The background of the slide is a photograph of a vast blue ocean under a bright blue sky with wispy white clouds. A bright sun is visible on the left side of the horizon, creating a shimmering reflection on the water's surface.

**What do you know about
water?**

Water on earth

70% of earth's surface is covered in water

Q: How much of this
is in the oceans?

- a. 65%
- b. 73%
- c. 88%
- d. 97%



Water on earth

A: How much water is in the oceans?

d. 97%. Only 3% is fresh water.



*Water, water everywhere,
Nor any drop to drink*

--Samuel Taylor Coleridge, The Rime of the Ancient Mariner

Q: How much of fresh water is groundwater?

- Icecaps and glaciers 68.7%
- Other 0.9%
- Drinkable water:
 - Groundwater _____%
 - Surface water _____%



If all glaciers melted today, the seas would rise about 230 feet.

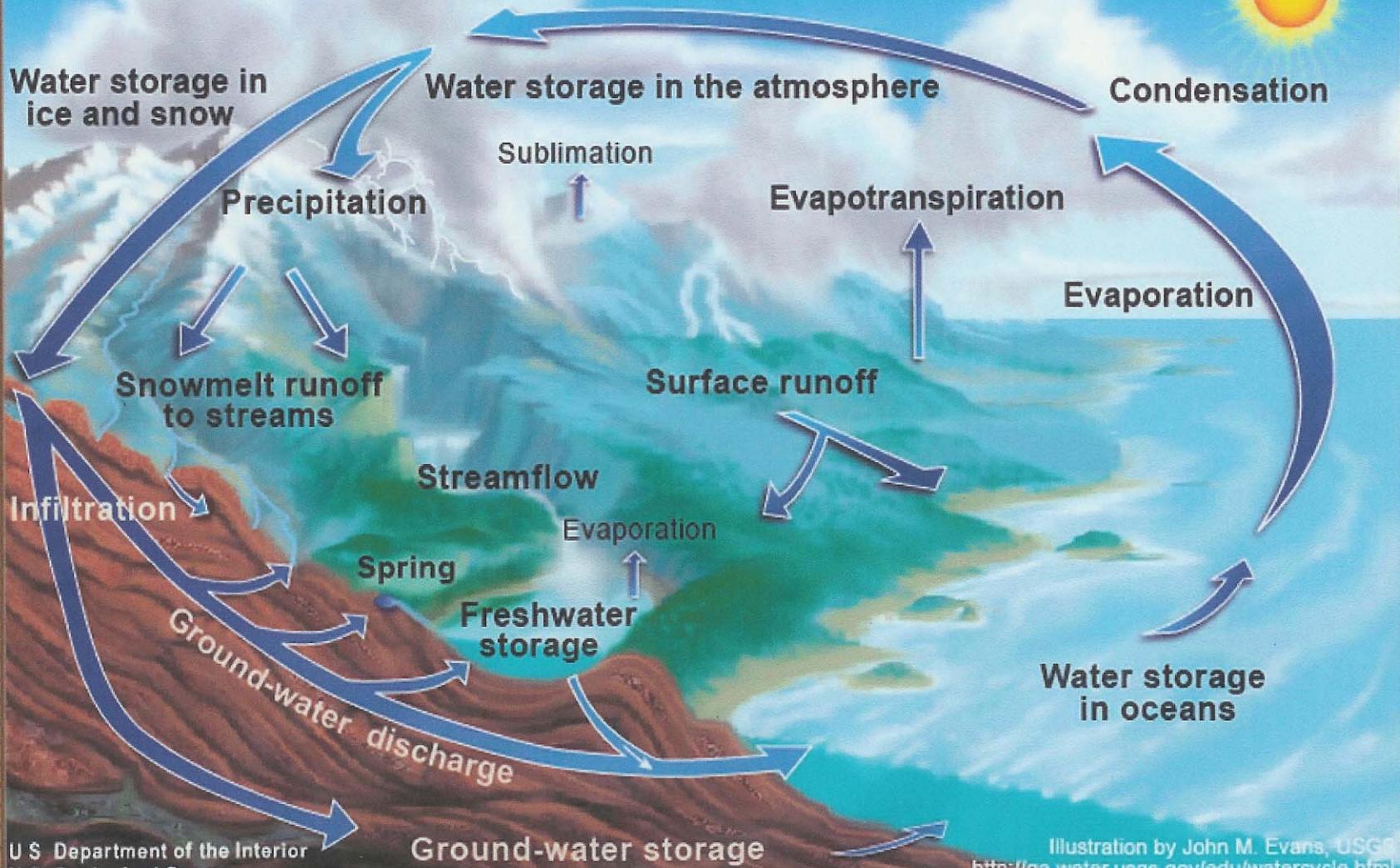
A: How much of fresh water is groundwater?

