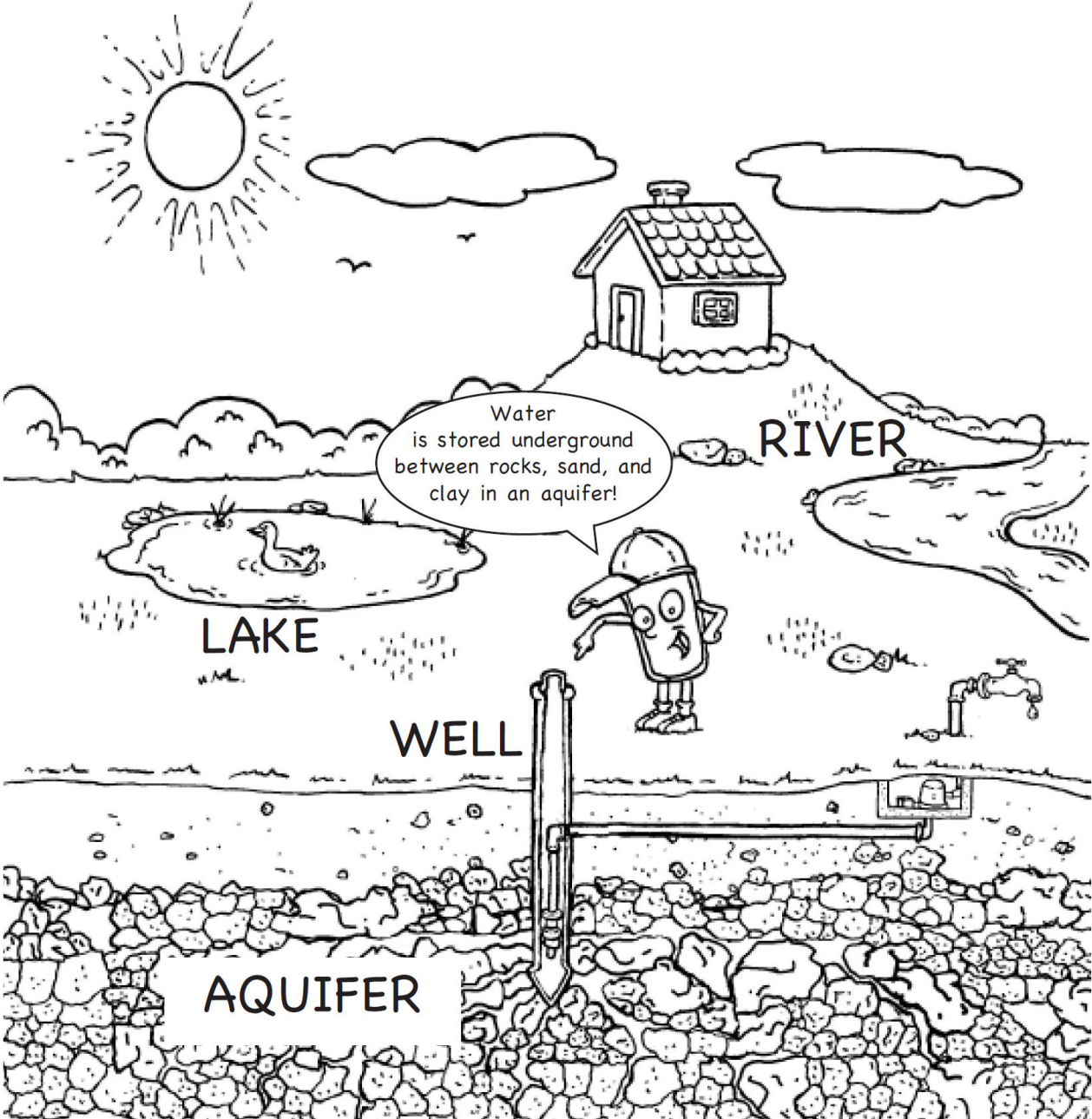


Chapter 3: Groundwater



GROUND WATER DIAGRAM



Here are some clues that will help you label the diagram above:

1. Air and some water fill the spaces in this *zone* of the ground.
2. This *zone* exists when all the spaces in the soil are completely filled with water.
3. Top layer of number 2.
4. This is what water is called when it is found underground.

