Watershed Come Alive

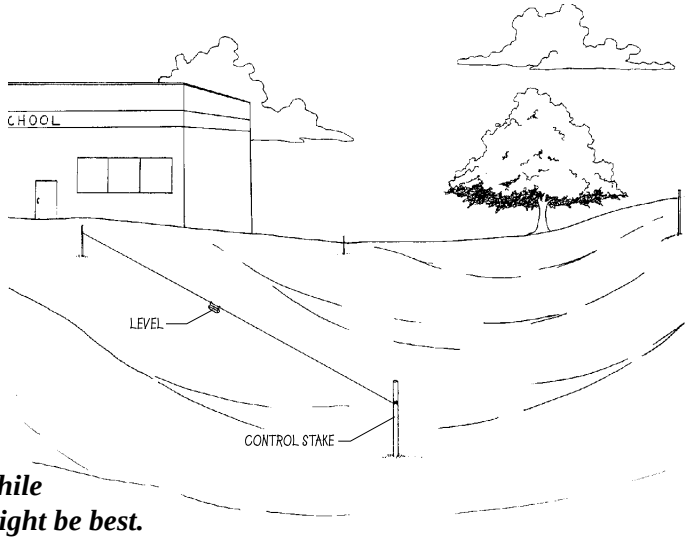
Americans dump 16 tons of sewage into surface waters every minute

This exercise allows participants to map a small watershed, giving them options to calculate its area or construct a topographic map of the area. A relatively small amount of equipment is required, and a wide array of analytical, mathematical and manual skills are involved. Although the exercise seems a bit complicated, it is relatively easy to complete with a minimum of equipment. Its benefits far outweigh the costs, and measurable areas can frequently be found very close at hand.

Equipment/Materials

stakes/markers (several per small group)
tall control stake
100-foot or 30-meter measuring tapes (2)
graph paper (1/10 inch grid best)
ruler (clear decimal ruler preferred)
Record Sheet 6.2
hammer
meter stick(s) or yard sticks
50-foot or 15-meter measuring tapes (2)
twine/string
orienteering compass
line level(s)
pens/pencils
clipboards
protractor

Time Required: 45 minutes or longer



Procedure

1. Select a site that has visible slope and drainage patterns, like a small hollow draining a playground or playing field, or a field edge that shows clear drainage patterns. The presence of obvious ridges is helpful and makes the exercise clearer to the participants. You may predetermine the locations of stakes or wait until the participants come to the site and let them determine the stake locations. ***Hint: Decide on a contour interval for the map. On flat areas, differences of 5 cm or 2 inches might make sense, while on steep areas, intervals on 1 foot or even 1 meter might be best.***
2. Before the field exercise, review the watershed concept, stressing the capture and channeling of water. Lead them to conclude that high points or ridges represent breaks between tiny watersheds or even between major ones. Note that this exercise maps and measures a very small part of a larger watershed. ***Use the hand example in Applications of desired.***
3. Move to the site and let participants decide on a low point (it will be checked later), setting a tall control stake at that point. ***Using a control stake that is premarked with the selected contour interval makes the measuring process much easier for the participants and provides a more accurate map. Be sure the stake is driven into the ground until the indicator mark for the first interval is level with the soil surface.***
4. Divide the participants into smaller groups (three to five works well). Each group can be given a segment of the watershed, a contour interval, or a task (e.g. taking compass bearings, adjusting the line on the control stake, determining when the line is level, measuring distances from the control stake to the contour stake, plotting the points on graph paper, etc.). Stakes should be located so they are on a selected contour level with enough points to permit drawing a contour map of the watershed. ***Hint: You may want to use 5- or 10-degree segments of the circle around the stake for simplicity in mapping.*** Every mapped point should include the contour interval, the distance from the control stake and the direction from the control stake to the mapped point. ***Suggestion: You may want to lead the group in determining the information they will need to accomplish the mapping once their field data collection is completed.*** Ideally the watershed should be mapped to its perimeter. But that is not essential for participants to understand the process or produce a valid map.

