CFWEP Lesson Plan: World Water Monitoring Day Lesson 1: Introduction

Duration: 1 class period (45-60 minutes)

Grade Level: 9-12

I. Lesson Topic This lesson introduces students to water and ecological studies through involvement in World Water Monitoring Day (WWMD), an international education and outreach program that engages students to conduct basic monitoring of their local water bodies to protect water resources around the world.

II. Montana Standards and Benchmarks

Science Standard 1: Grade 12 Benchmarks: 1, 2, 3, 5, 6
Science standard 2: Grade 12 Benchmarks: 2, 3
Science Standard 3: Grade 12 Benchmarks: 5
Science Standard 4: Grade 12 Benchmarks: 4
Science Standard 5: Grade 12 Benchmarks: 3, 4, 5
Science Standard 6: Grade 12 Benchmarks: 3

For support, equipment and additional information, contact the **Clark Fork Watershed Education Program (CFWEP) (406) 496-4124**
www.cfwep.org

III. Objectives

- Students will learn about the standard criteria for "healthy" water.
- Students will observe various water samples, develop hypotheses regarding the point source of each sample, design and implement an experiment to determine the quality and source of samples, collect and measure data from samples, and record their data.
- Students will sort, classify and categorize water samples based on their observations.
- Students will report the results of their water sample assessment and debate and persuade one another as to the likely point source of each sample, and formulate questions about what relationships or patterns may have affected the water quality of each sample.

IV. Materials/Equipment/Resources Needed:

- Copies of the Water Monitoring Pre/Post Test for each student.
- Pre/Post Test answer key.
- Water quality test strips or multimeter (available in WWMD Test Kits; Test Kits and GLX Multimeters are available to check-out from CFWEP); pH, turbidity, dissolved oxygen.
- *Optional*: A colorimeter to measure dissolved copper (available from CFWEP).
- Various water samples: 1) a salt water solution; 2) tap water; 3) bottled water; 4) soda; 5) water sample from a local water body; 6) tap water mixed with a tablespoon of dirt; 7) Berkeley Pit water (available from CFWEP); 8) Milltown groundwater (available from CFWEP); 9) mine tailings slurry (available from CFWEP); 10) have students bring water samples from their tap or well.
  Note: 3-4 different samples from the list above are sufficient for this lesson.
- Copies of the WWMD Indicator Fact Sheet for each student.
- 4 or more cups.
- *Optional:* Copies of the USGS Water Quality Primer for each student.
- *Optional*: 2007 WWMD Year in Review Report.
- Teacher Resource Sheet.
- Water Sample Worksheet.

V. Vocabulary

pH Scale	Turbidity	Dissolved Oxygen	Acid
Base	Watershed	Tailings	Point Source
Pollution	Nonpoint Source Pollution	Total Maximum Daily Load (TMDL)	Riparian
Water Cycle	Solution	Ion	Colloid
Acid Mine Drainage (AMD)		*Optional*: Conductivity, copper, arsenic, colorimeter	

VI. Assessment

A Pre/Post Test will assess students' content knowledge. A water testing activity will assess students' science process and inquiry skills. A post Stewardship Survey will assess student attitudes.

VII. Procedure

Teacher Input

1. Before class: Ready 3-4 WWMD Test Kits (or GLX Multimeters, if used, or a combination of Kits and Multimeters).
2. Before class: Prepare 3-4 (or more, if desired) water samples. At a minimum, the samples should be 1) a salt water solution; 2) tap water; 3) water from a local stream or lake; 4) tap water mixed with a tablespoon of dirt.
3. Deliver Pre Test.

Objective, Steps 4-8: Students will learn about the standard criteria for "healthy" water.

4. Describe WWMD, the goals and significance of the event to students. Note important factors affecting water quality in western Montana, distinguishing between point source and nonpoint source factors (refer to CFWEP WWMD Teacher Resource Sheet).
5. Hand out the WWMD Indicator Fact Sheet and instruct students to review it and use it to follow along during the next step.
6. On the board, review the definitions of pH, turbidity and dissolved oxygen. Note typical values for each parameter in Montana streams and rivers (refer to CFWEP WWMD Teacher Resource Sheet). Also note that water temperature is an important measure of stream health.
7. *Optional, if time allows:* Also review the definitions of conductivity, copper and arsenic (refer to CFWEP WWMD Teacher Resource Sheet).
8. *Optional, if time allows:* Using the 2007 WWMD Year in Review Report (or any current WWMD Year in Review Report), write average water quality values listed in the report for Montana on the board, along with the average values for 1-2 other locations. In a classroom discussion, ask students to develop hypotheses to explain observed differences in average values.

Objective, Steps 9-14: Students will observe various water samples, develop hypotheses regarding the point source of each sample, design and implement an experiment to determine the quality and source of samples, collect and measure data from samples, and record their data.