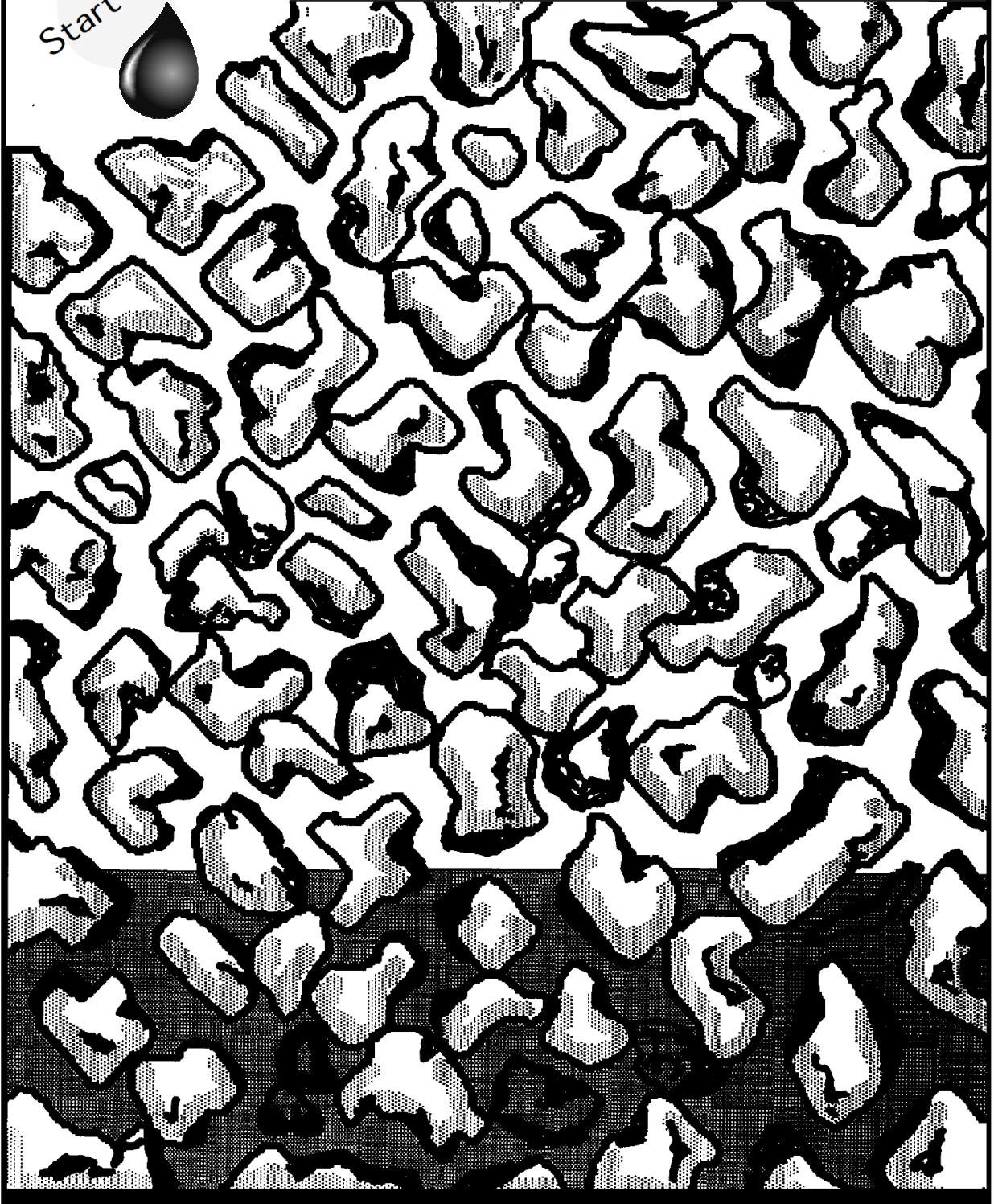
WORD BANK: groundwater, saturated zone, unsaturated zone, water table

