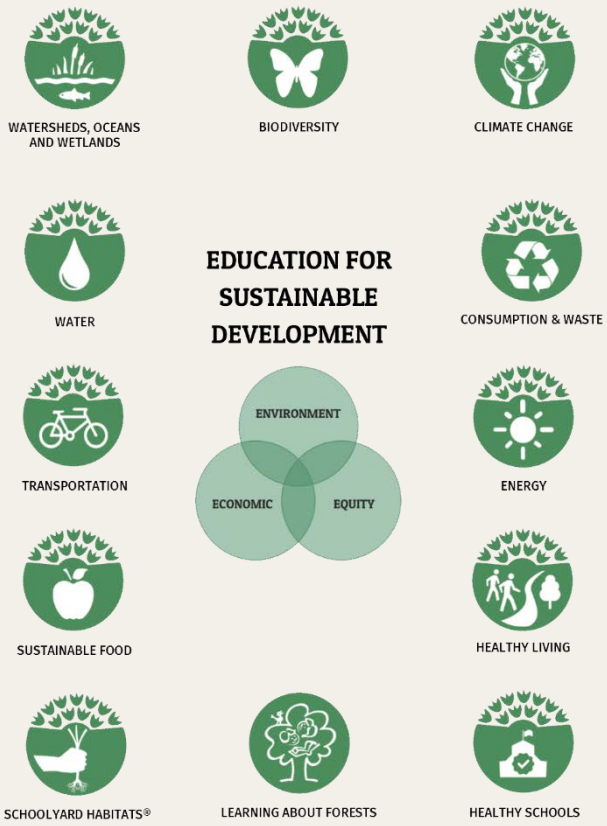
Pathways to Sustainability

Alignment to NGSS – HS: Engineering Design

At the high school level students are expected to engage with major global issues at the interface of science, technology, society and the environment and to bring to bear the kinds of analytical and strategic thinking that prior training and increased maturity make possible. As in prior levels, these capabilities can be thought of in three stages—defining the problem, developing possible solutions, and improving designs.



Defining the problem at the high school level requires both qualitative and quantitative analysis. For example, the need to provide food and fresh water for future generations comes into sharp focus when considering the speed at which world population is growing, and conditions in countries that have experienced famine. While high school students are not expected to solve these challenges, they are expected to begin thinking about them as problems that can be addressed, at least in part, through engineering.

Developing possible solutions for major global problems begins by breaking them down into smaller problems that can be tackled with engineering methods. To evaluate potential solutions, students are expected to not only consider a wide range of criteria, but to also recognize that criteria need to be prioritized. For example, public safety or environmental protection may be more important than cost or even functionality. Decisions on priorities can then guide tradeoff choices.
Improving designs at the high school level may involve sophisticated methods, such as using computer simulations to model proposed solutions. Students are expected to use such methods to take into account a range of criteria and constraints, to try and anticipate possible societal and environmental impacts, and to test the validity of their simulations by comparison to the real world.

Connections with other science disciplines help high school students develop these capabilities in various contexts. For example, in the life sciences students are expected to design, evaluate, and refine a solution for reducing human impacts on the environment (HS-LS2-7) and to create or revise a simulation to test solutions for mitigating adverse impacts of human activity on biodiversity (HS-LS4-6). In the physical sciences students solve problems by applying their engineering capabilities along with their knowledge of conversion of energy from one form to another (HS-PS3-3). In the Earth and space sciences students apply their engineering capabilities to reduce human impacts on Earth systems and improve social and environmental cost-benefit ratios (HS-ESS3-2 and HS-ESS3-4).

By the end of twelfth grade students are expected to achieve all four HS-ETS1 performance expectations (HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, and HS-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. These include analyzing major global challenges, quantifying criteria and constraints for solutions; breaking down a complex problem into smaller, more manageable problems, evaluating alternative solutions based on prioritized criteria and trade-offs, and using a computer simulation to model the impact of proposed solutions. While the performance expectations shown in HS. Engineering Design couple particular practices with specific disciplinary core ideas, instructional decisions should include use of many practices that lead to the performance expectations.

The National Wildlife Federation's Eco-Schools USA program has aligned their program Pathways of Sustainability to the Next Generation Science Standards, NGSS. As a part of the Eco-Schools Seven Step Framework, linking to the curriculum is a priority. This alignment is designed to highlight the natural connections between the NGSS and the Eco-Schools USA program.

Our program icons are used to denote pathway connections to the NGSS Performance Expectations and alignment to the Common Core State Standards, CCSS, English Language Arts, ELA and Mathematics.

