Natural Remediation of Water Pollution

Learning Objectives:

Students will be able to:

Content

- Describe how waste changes the dissolved oxygen and turbidity of a river.
- Summarize the processes occurring in water bodies to naturally improve water quality after a pollution event.

Process

Information Processing: Interpret

- Provide meaning to information in diagrams.

Teamwork: Building community

- Act as a cohesive unit that includes all team members

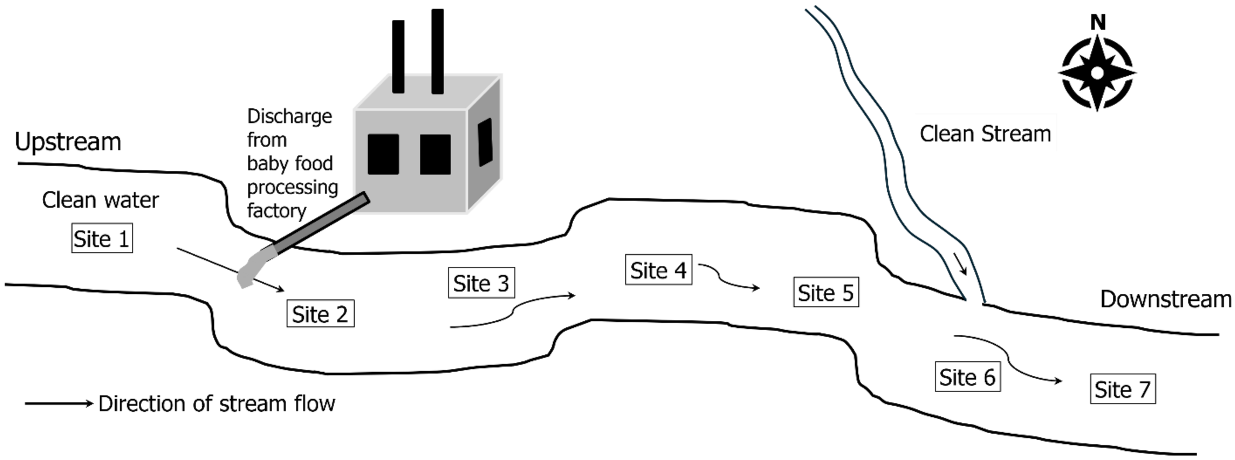
Authors: Susan Sutheimer and Caryl Fish

Natural Remediation of Water Pollution

Why?

Water pollution is harmful to ecosystems and to humans. A limited amount of remediation occurs naturally in a stream. Understanding natural processes can help humans identify when there is too much pollution for natural remediation to be successful.

Model 1: Natural Remediation in a Stream Impacted by Factory Discharge



Include all team members as you discuss and answer Q1-Q3.

1. Examine Model 1. In what direction is the stream where the factory is located flowing?

2. At which sampling site would you expect to see the first impact of the factory discharge?

3. The input of the clean stream will have an impact on which sampling sites?

Read This:

This factory produces baby food, so most of their waste is food waste. This waste is decomposed by bacteria in the stream, using up oxygen. The discharge also includes small particles that are not easily decomposed and cause the water to be cloudy.

Oxygen in water is called **dissolved oxygen or DO**. Levels of DO above 4.0 mg/L are required for most aquatic animals to survive. High levels of DO (above 9.5 mg/L) are required for some fish, like trout, to survive.

The cloudiness of the water is called **turbidity**. Clean water has turbidity levels below 10 NTU (nephelometric turbidity units). Levels above 100 NTU are considered very turbid and can cause problems for fish to breathe and see their prey. Both DO and turbidity in the stream is easily measured using handheld probes.