9. Break students into 3-4 groups. Give each group a Water Sample Worksheet.
10. Put a list of water sample sources on the board, and explain to students that they are to use their scientific knowledge and the tools at their disposal to determine which sample is which.
11. Ask student groups to offer hypotheses based on simple observation as to which sample is which and write their hypotheses, including the reasoning behind it, on the Water Sample Worksheet (e.g. that sample is bubbly and brown so we hypothesize that it is cola based on our prior knowledge).
12. Demonstrate the use WWMD Test Kits (or GLX Multimeters, if used) to students, and give each group a Kit or Multimeter.
13. Assist student groups as they use Kits/Multimeters to take measurements of water quality parameters (pH, turbidity, dissolved oxygen) for each sample. Ensure that groups are accurately recording data on the Water Sample Worksheet.
14. *Optional, if time allows:* Describe the Colorimeter and the process for using it to determine the amount of dissolved copper present in samples. Allow groups to use it to record this additional measurement. If GLX Multimeters are used, students should also measure conductivity for each sample.

Objective, Step 15: Students will sort, classify and categorize water samples based on their observations.

15. Each groups reports on their results, explaining the process and logic they used to determine the point source of each sample.

Objective, Steps 16-19: Students will report the results of their water sample assessment and debate and persuade one another as to the likely point source of each sample, and formulate questions about what relationships or patterns may have affected the water quality of each sample.

16. Discuss with students what factors could affect the various samples and water bodies in Montana, and the effectiveness of current established water monitoring procedures (refer to CFWEP WWMD Teacher Resource Sheet). Ask students to speculate on how Montana American Indians may have observed water quality, and how that may have affected their culture and lifestyle.
17. On the board, review the chemical reaction that causes Acid Mine Drainage in western Montana (refer to CFWEP WWMD Teacher Resource Sheet).

18. *Optional, if time allows*: Review the Pre Test with students, pointing out and explaining correct answers (refer to the Pre/Post Test Answer Key).
19. *Optional*: Give each student a copy of the USGS Water Quality Primer and ask them to review it for homework.

Student Activities

1. Complete the Pre-Test.
2. Through teacher demonstrations and discussion, students learn about World Water Monitoring Day, point and nonpoint source pollution, the parameters measured in assessing water quality, and the instruments used to measure water quality.
3. In groups, students conduct an inquiry investigation into various water samples. Using their knowledge of water quality and the instruments provided, students must determine the source of each water sample.
4. Groups explain the results of their inquiry investigation to the class, including the data collection procedures and methods used to reach their results.
5. Through class discussion, students explore the factors affecting water quality in Montana.

VIII. Homework Students should review the USGS Water Quality Primer.

IX. Resources

WWMD Website: http://www.worldwatermonitoringday.org/
CFWEP Website: http://www.cfwep.org

X. Extensions This lesson is designed as part 1 of a 3-part module. Part 2 involves collection of water quality data in the field, and part 3 is a concluding in-class follow-up lesson. Considerable options exist for further extension; refer to the resources listed above as a starting point for extended activities. Teachers interested in potential extensions can also contact the CFWEP (see contact info above) for additional suggestions and support.

XI. Notes Teachers should take time to review the Teacher Resource Guide for this lesson prior to delivery. A quick web search or visit to the "News" section of www.cfwep.org can offer recent media stories on current environmental issues that can be used in classroom discussions.

XII. Science Process Skills

1. ***Knowledge***

Students will observe various water samples, collect and measure data from samples, and record their data.

2. ***Comprehension***

Students will generalize and summarize data about various water samples, infer the point source of each sample, define problems observed in samples, and identify the cause and effect of each sample's state.

3. ***Application***

Students will design and implement an experiment to determine the point source of various water samples, predicting point sources prior to experimentation. Students will make their own decisions in experimentation and assessment. Students will sort, classify and categorize water samples based on their observations.

4. a. ***Analysis***

Students will identify relationships and patterns affecting water quality, formulate questions about water quality, and discuss the procedures of water quality assessment and the results of their own assessment of various water samples.

b. ***Analysis and Synthesis***

Students will report results of water sample assessment, and then debate and persuade one another as to the likely point source of each sample.

5. ***Evaluation and Synthesis***

Students will establish criteria for "healthy" water, test hypotheses regarding the point source of various water samples, assess water quality, and critique results of water quality assessment.

XIII. Montana Standards and Benchmarks (Item II in full)

Note: Standards are bolded and Benchmarks are italicized, with connections to this lesson explained in plain text.

Science – Standard 1:

Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate the results and form reasonable conclusions of scientific investigations.

In the activity for this lesson, students engage in the inquiry process and are required to demonstrate the ability to design, conduct and communicate the results and form reasonable conclusions of a scientific investigation in determining the point source of various water samples.

Grade 12 Benchmarks:

1. Generate a question, identify dependent and independent variables, formulate testable, multiple hypotheses, plan an investigation, predict its outcome, safely conduct the scientific investigations, and collect and analyze data.

