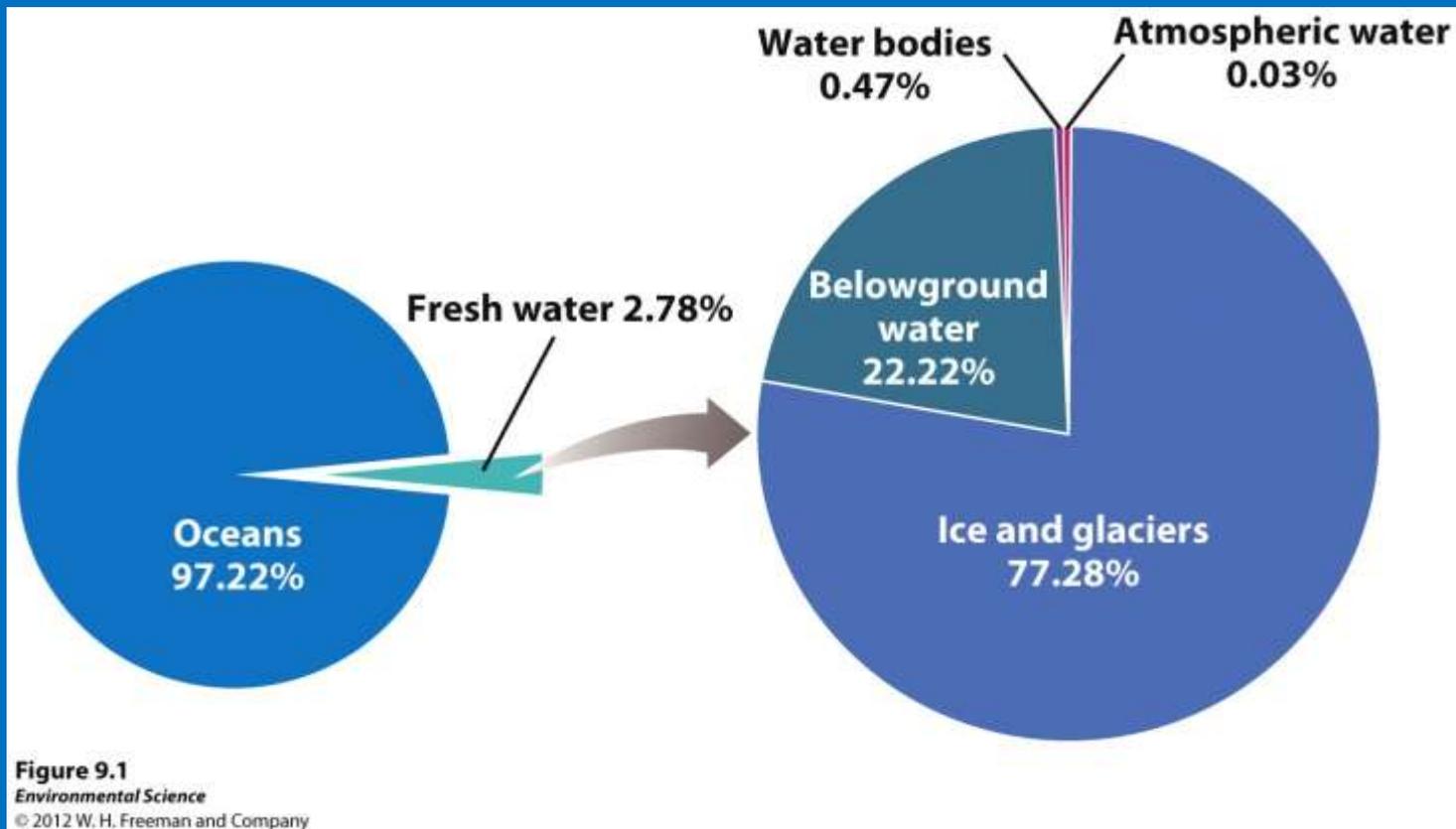




Water Resources

Usable Water is Rare



Groundwater

- ▣ Aquifers- small spaces found within permeable layers of rock and sediment where water is found.
- ▣ Unconfined aquifers- an aquifer that is simply porous rock covered by soil.
- ▣ Confined aquifers- an aquifer surrounded by a layer of impermeable rock or clay.