WATER MAZE

Start Here

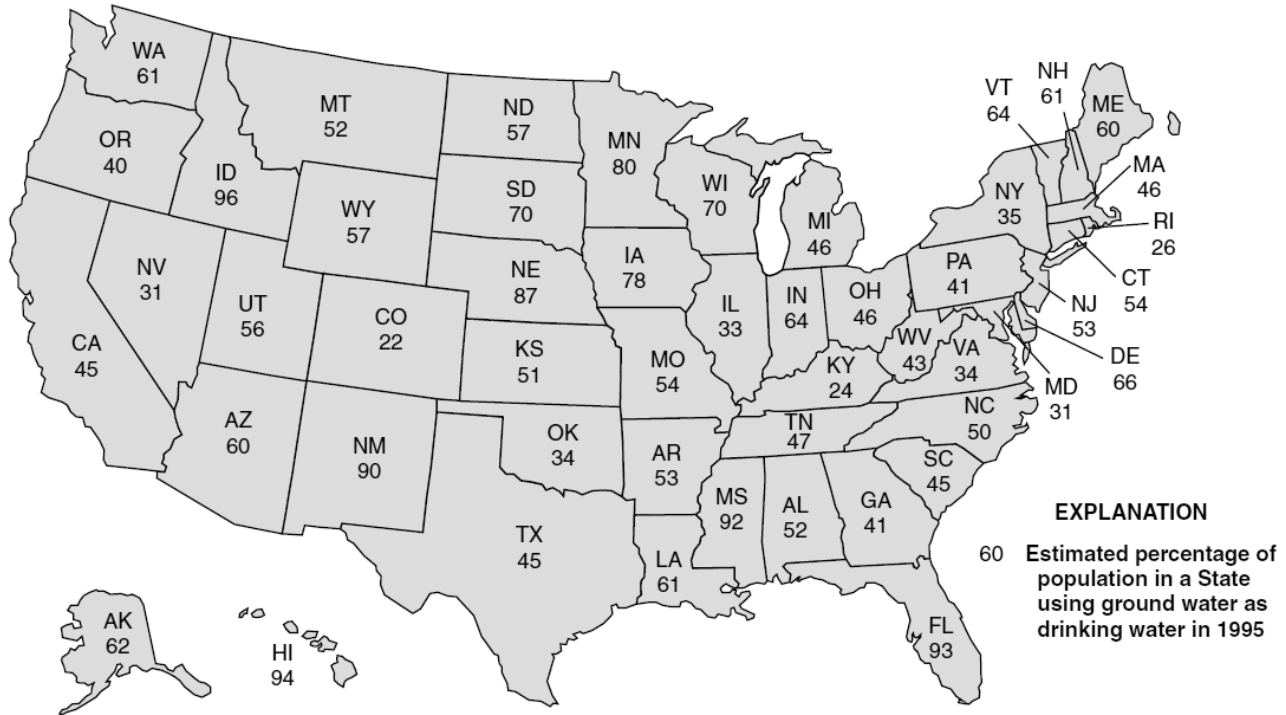


Using a pencil, follow the paths that rain water might take as it travels down into the ground between the soil particles to the water table (the shaded area at the bottom).



Hint: There may be more than one way for the water drop to travel.