In the activity for this lesson, students identify dependent and independent variables affecting water samples; formulate testable, multiple hypothesis; plan an investigation; predict its outcome; safely conduct the investigation; and collect and analyze data in determining the point source of various water samples.

2. Select and use appropriate tools including technology to make measurements (in metric units), gather, process and analyze data from scientific investigations using appropriate mathematical analysis, error analysis, and graphical representation.

In the activity for this lesson, students select and use appropriate technological tools to make measurements (in metric units) of water quality; and gather, process and analyze data from their scientific investigation to evaluate water quality.

3. Review evidence, communicate and defend results, and recognize that the results of a scientific investigation are always open to revision by further investigations. (e.g. through graphical representation or charts).

In the activity for this lesson, students review evidence regarding water quality, communicate and defend results, and recognize that the results of a scientific investigation are always open to revision by further investigation.

5. Identify strengths, weaknesses, and assess the validity of the experimental design of an investigation through analysis and evaluation.

In the activity for this lesson, students conduct an investigation, and the lesson concludes with students identifying the strengths and weaknesses of that investigation through analysis and evaluation in a classroom discussion.

6. Explain how observations of nature form an essential base of knowledge among the Montana American Indians.

In the concluding classroom discussion for this lesson, students review how observations of water quality may have contributed to the culture and lifestyle of Montana American Indians.

Science – Standard 2:
Students, through the inquiry process, demonstrate knowledge of properties, forms, changes and interactions of physical and chemical systems.

In this lesson, students use the inquiry process to assess the properties ,forms, changes and interactions of physical and chemical parameters of natural and human-made water systems.

Grade 12 Benchmarks:
2. Explain how the particulate level structure and properties of matter affect its macroscopic properties, including the effect of (a)valence electrons on the chemical properties of elements and the resulting periodic trends in these properties, (b) chemical bonding,(c) molecular geometry and intermolecular forces, (d) kinetic molecular theory on phases of matter, and (e) carbon-carbon atom bonding on biomolecules.

In this lesson, students will observe how the particulate level structure and properties of water molecules affect the macroscopic properties of water, including the effect of (b) chemical bonding.

3. Describe the major features associated with chemical reactions, including (a) giving examples of reactions important to industry and living organisms, (b) energy changes associated with chemical changes, (c) classes of chemical reactions, (d) rates of reactions, and (e) the role of catalysts.

In this lesson, students will study examples of (a) reactions important to living organisms.

Science – Standard 3:
Students, through the inquiry process, demonstrate knowledge of characteristics, structures and function of living things, the process and diversity of life, and how living organisms interact with each other and their environment.

In this lesson, students use the inquiry process to study how living organisms interact with each other and their environment.

Grade 12 Benchmarks:
5. Generate and apply biological classification schemes to infer and discuss the degree of divergence between using ecosystems.

In this lesson, students apply biological classification schemes to infer and discuss riparian ecosystems.

Science – Standard 4:
Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

In this lesson, students use the inquiry process to study the composition, structures, processes and interactions of Earth's water cycle system.

Grade 12 Benchmarks:
4. Collect and analyze local and regional weather data to make inferences and predictions about weather patterns; explain factors influencing global weather and climate; and describe the impact on earth of fluctuations in weather and climate (e.g., drought, surface and ground water, glacial instability).

In this lesson, students collect and analyze local water data to make inferences and predictions about factors influencing weather and riparian climates and explore fluctuations in weather and riparian climate.

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

Through the inquiry process, in this lesson students explore how scientific knowledge and technological developments impact western Montana communities, cultures and societies.

Grade 12 Benchmarks:
3. Evaluate the ongoing, collaborative scientific process by gathering and critiquing information.

In this lesson, students evaluate the ongoing, collaborative scientific process of studying and restoring the Clark Fork Basin by gathering and critiquing information about water quality.

4. Analyze benefits, limitations, costs, consequences, and ethics involved in using scientific and technological innovations (e.g., biotechnology, environmental issues).

In this lesson, students analyze the benefits, limitations, costs, consequences, and ethics involved in using scientific and technological innovations in regards to environmental issues in the Clark Fork Basin.

5. Explain how the knowledge of science and technology applies to contemporary Montana American Indian communities (e.g., natural resources development, management and conservation).

In this lesson, students study how the knowledge of science and technology applies to contemporary Montana American Indian communities in regards to water quality and water resource management and conservation.

Science – Standard 6:
Students understand historical developments in science and technology.

In this lesson, students review historical and recent developments in science and technology as they pertain to the Clark Fork Basin.

Grade 12 Benchmarks:
3. Describe, explain, and analyze science as a human endeavor and an ongoing process.

In this lesson, students analyze science as a human endeavor and an ongoing process in regards to the assessment, management and restoration of water resources in Western Montana.