- Icecaps and glaciers 68.7%
- Other 0.9%
- Drinkable water:
 - Groundwater 30.1%
 - Surface water 0.3%
 - Rivers 2%
 - Swamps 11%
 - Lakes 87%



20% of all fresh water is in Lake Baikal in Siberia.

The Water Cycle



Evaporation & transpiration

Q: How much of the moisture in the atmosphere is from:

- Evaporation (from water bodies)?
- Transpiration (from plants)?

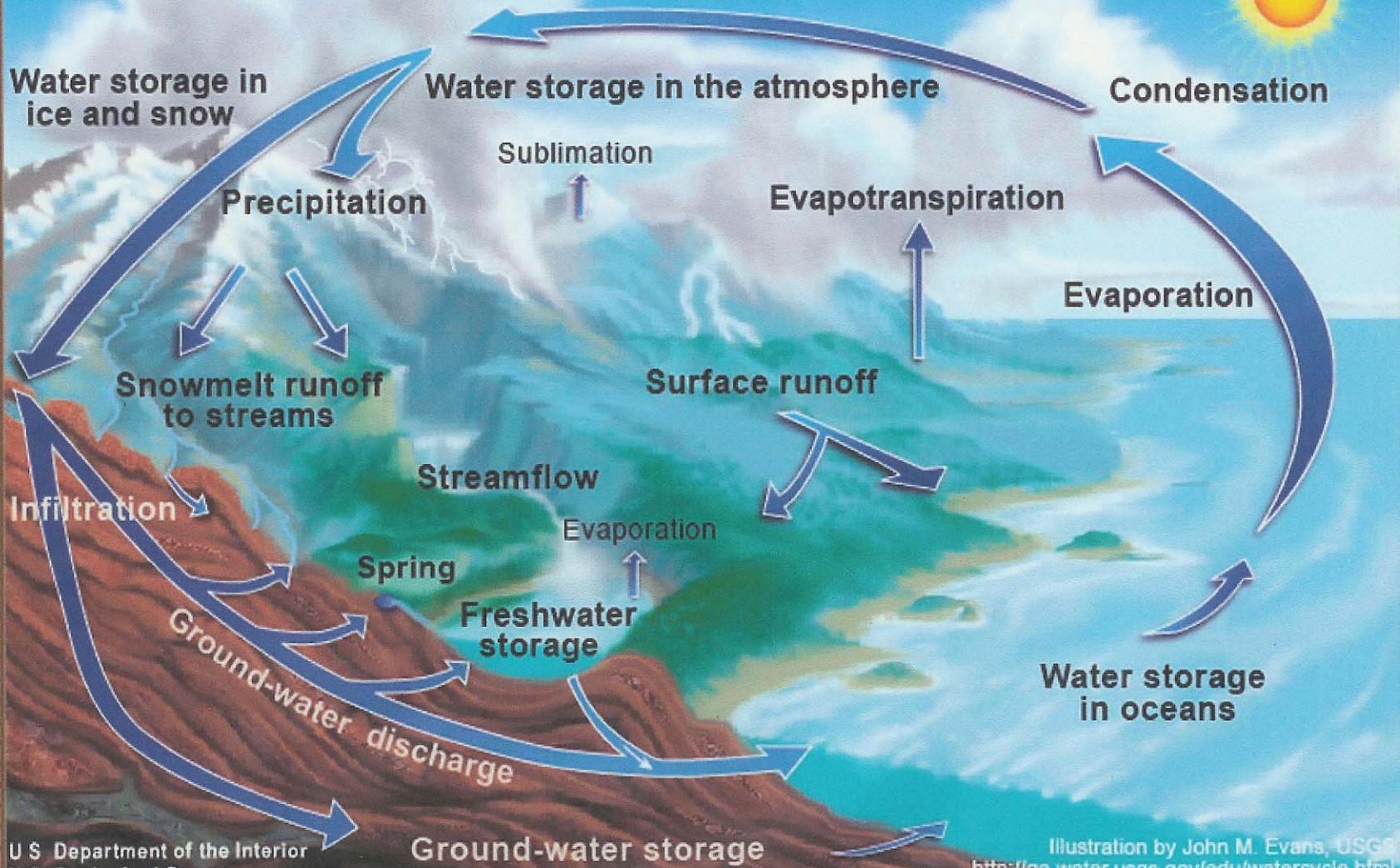
Evaporation & transpiration

A: 90% of moisture in atmosphere is from evaporation.
10% is from transpiration.

A large oak tree can transpire 40,000 gallons per year.

