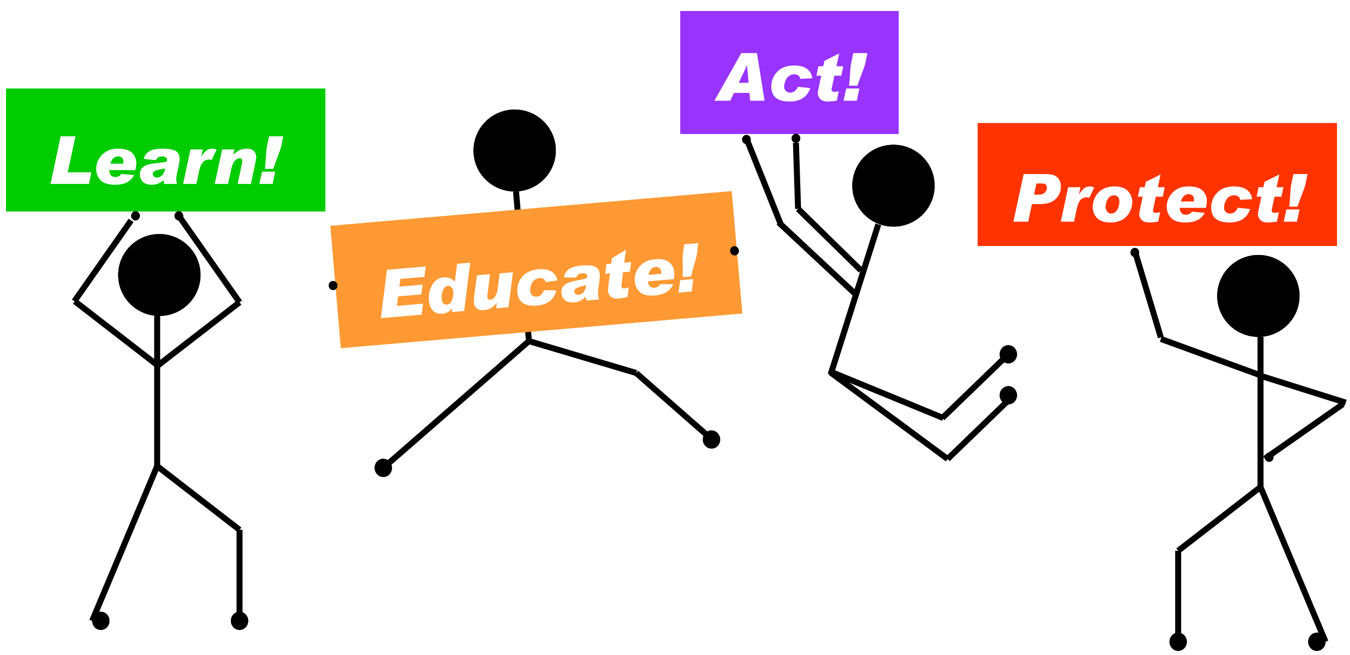
LEAP INTO GROUNDWATER



A Groundwater Foundation Program

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Welcome to LEAP into Groundwater

What is LEAP?

LEAP into Groundwater is a project-based educational curriculum developed to engage students in learning about groundwater, taking action to protect their water resources, and making a difference in their community.

The project is presented in four phases:
Learn about groundwater
Educate others about groundwater
Act in your local community
Protect groundwater

Why offer the LEAP project to my group?

LEAP encourages the development of strong environmental ethics and personal worth in young people.

LEAP develops an understanding of civic responsibility in youth.

LEAP empowers youth to think globally and act locally; it allows youth to become examples of what they can accomplish individually, and understand how their accomplishments can benefit the community and world.

LEAP meets many of the National Science Standards (listed in the Teaching Tools section of the manual,) therefore it provides educators with a creative approach to meeting curriculum requirements.

Who can lead the LEAP project?

You can! LEAP is designed so that any group leader or educator, whether you have a science background or not, can lead the project.

This manual provides background information and tools needed to conduct and complete the LEAP project. The Groundwater Foundation is also available to assist with questions and direct you to additional resources you many need. In addition, all LEAP educators are encouraged to join the LEAP listserv and utilize the resources available at www.groundwater.org.

Reading through the manual before beginning the project will allow you to familiarize yourself with the complete project and maximize each phase of LEAP.

Who can participate in LEAP?

LEAP is designed for middle and high school-age students, but the curriculum can be adapted for students of all ages or academic levels.

LEAP can be implemented in the classroom, during after school programs, as girl or boy scouts projects, or any number of other groups/clubs/meeting etc.

Now, get ready for fun as you LEAP into Groundwater!

Join the LEAP Listserv!
Get extra activity ideas!
Give feedback!
Share what you have done!
Learn what others are doing!

www.groundwater.org

The LEAP network will provide you with project updates, tips, additional resources, and networking with other LEAP educators and participants.

To provide you with the best resources possible it is important that we receive feedback from you and your students. After completing each LEAP phase please complete the evaluation and send to LEAP@groundwater.org

How does it work?

As mentioned, the LEAP project is made up of four phases:

Learn – Participants learn the basics of groundwater. Topics such as how groundwater moves, how it becomes contaminated, and how groundwater can be protected are taught through hands-on activities and model building.

Educate - Participants will share the concepts learned with a larger audience (parents, peers, community leaders, or the community at large) by hosting an open house or a mini-festival.

Act – The act phase will provide structure for youth to directly protect their water supply. This phase asks the students to choose a groundwater-friendly activity to implement at their school or in their community.

Protect - The last phase incorporates students in long-term protection efforts through participation in one of The Groundwater Foundation's community-based action programs.

This manual will guide groups through each stage. Additional resources are available in the Resources section of this manual and at www.groundwater.org

We want to learn as you are going through the process, so please take time to share your experiences with us. Complete the LEAP evaluation after the completion of each phase.

What do we need to complete the project?

- A group of students and at least one educator/leader
- The LEAP manual
- The Awesome Aquifer Kit
- Additional funding may be needed for the Act phase but is not required

How long does it take to complete the project?

How long it will take you to complete LEAP will vary for each group. You decide how long you and your students will need to accomplish the goals of each phase of the project. So the length of the project is up to you. A sample timeline is included in the Other Resources section.

What outcomes can be achieved through LEAP?

- **Educated youth** and increased community awareness about the role groundwater plays in their lives.
- **Involved youth** and community members in the protection of groundwater resources on a local level.
- **Inspired youth** through project-based learning experiences

What is an Awesome Aquifer Kit?

The Awesome Aquifer Kit is a fun and educational groundwater kit that includes everything you need to construct your very own groundwater flow model! The Awesome Aquifer Kit comes with accessories and detailed activity instructions for experiments that demonstrate:

- aquifer construction
- connection between surface water and groundwater
- porosity and permeability
- contamination and remediation

What does it contain?

- durable, clear plastic activity and storage box
- illustrated activity book
- well simulators/pumps
- mock contamination and remediation supplies
- aquifer construction materials

The Awesome Aquifer Kit will be used in the Learn and Educate phases of LEAP.

Awesome Aquifer Kits can be purchased from The Groundwater Foundation.
Visit the online catalog at www.groundwater.org or
call 1-800-858-4844 or email LEAP@groundwater.org

The LEAP project offers a unique way to engage students in learning about the importance of groundwater and why it should be protected. Students get to build their own aquifer model. But, first, let's collect some baseline data.

First Assess!

It is important to see what information your students already know about groundwater. Provided in the Resources section under "Teaching Tools" you will find pre and post tests, a brain-web evaluation tool, as well as a participation survey. Please use one or all of these tools to assess your students' groundwater knowledge prior to doing any activities.

Educators are encouraged to select the level of groundwater education that is appropriate for their audience. Some educators may only need the Awesome Aquifer Kit guide booklet as a resource. While educators, less familiar with general groundwater concepts, or who have students who would like more in depth information can refer to the sections Groundwater 101, Groundwater Glossary, Awesome Aquifer Building and Other Resources of this manual.

Second Build!

The Awesome Aquifer Kit is used in this phase. It provides all the materials for you and your students to learn about the characteristics of groundwater by building an aquifer model. See "Awesome Aquifer Building" in the Resources section for more information about the Awesome Aquifer activities.

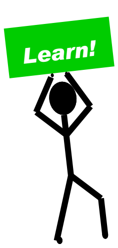
TIPS:

Prepare to guide the activity

- Before presenting to the students first build your own groundwater model to become familiar with the activities and concepts.
- Utilize the Awesome Aquifer Kit instruction manual and the How to Guide online at www.groundwater.org for tips and instructions.

Now guide students through the Awesome Aquifer activities.

- Allow about 45-50 minutes to complete this activity. You may also decide to break the model building up into 2-3 shorter sessions.
- Divide your class into teams of 2-4 students. Each team will need an Awesome Aquifer kit or supplies.
- Ask questions first. It is important to ask the students to predict what will happen and figure out why something occurred rather than showing or explaining it to them. Also allowing them to experiment with the models beyond the Awesome Aquifer kit activities is encouraged.
- Initiate a student discussion of what they learned and how these concepts relate to their school campus, local parks, community, local farm and agriculture land. What threatens the groundwater in your community/state? What can be done to prevent your groundwater from becoming contaminated? This discussion will motivate students for the next phases of LEAP!



Third Experiment!

Once your students have become familiar with the groundwater concepts allow them to continue to manipulate their models and/or create new ones. An Awesome Aquifer Concept List is provided in "Awesome Aquifer Building" in the Resources section. This concept list will challenge students and may initiate further discussion and research of groundwater in your class. As students begin to create and manipulate their aquifer models it is now time to think about the next phase of LEAP, Educate.

TIPS:

- Utilize the Resources in this manual to help you and your students learn and understand groundwater concepts.
- Visit www.groundwater.org for additional resources.

Educate

Education is a powerful motivator. Giving students the opportunity to be the experts will help them to better understand and better retain the groundwater information they acquired in Learn. It will also build awareness about groundwater in the larger community!

First Decide!

Decide what type of educational event is best suited for your group. There are many different ways to educate the larger public. Here are some ideas:

- **Host an Open House**: Hosting an open house for family, friends and community leaders is a great way to share the information you have learned. It is an event students can organize, and can also serve as a fundraiser to raise the money to enhance the Act phase, when students will be implementing a project in the community. For more open house ideas see the How to Host an Open House in the Other Resources section.
- **Host a mini-groundwater festival**: Hosting a groundwater festival is a big task, but The Groundwater Foundation has numerous resources to make your event successful. If you would like additional resources to assist in planning your mini festival, contact The Groundwater Foundation to order a copy of: Making Ripples - How to Organize a School Water Festival, or Making a Bigger Splash - A Collection of Water Education and Festival Activities.
- **Host a Public Awareness Campaign**: To offer a comprehensive Public Awareness Campaign download The Groundwater Foundation's Public Awareness Campaign Kit (www.groundwater.org)
    - Think about the numerous ways technology allows us to spread the news:
        - Create a YouTube video on aquifer model building
        - Create a webpage for your school's website on groundwater protection
        - Get interviewed on local TV stations
        - Write a story for your school newsletter, local paper
        - Write and record a public service announcement for a local radio station
- **Organize visits** to local businesses to educate them on groundwater
- **Decorate your school** with groundwater messages
- **Dedicate a week to groundwater awareness**: offer messages at events (sporting events, all-school assemblies, etc)
- **Speak to local leaders:** local government officials, board or council
    - Set up a time to meet with local public officials
    - Develop discussion topics to address
- **Create and distribute** educational posters, brochures and newsletters in your community.
- **Celebrate** Earth Day, National Groundwater Awareness Week, World Water Monitoring Day and other nationally recognized environmental events or holidays by providing a groundwater education booth or presentation.
- **Develop a new public education event** (Remember to share your experiences with us in the evaluation.)

Second Organize!

Work with your students to identify which groundwater concepts should be demonstrated at their educate event. Make sure to take into consideration the age of the audience! Next you and or your students will need to begin planning for the event and practicing their demonstrations.

TIPS:

- Make sure students have been given enough time to prepare so that they feel confident in the groundwater protection message they will relay.
- Make it fun!

Now that students realize the fragility of the environment, it is important they take action to protect the environment.

First Discuss!

There are numerous activities students can do. Some are basically free while others have a cost associated with them. This is a great opportunity for students to understand one of the obstacles to environmental protection: cost.

How to overcome the cost obstacle:

- Apply got grant funding if available.
- Organize a fundraiser
- Recruit a local business to be a sponsor
- Collect donations at your Educate event (make sure to provide information about how project funds will be used)
- Select an activity that requires only volunteer resources

Please keep in mind that the Act phase should allow the students to actually make a difference and participate in a groundwater-friendly action. Make sure the chosen activity is practical and can be accomplished by your students in the time frame available for your project.

Groundwater-friendly action suggestions:

- **Organize a pick up litter event** in your neighborhood, on your school grounds, or at a nearby park.
- **Stencil the storm drains** in your neighborhood or community. Did you know that whatever is put down the storm drains ends up in the lake and streams where you go fishing, swimming and boating?
- **Research and identify "green" cleaning products**. Many of the best products are homemade. Do your research in the library or on the internet in addition to checking what is available in stores. Market these products for use in your school and at home. Collect data and evaluate how many homes have switched to "green" cleaning products.
- **Join or start a water/environmental/natural resource club**.
- **Install a rain garden** at your school/church/park/etc.
- **Paint and install rain barrels** at your school/church/community gardens/ etc.
- **Recruit private well owners** to join the wellcare wellowners network.
- **Work with your local community** and water utilities to develop a wellhead protection plan.

TIP:
For more information and resources about many of the Act ideas listed above visit, www.groundwater.org

Second Plan!

Make a plan of action. Think through all of the important questions: How, What, Where, When…to make sure your action is successful.

Third Act!

Don't just do it! Have fun doing it, and know that you are positively impacting your environment.

Fourth Share!

Share your successes! Inform sponsors or funders and your community about what you have accomplished. Write a press release for your local media. Post information to your school/group website. Tell The Groundwater Foundation and with your permission your success will be featured on our website and/or in our publications.

TIPS:

- Make sure you get authorization to do whatever action you choose before you start.
- Don't forget to tell us about your event!

Protect

Through the students your larger community has been educated about groundwater, the role it plays in their lives, the impact each of us has on groundwater and the role we play in protecting it. Therefore the next logical step is for students to capitalize on the momentum and get the community actively involved in long-
term protection efforts.

First Decide!

The LEAP project offers two effective options:

- **Recruit** a site for the Groundwater Guardian Green Site (Green Sites) program. The Green Sites program recognizes sites with highly managed turf (such as school grounds, city or state parks, churches, ball parks, etc) that are implementing groundwater-friendly practices. The sites are designated into the program after completing an application and scoring at least 70 percent. LEAP participants can identify a site in their community, assist in the process to become a Green Site and participate in or host the designation ceremony. To learn more about Green Sites visit http://www.groundwater.org/action/community/green-sites.html.
- **Participate** in the Groundwater Guardian (GG) program by forming a new GG Community or joining an existing GG Community. A GG Community is a group of volunteers that work locally to provide education and action. The GG program provides the structure for these volunteer teams to act locally, and the opportunity to think globally by networking with the GG Communities across North America. To learn more about GG visit http://www.groundwater.org/action/community/guardian.html.
- **Recruit and participate** in both programs. You, your students, and community may also decide to be active in both programs!

