

Groundwater Protection

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Objectives:

- Use GIS to investigate groundwater surface water interactions
- Improve map skills and problem solving

Remember, computer steps are indicated by a ► symbol and questions you need to answer are numbered.

Prior Skills: You will need to know how to turn layers on and off, use the ID tool and, zoom in and out of the map, toggle from layers to the legend, and perform a search (Boolean) query. You should also be able to convert units of measure using multiplication or division.

This lesson looks at the connection between groundwater, surface water and water quality. Below is a link to an excellent introduction to septic systems and groundwater with regards to septic tanks and agriculture protection. If you are unfamiliar with groundwater and septic systems, please refer to:

http://gis.lanecc.edu/modules/groundwater/GW_protection_septic_tank.pdf

Remember to work through the lab to answer the questions. If you try to just answer the questions they will not make sense.

The map we will be using is web-based GIS so you can also do some of the work at home if you do not finish by the end of the exercise.

- Open a web browser and go to:
<http://arcgis.lanecc.edu/website/gwater>

The general organization of the screen should look like:

<i>Tools (Notice that tools are in a different Arrangement from the prior exercise.)</i>	<i>Map Area</i>	<i>Layers/ Legend</i>
	<i>Selection/Table Display (blank at start-up)</i>	

Look at the layers:

- Look at the layers available on our map.

You see a map of a watershed in the Pacific Northwest.

- ▶ Turn on all of the layers and refresh the map. You will notice that some of the layers do not extend all the way to the watershed boundary.

1. *Why do you think that the data does not extend throughout entire watershed? Need a hint? See the footnote at the bottom of the page*.*

Besides simply being a digital map, a GIS allows different data layers to be analyzed and compared against each other both in terms of their spatial location (latitude, longitude) and their attributes. For instance a house would have latitude and longitude (spatial attribute) and also some characteristic of the house (3 bedroom, 1 bath) which would be the attributes.

2. *What data layers are available and what attributes are associated with each one?*

Now we will start to analyze the data.

- ▶ Make all layers visible except for the elevation layer and make septic tanks the active layer. Remember as you work with the map to be patient and to “Refresh Map” after you add layers.

- ▶ Use the identify tool  and select one of the septic tanks. Remember that each geographic location has attributes associated with it. For the septic tanks field the attribute fields are:

Attribute Name	What it represents
FID	Unique identifier
YEAR	Year of installation
ID	A building code
USECODE	Type of use (residential, commercial, or mixed)

Also remember that you can ask the data questions, which is called a query. We are going to select multiple septic tanks in our analysis.

For this part of the exercise, you are coordinating a water quality survey. Before you begin the study you want to identify reaches that are potentially problematic. The *first set* of criteria for determining the streams to sample is:

Stream reaches within 50 meters of a septic tank whose

- Installation date is before 1989

AND

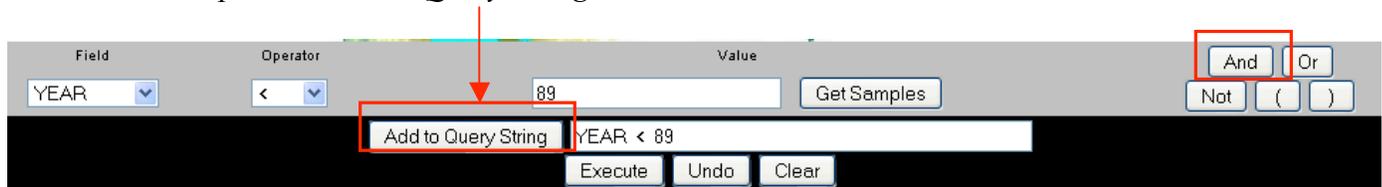
- Is zoned residential.

* In 1878, recognizing that the link between watersheds and public policy was critical, John Wesley Powell, the great explorer of the Colorado River, proposed that political jurisdictions conform to watersheds in the west. For this progressive watershed management idea, Powell lost his job as the head of the U.S. Geological Survey (Powell, 1878).

