High School Lesson Plan #5

COURSE(S): Integrated Physics and Chemistry; Environmental Studies; Aquatic Sciences; Geology, Meteorology, and Oceanology

TOPIC: Management of Watersheds as a Water Resource

TITLE: What Makes Up a Healthy Watershed

OVERVIEW: The student will observe the elements of a local watershed and develop an appreciation for the need to protect watersheds as valuable water resources. The student will observe the interdependence of a variety of factors on a watershed. These factors include local geology, the ecology of the watershed, and the effect of man's influence.

TEXAS ESSENTIAL KNOWLEDGE AND SKILLS:

Integrated Physics and Chemistry

(c) Knowledge and Skills

(1) Scientific processes. The student, for at least 40% of the instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(C) organize, analyze, evaluate, make inferences, and predict trends from data.

(D) communicate valid conclusions.

(8) Science concepts. The student knows that change in matter affect everyday life. The student is expected to:

(A) distinguish between physical and chemical changes in matter such as oxidation, digestion, changes in state, and stages in the rock cycle.

Environmental Studies

(c) Knowledge and Skills

(1) Scientific processes. The student, for at least 40% of the instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(C) organize, analyze, evaluate, make inferences, and predict trends from data.

(D) communicate valid conclusions.

(4) Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to:

(C) evaluate the impact of human activity such as methods of pest control, hydroponics, organic gardening, or farming on ecosystems.

(E) predict changes that may occur in an ecosystem if biodiversity is increased or reduced.

(5) Science concepts. The student knows the interrelationships among the resources within the local environmental system. The student is expected to:

(B) identify source, use, quality, and conservation of water.

(F) evaluate the impact of human activity and technology on land fertility and aquatic viability.

(8) Science concepts. The student knows that environments change. The student is expected to:

(A) analyze and describe the effects on environments of events such as fires, hurricanes, deforestation, mining, population growth, and municipal development.

Aquatic Sciences

(c) Knowledge and Skills

(1) Scientific processes. The student, for at least 40% of the instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(C) express and manipulate quantities using mathematical procedures such as dimensional analysis, scientific notation, and significant figures.

(D) organize, analyze, evaluate, make inferences, and predict trends from data.

(E) communicate valid conclusions.

(10) Science concepts. The students knows the origin and use of water in a watershed. The student is expected to:

(A) identify sources and determine the amounts of water in a watershed including groundwater and surface water.

Geology, Meteorology, and Oceanology

(c) Knowledge and Skills

(1) Scientific processes. The student, for at least 40% of the instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during field and laboratory investigations.

(2) Scientific processes. The student uses scientific methods during field and laboratory investigations. The student is expected to:

(C) organize, analyze, evaluate, make inferences, and predict trends from data.

(D) communicate valid conclusions.

(10) Science concepts. The student knows the interactions that occur in a watershed. The student is expected to:

(A) identify the characteristics of a local watershed such as average annual rainfall, runoff patterns, aquifers, locations of river basins, and surface water reservoirs.

(B) analyze the impact of floods, droughts, irrigation, and industrialization on a watershed.

(C) describe the importance and sources of surface and subsurface water.

RELATED ESSENTIAL KNOWLEDGE AND SKILL:

Environmental Studies

(c) Knowledge and Skills

(4) Science concepts. The student knows the relationships of biotic and abiotic factors within habitats, ecosystems, and biomes. The student is expected to:

(A) identify indigenous plants and animals, assess their role within the ecosystem, and compare them to plans and animals in other ecosystems and biomes.

(D) predict how the introduction, removal, or reintroduction of an organism may alter the food chain and affect existing populations.

Aquatic Sciences

(c) Knowledge and Skills

(10) Science concepts. The students knows the origin and use of water in a watershed. The student is expected to:

(B) research and identify the types of uses and volumes of water used in a water shed.

(C) identify water quantity and quality in a local watershed.

Mathematical Models with Applications

(c) Knowledge and Skills

(3) The student develops and implements a plan for collecting and analyzing data in order to make decisions. The student is expected to:

(A) formulate a meaningful question, determine the data needed to answer the question, gather the appropriate data, analyze the data, and draw reasonable conclusions.