Green STEM is an initiative of NWF's Eco-Schools USA program and is focused on identifying best practice in the STEM fields as it relates to environment-based learning. These elements include:

- Project, problem and place-based learning
- Utilizing the school, both inside and outside, as a learning laboratory
- Interdisciplinary approach
- Innovation space
- A commitment to stewardship
- An inclusive culture, where all students can learn, participate and take action

ENGINEERING DESIGN

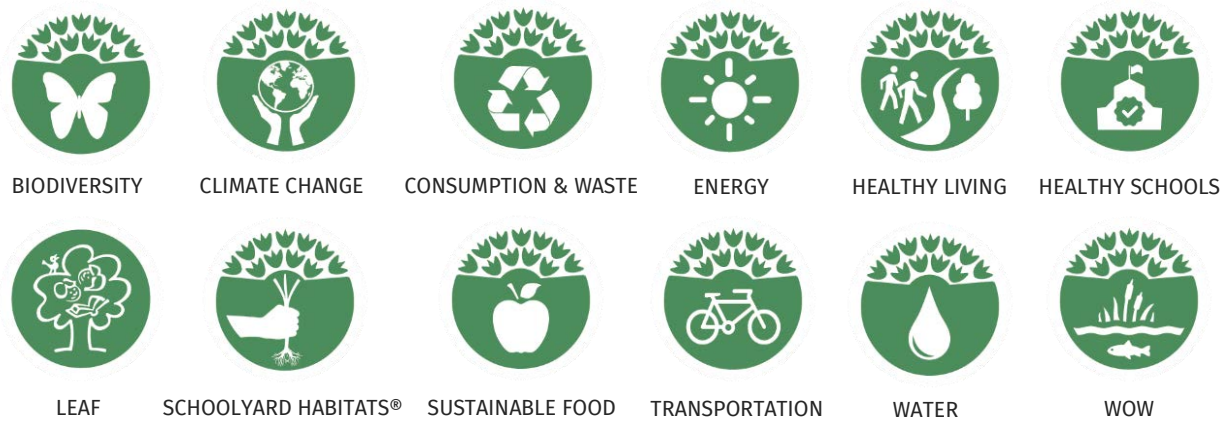
Students who demonstrate understanding can:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-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.

HS-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.

HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.



Each Performance Expectation is more successfully accomplished by students who have spent significant time outdoors in the natural world. Connecting to nature improves student engagement, focus, creativity and innovation. Connecting to nature also builds an appreciation and respect for the community, state, country, and world we live in.

Engaging students using any of the Eco-Schools USA pathways provides them with age appropriate knowledge, skills and tools to make meaningful change in their community while providing opportunities to participate in the design process. Ultimately, we want students to feel they have the confidence and resources to develop solutions for their generation and future generations greatest challenges.

ENGINEERING DESIGN - CONTINUED

SCIENCE AND ENGINEERING PRACTICES

- Asking Questions and Defining Problems
- Using Mathematics and Computational Thinking
- Constructing Explanations and Desgining Solutions

DISCIPLINARY CORE IDEAS

ETS1.A Defining and Delimiting Engineering Problems

ETS1.B Developing Possible Solutions

CROSSCUTTING CONCEPTS

- Systems and System Models

CONNECTIONS TO ENGINEERING, TECHNOLOGY AND APPLICATIONS OF SCIENCE

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

Connections to other DCIs to this grade band:

Connections to ETS1.A Defining and Delimiting Engineering Problems | Physical Science (HS-PS3-3)
Connections to ETS1.B Designing Soluions to Engineering Problems | Earth and Space Science (HS-ESS3-2); Life Science (HS-LS2-7) (HS-LS4-6)

Articulation of DCIs across grade-bands: **MS.ETS1.A** (HS-ETS1-1) (HS-ETS1-2) (HS-ETS1-3); **MS.ETS1.B** (HS-ETS1-2) (HS-ETS1-3) (HS-ETS1-4); **MSETS1.C** (HS-ETS1-2) (HS-ETS1-4)

Common Core State Standards Connections

ELA/Literacy

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. (HS-ETS1-1) (HS-ETS1-3)

RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS-ETS1-1) (HS-ETS1-3)

RST.11-12.9 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. (HS-ETS1-1) (HS-ETS1-3)

Mathematics

MP.2 Reason abstractly and quantitatively. (HS-ETS1-1) (HS-ETS1-3) (HS-ETS1-4)

MP.4 Model with mathematics. (HS-ETS1-1) (HS-ETS1-2) (HS-ETS1-3) (HS-ETS1-4)