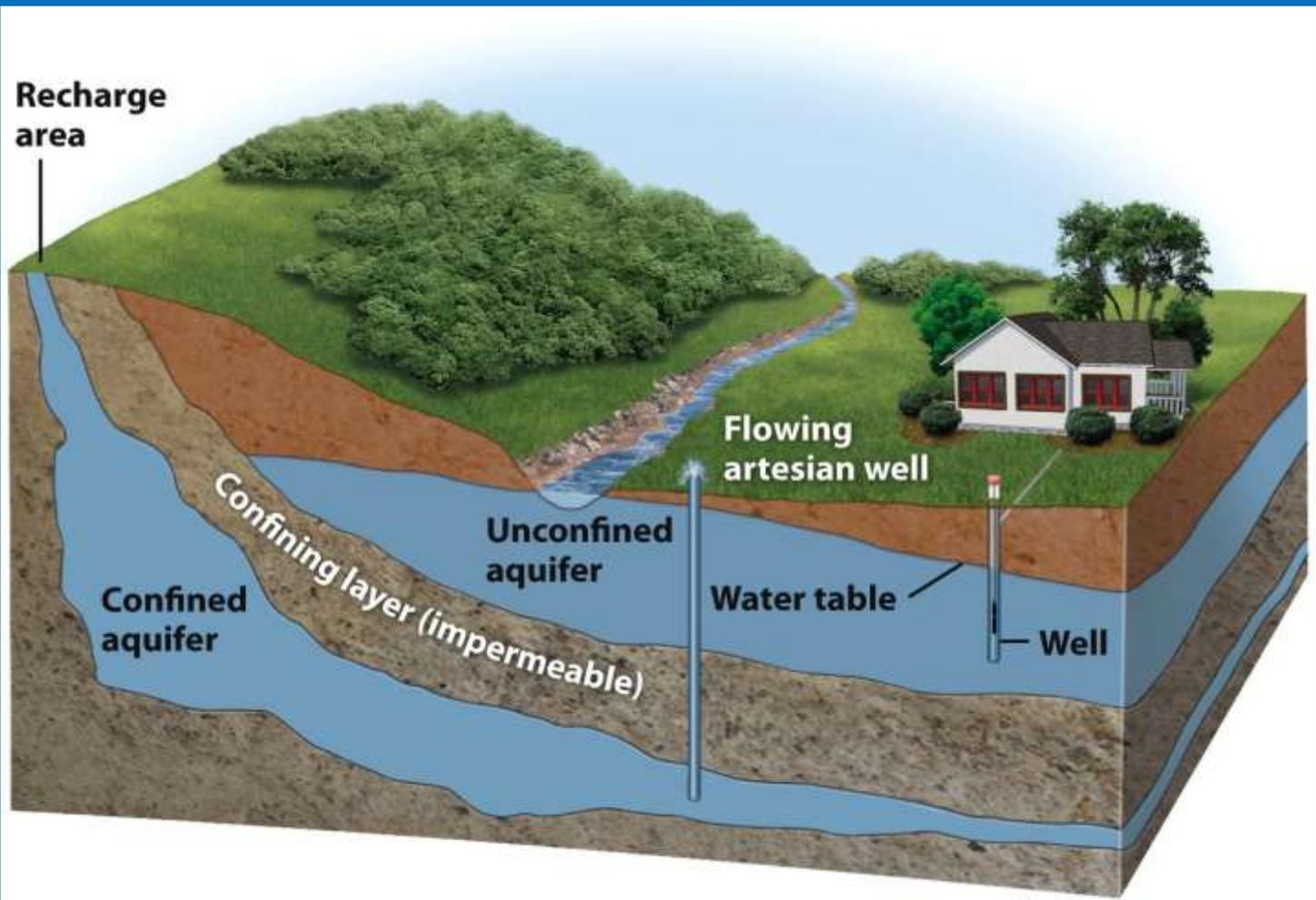


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Groundwater

- ❑ Water table- the uppermost level at which the water in an area fully saturates the rock or soil.
- ❑ Recharge- the input process of water percolating into an aquifer.
- ❑ Springs- water from an aquifer that naturally percolates up to the surface.



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Groundwater

- Cone of depression- an area where there is no longer any groundwater.

