SOIL&WATER CONSERVATION VIRTUAL FIELD TRIP SERIES

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CONSERVATION VIRTUAL FIELD TRIP SERIES

DIVISION OF AGRICULTURE RESEARCH & EXTENSION University of Arkansas System | USDA United States Department of Agriculture Natural Resources Conservation Service

Stevens Cotton Discovery Farm Virtual Field Trip

3D-Student Science Performance

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Grades: 9-12 Integrated Chemistry, Environmental Science, Physics and Agricultural Science

Lesson Topic:

Water Quality

Water Flow Monitoring

Water Conservation in Farming

Water Ecology

Essential Chemistries in Irrigation Water

Performance Expectations (Standard) from State Standards or NGSS:

Chemistry:

Topic One: Matter and Chemical Reactions:

Cl-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials or melt generation (by examining how water lowers the melting temperature of most solids.]

Cl1-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Examples of real-world problems could include wastewater treatment, production of biofuels, and the impact of heavy metals or phosphate pollutants on the environment.]

Connections to the Arkansas Disciplinary Literacy Standards:

WHST.9-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and medial in order to address a question or solve a problem.

Connections to the Arkansas Mathematic Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measuring when reporting.

MP.4: Model with mathematics.

Environmental Science:

Topic One: Systems

EVS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. [Clarification Statement: Emphasis on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids.]

EVS1-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Qualitative and quantitative constraints can be used to analyze a major global challenge. Examples could include water quality with relation to biosphere, atmosphere, cryosphere and geosphere.]

Topic 4: Sustainability

EVS-ESS3-2: Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios. [AR Clarification Statement: Emphasis is on conservation, sustainability, (e.g., recycling and reuse of resources), and minimizing impacts (e.g., Low Impact Design).]

EVS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. [AR Clarification Statement: Examples of data on the impacts of human activities could include the sequencing of traffic lights, adding lanes to main traffic arteries, docking and dredging of waterways, transportation of goods to market, use of drones, and use of alternate energies.]

EVS-LS2-7: Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity. [AR Clarification Statement: Emphasis in this course is on Arkansas-specific solutions. Examples of human activities can include land use (agriculture, forestry, recreation, industry); sustainable and non-sustainable practices) crop rotations, eradication of invasive species); and solution resources may include Low Impact Design (LID) or bioremediation (Faulkner County, AR; Gulf of Mexico hypoxia zone.)]

EVS-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. [AR Clarification Statement: Emphasis is on designing solutions for a proposed problem (e.g., micro-bead pollution, invasive species, effects of sedimentation on the Arkansas Fatmucket, White-nose Syndrome affecting bat populations, and environmental pollution from hormones and antibiotics.]

EVS4-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. [AR Clarification Statement: Modeling complex real-world problems using computer software could include simulating future population growth in terms of limited resources or evaluating water flow though different Earth and geoengineering materials.]

Connections to the Arkansas Disciplinary Literacy Standards:

WHST.9-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

RST.11-12.8: Evaluate the hypotheses, data, analysis, and/or conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusion with other sources of information.

RST.11-12.9: Synthesize information from a range of sources into a coherent understanding of a process, phenomenon or concept, resolving conflicting information when possible.

RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

WHST.9-12.7: Conduct short and well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.9-12.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Connections to the Arkansas Mathematic Standards:

HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measuring when reporting.

MP.2: Reason abstractly and quantitatively.

MP.4: Model with mathematics.

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

Physics:

Topic 1: Motion

P-PS1-1AR: Create a model of motion and forces, including vectors graphed on the coordinate plane, to describe and predict the behavior of a system. [Clarification Statement: Emphasis is on vector addition for 1-D (frame of reference), 2D motion (projectile, rotational motion), vectors applied to force diagrams, and vector direction for gravitational forces.]

P-PS2-1: Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. [Clarification Statement: Examples of data could include tables and graphs of position or velocity as functions of time for objects subject to a net unbalanced force (falling object, object rolling down a ramp, moving object being pulled by a constant force.]

