Clark Fork Watershed Education Program
Education Portal Lesson: Not in My Backyard!

Prep time: 20-25 minutes
Class Time: 55 minutes
Grade: 8 (Adapt for other grade levels)

Teacher Lesson Plan Outline:

Objectives: Students will be able to:

- Describe the relative amounts of Milltown sediments to historic tailings deposited at the BP-ARCO Repository site (Opportunity Ponds)
- Logically analyze how much "toxic waste" from Milltown is actually being deposited at the BP-ARCO repository site
- Discuss concerns about the location of tailing storage from the perspective of the communities of Bonner and Opportunity

Materials: It is recommended to have approximately two to four students per study group.

Enough jars and glass beads for each student study group to have:

- 160 clear beads
- 8 blue beads
- 3 green beads

(Color selection is flexible; the ratio is the important factor for this lesson.)

Correlations to Montana Curriculum Standards → *Benchmarks noted are for 8th grade.* (**NOTE:** Detailed text of content standards and benchmarks appear at the end of this document.)

Science Standards:
Standard 5: *Benchmark 2, 3, 4*

Mathematics Standards:
Standard 1: *Benchmarks 1, 2*
Standard 2: *Benchmark 3*
Standard 5: *Benchmark 3*

Vocabulary

BP-ARCO Repository: More commonly known as the Opportunity Ponds, this 5,000+ acre area has been designated the permanent waste-management repository for all wastes removed in the Upper Clark Fork Basin Superfund Complex. Prior to its designation as a Superfund waste repository, this site served as tailings ponds for the Anaconda Smelter and Reduction works until 1960. It is currently operated by British Petroleum-Atlantic Richfield Company (BP-ARCO), the Potentially-Responsible-Party (PRP) under Superfund law. The site contains approximately 160 million cubic yards of historic mine tailings.

Sediment: Material in suspension in water or recently deposited from suspension. In the plural the word is applied to all kinds of deposits from the waters of streams, lakes, or seas. In the example of the Milltown Dam, the "sediment" that deposited behind the dam for 100 years include organics (decomposing plant and animal material) and sediments carried from tributaries upstream from Milltown.

Tailings: The materials left over after the process of separating the valuable fraction (minerals) from the undesirable fraction of crushed ore. Tailings are fine in texture and often appear powdery to the touch. In the case of the Clark Fork Basin, tailings can lead to Acid Rock Drainage particularly due to high concentrations of pyrite. Tailings are very mobile, either via water or wind, due to their fine-grained nature.

In the case of the Clark Fork River and Silver Bow Creek, tailings made up a large fraction of the sediments in both systems prior to clean up and restoration efforts.

Lesson Procedure

1. Engage (Pre-assessment)

- **Who knows the story of the Milltown Dam?**
- **What if you were to learn that a significant amount of "toxic waste" was going to be hauled to your city for disposal?**
- **Why do you think that "toxic waste" from the Milltown Dam removal is being deposited in the ARCO-BP repository at Opportunity rather than storing it near Missoula?**
- **What other factors do you think can influence a community decisions regarding handling of wastes?**

2. Explore

Working in pairs or small groups, each group should be give a copy of the student guided inquiry worksheet and a jar with the following number of beads:

- 160 clear beads
- 8 blue beads (6 representing Silver Bow Creek; 2 representing Clark Fork River)
- 3 green beads

Each one of the beads represents **approximately** 1 million cubic yards of waste material. The total number of beads should be 171, with 160 for the existing Opportunity wastes, 8 for the materials to be hauled out of the Clark Fork River Superfund cleanup (Silver Bow Creek and Clark Fork River), and 3 from the Milltown site.

Students will calculate the overall ratio of existing wastes (clear beads) to additional wastes being added to the BP-ARCO waste repository and calculate percent composition at the waste repository.

3. Explain

There were 160 million cubic yards of highly contaminated tailings wastes at the former Opportunity Ponds, now called the BP-ARCO Waste Repository. That waste, the byproduct of copper smelting, is what the old Washoe Smelter and Anaconda Reduction Works disposed at the site from the turn of the 20th century up until around 1960 when concentrating operations were moved to Butte. (To expand the lesson, take a look at the Yankee Doodle Tailings Pond on Google Earth.)

In the early stages of the Silver Bow Creek cleanup – a 22-mile restoration/remediation project on the headwaters of the Clark Fork near Butte – it was decided that the roughly 6 million cubic yards of waste to be removed from the restoration sites would be disposed of and managed at the Opportunity site. Due to this decision on the Silver Bow Creek project in 2000, Opportunity has become the central dumping ground for all

mining wastes removed from the Clark Fork River Superfund sites, including the Milltown Dam project.

Green Beads for Milltown Wastes

In volume, the Milltown wastes (which will actually be a little less than 3 million cubic yards) make up 1.75% of the total waste to be managed forever at the BP-ARCO Waste Repository (formula = 3 /171 x 100%).