TIPS:

- For more about these programs see the Groundwater Guardian Green Sites and Groundwater Guardian Program information in the Other Resources section and on the websites listed above. Follow the appropriate process and submit your application!
- There is no cost to LEAP participants for either Groundwater Guardian or Groundwater Guardian Green Sites.

Second Celebrate!

Celebrate your achievements! Look how far you have come. Let your community know the efforts that you have made to ensure a better life for everyone in your community.

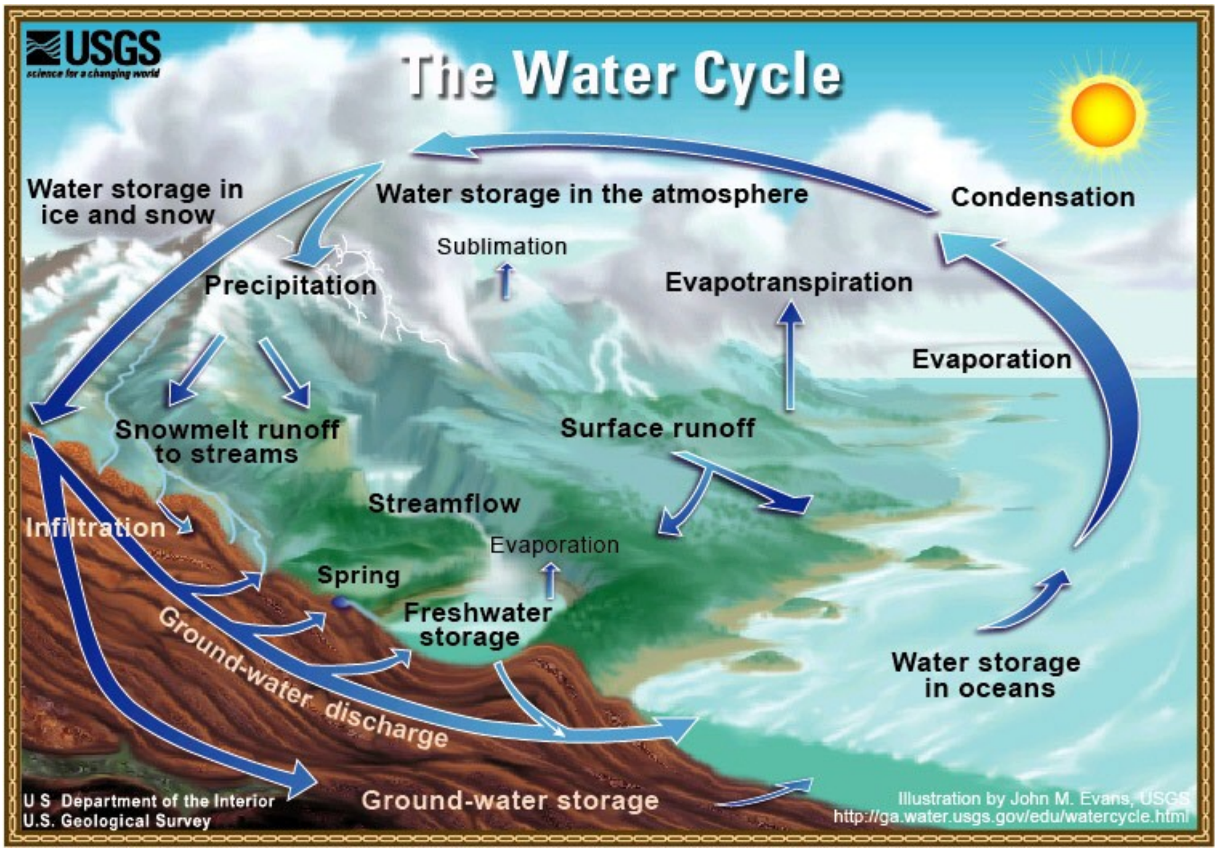
TIPS:

- Hold an event at school/church/local community center/etc.
- Write a story for the school/local newspaper or newsletter
- Share your story on a local radio station
- Post an article on your school/community website

Groundwater 101

Where is all the water?

From the time the earth was formed, there has been the same amount of water on Earth and it has been endlessly circulating. This circulation is known as the hydrologic cycle or the water cycle. Groundwater is part of this continuous cycle with no beginning or ending. Water evaporates, forms clouds, and returns to earth as precipitation.



A walk through the cycle, starting in the oceans, since that is where most of Earth's water exists.

1. The sun, which drives the water cycle, heats water in the oceans.
2. Some of it evaporates as vapor into the air.
3. Rising air currents take the vapor up into the atmosphere, along with water from evapotranspiration, which is water transpired from plants and evaporated from the soil.
4. The vapor rises into the air where cooler temperatures cause it to condense into clouds.
5. Air currents move clouds around the globe; cloud particles collide, grow, and fall out of the sky as precipitation (rain, snow, sleet).
6. Most precipitation falls back into the oceans or onto land, where, due to gravity, the precipitation flows over the ground as surface runoff
7. A portion of runoff enters rivers in valleys in the landscape, with streamflow moving water towards the oceans.

1. Not all runoff flows into rivers, though. Much of it soaks into the ground as infiltration.
   a. Some water infiltrates deep into the ground and replenishes aquifers.
   b. Some infiltration stays close to the land surface and can seep back into surface-water bodies (and the ocean) as groundwater discharge.
   c. Some groundwater finds openings in the land surface and emerges as freshwater springs.

What is groundwater and where is it located?

As seen in the water cycle diagram, when rain falls to the ground, the water does not stop moving. Some of it flows along the surface to streams or lakes, some of it is used by plants, some evaporates and returns to the atmosphere, and some sinks into the ground. Imagine pouring a glass of water onto a pile of sand. Where does the water go?

Groundwater is water that is found underground in the cracks and spaces in soil, sand and rock. Groundwater is stored in--and moves slowly through--layers of soil, sand and rocks called aquifers. Aquifers typically consist of gravel, sand, sandstone, or fractured rock, like limestone.

These materials are permeable because they have large connected spaces that allow water to flow through. The speed at which groundwater flows depends on the size of the spaces in the soil or rock and how well the spaces are connected.

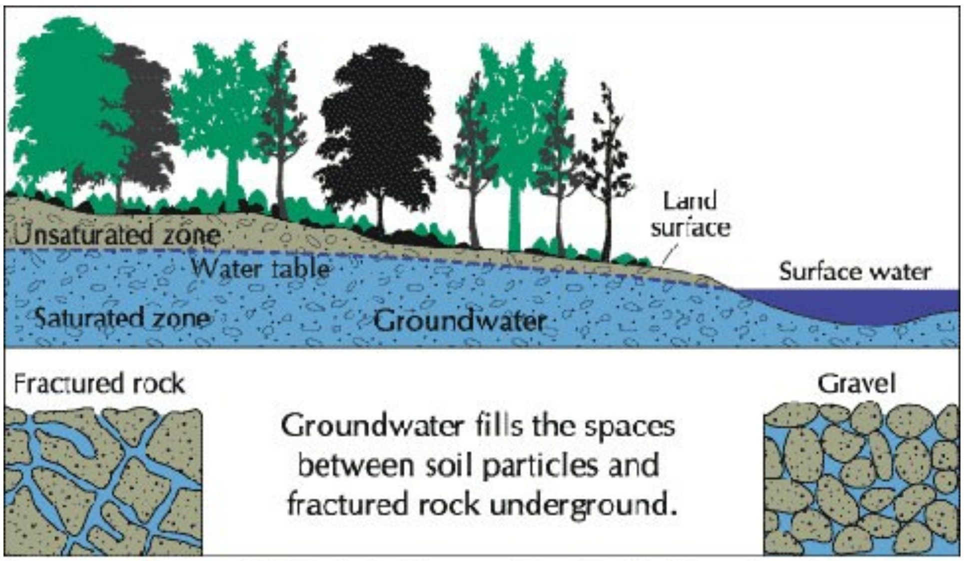


Image compliments of US Geological Survey, adapted by The Groundwater Foundation.

The area where water fills the aquifer is called the saturated zone (or saturation zone). The top of this zone is called the water table. The water table may be located only a foot below the ground's surface or it can sit hundreds of feet down, this depends on many factors. Heavy rains or melting snow may cause the water table to rise, or heavy pumping of groundwater supplies may cause the water table to fall.

How does groundwater move underground?

An aquifer is not only a storage reservoir, but also a pathway for water movement underground as a vital step of the water cycle. Underground, water moves from an aquifer's recharge areas (areas where water seeps into the saturation zone from rain fall, snow melt, etc.) to its discharge areas (springs, lakes). Water moves very slowly underground, often measured in inches per day, and may take from a few hundred days to hundreds of years to reach its natural discharge area.

Groundwater can also be extracted through a well drilled into the aquifer. A well is a pipe in the ground that fills with groundwater, which can then be brought to the surface by a pump. Some wells, called artesian wells, do not need a pump because of natural pressures that force the water up and out of the well. Naturally or artificially, groundwater is constantly on the move.

How is groundwater used?

Groundwater impacts our daily lives, though we often don't realize it. Of all the water on Earth that is usable by humans, 98 percent is groundwater. It is used for drinking, agricultural, recreational and industrial purposes.

- Groundwater provides drinking water for more than half of the people in the United States, including almost everyone who lives in rural areas. Without groundwater, many people would not have clean drinking water at all.
- Groundwater is also one of the most important sources of irrigation water.
- Groundwater is heavily used in industrial processes.
- Groundwater plays a significant role in providing recreation as it recharges many streams and lakes.

How do you get the water up from the ground?

Wells are used to pump water from aquifers. A well is a bored, drilled or driven shaft, or dug hole whose purpose is to reach underground water supplies. A pipe and a pump are used to pull water out of the ground, and a screen filters out unwanted particles that could clog the pipe. Wells come in different shapes and sizes, depending on the type of material the well is drilled into and how much water is being pumped out. But not all wells extract water some wells are made to inject or monitor water.

A well can easily be contaminated if it is not properly constructed or if toxic materials are released into the well. Toxic material spilled or dumped near a well can leach into the aquifer and contaminate the groundwater drawn from that well. Contaminated wells used for drinking water are especially dangerous. Wells can be tested to see what chemicals, pathogens and other contaminants may be in the well and if they are present in dangerous quantities.

The area in which productive wells are drilled is called the well field. The land management and water use of the surface and subsurface area surrounding the well and well field is critical in the prevention of potential groundwater contamination and maintenance of current water quality.

How is groundwater contaminated?

Due to its protected location (underground), most groundwater is naturally clean, but it can become polluted. In areas where material above the aquifer is permeable, pollutants can readily sink into groundwater supplies. If groundwater becomes polluted it will no longer be safe to drink. Groundwater contamination occurs when man-made products or naturally occurring materials seep into groundwater supplies and render it unsafe and unfit for human use. Examples of potential sources of groundwater contamination are:

- Gasoline and other harmful liquids leak from underground storage tanks into the groundwater supply.
- Pollutants soak into groundwater from poorly constructed landfills or septic systems.
- Runoff from fertilized fields, livestock areas, abandoned mines, salted roads and industrial areas.
- Dumping household chemicals down the drain or pouring them on the ground.
- Pharmaceuticals and personal care products, improperly disposed of, are contaminants.
- If barrels or other containers of hazardous materials leak, those contaminants can move through the soil and into the groundwater.
- Naturally occurring high levels of arsenic.

What happens if groundwater becomes contaminated?

Contaminated groundwater can be restored, but it is always time consuming and expensive. Many communities whose drinking water sources have been contaminated must spend millions of dollars to remove contaminants from the water before it can be piped to homes and businesses. Even then, the cleanup process rarely removes all of the contamination in the water and can double or triple the cost of water.

How can groundwater contamination be prevented?

Communities generally protect groundwater and prevent pollution by carefully monitoring land use, minimizing hazards such as shallow injection wells, and making sure environmentally friendly materials are used in other practices, such as de-icing roads.

Restricting certain activities near the wellfield area and removing hazardous materials such as leaky tanks is also helpful. Wells should be tested regularly to maintain a safe and reliable source of water. The test results allow individuals and communities to properly address the specific problems of a water supply.

Individuals help protect groundwater by using and disposing of chemicals properly and getting involved in monitoring and education activities.

There are simple things individuals can do to help protect groundwater, such as:

- Take used motor oil to a recycling center
- Limit the amount of fertilizer used on plants
- Pickup and properly dispose of pet waste
- Reduce or eliminate pesticide use
- Reduce the amount of trash you produce
- Use environmentally safe cleaning products
- Use low-phosphate or phosphate free detergents
- Test soil before fertilizer application to determine proper amounts
- Inspect your septic system annually

Protecting groundwater requires a conscious community effort, but it is not hard. True impact can begin with just one individual.

Groundwater Glossary

Groundwater Glossary

A

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

Aquifer storage and retrieval (ASR): Use of a well or series of wells to inject surface water into an aquifer during wet weather or low demand periods for purposes of withdrawal and use during drought and/or high demand periods.

Artesian aquifer: See confined aquifer.

Artesian well: A well tapping a confined aquifer. Water in the well rises above the top of the aquifer under artesian pressure, but does not necessarily reach the land surface; a flowing artesian well is a well in which the water level is above the land surface.

Artificial recharge: Putting water back into groundwater storage from surface water supplies such as irrigation, or induced infiltration from streams or wells. Includes aquifer storage and retrieval (ASR).

B

Baseflow: Streamflow coming from groundwater seepage into a stream or river. Groundwater flows underground until the water table intersects the land surface and the flowing water becomes surface water in the form of springs, streams/rivers, lakes and wetlands. Baseflow is the continual contribution of groundwater to rivers and is an important source of flow between rainstorms.

Best management practices (BMP's): 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.

Brackish: Mixed fresh and salt water.

C

Capillary water: Just above the water table, in the aeration zone, is capillary water that moves upward from the water table by capillary action. This water can move slowly and in any direction. While most plants rely upon moisture from precipitation that is present in the unsaturated zone, their roots may also tap into capillary water or into the underlying saturated zone.

Collection site: A stream, lake, reservoir, or other body of water fed by water drained from a watershed.

Condensation: The process in the hydrologic cycle by which a vapor becomes a liquid; the opposite of evaporation.

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. The land surface overlying the cone of depression is referred to as the area of influence.

Confined aquifer: (also known as artesian or pressure aquifers) exist where the groundwater is bounded between layers of impermeable substances like clay or dense rock. When tapped by a well, water in confined aquifers is forced up, sometimes above the soil surface. This is how a flowing artesian well is formed.

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.

Conservation: The use of water-saving methods to reduce the amount of water needed for homes, lawns, farming, and industry, and thus increasing water supplies for optimum long-term economic and social benefits.

Consolidated rock: Tightly bound geologic formation composed of sandstone, limestone, granite, or other rock.

Consumptive use: The use of a resource that reduces the supply (removing water from a source like a river, lake or aquifer without returning an equal amount). Examples include the intake of water by plants, humans, and other animals and the incorporation of water into the products of industrial or food processing.

Contaminant: Any substance that when added to water (or another substance) makes it impure and unfit for consumption or an intended use.

D

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

Diffusion: The movement of a substance from an area of high concentration to an area of low concentration.

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

Discharge area: The area or zone where groundwater emerges from the aquifer. The outflow may be into a stream, lake, spring, wetland, etc.