United States Groundwater Use Map

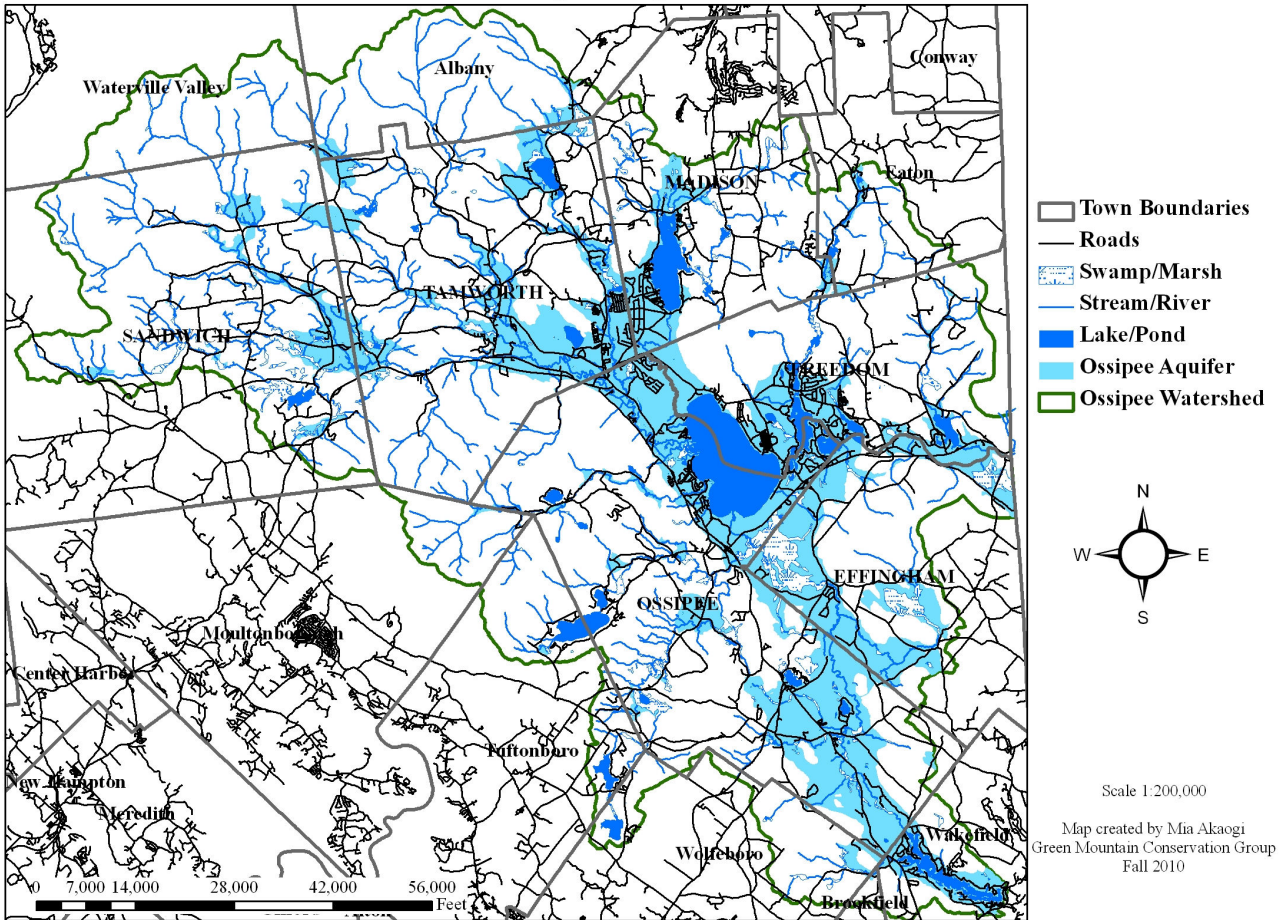


Questions:

1. What percentage (%) of people living in New Hampshire get their drinking water from the ground?
2. Which state has the *lowest* percentage (%) of people who use groundwater for drinking water?
3. Which state has the *highest* percentage (%) of people who use groundwater for drinking?
4. If drinking water is not coming from groundwater, then where is it coming from?

Ossipee Watershed Map

Ossipee Aquifer



Questions:

1. Draw a star (★) where your school is on the map. Is it located above the Ossipee Aquifer (light blue area)?
2. Draw a triangle (▲) where your house is on the map. Is it located above the Ossipee Aquifer (light blue area)?
3. Does your school have a well?
4. How deep is the well at your school?

My Drinking Water Well

My well is _____ (dug, driven, or drilled).