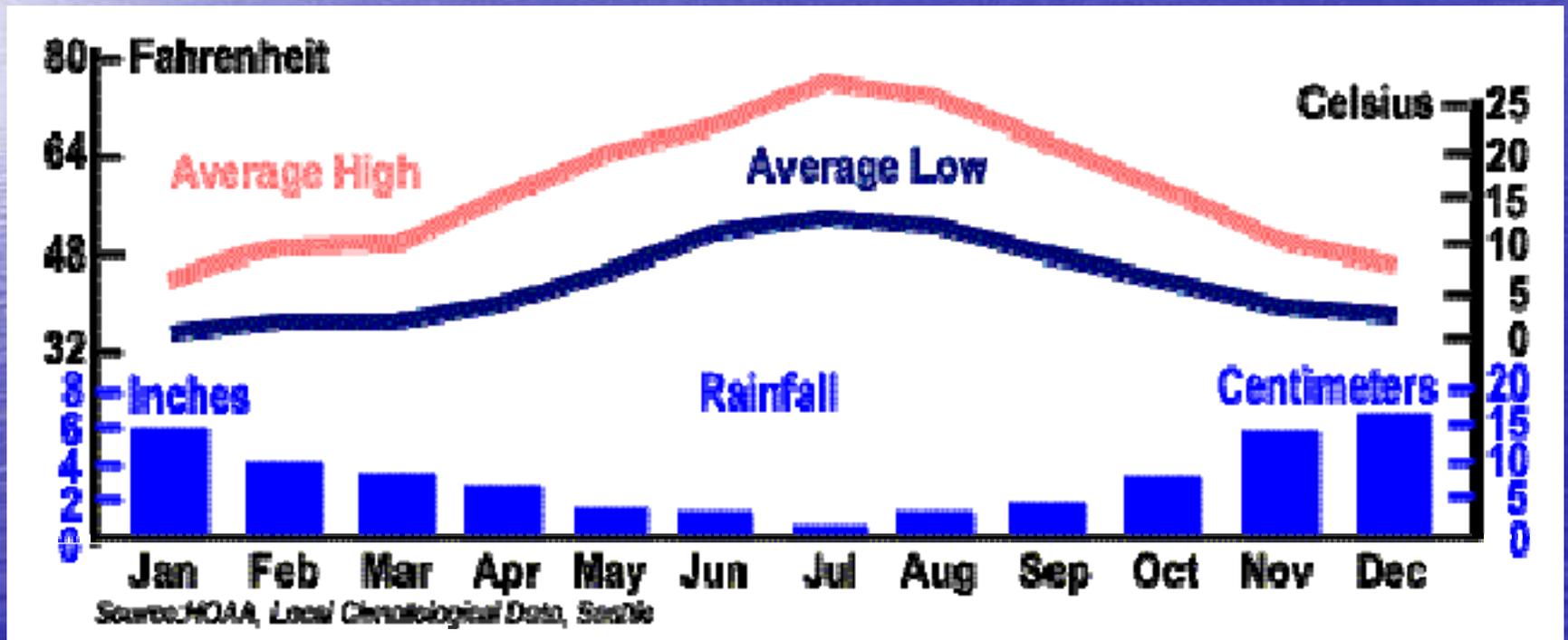


The Water Cycle

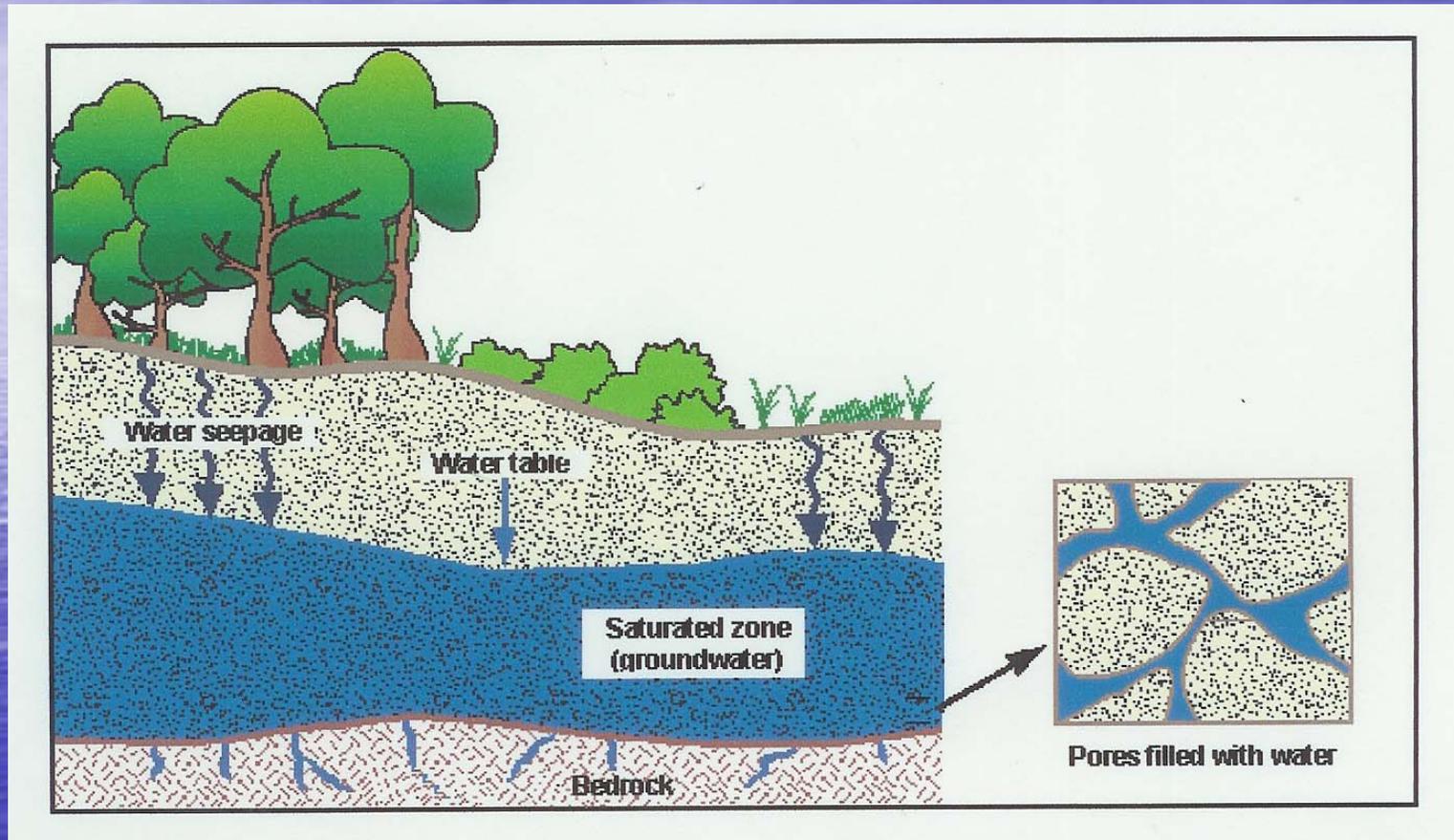


Local precipitation doesn't match water use

Monthly Temperatures and Rainfall in Seattle



Groundwater begins at surface



Groundwater myths & facts

Q: True or false?

