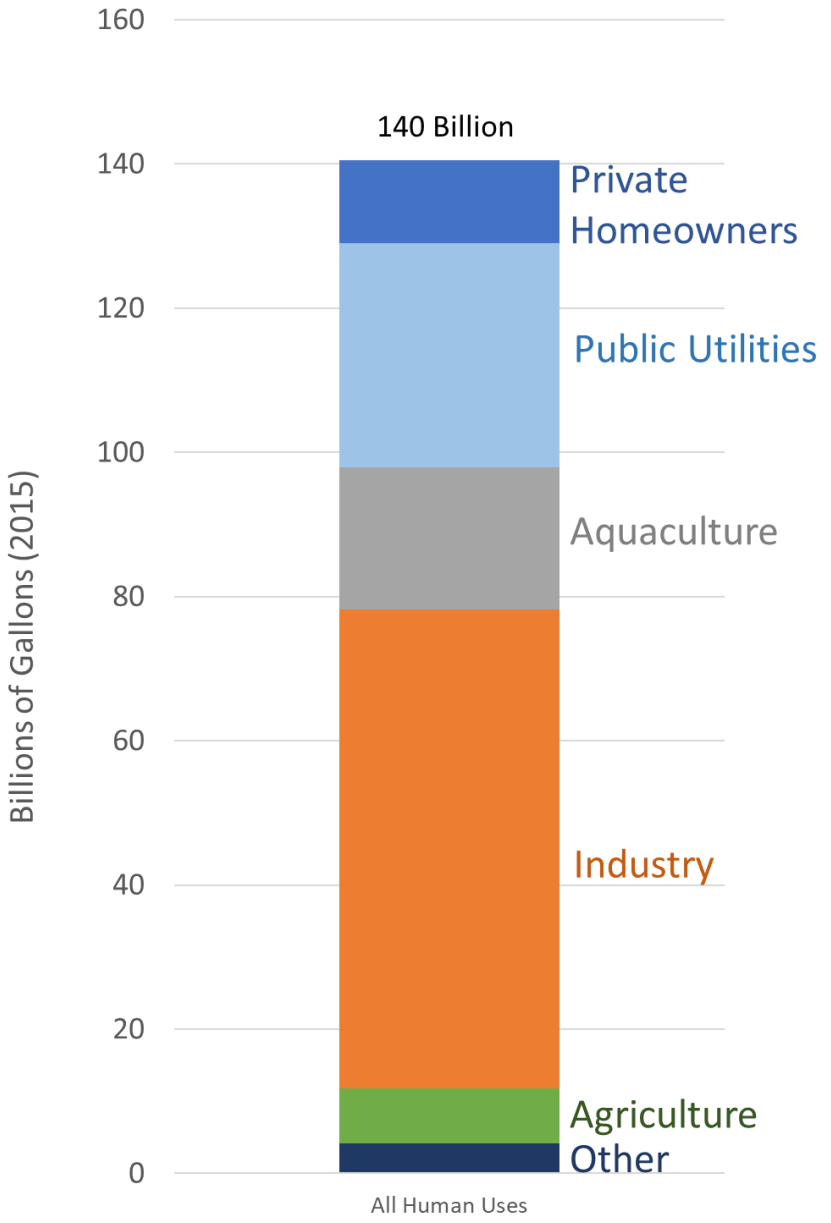
Out of Maine's 26 trillion gallons of annual precipitation, total human use is 141 billion gallons (0.6%).

Out of Maine's 4 trillion gallons of groundwater recharge, human use is 32 billion gallons (<1%)

Maine's Annual Water Use

Example uses (both GW and SW):

- Industrial - 66 billion gallons
- Domestic - 24 billion gallons
- Aquaculture - 20 billion gallons
- Irrigation - 7 billion gallons
- Bottled water - 1 billion gallons



Human Groundwater Use

Human groundwater use per year:
= 32 billion gallons = <1% of total recharge

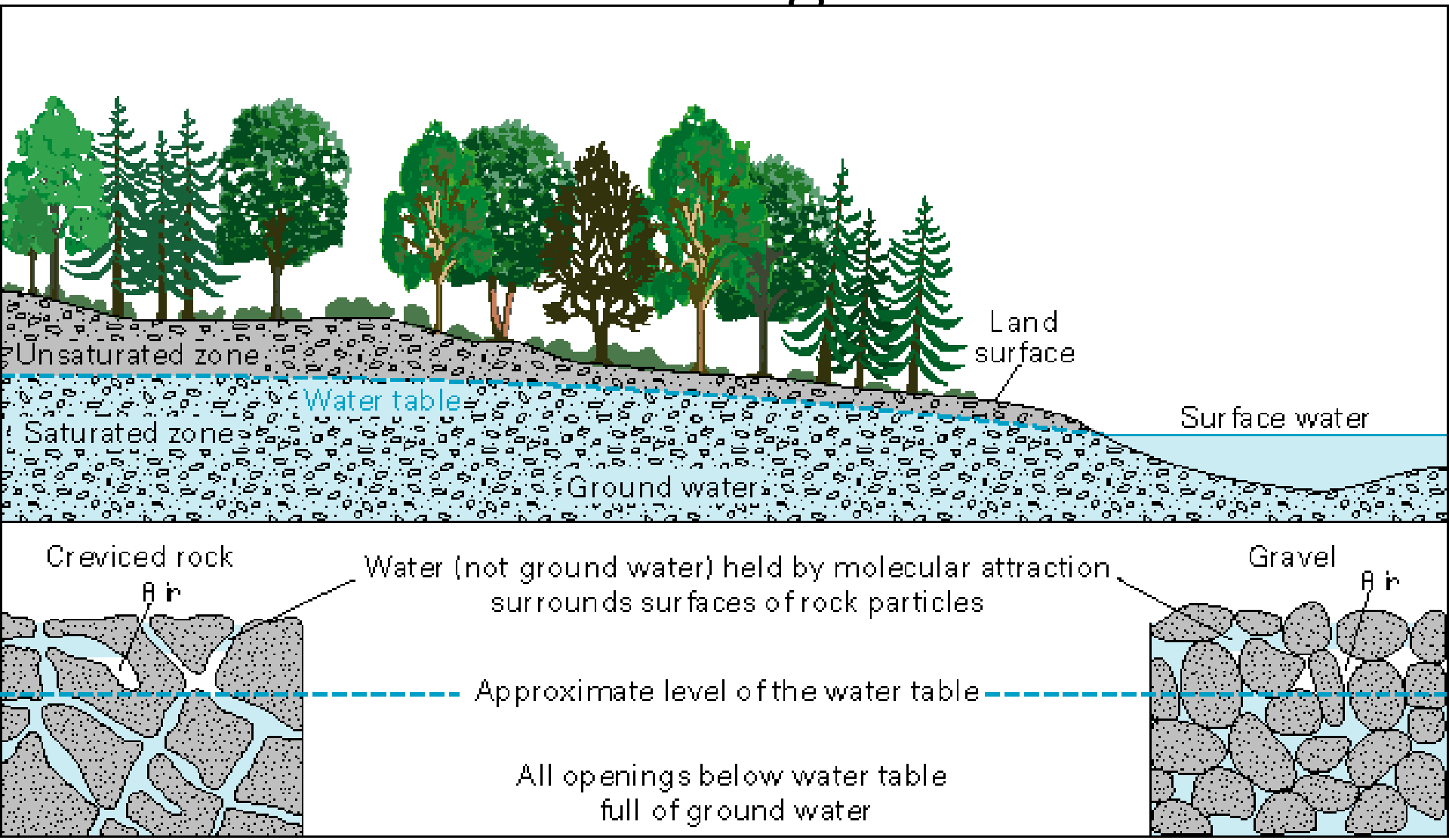
- Private domestic wells: 12 billion gallons
- Public water supplies: 10 billion gallons
- Aquaculture: 4 billion gallons
- Industrial and mining: 3 billion gallons
- Crops and livestock: 2 billion gallons
- Bottled water: 1 billion gallons (3% of human use)