5. The location of each stake should be checked by compass bearing and with a line level to make sure it is on the proper interval. ***Hint: Critical thinking may be stimulated by challenging them to determine if using a level is important to obtaining accurate measurements or if other means could be used to make sure the contours are being followed. Remember to reward critical thinking and to correct any proposed methods that will not accomplish the task with positive reinforcement of the thought process involved. Creating a huge paper compass rose on preselected intervals might make the measurements more accurate and easier.***
6. The distance and direction to each contour stake should be measured carefully. If the ridge line can be identified, the height of the ridge line from the control stake should be recorded and distances measured as well. ***Data Collection Hint: Like most other data collection processes, at least three estimates of the distance and direction should be recorded and an average used for each data point.***
7. Once all the measurements have been taken, the stakes may be removed. The remainder of this exercise can be completed in a comfortable site with writing surfaces.
8. Pool all the measurements taken at the site.
9. Have participants lay out a piece of paper large enough to mark from the control point to the edges of the watershed. Lay out faint north-south and east-west lines that cross at the point indicating the control stake. These lines need not be in the center of the paper, but north should be at the top of the map by convention. ***Hint: North is oriented to the top of the map as a standard practice. Students may need some help deciding where to put the control point.***
10. Use a protractor or compass rose to locate each point by determining the direction and the distance to the point from the control point. With a compass rose, place the 0/360 line on the north line. With a protractor, place the center mark on the protractor on the north or south line and calculate the position for the mark. ***Hint: Note that convention places North at 0 or 360 degrees, East at 90 degrees, South at 180 degrees and West at 270 degrees. Some students may find it difficult to visualize the problems, but a little help and superimposing the 360 degree units and the 180 degree units of the protractor should enable them to get their points in the proper locations. A small mark at the edge of the protractor or rose should be adequate to allow alignment of the ruler from the origin to the endpoint.***
11. Using a scale that will fit the map on the paper and make it readable, lay out the contour points. If English units are used, a 1 inch = 10 feet scale is recommended. A clear decimal ruler and graph paper with 10 grid lines to the inch make layout fairly simple. ***Hint: Remind the students to measure on the azimuth line rather than simply counting squares!***
12. Have the participants connect each set of contour points at each contour level, interpolating between points to create a scaled contour map of their watershed.
13. If desired, have the participants calculate the area of the watershed they mapped. ***Hint: A good estimate can be obtained simply by counting the squares (and estimating parts of the squares) included in the mapped area. A more challenging technique, but one that lays some foundation for calculus at an early age, is to treat all the sampled areas as triangles. The areas of each of the triangles can then be calculated using the formula, area = $^1/_2$ base x height. Adding all the triangles together yields an estimate of the total area for the watershed studied. Critical thinking can be encouraged by asking if the estimate would improve if many more, smaller triangles were used (to fit the shape of the watershed better). Lead them to conclude that as the number of triangles increases, the error at the margins decreases, yielding a better approximation of the area (a foundation principle of calculus).***
14. The topography of the watershed also can be shown for those who are mor spatially oriented by transferring the contour lines to layers of cardboard or similar material. These can be stacked using a common origin and North-South or East-West line to form a relief map of the area. If desired, the contour mode can be covered with a thin layer of modeling clay or papier-maché to mold a model of the watershed. The model can be an excellent teaching device to look at the influences of slope and runoff rates.
15. A similar model can be made from USGS $7^1/_2$ minute topographic maps of your area. Once the watershed in question is located on the map, the participants can explore the area noting things like oil or gas leaked into parking areas, trash, signs of erosion, grassy areas, wooded areas, etc. Explore this in a discussion of the influence that area has on the watershed as a whole, on us as individuals, and on our downstream neighbors.

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Name_____Date_____

Record you data below:

1. Describe the location of the watershed

2. What are the measurements from the control stake to the ridge stakes?

Stake Number	Direction (°)	Distance	Elevation

3. Draw a map of the watershed using the data collected.

4. Calculate the area of the watershed. *(Hint: Length x width = area of a rectangle; 1/2 base x height = area of a triangle)*