Contaminants from oil poured on the ground will be filtered by soil & gravel before reaching groundwater.



Groundwater myths & facts

A: False.

- Chemicals added to gasoline & oil are not filtered by soils & often reach groundwater.



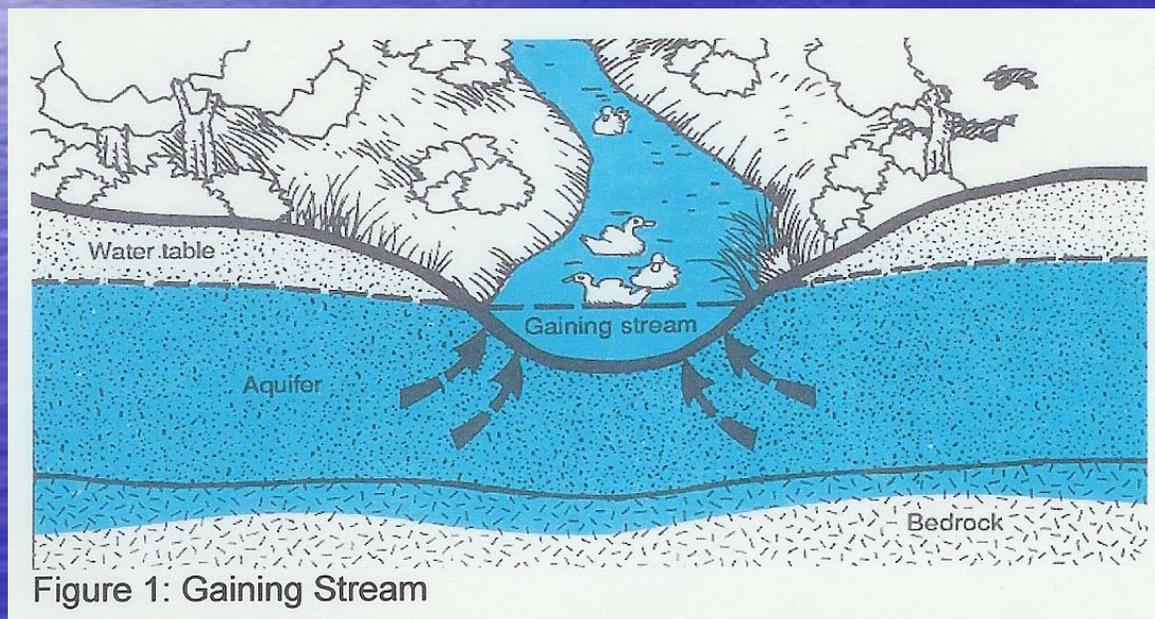
Groundwater myths & facts

Q: True or false?