The first part of the query is:



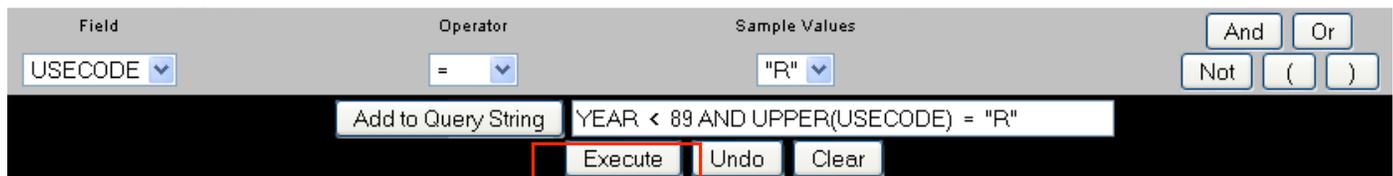
- ▶ Activate the query tool by clicking on the  icon.
- ▶ At the bottom of the screen you will now create the query.
 - ▶ For *Field* select YEAR. This will designate which data field to use.
 - ▶ For *Operator* use <. This will select all areas that are less than the designated field.
 - ▶ For Value enter 89
 - ▶ Then push the *Add to Query String* button. Your screen should look similar to this:



You have completed the first part of the query, which asked the data behind the map “Select all of the septic tanks that were installed before 1989.”

We will now do the next part of the query, which will refine it.

- ▶ Make sure that the query described above is correct. View the results and then erase it. Repeat the first part of the query but this time
- ▶ Select the *And* button from the query tools.  is highlighted by a red box in the above screenshot.
- ▶ With  query builder, create query with the tools that has USECODE equal to “R” (residential). Use the Get Samples tool to get the “R” value.
- ▶ Add to query string. Your query should look like:



- ▶ **Press Execute** (Look at the bottom of the screen).

3. Explain in words what you just asked the GIS to do.

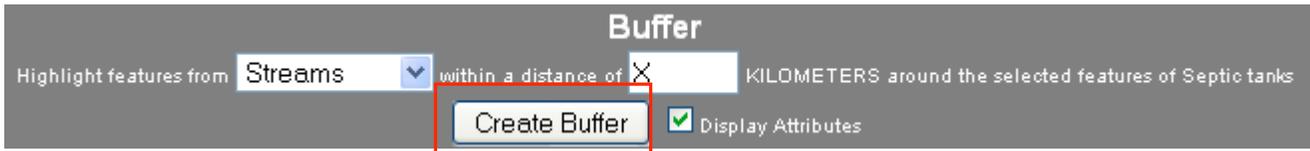
4. How many records did you get (make sure to use the more records if necessary)?

We will now use the Buffer tool  to highlight and display the attributes of the stream reaches within 50 meters of a septic tank.

The first thing that needs to be done is to convert 50 meters to kilometers. There are 1000 meters in a kilometer or 1 meter is equal to 0.001 kilometers. You can use the Calculator application in Start → Programs → Accessories. Write down your conversion. It will be referred to as X in the next section.

5. *What value did you get for the conversion?*

- ▶ Select the Buffer tool .
- ▶ Now at the bottom of the page select “Highlight features from Streams”
- ▶ Within a distance of X KILOMETERS around the select features of Septic tanks.
- ▶ Choose display attributes, and **Create Buffer**.



6. *How many stream reaches did you find?*

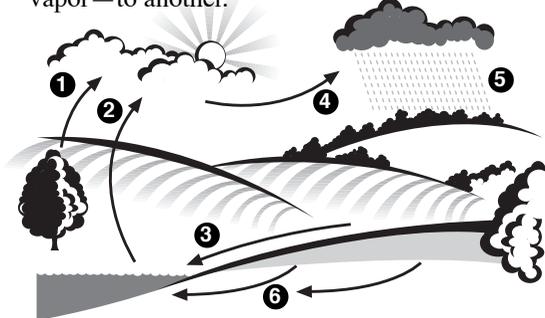
7. *Now using this information how would you go about prioritizing streams to monitor water quality?*
[Hint: Feel from to use the Zoom tool to view some of the septic tanks in greater detail.]

8. *Would it make any difference where you did water quality sampling with regards to elevation in the basin?*

Groundwater protection and your septic system

WHAT IS GROUNDWATER?

Water in the saturated zone beneath the soil surface is commonly referred to as *groundwater*. Groundwater is but one stage, or form, through which water passes in the earth's *hydrologic cycle* (see Figure 1). The hydrologic cycle is the continual movement of water over, in, and through the earth and its atmosphere as it changes from one form—solid, liquid, or vapor—to another.



- 1 evapotranspiration
- 2 evaporation
- 3 runoff
- 4 water-vapor transport
- 5 precipitation
- 6 groundwater flow

Hydrologic cycle Fig. 1

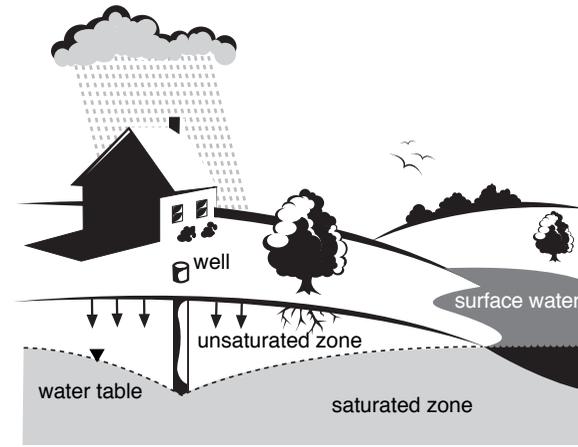
The water you use today may have evaporated from an ocean, traveled through the atmosphere, fallen back to the earth's surface, gone underground, and flowed through streams leading back to the oceans. Water is readily visible in many forms, including clouds, rain, snow, fog, lakes, streams, oceans, and polar ice caps. However, groundwater located beneath the soil surface is a vital resource for the success and survival of the entire ecosystem.

