Science: Watershed Studies

Core Ideas/Crosscutting Concepts:

A watershed is a stream, river, or lake and the land area that drains into it. Human activity alters watersheds. Crosscutting connection to Engineering: Influence of engineering, technology, and science on the natural world; Crosscutting connection to Environmental Science

75% of the earth's surface is covered by water, which continually cycles between the atmosphere and the earth's surface

Water has chemical and physical properties that are unique compared to other liquids Crosscutting connection to Chemistry

Crosscutting Connection: Cause and Effect: Humans exploit water for many vital uses and conveniences, and impact the quality of water as well as the water cycle

Learning Targets:

Environmental Science

- Surface and ground water flow patterns and movement
- Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere
- Biogeochemical cycles
- Ecosystems
- Potable water and water quality
- Clean Water Act
- Point source and non-point source contamination
- Human population
- Potable water quality, use and availability
- Climate change
- Deforestation and loss of biodiversity

Physical Geology

- Water
- Potable water and water quality
- Hypoxia, eutrophication

Science Inquiry and Application

- During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.

Core Ideas/Crosscutting Concepts:

Aquatic macroinvertebrate surveys can be used to assess stream water quality over a long term period.

Macroinvertebrates are members of biological taxa including insects, crustaceans, mollusks, flatworms, and annelids

Macroinvertebrates can be classified into three groups based on their tolerance of pollution

There are a variety of methods used to conduct macroinvertebrate surveys. Both accuracy and extent of environmental disturbance must be considered in selecting the method to be used.

Learning Targets:

Agriculture and Environmental Systems

- Assess water quality using basic indicators. *Introduced*
- Analyze and interpret the biological, chemical and physical properties of water quality. *Introduced*
- Measure pH, dissolved oxygen (DO), biological oxygen demand (BOD), temperature and macroinvertebrate populations to determine water quality. *Introduced*
- Explain the biotic and abiotic factors affecting water quality. *Introduced*
- Monitor and analyze water quality and quantity. *Introduced*
- Inventory and evaluate the habitats of specific ecosystems. *Introduced*
- Determine conservation and restoration practices according to specific ecosystem characteristics. *Introduced*

- Explain biotic (plant and animal) interactions with the abiotic (non-living) environment. *Introduced*

Core Ideas/Crosscutting Concepts:

Nine chemical parameters can be monitored in order to determine water quality.

Chemical parameters give a momentary snapshot of water quality. Human activities can immediately alter quality of water and influence aquatic life and human health

Field research is hampered by many uncontrollable variables, but has advantages over prescribed laboratory exercises

Valid data require accuracy and precision in measurements, as well as the proper collection of replicate samples.

Raw data must be manipulated mathematically in order to obtain units of measure that confer with local and national databases.

Current data will be compared to baseline data, as well as long term data in order to determine significant changes that have occurred in local water quality

Recommendations for maintaining and/or improving water quality will be part of a written report to local governmental officials. This will accompany a formal presentation at council chambers in May of each year

Learning Targets:

Agriculture and Environmental Systems

- Assess water quality using basic indicators. *Introduced*
- Analyze and interpret the biological, chemical and physical properties of water quality. *Introduced*
- Determine water quality according to industry standards, and recommend protection and restoration techniques. *Introduced*
- Measure pH, dissolved oxygen (DO), biological oxygen demand (BOD), temperature, and macroinvertebrate populations to determine water quality. *Introduced*
- Measure hardness, nitrogen, phosphorus, vegetation and physical characteristics of lentic and lotic waters to determine water quality. *Introduced*
- Explain the hydrological cycle (e.g., condensation, evaporation, transpiration) and how human activity impacts the cycle. *Developed*

- Explain the biotic and abiotic factors affecting water quality. *Introduced*
- Monitor and analyze water quality and quantity. *Introduced*
- Explain the interactions between human activities and the earth's hydrosphere (e.g., septic systems, desalinization, point and nonpoint sources of pollution). *Developed*
- Implement practices that maintain or improve water quality. *Introduced*
- Assess water quality using basic indicators. *Introduced*
- Analyze and interpret the biological, chemical and physical properties of water quality. *Introduced*
- Determine water quality according to industry standards, and recommend protection and restoration techniques. *Introduced*
- Measure pH, dissolved oxygen (DO), biological oxygen demand (BOD), temperature, and macroinvertebrate populations to determine water quality. *Introduced*
- Measure hardness, nitrogen, phosphorus, vegetation and physical characteristics of lentic and lotic waters to determine water quality. *Introduced*
- Explain the biotic and abiotic factors affecting water quality. *Introduced*
- Monitor and analyze water quality and quantity. *Introduced*
- Explain the interactions between human activities and the earth's hydrosphere (e.g., septic systems, desalinization, point and nonpoint sources of pollution). *Introduced*
- Implement practices that maintain or improve water quality. *Introduced*

Core Ideas/Crosscutting Concepts:

TOPOGRAPHIC MAPPING

A map is a symbolic representation of the earth used to determine regions and locations. Topographic maps use contour lines to represent the 3D shape of the land.