Contaminated groundwater can eventually enter surface water and contaminate it.

Groundwater myths & facts

A: True. Groundwater can contaminate surface water when the water level of stream, lake or wetland is at or below water table of aquifer.



Aquifer feeds water to "gaining stream."

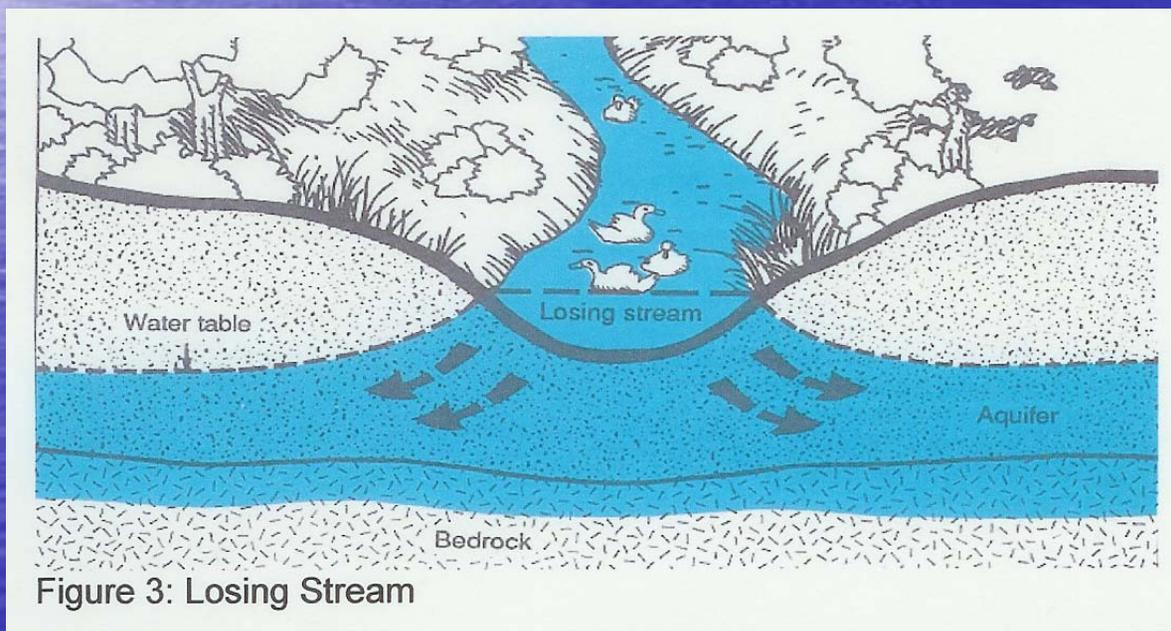
Groundwater myths & facts

Q: True or false?

Contaminated surface water can eventually reach ground water and contaminate it.

Groundwater myths & facts

A: True. A stream, lake or wetland can contaminate groundwater if it is higher than adjacent aquifer.