4. Use your own words to describe the terms *dissolved oxygen* and *turbidity*.

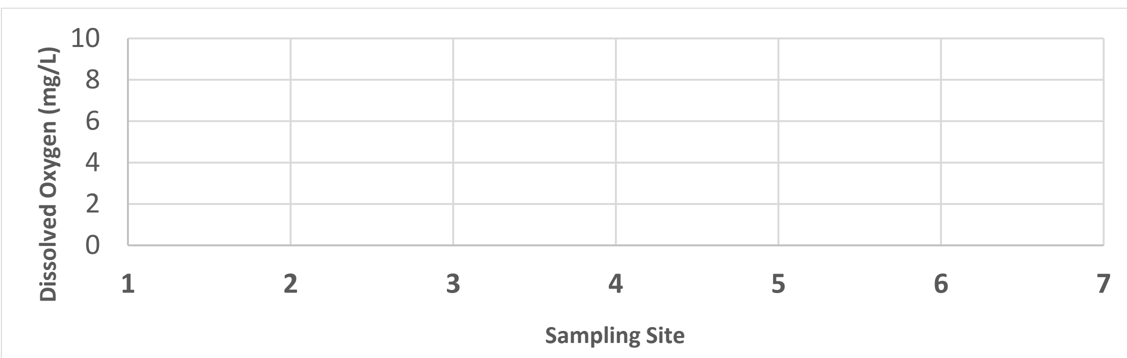
5. Discuss with your team how you would predict the dissolved oxygen levels to change through the sampling sites in Model 1. Sketch a graph of DO vs. sampling site or construct a table of values. During your discussion, ask each team member for their ideas to expand your understanding. This is just a prediction; there is no correct answer.

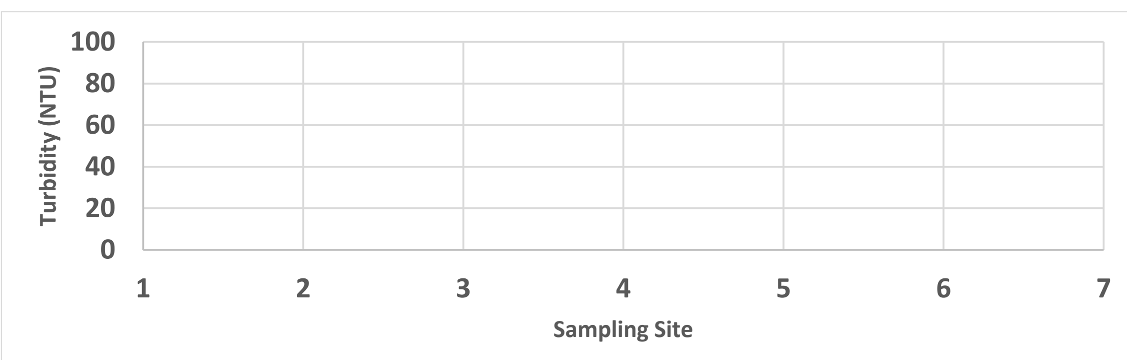
6. Dissolved oxygen and turbidity were measured in samples taken at each sampling site shown in Model 1. Results are shown in Table 1. Using the graph templates in Figure 1, draw graphs for the dissolved oxygen and turbidity. Compare your graphs with those of your teammates to be sure you all agree before continuing.

Table 1: Measurements of dissolved oxygen (DO) and turbidity at the 7 sample sites.

Sample Site	DO (mg/L)	Turbidity (NTU)
1	9.1	7
2	6.3	82
3	3.5	75
4	2.1	56
5	3.4	39
6	7.5	12
7	8.0	11

Figure 1: Graphs of Dissolved Oxygen and Turbidity Measurements





7. Interpret the graphs by describing the trends you see for each graph. In other words, how do the measurements for dissolved oxygen and turbidity change as you move downstream from Site 1 to Site 7? Use specific data to support your description.

    a. Dissolved oxygen:

    b. Turbidity:

8. Based on the measurements in Table 1, which sampling sites indicate water quality issues from the factory discharge? Explain your reasoning.