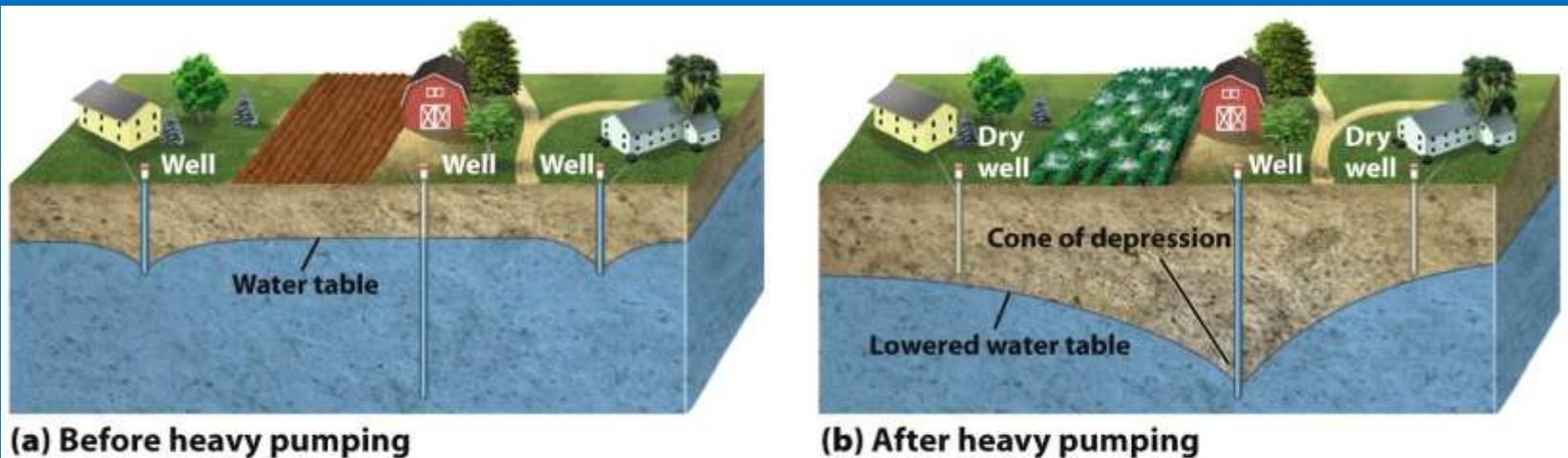


Figure 9.5

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Groundwater

- ❑ Saltwater intrusion- when the pumping of fresh water out of a well is faster than the recharge. Near coastal areas this can cause salt water to infiltrate the aquifer.