(B) communicate methods used, analysis conducted, and conclusions drawn for a data-analysis project by written report, visual display, oral report, or multimedia presentation.

(C) determine the appropriateness of a model for making predictions from a given set of data.

Geometry

(f) Similarity and the geometry of shape: knowledge and skills and performance descriptions. The student applies the concepts of similarity to justify properties of figures and solve problems.

Following are performance descriptions.

(4) The student describes the effect on perimeter, area, and volume when length, width, or height of a three-dimensional solid is changed and applies this idea in solving problems.

United States History Studies Since Reconstruction

(c) Knowledge and Skills

(11) Geography. The student understands the relationship between population growth and modernization on the physical environment. The student is expected to:

(A) identify the effects of population growth and distribution and predict future effects on the physical environment.

(B) trace the development of the conservation of natural resources, including the establishment of the National Park System and efforts of private nonprofit organizations.

(26) Social studies skills. The student uses problem-solving and decision-making skills, working independently and with others, in a variety of settings. The student is expected to:

(A) use a problem-solving process to identify a problem, gather information, list and consider advantages and disadvantages, choose and implement a solution, and evaluate the effectiveness of the solution.

(B) use a decision-making process to identify a situation that requires a decision, gather information, identify options, predict consequences, and take action to implement a decision.

World Geography Studies

(c) Knowledge and Skills

(8) Geography. The student understands how people, places, and environments are connected and interdependent. The student is expect to:

(A) explain the interrelationships among physical and human processes that shape the geographic characteristics of places such as connections among economic development, urbanization, population growth, and environmental change.

(B) compare ways that humans depend on, adapt to, and modify the physical environment using local, state, national, and international human activities in a variety of cultural and technological contexts.

(22) Social studies skills. The student communicates in written, oral, and visual forms. The student is expected to:

(A) design and draw appropriate maps and other graphics such as sketch maps, diagrams, tables, and graphs to present geographic information including geographic features, geographic distributions, and geographic relationships.

English I

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:

(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.

(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English II

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:

(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.

(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English III

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning. The student is expected to:

(D) represent information in a variety of ways such as graphics, conceptual maps, and learning logs.

(F) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

English IV

(b) Knowledge and Skills

(3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage to write clearly and effectively. The student is expected to:

(A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses.

(D) produce error-free writing in the final draft.

(4) Writing/inquiry/research. The student uses writing as a tool for learning and research. The student is expected to:

(E) organize notes from multiple sources in useful and informing ways such as graphics, conceptual maps, and learning logs.

(G) compile written ideas and representations into reports, summaries, or other formats and draw conclusions.

DID YOU KNOW?

Activities in and adjacent to watersheds have an important effect on watersheds as a water resource. Everything that occurs in a watershed contributes to the water supply used daily, whether it be for residential use, for recreational use, in agriculture, or in manufacturing. With ever increasing demand for water the protection and management of watersheds help insure watersheds continue to be a valuable component of water resources overall.

Terms often encountered when studying a watershed include:

watershed - defined by EPA as a geographic area in which, sediments, and dissolved materials drain into a common outlet

pollutant - material or substance that is unwanted and can cause contaminated and/or impure air, water and/or soil

point source pollution - condition were an unwanted material or substance enters the environment (air, water and/or soil) from a single, discrete point such as a pipe

non point source pollution - unwanted material or substance(s) that enter the environment (air, water and/or soil) from an general area and not a discrete or designated point, often carried by runoff or groundwater seepage into water sources

hydrologic cycle - the cyclic pathway water follows in nature from rainfall and other forms of precipitation through use and discharge back into environment to evaporation/transpiration and condensation back to precipitation

ecosystem - the plants and animals that live in a given area and their relationships to each other and the water, air, and soil in that area

abiotic - non living portions of an ecosystem
biotic - living portions of an ecosystem
erosion - soil transported from the original location by wind or water action
intermittent stream - a stream that contains water only part of the time. (Common in areas with low rain fall averages)

LEARNING EXPERIENCE:

GENERAL TIME FRAME: 5-7 hours depending on length of field trip and student responses.

