ENVIRONMENTAL MANAGEMENT: CLEAN WATER RESEARCH AS RELATED TO ACID MINE DRAINAGE

LESSON PLAN CREATED BY:

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BACKGROUND INFORMATION

The United States Environmental Protection Agency has singled out drainage from abandoned coal mines as the number one water quality problem in Appalachia.

Coal mine drainage is water containing iron and sulfate and sometimes other metals, such as, manganese and aluminum. It is often acidic (low pH) and is commonly referred to as acid mine drainage or AMD. AMD forms through a series of chemical and biological reactions that occur when the pyrite (iron sulfide, aka fool's gold) found in coal and other rock strata is disturbed and exposed to oxygen and moisture as a result of mining operations. AMD may contaminate surface and ground water.

President Carter signed the Surface Mining Control and Reclamation Act (SMCRA – pronounced "smack-cra") in 1977. One of the main reasons the new law was needed was to prevent future coal mining from creating mine drainage problems. Another was to clean up abandoned mine land problems created by past mining. Some of the worst pollution problems are in decades-old abandoned mines in Pennsylvania and West Virginia. Some sites mined at the turn of the century (1890s) still produce contaminated water.

Cleaning up mine drainage from abandoned coal mines is very difficult and expensive. Approximately ten percent of mine drainage

comes from abandoned surface mines. Preventing mine drainage from surface mines requires the elimination of water movement through the pyritic material.

Most mine drainage originates in abandoned underground coal mines and flows in surface or ground water into nearby streams. Some success has been achieved by filling or grouting mine voids with alkaline material that is a by-product of coal-fired plants. However, this method is expensive and results are inconsistent. For this reason, water treatment is the most practical solution to the problem.

Methods of water treatment used to eliminate acid mine drainage from abandoned underground mines can be grouped into two types, active and passive. Active treatment, which requires constant maintenance, involves neutralizing acid-polluted water with lime, sodium hydroxide (caustic soda), sodium carbonate (soda ash) or ammonia. This treatment reduces acidity and significantly decreases iron and other metals, but is expensive to construct and operate. The laws require treatment as long mine drainage is produced ("in perpetuity"), which can be several decades.

Passive treatment involves the construction of a treatment system that is typically designed to last 20 – 40 years and requires much less maintenance than active treatment. This technology involves the use of wetlands, ponds, and anoxic limestone drains. Passive treatment systems are relatively inexpensive to construct and many are very

successful. To date, many of these passive systems have been used to treat smaller, less contaminated mine drainage discharges. As confidence in these systems grows, they are also used to treat larger and more contaminated discharges.

The Clean Water Team at FETC monitors the performance of passive treatment systems, develops criteria used to size these systems, and works on the development of new passive treatment technology.

OBJECTIVES

- The students will be able to work in cooperative learning groups to study the effects of Acid Mine Drainage (AMD) and experimentation being conducted to eliminate them.
- The students will be able to gain an appreciation for the work done by scientists to solve environmental problems caused by acid mine drainage.
- The students will be able to demonstrate knowledge of scientific vocabulary used in acid mine drainage research.
- The students will be able to demonstrate how neutralization processes are used in the passive treatment of acid mine drainage.
- The students will be able to apply mathematics and graph results by analyzing the data collected during lab activities.
- The students will be able to explore the different types of careers in environmental science.

PROCEDURES

1. Present background information to the students.
    - Use various beakers containing water (yellow, orange, blue-green, clear, and white) to illustrate to the students the physical characteristics of water contaminated with acid mine drainage.
    - By lecture and discussion, make students aware of the acid mine drainage problems within our environment caused by the mining of coal.
2. Introduce and discuss science and environmental vocabulary.
    - Present students with a glossary of terms.
    - Discuss the terms most relevant to the current lesson.
    - Discuss the role the Department of Energy has in environmental management.
3. Using various Internet sites, students will research sources of acid mine drainage and possible solutions to this problem (suggested sites listed at end of lesson plan).
4. Working in small cooperative groups, students will compile and share research information with the class.
5. Students will demonstrate through various activities the chemical processes involved in the treatment of AMD. Please refer to the list of activities in the next section.

6. As a concluding activity, students can present the advantages and disadvantages of the possible solutions being researched for the control of acid mine drainage.

ACTIVITIES

CHEMICAL PROCESSES:

- Test pH levels of various substances such as rain water, soda, tap water, and bottled water, etc.
- Perform neutralization reactions using common bases (baking soda solution, lime water, sodium hydroxide) with common acids such as acetic acid or dilute HCl.
- Prepare precipitates so students can observe how substances such as Fe, Mn, Al, etc. come out of solution in acid mine water.

WATER SAMPLING:

- Test pH levels of local streams.

FIELD EXPERIENCES:

- Go on a watershed tour. Contact your state Department of Conservation and Natural Resources or Bureau of State Parks.
- Adopt a Stream.
- Contact Environmental Education Centers such as the Jennings Environmental Education Center at Slippery Rock, PA.

SPEAKERS:

- Invite speakers from Watershed Conservation groups.

VOCABULARY

ACID MINE DRAINAGE (AMD)

ACTIVE TREATMENT

ALKALINITY

ANOXIC DRAIN

ARTESIAN FLOW

CALCITE

HYDROGEOLOGY

LIMESTONE

NEUTRALIZATION

OXIDATION

PASSIVE TREATMENT

pH

PRECIPITATES

PYRITE

SLUDGE

WATERSHED

YELLOWBOY

MATERIALS

BAKING SODA

BEAKERS

BOTTLED WATER

FOOD COLORING

HYDROCHLORIC ACID

LIME WATER

PAPER TOWELS

pH PAPER

RAIN WATER

SODA

SODIUM HYDROXIDE

TAP WATER

VINEGAR

WATER POLLUTION KIT or ACID RAIN TEST KIT

SUGGESTED INTERNET RESOURCES

www.fetc.doe.gov

www.coolscience.com

www.dep.state.pa.us.gov

www.osmre.gov

www.usgs.gov

eelink:environmental education on the internet

whyfilesnews.wisc.edu

www.ctc.net/scrip/problem.htm

www.cotf.edu/ete/modules/waterq/wqacidmine.htm

www.enviromine.com

www.caf.wvu.edu/faculty/skousen/research.htm