Grades 9–12

3.3.9-12.H Earth and Space Science: Earth's Systems
Students who demonstrate understanding can *analyze geoscience data to make the claim that one change to Earth's surface can create feedback that causes changes to other Earth systems.*
Clarifying Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.
Assessment Boundary: N/A

Science and Engineering Practices (SEP)	Disciplinary Core Ideas (DCI)	Crosscutting Concepts (CCC)
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	**ESS2.A: Earth Materials and Systems** • Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. **ESS2.D: Weather and Climate** • The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	**Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system. --- *Connections to Engineering, Technology, and Applications of Science* **Influence of Engineering, Technology, and Science on Society and the Natural World** • 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.

Pennsylvania Context: Examples of Pennsylvania context include but are not limited to the critical importance of watersheds in Pennsylvania; investigation of impacts on local watersheds may be considered.
PA Career Ready Skills: Evaluate consequences from a personal, and civic perspective to inform decision-making.

Science, Technology & Engineering, and Environment Literacy & Sustainability (STEELS)

Connections to Other Standards Content and Practices

Standard Source	Possible Connections to Other Standard(s) or Practice(s)
Agriculture (AFNR)	CS.02.01.01.a: Research and describe different types of geographic data used in AFNR systems.
Science, Environmental Literacy and Sustainability (NAAEE)	9-12 Strand 2.1.A. Earth's physical systems: Learners describe the major processes and systems that form Earth and relate these processes, especially those that are large-scale and long-term to characteristics of Earth. They explain how changes in one system (hydrosphere, atmosphere, geosphere, and biosphere) result in changes to another. They describe how human sustainability depends on Earth systems. 9-12 Strand 3.1.B. Sorting out the consequences of issues: Learners evaluate the consequences of a broad range of environmental changes, conditions, and issues on environmental quality and long-term sustainability. They identify environmental justice and social equity implications.
PA Core Standards: ELA	CC.3.5.9-12.A: Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. CC.3.5.11-12.A: 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. CC.3.5.9-10.B: Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text. CC.3.5.9-12.B: Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
PA Core Standards and Practices: Math	MP.2: Reason abstractly and quantitatively. CC.2.1.HS.F.3: Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data display. CC.2.1.HS.F.5: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
PA Standards: Social Studies	7.2.9.B: Explain the dynamics of the fundamental processes that underlie the operation of Earth's physical systems.
Educational Technology (ISTE)	1.5. Computational Thinker: Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
Technology and Engineering (ITEEA)	STEL-10: Assess how similarities and differences among scientific, mathematical, engineering, and technological knowledge and skills contributed to the design of a product or system.