



AWESOME AQUIFERS

Study Guide



AAB STUDY GUIDE

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How to Compete in Awesome Aquifers

This guide is written for coaches and students who are training to compete in Awesome Aquifers (AAB), a Science Olympiad event.

Awesome Aquifers is a fun competition that utilizes geology, earth science, hydrology, and meteorology topics.

This event will challenge your creativity by incorporating skills in three-dimensional model building, public speaking, thinking on your feet, and scientific knowledge.

During the competition, teams of up to two students build an aquifer and demonstrate an understanding of groundwater in the hydrologic cycle, the physical makeup of an aquifer, changes to the groundwater system, contamination clean-up, and much more.

The event uses a holistic approach by including a written test component in addition to the building component.

This guide includes sample test questions, model making ideas, and

possible demonstration concepts to help you prepare for competition.

The event Awesome Aquifers was designed by The Groundwater Foundation, a nonprofit organization that educates people and inspires action to ensure sustainable, clean groundwater for future generations.

Learn more at www.groundwater.org.

Get Started!

1. Learn everything you can about groundwater.
2. Experiment by constructing various models.
3. Quiz yourself on the topics.
4. Practice presenting your model to other people.

Official Rules for Competition: Awesome Aquifers

AWESOME AQUIFERS

1. **DESCRIPTION:** Students will construct an aquifer and answer questions about groundwater concepts.

A TEAM OF UP TO: 2

APPROXIMATE TIME: 50 Minutes

2. **EVENT PARAMETERS:** The supervisor will supply score sheets, water, Station 2 resources, and Station 3 building objectives. Students are required to bring any materials needed to assemble an aquifer on-site. The entire aquifer is to be housed in one transparent container not exceeding a total volume of 3 liters. This container can be cut or punctured in advance but must be brought to the competition empty. Electric pumps/tools and commercial flow models are not allowed. Students cannot bring notes, texts, or references. Students are responsible for taking and/or properly disposing of all materials used in assembling their aquifer. An extended list of suggested materials and possible concepts are available at http://www.groundwater.org/pe/so_aa.html and may include but not limited to material such as:
 - a) Sand and gravel (such as pea-sized or aquarium gravel)
 - b) Modeling clay or plumber's putty
 - c) Materials for wells and pumps, such as soap bottle pumps or aquarium tubing and plastic syringes. No electric or commercial pumps permitted.
 - d) Well screening materials, such as nylon hose, cotton, coffee filters, etc.
 - e) Sponge
 - f) Aluminum foil and/or plastic wrap or sheeting
 - g) Empty 35 mm plastic film canisters or equivalent
 - h) Material to represent contaminants, such as food coloring or powdered drink mix
 - i) Materials that could be used for remediation such as coffee filters, fabric squares, charcoal, etc.
 - j) Items useful in creating or demonstrating the aquifer but that will not be part of the aquifer, such as scissors, tacks, tape, containers to hold water and/or contaminants, blank paper, pen or pencil, etc.
3. **THE COMPETITION:** Students will be given 10 minutes to complete each station.
 - a) **Station 1:** Students take a written test on groundwater concepts and vocabulary. Questions can be multiple choice, true/false, fill in the blank, or short answer.
 - b) **Station 2:** Students take a written test utilizing provided resources such as maps, charts, graphs, models, and scientific publications. Questions can be multiple choice, true/false, fill in the blank, or short answer.
 - c) **Station 3:** Students build an aquifer that will explain and demonstrate concepts chosen by the event supervisor. Students may create notes at Station 3 to use at Station 4. Possible concepts include but are not limited to: recharge, discharge, connection between surface and groundwater, water table, porosity, permeability, well location and abandonment, groundwater contamination, remediation, and safe yield from an aquifer. See list of presentation concepts for regional, state, and national tournaments at Awesome Aquifer event page at www.soinc.org.
 - d) **Station 4:** Students use the aquifer built at Station 3 to explain and demonstrate the required concepts to a judge(s). Information may be presented in any way or order students choose and the same demonstration may be used to explain more than one concept. Judge(s) may ask clarifying questions but only if a team has finished its demonstration and there is time remaining.
4. **SCORING:** Highest score wins. Station 1-25%, Station 2-25%, and Station 4-50%. First tiebreaker: highest score at station 4. Second tiebreaker: highest score on pre-selected questions at station 1 and 2. Answers must include units where appropriate.