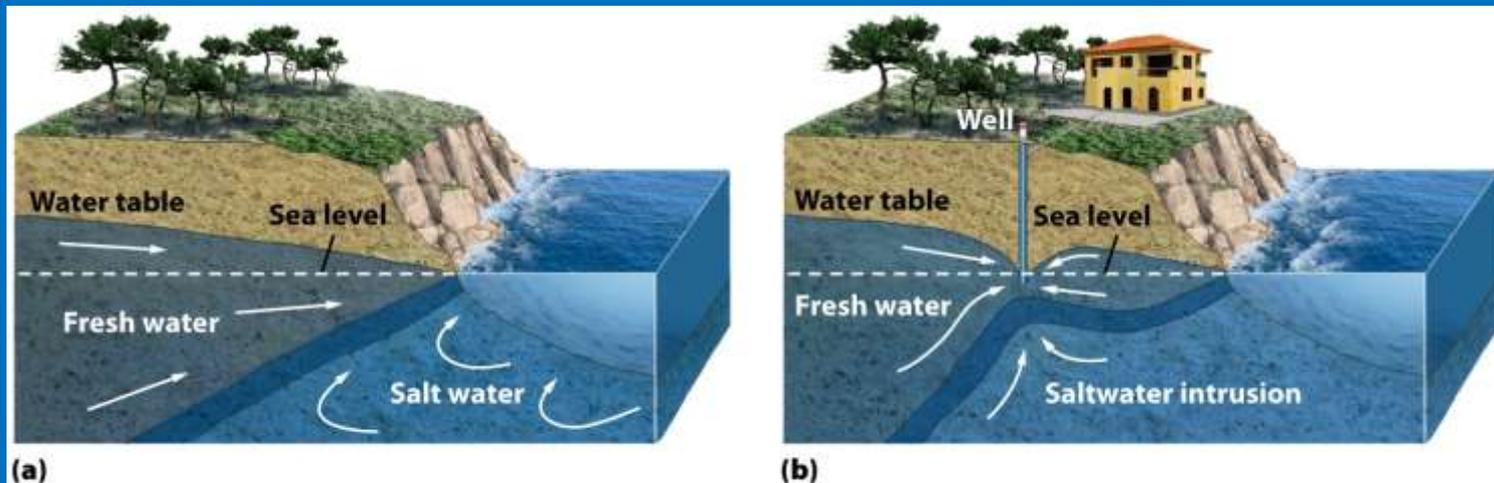
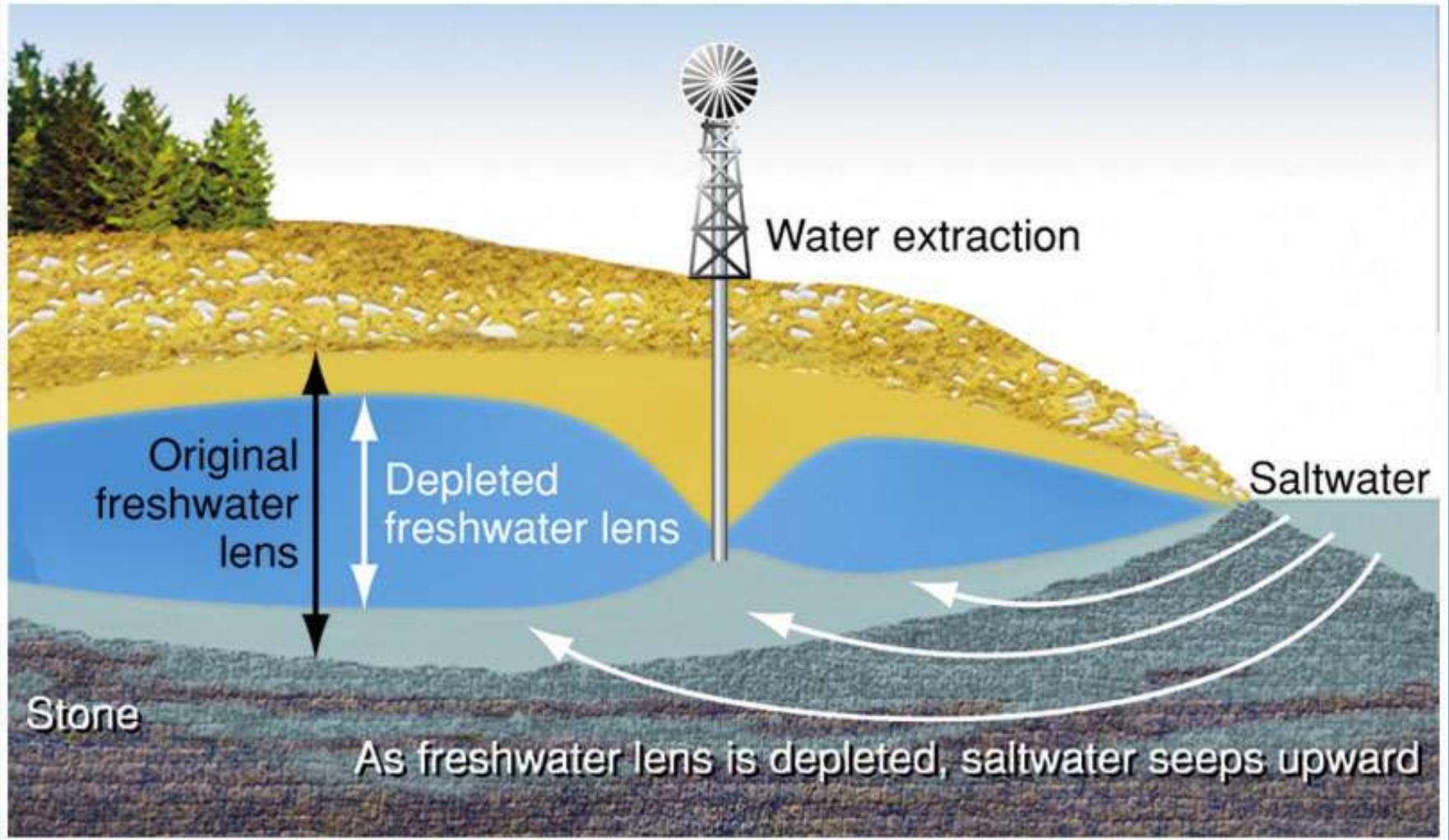


