United States Environmental Protection Agency

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Building a Greenway: Using EnviroAtlas in the Classroom

CASE STUDY

Office of Research and Development
National Exposure Research Laboratory
National Health and Environmental Effects Research Laboratory

ENVIROATLAS
EDUCATIONAL CURRICULUM
BUILDING A GREENWAY: A CASE STUDY

DESIGNED FOR HIGH SCHOOL STUDENTS AND ABOVE

This is a reformatted version of EPA Report EPA/600/R-16/006 with improvements for teacher use and the addition of state science standards.

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DISCLAIMER

The city of Canton and the detailed narrative are fictional. They are intended to represent situations that could occur and the challenges and opportunities that may accompany said circumstances. Though this material was reviewed and approved by EPA, it does not necessarily reflect official Agency policy. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PREFACE

The following lesson plan was created as part of a larger curriculum of activities for educational use to introduce students to *EnviroAtlas* and the concepts of watersheds, pollution, connections between the environment and human health, greenways, and using maps in decision-making. This lesson plan specifically addresses decision-making, policy, geospatial mapping, and greenways. Additional lesson plans are available that address a variety of other topics directed at a range of grade-levels and ages.

There is also an **Educational Overview** document that outlines some of the tools in *EnviroAtlas* for educators who wish to design their own lesson plans around the tools. We encourage you to look over that Educational Overview document so that you can use *EnviroAtlas* to best meet your needs. All Educational materials can be found here: https://www.epagov/enviroatlas/enviroatlas-educational-materials

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For questions regarding this case study and supplemental materials, please contact the *EnviroAtlas* Team at EnviroAtlas@epa.gov.

ACKNOWLEDGMENTS

This case study was developed though the joint efforts of multiple contributors. Much appreciation goes to Alexandra Sears, EPA ORISE Participant, who provided the map images used in the "Building a Greenway: Case Study" and has been integral to the *EnviroAtlas* Community component. Thanks to our reviewers Dana Haine, K-12 Science Education Manager, UNC-Chapel Hill Institute for the Environment, and Kelly Witter, US EPA National Exposure Research Laboratory. Their feedback was extremely valuable in the completion of this product.

Additional thanks to our classroom teachers and informal educators as well as their students for carrying out these *EnviroAtlas* Lesson Plans:

- Linda Schmalbeck, North Carolina School of Science and Mathematics: *Building a Greenway (2016)*
- Diane C. Whitaker, Southwest Guilford High School: *Building a Greenway (2016)*

We learned much from these pilot tests and utilized the teachers' feedback to adjust and edit the Lesson Plan.

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Lesson Plan

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Building a Greenway: A Case Study

A Case Study that makes students the decision-makers in a hypothetical planning scenario.

Lesson can be done with or without internet.

Suggested Grades: 9-12+

Suggested Topics: mapping, city planning, decision-making, ecosystem services, environmental impact, technological solutions, green space, policy, debate

Key Concept: Decision-making can be driven from easily available environmental and geospatial data.

Time Considerations
Prep Time: 10 minutes
Option 1: 45-60 minutes
Option 2: 90 minutes
Option 3: Varied

Materials: computer(s), internet, handouts (provided), maps (provided)

NGSS Standards *(State Standards in Resources Section in back)*: HS-LS2-6, HS-LS2-7, HS-LS4-5, HS-ESS3-1, HS-ESS3-3, HS-ETS1-3. NGSS Science and Engineering Practices: 1, 2, 4, 5, 6, 7, 8.