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

Drought: An extended period with little or no precipitation; often affects crop production and availability of water supplies.

E

Erosion: The wearing down or washing away of the soil and land surface by the action of water, wind, or ice.

Evaporation: The conversion of a liquid (water) into a vapor (a gaseous state) usually through the application of heat energy during the hydrologic cycle; the opposite of condensation.

Evapotranspiration: The loss of water from the soil through both evaporation and transpiration from plants.

F

Filtering: The soil's ability to attenuate substances by retaining chemicals or dissolved substances on the soil particle surface, transforming chemicals through microbial biological processing, retarding movement, and capturing solid particles.

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

Fresh water: Water with less than 0.5 parts per thousand dissolved salts.

G

Gaining stream: A stream in which groundwater discharges contribute significantly to the streamflow volume. The same stream could be both a gaining stream and a losing stream, depending on the conditions.

Gas (gaseous): See vapor.

Gray water: Domestic wastewater composed of wash water from household sinks, tubs, and washers.

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.

Groundwater basin: The underground area from which groundwater drains. The basins could be separated by geologic or hydrologic boundaries.

Groundwater divide: The boundary between two adjacent groundwater basins, which is represented by a high point in the water table.

Groundwater quality: The chemical, physical, and biological characteristics of groundwater with respect to its suitability of a particular use.

Groundwater under the direct influence (UDI) of surface water: A groundwater source located close enough to nearby surface water, such as a river or lake, to receive direct surface water recharge. Since a portion of the groundwater source's recharge is from surface water, the groundwater is at risk of contamination from pathogens such as *Giardia lamblia* and viruses, which are not normally found in groundwater.

H

Hydrogeology: The study of the interrelationships of geologic materials and processes with water, especially groundwater.

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.

Hydrology: The study of the occurrence, distribution, and chemistry of all waters of the earth.

I

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

Induced recharge: The recharge to an aquifer that occurs when a pumping well creates a cone of depression that lowers an adjacent water table below the level of a stream or lake, causing the stream or lake to lose water to the adjacent groundwater aquifer.

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.

Injection well: A well constructed for the purpose of injecting treated water, often wastewater, directly into the ground. Water is generally forced (pumped) into the well for dispersal or storage into a designated aquifer. Injection wells are generally drilled into aquifers that are not used as a drinking water source, unused aquifers, or below freshwater levels.

Integrated management: Any combination of physical, technical, administrative, and legal practices relating to surface water and groundwater in a manner designed to increase combined benefits or achieve a more equitable apportionment of benefits from both sources. Also referred to as conjunctive use.

Interflow: Water that travels laterally or horizontally through the aeration zone during or immediately after a precipitation event and discharges into a stream or other body of water.

Irrigation: The controlled application of water to cropland, hay fields, and/or pasture to supplement that supplied by nature.

J

K

Karst: A geologic formation of irregular limestone deposits that dissolve forming sink holes, underground streams, and caverns.

L

Leachate: Liquids that have percolated through a soil and that carry substances in solution or suspension.

Leaching: The process by which soluble materials in the soil, such as salts, nutrients, pesticide chemicals, or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

Liquid: The part of the hydrologic cycle in which molecules move freely among themselves but do not separate like those in a vapor/gaseous state.

Losing stream: A stream that is losing water to (or recharging) the groundwater system. The same stream could be both a gaining stream and a losing stream, depending on the conditions.

M

Maximum contaminant level (MCL): Designation given by the U.S. Environmental Protection Agency (EPA) to drinking water standards promulgated under the Safe Drinking Water Act. A MCL is the greatest amount of a contaminant allowed in drinking water without causing a risk to human health.

Mining: See overwithdrawal

Monitoring well: A non-pumping well, generally of small diameter, that is used to measure the elevation of a water table or water quality. A piezometer, which is open only at the top and bottom of its casing, is one type of monitoring well.

Municipal water system: A network of pipes, pumps, and storage and treatment facilities designed to deliver potable water to homes, schools, businesses, and other users in a city or town and to remove and treat waste materials.

N

Nonpoint source (NPS) pollution: Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land use activities which are carried to lakes and streams by surface runoff. Nonpoint source pollution is contamination that occurs when rainwater, snowmelt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants, such as nutrients and pesticides.

O

Overdraft: See overwithdrawal.

Overwithdrawal: Withdrawal (removal) 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.

P

Parallel flow paths: Layers of groundwater flow that do not mix with other flow layers because groundwater movement is too slow to create sufficient turbulence to cause mixing to occur. This becomes an important factor in the location and movement of contaminants that enter the groundwater.

Perched aquifer: Localized zone of saturation above the main water table created by an underlying layer of impermeable material.

Percolation: (1) The movement of water through the openings in rock or soil. (2) The entrance of a portion of the streamflow into the channel materials to contribute to groundwater replenishment.

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.

Point source pollution: Pollutants discharged from any identifiable point, including pipes, ditches, channels, sewers, tunnels, and containers of various types.

Pollution: An alteration in the character or quality of the environment, or any of its components, that renders it less suited for certain uses. The alteration of the physical, chemical, or biological properties of water by the introduction of any substance that renders the water harmful to use.

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 small grain sand contains less water than coarse gravel.

Potable water: Water of a quality suitable for drinking.

Precipitation: The part of the hydrologic cycle when water falls, in a liquid or solid state, from the atmosphere to Earth (rain, snow, sleet).

Q

R

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.

Reclaimed wastewater: Treated wastewater that can be used for beneficial purposes, such as irrigating certain plants.

Recycled water: Water that is used more than one time before it passes back into the natural hydrologic system.

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.

Return flow: (1) That part of a diverted flow that is not consumptively used and returned to its original source or another body of water. (2) Irrigation water that is applied to an area and which is not consumed in evaporation or transpiration and returns to a surface stream or aquifer.

Ridge lines: Points of higher ground that separate two adjacent streams or watersheds; also known as divides.

Runoff: Precipitation that flows over land to surface streams, rivers, and lakes.

S

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."

Salinization: The condition in which the salt content of soil accumulates over time to above normal levels; occurs in some parts of the world where water containing high salt concentration evaporates from fields irrigated with standing water.

Salt marsh: A low coastal grassland frequently inundated by the tide.

Salt water: Water that contains a relatively high percentage (over 0.5 parts per thousand) of salt minerals.

Groundwater Glossary

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.

Saturated thickness: Total water-bearing thickness of an aquifer.

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.

Seepage: (1) The slow movement of water into or out of a body of surface or subsurface water. (2) The loss of water by infiltration into the soil from a canal, ditch, lateral, watercourse, reservoir, storage facility, or other body of water, or from a field.

Septic system: Used to treat household sewage and wastewater by allowing the solids to decompose and settle in a tank, then letting the liquid be absorbed by the soil in a drainage field. Septic systems are used when a sewer line is not available to carry wastes to a sewage treatment plan. Also called an onsite wastewater treatment system.

Soil: The top layer of the Earth's surface, containing unconsolidated rock and mineral particles mixed with organic material.

Soil moisture: Water contained in the aeration or unsaturated zone.

Sole source aquifer: An aquifer that supplies 50% or more of the drinking water of an area.

Source water assessment: A process in which the land area that impacts a public drinking water source is delineated, possible sources of contaminants that could impact that drinking water source are identified, and a determination of the likelihood that the contaminants will reach the drinking water source is made. The federal Safe Drinking Water Act requires states to provide each public water system with a source water assessment. Public water systems are then required to make the assessments available to the public. A community may verify, refine or expand the list of potential contaminants. See source water protection.

Source water protection: Voluntary action taken to prevent the pollution of drinking water sources, including groundwater, lakes, rivers, and streams. Source water protection is developing and implementing a plan to manage land uses and potential contaminants. To be effective, source water protection should be directed to major threats to the drinking water source identified in the source water assessment. As part of the source water protection plan, a contingency plan for use in the event of an emergency is developed. Source water protection for groundwater is also called wellhead protection. See source water assessment.

Spring: The emergence of groundwater at the land surface, usually at a clearly defined point; it may flow strongly or just ooze or seep out.

Static water level: (1) Elevation or level of the water table in a well when the pump is not operating. (2) The level or elevation to which water would rise in a tube connected to an artesian aquifer or basin in a conduit under pressure.

Storm drain: Constructed opening in a road system through which runoff from the road surface flows into an underground system.

Stratum, *pl.* strata: A layer within the earth’s crust that generally consists of the same kinds of soils or rock material.

Sublimation: The transition of a substance from the solid phase directly to the vapor phase, or vice versa, without passing through an intermediate liquid phase.

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

Sustainable yield: See safe yield.

Substrate: A layer of material beneath the surface soil.

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

T

Temporary wetland: A type of wetland in which water is present for only part of the year, usually during wet or rainy seasons; also known as vernal pools.

Thermal spring: Heated groundwater that naturally flows to the land surface.

Transpiration: The process by which water absorbed by plants (usually through the roots) is evaporated into the atmosphere from the plant surface (principally from the leaves).

Turbidity: A cloudy condition in water due to suspended silt or organic matter.

U

Unconfined aquifers: An aquifer in which the water table is at or near atmosphere pressure and is the upper boundary of the aquifer. Because the aquifer is not under pressure the water level in a well is the same as the water table outside the well.

Unconsolidated rock: Loosely bound geologic formation composed of sands and gravel.

Unsaturated 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.

V

Vapor: The state of water in the hydrologic cycle in which individual molecules are highly energized and move about freely; also known as gas/gaseous.

W

Wastewater: Water that contains unwanted materials from homes, businesses, and industries; a mixture of water and dissolved or suspended substances.

Wastewater treatment: Any of the mechanical or chemical processes used to modify the quality of wastewater in order to make it more compatible or acceptable to humans and the environment.

Water (H2O): An odorless, tasteless, colorless liquid made up of a combination of hydrogen and oxygen. Water forms streams, lakes, and seas, and is a major constituent of all living matter.

Water-bearing rocks: Several types of rocks can hold water, including: sedimentary deposits (sand and gravel), channels in carbonate rocks (limestone), lava tubes or cooling fractures in igneous rocks, and fractures in hard rocks.

Water cycle: See hydrologic cycle.

Water quality: The chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.

Water quality standards: Recommended or enforceable maximum contaminant levels of chemicals or materials (such as chlorobenzene, nitrate, iron, arsenic) in water. These levels are established for water used by municipalities, industries, agriculture, and recreationists.

Watershed: The land area from which surface runoff drains into a stream, channel, lake, reservoir, or other body of water; also called a drainage basin.

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.

Water treatment plant: A facility that treats water to remove contaminants so that it can be safely used.

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 field: An area in which productive wells are drilled.

Well screen: Part of a well constructed to prevent sediment and rock particles from clogging the well and from being pumped into the water supply.

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.

Wetlands: Lands where water saturation is the dominant factor in determining the nature of soil development and the types of plant and animal communities. Other common names for wetlands are sloughs, ponds, and marshes.

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

X

Xeriscaping: An environmentally friendly form of landscaping that uses a variety of indigenous and drought-tolerant plants, shrubs, and ground cover.

Y

Z

Awesome Aquifer Building

How do I build a model Aquifer?

Use the Awesome Aquifer Kit and instruction booklet as your guide and the activity planning sheets found in the Teaching Tools section of the manual as your guide. Be creative and have fun creating your own model!

Material Ideas

This is a sample list of items that could be used in addition to the materials provided in the Awesome Aquifer kit. These items can be used to construct strata layers,

- wetlands, lakes, rivers, wells, water treatment (remediation) techniques, etc. Potting soil
- Sponge (kitchen or natural)
- Floral foam (used in flower arrangements), styrofoam
- Coffee filter paper, cotton balls
- Turf, carpet or door mat (represent a lawn or farm)
- Panty hose, cheese cloth, window screen (attach to the bottom of a well to keep well from clogging – represent a well screen)
- 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 mock contaminant)
- Aluminum foil, cling wrap, plastic sheeting
- Smaller containers such as drinking cups, beakers, squeeze bottles, 35mm film canisters, salt shakers, etc) are useful to put inside your larger container, or use externally to store water or a "mock" contaminant.
- Plastic aquarium plants, toy buildings/people, sticks and twigs (decorative)

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 should not be used (motor oil, fertilizer, bleach, etc.)

- Powder drink mix (Kool-Aid, hot cocoa, instant tea, etc.)
- Baking soda and vinegar
- Coffee filters, sponges, cotton balls, etc.

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

More Model Building Ideas

If you don't have an Awesome Aquifer kit, models can also 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.

Any transparent container will work.

- Plastic storage bin
- Plastic food container
- 2 liter soda bottle, juice bottle, or similar; cut down to 4-5 inches tall or lengthwise
- Acrylic display box (for collectibles like Beanie Babies)
- Small pet aquariums (for fish, reptiles, hermit crabs, etc.)
- Smaller containers such as drinking cups, beakers, squeeze bottles, 35mm film canisters, salt shakers, etc) are also useful to put inside your larger container, or use externally to store water or a "mock" contaminant.

In addition to the materials ideas listed on the previous page here are some additional items that you will need to build an aquifer model.

- Sand (play or beach)
- Gravel (various sizes: aquarium, pea, landscape, lava, quartz, etc.)
- Tubing (aquarium air line), drinking straws, plastic hose (represent a well)
- Hand pump from a soap or lotion bottle (represent a well)
- Plastic lure tip (no needle) syringe (obtain from a medical supply store or veterinarian – attach to tubing to function as a well pump)
- Squirt bottle, squeeze bottle or spray bottle (hold water or a contaminant)
- Liquid food coloring (diluted with water)
- Activated charcoal (for aquariums)

Awesome Aquifer Concept List

When practicing the design, construction, and presentation of the Awesome Aquifer model students should ask the following:

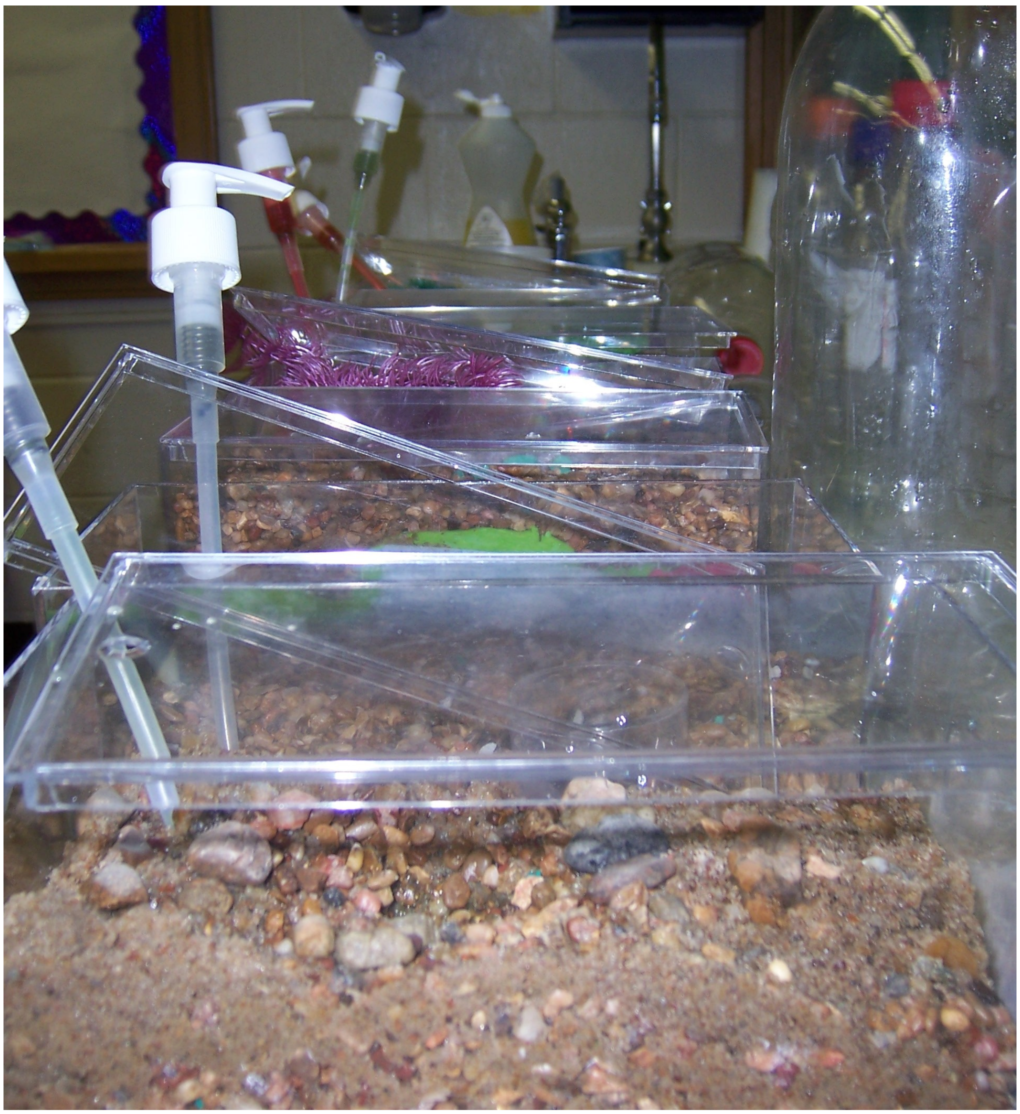
Can I verbally define ____________________?
Can I clearly explain ____________________?