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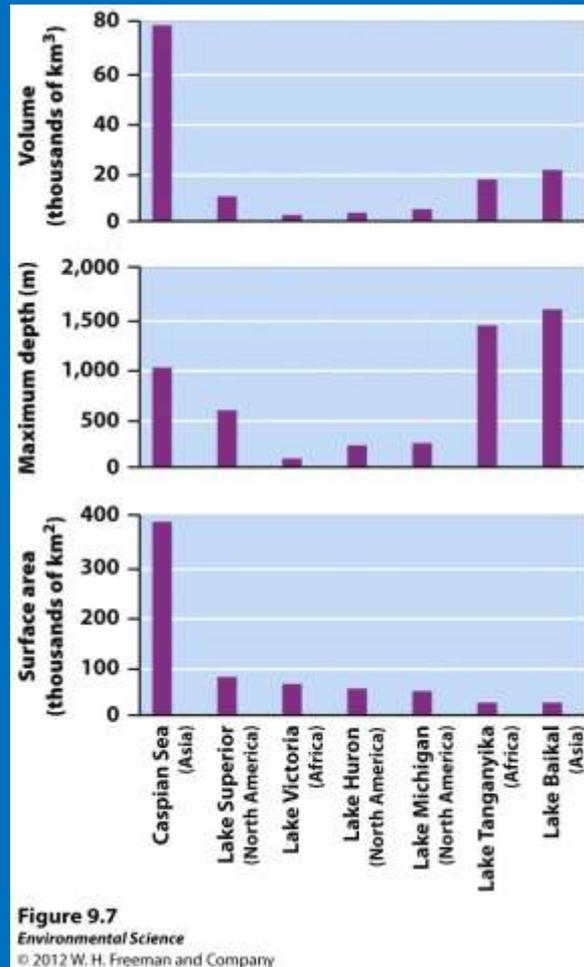
Saltwater Intrusion

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Surface Water

- Streams, rivers, ponds, lakes and wetlands.



Surface Water

- ▣ Productivity in a lake:
 - ▣ Oligotrophic- low amounts of nutrients such as phosphorous and nitrogen.
 - ▣ Mesotrophic- a moderate level of productivity
 - ▣ Eutrophic- high levels of productivity

Altering the Availability of Water

- ▣ Levees- an enlarged bank built up on each side of the river.
- ▣ Dikes- similar to a levee but built to prevent ocean waters from flooding adjacent land.



Figure 9.9
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Altering the Availability of Water

- ▣ Dams- a barrier that runs across a river or stream to control the flow of water.
- ▣ Reservoir- the area where water is stored behind the dam.



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Dams and Diversions

- ▣ Before 1900 there were 250 high dams in the world; today there are more than 45,000.
- ▣ In the U.S. dams are built by Army Corps of Engineers and Bureau of Reclamation
 - Provide cheap hydroelectric power
 - Jobs
 - Reduce flooding
 - Allow farming on lands that would otherwise be too dry

Dams and Diversions

- ▣ On the downside, dams
 - Drown free flowing rivers
 - Submerge farmlands and towns
 - Block fish migration e.g. salmon
 - Change aquatic habitats for native species
 - Can sometimes fail, causing catastrophe
 - ▣ Johnstown flood (city just east of Pittsburgh, PA) killed 2,200 people when dam broke.
 - ▣ Dam failure in China killed 230,000.

Altering the Availability of Water

- ▣ Fish ladders- a set of stairs with water flowing over them that have been added to some dams to help migrating fish such as salmon get upstream.