Learning Objectives

By the end of this lesson module, students will be able to:

- Explain an issue or problem from multiple perspectives.
- Integrate data from multiple sources to generate an argument.
- Compare and contrast different ecosystem services as they relate to sustainable and healthy communities.
- Explain how human activity may impact the environment.
- Explain how human activities impact the biosphere.
- Assess and refine a technological solution that reduces the impacts of human activities on natural systems.
- Incorporate an environmental justice perspective into decision-making.
- Describe the opportunities and challenges associated with multi-sectoral decision-making.
- Compare scenarios that integrate access to recreational opportunities, conservation of open space, and community development.
- Generate and defend recommendations based on the available data.
- Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Key Words/Vocabulary

active transportation	alternative transportation	
biodiversity	buffering	case study
conservation	connectivity	ecosystem services
greenspaces	greenway	habitat
health outcomes	inbreeding	impervious
mitigation	neighborhood connectivity	
patch (habitat)	preservation	public hearing
restoration	siting	social capital
sustainability plan	urbanization	vector borne diseases

Summary

This module uses the **BSCS 5E model** to promote student discovery and learning about the complex interactions between the natural environment, the built environment, and human behavior.

In this hypothetical case study, funding to complete a pilot section of a greenway has been granted to a city Parks and Recreation Department. The proposed pilot section is being presented to the city council for review and approval. The proposal was drafted by the Parks and Recreation Department and selected to meet the goals of the Department. Numerous data and maps were used in determining this selection and are included in the proposal. The reader is asked to generate an opinion and justification for supporting or not supporting the proposed route. The Parks and Recreation Department goals include the following:

- Improve access to and use of parks and green spaces,
- Enhance habitat for biota,
- Encourage physical activity and recreational opportunities, particularly for aging populations.

This case study is intended to showcase ways in which EnviroAtlas, an interactive web-based tool that combines maps, analysis tools, fact sheets, and downloadable data, can support decision-making.

Available data can inform alternatives and help prioritize action at the local, regional, and national level. Such planning efforts also present a unique educational opportunity for students to be introduced to complex problems and learn to analyze and interpret relevant data while being asked to generate recommendations.

Target Audience

This case study is intended for secondary education, undergraduate, and community (e.g. municipal agencies and community organizations) education/engagement programs focusing on ecology, environmental science, urban planning, public health, or public policy/civics. Prior to starting this activity, participants should possess a basic understanding of ecological principles and cartography/map interpretation.

At-a-glance Summary

The case study can be carried out completely without the use of the internet or with the use of internet. Below is an At-a-glance Summary for both without and with the use of internet.

Teaching Strategies	Student/teacher actions
Engage	Prior to the class session, students will read the case narrative, complete the "Questions from the Reading," and come up with a few key points that they plan to make during the Case Study.
Explore	**Option 1, Parks & Rec. Perspective:** Student roles: All students complete the Case Study from the point-of-view of the Parks and Recreation Department. **Option 2, Stakeholder Perspective:** Student roles: varied. Intended to promote spirited discussion and increase student understanding of the decision-making process. **Option 3:** Multiple activities are available to choose from in addition to the Case Study as carried out in **Option 2.**
Explain	**Option 1:** Students discuss their reasoning and their key points from the "Engage" portion of the lesson, and then the teacher guides the class to an agreed-upon decision. **Option 2:** Students present their key points based on their individual roles. Teacher guides students to the "guiding questions" section to generate student discussion. **Option 3:** Students present their key points based on their individual roles. Teacher guides students to the "guiding questions" section to generate student discussion. Students then complete an additional activity (choice of the teacher).
Elaborate	Teacher prompts students with **Discussion Questions** to further understanding of policy and decision-making.
Evaluate	Students **complete the Understanding Maps Worksheet**, answering questions pertaining to the lesson at the completion of the Case Study. Students also submit a short rationale paragraph.