- Groundwater recharge from precipitation
- Groundwater recharge from surface water
- Groundwater discharge to surface water
- Artesian aquifer, artesian well
- Water table, saturated zone and unsaturated zone
- Porosity
- Permeability
- Impact a well has on groundwater quantity
- Impact a well has on groundwater quality
- Impact a well has on surface water
- Importance of well siting (location)
- Importance of well closure (abandonment)
- Potential groundwater contamination source(s) produced by human activities
- Naturally occurring groundwater contamination source(s)
- Impact those contaminant sources have on humans and the environment
- Movement of a contaminant in groundwater
- Remediation techniques
- Safe yield (aka sustainable yield)
- Impact of a major weather event on groundwater (drought, hurricane, etc)
- Current water policy (rights, lawsuits)

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

- Groundwater recharge from precipitation
- Groundwater recharge from surface water
- Groundwater discharge to surface water
- Artesian aquifer, artesian well
- Water table, saturated zone and unsaturated zone
- Porosity
- Permeability
- Impact a well has on groundwater quantity
- Impact a well has on groundwater quality
- Impact a well has on surface water
- Importance of well siting (location)
- Importance of well closure (abandonment)
- Potential groundwater contamination source(s) produced by human activities
- Naturally occurring groundwater contamination source(s)
- Impact those contaminant sources have on humans and the environment
- Movement of a contaminant in groundwater
- Remediation techniques
- Safe yield (aka sustainable yield)
- Impact of a major weather event on groundwater (drought, hurricane, etc.)
- Current water policy (rights, lawsuits)

Groundwater Trivia



Did you know…

- The water we drink today is the same water the dinosaurs drank.
- It takes 1,303 gallons of water to produce a single hamburger.
- The average American uses 100 gallons of water each day.
- Little leaks can waste a lot of water. A faucet that leaks at a rate of one drop per second wastes five gallons of water per day and 2,082 gallons per year.
- Nearly ¾ of the water that comes into our homes goes down the drain.
- What is poured on the ground today can end up in our drinking water many years later.
- Americans drink more than one billion gallons of tap water per day.
- Groundwater provides drinking water for 51 percent of the total US population.
- Groundwater provides drinking water for 99 percent of the rural US population.
- Of all the Earth's water that is useable by humans, 98 percent is groundwater.
- Groundwater provides 37 percent of water used in US agriculture, primarily for irrigation.
- Irrigation is one of the largest uses of groundwater.
- Forty percent of the world's food supply is grown on irrigated cropland.
- More than 42 million people in the US rely on private wells to supply drinking water for their families.
- Drinking contaminated groundwater can have serious health effects, from diseases such as hepatitis and dysentery to poisoning from toxins in supplies. Certain types of cancer may also result from exposure to polluted water.

Groundwater Trivia

1. An outflow of water from a stream, pipe, groundwater aquifer or watershed is called:
   A. Recharge B. Dismiss **C. Discharge** D. Ejection

2. Material that allows water to penetrate through it is considered:
   A. Leaky B. Absorbent C. Resistant **D. Permeable**

3. The process of lowering the groundwater level from pumping is called:
   A. Drawdown B. Attenuation C. Reduction D. Dwindling

4. The solid rock beneath the soil and superficial rock is:
   A. Foundation B. Core Rock **C. Bedrock** D. Base

5. 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**

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) ________ aquifer:
   A. Unconfined B. Confined C. Restricted D. Upper aquifer

9. The zone immediately below the land surface where the pores and the fractures contain both water and air is the ___________ zone:
   A. Confining B. Withdrawal **C. Unsaturated** D. Saturated

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

11. The top of the saturated zone is called the:
    A. Water top **B. Water table** C. Cone of depression D. Vadose zone

12. Water found in rivers, lakes, oceans and streams is called:
    A. Groundwater B. Fresh Water **C. Surface water** D. Potable water

13. Groundwater supplies are replenished by rainfall and snowmelt. This process is called:
    A. Transpiration B. Condensation C. Recycling **D. Recharge**

14. Most of the time groundwater moves through the ground very slowly. This movement is called groundwater:
A. Flow B. Movement C. Travel D. Motion

15. A layer of material (such as clay) in an aquifer through which water does not pass is called the _________ layer :
A. Closed B. Watertight **C. Impermeable** D. Waterproof

16. The period of time water remains in an aquifer is called _______ time.
A. Existence **B. Residence** C. Infiltration D. Habitation

17. Pollution on the surface of the ground:
A. Will flow laterally toward streams and not impact groundwater
B. Will never harm groundwater because of natural filtration
C. Can leach contaminants to the groundwater supply below
D. Will leach through the usable groundwater into highly saline groundwater below

18. The paths water takes through its various states (vapor, liquid, solid) as it moves throughout the oceans, atmosphere, groundwater, streams, etc. is called the:
A. Recharge cycle
B. Integrated water process
C. Water pathway
D. Hydrologic cycle

19. A nonpumping well, generally small in diameter, used to sample groundwater quality is called a(n) _________ well :
A. Sampling B. Irrigation **C. Monitoring** D. Dewatering

20. The loss of water from groundwater aquifers at a rate greater than that of recharge is called:
A. Exhaustion **B. Depletion** C. Reduction D. Consumption

21. Which of the following would have the highest hydraulic conductivity if actually part of a geological area?
A. Fine grain sand B. Concrete **C. Coarse gravel** D. Clay

22. The recharge rate is:
A. The period of time that groundwater remains in an aquifer
B. The quantity of water per unit of time that replenishes an aquifer
C. The time required for a volume of groundwater to move between points
D. The maximum amount of pumping that is considered acceptable

23. The zone around a well in an unconfined aquifer that becomes unsaturated when pumped is called:
A. Infiltration zone B. Capillary fringe C. Aeration zone **D. None of the above**

24. The openings between geological materials found underground are called:
    A. Karsts layers **B. Pore spaces** C. Crevasses D. Aquifers

25. Soils are important to groundwater systems because:
    A. Soils act as filter and always prevent contamination from leaching into the groundwater
    B. Soils have the ability to retain chemicals and dissolve some substances before reaching the groundwater
    C. Soils hold water and regulate the recharge rate, allowing only a desired amount of water into the groundwater systems, preventing groundwater systems overflow
    D. Soils are NOT important to groundwater systems

26. If all of the rivers flow into the ocean, why does the water level in the oceans stay the same?
    A. Tides B. Turnover C. Recalculation **D. The water cycle**

27. About how much water does it take for a normal shower?
    A. 5 gallons per shower C. 5 gallons per hour
    B. 5 gallons per minute D. 5 quarters per minute

28. What is the Spanish word for water?
    A. Eau B. Wasser **C. Agua** D. Mai

29. What percentage of the earth's surface is water?
    A. 90 B. 40 **C. 70** D. 20

30. What percentage of the earth's water is fresh water?
    A. 40 **B. 1** C. 10 D. 60

31. How much water is used to flush a standard toilet?
    A. 1-2 gallons **B. 3-7 gallons** C. 5-8 gallons D. 10-12 gallons

32. What does the word, Nebraska, mean?
    A. Land without water B. Horses run here C. Bug Eaters **D. Flat water**

33. How long can a person live without water?
    A. about 10 hours B. About 1 day **C. About 1 week** D. About a month

34. About how much snow makes up an inch of water?
    A. 5 inches B. 1 inch **C. 10 inches** D. 20 inches

35. What were the first water pipes made from in the United States?
    A. Aluminum **B. Logs** C. Copper D. Plastic

36. The beginning of a river is known as what?
    A. Head B. Snake **C. Source** D. Noodle

37. What is another name for drainage basin?
    A. Watershed B. Wellhead area C. Turnover D. Navigator

38. Who has the ultimate responsibility to protect groundwater?
    A. Environmental Protection Agency (EPA)
    B. Nebraska Department of Environmental Quality (DEQ)
    C. Harry Potter
    D. Everyone

39. About how many gallons of water can you save by turning the faucet off while brushing your teeth?
    A. 2 gallons B. Half a gallon C. 4 gallons D. 10 gallons

40. What percentage of homes in the United States use bottled water as a primary source of drinking water?
    A. 20 B. 40 **C. 60** D. 80

41. What is the alternate rise and fall of waters caused by the gravitational attraction of the moon and sun?
    A. Water cycle B. Rip **C. Tides** D. Summit

42. Groundwater is located in spaces between particles of geologic materials called:
    A. Aqua spaces B. Geologic spaces **C. Interstices** D. Interspaces

43. A cone of depression forms when:
    A. water from an injection well enters the aquifer
    B. A pumping well stops pumping for more than 24 hours
    C. A lake is drained for rehabilitation
    D. A pumping well extracts water from the aquifer

44. The average cost for water supplied to a home in the United States is about $2 for every ______gallons, which equals about 5 gallons for a penny.
    A. 500 **B. 1,000** C. 100 D. 750

45. The amount of water on earth ____________ is the same amount as yesterday.
    A. Two days ago B. Tomorrow C. Today **D. All of the Above**

46. More than _____ million wells supply people in the United States with 76.4 billion gallons of groundwater each day.
    A. 100.4 B. 25.3 **C. 15.9** D. 5.7

47. The groundwater of the High Plains Aquifer (Ogallala Aquifer) lies under _______ square miles of land in eight different states
    A. 174,000 B. 350,000 C. 8,500 D. 2,000

48. The largest use of household water is to flush toilets. The second largest is for ___________.
    A. Showers and baths B. Cooking C. Brushing teeth D. Washing the car

49. Wells that are no longer in use are called abandoned wells. Abandoned wells should always be properly ____________ to prevent groundwater contamination.
A. Filled B. Forgotten C. Sealed **D. A and C**

50. The water from your private drinking water well should be tested ________ for nitrates and bacteria.
A. Every two months B. Once a month **C. Annually** D. Never

51. ____________ are made from a combination of materials including plastic, metal, concrete, clay and gravel.
A. Sand castles **B. Wells** C. Aquifers D. Water sheds

52. A protected surface and subsurface zone surrounding a well or wellfield to keep contaminants from reaching the public water supply well is called a:
A. Wellhead protection area
B. Water protection area
C. Recharge protection area
D. Vadose zone

53. The emergence of groundwater at the land's surface, usually at a clearly defined point is a(n):
A. Emergence area B. Eruption area C. Outcrop **D. Spring**

54. The depression of land as a result of groundwater being overpumped is called:
A. Subsidence B. Subsistence C. Depletion zone D. Depression zone

55. What is meant by an artesian well?
A. A well with water that is under enough pressure to come to the surface
B. A well that contains only 100 percent pure water
C. A well that is only found within 200 miles of the Canadian mountain of Artesius
D. A well that is constantly being recharged by water from other places

56. The hydrologic cycle is the name for the continual movement of water from one place to another. Where does most of the groundwater directly come from?
A. Precipitation B. Evaporation C. Transpiration D. Antarctica

57. In the hydrologic cycle, what is the process by which water leaves plants and enters the atmosphere?
A. Precipitation B. Evaporation **C. Transpiration** D. Binomial nomenclature

58. Where would the rate of the flow of water generally be the slowest?
A. Stream B. Lake **C. Aquifer** D. Faucet

59. A word that does not describe the movement of water through geologic materials is:
A. Percolation **B. Sublimation** C. Infiltration D. Recharge

60. The process by which an aquifer is overdrafted (or mined), creating a flow imbalance within a coastal area that results in salt water encroaching into a fresh water supply is called salt water _______:
    A. Intrusion   B. Mining   C. Salt water invasion   D. Salt water overdraft

61. How much does one gallon of water weight?
    A. 8.35 pounds   B. 2.76 pounds   C. 5.83 pounds   D. 10.82 pounds

62. At what temperature (F) does water freeze?
    A. 32 degrees   B. 0 degrees   C. 18 degrees   D. 100 degrees

63. **T** / F Groundwater is water that is stored in geologic formations called aquifers.

64. T / **F** The bottom of the saturation zone is called the water table.

65. **T** / F Sinkholes indicate the possible presence of karst geology beneath the Earth's surface.

66. **T** / F Irrigation is the controlled process of applying water to grow crops and plants.

67. What is the only substance found naturally on Earth in three forms?
    A. Water   B. Oxygen   C. Petroleum   D. Carbon

68. What percentage of the human body is water?
    A. 65   B. 88   C. 22   D. 44

69. Using the force of water to produce electricity is known as what?
    A. Biofuel   B. Solar energy   **C. Hydroelectricity**   D. Thermoelectricity

70. At what degree F does water vaporize?
    A. 100   **B. 212**   C. 60   D. 942

71. How much water does the average home use during a year?
    A. 500,000   B. 1,000   **C. 100,000**   D. 37,000

72. How much water (in gallons) must a dairy cow drink to produce one gallon of milk?
    A. 2   B. 10   C. 15   **D. 4**

73. The amount of water that can be removed from a source (aquifer, river, etc.) on a sustained basis without unacceptable depletion of the resource is called?
    A. Section   B. Surface   **C. Safe yield**   D. Well

74. The human brain is made up of what percentage of water?
    A. 20   B. 10   C. 45   **D. 75**

75. Name two possible sources of groundwater contamination:
    A. **Feed lot**   **B. Fertilizer**   **C. Pesticides**   **D. Gas/oil leak**

Teaching Tools

Teaching Using Inquiry and The Scientific Method

Do your students look forward to doing science? Do they demonstrate a desire to learn and work together to solve problems? Helping your students to enjoy science can be achieved through LEAP. LEAP uses aspects of teaching with inquiry and the scientific method to guide your students' learning so that it is more than just knowing vocabulary words and concepts but building understanding through asking questions, proposing explanations and solutions, making observations, and having the ability to ask new questions and propose new solutions based on their knowledge gained through previous activities.