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Altering the Availability of Water

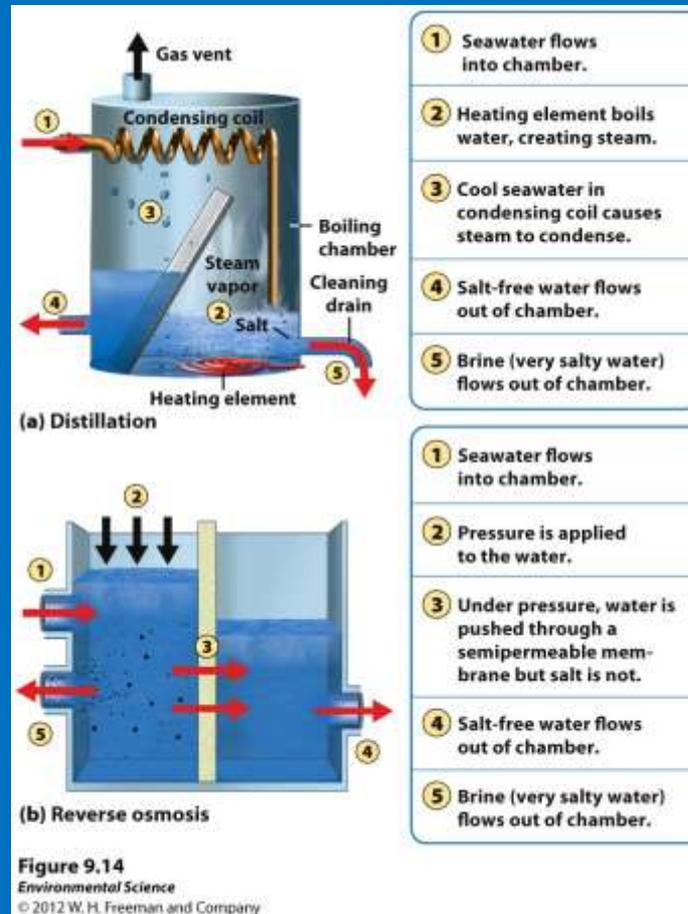
- ▣ Aqueducts- canals or ditches used to carry water from one location to another.



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Altering the Availability of Water

- Desalination- removing the salt from salt water to obtain fresh water.



Agriculture, Industry and Household Needs

- ▣ Agriculture- the largest user of water around the world.



Furrow irrigation

Figure 9.17a
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Flood irrigation

Figure 9.17b
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Spray irrigation

Figure 9.17c
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Drip irrigation

Figure 9.17d
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Agriculture, Industry and Household Needs

- ▣ Irrigation techniques-
 - ▣ Furrow irrigation- a trench that is flooded with water.
 - ▣ Flood irrigation- the entire field is flooded with water.
 - ▣ Spray irrigation- an apparatus that sprays water across a field.
 - ▣ Drip irrigation- using a slow dripping hose that is laid on or buried beneath the soil.
 - ▣ Hydroponic agriculture- crops grown in fertilized water and no soil.

Agriculture, Industry and Household Needs

- ▣ Industry- the second largest user of water worldwide.



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Agriculture, Industry and Household Needs

- Households- the third largest user of water worldwide .