Groundwater has been tapped for thousands of years, but only recently have we started to understand its importance and how to manage this precious resource. Much remains to be discovered about groundwater, and wider public awareness of its nature and properties is an important first step.

Recharge

The process by which water—from rainfall, snow-melt, and other sources—flows into a water-bearing geologic formation (aquifer) is known as *recharge*. Water first passes through the *unsaturated zone*, where soil pores are filled partly with air and partly with water. The water then flows downward through the unsaturated zone into the *saturated zone*, where the soil pores are completely filled with water.

The boundary between these two zones is called the *water table* (see Figure 2). The water table rises when water enters the saturated zone and falls when water is discharged from the saturated zone either naturally (e.g., springs, lakes, or rivers) or by pumping (e.g., wells).



Water table Fig. 2

The unsaturated zone is important to the groundwater underlying it. As incoming water seeps down through the unsaturated zone, impurities are removed, helping to cleanse the water. Both the quantity and quality of groundwater is affected by the condition of the unsaturated zone in a recharge area.

SEPTIC SYSTEMS

A properly designed, installed, and maintained septic system poses no threat to groundwater. However, inadequately functioning and/or failing septic systems can contribute to the contamination of groundwater. Wastewater from septic systems may include many types of contaminants, such as nitrates, harmful bacteria, and viruses.

Trace amounts of metals may be contributed to the system from persons using some medications. Also, commonly used chemical substances, such as pesticides, paints, varnishes, and thinners, can contaminate the groundwater if they are not disposed of properly. Some chemicals, even in small amounts, can be dangerous to both the environment and public health.

Through physical, chemical, and biological processes, the soil acts as a natural buffer to remove bacteria and viruses in the unsaturated zone. However, various geologic conditions, such as fractured bedrock and shallow groundwater tables, may allow these bacteria and viruses to be transported very rapidly and could contaminate nearby drinking water supplies.

Therefore, it is critical that your drinking water well is properly sited, has a sealed casing, and the required distances from nearby septic systems are maintained. This will help prevent contaminants from seeping into and mixing with your drinking water (see Figure 3).

Separation Distances

A septic system must be located a certain distance away from drinking water wells, streams, lakes, and houses. These distances are referred to as *horizontal separation distances*. Figure 4 (see back) shows a typical layout of a conventional onsite wastewater disposal system. Actual horizontal separation distances have been established and are specified in local regulations.

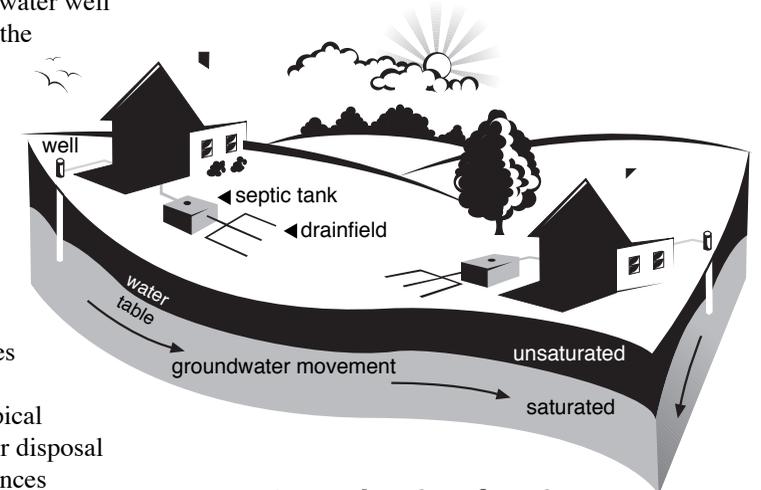
In order to maintain aerobic digestion processes and remove contaminants effectively, the absorption field must be adequately separated from the groundwater or other limiting layer. This is known as the *vertical separation distance* and is also specified by local regulations.

Determining System Size and Water Usage

Water use in rural households can be predicted from the house plan, depending on the number of bedrooms, water-using appliances, and potential additions. Although the actual number of residents

determines water use in a house, the house plan determines the potential number of residents (e.g., number of bedrooms), water usage, and subsequent wastewater flow.