It is _____ feet deep and pumps groundwater from a _____ (bedrock, sand and gravel) aquifer.

Here is a drawing of my house and well (*roads, backyard, neighbors*):

Things that could pollute my well include:

A large, empty rectangular box with a thin black border, intended for a student to draw a house and well. The box is positioned below the text prompts and occupies the lower half of the page.

GET WET! Water Testing Parameters

	Definition	Sources	Maximum level that is safe in drinking water
CHLORIDE			
CONDUCTIVITY			
HARDNESS			
IRON			
NITRATE			
pH			

BOTTLE ID NUMBER _____ **Date** _____ **State** _____

First Name _____ **Last Name** _____

School _____ **Town** _____

Get Wet!

Groundwater Education Through Water Evaluation & Testing Laboratory Station Sampling Sheet

	Maximum Safe Limit or Range
CHLORIDE TEST	
Sample Result: Number of drops = _____	250 mg/L
Multiply Number of drops by 20 or 5 = _____ Cl mg/L	
Multiply the above Cl number by 1.6 = _____ NaCl mg/L	

NITRATE TEST

Sample Result = _____ mg/L **10 mg/L**

pH TEST

Sample Result = _____ **6.5-8.5**

HARDNESS TEST

Sample Result: Number of Drops = _____ **< 75 (soft)-**

Multiply by 17.1 or 20 = _____ mg/L **300 (hard)**

IRON TEST

Sample Result = _____ mg/L **0.3 mg/L**

CONDUCTIVITY TEST

Sample Result = _____ μ S/cm **625 μ S/cm**

Nice Job! Thank you!

Glossary

Anion: An ion with a negative charge (e.g. Cl^- , NO_3^-).

Aquifer: Underground sediments, which can be soil or rock, that are saturated and yield significant quantities of water.

Artesian well: Artesian wells are a specific type of drilled well that penetrate a confined aquifer which is under sufficient pressure to raise water levels above the land surface. Because of this natural pressure, some artesian wells do not require a pump.

Best management practices (BMPs): Structural, nonstructural, and managerial techniques recognized to be the most effective and practical means to reduce surface water and groundwater contamination while still allowing the productive use of resources.

Cation: An ion with a positive charge (e.g. Na^+ , NH_4^+).

Confined aquifer: An aquifer that is bounded above and below by impermeable or semi-permeable layers which are often referred to as a confining layers or beds. Confined aquifers are not directly recharged by precipitation, but will be recharged more slowly through fractures, small cracks, and pore spaces in the confining beds or through small unconfined regions.

Confining layer (confining bed): A layer of material (e.g. rock or clay) that prevents groundwater movement or the rate of movement is extremely slow and keeps the aquifer below it under pressure. This pressure creates springs and helps supply water to wells.

Discharge area: Where groundwater naturally resurfaces when it intersects with surface water, emerges from a hillside as a spring, or is pumped to the land surface through a well.

Drilled well: Wells that use percussion or rotary drill machines to penetrate about 100-400 feet into the bedrock. In order to be a useful water supply, a drilled well must intersect bedrock fractures containing groundwater.

Driven well: Wells that are constructed by driving a small diameter pipe into areas with thick sand and gravel deposits where the water table is within 15 feet of the land surface. A screened well point at the end of the pipe is attached before driving to help push the pipe through the soil and ultimately allows water to enter the well while at the same time filtering out sediment.

Dug well: Holes dug in the ground by shovel or backhoe until incoming water exceeded the digger's bailing rate. The well is lined with stones, brick, tile, or other material to prevent collapse and covered with a cap of wood, stone, or concrete. Dug wells tend to be shallow, typically only 10-30 feet deep.

Groundwater: Water found in spaces between soil particles underground (located in the saturation zone).

Groundwater recharge: Process where precipitation moves through the soil and reaches groundwater, replenishing aquifers.

Impermeable: A material that prevents water from moving through it.

Ion: An atom or a group of atoms that has acquired a net electric charge by gaining or losing one or more electrons.