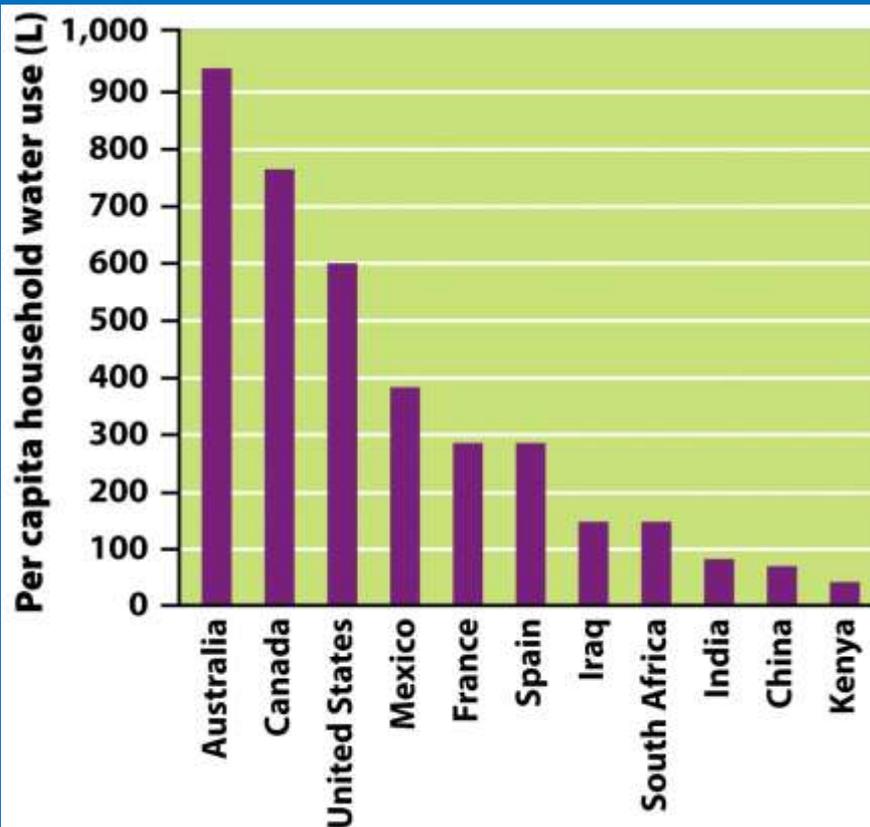


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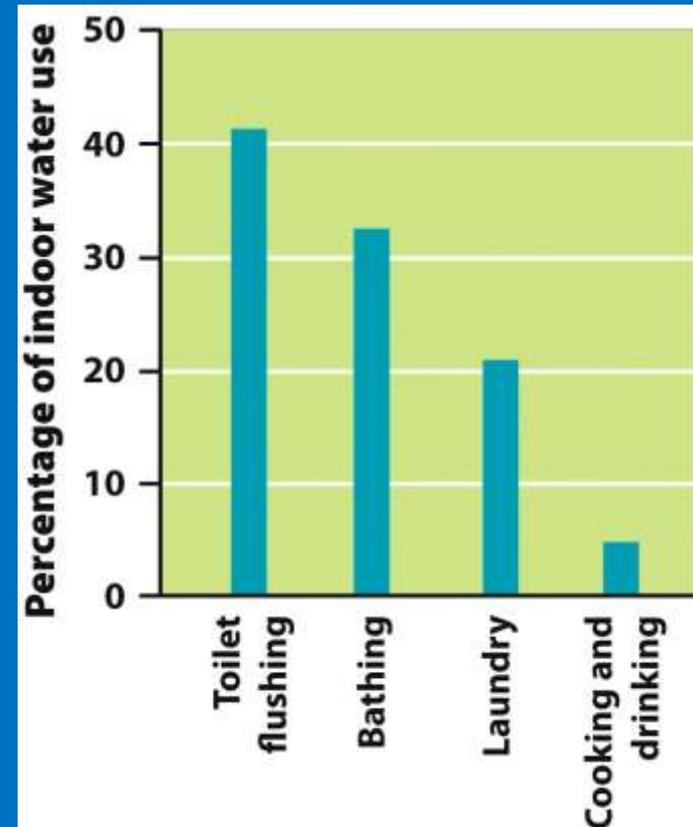


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The Future of Water Availability

- ❑ Water ownership- people can have rights to water use, but they do not own the water.
- ❑ Water conservation- using techniques such as more efficient water fixtures, faucets and washing machines.



Figure 9.23
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Freshwater Shortages

- ▣ U.N. estimates a billion people lack access to safe drinking water.
 - 2.6 billion lack acceptable sanitation.
- ▣ At least 50 countries, mostly in Africa and the Middle East, are considered to have serious water stress.
- ▣ In many countries it is not access to water that is a problem, it is access to *clean* water that is the problem.

Many People Lack Access to Clean Water

- ▣ More the 2/3 of the world's population lack indoor plumbing and must fetch water from outside the home.
- ▣ Where water is available in the home, it may be expensive. In Lima Peru, a typical poor family uses 1/6 as much water as a typical middle class family in the US and pays 3 times as much for the water and they must boil the water before it is safe to drink.
- ▣ By 2025, the U.N. estimates that 2/3 of the world's population will be living in water stressed countries.

Climate Change Threatens Water Supplies

- The IPCC warns that climate change together with the developing problems of urban sprawl, population growth and pollution will result in significant water shortages around the world.
- The IPCC predicts that reduced precipitation and increased evaporation from higher temps will result in 10-30% reduction in runoff in arid regions over the next 50 years.