Description: Students will visit a watershed area surrounding a local creek, stream, pond, or reservoir and identify components of the watershed ecosystem as well geological features. Students will record observations and write a short report about the watershed area visited. The report is to include the effect (or possible effect) of man's activities on the watershed as a water resource.

Time Frame: 2 to 4 hour field trip plus 4 – 45 minute periods

Materials:

1. Data on the last rain event including duration, location, and amount of precipitation received
2. Topographic maps of watershed and surrounding area
3. Forms for recording data and observations during the visit to the watershed
4. Disposable cameras (optional) - 1 for every group of 2 or 3 students
5. Meter stick

Advanced Preparation:

1. Determine the watershed area to be visited. Check with the district science coordinator, district environmental center (if one exists), and/or local nature museums or clubs for suggestions.
2. Arrange for access to the watershed area during the anticipated date and time of the field trip. Have alternative days and/or times planned should it become necessary.
3. Arrange for transportation.
4. Determine whether or not the field trip will extend into lunch and plan for sack lunches, etc.
5. Make sure all permission slips are returned and are signed by a parent or guardian before the field trip. Follow all other school/district requirements for field trips including the provision for additional adults to accompany the students.

Procedure:

Before the field trip

1. Divide students into teams of 2 or 3 individuals.
2. Go over safety procedures.
3. Use a meter stick to determine the length of each student's stride. This information will be used by the students as a method of measuring or estimating distances.
4. Review the hydrologic cycle with an emphasis on the recycling of water by nature.
5. Discuss the last rain event - how long ago, how much rainfall was received, and how that information could influence what is seen during the visit to the watershed.
6. Discuss the possible effects of point source and non-point source pollution on the watershed.
7. Discuss/review how to read a topographic map.
8. Review procedures on how to record data and observations in an orderly manner.
9. Make sure all permission slips have been returned and are signed by a parent or guardian.

During the field trip students should record as much of the following information as time allows. (Photographs often help in remembering and later describing what was seen.)

1. Descriptions and identification of the plants observed, the occurrence of each plant, and where each plant was encountered (in the water or approximate distance from the stream, creek, lake, etc.)
2. Descriptions and identification of any animals (including insects) observed, how many seen, and where they were encountered (approximate distance for the stream, creek, lake, etc.)
3. Descriptions and approximate numbers of any fish observed
4. Evidence of animals not seen - footprints, etc.
5. Geology observed in the area
6. Location of any standing water
7. The length and width of any stream, creek, pond, or stock tank encountered
8. A description of the shape and surrounding terrain of surface water including of any stream, creek, pond or lake
9. A description of water clarity - was the water surface green, foam on the surface of the water, an oily sheen on the surface, the water cloudy or clear?
10. If the bottom of the water can be seen, describe the material that covered the bottom of the stream/creek bed, pond or stock tank, or lake shore - gravel, small rocks, large rocks, mud/silt, sold rock, or a combination of any of these materials
11. Whether or not the water had an odor - if so, attempt to describe the odor
12. Whether or not any manmade trash was seen in or near the water along with a description of that trash
13. Whether or not any natural debris was seen in or near the water along with a description of that debris
14. Any evidence of point source and/or non-point source pollution. Where? Appearance?

15. A description of water movement - was the water gently flowing, were any pools seen, was the water barely moving or not moving at all (stagnant), was the water rushing pass (rapids)?
16. Description(s) of surrounding land use with an emphasis on possible impact on the watershed as a water resource

After the field trip

Using the information gathered on the field trip, each student or group of students will compile a written report which covers the following information:

a. A complete description (including tables, tabulations, etc.) of the watershed including abiotic and biotic components observed
b. A map showing boundaries of the watershed and uses of adjacent land
c. Possible sources of any pollution (including debris) observed
d. Ways the watershed could be protected and managed in order to maintain it as a water resource.