Students should have a question or problem to solve. Asking open ended questions or posing a challenge will create a need to know and will prompt your students to use inquiry.

Allow your students' voice to be heard and represented in the LEAP process. You may start out answering one question however it will lead to many more questions and many more discoveries. Do not discourage this in the process, allow each question to build on previous discoveries.

Decide with your students what questions you will be answering. Some example questions for LEAP:

- Where does our community's water come from?
- How does groundwater move?
- How does groundwater become contaminated?
- How much do we rely on groundwater in my community?
- Is my community's groundwater safe?
- What are potential groundwater contaminant sources in my community?
- How can contaminated groundwater be remediated?
- What can I do to help protect the quality/quantity of the groundwater supplies my community depends on?

Encourage the use of Scientific Method

The process includes:

- Making an observation and asking a question.
- Forming a hypothesis.
- Designing and performing an experiment and collecting information.
- Interpreting the data and making conclusions.
- Formulating a final or a new hypothesis.
- Asking a new question.

Scientific Method Checklist for Educators:

Form a hypothesis/question:

- □ Did the team form a hypothesis or question?
- □ Can hypothesis or question be tested?
- □ Can hypothesis or question be tested or answered using the materials and data provided?
- □ Is supporting explanation or background science knowledge included?
- □ Is explanation and background clear and complete?
- □ Is explanation and background relevant and appropriate?
- □ Are observations made that are relevant to the investigation?

Design an investigation:

- □ Is background science knowledge or preliminary observations used in the design of the investigation?
- □ Is the plan clear and complete?
- □ Is plan safe, reasonable, and logical?
- □ Is plan communicated so that the investigation can be replicated?

Collect and present data:

- □ Do measurements include correct units?
- □ Are observations recorded?
- □ Are observations recorded that are appropriate to the task?

Analyze and interpret results:

- □ Are reflections made on observations recorded?
- □ Does the team reflect on initial investigation and communicate possible changes or that there are no changes needed.
- □ Are the changes for a refined model or investigation or reason(s) why no changes are necessary backed up with observations and data or explanation through scientific knowledge?
- □ Does the team communicate insights that are related to the investigation and go beyond the realm of the problem presented?

General:

- □ Is the work organized?

Lesson Planning

On the following pages you will find the complete planning sheets for the six Awesome Aquifer activities and a blank sheet for you to use for any additional or alternate activities. Each planning sheet list the activity instructions, vocabulary, supplies needed, and optional extension activities.

Groundwater and Surface Water: Are they connected?

Activity Planning Sheet

Time:	**Date:**
Phase:	**Location:**

Activity:

1) Pour gravel into the clear plastic container and spread out evenly.
2) Add water. Slowly pour the water near a wall of the container, this will allow the water infiltrating the aquifer to be more visible. Stop adding water when about half of the gravel is saturated.
3) Locate the water table.
4) Scoop gravel from the middle of the container, digging down to the water table. Push the gravel to the sides of the container allowing the water to create a lake.
5) Slowly add more water, pouring the water on the gravel close to the sides of the container. Again watch how the water percolates down through the gravel and becomes groundwater. This time also observe what happens to the elevation of the surface water.
6) Add water directly to the lake. Watch the water table level. The water in the lake is recharging the aquifer, causing the water table to rise.

Key Vocabulary Terms:

Aquifer / unconfined aquifer/ groundwater / recharge / infiltration / water table / saturated zone / unsaturated zone / surface water / percolates / discharge / groundwater under the direct influence / confining layer

Opportunities/Extensions:

Demonstrate how groundwater is a part of the hydrologic cycle. (Think about: surface water, evaporation, condensation, precipitation, runoff, recharge, groundwater, discharge, surface water) Use a spray bottle or cup with holes punched in the bottom to sprinkle rain on the model, add hills, and a river to the model.

Add different layers of strata to your model by using different materials (different grades of gravel, sand, soil, clay, etc.) Include a confined aquifer or confining layer to the model. Experiment with different materials such as sand, clay, or foil to create bottoms of the surface water bodies in the model.

TIP: Use the modeling clay to make a confining layer by pressing the clay tightly to all edges and making a thin layer of clay across the surface. More sand or gravel can be added to the top.

Supplies needed for activity:

Water
Clear plastic container
Gravel

Notes:

Pumping the Supply: Is groundwater a renewable resource?

Activity Planning Sheet

Time:	**Date:**
Phase:	**Location:**

Activity:

1) Pour gravel into the clear plastic container and spread out evenly.
2) Slowly pour water into the container. Stop pouring water when about half of the gravel is saturated.
3) Scoop gravel from the middle of the container, digging down to the water table. Push the gravel to the sides of the container allowing the water to create a lake.
4) Cut a small piece of nylon hose (about 1 inch by 2 inches), and fold into a smaller square.
5) Cover the end of the hand pump tube with the nylon securing it with a rubber band. This creates a well and well screen.
6) Insert the well into the gravel. Choose a location and depth that will allow an adequate amount of water to be pumped. *The well should be inserted so that the base (with the nylon cover) touches the bottom of the container. Place the well against the side of the container and stabilie it with a small amount of clay.*
7) Pump the water out of the container with the well. *Use the two small plastic cups or other container to catch the water that is pumped.*
8) Observe the level of the water table and the lake as the well is pumped.
9) Continue to pump the well. What begins to happen to the amount of water available for withdrawal?
10) If water is being pumped but no water is being added to the aquifer what will happen?
11) What complications may result from mining an aquifer?
12) Recharge the aquifer, by adding water to the container.
13) Again, pump the well. As the water is withdrawn add water to the aquifer by having it rain over the container.
14) Discuss the value of pumping a well at its safe yield.

Key Vocabulary Terms:

Well / well screen / well siting / withdrawal / drawdown / depletion / overwithdrawal / overdraft / safe or sustainable yield / cone of depression / area of influence

Opportunities/Extensions:

Rebuild the aquifer and include a confining layer. How does a confined aquifer respond to drawdown and recharge?
Demonstrate the effects of pumping wells at various depths.
Research and demonstrate factors affecting well location due to water quality concerns.
Rebuild the aquifer with sand or a mixture of sand and gravel. Does the material the aquifer is made of affect the recharge and pumping rates?
Demonstrate and explain a cone of depression. This is best demonstrated in sand.

Notes:

Supplies needed for activity:

Water
Clear plastic container
Gravel
Clay
Nylon hose
Rubber band
Hand pump
2 small plastic measuring cups

Discover Porosity: Which holds more water – sand or gravel?

Activity Planning Sheet

Time:	Date:
Phase:	**Location:**

Activity:

1) Estimate the volume of the small plastic cup in cubic centimeters (cc). Record your theories on a sheet of paper.
2) Fill the syringe to the 35cc line. Dispense the water from the syringe into the plastic cup until the cup is filled to the rim.
3) Determine how many cubic centimeters of water are held in the cup by subtracting the amount of water left in the syringe from the initial amount, 35cc. Record this amount. *For example if the syringe initially held 35cc and after dispensing the water into the cup there are 5cc left in the syringe, then the cup holds 30cc.*
4) Empty and dry the cup.
5) Next fill the cup with dry gravel.
6) Estimate how many cubic centimeters of water can be added to the cup filled with gravel. Record your estimation.
7) Fill the syringe with water (35cc). Dispense the water from the syringe into the cup with the gravel.
8) Subtract the amount left in the syringe from the initial amount. This is how much water fits in the spaces between the gravel. Record this amount.
9) Fill the second cup with dry sand.
10) Repeat steps 6-8 with the cup holding the sand.
11) Which material (sand or gravel) was able to hold more water?
12) Which material (sand or gravel) is more porous?
13) To find the porosity of each material first determine the volume of material in each cup. *The volume of sand and gravel in the cup will be equal to the volume of water the cup is able to hold when full. If the cup holds 30cc of water when filled to the rim, the cup will also hold 30cc of sand or 30cc of gravel.*
14) Divide the volume of water that you were able to add to the material by the total volume of material. This fraction will give you the porosity of the material. Porosity is always expressed as a fraction or percent.
    For example if 15cc of water were added to a cup filled with 30 ccs of gravel, divide 15 by 30 and multiply by 100 to get a percent. In this example the porosity of the gravel would be 50%.

Key Vocabulary Terms: Porosity

Opportunities/Extensions:

Try the activity again using larger containers. Does the porosity of sand and gravel change?

Does the porosity change when the material is compacted? Tap the bottom of the container while adding the sand or gravel in order to compact and settle the material. (Best if done in containers larger than the cups provided.)

How does mixing materials affect porosity? Mix sand and gravel together. Test porosity and compare with results of pure sand and gravel.

How does grain size affect porosity? Find sands, gravels, and soils with different grain size than provided. Test porosity and compare results.

Notes:

Supplies needed for activity:

Water
2 small plastic measuring cups
Syringe
Gravel
Sand
Writing utensil
Paper
Calculator (optional)

Explore Permeability: Does water move at different speeds?

Activity Planning Sheet

Time:	**Date:**
Phase:	**Location:**

Activity:

1) Estimate which material water will travel through the fastest – sand or gravel. Record your theories on a sheet of paper.
2) Take the syringe apart by removing the inside piece of the syringe.
3) Fill the syringe to the top with gravel.
4) Measure one ounce of water with one of the small cups.
5) Hold the syringe with gravel above the clear plastic container.
6) Pour the water into the syringe.
7) Observe the speed of the water as it travels through the syringe.
8) Empty the syringe. Wash out and dry.
9) Fill the syringe with dry sand.
10) Repeat steps 3-8.
11) Which material (sand or gravel) was able to transmit water at a faster rate?
12) Which material (sand or gravel) is more permeable?
13) Are porosity and permeability related concepts?

Key Vocabulary Terms:
Permeability / pore space

Opportunities/Extensions:
Use a clock or stopwatch to time the rate the water travels through the material.
Does the permeability change when the material is compacted? Tap the bottom of the container while adding the sand or gravel in order to compact and settle the material. (Best if done in containers larger than the syringe provided such as a funnel.)

Notes:

Supplies needed for activity:

Water
Gravel
Sand
Syringe
Clear plastic container
Small plastic measuring cup
Writing utensil
Paper
Stopwatch (optional)

Contamination Clues:
How does our groundwater become polluted?

Activity Planning Sheet

Time:	Date:
Phase:	Location:

Activity:

1) Pour gravel into the clear plastic container and spread out evenly.
2) Slowly add the water into the container. Stop adding water when about half of the gravel is saturated.
3) Scoop gravel from the middle of the container, digging down to the water table. Push the gravel to the sides of the container allowing the water to create a lake.
4) Build two wells. One well will be made from the plastic tubing provided.
    a) Cut a small piece of nylon hose (about 1 inch by 2 inches), and fold in half.
    b) Cover one end of the tube with the nylon securing it with a rubber band.

    Use the hand pump provided for the second well.
    a) Cut a small piece of nylon hose (about 1 inch by 2 inches) and fold in half.
    b) Cover one end of the tube with the nylon securing it with a rubber band.
5) Insert the wells in two different corners of the model on opposite sides of the lake. *The end of the tube with the nylon cover is the bottom of the well.*
6) Pump water from each well, one with the syringe, one with the hand pump. Observe the water that is pumped. *The water should be clear*.
7) Fill one of the small measuring cups with water.
8) Add 2-4 drops of liquid food dye to the cup of water. This cup of colored water will represent contamination.
9) In one of the corners of the model that does not house a well, slowly pour the entire cup of contamination.
10) Observe the contaminant as it infiltrates the groundwater.
11) Pump the well on the opposite end of the model. Watch the surface water as the well is being pumped. Notice the color of the water that was pumped from this well. Collect the pumped water in a separate container.
12) Pump the well that is closest to the contamination site. Notice the color of the water that was pumped from this well.
13) How can this contamination affect humans and the environment?

Key Vocabulary Terms:
Monitoring well / contaminant / plume / groundwater quality / point source pollution / non-point source pollution / well closure

Opportunities/Extensions:
Experiment with other ways to contaminate the groundwater that are representative of real threats to groundwater quality. *Do not use actual hazardous and harmful chemicals*. What are some potential groundwater contamination sources produced by human activities? What are examples of naturally occurring groundwater contamination sources?
Demonstrate the difference between point and non-point contamination.
What impact does a well have on groundwater quality? Demonstrate how well closure can prevent contamination of groundwater.

Notes:

Supplies needed for activity:
Water / Gravel / Clay
Clear plastic container
2 small plastic measuring cups
Plastic tube
Hand pump
Nylon hose
Rubber bands
Liquid food dye
Syringe

Clean it Up: Can contaminated water be cleaned?

Activity Planning Sheet

Time:	Date:
Phase:	Location:

Activity:

Pour gravel into the clear plastic container and spread out evenly.

2) Slowly pour water into the container. Stop adding water when about half of the gravel is saturated.
3) Scoop gravel from the middle of the container, digging down to the water table. Push the gravel to the sides of the container allowing the water to create a lake.
4) Build two wells. One well will be made from the plastic tubing provided.
   a) Cut a small piece of nylon hose (about 1 inch by 2 inches), and fold in half.
   b) Cover one end of the tube with the nylon securing it with a rubber band.