2015 values, from
USGS Circular 1441

Aquifers in Maine

Groundwater storage and distribution in the State

Groundwater storage in the earth

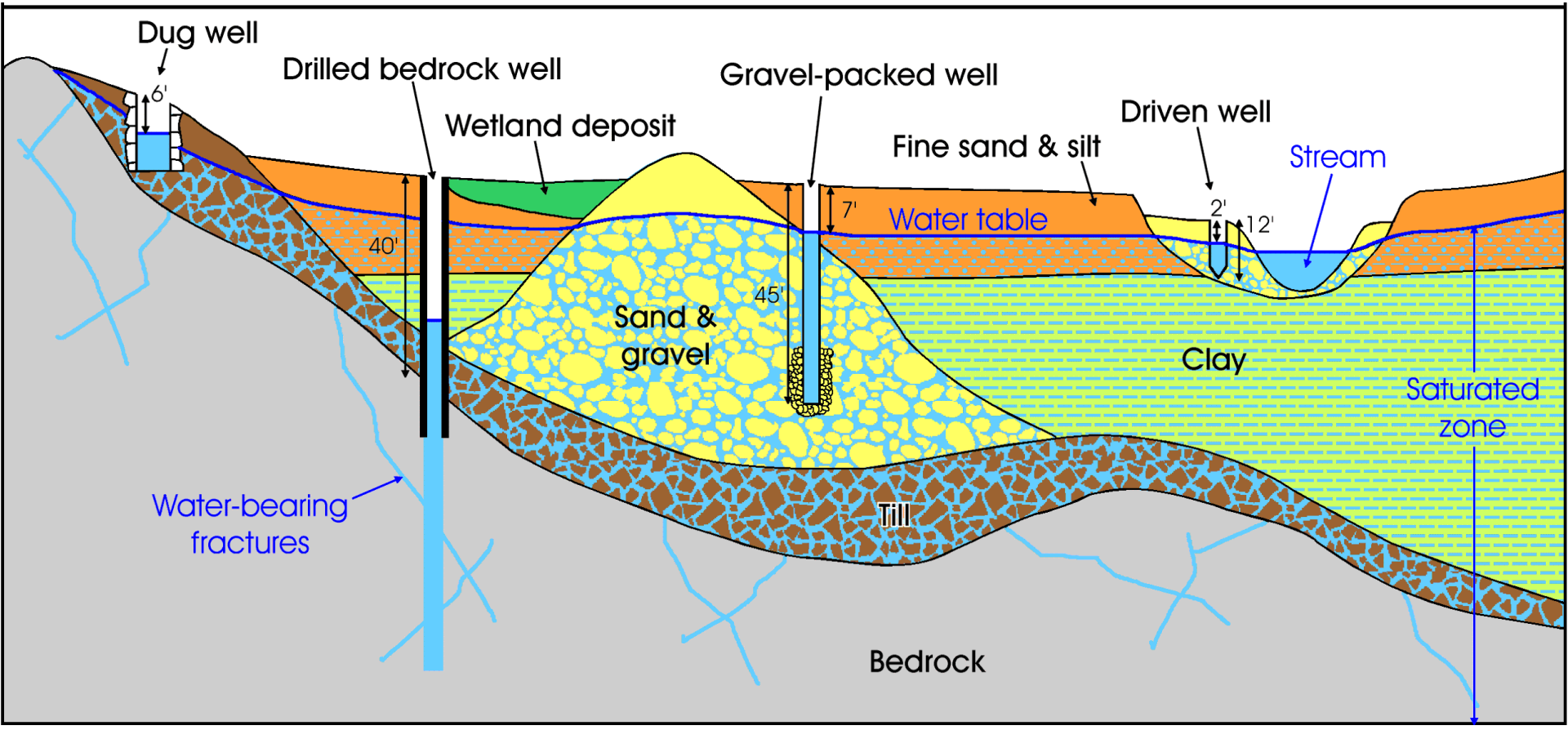


Aquifers

An aquifer is:

- A subsurface material (sediment or rock) that has enough connected pore space to transmit “useable” amounts of water to a well or spring