Recommended Resources: All reference and training resources including the **Awesome Aquifer DVD** are available on the Official Science Olympiad Store or Website at www.soinc.org

THIS EVENT IS SPONSORED BY THE GROUNDWATER FOUNDATION (www.groundwater.org/pe/so_aa.html)



Sample Score Sheet: Awesome Aquifers

Awesome Aquifers Score Sheet

Name(s): _____ Raw score/rank: _____

School Name: _____ Team Number: _____ State: _____

Point Totals

	Possible	Total
Station 1: Test	15	
Station 2: Test	15	
Station 4: Demonstration Points	30	
Total Stations 1, 2, 4	60	
1 st Tiebreaker: Highest score at Station 4	.5 pt	
2 nd Tiebreaker: Highest score on pre-selected demonstration items/test questions—.01pt per question needed to break a tie	.01 pt each	
Total Points		

Station 1:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Station 2:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

sample

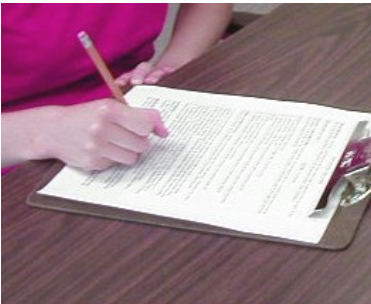
**Station 1: Hydrology Test**

Teams will have 10 minutes to complete a written test covering groundwater concepts and vocabulary.

Questions will be formatted as multiple choice, true/false, fill in the blank, short answer or a combination of both.

Prepare for this test by studying groundwater related terminology.

Station 1 counts as 25% of a team's total score.



Learn important terminology at
www.groundwater.org.
Answer key is on page 9.

Station 1: Sample Test Questions

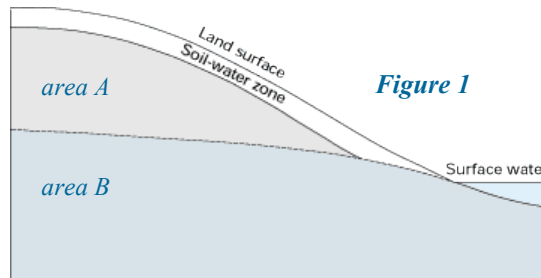
1. A hole or shaft drilled into the earth to pump water to the surface is referred to as a:
A. sink hole B. spring
C. water supply D. well
2. An outflow of water from a stream, pipe, groundwater aquifer, or watershed is called:
A. recharge B. dismiss
C. discharge D. ejection
3. Material that allows water to penetrate through it is considered:
A. leaky B. absorbent
C. resistant D. permeable
4. The process of lowering the groundwater level through pumping a well is called:
A. drawdown B. attenuation
C. reduction D. dwindling
5. The solid rock beneath the soil and superficial rock is:
A. foundation B. core rock
C. bedrock D. base
6. Water that does not become absorbed by the earth but flows across the surface of the land into a stream or lake is called:
A. runoff B. overflow
C. overspill D. discharge
7. The flow of water from the land surface into the subsurface is:
A. permeation B. admission
C. penetration D. infiltration
8. An aquifer containing groundwater that has an impermeable layer below but not above it is called a(n):
A. unconfined aquifer B. confined aquifer
C. restricted aquifer D. upper aquifer
9. The zone immediately below the land surface where the pores and fractures contain both water and air is the:
A. confining zone B. withdrawal zone
C. unsaturated zone D. saturated zone
10. What is the term that describes or measures the open or void spaces in rocks or sediments?
A. permeability B. porosity
C. absorbency D. sustainability



Station 2: Sample Test Questions

1. In figure 1, what is the proper name for area A?

A. saturated zone
B. unsaturated zone
C. polyunsaturated zone
D. free fall zone



2. What would you expect to find in the voids (spaces between the sediment particles) throughout most of area B in figure 1?