Topographic maps also use symbols to show other human and natural features in a landscape area.

The topography of the land influences stream slope, velocity, and amount of erosion.

Land use decisions require a knowledge of topography and stream dynamics

General rules for topographic mapping must be kept in mind when reading or creating a topo map.

Learning Targets:

Agriculture and Environmental Systems

- Interpret maps and topographic site plans.
- Read maps, topographic site plans, deeds, and/or aerial and/or satellite imagery.
- Define, delineate and assess watersheds and streams. *Introduced*
- Use GIS software to interpret maps. *Introduced*

Core Ideas/Crosscutting Concepts:

Sewage is a major environmental pollutant and can be pathogenic.

Sewage is organic rich and can act as a fertilizer, promoting algal blooms and eutrophication of surface waters

Sewage/ wastewater treatment methods must be employed in order to facilitate the recycling of excess nutrients produced by humans and to reduce pollution and contamination of waterways

Wastewater from both domestic and industrial sources must be received and treated prior to being discharged back into the environment in order to prevent disease and endanger health

Sewage treatment methods include small residential septic systems and municipal sewage treatment systems. Overpopulated areas put great stress on wastewater treatment systems and jeopardize water quality.

Groundwater and surface water provide the two major sources of drinking water

Drinking water must be treated prior to consumption

Most bottled water is filtered municipal tap water and may not provide a safer supply, given the expense and carbon emissions that result from the manufacture and recycling of plastic bottles

Learning Targets:

Environmental Science

- Potable water and water quality

- Clean Water Act

- Point source and non-point source contamination

Agriculture and Environmental Systems

- Explain the interactions between human activities and the earth's hydrosphere (e.g., septic systems, desalinization, point and nonpoint sources of pollution).

- Implement practices that maintain or improve water quality.

Core Ideas/Crosscutting Concepts:

FLOODING and DAMS

Floods are the number one disaster in terms of lives lost and property damage

Floods can be classified based on location, cause, and predictability

Floods can result from natural or human induced causes (*crosscutting concepts: cause and effect)*

The magnitude of a flood can be described in terms of a Recurrance Interval (RI)

Humans attempt to intervene and prevent flooding of developed areas, but in doing so, sacrifice the health and function of floodplains *(Engineering connection: influence of engineering, technology, and science on the natural world)*

Two major types of dams have *been* designed for humans to control the flow of river water for a variety of exploitations

Dams damage rivers and aquatic life, consequently, dam construction in many areas is being reevaluated, and some dams are being removed

Global climate change may have an impact on the severity and frequency of natural disasters including floods, tsunamis, and hurricanes

Rain gardens and rain barrels can help to reduce storm water runoff

Learning Targets:

Agriculture and Environmental Systems

- Interpret maps and topographic site plans.

- Read maps, topographic site plans, deeds, and/or aerial and/or satellite imagery.

- Explain the hydrological cycle (e.g., condensation, evaporation, transpiration) and how human activity impacts the cycle.

- Explain the biotic and abiotic factors affecting water quality.

- Explain the interactions between human activities and the earth's hydrosphere (e.g., septic systems, desalinization, point and nonpoint sources of pollution).

- Implement practices that maintain or improve water quality.

- Secondary Benchmark 5.8.L1 Identify sources of water (e.g., surface water, soil water, bedrock water, and aquifer.

- Explain the geological and meteorological principles affecting groundwater supply.

- Conduct a channel flow analysis.

- Measure volumes of water (e.g., wells, ponds, runoff, and waterways).

- Control water (e.g., pumps, dams, retention ponds, drainage).

- Identify sources of water (e.g., surface water, soil water, bedrock water, and aquifer).

Core Ideas/Crosscutting Concepts:

Stream systems are dynamic; flowing water results in erosion of soil and rocks, they are transported, and later deposited as velocity decreases.

Erosion has significant effects on the shape of a stream channel and on the nature of the riparian zone.