Aquifers in Maine



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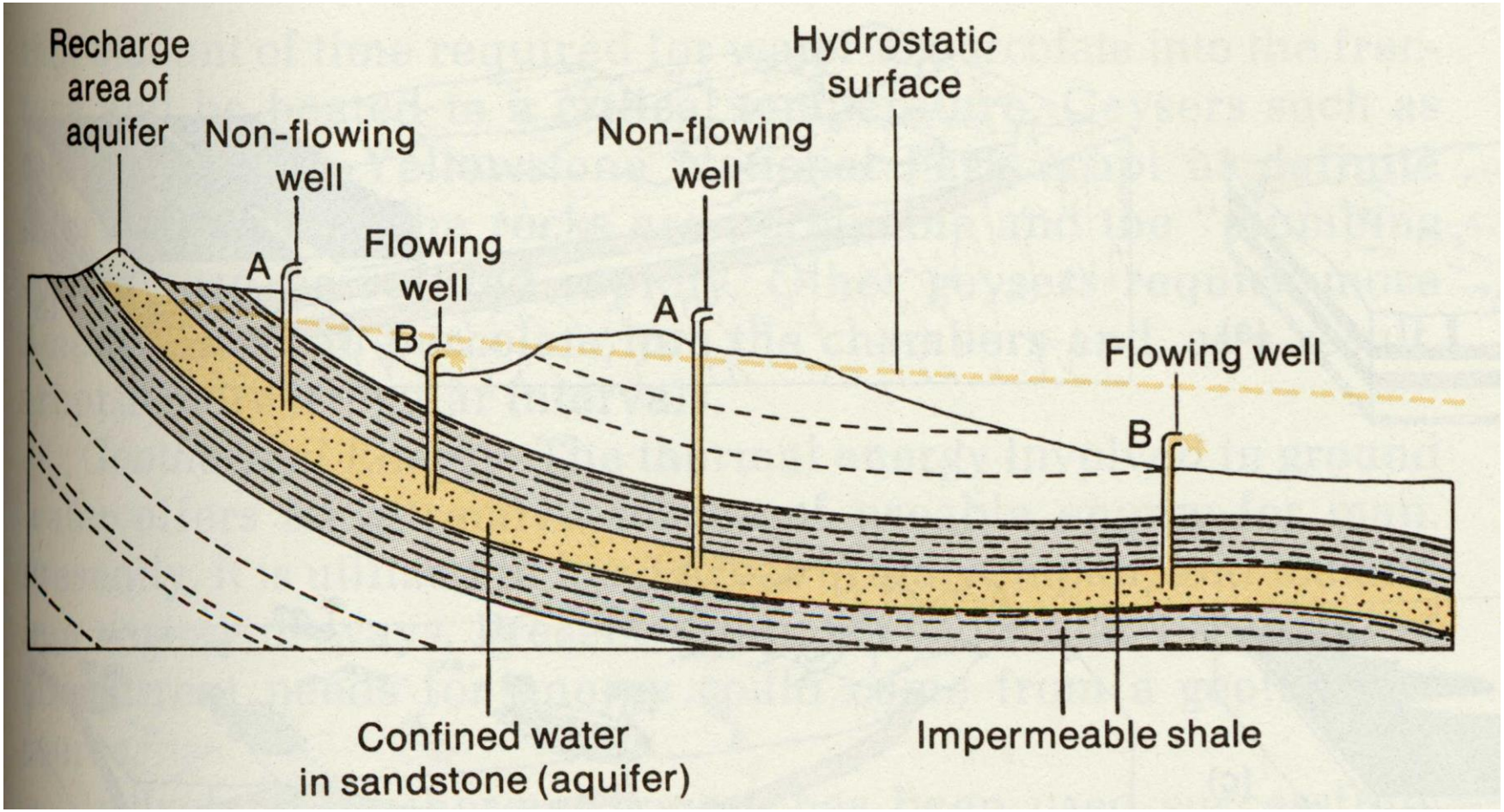
scale bar = 1-5 miles

Typical Western US aquifer



Hamblin, 1975, Burgess Press

scale bar = 500 – 1000 miles

This does not occur in Maine!!

http://itsmorefuninthephilippines.com/puerto-princesa/

Bedrock aquifers

- Metamorphic and igneous bedrock
- Underly all of New England
- Water flows through discrete, thin fractures

The frequency of fractures generally decreases with depth.

Surficial aquifers

- Sediment (sand, gravel, silt)
- Lies on top of bedrock in some locations
- Water flows in spaces between grains