Time Considerations

5E Stage	Part of Lesson	Suggested Time
Engage	Students read case narrative	*Homework/varies*
Explore	**Complete Case Study** Option 1: Parks and Rec. Perspective Option 2: Stakeholder Perspective	 30-40 minutes 40-50 minutes
Explain	Students present their perspectives	15-20 minutes
Elaborate	Discussion Questions	5-10 minutes
Evaluate	Understanding Maps Worksheet	*Homework/varies*

Using the EnviroAtlas Greenway Case Study without Internet

This case study can be carried out completely without the use of the internet. Use the following as guidance for administering this case study in the classroom. *It is recommended that each student have their own copy of 1) the case study and 2) the Understanding Maps Worksheet.* Map sets can be printed in color to be used in groups or displayed on computer/projector screens. Printing appendices is optional, though glossary terms, citations, and additional maps can be found there.

Teaching Plan

Case Preparation

There are multiple options for using the Building a Greenway Case Study. First, decide which activity or activities you wish to complete. Some options are below.

> ***Teacher Tip:*** It should be noted that this activity was designed for students to all be members of a Parks & Recreation department that had a decision to make (shown below as Option 1).
>
> However, upon repeated demonstrations in classrooms and to teachers, Option 2 (participants assuming Stakeholder roles) revealed itself to be a more popular option. This document has been updated (2018) from its original publication (2016) to include a worksheet and PowerPoint presentation that serve to better support teachers and participants that choose to complete this activity using Option 2.

- **Option 1: Carry out the case study as written, with all students assuming the role of a member of the Parks and Recreation Department during the case study and completing the Understanding Maps Worksheet.** *This requires minimal prior class preparation and can be completed in a 30-40 minute class session.*
  1. **Student prep:** Prior to the case study class session, have students read the case narrative, complete the 'Questions from the Reading', and come up with a few key points they would make.
  2. **Assign roles.** All students will complete the case study from the viewpoint of the Parks and Recreation Department, whose goals are outlined in the case study. Additional questions for class discussion are provided below.
- **Option 2: Assign each student a role from which to complete the case study.** *This requires some prior class preparation and may take 40-50 minutes of class time.* This is a great way to promote spirited discussion and will increase student understanding of the complexity of the decision-making process.
  1. **Assign student roles. Potential roles include:** representative from the parks and recreation department, city planner, environmentalist, concerned citizen,

environmental justice advocate, public health worker, neighborhood representative, or small business owner. There is a worksheet with these roles included.

2. **Assign groups.** Once roles are assigned, create groups that have a mix of roles.
3. **Student prep:** Prior to the case study class session, have students read the case narrative and come up with a few key points they would make to their group based on their role. Point them to Page 6 of the case study for guiding questions to prepare their report-back. If desired, encourage students to do some outside research for background for their role.

- **Option 3: Complete an activity from the Suggested Activities section below.** *More significant preparation outside of class time will be needed. In class time needed will vary among these activities. More than one class period will be required to complete the case study and an additional activity.* These individual activities can be used to tailor the Building a Greenway case study to individual class curricula and learning objectives. Students will complete the case study during class time and have an additional activity from the Suggested Activities assigned for more in-depth discovery. Students will need to make use of additional resources and work outside of classroom hours to complete assigned activities.

Engage: Priming Questions for the Instructor

Students should have already read and become familiar with the case study. Take the first 10 minutes of class and prime the class for more in-depth discussion. The most straightforward way to do this is to use some of the prompting questions students that were given as a part of the case narrative, including:

- What is the situation? What issues are at stake?
- What is the context of the problem? What are the underlying assumptions of the case?
- What key facts should you consider?
- What questions do you have?
- What criteria should you use when selecting a route?
- What alternatives are available? What are the pros and cons of each alternative?
- What other information, including maps, would be useful to have in making your decision?

After priming the class, reiterate the instructions based on the class option that you have chosen. Students should have access to the map set during class time in order to complete the assignment.

- ***Explore, Option 1:*** **Carry out the case study as written, with all students assuming the role of a member of the Parks and Recreation Department.**

1. Each student should use the provided map set to complete the Understanding Maps Worksheet. Once they complete the worksheet, students should draft a short paragraph explaining their recommendation for the public hearing.
2. ***Explain, Option 1:*** Have a few students read their recommendations to the class or introduce interesting observations from the Understanding Maps Worksheet.
3. If time allows, continue discussion with some of the provided discussion questions.