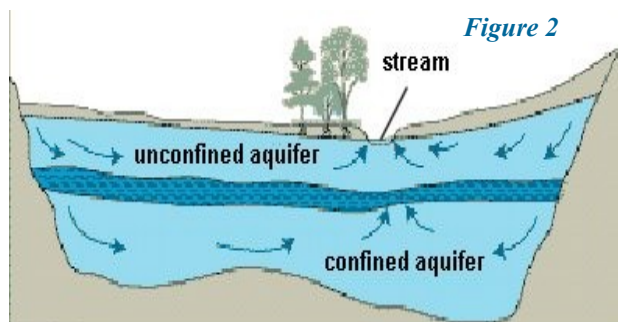
A. worms
B. roots and other living plant materials
C. air and a little water
D. water

3. In figure 1, the line separating area A and area B is known as the ____.

A. water line
B. hydroequalization gradient
C. aquatic differentiation margin
D. water table

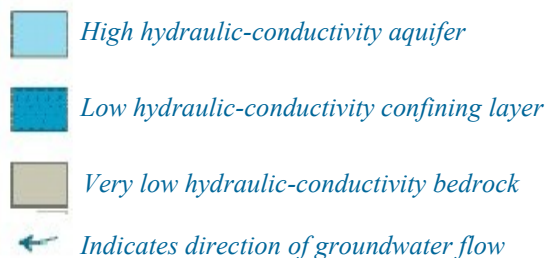
4. Which of the following would be the most likely type of material in the confining layer in figure #2?

A. sandstone
B. gravel
C. granite
D. topsoil



5. What is the relationship between the stream and the unconfined aquifer in figure 2?

A. water is moving from the stream into the aquifer
B. water is moving from the aquifer into the stream
C. there is no relationship between the stream and the unconfined aquifer
D. None of these answers are possible based upon information provided



6. In figure 2, which body of water would probably have the highest rate of flow?

A. groundwater in the unconfined aquifer
B. surface water in the stream
C. confining layer
D. None of the above; they have equal flow rates

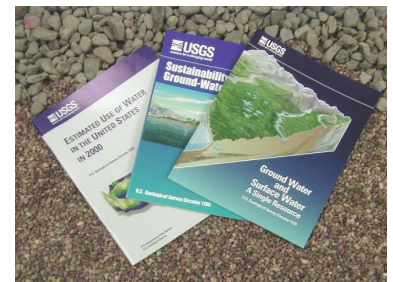
Station 2: Resource Test

Teams will have 10 minutes to complete a written test covering groundwater concepts and occurrences using maps, charts, graphs, booklets, textbooks, models and/or other resources as provided by the event supervisor.

Questions will be formatted as multiple choice, true/false, fill in the blank, short answer or a combination of both.

Prepare for this test by reviewing groundwater related texts and journals.

Station 2 counts as 25% of a team's total score.



Find sample resources to study from at www.groundwater.org. Answer key is on page 9.

**Station 3: Model Building**

During competition, your team will be given 10 minutes to construct one aquifer model.

The event supervisor will pre-select concepts from the possible concept list on page 8 for your team to explain and demonstrate. While building at Station 3, teams will be provided with the list of selected concepts to incorporate into their model.

It is a good idea to practice building and presenting several different models before competition.

Models can be built from a variety of items you can find around your home (kitchen, garage) or school (science classroom, art room, playground) for little to no cost. Great places to shop for these items include discount stores, hardware stores and pharmacies.

During competition, students are allowed to make notes as they build at Station 3. These notes can be used only at Station 4 while presenting. Notes will be turned into the judge(s) at Station 4.



Station 3: Sample Supply List

CONTAINER IDEAS

Rules require teams to bring one transparent container with a volume that does not exceed 3 liters. Teams will construct their model inside this container. If desired, this container can be cut or punctured prior to competition, but must be carried in to the tournament EMPTY. This container can hold smaller containers within and/or be partitioned into sections. We do NOT recommend constructing your own container because they have a tendency to leak and can be costly to make. Commercially produced groundwater flow models are not allowed.

- Plastic storage bin (common manufacturers include Rubbermaid, Sterilite, etc.)
- Plastic food container (common manufacturers include Ziplock, Gladware, etc.)
- 2 liter soda bottle, juice bottle, or similar; cut any way
- Acrylic display box (for collectibles like Beanie Babies)
- Small pet aquariums (for fish, reptiles, hermit crabs, etc.)
- Other
- You may wish to bring additional smaller containers (drinking cups, beakers, squeeze bottles, 35mm film canisters, salt shakers, etc) to put inside your larger container, or use externally to store water or a “mock” contaminant. This use of additional containers is permitted.