Glacial outwash deposit

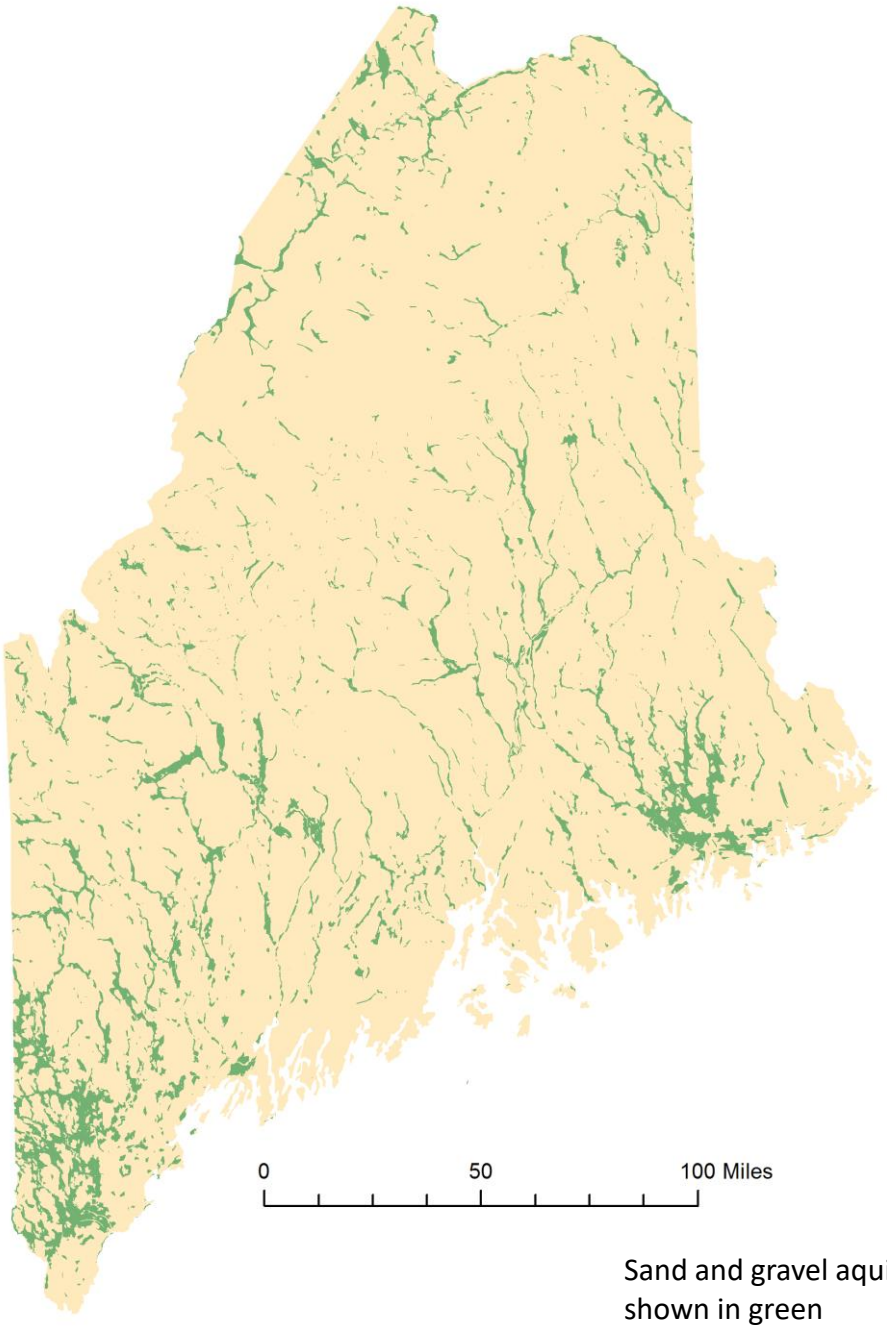
Sinuous glacial ridge (esker) of sand and gravel.

Sand and gravel deposits are the best resources for high-yield wells, but their distribution is limited.

Sand and Gravel Aquifer Distribution

Distribution confined to:

- Stream valleys
- Glacial esker ridges
- Glacial fans, deltas, and outwash plains

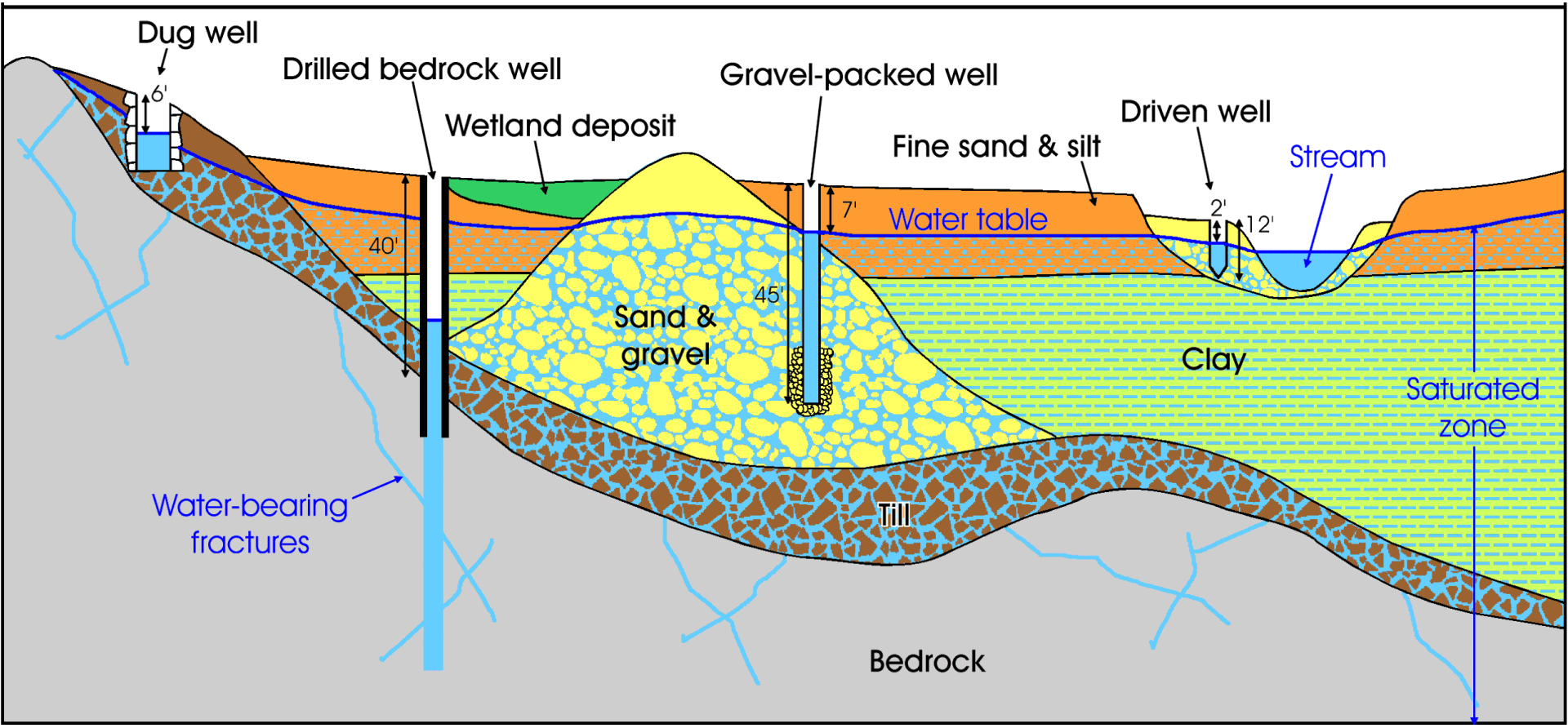


Sand and gravel aquifers shown in green

Groundwater Extraction

How do humans affect groundwater flow by pumping from wells?

