Supplemental File:
Alignment of InTeGrate's Guiding Principles with the NGSS

GUIDING PRINCIPLE 1: Curricular materials must address one or more Earth-related grand challenges facing society:

- Resource challenges include (but aren't limited to) ensuring availability of sufficient mineral and energy resources, freshwater, and sustainable development;
- Environmental challenges include (but aren't limited to) climate change and variability, natural hazards, waste disposal, environmental degradation, pollution, ecosystem services.

Science and Engineering Practices	Cross-cutting Concepts	Disciplinary Core Ideas
Asking Questions and Defining Problems **HS-PS1.9** Analyze complex real-world problems by specifying criteria and constraints for successful solutions. *Constructing Explanations and Designing Solutions* **HS-P6.5** Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	*Cause and Effect* **HS-CCC2.3** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system	**HS-ESS3.A1** Resource availability has guided the development of human society. **HS-ESS3.A2** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. **HS-ESS3.B1** Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. **HS-ESS3.C1** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources **HS-ESS3.C2** Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

GUIDING PRINCIPLE 2: Curricular materials must develop student ability to address interdisciplinary problems;

- Build student capacity to work on interdisciplinary teams
- Integrate robust geoscience with knowledge from other disciplines such as engineering, the social sciences, and the humanities

Science and Engineering Practices	Cross-cutting Concepts	Disciplinary Core Ideas
Planning and Carrying out investigations **HS-SEP3.1-2** Plan ... individually and collaboratively... *Engaging in Argument from Evidence* **HS-SEP7.3** Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence, challenging ideas and conclusions, responding thoughtfully to diverse perspectives, and determining additional information required to resolve contradictions. **HS-SEP7.6** Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).		**HS-ESS3.D1** Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.

GUIDING PRINCIPLE 3: Curricular materials must improve student understanding of the nature and methods of geoscience and promote the development of geoscientific habits of mind;

- Compare modern processes to those found in the geologic record, or compare cases to understand commonalities and differences attributable to process, history, and context
- Develop converging lines of evidence
- Test through prediction
- Emphasize the fundamental role of observation and of a spatial and temporal organizational schema in understanding the Earth
- Recognize Earth as a long-lived, dynamic, complex system whose history is shaped by a continuum of long-lived low impact processes and short-duration high impact processes

Science and Engineering Practices	Cross-cutting Concepts	Disciplinary Core Ideas
Asking questions and defining problems **HS-SEP1.1** Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information. *Developing and using models* **HS-SEP2.4** Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. *Planning and carrying out investigations* **HS-SEP3.5** Make directional hypotheses that specify what happens to a dependent variable when an independent variable is manipulated. *Constructing explanations and designing solutions* **HS-SEP6.2** Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **HS-SEP6.4** Apply scientific reasoning, theory, and/or models to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	*Patterns* **HS-CCC1.2** Empirical evidence is needed to identify patterns. *Cause and Effect* **HS-CCC2.1** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. *Scale, Proportion, and Quantity* **HS-CCC3.4** Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. *Structure and function* **HS-CCC6.1** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. *Stability and Change* **HS-CCC7.4** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.	**HS-ESS2.A3** The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

GUIDING PRINCIPLE 4: Curricular materials must make use of authentic and credible geoscience data to learn central concepts in the context of geoscience methods of inquiry;

- Make use of the most current and appropriate data available for the topics under discussion.

Science and Engineering Practices	Cross-cutting Concepts	Disciplinary Core Ideas
Analyzing and interpreting data **HS-SEP4.4** Compare and contrast various types of data sets (e.g., self-generated, archival) to examine consistency of measurements and observations. **HS-SEP4.1** 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.	*Using Mathematical and Computational Thing* **HS-SEP5.3** Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.	

GUIDING PRINCIPLE 5: Curricular materials must incorporate systems thinking.

- Promote the understanding of the basic interactions among the spheres (atmo-, hydro-, geo-, cryo-, anthropo-, bio-) and that a perturbation in one sphere may have effects throughout Earth's system
- Promote the idea that multiple causal factors that could influence a single observation or outcome
- Address the differences between open and closed systems and between positive (reinforcing) and negative (countervailing) feedback loops
- Make use of the concepts of flux, reservoir, residence time, lag (delay), and limit (threshold), in explaining the behavior of natural systems, human systems, and linked human/environment systems

Science and Engineering Practices

Developing and Using Models
HS-SEP2.3 Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.

Constructing explanations and designing solutions
HS-SEP6.1 Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.

Cross-cutting Concepts

Cause and Effect
HS-CCC2.4 Changes in systems may have various causes that may not have equal effects.

Systems and System Models
HS-CCC4.1 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.

Energy and Matter
HS-CCC5.4 Energy drives the cycling of matter within and between systems.

Stability and Change
HS-CCC7.3 Feedback (negative or positive) can stabilize or destabilize a system.

Disciplinary Core Ideas

HS-ESS3.D1 Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.

HS-ESS2.A1 Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.