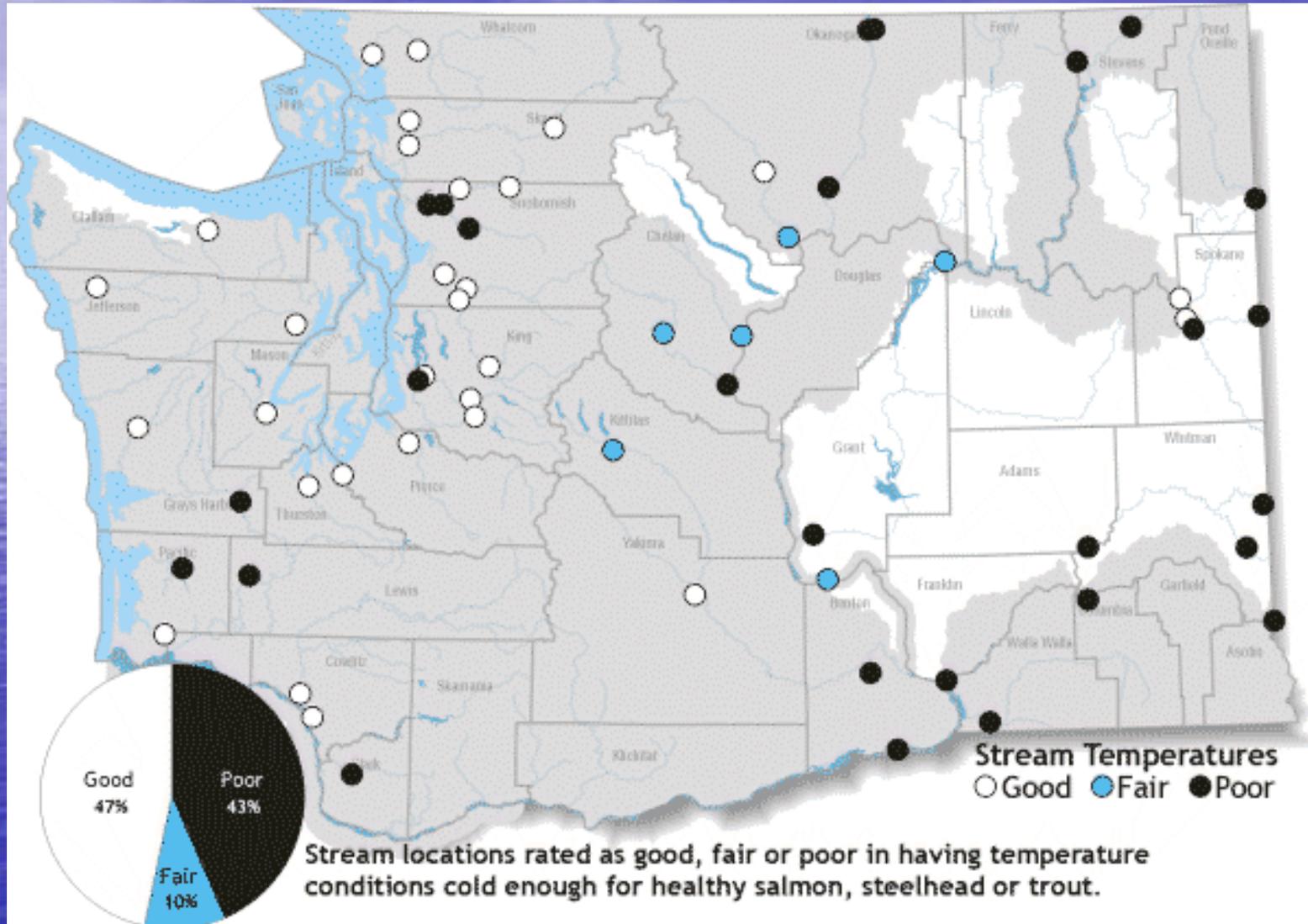


"Losing stream"
feeds water to
aquifer.

Groundwater cools streams for salmon

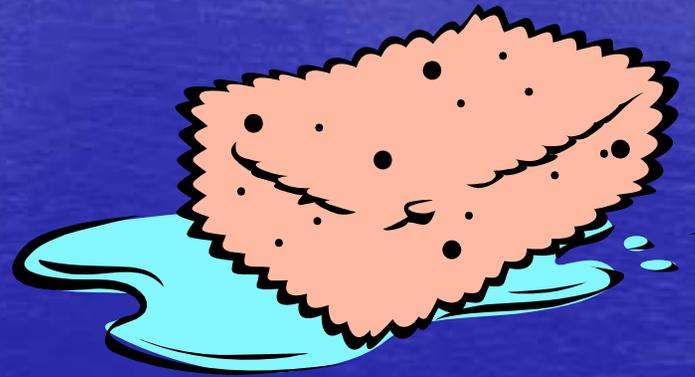


Groundwater cools streams for salmon



Wetlands functions

- Recharge groundwater
- Filter some pollutants through plants & soil
- Discharge groundwater, stabilizing stream flow



Some major threats to groundwater

- Water overuse
- Pollution (pesticides, fertilizers, toxics)
- Land drainage
- Development, impervious surfaces
- Population growth
- Climate changes

US water use: 2000 statistics

- Water use in US: 408 billion gal/day
- Per capita:
 - 1,620 gal/day in 1990
 - 1,430 gal/day in 2000
- Amount withdrawn from groundwater has increased over time

Q: Hidden water uses

- Much of our water use is hidden. How much water does it take to grow and process a hamburger, fries & soft drink?
 - a. 500 gallons
 - b. 1,000 gallons
 - c. 1,500 gallons
 - d. 2,000 gallons

A: Hidden water uses

- To grow and process a hamburger, fries & soft drink takes 1,500 gallons
- To grow the cotton for a pair of blue jeans takes 400 gallons
- To manufacture a new car and tires takes 39,090 gallons

Water overuse

- Ogallala aquifer in western Kansas
 - Water consumed 25 times faster than replenished
 - Arkansas River no longer flows from Garden City to Dodge City (>100 miles)
 - Drawing geologic water 10,000+ years old

Water overuse

- California's San Joaquin Valley: groundwater pumping for agriculture
- Land subsidence of **29.5 feet** between 1925 and 1977



Homeowners use millions of pounds of pesticides

US households using pesticides, 2000

Insecticides	59 million
Fungicides	14 million
Herbicides	41 million
Repellents	53 million
Disinfectants	59 million
Any pesticides	78 million

EPA statistics, 2000.