MATERIAL IDEAS

This is a sample list of possible items that may be used to build an aquifer, strata layers, wetlands, lakes, rivers, wells, water treatment (remediation) techniques, etc. There is no limit to the number of items included inside your model, however simple models outperform complex ones. Electric pumps and power tools are not allowed. NOTE: Students are required to bring their own supplies to the tournament.

- Sand (play or beach)
- Gravel (various sizes: aquarium, pea, landscape, lava, quartz, etc.)
- Potting soil
- Sponge (kitchen or natural)
- Floral foam (used in flower arrangements), styrofoam
- Coffee filter paper, cotton balls
- Tubing (aquarium air line), drinking straws, plastic hose (represent a well)
- Hand pump from a soap or lotion bottle (represent a well)
- Plastic syringe (obtain from a medical supply store or veterinarian – attach to tubing to function as a well pump)
- Panty hose, cheese cloth, window screen (attach to the bottom of a well to keep well from clogging – represent a well screen)
- Green astro turf, carpet or door mat (represent a lawn or farm)



Station 3 (cont.)

- Modeling clay or plumber's putty (use to make confining layers as well as an adhesive to hold smaller items in place)
- Squirt bottle, squeeze bottle or spray bottle (hold water or a contaminant)
- Aluminum foil, cling wrap, plastic sheeting
- Plastic aquarium plants, toy buildings/people, sticks and twigs (decorative)
- Other

CONTAMINATION IDEAS

This is a list of items that may be used to contaminate and/or remediate your model. Use only items that REPRESENT a contaminant. The use of actual hazardous and harmful chemicals is NOT allowed (motor oil, fertilizer, bleach, etc.)

- Powder drink mix (Kool-Aid, hot cocoa, instant tea, etc.)
- Liquid food coloring (diluted with water)
- Activated charcoal (for aquariums)
- Baking soda and vinegar
- Coffee filters, sponges, cotton balls, etc.
- Other

ADDITIONAL HELPFUL SUPPLIES

These items might be useful while designing, assembling, and practicing your model.

- Scissors, craft knife
- Tape (electrical, duct, etc.)
- Thumb tacks (poke drainage holes in something)
- Cups, beakers
- Scoops, medicine cups, spoons
- Eye dropper or pipette
- Rubber bands
- Toothpicks, wooden dowels
- Pencil and paper (making notes/drawings, taking tests)
- Paper towels
- Tape recorder, video camera, or live audience
- Other



View more photos online at
www.groundwater.org.

**Station 4: Presenting**

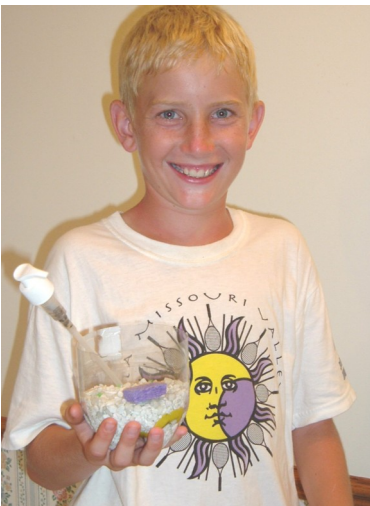
At Station 4, teams will have 10 minutes to thoroughly explain (verbally define and give examples) AND demonstrate (manipulate their model to show) the pre-selected concepts in any order or format.

Points for each concept are determined before competition and are based on the complexity of concept. Points are awarded for comprehensiveness, accuracy, and clarity.

Teams will present their model to a panel of one or more judges.

Possible concepts are listed on the right.

Station 4 counts as 50% of a team's total score.



When practicing the design, construction, and presentation of your model ask yourself the following:

Can I verbally define _____?

Can I clearly explain _____?

Can I point out or manipulate my model to clearly show _____?