   Use the hand pump provided for the second well.
   a) Cut a small piece of nylon hose (about 1 inch by 2 inches) and fold in half.
   b) Cover one end of the tube with the nylon securing it with a rubber band.
5) Insert the wells in two different corners of the model on opposite sides of the lake. *The end of the tube with the nylon cover is the bottom of the well.*
6) Pump water from each well, one with the syringe, the other with the hand pump. Observe the water that is pumped. *The water should be clear.*
7) Fill one of the small measuring cups with water.
8) Add 2-4 drops of liquid food dye to the cup of water. This cup of colored water will represent contamination.
9) In one of the corners of the model that does not house a well, slowly pour the entire cup of contamination.
10) Observe the contaminant as it infiltrates the groundwater.
11) Pump water from the well that is closest to the contaminant spill with a syringe. *Pump until water drawn from well is colored.*
12) Set the syringe filled with the colored water aside.
13) Once groundwater is contaminated it can be costly and difficult to remediate.
14) Remediate the contaminated groundwater (colored water). Fill one of the small plastic measuring cups half full with charcoal. *The first time the charcoal is used it must be rinsed thoroughly with cool water to remove excess dust then thoroughly dried.*
15) Dispense the colored water from the syringe into the cup with the charcoal, filling the cup ¾ full.
16) Make a lid for the cup.
    a) Cut a small piece (roughly 4 x 4 inches) of plastic cling wrap so that it fits over the top of the cup (plastic cling wrap is not included in kit).
    b) Secure the plastic to the cup with a rubber band.
17) Gently shake the cup with the contaminated water and charcoal for 30-60 seconds.
18) Remove the plastic wrap and rubber band.
19) Make a second lid from a piece of coffee filter paper.
    a) Cut a small piece (roughly 4 x 4 inches) of coffee filter.
    b) Secure the piece of coffee filter to the cup with a rubber band.
20) Invert the cup and drain the water from the cup through the filter into the second plastic measuring cup.
21) The water should no longer be the color of the food dye. *The water may need to be filtered a few more times through a piece of coffee filter in order to separate out all the charcoal dust particles. Depending upon the concentration of food dye, this process may need to be repeated.*

Teaching Tools

<table>
<tr><td colspan="2">Key Vocabulary Terms: Remediation</td></tr>
<tr><td>Opportunities/Extensions:
Experiment with other materials for building a filter or treatment device such as small sponges, floral foam etc.
Experiment with other materials for contaminating the groundwater such as powdered drink mix.
Research other forms of water treatment and groundwater remediation.
Discuss prevention of groundwater contamination versus the cost of clean-up.</td><td rowspan="2">Supplies needed for activity:

Water
Clear plastic container
2 small plastic measuring cups
Plastic tube
Hand pump
Gravel
Clay
Nylon hose
Rubber bands
Liquid food dye
Syringe
Activated carbon/ charcoal (rinse and dry prior to first use)
Coffee filter
Small piece of plastic cling wrap or similar plastic (not included)</td></tr>
<tr><td>Notes:</td></tr>
</table>

LEAP

Activity Planning Sheet

Time:	Date:
Phase:	Location:

Activity:

Key Vocabulary Terms:

Opportunities/Extensions:

Notes:

Supplies needed for activity:

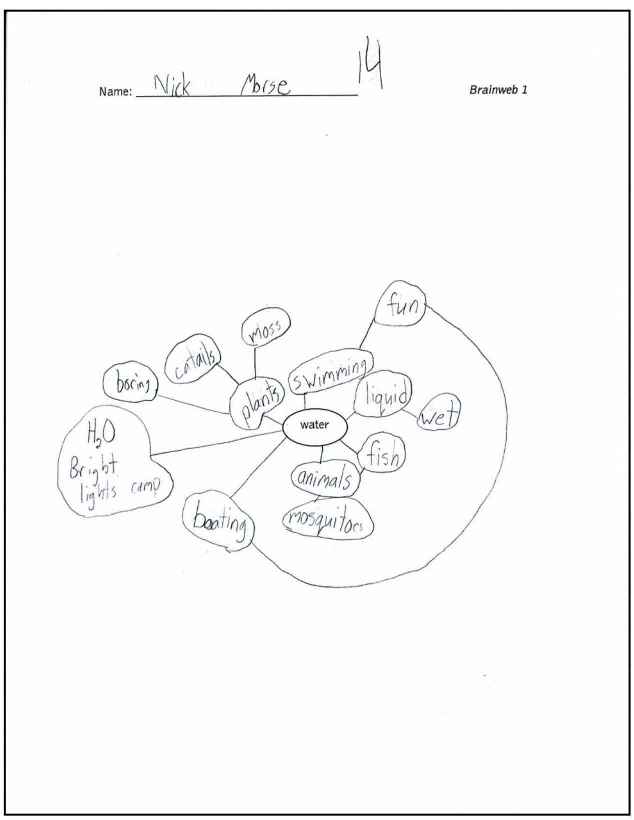
Water Web Evaluation Tool Instructions:

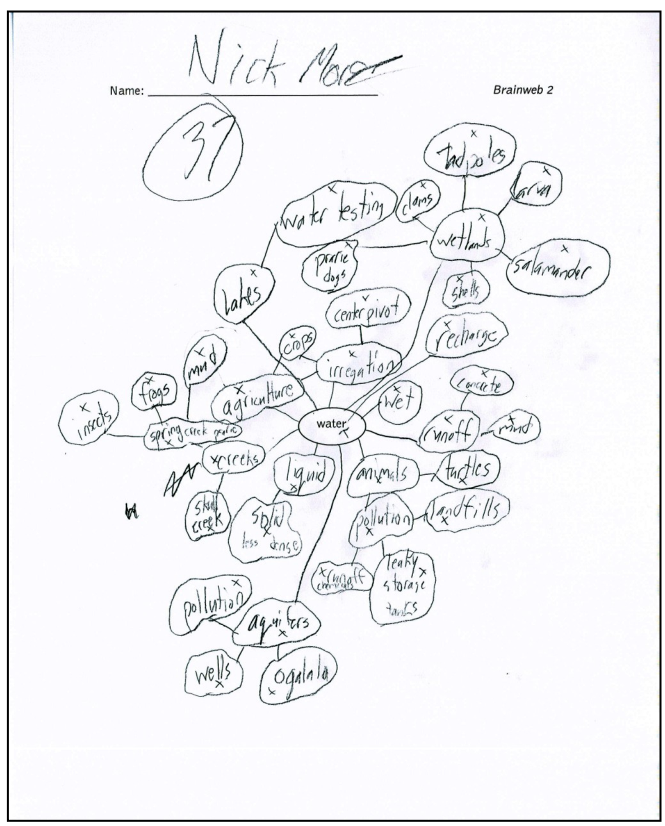
Use the Water Web activity as an evaluation tool to assess your students' knowledge of water.

Before you begin LEAP ask each student to complete their first Water Web by adding as many word bubbles they can think to the blank activity sheet. Each word should be connected to water or another word that was added to their web. At the completion of LEAP or at stages throughout ask your students to make a new Water Web. You will see each student's web will be different. The web will help to measure what concepts or events were the most effective as well as individual experiences.

1) Copy the blank Water Web activity sheet, located on the following page
2) Since many students may have not done this type of activity before use a different word and demonstrate how they are to complete the activity sheet.
1) Ask the students to think of as many words that related to water and add them to their sheet making a web of water words. And stress that there are no right or wrong answers.
2) Allow about 5 minutes for the students to complete their word web.
3) You can decide to have students complete this activity at the beginning and end of the project or at the beginning and end of each phase.
4) Save the word webs so that you can compare their results.
5) Send The Groundwater Foundation feedback of the results or copies of the webs.

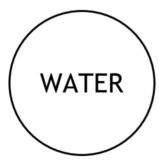
Water Web Example:





Water Web

Name ____ Date __________



Test Groundwater Knowledge

How much do your students know about groundwater? To find out what they know and how much they have learned test their groundwater knowledge before you begin LEAP and after you have completed the program.

On the following pages there are four different groundwater quizzes. These quizzes were created for you to easily copy and use to test your students' groundwater knowledge. All of the questions directly correspond to the concepts and terms associated with LEAP and are covered in the Groundwater 101 and Groundwater Trivia sections of this manual. Allow 10-15 minutes for students to complete the quiz. You can decide to have students complete this activity at the beginning and end of the project or at the beginning and end of each phase. Save the quiz results so that you can measure your students' progress.

You will find the LEAP Quiz Answer Keys at the end of this section, following last quiz.

Share your students' quiz results with The Groundwater Foundation by either emailing them to LEAP@groundwater.org or providing your results when completing the educator evaluation surveys.

The Groundwater Glossary and Groundwater Trivia sections of this manual are excellent resources to help your students to become more familiar with groundwater concepts and terms. To reinforce learning of these terms utilize the groundwater crossword puzzle and groundwater flashcard template found following the quizzes in this section.

Name ____ Date __________

True or False (circle T for true, F for false)

1) T F Groundwater is water that is stored in geologic formations called aquifers.
2) T F The bottom of the saturation zone is called the water table.
3) T F Surface water and groundwater systems are not connected; meaning water cannot travel from one to the other.
4) T F A confined aquifer is also known as artesian or pressure aquifers.
5) T F The purpose of a monitoring well is to measure the depth of the water table and collect groundwater samples to test for the presence of contaminants.
1) T F Groundwater is a natural resource that is used for drinking, recreation, industry, and growing crops.
2) T F Porosity is the rate at which water is able to transmit or travel through a material like gravel.
3) T F Infiltration is the sinking movement of water from the Earth's surface into the ground.
4) T F An example of an impermeable ground surface is native prairie.
5) T F Remediation means the discovery of contaminants in groundwater supplies.

Multiple Choice (circle the best answer)

11) A natural (or artesian) spring is caused by:
   A) gravity pulling water down hill
   B) underground pressures forcing water to the Earth's surface
   C) differences in air and ground temperatures
   D) none of the above, artesian springs do not exist

12) The loss of water from groundwater aquifers or surface water reservoirs at a rate greater than that of recharge is called:
   A) diffusion
   B) depletion
   C) discharge
   D) drawdown

13) Groundwater contamination may be caused by:
   A) road salts and motor oil
   B) fertilizers and pesticides
   C) leaky underground storage tanks and septic systems
   D) all of the above

14) MCL is a drinking water measurement that stands for:
   A) maximum contaminant level
   B) magnesium chlorine lithium
   C) minimum contaminant level
   D) management classification list

15) The controlled process of applying water to grow crops is called:
   A) drinking
   B) Irrigation
   C) fertilizing
   D) injection

Name ____ Date _________

Multiple Choice (circle the best answer)

1) A geological layer of material (such as clay) in an aquifer through which water does not pass, is called the:
   A) closed layer
   B) watertight layer
   C) impermeable layer
   D) porous layer

2) The loss of water from groundwater aquifers at a rate greater than that of recharge is:
   A) diffusion
   B) depletion
   C) discharge
   D) drawdown

3) Most of the time groundwater moves through the ground very slowly. The rate at which groundwater moves between two points is referred to as the:
   A) travel time
   B) circulation strength
   C) flow rate
   D) speed

4) The area around a well in an aquifer that is saturated but becomes unsaturated as a well is pumped is called the:
   A) wellhead protection area
   B) discharge area
   C) cone of depression
   D) confining zone

5) The openings between soil particles are called:
   A) pore spaces
   B) karst layers
   C) crevasses
   D) aquifers

6) An aquifer containing groundwater that has an impermeable layer below but not above it is called a(n):
   A) upper aquifer
   B) confined aquifer
   C) restricted aquifer
   D) unconfined aquifer

7) The aeration zone is also known as the _________ zone.
   A) unsaturated
   B) capillary fringe
   C) saturated
   D) water table

8) An example of the connection between groundwater and surface water is a loosing stream. A losing stream:
   A) contributes only flood water to the groundwater system
   B) contributes water to the groundwater system
   C) receives water from the groundwater system
   D) has an increased level of water loss from evaporation

(over)

9) An underground pattern of contaminant concentrations created by the movement of groundwater beneath a contaminant source is called a(n):
   A) pore space
   B) cone of depression
   C) plume
   D) aeration zone

10) The process by which an aquifer is overdrafted (or “mined”), creating a flow imbalance within a coastal area that results in salt water encroaching into a fresh water body:
   A) saltwater invasion
   B) saltwater mining
   C) saltwater intrusion
   D) saltwater overdraft

True or False (circle T for true, F for false)

11) T F Porosity is the rate at which water moves through porous rocks, sediments and soils.

12) T F Residence time is the period of time groundwater remains in an aquifer.

13) T F The loss of water from an aquifer at a rate greater than that of recharge is called reduction.

14) T F A depression of the land surface as a result of groundwater being pumped is called a cone of depression.

15) T F Groundwater under the direct influence of surface water discharges water to a surface water body.

Name ____ Date __________

Multiple Choice (circle the best answer)

1. An outflow of water from a stream, pipe, groundwater aquifer, or watershed is called:
   - A) recharge
   - B) dismiss
   - C) discharge
   - D) ejection

2. Material that allows water to penetrate through it is considered:
   - A) leaky
   - B) dbsorbent
   - C) resistant
   - D) permeable

3. The process of lowering the groundwater level from pumping is called:
   - A) drawdown
   - B) attenuation
   - C) reduction
   - D) dwindling

4. The solid rock beneath the soil and superficial rock is:
   - A) foundation
   - B) core rock
   - C) bedrock
   - D) base

5. A hole or shaft drilled into the earth to pump water to the surface is referred to as
   - A) sink hole
   - B) spring
   - C) water supply
   - D) well

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

Name ____ Date __________

Multiple Choice (circle the best answer)

1. The top of the saturated zone is called the:
    A) water top
    B) water table
    C) cone of depression
    D) vadose zone

2. Water found in rivers, lakes, oceans, and streams is called:
    A) groundwater
    B) fresh water
    C) surface water
    D) potable water

3. Groundwater supplies are replenished by rain fall and snowmelt. This process is called:
    A) transpiration
    B) condensation
    C) Recycling
    D) recharge

4. Most of the time groundwater moves through the ground very slowly. This movement is called groundwater:
    A) flow
    B) movement
    C) travel
    D) motion

5. A layer of material (such as clay) in an aquifer through which water does not pass is called the:
    A) closed layer
    B) watertight layer
    C) impermeable layer
    D) waterproof layer

6. The period of time water remains in an aquifer is called _________ time.
    A) existence
    B) residence
    C) infiltration
    D) habitation

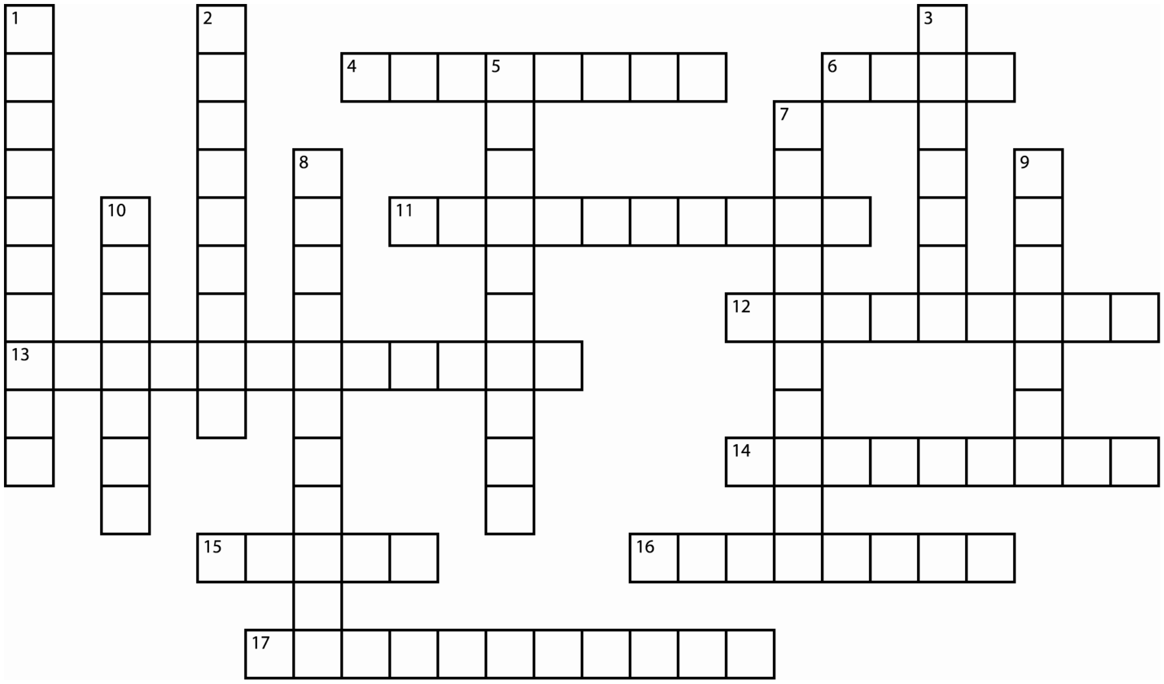
7. Pollution on the surface of the ground
    A) can leach contaminants to the groundwater supply below
    B) will never harm groundwater because of natural filtration
    C) will flow laterally toward streams and not impact groundwater
    D) will leach through the usable groundwater into highly saline groundwater below

8. The paths water takes through its various states--vapor, liquid, solid--as it moves throughout the oceans, atmosphere, groundwater, streams, etc. is called the:
    A) recharge cycle
    B) integrated water process
    C) water pathway
    D) hydrologic cycle

9. A nonpumping well, generally small diameter, used to sample groundwater quality is called:
    A) a sampling well
    B) an irrigation well
    C) a monitoring well
    D) a dewatering well

10. The loss of water from groundwater aquifers at a rate greater than that of recharge is called:
    A) exhaustion
    B) depletion
    C) reduction
    D) consumption

Name ____ Date __________



DOWN

1. The area below the water table is called the ____ zone.
2. A geologic material that is capable of transmitting water (like porous rocks, sediments and soils) is considered this.
3. The process of sealing (or properly abandoning) a well that is no longer being used in order to prevent groundwater contamination and harm to people and animals.
5. The paths water takes through its various states--vapor, liquid, solid--as it moves throughout the oceans, atmosphere, groundwater, streams, etc
7. A Wellhead _____ Area is a designated area around a public water supply well/well field that is to be sheltered from contaminants and other activities that threaten groundwater quality.
8. A geologic material (such as clay) in an aquifer through which water cannot pass is considered this.
9. The geologic formation that groundwater is stored in.
10. Oceans, rivers, streams and lakes are all examples of water.