P1-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. [AR Clarification Statement: Problems could include acceleration factors (one–dimensional motion), vectors (two-dimensional motion), and gravity (Newton's laws).]

Topic 2: Work and Energy

P-PS2-5AR: Use mathematical representations to support the claim that the change in kinetic energy of a system is equal to the net work performed upon the system. [Clarification Statement: Emphasis is on quantitative kinetic energy in interactions.]

Topic 3: Heat and Thermodynamics

P-PS3-3AR: Use mathematical representations to model the conservation of energy in fluids. [Clarification Statement: Emphasis is on fluid dynamics as expressed in Bernoulli's equation and Pascal's principle.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.9-10.7: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g.: quantitative data, video, multimedia) in order to address a question or solve a problem.

WHST.9-12.9: Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process phenomenon, or concept, resolving conflicting information when possible.

Connections to the Arkansas English Language Arts Standards:

SL.11-12.2: Integrate multiple sources of information that is gained by means other than reading (e.g., texts read out loud, oral presentations or charts, graphs, diagrams, speeches) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11-12.4: present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

Connections to the Arkansas Mathematic Standards:

MP.2: Reason abstractly and quantitatively.

MP.4: Model with mathematics

HSN.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling.

HSN.Q.A.3: Choose a level of accuracy, appropriate to limitations on measurement when reporting quantities.

HSN.VM.A.1: Recognize vector quantities as having both magnitude and direction; represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes.

HSN.VM.A.3: Solve problems involving velocity and other quantities that can be represented by vectors.

HSN.VM.B.4: Add and subtract vectors: add vectors end-to-end, compound-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes; given two vectors in magnitude and direction form, determine the magnitude and direction of their sum; understand vector subtraction ***v-w as v+(-w),*** where ***–w*** is the additive inverse of ***w***, with the same magnitude as ***w*** and pointing in the opposite direction; represent vector subtraction graphically by connecting the tips in the appropriate order; perform vector subtraction component-wise.

HSA.SSE.B.3: Choose and produce an equivalent form of expression to reveal and explain properties of the quantity represented by the expression.

HSA.CED.A.3: Represent and interpret constraints by equations or inequalities, and by systems of equations and/or inequalities.

HSA.CED.A.4: Rearrange literal equations using the properties of equality.

HSF.IF.C.7: Graph functions expressed algebraically and show key features of the graph, with and without technology; graph linear and quadratic functions and, when applicable, show intercepts, maxima, and minima; graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions; graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior; graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior; graph exponential and logarithmic functions, showing intercepts and end behavior, graph trigonometric functions, showing period, midline, and amplitude.

Lesson Performance Expectations:

- **Students will understand the importance of irrigation conservation in farming.**
- **Students will understand the importance of water flow monitoring with regard to water ecology.**
- **Students will understand how irrigation water quality monitoring has a widespread impact.**
- **Students will understand how irrigation conservation impacts their lives through food and water usage.**

Student Science Performance

Phenomenon: Conventional irrigation and tillage leads to water loss and contaminated water runoff. Conservation irrigation and no-till farming has been shown through experimentation to decrease water loss and contaminated runoff.

Gather *(In this section students will generally be asking questions, obtaining information, planning and carrying out an investigation, using mathematical and computational thinking, or using models to gather and organize data and/or information.)*

1. Students will break into groups to define the following word groups:

- Conservation Tillage Management
- Conventional Tillage
- Conservation Tillage (no tillage)
- Poly-Pipe tubing furrow irrigation
- Cover Cropping
- Water Flow pacing
- Hydrologist
- Hypoxic Zone
- Flowlink Computer Program
- Watermark Granular Matrix Sensors
- Nitrates in water
- Nitrites in water
- Ammonia in water
- Water Quality Analysis; focus on salts, pH, Salinity, Sediments and Solids in water

Reason *(In this section students are generally: evaluating information, analyzing data, using* *mathematical/computational thinking, constructing explanations, developing arguments, and/or using models to reason, predict, and develop evidence.)*

1. Students in groups will come up with two questions they have about the above word groups that may be answered in the video.