Typical wells in Maine



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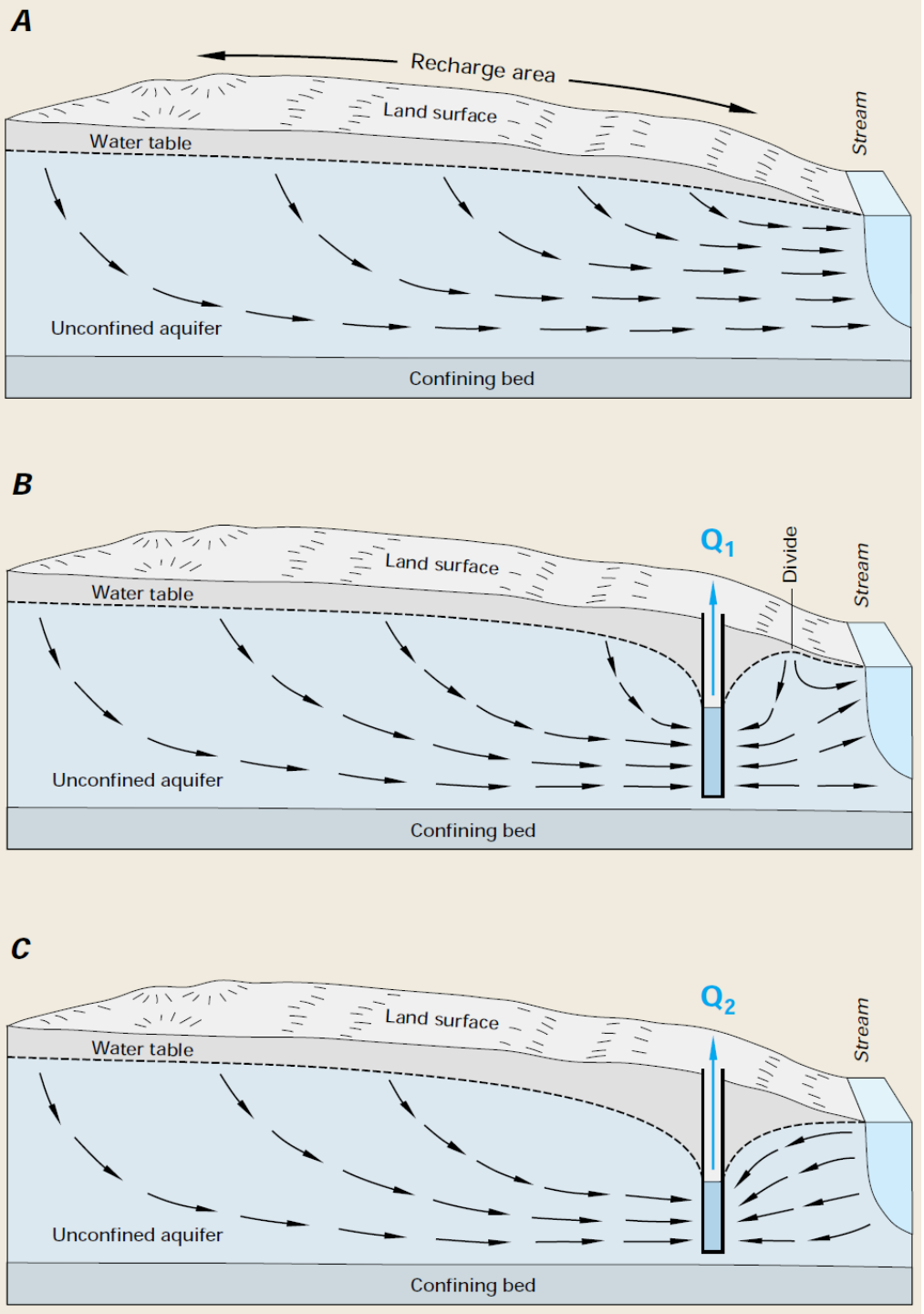
Effect of well pumping

Removing water from an aquifer can:

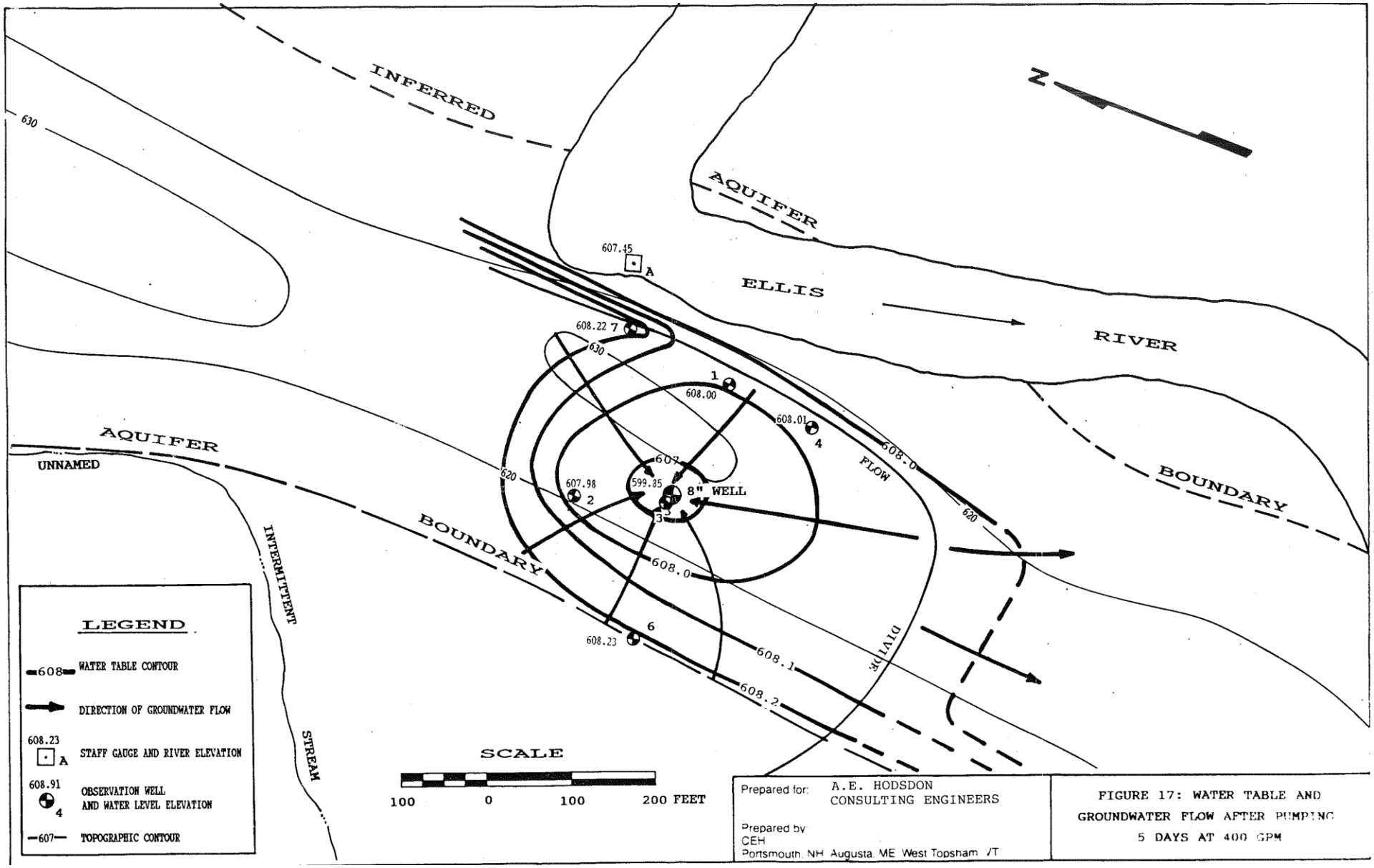
- Lower the water table in an area near the well
- Change the direction of groundwater flow
- Reduce the discharge of groundwater into streams or wetlands