ACROSS

4. To add to, or increase the volume of water in an aquifer.
6. A bored, drilled or driven shaft/hole whose purpose is to reach underground water supplies for extraction, injection or monitoring of.
11. The controlled application of water to cropland, hay fields and/or pasture to supplement that supplied by nature.
12. The loss of stored water at a rate faster than it is replenished.
13. The downward (sinking) movement of water from the earth's surface into the ground.
14. The natural outflow of groundwater through a spring or the natural outflow of water from a lake to a stream.
15. The top of the saturation zone is called the water ____.
16. The Safe _____ Water Act is a federal law that ensures the quality of Americans' drinking water.
17. The treatment, containment or removal of contaminated groundwater.

Groundwater Flash Cards Instructions:
First cut out the words and paste each on a separate index card. Next, use the Groundwater Glossary to find the definition of each word and write the definition on the back of the card to create groundwater flash cards!

Aquifer	Artesian Well
Condensation	Cone of Depression
Confined Aquifer	Confining Layer
Conservation (Water Conservation)	Contaminant
Depletion	Discharge
Drawdown	Drought
Evaporation	Flow Rate
Groundwater	Groundwater Quality
Groundwater Under the Direct Influence	Hydrogeology
Hydrologic Cycle	Impermeable
Infiltration	Leachate

Monitoring Well	Nonpoint Source Pollution
Overdraft	Overwithdrawal
Percolation	Permeable/Permeability
Plume	Point Source Pollution
Pore Space	Porosity
Precipitation	Recharge
Remediation	Runoff
Safe Yield	Saturation Zone
Surface Water	Transpiration
Unconfined Aquifer	Unsaturated Zone
Water Table	Water Treatment

Well	Well Closure
Well Screen	Well Siting
Withdrawal	LEAP!

LEAP QUIZ ANSWER KEYS

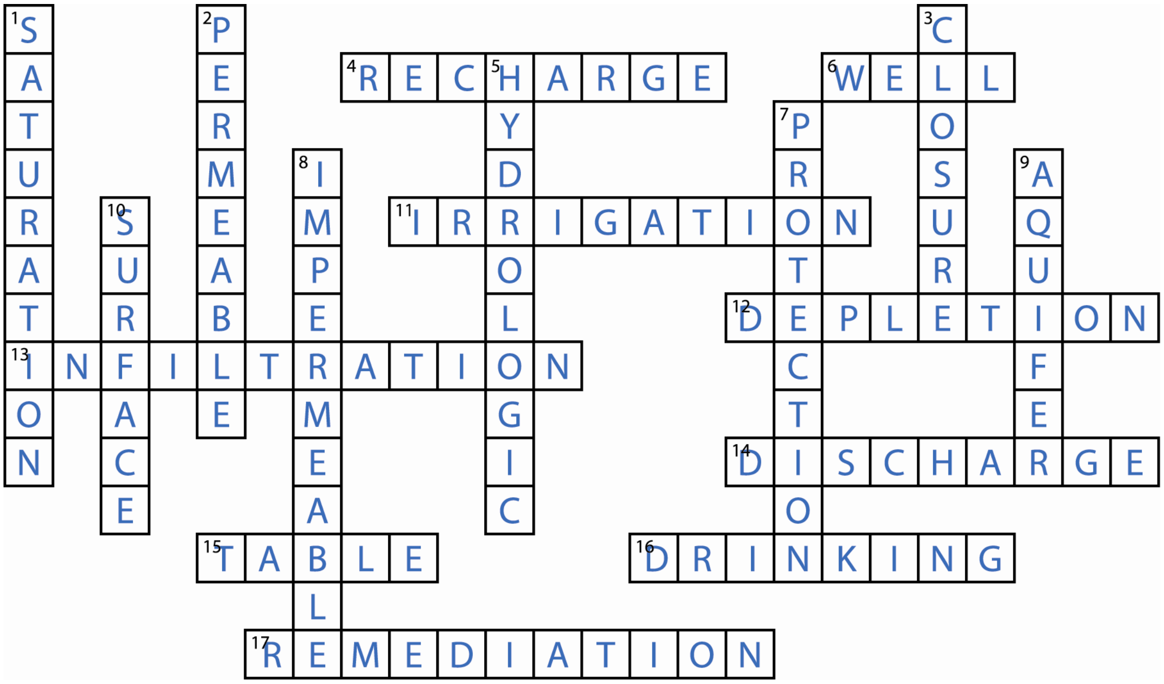
LEAP Quiz A
True
False – the water table is located at the top of the saturation zone
False – surface water and groundwater systems are connected
True
True
True
False – permeability, definition of
True
False – examples of impermeable ground cover would be concrete and asphalt
False – remediation means to clean or remove contaminants from groundwater
B. underground pressures forcing water to the Earth's surface
B. depletion
D. all of the above
A. maximum contaminant level
B. irrigation

LEAP Quiz B
C. impermeable layer
B. depletion
C. flow
C. cone of depression
A. pore spaces
D. unconfined aquifer
A. unsaturated
B. contributes water to the groundwater system
C. plume
C. saltwater intrusion
False – permeability
True
False – depletion
False – subsidence
False – received recharge from a surface water body

LEAP Quiz C
C
D
A
C
D
A
D
A
C
B

LEAP Quiz D
B
B
C
D
A
C
B
A
D
C
B

Crossword Puzzle ANSWER KEY



DOWN

1. saturation
2. permeable
3. closure
5. hydrologic
7. protection
8. impermeable
9. aquifer
10. surface

ACROSS

4. recharge
6. well
11. irrigation
12. depletion
13. infiltration
14. discharge
15. table
16. drinking
17. remediation

The LEAP project meets the following National Science Standards

Unifying Concepts and Processes

Systems, order and organization (K-4, 5-8, 9-12)
Evidence, models and explanation (K-4, 5-8, 9-12)
Change, constancy, and measurement (K-4, 5-8, 9-12)
Evolution and equilibrium (K-4, 5-8, 9-12)
Form and function (K-4, 5-8, 9-12)

Content Standard A: Science as Inquiry

Abilities necessary to do scientific inquiry (K-4, 5-8, 9-12)
Understanding about scientific inquiry (K-4, 5-8, 9-12)

Content Standard B: Physical Science

Properties of objects and materials (K-4, 5-8)
Position and motion of objects (K-4, 5-8)

Content Standard D: Earth and Space

Properties of Earth materials (K-4)
Changes in Earth and sky (K-4)
Structure of the Earth system (5-8)
Energy in the Earth systems (9-12)

Content Standard E: Science and Technology

Abilities to distinguish between natural objects and objects made by humans (K-4)
Abilities of technological design (K-4, 5-8, 9-12)
Understanding about science and technology (K-4, 5-8, 9-12)

Content Standard F: Science in Personal and Social Perspectives

Personal health/community health (K-4, 5-8, 9-12)
Types of resources/natural resources (K-4, 9-12)
Changes in environments/environmental quality (K-4, 9-12)
Science and technology in society/local/global challenges (K-4, 5-8, 9-12)
Populations, resources, and environments (5-8)
Natural/human-induced hazards (5-8, 9-12)
Risks and benefits (5-8)

Content Standard G: History and Nature of Science

Science as a human endeavor (K-4, 5-8, 9-12)
Nature of science (5-8, 9-12)

TIP:

Remember LEAP can be used to discuss topics in other areas of study (social studies, health, arts and humanities.) How many areas of learning can you incorporate into LEAP?

Evaluating Your Progress

It is important that we ask the students who participated in LEAP about their experience. Please copy and distribute the participant survey provided on the following page to your students after completing the Protect phase of LEAP.

Please send copies of the completed participant surveys to:
The Groundwater Foundation
Attn: LEAP Survey
5561 S. 48th Street, Suite 215
Lincoln, NE 68516

Evaluation surveys can also be completed and submitted at LEAP@groundwater.org.

Educators are encouraged to complete evaluations after each of the four phases of LEPA. Please see the Other Resources section of this manual for the Educators Survey.

Participant Survey:
After completing the final phase of LEAP please answer the following questions. Your feedback is important to The Groundwater Foundation. Thank you.

1. Did you enjoy participating in LEAP into Groundwater? Why or Why not?

2. What part of LEAP was your favorite? Any why?

3. What part of LEAP was your least favorite? And why?

4. Would you like to participate in LEAP into Groundwater again? Yes No
   If no, why?

5. What did you learn from participating in LEAP?

6. Did LEAP influence you to conserve or protect groundwater? If so, what are you doing now that you were not doing before LEAP?

7. Do you have any suggestions to improve LEAP?

Other Resources

LEAP Timeline/Checklist

DATE	ACCOMPLISHMENT
	Received Leap Manual.
	Ordered Awesome Aquifer Kits.
	Began Learn phase of LEAP.
	Presented model building activities.
	Completed Learn phase and submitted educator survey and photos of students.
	Began Educate phase of LEAP.
	Decided on educational event.
	Contacted appropriate individuals to be involved.
	Planned for the event.
	Sent out invites and news releases about the event.
	Held event.
	Completed Educate phase and submitted educator survey and photos.
	Began Act phase of LEAP.
	Researched and decided what type of activity to do.
	Raised funds to implement the project. (optional)
	Sent out news release and information to the community about the activity students will be doing.
	Completed groundwater-friendly act.
	Sent out news release about success of activity.
	Completed Act phase and submitted educator survey and photos of students.
	Began Protect Phase of LEAP.
	Decided to recruit a Green Site or participate in the Groundwater Guardian program.
	Sent in Green Site or Groundwater Guardian application.
	Celebrated achievements and success!
	Completed Protect phase and submitted educator survey, participant surveys, photos of students, and any media coverage from throughout the LEAP program.

How to Host an Open House

Here is what you need to do to get started:

- Get approval from an authorized person
- Set a date and time for the event: this could be during the regular school day, or perhaps during a science fair, Earth Day event, open house, after-school event, or other community fair, festival or event. Keep in mind that it doesn't have to be directly related to water or the environment.
- Make sure the location you want to hold the Open House is available for the selected date and time
- Decide whether you are going to charge for the event or ask for donations. Fundraising may be important for the Act of this project; this may be a good time to do that. If you do charge or ask for donations make sure you publicize what you are planning on doing with the funds raised (see the Act section for more details).
- Publicize your event
- Make an invitation list
- Invite community leaders and other VIPS: It is vital that these parties learn about the groundwater in your community and find out what they can do to keep it safe for everyone and for generations to come.
- Design invites
- Distribute invites (hand deliver invites to VIPS)
- Make posters and flyers

Plan the Open House. Here is one example:

- You as the leader of the group or other prominent figure should welcome the special guests and the audience; then turn the floor over to the students.
- In advance, ask one or two students who have shown a particular interest in the project to prepare a special opening presentation for the audience. This opening presentation should cover the basics such as what groundwater is and how groundwater is used. Be creative, this presentation could be a short skit, rap, or other fun way to engage the audience.
- Invite guests to visit each station where each team presents their model; showing and describing their assigned groundwater concepts to the audience.
- Each team should also have tips for guests on how they can help protect groundwater. Students can share the tips verbally or prepare handouts with this useful information for guests. *(See the Groundwater Protection Tips handout on the next page.)*

Suggestion: hold a rehearsal! You want to make sure your event will run smoothly. Having a practice run through is the best way to make sure this will happen.

Top Ways to Protect and Conserve Groundwater

- Take used motor oil to a recycling center.
- Limit the amount of fertilizer used on plants.
- Sweep your walks or driveways rather than rinsing with water.
- Take short showers.
- Shut water off while brushing teeth.
- Run full loads of dishes and laundry.
- Check for leaky faucets and have them fixed.
- Water the grass during cooler hours of the day and only when the grass needs water.
- Keep a pitcher of drinking water in the refrigerator.
- Get involved in water education.
- Switch to environmentally friendly cleaning products, instead of using products with harmful chemicals.
- Dispose of chemicals and hazardous waste at local collection sites/events
- Install native, low-water use plants in the garden.
- When mowing the lawn, mulch the clippings instead of bagging them.
- Wash your car on grass instead of cement.
- Recycle.

Groundwater is the water you drink and
the water that helps grow your food.

Let's keep it clean!

THE GROUNDWATER FOUNDATION

Learn more at
www.groundwater.org

Groundwater Guardian Program

The Groundwater Guardian program is designed to encourage communities of all types (cities, counties, watersheds, etc.) to begin and/or enhance groundwater education and protection efforts. The program is open to any community dedicated to groundwater protection and education.

Community members form a Groundwater Guardian team consisting of citizens, business and/or agricultural representatives, educators, and local government officials. Teams then develop education and protection initiatives within their communities, called Result-Oriented Activities (ROAs). Groundwater Guardian supports communities in their efforts and recognizes their achievements.

Groundwater Guardian teams must submit Annual Entry forms to The Groundwater Foundation. Communities entering the program for the first time can do so at any time during the year.

Program Benefits
Groundwater Guardian can help provide communities with the structure to educate citizens about groundwater and involve them in protection efforts.
The program will:

- Provide a framework for local action
- Allow you to take advantage of lessons learned by past communities
- Provide recognition for community efforts and celebrate their successes
- Provide incentives to continue activities year after year
- Offer resources to support community action, including the Assistance Kit, a subscription to *The Aquifer*, and updates about Groundwater Foundation events and projects
- Create visual recognition within communities with the Groundwater Guardian logo
- Include assistance from The Groundwater Foundation
- Encourage sustainability of protection and education activities through an annual earned designation

It's Free
There is no charge to participate in Groundwater Guardian.

Visit www.groundwater.org to learn more about the Groundwater Guardian program and how to get involved.

Become a Groundwater Guardian Community today to begin protecting your groundwater supply!

How Does My Community Become a Groundwater Guardian?

The first step is to identify who will make up your Groundwater Guardian team. A team must include at least four members, one from each representative category: citizen, business and agriculture, education, local government. Keep in mind that your students can be a part of the teams as well.

