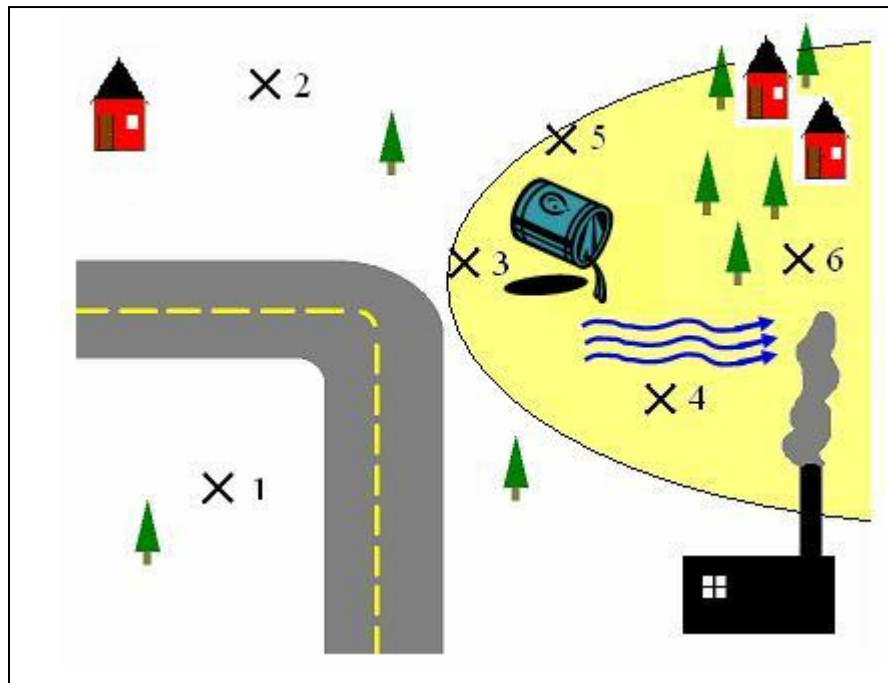


ANSWER KEY Groundwater Pollution Worksheet



PART 1

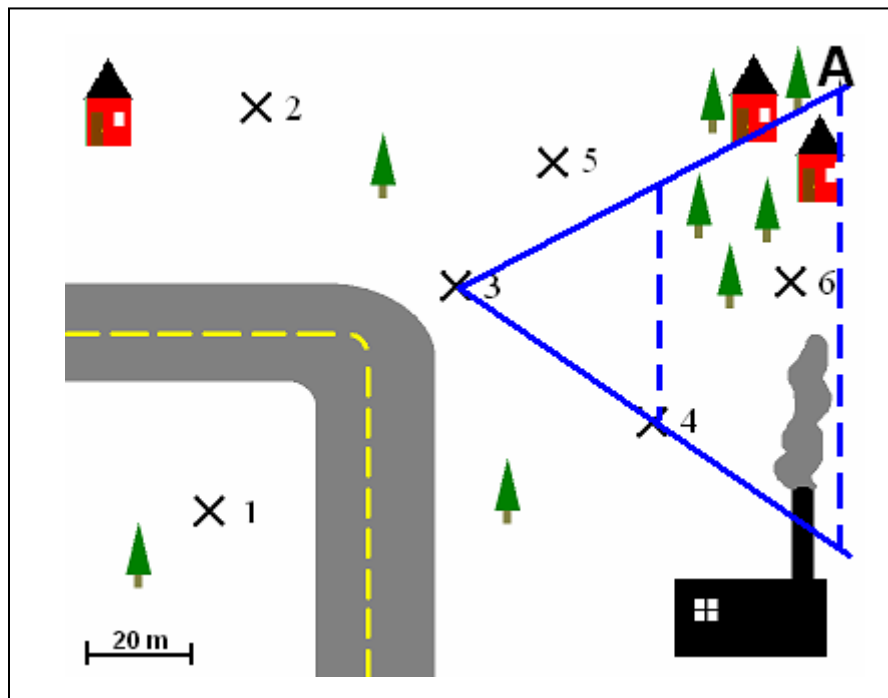
- Find the pH at each sample site. Label the *concentration* as high (H), low (L) or none(N). Draw the direction of the contaminated groundwater flow on the diagram.