Class Discussion:
Questions to initiate Discussion:
Q: How do farmers water their crops?
Q: How do farmers measure irrigation water to prevent waste?
Q: How do farmers keep plants healthy?
Q: Does all fertilizer placed on a field end up in a plant? Q: Where does the excess fertilizer go?
Q: Considering the properties of water and the interaction water has on the environment, how could this excess fertilizer impact our ecosystem?
Q: How can farmers measure this excess and what can they do to prevent this?

Teaching suggestion:

Do a KWL Chart about irrigation and runoff water. How do farmers water their crops? How do farmers measure irrigation water to prevent waste? Get students thinking about the drawbacks of irrigation runoff by asking students how do farmers keep plants healthy (fertilizers) and do they think all the fertilizer that is placed on the field goes into the plant? If not, where does the excess fertilizer go? Considering the properties of water and the interaction water has on the environment, how could this excess fertilizer impact our ecosystem? How can farmers measure this excess and what can they do to prevent this?

Tell the students that they are going to watch a video titled '*Stevens Cotton Discovery Farm Virtual Field Trip.'* Before they start the video, have the students break into groups to define the above words.

Once all the words are defined, have each group come up with two questions they have about the above word groups that may be answered in the video. ***Their jobs are to turninthequestionsandtheanswersbytheendofthe virtualfieldtrip.****

*****The live video stream will give your students an opportunity to ask questions throughout the field trip. If they are not finding their questions adequately answered during the broadcast, you can send in their questions to be answered at the end of the video.

BEFORE THE VIDEO be sure the students understand that irrigation water is a precious commodity both economically and ecologically. Water that is getting to the plant roots isn't becoming runoff and isn't taking fertilizer with it.

If you are in chemistry, this is a good time to discuss the water cycle, the properties of water, the structure and function of the dipole molecule and its impact on systems around it.

Environmental Science concepts could involve ecosystem dynamics, natural resources, human impact and the role of water in surrounding systems.

Physics teachers: This video covers the physics of flow (open and closed channel) involving diameter of pipes, volume, height, pressure flow and velocity of water. It also discusses the velocity of particulates in a water stream. Consider working up some problems beforehand for your students to work on after the video.

Communicate *(In this section students will be communicating information, communicating arguments (written and oral for how their evidence supports or refutes an explanation, and using models to communicate their reasoning and make their thinking visible.)*

After the video, break the students into three groups: the *Measurement of Water Flow* Group, the *Conservation Tillage of Furrow* group and the *Water Quality Analysis* group. Have each group brainstorm how their 'area of study' affects their daily lives. Tell students they need to come up with at least five ways and then report them to the rest of the class.

Students will turn in a two-paragraph reflection paper on what they learned and how these conservation efforts affect their personal lives and the answers to their two questions from the video.

Formative Assessment for Student Learning
Elicit Evidence of Learning:

Evidence of Student Proficiency

Students will understand the importance of irrigation watering with regard to conservation of water and the lessening of the environmental impact contaminated runoff water will have on the local ecosystem. Students will understand that this takes constant monitoring and testing through computer applications, flow meters and water chemistries.

Range of Typical Student Responses *This section provides a range of typical student responses, often using a three-point scale.*

Descriptors of grade-level appropriate student responses:

- *Full understanding: Student will have all the vocabulary defined, two questions for the video and will participate fully in the post video discussion, coming up with five different ways irrigation conservation impacts their personal lives. Reflection paper will show full connection between what they experienced and understand.*
- *Partial understanding: student will have 75% of the vocabulary defined, one question for the video and an average of three questions from the post video group. Reflection paper will only show partial*

connection between what they experienced and understand.

- *Limited understanding: Student will have 50% or less of vocabulary defined, no questions for the video and show no understanding of what was learned in the reflection paper.*

Acting on Evidence of Learning *This is a brief description of the instructional actions to take based on the students' performance. When the action includes extensive descriptors and/or materials you may wish to use* ***Appendix C.***

Description of instruction action and response to support student learning.