Second, decide who will be the Groundwater Guardian team leader. This person will be the main contact between the Groundwater Guardian team and The Groundwater Foundation.

Next provide your team leader with the Groundwater Guardian entry package, which includes all the necessary forms to get you started in the program. The entry package can be downloaded at http://www.groundwater.org/action/community/guardian.html, under the Forms heading. Be sure to fill out the Community forms, and NOT the Affiliate forms.

The entry package consists of information about the Groundwater Guardian team, your community's groundwater-related concerns, how you community will use Groundwater Guardian to address these concerns, and your Result-Oriented Activity (ROA) plans.

Completed entry forms may be submitted to The Groundwater Foundation by mail (P.O. Box 22558, Lincoln, NE 68542-2558), fax (402-434-2742), or email (guardian@groundwater.org) at anytime throughout the year.

In August, your Groundwater Guardian team will report your progress to The Groundwater Foundation. The Annual Progress Report is due August 31 of each year, and will be reviewed by the Groundwater Guardian Council. Groundwater Guardian designation is based on the action and progress reported on this report. Groundwater Guardian community designation announcements are made in the fall of every year.

The "Guide to Groundwater Guardian" can also be downloaded at http://www.groundwater.org/action/community/guardian.html. This is an excellent resource and can assist applicants in completing program forms.

Groundwater Guardian Green Site

The Groundwater Guardian Green Site (Green Site) program recognizes groundwater and environmental stewardship. The program encourages managers and superintendents of highly-managed green spaces to implement, measure, and document their groundwater-friendly practices. The program documents current practices related to pesticide and fertilizer use, water use, pollution prevention, water quality, environmental stewardship, and environmental education. Managers of highly-managed green spaces can apply for Green Site designation by completing a multiple choice application.

Highly-managed green spaces include, but are not limited to:

- Schools
- Golf courses
- Ball fields
- Parks
- Nature centers

Program Benefits

Being guardians and good stewards of groundwater is something managers and superintendents of many highly-managed green spaces strive to do every day, whether it's through protecting a well, using water efficiently, managing fertilizer and pesticide use, or controlling runoff. The Green Site program:

- Publicly recognizes the site for groundwater stewardship.
- Generates positive PR in the community.
- Provides an opportunity to educate others about groundwater.
- Documents the environmental benefit of the groundwater-friendly practices.
- Encourages the sustained use of groundwater-friendly practices.

It's Confidential

All information contained in the Green Site application is confidential, and will not be shared without the permission of the site.

It's Free

For LEAP participants there is no cost to apply or become certified as a Green Site.

Visit http://www.groundwater.org/action/community/green-sites.html to learn more about the Green Site program and how to apply.

How Do I Recruit A Green Site?

The first step is to identify a site or multiple sites in your community that have Green Site potential. A site can be any space with turf or green space, such as parks, golf courses, school grounds/campus, etc. Even churches, hotels, and theme parks have become Green Sites.

The next step is to contact the site. Knowing someone at the site is always an advantage but if not, you will first need to identify the individual in charge/the person that overseas the site/business such as the a principle at a school, the director of a nature center, manager of the parks department, etc.

Once you have made contact it may be advantageous for your students to present information to this person or group at the site about LEAP and why they would like the site to apply for the Green Site recognition.

Next provide your contact with a Green Site application. The application can be downloaded from the Green Site website at http://www.groundwater.org/action/community/green-sites.html. It only takes about 30-45 minutes to answer all of the questions.

Completed applications may be submitted to The Groundwater Foundation by mail (P.O. Box 22558, Lincoln, NE 68542-2558), fax (402-434-2742), or email (guardian@groundwater.org).

The Groundwater Foundation will review the application and notify the applicant of their Green Site status. Once a site is designated they will receive a plaque and have exclusive use of the GG Green Site logo and name!

Utilize the *Share the Green: Making the Most of Your Groundwater Guardian Green Site Designation - A Public Relations Toolkit* available at http://www.groundwater.org/action/community/green-sites.html to help celebrate your progress and site designation!

Visit http://www.groundwater.org/action/community/green-sites.html to learn more about the program, see a list of designated sites, view sample applications, and much more!

Evaluating Your Progress

Your feedback helps The Groundwater Foundation to improve our materials and continue to provide you with the best educational resources possible.

After completing each phase of LEAP please fill out the corresponding evaluation survey and send it to:

The Groundwater Foundation
Attn: LEAP Survey
5561 S. 48th Street, Suite 215
Lincoln, NE 68516

Fax: 402-434-2742 / To: LEAP Survey

Email: LEAP@groundwater.org / Subject: LEAP Survey

All surveys can also be completed and submitted to LEAP@groundwater.org

Friendly Reminder!

Don't forget to have your students complete the participant survey which can be found in the Teaching Tools section, at the end of this section, and on the LEAP website.

Documenting Your Progress!

You are also encouraged to submit photos of your students taking part in all phases of the LEAP program. All photos will become property of The Groundwater Foundation and may be use in various printed and online publications. Please send photos to LEAP@groundwater.org.

Were your students recognized in local media outlets for their educational, act, or protection efforts? The Groundwater Foundation would like to see these articles. Please send copies or links of your media coverage to LEAP@groundwater.org. Your stories may also be featured on the LEAP website!

Educator Survey: LEARN

After completing the Learn phase of LEAP please answer the following questions.
Your feedback is important to The Groundwater Foundation. Thank you.

General information

Group type (7th grade class/boy scout troop/club/etc: ___________________________

Number of students in your LEAP program: ___________________________

Age/grade level of your LEAP students: ___________________________

Start date of the LEAP Program: ___________________________

1. How did you hear about LEAP and why did you decide to use LEAP in your program?

2. Have you joined the LEAP Listserv? Yes No
   If no, would you like to join? If so, please provide your email address.

3. Did you use the Awesome Aquifer kit in the Learn phase? Yes No

ANSWER QUESTIONS 4-6 IF YOU USED THE AWESOME AQUIFER KIT:

4. Did you have the opportunity to build your own model prior to presenting to your students?
   Yes No

5. Did you find the Awesome Aquifer kit useful for the Learn phase? Yes No

6. Did you use other activities in addition to the Awesome Aquifer activities? Yes No
   If yes, please list what activities you used.

ANSWER QUESTIONS 7 AND 8 IF YOU DID NOT USE THE AWESOME AQUIFER KIT:

7. What materials did your students use to build the models?

8. Did you use other activities in addition or in exchange for those in the manual? Yes No
   If yes, please list what activities you used.

9. Did you use resources from the LEAP manual or on the LEAP website? Yes No
   If yes, please check any resources you used.
   - □ How to Guide (video)
   - □ Groundwater Glossary
   - □ Groundwater Trivia
   - □ Evaluation Brain Web
   - □ Crossword Puzzle
   - □ Groundwater 101
   - □ Awesome Aquifer Building
   - □ Activity Planning Sheets
   - □ Groundwater Quiz
   - □ Groundwater Flash Cards

10. Did you use resources not found in the LEAP manual or on the website? Yes No
    If yes, please list the resources you used.

11. Of the resources used (checked off or listed above) which did you find to be most useful?

(over)

12. How did you presented the Awesome Aquifer model building activity to your students? Please check all that apply.
    - □ One session about 45-60 minutes in length.
    - □ Multiple short sessions, about 20-30 minutes in length.
    - □ Students worked in teams/partners.
    - □ Background information was given prior to beginning the model building activities.
    - □ Students asked questions before/during/after the model building activity time.
    - □ Students had time to experiment with their models outside of the model building activity time.
    - □ A discussion was initiated relating what they learned to their school campus/local parks/ community/farm and agricultural land/etc.
    - □ Used the activity planning sheets provide in the Teaching Tools section.
    - □ Other, please explain.

13. What was your biggest challenge in the Learn phase of LEAP? How did you overcome this challenge?

14. Do you feel the Awesome Aquifer model building activities have prepared your students for the next phase of LEAP, Educate? Yes No

    If no, what have you done to help better prepare your students to move on to the Educate phase of LEAP?

You are encouraged to submit photos of your students taking part in all phases of the LEAP program. All photos will become property of The Groundwater Foundation and may be use in various printed and online publications.

Also please remember if you used the brain web and groundwater quiz in this phase please send in results and copies of the brain webs to The Groundwater Foundation. Thank you!

Send photos, media coverage, completed evaluation surveys, quiz results, and brain webs to:

The Groundwater Foundation
Attn: LEAP
5561 S. 48th Street, Suite 215
Lincoln, NE 68516

OR

LEAP@groundwater.org

Educator Survey: EDUCATE

After completing the Educate phase of LEAP please answer the following questions.
Your feedback is important to The Groundwater Foundation. Thank you.

General information

Group type (7th grade class/boy scout troop/club/etc: ______________________________

Number of students in your LEAP program: ______________________________

Age/grade level of your LEAP students: ______________________________

Start date of the LEAP Program: ______________________________

1. What type of educational event did your group decide to organize?
   - □ Open House
   - □ Mini-groundwater festival
   - □ Public Awareness Campaign
   - □ Educational event with local businesses
   - □ Educational messages at local school/community/businesses
   - □ Educational event with local leaders
   - □ Educational event during national holiday such as groundwater awareness week, Earth Day, World Water Monitoring Day, etc.
   - □ Other – Please explain below.

2. Please give a brief description of the educational event you and your students organized.
   Where was the event held?/How long did it last?/How many people were educated at your event?/Who was the audience?/etc.

3. What activities did your students use to educate their audience?

4. What groundwater concepts were chosen to be presented?

5. How much time prior to the event did your students have to prepare their educational activities? Was this enough time?

6. Did you or your students do the majority of the planning efforts?

7. Did you receive positive feedback from the audience?

8. Did your students have a positive experience?/Was the event successful? Why or why not?

(over)

10. Did you use How to Host an Open House or other resources provided in the LEAP manual and/or on the LEAP website for your event planning?

11. What additional resources or information would have been helpful?

You are encouraged to submit photos of your students taking part in all phases of the LEAP program. All photos will become property of The Groundwater Foundation and may be use in various printed and online publications.

Also please remember if you used the brain web and groundwater quiz in this phase please send in results and copies of the brain webs to The Groundwater Foundation. Thank you!

Send photos, media coverage, completed evaluation surveys, quiz results, and brain webs to:

The Groundwater Foundation
Attn: LEAP
5561 S. 48th Street, Suite 215
Lincoln, NE 68516

OR

LEAP@groundwater.org

Educator Survey: ACT

After completing the Act phase of LEAP, please answer the following questions.
Your feedback is important to The Groundwater Foundation. Thank you.

General information

Group type (7th grade class/boy scout troop/club/etc: ______________________________

Number of students in your LEAP program: ______________________________

Age/grade level of your LEAP students: ______________________________

Start date of the LEAP Program: ______________________________

1. What activity did you and your students decide to do for the Act phase of LEAP? Please share a bit about your activity including the response of your students and community to your efforts and success.

2. Did this activity require your group to raise money in order for it to be implemented? Yes No
   If yes, please share how funds were raised.

3. Were your efforts shared with local media/school/community groups/etc? Yes No
   If yes, please send a link or copy of the article/media coverage to LEAP@groundwater.org.

You are encouraged to submit photos of your students taking part in all phases of the LEAP program. All photos will become property of The Groundwater Foundation and may be use in various printed and online publications.

Also please remember if you used the brain web and groundwater quiz in this phase please send in results and copies of the brain webs to The Groundwater Foundation. Thank you!

Send photos, media coverage, completed evaluation surveys, quiz results, and brain webs to:

The Groundwater Foundation
Attn: LEAP
5561 S. 48th Street, Suite 215
Lincoln, NE 68516

OR

LEAP@groundwater.org

Educator Survey: PROTECT

After completing the Protect phase of LEAP, please answer the following questions.
Your feedback is important to The Groundwater Foundation. Thank you.

General information

Group type (7th grade class/boy scout troop/club/etc: ______________________________

Number of students in your LEAP program: ______________________________

Age/grade level of your LEAP students: ______________________________

Start date of the LEAP Program: ______________________________

1. Did you recruit a Green Site(s) or choose to have your school/community participate in the Groundwater Guardian program?

   For Green Sites:
   Please briefly explain why you chose the potential Green Site and how you were able to recruit the site to participate in the Green Site program.

   For Groundwater Guardians:
   Please briefly explain who makes up the Groundwater Guardian team and next steps for the team.

2. Was there sufficient information about Green Sites/Groundwater Guardian provided in the LEAP manual and/or through The Groundwater Foundation website?

3. How did you celebrate your achievement of completing the LEAP program?

4. Did you enjoy participating in LEAP into Groundwater? Why or Why not?

5. What part of LEAP was your favorite? Any why?

6. What part of LEAP was your least favorite? And why?

7. Would you use the LEAP program again? Yes No
   If no, why?

(over)

8. What did you learn from participating in LEAP?

9. Did LEAP influence you to conserve or protect groundwater?

10. Do you have any further suggestions to improve LEAP?

You are encouraged to submit photos of your students taking part in all phases of the LEAP program. All photos will become property of The Groundwater Foundation and may be use in various printed and online publications.

Also please remember if you used the brain web and groundwater quiz in this phase please send in results and copies of the brain webs to The Groundwater Foundation. Thank you!

Send photos, media coverage, completed evaluation surveys, quiz results, and brain webs to:

The Groundwater Foundation
Attn: LEAP
5561 S. 48th Street, Suite 215
Lincoln, NE 68516

OR

LEAP@groundwater.org

Participant Survey:
After completing the final phase of LEAP please answer the following questions. Your feedback is important to The Groundwater Foundation. Thank you.

1. Did you enjoy participating in LEAP into Groundwater? Why or Why not?

2. What part of LEAP was your favorite? Any why?

3. What part of LEAP was your least favorite? And why?

4. Would you like to participate in LEAP into Groundwater again? Yes No
   If no, why?

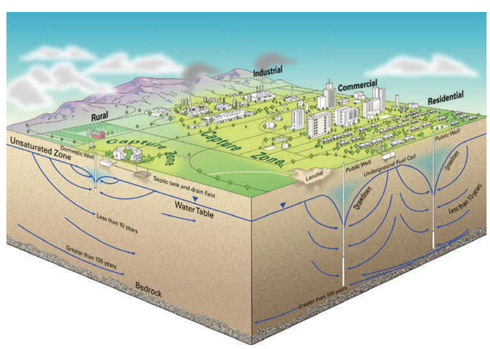
5. What did you learn from participating in LEAP?

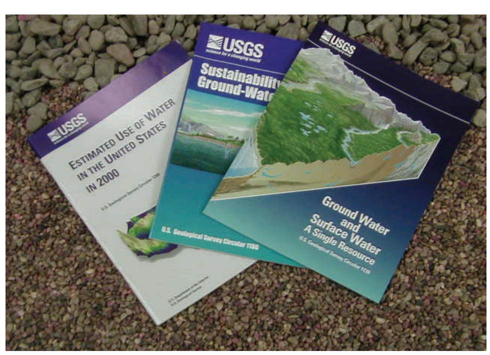
6. Did LEAP influence you to conserve or protect groundwater? If so, what are you doing now that you were not doing before LEAP?

7. Do you have any suggestions to improve LEAP?

Additional Materials

Add additional materials and resources used throughout the LEAP project to this section.





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