Maximum contaminant level (MCL): The highest level of a contaminant that the Environmental Protection Agency (EPA) allows in public water systems. This is a legally enforceable standard under the Safe Drinking Water Act and is the maximum amount of a contaminant allowed in drinking water without causing risk to human health.

Mean: The mean is found by adding all the numbers in a data set and then dividing the sum by the total number of numbers. A mean is often called an average.

Median: The median is the middle value in a list of numbers. To find the median, the numbers should be arranged in order from least to greatest.

Mode: The mode is the number that occurs most often within a set of numbers.

Ossipee Aquifer: Stratified drift aquifer that lies underneath the Ossipee Watershed providing drinking water for a majority of the population.

Outlier: An outlier is a value that is numerically distant from the rest of the data. Outliers can be an indication of human error (either in data collection or entry) or equipment error (the kit or meter did not work correctly). However, an outlier could also be a legitimate result and an indication that the well or groundwater sample is unique in comparison to general trends across the town or watershed. It would be important to investigate this outlier further.

Permeable: Porous material that allows water to move freely through it.

Primary recharge area: Areas where aquifer materials are exposed at the land surface and where surface water and runoff directly infiltrate the ground and recharge the aquifer.

Range: The range is the difference between the largest (maximum) and smallest (minimum) number.

Recharge area: The entire land area that contributes precipitation to a groundwater resource.

Remediation: Containment, treatment or removal of contaminated groundwater. This may also include containment, treatment or removal of contaminated soil above the water table.

Saturated zone: The underground area below the water table where all of the spaces between soil and rock material are filled with water. Water found in the saturated zone is called groundwater.

Secondary maximum contaminant level (SMCL): The EPA also sets non-enforceable guidelines for contaminants that may cause cosmetic effects (such as skin and tooth discoloration) or aesthetic effects (such as taste or odor). Public water systems are not required to adopt these SMCL, but states may choose to adopt and enforce them.

Secondary recharge area: Zones adjacent to the aquifer where surface water and groundwater flow into primary recharge areas.

Standard deviation: A standard deviation is a measure of how spread out the data is. A low standard deviation indicates that the data points tend to be very close to the mean, whereas a high standard deviation indicates that the data is spread out over a large range of values.

Stratified drift aquifer: A type of unconfined aquifer that is comprised of thick layers of sand and gravel deposited by glacial meltwater.

Tertiary recharge area: Zones that supply water to streams that flow into primary recharge areas and may or may not recharge the aquifer depending on water levels.

Unconfined aquifer (water table aquifer): An aquifer made up of permeable geologic formations, either solid rock or loose sediments, which consist of sand, gravel, or clay, in which the upper boundary is the water table. These aquifers are also known as water table aquifers because they receive recharge directly from the infiltration of rainfall and surface water.

Unsaturated zone: The area between the land surface and the water table where some of the spaces between soil particles are filled with water and others are filled with air.

Volatile organic chemicals (VOCs): Many household products, including paints, varnishes, waxes, cleaners, disinfectants, and fuel and automotive products, contain VOCs or chemicals that form VOCs when added to water. VOC contamination of drinking water is a human health concern because many are toxic and known or suspected human carcinogens.

Water pollution: The introduction of any substance that changes the physical, chemical, or biological properties of water and makes it harmful to use.

Water table: The top of the saturated zone, which is also the upper surface for unconfined aquifers. This level varies greatly across the landscape and also varies seasonally depending on the amount of rain and snowmelt.

Answers

Ground Water Diagram

1. Unsaturated zone
2. Saturated zone
3. Water table
4. Groundwater

United States Groundwater Use Map

1. 61%
2. Colorado with 22%
3. Idaho with 96%
4. Surface water (lakes, rivers, reservoirs)

Image Credits

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Environmental Protection Agency (2004). Thirstin's Wacky Water Adventure Activity Book. Retrieved from <http://www.epa.gov/kids/water.htm>

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<http://www.umaine.edu/waterresearch/outreach/GetWet/Teachers.htm>