In addition to the small percentage of waste volume the Milltown wastes occupy at Opportunity, they also have much different toxicity characteristics. The Milltown sediments are toxic wastes being removed as part of a federal Superfund remediation project, and they are not clean soil. However, it is not accurate to generalize by saying "all toxic wastes are created equal." For instance, when compared to Superfund sites like Love Canal (chemicals) and Three-Mile Island (nuclear), all of the wastes within the Clark Fork unit – even the worst stuff of all – are relatively mild in toxicity to humans and the environment. That being said, not all of the wastes found in the Clark Fork unit are the same in their toxicity.

The wastes at Opportunity are processed mineral wastes called tailings; they are very acidic and contain highly concentrated metals, including copper, zinc, lead, cadmium and the nasty metalloid arsenic. The wastes being removed from Milltown are the same type of wastes that are at Opportunity, a site that has served as a waste disposal area since the late 1800s, with one significant exception. The Milltown wastes are different in that most of them were washed downstream in the 1908 flood and have been sitting underwater at the bottom of a lake/reservoir for 100 years.

How does this placement change the Milltown wastes?

Arsenic in the drinking water was a key factor leading to the addition of Milltown to the Clark Fork Superfund site. Where did the arsenic in the drinking water of the Milltown residents come from? It came from the tailings that washed downstream and settled to the bottom of the reservoir behind Milltown Dam. Water has dissolved many of the metals out of those tailings continuously for the last 100 years. Also during this time, clean sediments from upstream tributaries and tons of organic matter from dead leaves, plants and animals have washed downstream and settled on top of the tailings that were deposited in the big flood. Their location behind the dam and the fact that water is continually seeping through the deposits and carrying dissolved material such as arsenic to the groundwater is part of the reason they are considered toxic. Location in this case is everything!

The toxicity of the Milltown wastes is much different now than it was 100 years ago.

When comparing a sample of the Milltown and Opportunity wastes, you can see the difference just by looking: Opportunity waste is orange, evidence that Acid Rock Drainage is present and ongoing; the Milltown waste looks a lot like the dirt you might dig up out of your yard, dark-brown with pieces of roots and river pebbles. Given the

visual difference, ask yourself which one you would use if you were going to plant a garden?

This visual comparison is just the beginning of their differences. The pH, or acidity of the Milltown sediments, is approximately 10,000 times or "four orders of magnitude" less acidic than the wastes that were already at the BP-ARCO site (Milltown pH = 7.5; Opportunity pH = 3.5). The concentration of heavy metals and arsenic in the Milltown wastes is at least 10 times less than those at Opportunity. This lower concentration level is the result of 100 years of dilution, sitting at the bottom of a lake, mixing with clean sediments and water.

Are Milltown wastes actually toxic?

While the Milltown wastes are still considered toxic because they come from a Superfund site, they are so different than the wastes already at Opportunity that their disposal there is actually expected to improve the conditions of the Opportunity site. Because of the neutral pH and high organic content of the Milltown sediments (~2-3%), the sediments are being spread out in a layer across the more acidic, more concentrated Opportunity tailings in hopes that grass will be able to grow and prevent erosion, holding all of the waste in place. For years, the frequent winds coming out of the Deer Lodge valley have stirred up the barren, fine-grained wastes at Opportunity and blown them in dust-storm fashion. This blowing spreads tailings across the entire valley, including within the attics of nearby homes. By placing Milltown sediments on top of these old Opportunity wastes and getting plants to grow, the contaminated wastes will be held in place and the plants will reduce the amount of precipitation and snow melt that seeps through the wastes and into the aquifer. This layer of cleaner dirt on top of more-contaminated dirt is called a *cap*.

4. Extend/Elaborate

This lesson can be extended in many different fashions. The student worksheet for Not in My Backyard! contains a set of elaboration questions for students to consider. Students and teachers could conduct investigations of samples to further illustrate the relative toxicity of Milltown Sediments vs. Opportunity Tailings. (Teachers will need to request permission and small reference samples to complete this type of testing; for samples, contact CFWEP at (406) 496-4124.)

This lesson compliments What is a Part per Million?, which is located in the Clark Fork Education Program Education Portal Lessons at www.cfwep.org.

5. Evaluate

The guided inquiry student worksheet can be used for evaluation of this lesson.

Montana Content Standards Alignment

Science

Standard 5: Students, through the inquiry process, understand how scientific knowledge and technological developments impact communities, cultures and societies.

Benchmarks:
2. Apply scientific knowledge and process skills to understand issues and everyday events.
3. Simulate collaborative problem solving and give examples of how scientific knowledge and technology are shared with other scientists and the public.
4. Use scientific knowledge to investigate problems and their proposed solutions and evaluate those solutions while considering environmental impacts.

Mathematics

Standard 1: Students engage in the mathematical processes of problem solving and reasoning, estimation, communication, connections, and application, and using appropriate technology.

Benchmarks:
1. Formulate and solve multi-step and non-routine problems using a variety of strategies. Generalize methods to new problem situations.
2. Select and apply appropriate estimation strategies throughout the problem-solving process.

Standard 2: Students demonstrate understanding of and an ability to use numbers and operations.

Benchmark:
3. Use relationships and application of ratio, proportion, percent, and scientific notation.

Standard 5: Students demonstrate understanding of and ability to use data analysis, probability and statistics.

Benchmark:
3. Draw inference, construct, and evaluate arguments based on data analysis and measures of central tendency.