Predicting Ground Water Flow

Grades 9-11

Objectives

- Be able to draw a ground water contour map.
- Have a basic understanding of how to predict the direction of ground water flow.
- Understand the interrelated nature of ground water and surface water flow.

Interdisciplinary Skills

Science, Math

Estimated Time

45 minutes

Materials

- ❑ Activity handout

Teaching Strategy

Through the handout, students will learn how to draw ground water contours and will understand how ground water flow may be predicted. A teacher's copy of the correct ground water contour map is included with this activity. Be sure students have read "Getting Up to Speed" for this section and are familiar with the material in the activity "Revealing Stories—Resource Maps Tell All."

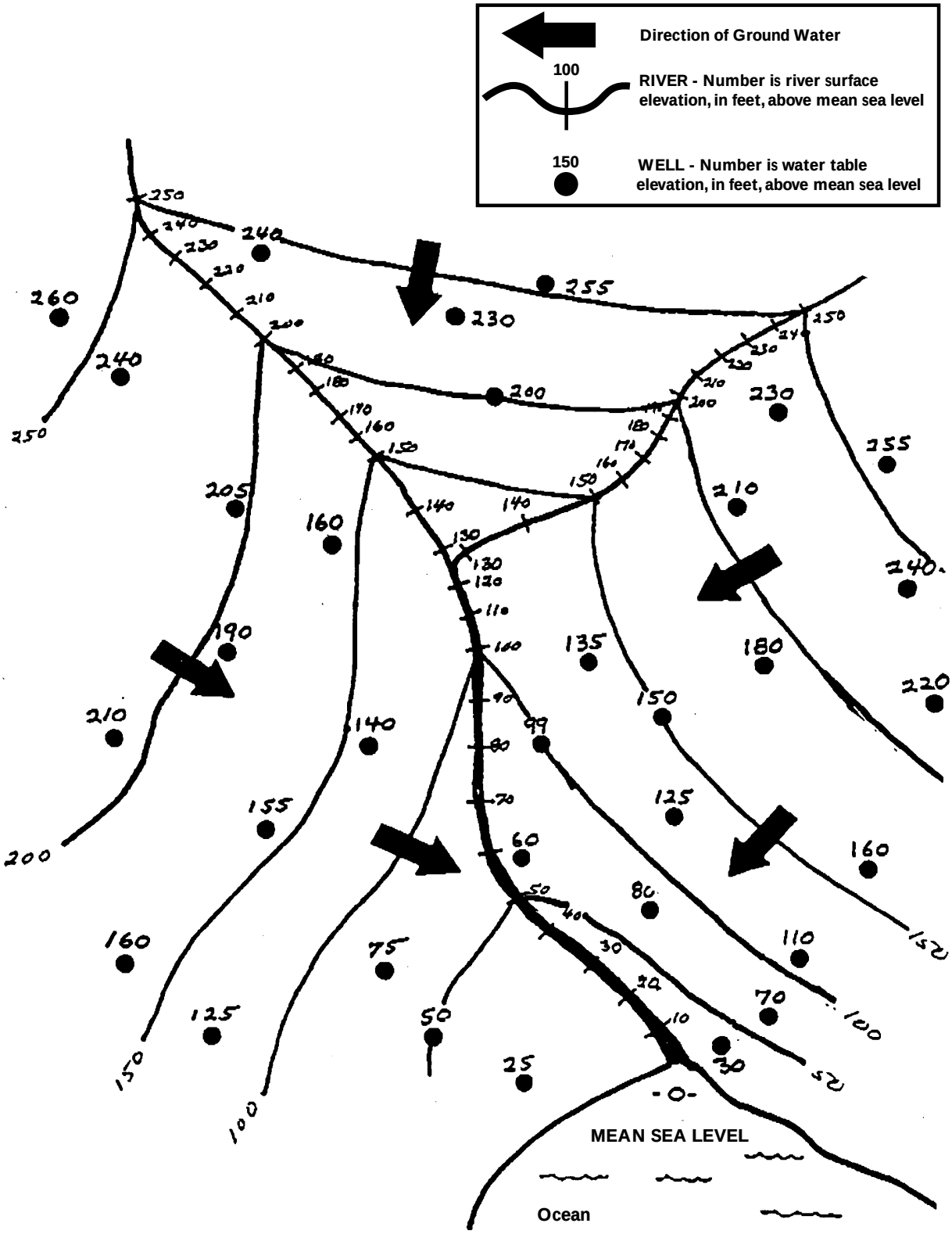
1. Distribute copies of the handout to each student.
2. Either lead students through the exercise as a class activity, or divide the students into teams to complete the assignment.

Follow-up Questions

1. Why should communities be aware of the direction of ground water flow? *By knowing the direction of ground water flow, communities can map out the land area that recharges their public water supply wells, streams, rivers, lakes, or estuaries and thereby take steps to ensure that land use activities in the recharge area will not pose a threat to the quality of the ground water and the resources dependent on it. Since contaminants generally move in the direction of ground water flow, communities can also predict how contaminants might move through the local ground water system.*
2. Why is it important to know if a stream in your community is a "gaining" stream or a "losing" stream? *Gaining streams receive much of their water from ground water, and the water level in the stream is generally at the same elevation as the water table in the adjacent aquifer. Water quality in the stream will be affected by the quality of ground water entering the stream. Because the water table elevation is approximately the same as the gaining stream surface elevation, both elevations may be used to construct water table maps and to predict ground water flow direction.*

   Losing streams lose water to the adjacent aquifer because the water table has dropped below the stream level. If there is no major source of upstream flow, the stream may dry up between storm events.