U.S. Census: 281.4 million people, 105.5 million households.

Pesticide use

Q: What is the most widely used pesticide?

Pesticide use

A: What is the most widely used pesticide?

- Herbicides top the list in both \$ and volume
- Agriculture: glyphosate (Roundup) was top (85-90 million pounds)
- Home & garden: 2,4-D was top (8-11 million pounds)

EPA statistics, 2001.

Pesticide contamination

- Pesticides found in groundwater in nearly all 50 states
- Pesticide leaching depends on:
 - Pesticide properties
 - Soil properties
 - Site conditions
 - Management practices

Nitrates & groundwater

Q: What are major sources of nitrates in groundwater?

Nitrates & groundwater

A: Major nitrate sources:

- Fertilizers (agriculture and home use)
- Human, animal waste (septic systems, farms)

Why are nitrates a problem?

- Very soluble in water
- High potential to migrate to groundwater
- Health risks, especially for babies

Toxics in groundwater: MTBE

- MTBE added to gasoline to make it burn more cleanly & efficiently
- EPA requires reformulated gas (RFG) in areas with highest ozone & smog rates
- MTBE is common additive in RFG
- Potential carcinogen
- Banned in California since 2004

Toxics in groundwater: MTBE

- Found in Santa Monica drinking water wells
- Wells provided half of city's daily water demand
- Oil companies have removed:
 - >346 million gallons of contaminated gasoline
 - >4,000 cubic yards of contaminated soil
 - 6,000 pounds of MTBE
- \$3 million/year for replacement water

Land drainage

- The US is losing over 58,000 acres of wetlands every year
- In Washington, development has led to:
 - 90 to 98% loss of estuaries & wetlands in coastal urban areas
 - 70% loss of tidal wetlands in Puget Sound

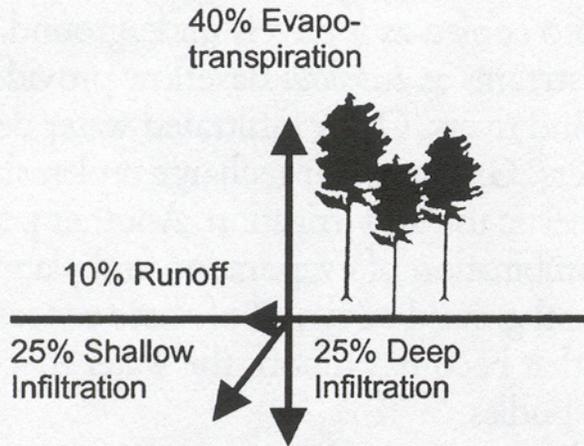
Impervious surfaces

- Impervious surfaces include:
 - Buildings, roofs
 - Roads, parking lots
 - Severely compacted soil
- Q: What are some environmental impacts of impervious surfaces?

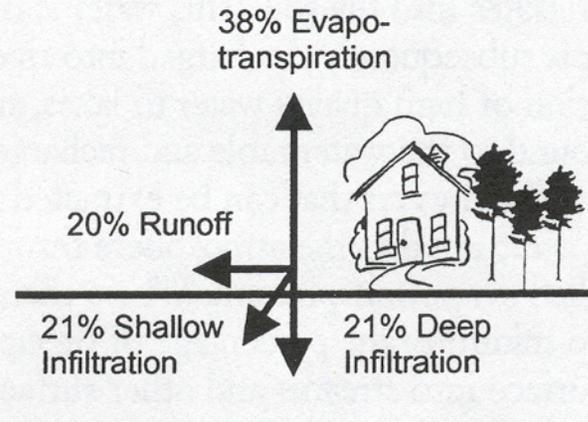
Impervious surfaces

A: Environmental impacts include:

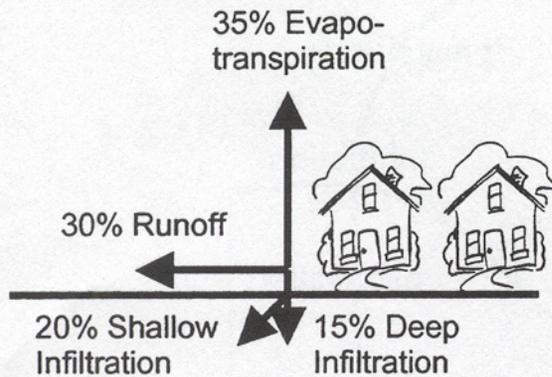
- Reduced groundwater recharge
- Increased stormwater volume
- Decreased water quality (runoff)
- Damaged aquatic habitat