Effects in Maine are generally small and localized (usually hundreds of feet).



USGS Circular 1139

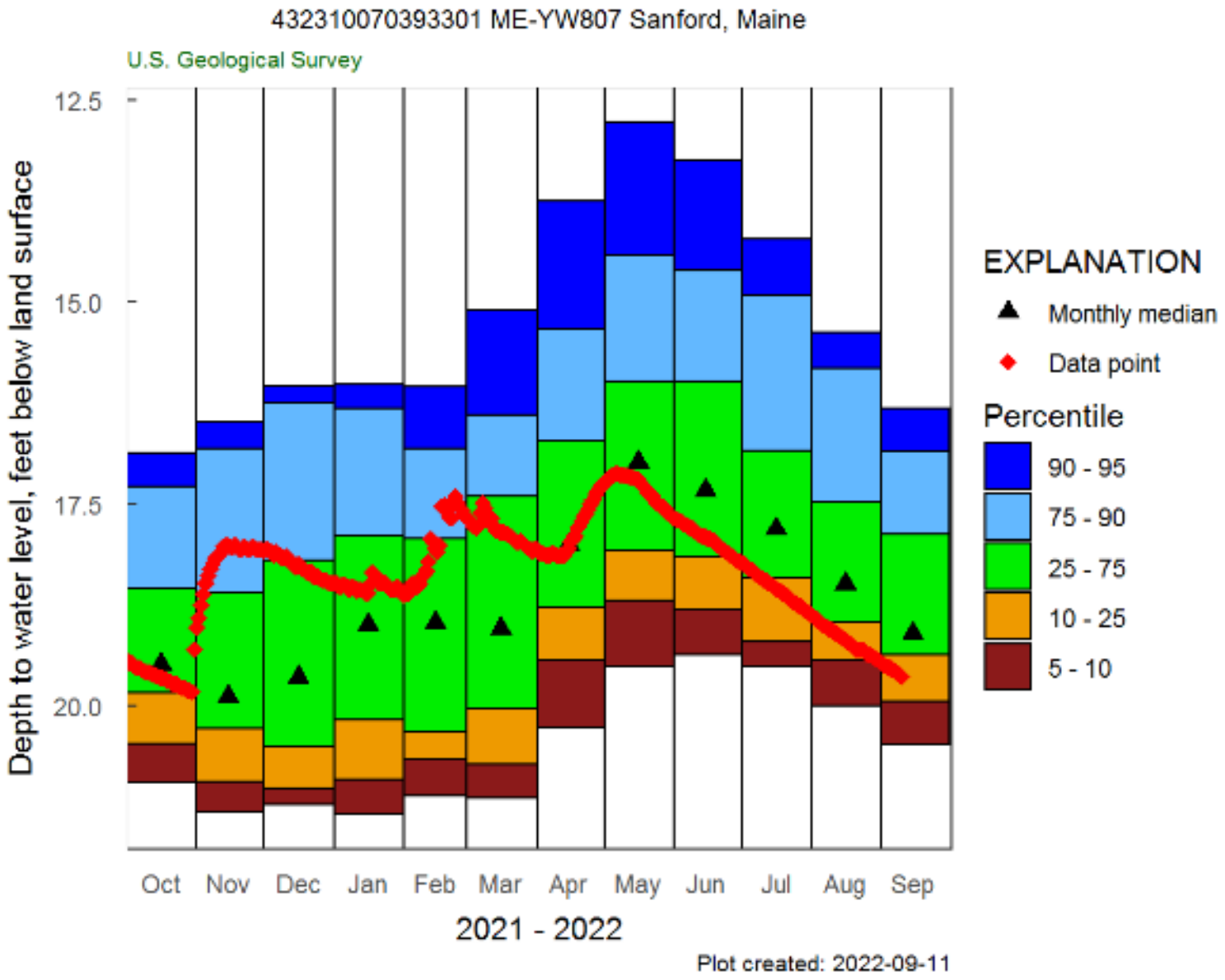
Example cone of depression in esker (Rumford)