Contouring the Water Table



Predicting Ground Water Flow

NOTE: Read this entire handout before beginning the activity.

BACKGROUND

The water table is the surface of the saturated zone, below which all soil pores or rock fractures are filled with water. Ground water moves through the subsurface much like water on the ground surface, except that it travels a great deal more slowly. If the soil is mostly sand and gravel, ground water can move as much as five feet per day. But, more often than not, ground water moves at speeds of a few inches per day (or less).

Like streams and rivers, ground water moves from high areas to low areas. In this exercise, you will draw the contours of the water table to show how ground water moves beneath the ground, down the sides of a valley, to a river that flows to the sea. Before you begin this exercise, however, it is important that you understand three main principles.

First, ground water and surface water share a strong connection in New England. Have you ever noticed that streams continue to flow even when it hasn't rained for days? Where does the water come from? In most areas of New England, water is discharged to surface waters from ground water at the point where the water table intersects the surface of the land. In this situation, the surface water is called a **gaining stream** or **gaining pond**.

Second, because the water table is at the land surface adjacent to "gaining" surface waters, the elevation of ground water is generally the same as that of the river, especially between rain storms.

Third, ground water is assumed to flow at right angles to water table contours. This is because ground water moves downhill in the path of least resistance due to gravity. In this exercise, you'll use all three of these principles.

During this activity you will learn how to draw a water table contour map. Water table measurements that are taken at the same time of year can be used to develop a water table contour map to show the direction of ground water flow. Monitoring wells are typically used to determine the elevation of the water table. The elevation of the water table is determined at several locations throughout the area of interest. Like topographic map contours, water table contours represent lines of equal elevation. The difference between the maps is that water table elevations are measured in wells and at the river channel, not on the ground surface. Thus, just as surface water flow is downhill and perpendicular to topographic contours, the direction of ground water flow is also downhill and perpendicular to the water table contours.

Don't worry—drawing contours is easier than you think. Just follow these simple steps:

DIRECTIONS

ASSIGNMENT

1. Using the "Contouring the Water Table" worksheet, take a pencil (in case you make mistakes), and *lightly* draw in 3 or 4 arrows to show your prediction for the direction(s) of ground water flow.
2. Draw contours at 50-foot intervals. The pencil lines can always be inked-in later. Begin at 50 feet (the shoreline along the ocean will be sea level), then draw the other contours for 100, 150, 200, and 250 feet.
3. To get started, draw the 50-foot contour. Find the 50-foot elevation on the river. Draw a line from that point through the 50-foot elevation at the well just southwest of the river. Don't go much past the well, because there are no more data to tell you where to go!
4. Draw the contour on the other side of the river. When locating a contour between two points, you will have to **interpolate**—that is, figure out the proportional distance between the points.The 50-foot contour between the 30- and 80-foot elevations should be drawn closer to the 30-foot value (20 feet difference) than the 80-foot value (30 feet difference). You can do this by hand after a little practice, or measure it precisely with a ruler and calculator. For the other two wells, draw the contour exactly between the 30- and 70-foot elevations, because they are both 20 feet different from the 50-foot contour's value.
5. When you are finished, you will notice that the contours form V's with the river and its tributaries. That's because the river is a "gaining" river. It is receiving recharge from the aquifer. The contours show that ground water is moving down the sides of the valley and into the river channel. The opposite of a gaining stream is a "losing" stream. It arises when the water table at the stream channel is lower than the stream's elevation, or stage, and stream water flows downward through the channel to the water table. This is very common in dryer regions of the Southwest. In the case of a losing stream, the V will point downstream, instead of upstream.

NOTE: When making a water table map, it's important that your well and stream elevations are accurate. All elevations should be referenced to a standard datum, such as mean sea level. This means that all elevations are either above or below the standard datum (e.g., 50 feet above mean sea level datum). It's also very important to measure all of the water table elevations within a short period of time, such as one day, so that you have a "snapshot" of what's going on. Because the water table rises and falls over time, your map will be more accurate if readings are made before these changes occur.

Understanding how ground water flows is important when you want to know where to drill a well for a water supply, to estimate a well's recharge area, or to predict the direction contamination is likely to take once it reaches the water table. Water table contouring can help you do all these things!

FOLLOW-UP QUESTIONS

1. Why are communities interested in learning the direction of ground water flow?

_____

_____

_____

_____

2. Why would it be important to know if a stream in your community is a **"gaining" stream** or **"losing" stream**?

_____

_____

_____

_____

3. Compare and contrast your predictions for ground water flow to your mapped ground water flow direction(s). Briefly explain and differences.

_____

_____

_____

_____

KEY TERMS

- **Gaining Stream/Pond**
- **Interpolate**
- **Losing Stream/Pond**

Contouring the Water Table