- *Action for student who displays partial or limited understanding: student will be partnered with a student who has full understanding and material will be reviewed with mentoring from the teaching student.*

- *Extensions of learning for student who displays full understanding: Assign a brainstorming project that allows students to design their own aquifer recharging project or alternate irrigation method*

Science Practices:

Planning and Carrying Out Investigations

Constructing Explanations and Designing Solutions

Asking Questions and Defining Problems

Engage an Argument from Evidence

Using Mathematics and Computational Thinking

Developing and Using Models Analyzing and Interpreting Data

Science Essentials:

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data and refine the design accordingly.
- Design a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.
- Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
- Evaluate competing design solutions to a real-world problem based on scientific ideas and

principles, empirical evidence, and logical arguments regarding relevant factors.

- Create a computational model or simulation of a phenomenon, designed device, process, or system.
- Use mathematical representations of phenomena to support claims.
- Use a model to predict the relationships between systems or between components of a system.
- Analyze data using tools, technologies, and/or models in order to make valid and reliable scientific claims or determine an optimal design solution.

Crosscutting Concepts:

Structure and Function

Influence of Engineering, Technology and Science on Society and the Natural World

Science Addresses Questions About the Natural and Material World

Stability and Change Cause and Effect

Systems and System Models

Interdependence of Science and Technology

Energy and Matter

Science Essentials:

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.
- New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology.
- Science knowledge indicates what can happen in natural systems- not what should happen. The latter involves ethics, values and human decisions about the use of knowledge.
- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Science and engineering complement each other in the cycle known as research and development (R&D)

- Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. The total amount of energy and matter in closed systems is preserved.

Disciplinary Core Ideas:

ESS2.C: The roles of water in Earth's Surface Processes

ETS1.C: Optimizing the Design Solution

ETS1.A: Defining and Delimiting Engineering Problems

ESS3.A: Natural Resources

ETS1.B: Developing Possible Solutions

ESS3.C: Human Impacts on Earth Systems

LS4.C: Adaptation

LS4.D: Biodiversity and Humans PS2.A: Forces and Motion

ETS1.C: Optimizing the Design Solution

PS3.C: Relationship between energy and forces

PS3.B: Conservation of Energy and Energy Transfer

Science Practices:

- Criteria may need to be broken down into simpler ones that can be approached systematically, and decision about the priority of certain criteria over others may be needed.
- Humanity faces major global challenges today, such as the need for supplies of clean water and food or for an energy source that minimizes pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.
- Resource availability has guided the development of human society.
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will fit his or her needs.
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

- Changes in the physical environment whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline-and sometimes the extinction of some species.
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction to invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.
- Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.
- When two objects interacting through a force field change relative position, the energy stored in the force field is changed.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration and how kinetic energy depends on mass and speed, allow the concept conservation of energy to be used to predict and describe system behavior.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

Appendix A - Student Prompts

Student Prompts for the Lesson

Phenomenon: Conventional irrigation and tillage leads to water loss and contaminated water runoff. Conservation Irrigation and no-till farming has been shown through experimentation to decrease water loss and contaminated runoff.

Group Performances:

1. Ask questions to plan an investigation for understanding that conservation irrigation can decrease water loss and contaminated runoff.

2. Plan an investigation by defining the words necessary and having questions ready for the video.

3. Construct an explanation by forming groups and discussing how conservation irrigation can affect a person's everyday life.

4. Use a model to explain how the constant monitoring of water flow and testing of irrigation water runoff ultimately benefits both people and the ecosystem they live in.

Class Discussion

Individual Performances:

5. Develop an argument for how irrigation conservation can and does help our economy and ecology.

Appendix C – *Below are good resources for understanding irrigation conservation better.*

https://www.uaex.uada.edu/publications/pdf/FSA-2156.pdf *Understanding cover crops*

https://www.uaex.uada.edu/publications/PDF/FSA-1015.pdf *Reduced tillage soybean*

http://www.flowmeters.com/how-flowmeters-work *Explains how flow meters work*