Typical wastewater flow rates range from 60–120 gallons per person per day. Typical minimum septic tank sizes range from 750–1000 gallons. The flow estimate, plus the soil permeability estimate (i.e., how easily water moves through the soil), is used to determine the area of the absorption field needed for the system. Installing a drainfield of sufficient size is critical to the proper functioning of your septic system. Local regulations should always be reviewed before installing a septic system.



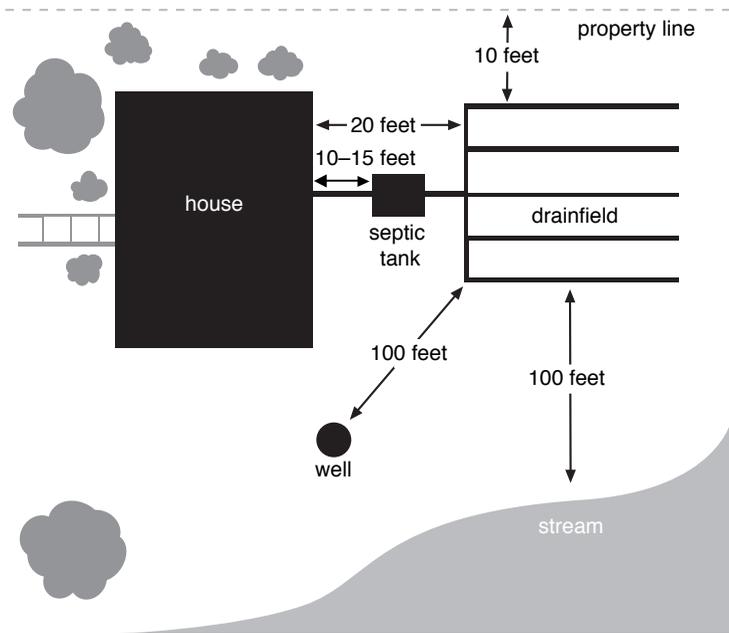
Correct location of septic systems and drinking water wells Fig. 3

Are Contaminants Reaching the Water?

Signs that wastewater from your septic system could be reaching water sources include:

- **Unpleasant odors (e.g., persistent rotten egg smell), soggy soil, liquid waste flow, or excessive grass growth over the soil absorption area.** These symptoms often indicate failure of the system and the need for repairing, expanding, or replacing the absorption area.

continued . . .



Typical layout of a septic system Fig. 4

- Maintain your septic system by having it inspected and pumped regularly.
- Conserve water in your home by using low-flow fixtures and by implementing water conservation practices to avoid hydraulic overload of your septic system.
- Redirect surface water flow away from your soil absorption field.
- Do not drive vehicles or heavy equipment over the absorption field. This will compact the soil and reduce its ability to absorb water.
- Plant a greenbelt (grassy strip or small, short-rooted vegetation) between your soil absorption field and the shoreline of any nearby surface water body.

- **Excessive weed or algae growth in the water near shorelines.** Nutrients leaking from septic systems could be a cause of this type of growth.
- **Health department test results of well water indicate the presence of contamination.** These tests may show the presence of indicator bacteria (e.g., total coliform, fecal coliform) in the water. Nitrate testing is not commonly performed and may need to be requested. Although wastes from septic systems are not the only source of these contaminants, they can be likely suspects.
- **Indicator dye put into your septic system reaches nearby ditches, streams, lakes, or drinking water supplies.** Special dyes are available from your local health department that may help find problems that otherwise are difficult to detect. This method can also help verify the other symptoms listed above.

How to Prevent Problems

- Before installation is complete, have the septic tank tested for watertightness.

- Keep chemicals and other hazardous wastes out of the septic system.
- If you have a drinking water well, have it tested yearly for contaminants. If you suspect a contamination problem, have it tested more often.



For more information regarding the care of your septic system, contact your local health department.

More information about septic systems is available from the National Small Flows Clearinghouse (NSFC) through other brochures in this series:

So . . . now you own a septic system,
Item #WWBRPE20

The care and feeding of your septic system,
Item #WWBRPE18

For more information about this or other NSFC products, please contact us by writing to:
National Small Flows Clearinghouse
West Virginia University
P.O. Box 6064
Morgantown, WV 26506-6064
or phone:
(800) 624-8301, (304) 293-4191
or fax: (304) 293-3161

www.nsfv.wvu.edu

Groundwater protection and your septic system

One in a series of three brochures designed to aid you in caring for your septic system.



Helping America's small communities meet their wastewater needs



Helping America's small communities meet their wastewater needs