Station 4: Sample Presentation ConceptsRegional Tournament Presentation Concepts:

- ☐ Groundwater recharge from precipitation
- ☐ Groundwater recharge from surface water
- ☐ Groundwater discharge to surface water
- ☐ Water table
- ☐ Saturated zone
- ☐ Unsaturated zone
- ☐ Pore space
- ☐ Impact a well has on groundwater quantity
- ☐ Impact a well has on surface water
- ☐ Importance of well siting (location)
- ☐ Importance of well closure (abandonment)
- ☐ Infiltration
- ☐ Groundwater as a part of the hydrologic cycle.
- ☐ Unconfined aquifer

State Tournament Presentation Concepts: *All of the regional tournament concepts listed above with the addition of the following concepts.*

- ☐ Potential groundwater contamination source(s) produced by human activities
- ☐ Naturally occurring groundwater contamination source(s)
- ☐ Movement of a contaminant in groundwater
- ☐ Impact a well has on groundwater quality
- ☐ Safe yield (aka sustainable yield)
- ☐ Confining layer/confined aquifer
- ☐ Contamination plume
- ☐ Area of influence/cone of depression
- ☐ Impermeable layer
- ☐ Overwithdrawal
- ☐ Leachate
- ☐ Nonpoint source pollution
- ☐ Point source pollution

National Tournament Presentation Concepts: *All of the regional and state tournament concepts listed above with the addition of the following concepts.*

- ☐ Impact contaminant sources have on humans and the environment
- ☐ Porosity (in at least two different materials and quantify difference)
- ☐ Permeability (in at least two different materials and quantify difference)
- ☐ Artesian aquifer, artesian well
- ☐ Remediation techniques (simulate technique and show reduction of contamination)
- ☐ The Wellhead Protection Area
- ☐ A Best Management Practice
- ☐ Groundwater under the direct influence of surface water
- ☐ Salt water intrusion
- ☐ Subsidence/Sink holes

Answer Key for Sample Tests

STATION 1

1. D
2. C
3. D
4. A
5. C
6. A
7. D
8. A
9. C
10. B

STATION 2

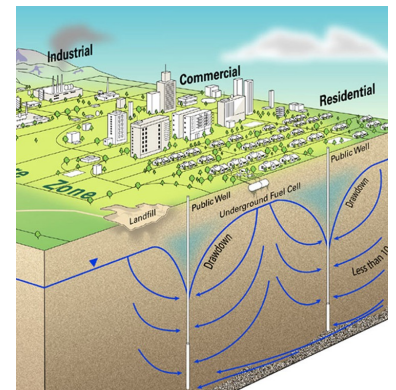
1. B
2. D
3. D
4. C
5. B
6. B

Internet Resources

- Study at www.groundwater.org/pe/so_aa.html, www.usgs.gov, and www.epa.gov
- Check www.soinc.org for updates
- Check the SO student forum at www.scioly.org for AA(B) discussion threads

Add your own

-
-
-
-
-
-





Glossary: Terms to Know

Aeration zone: The zone immediately below the land surface where the pores contain both water and air, but are not totally saturated with water. Plant roots can capture the moisture passing through this zone, but it cannot provide water for wells. Also known as the unsaturated zone.

Aquifer: An underground geological formation able to store and yield water.

Cone of depression: The zone around a well in an unconfined aquifer that is normally saturated, but becomes unsaturated as a well is pumped, leaving an area where the water table dips down to form a cone shape. The shape of the cone is influenced by porosity and the water yield or pumping rate of the well.

Confining layer: Geologic material with little or no permeability or hydraulic conductivity. Water does not pass through this layer or the rate of movement is extremely slow.

Depletion: The loss of water from surface water reservoirs or groundwater aquifers at a rate greater than that of recharge.

Discharge: An outflow of water from a stream, pipe, groundwater aquifer, or watershed; the opposite of recharge.

Drawdown: A lowering of the groundwater level caused by pumping.

Flow rate: The time required for a volume of groundwater to move between points. Typically groundwater moves very slowly—sometimes only inches per year.

Groundwater: Water found in the spaces between soil particles and cracks in rocks underground (located in the saturation zone). Groundwater is a natural resource that is used for drinking, recreation, industry, and growing crops.

Hydrologic cycle: (also known as the water cycle) The paths water takes through its various states--vapor, liquid, solid--as it moves throughout the oceans, atmosphere, groundwater, streams, etc.

Impermeable layer: A layer of material (such as clay) in an aquifer through which water does not pass.

Infiltration: Flow of water from the land surface into the subsurface.

Infiltration rate: The quantity of water that enters the soil surface in a specified time interval. Often expressed in volume of water per unit of soil surface area per unit of time.

Monitoring well: A non-pumping well, generally of small diameter, that is used to measure the elevation of a water table or water quality.