Teacher Talk:

Water is a valuable resource needed in a variety of areas ranging from residential to agricultural to manufacturing. As the demand on Texas available water supplies grows the need to protect existing water resources, in addition to conservation and reuse measures and the development of new water resources, becomes increasingly important. Watersheds are a water resource important in meeting the ever increasing demand for water.

Teacher Questions	Possible Replies
1. What are the possible effects of disturbing ground cover in a watershed?	1. Increased erosion of soil, leading to increased run-off and less water percolating through the soil to the groundwater. Less water transported through the rock strata to an aquifer.
2. What are the possible effects of paving over increasing larger sections of a watershed?	2. Increased run-off and resulting in less water percolating through the soil to the groundwater. Increased potential for flooding due to the increased volume of run-off and less water available to be transported through the rock strata to an aquifer.
3. Why is it important to protect a watershed as a water resource?	3. Watersheds allow streams, creeks, ponds, lakes, etc. to be refilled with rain water while also allowing for some of the rain to move downward through the soil to become groundwater. Both the surface water and groundwater may then be available as sources of water to meet anticipated demand.
4. How could activities on adjacent land negatively impact a watershed?	4. Activities on adjacent land can result in the water flow of a stream or creek being blocked and limiting the amount of water available for use downstream, overuse of available water in the watershed resulting in less water to meet the demand of other users, impact the amount of water available as groundwater, erosion problems (see #1 above), increased run-off and resulting problems (see #2 above).
5. What area is covered by the watershed that provides the local water supply?	5. Student answers will vary depending on location. At minimum the students should be able to name the river basin in which they live and give the boundaries of that river basin. Also included can be the watersheds for the local lake(s)/reservoir(s).
6. What effects could be observed on the watershed which provides the local water supply from different types of land use? Increasing water demand? Additional industry? Population growth? Climatic changes?	6. Student answers will vary. Negative land use related answers will be similar to those for #4 with positive land use preventing many of the listed problems. Increasing water demand and population growth will all put additional pressure on the watershed to supply more water, making measures such as conservation and recycling of available water of even greater importance. Additional industry can result in less pressure on the watershed if the industry takes steps to conserve, reuse, and recycle water used and then remove pollutants from the water before discharge back into the watershed. If not, there can be physical damage to the watershed resulting in less available water. Climatic changes can result in alterations to the watershed and have the potential for damage. Examples where damage can occur are flooding and droughts.

RESOURCES:

Literature on water conservation by the Texas Water Development Board. View and order currently available brochures at http://www.twdb.state.tx.us/assistance/conservation/pubs.htm, contact Patsy Waters at patsy.waters@twdb.state.tx.us, fax the form to (512) 936-0812, call (512) 463-7955, or write to:

Conservation
Texas Water Development Board
P.O. Box 13231
Austin, Texas 78711-3231

Maps of Texas River Basins, Aquifers, and Regional Reservoir Basin Maps are available on TWDB's website at http://www.twdb.state.tx.us/mapping/index.htm

State of Texas Water Quality Inventory by the Texas Commission on Environmental Quality: **http://www.tnrcc.state.tx.us/water/quality/**

Literature on water quality by the Texas Commission on Environmental Quality (search by publication number at http://www.tnrcc.state.tx.us/admin/topdoc/index.html or call (512) 239-1000

Conducting a Watershed Survey- GI 232
Watershed Owner's Streamwalk Guide- GI 218

For additional information, contact:

Texas Commission on Environmental Quality
Watershed Assessment and Planning Section
P.O. Box 13087
Austin, Texas 78711-3087
(512) 239-4594

EXTENSIONS:

1. Invite a geologist to speak to the students about the subsurface geological strata in the watershed area and how the different rock layers influence groundwater movement and availability as a water resource.

2. Invite a representative from the local water utility to speak to the students about the source(s) of water put into the distribution system and future availability of water to meet increasing demand. Ask the water utility representative to discuss the costs associated with plans to meet that increased demand.

3. If there is an environmental center or nature museum in the area, invite a representative to speak to the students about the impact of man's activities on the local watershed and those activities can limit future available water supplies.