A stream's maturity can be determined by valley shape, gradient, extent of floodplain, and degree of meandering.

Place characteristics refer to the influence and interactions of nature and humans on the Earth's surface Rivers naturally shape the landscape and generate recognizable
features such as meanders, floodplains, deltas, alluvial fans, oxbows, levees, etc.

Humans significantly alter the natural pathways of streams through channelization, increase erosion and

Environmental Science

- Interconnected Spheres of Earth

- Hydrosphere

- Surface and ground water flow patterns and movement

- Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere
- Biogeochemical cycles
- Ecosystems
- Earth's Resources
- Clean Water Act
- Point source and non-point source contamination
- Land use and land management (including food production, agriculture and zoning)
- Human population
- Destruction of floodplains through development, impacting stream ecosystems and degrading water quality

Learning Targets:

Environmental Science

- Interconnected Spheres of Earth
- Hydrosphere
- Surface and ground water flow patterns and movement
- Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere
- Biogeochemical cycles
- Ecosystems
- Earth's Resources
- Clean Water Act
- Point source and non-point source contamination
- Land use and land management (including food production, agriculture and zoning)

- Human population

Science Inquiry and Application

- During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:.

Core Ideas/Crosscutting Concepts:

Groundwater is an resource essential for human life, utilized for consumption, irrigation, business, and industry

Urbanization, overuse, and other human activities severely jeopardize groundwater quality and quantity

Contaminated groundwater can affect human health as well as that of the entire ecosystem

Soil porosity and permeability affect the quality of an aquifer in terms of usefulness to humans

Groundwater contamination can sometimes be tracked to the source, but proof is often difficult

Groundwater is part of the hydrologic cycle, and is contiguous with surface and atmospheric water

Several remediation methods exist for treating contaminated groundwater, but have major drawbacks in terms of success and expense

Karst topography features are a result of groundwater eroding limestone layers, resulting in caves, tunnels, karst towers, and sinkholes

Human activity causes an increase in the frequency of collapsing sinkholes

Learning Targets:

Science Inquiry and Application

- During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

21st Century Student Outcomes

- Critical Thinking and Problem Solving

- Communication and Collaboration

- Thinking, Problem Solving, and Decision Making - Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

Agriculture and Environmental Systems

- Explain the hydrological cycle (e.g., condensation, evaporation, transpiration) and how human activity impacts the cycle.
- Explain the biotic and abiotic factors affecting water quality.
- Determine the types, sources and impact of natural and man-made contaminants (e.g., manure; wastewater; soil; agriculture, residential and industrial chemicals).
- Identify, comply with and implement contaminant control, remediation and prevention practices (e.g., biological, radiological, sanitation, buffer strips for runoff). *Introduced*
- Identify sources of water (e.g., surface water, soil water, bedrock water, and aquifer).
- Assess the potential for water contamination at a specific site. *Developed*
- Define, delineate and assess watersheds and streams.

Core Ideas/Crosscutting Concepts:

Long-term Authentic field research can provide information that can be utilized by citizens and governmental officials to maintain and/or improve water quality resources

The Indian Hill Water Quality Project, initiated in 1993, is a student centered project involving the collection and analysis of physical, chemical, and biological data on the major watersheds in Indian Hill

High school students can play a role in decision making processes that impact individuals, families, and communities

Field research is hampered by many uncontrollable variables, but has advantages over prescribed laboratory exercises

Nine parameters can be tested by
employing chemical tests, using meters and probes, and making careful observations

Statistical analyses can be performed, allowing currently enrolled students to compare their stream data to that of the past, assessing changes that have occurred in their local watersheds

Students can compare nine parameters to standards established by the EPA in order to determine the general health of a given stream, and assess long term effects of human impact

Learning Targets:

Science Inquiry and Application

- During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

Environmental Science

- Potable water quality, use and availability
- Sustainability
- Waste management (solid and hazardous)

21st Century Student Outcomes

- Reason Effectively
- Make Judgments and Decisions
- Solve Problems
- Communicate Clearly
- Collaborate with Others
- Productivity and Accountability
- Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation
- Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media. *Introduced*
- Communicate information and ideas effectively to multiple audiences using a variety of media and formats. *Introduced*
- Contribute to project teams to produce original works or solve problems. *Developed*
- Identify and define authentic problems and significant questions for investigation. *Introduced*
- Plan and manage activities to develop a solution or complete a project. *Introduced*
- Collect and analyze data to identify solutions and/or make informed decisions. *Developed*