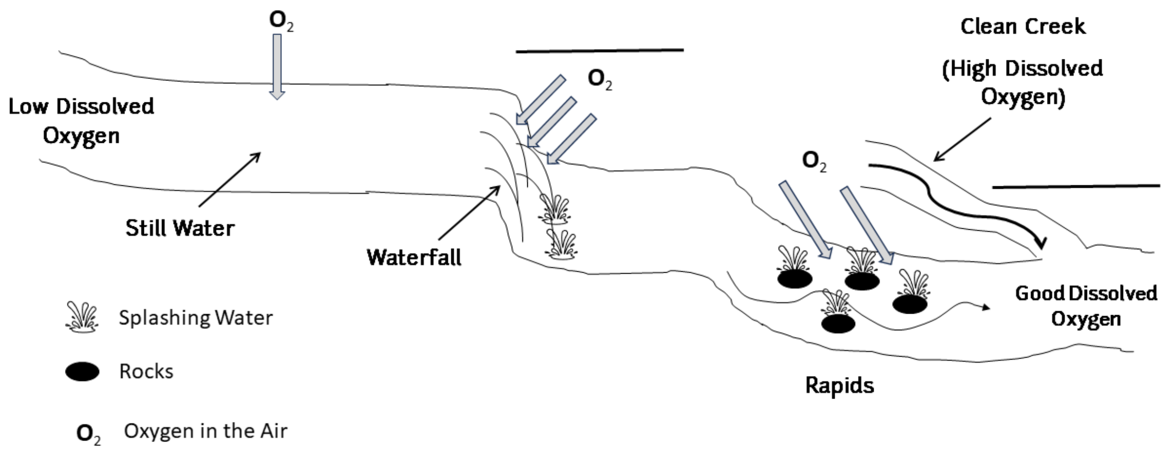
9. Support or refute the statement below using evidence from the data in Table 1 or the graphs in Figure 1. Discuss your ideas with your team and develop a collective answer. Respectfully discuss any disagreements.

    Both the dissolved oxygen and the turbidity naturally recovered after the input of waste from the baby food factory.

Read This:

The data in Table 1 shows that the river water quality improves as it flows. However, Model 1 does not indicate how. Models 2 and 3 will explore four processes that help to naturally clean up a stream.

Model 2: Natural remediation processes for dissolved oxygen



As a team, answer Q10-Q13.

10. What is the source of oxygen added to the stream?

11. In what parts of the stream is oxygen added?

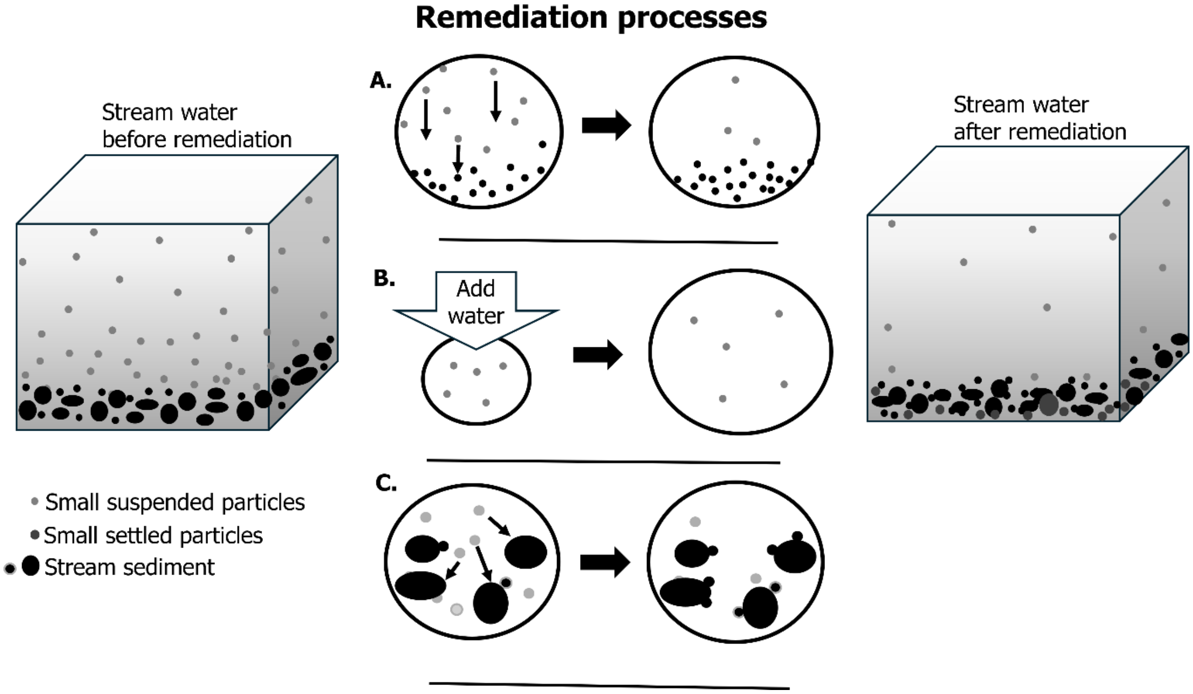
12. If the number of arrows indicates the amount of oxygen added to the water, in which part of the stream is the most oxygen added?