Overwithdrawal: Withdrawal of groundwater over a period of time that exceeds the recharge rate of the supply aquifer. Also referred to as overdraft or mining the aquifer.

Permeable/Permeability: Capable of transmitting water (porous rock, sediment, or soil); the rate at which water moves through rocks or soil.

Permeable layer: A layer of porous material (rock, soil, unconsolidated sediment); in an aquifer, the layer through which water freely passes as it moves through the ground.

Plume: In groundwater a plume is an underground pattern of contaminant concentrations created by the movement of groundwater beneath a contaminant source. Contaminants spread mostly laterally in the direction of groundwater movement. The source site has the highest concentration, and the concentration decreases away from the source.



Glossary (cont.)

Pore space: Openings between geologic material found underground. Also referred to as void space or interstices.

Porosity: The ratio of the volume of void or air spaces in a rock or sediment to the total volume of the rock or sediment. The capacity of rock or soil to hold water varies with the material. For example, saturated sand contains about 20% water; gravel, 25%; and clay, 48%.

Recharge: Water added to an aquifer. For example, when rainwater seeps into the ground. Recharge may occur artificially through injection wells or by spreading water over groundwater reservoirs.

Recharge rate: The quantity of water per unit of time that replenishes or refills an aquifer.

Recharge zone or area: An area where permeable soil or rock allows water to seep into the ground to replenish an aquifer.

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

Residence time: Period of time that groundwater remains in an aquifer.

Safe yield: The annual amount of water that can be taken from a source of supply over a period of years without depleting that source beyond its ability to be replenished naturally in "wet years." Also called sustainable yield.

Salt water intrusion: Process by which an aquifer is overdrafted creating a flow imbalance within an area that results in salt water encroaching into fresh water supply.

Saturation zone: The portion below the earth's surface that is saturated with water is called the zone of saturation. The upper surface of this zone, open to atmospheric pressure, is known as the water table.

Subsidence: A depression of the land surface as a result of groundwater being pumped. Cracks and fissures can appear in the lnd. Subsidence is virtually an irreversible process.

Surface water: Water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff.

Water table: The top of an unconfined aquifer; indicates the level below which soil and rock are saturated with water. The upper surface of the saturation zone.

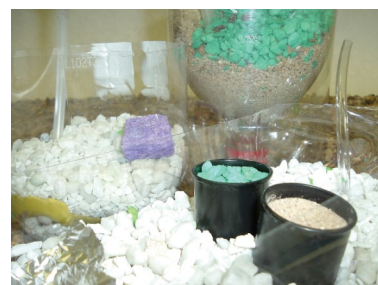
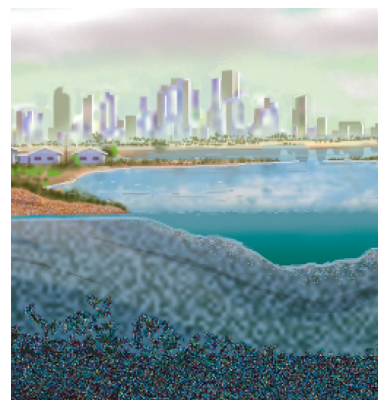
Well: A bored, drilled or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies to inject, extract or monitor water.

Well closure: The process of sealing a well that is no longer being used to prevent groundwater contamination and harm to people and animals.

Well siting: Location of a well placed to best protect water quality, access adequate water quantity, and allow for inspection and maintenance of the well.

Wellhead protection area: A protected surface and subsurface zone surrounding a well or well field supplying a public water system to keep contaminants from reaching the well water.

Withdrawal: Water removed from a surface or groundwater source for use.



Learn more terminology online
at www.groundwater.org.

Team Notes



Science Olympiad

Science Olympiad is a nonprofit organization devoted to improving the quality of science education, increasing student interest in science and providing recognition for outstanding achievement in science education by both students and teachers.

These goals are accomplished through classroom activities, research, training workshops and the encouragement of intramural, district, regional, state and national tournaments.

Science Olympiad tournaments are academic competitions that consist of a series of individual and team events which students prepare for during the school year. These competitions are balanced among the various science disciplines of biology, earth science, chemistry, physics, computers and technology.

For more information about Science Olympiad, visit their official website at www.soinc.org.

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