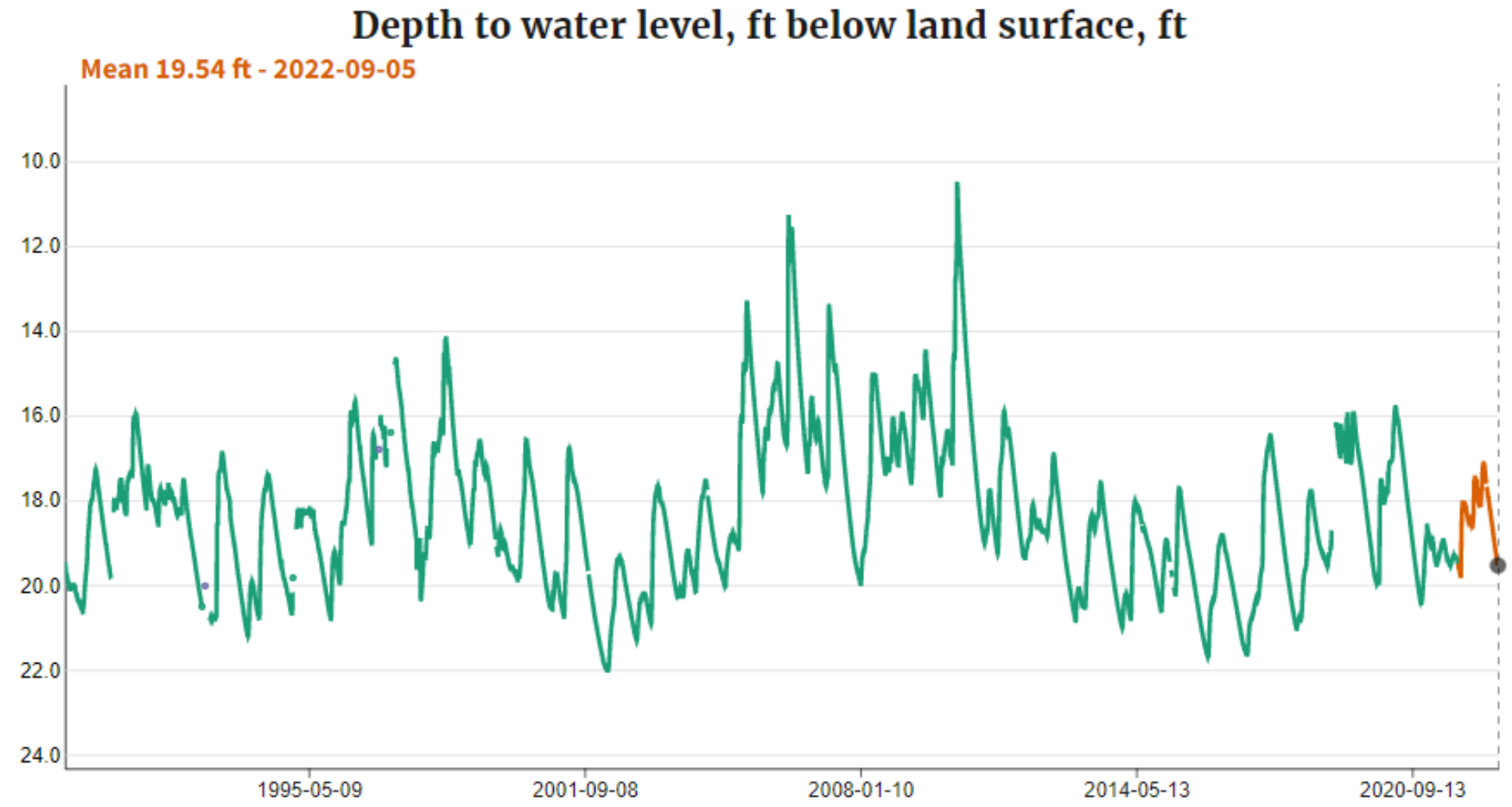
Statewide water levels

Groundwater levels in Maine are steady.