13. How will mixing high dissolved oxygen water from the clean stream change the dissolved oxygen levels in the large stream?

14. Oxygen is added where the surface of the stream meets the air. There must be contact between the air and the water surface. How is the surface of the water different at the waterfall than at the still water? (Hint: think about how water enters a sink when the faucet is turned on to its maximum volume.)

15. Discuss with your team why more oxygen is added in some parts of the stream than in others. Listen carefully as team members explain their reasoning. Summarize your team's answer.

Model 3: Three natural remediation processes for turbidity



16. Examine Model 3. The cube on the left shows which part of the stream?

17. What type of particle is shown in black in Model 3?

18. Consider the stream water before and after natural remediation.
    a. Does the stream water have more suspended particles before or after?
    b. Which situation (before or after) would have a higher turbidity?

19. Look carefully at the three turbidity remediation processes shown in Model 3. Which two processes move suspended particles from the water to the sediment?

20. Which natural remediation process changes the concentration (number of particles/volume of water) of suspended particles but does not remove them?

21. Describe each turbidity remediation process shown in Model 3 using the terms *suspended particles* and *stream sediment* when appropriate. Allow team members to choose a process to start with and then report their description to the team. Discuss each process as a team and summarize your team's descriptions.

    A.

    B.

    C.

Answer Questions 22 – 25 based on the information in Table 2.

Table 2: Natural remediation processes

Physical Process	Explanation of Process
Aeration	Water picks up oxygen from the air
Particle settling	Particles drop to the bottom of the river due to gravity
Dilution	Clean water from a creek enters the main water body
Filtration	Small particles in the water stick to larger particles of sand and gravel at the bottom of the stream

22. Using terms from Table 2, label the processes in Models 2 and 3 using the blank lines provided there.

23. Four examples of water pollution in streams are listed below. Determine whether turbidity or low dissolved oxygen (or both) are likely to occur in the stream. Then consider what natural remediation processes would likely happen in the stream in these situations. Each team member should choose one example to consider and then share their answers with the team.
    a. Dredging the bottom of rivers in Florida caused soil-filled water in the rivers. This could potentially kill coral reefs in the ocean.

    b. Animal waste from a huge turkey farm contaminated soil entering Chiques Creek (pronounced like "Chickies"), a tributary of the Susquehanna River. Downstream from the farm, Little Chiques Creek (a much cleaner stream) flows into Chiques Creek.

    c. Beer and yeast waste from washing down the brewing vats in a Milwaukee brewery entered the Menomonee River. Just downstream from the waste entry point are the Estabrook rapids and Estabrook Falls.

    d. Runoff carrying soil particles from a construction site flowed into Blacklick Creek after heavy rainfall.

24. Discuss with your team two concepts you learned about natural remediation of water pollution.

25. Examine the rubric below for one facet of the process skill “Teamwork—Building Community”. How would you rate your team on this skill? Explain your rating.

    Acted as a cohesive unit that supported and included all team members.

1	2	3	4	5
Rarely		Sometimes		Consistently

Extension Questions

26. In August of 2019, more than 330,000 gallons of hazardous, untreated sewage were released into the Allegheny River. Summarize the processes by which the Allegheny River could clean itself.

27. On November 26, 2004, the oil tanker M/T Athos I spilled oil into the Delaware River in Philadelphia. Only part of the oil was skimmed off the top of the river, but eventually all the oil dispersed into fine droplets and disappeared. What process(es) would account for the eventual disappearance of the oil droplets? Explain your reasoning.

28. Examine the graphs you made in Q6. Explain why the DO reached the worst level at site 4, but turbidity was at its worst at site 2.