Sample #	pH	Concentration (H, L or N)
1		N
2		N
3		H
4		L
5		L
6		L

- Why might the groundwater flow in that direction?

Answers will vary. The plume spreads in the direction of the groundwater. There is probably a hill or higher elevations on the left side of the map. Another reason might include the type of soil/substrate — such as high concentrations of clay on the left side of the map.

Now, we are going to *predict* how fast it will take for the contaminant to reach Community A using the diagram below. You will need a ruler.



3. First, soil samples were taken at site #4 over one year. On the 10th month, a rise in the level of contaminants was found. Find the velocity of the contaminant at sample site #4. Remember, Velocity (v) = distance (D) \div time (t).

D (measured with ruler) = 1.25 inch or 30m

t = 10 months

$$v = D \div t$$

$$v = 30 \div 10$$

$$v = 3.0 \text{ m/month}$$

4. Next, we need to find the area of a cross-section of the contaminant plume at site #4 (shown by the dotted line). Remember Area (A) = width (w) x depth (d). We know that the groundwater is 1 meter in depth.

w (measured with a ruler) = 1.25 inches or 30 m

d = 1 m

$$A = w \times d$$

$$A = 30 \times 1$$

$$A = 30 \text{ m}^2$$

5. We use the cross section of the area we just found to calculate the Flow (Q) of the groundwater over the whole area. Flow (Q) = Area (A) x velocity (v).

A (from #4) = 30 m²

v (from #3) = 3.0 m/month

$$Q = A \times v$$

$$Q = 30 \times 3.0$$

$$Q = 90 \text{ m}^3/\text{month}$$

Name: _____

Date: _____

6. Next, we need to find the area of a cross-section of the plume at community A (shown by the dotted line). Remember Area (A) = width (w) x depth (d). We know that the groundwater is 1 meter in depth.

w (measured with a ruler) = 2.25 inches or 90 m
d = 1 m

$$A = w \times d$$

$$A = 90 \times 1$$

$$A = 90 \text{ m}^2$$

7. Then, we use our flow (Q) from above (assuming the flow is constant) to find the velocity of the contaminant at community A. We rearrange our flow equation to read Velocity (v) = Flow (Q) ÷ Area (A).

Q (from #5) = 90 m³/month
A (from #6) = 90 m²

$$v = Q \div A$$

$$v = 90 \div 90$$

$$v = 1.0 \text{ m/month}$$

8. Lastly, we rearrange our velocity equation to solve for the amount of time for the contaminant to reach Community A. Our equation now reads time (t) = distance (D) ÷ velocity (v).

D (measured with ruler) = 2.5 inches or 100m
v (from #7) = 1.0 m/month

$$t = D \div v$$

$$t = 100 \div 1.0$$

$$t = 100 \text{ months}$$

9. Write your prediction for the time it will take the contaminated groundwater to reach Community A.

I predict the contaminated groundwater will reach the community is 100 months or 8 1/3 years.

Circle the groundwater treatment method you would choose for this site. **Answers will vary.**

Treatment Name	Description	Time
Containment (Physical barriers)	Placing something in the ground to stop the groundwater flow.	1 year
Biological treatment	Adding microorganisms like bacteria that eat the contaminant to make it less toxic.	10+ years
Chemical treatment	Adding chemicals like that react with the contaminant to make it less toxic.	6 months-3 years
Soil vapor extraction	Moving air and vapors through the groundwater in order to remove the contaminant.	3-5 years
Pump and treat	Pumping the contaminated water out of the ground, treat the water and put it back into the ground.	5-10 years

Name: _____

Date: _____

PART 2: Remediation (ANSWERS TO PART 2 WILL VARY)

1. Using the available tools for water treatment, *brainstorm* combinations to get your water sample clean. Make a list of your ideas. Be specific.
2. *Pick one* treatment combination from your above list to test. This is your treatment process. Which treatment process did your group choose and why?
3. *Test* your treatment process and write your observations here.
4. Was your treatment process *effective*? Why or why not?
5. What *improvements* would you make to your treatment process?
6. Test your *modified* treatment process from #5 and write your observations here.