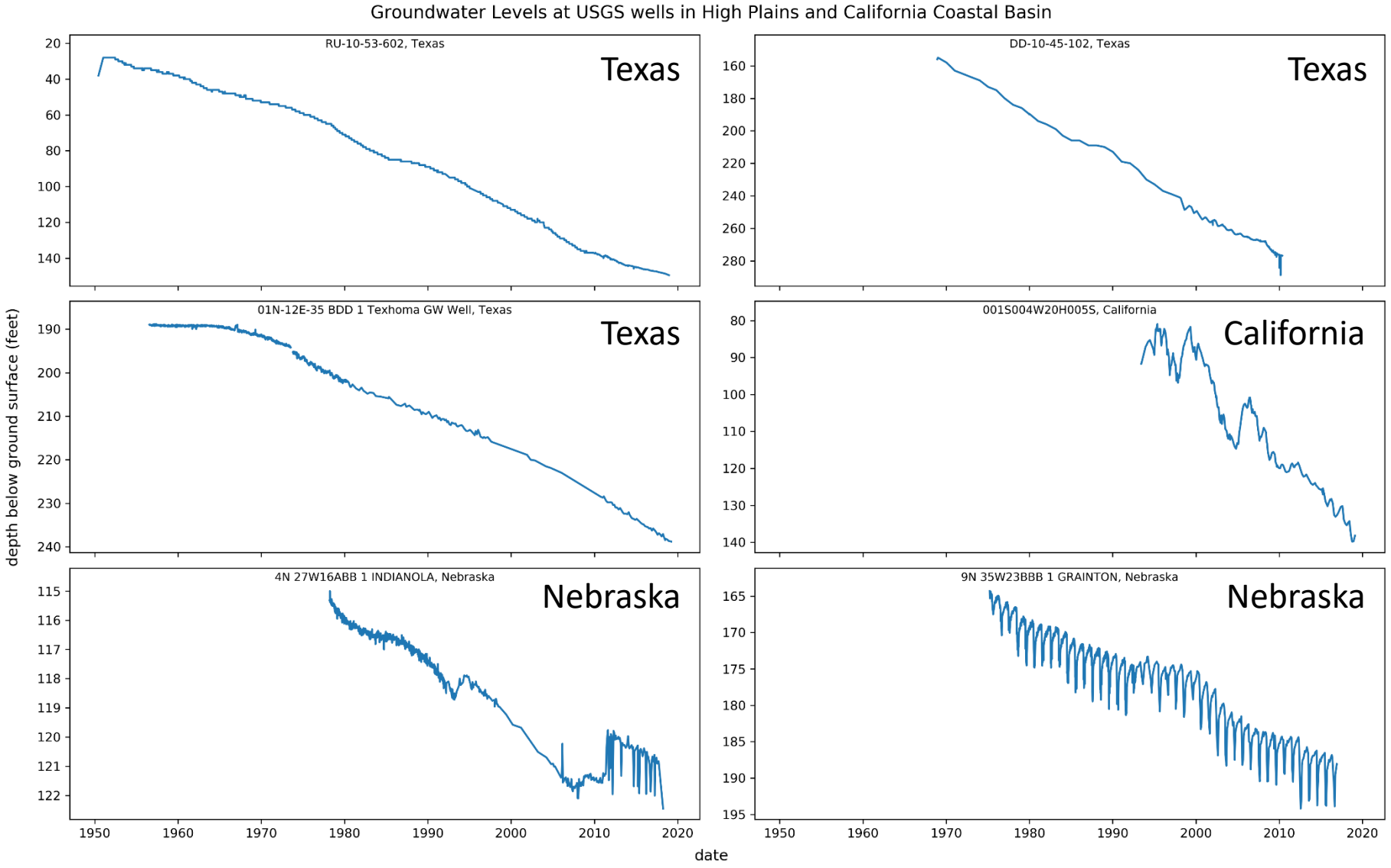
Annual cycle of recharge and recession



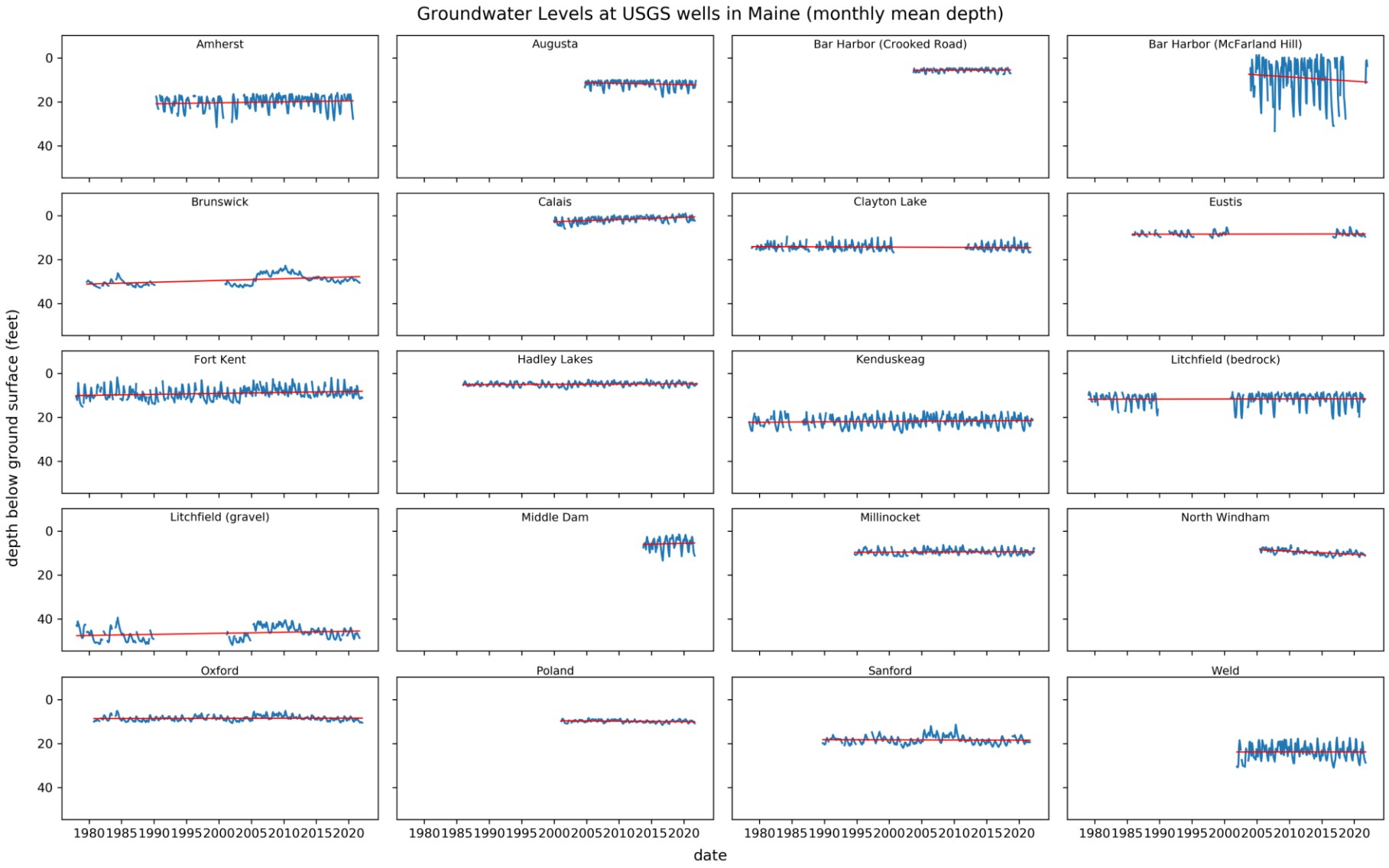
Long term record in Sanford sand plain



High Plains and California: Groundwater mining



Maine: Stable groundwater levels



Future Challenges

Climate change

- Increasing temperatures
- Increasing precipitation (on average)
- More climate variability
  - more short-term droughts
  - higher intensity rainfall events
- Sea-level rise
  - saltwater intrusion into coastal aquifers

Other human activity

- Sprawl and residential development
  - pesticides and nutrients
  - well conflicts
- Increasing road transportation
  - deicing salt, petroleum products, metals, microplastics, etc.

Summary

1. Groundwater in Maine is an abundant, renewable resource.
2. Human groundwater use is a very small component of the overall water budget.
3. Sand and gravel deposits are Maine's highest-yielding aquifers, but are not evenly distributed.
4. The effects of pumping wells are localized.
5. Groundwater levels in Maine are stable through time.
6. There will be challenges in the future.

Questions?

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