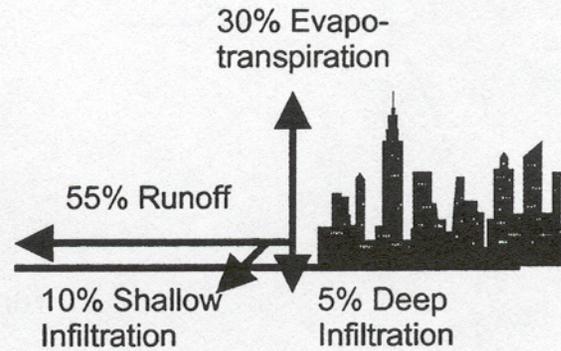
NATURAL GROUND COVER



10-20% IMPERVIOUS SURFACE



35-50% IMPERVIOUS SURFACE

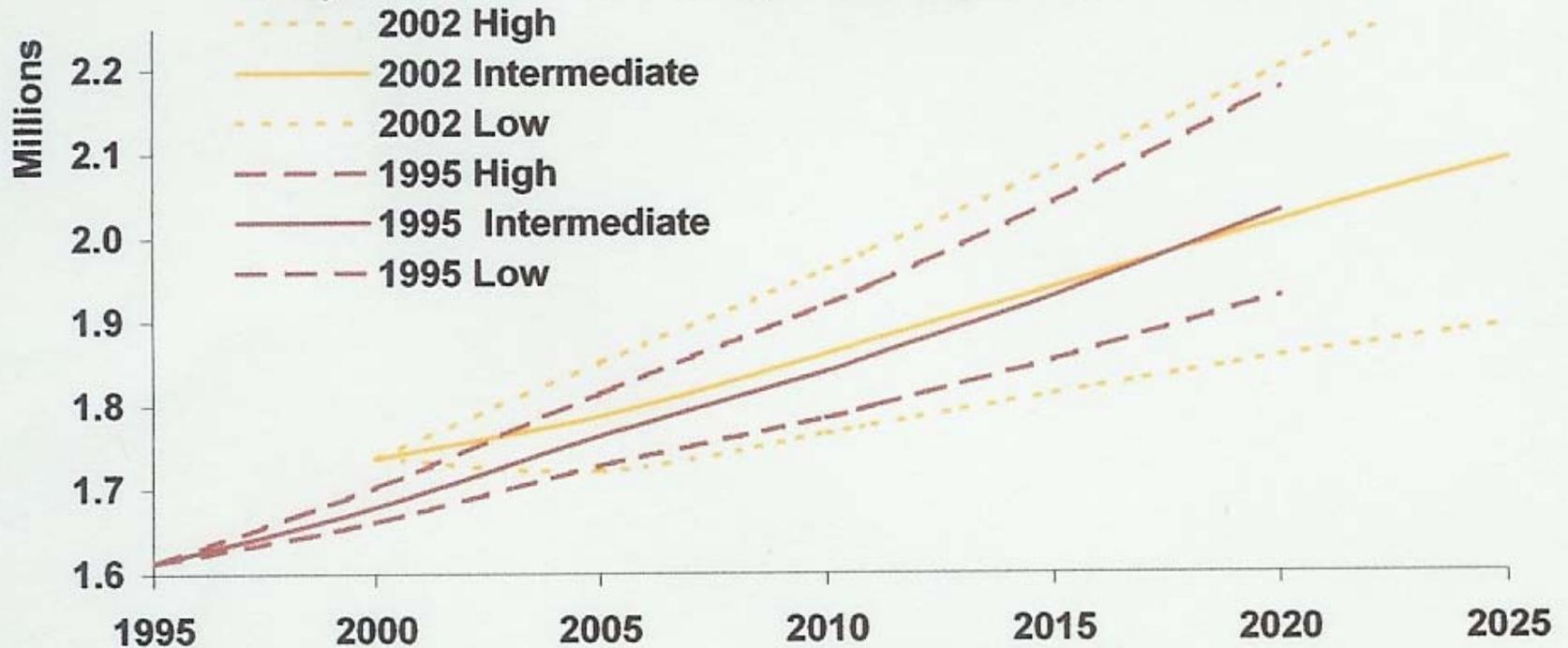


75-100% IMPERVIOUS SURFACE

Population growth

CHART 4

Projections for King County Population



Source: Office of Financial Management

Climate changes, 1950-2000

- 0.4°F increase per decade in PNW
- NW winters are 2.7°F warmer
- 13% less freshwater flows to Puget Sound
- >50% less snowpack at lower elevations



South Cascade Glacier,
WA, 1928 (left)



South Cascade Glacier,
WA, 2000 (right)

Estimates of glacier volume
in water equivalent:

1928: 0.32 km³

2001: 0.16 km³

Future climate changes

- Warming of about 0.9°F per decade expected in PNW
- Lower summer river flows, more competition for water
- Higher winter flows, more flooding
- Less groundwater recharge