- ***Explore, Option 2:*** **Assign each student a role from which to complete the case study.**
  Depending on class length, this activity may be split into two class sessions.
  1. During class time, have students complete the Understanding Maps Worksheet and draft their paragraph for their preferred route based on their individual role.
  2. Place students in their assigned group and have them report back their recommendations to their groups.
  3. ***Explain, Option 2:*** Have students complete the Group Decision portion of the case study and attempt to agree on a pilot route collectively.
  4. If time allows, have student groups report back to the class on the route they decided on collectively. If groups did not come to consensus, have them explain why no consensus could be reached.
- ***Explore, Option 3:*** **Complete an activity from the Suggested Activities document.**
  1. Class Session 1: Each student should use the provided map set to complete the Understanding Maps Worksheet.
  2. ***Explain, Option 3:*** Once they complete the worksheet, students should draft a short paragraph explaining their recommendation for the public hearing. Have a few students read their recommendations to the class. Assign the additional activity for students to complete.
  3. Class Session 2: Complete Additional Activity or report-back on additional activity that was assigned for homework.

Elaborate: Continuing the Conversation – Discussion Questions

Begin to explore some of the underlying issues present in the case. These issues may be present in a variety of situations, not just this case, and may spark a discussion related to other topics in the course curriculum. Sample discussion questions include:

- How important is public input in the decision-making process?
- How can cities balance goals across economic, social, and environmental sectors?
- Who is responsible for promoting/encouraging healthy communities?
- What impact do you think this decision will have in the next year? 5 years? 20 years?

Evaluate: Measuring Impact

For recording a grade, have students turn in their Understanding Maps Worksheet and short rationale paragraph that justifies their decision.

Additional Resources available online

All of the following Greenway activities can be found in the Greenway section online https://www.epa.gov/enviroatlas/building-greenway-case-study

- ***Case Study Synopsis***
- ***Student Map Set***
- ***Understanding Maps Student Worksheet***
- ***Teacher Powerpoint to use as an Introduction***
- ***Script to read alongside Teacher Powerpoint***
- ***Stakeholder Perspectives Handout***
- ***Guidance for using the Greenway Activity online in the EnviroAtlas Interactive Map***

Using the *EnviroAtlas* Greenway Case Study with Internet

If you have access to the internet, you can use the EnviroAtlas Interactive Map and available online resources to teach this case study. Having students use the internet will allow them to explore the maps via the mapping application and gain practical experience with online mapping tools. The below procedure is our recommendation for completing the case study using internet resources.

> ***Featured Collection:*** *The Greenway Case Study has an associated "Featured Collection" of mapsin the EnviroAtlas Interactive Map, making it easier for students to engage with the material directly on classroom computers. For instructions on how to use the Featured Collection online,* *refer to page 9.*

Teaching Plan

Engage: *Prior to class time, have students read the case narrative, complete the 'Questions from the Reading', and come up with a few key points they would make.*

> **Note to the teacher:** The "Case Study Background Information for Students" Handout is designed so that it can be re-used. Students should not write on the handout. Then you can just print them one time in color (for the maps) and re-use them in following years. You could also make them available for students to read online if that is an option for your students.

Class Session 1: Case Preparation

By the end of the first class, students should have a thorough understanding of the greenway concept and know how to access and navigate the EnviroAtlas interactive map.

1. Assign roles. If you are going to assign students to a role other than the Parks and Recreation Department, assign them at the beginning of Class 1. Create groups composed of the varied roles. Potential roles include: city planner, environmentalist, concerned citizen, environmental justice advocate, public health worker, neighborhood representative, small business owner, or outdoor enthusiast.

2. Introduction videos. To get students engaged and further acquainted with the greenways concept, consider showing show 1 or 2 short introduction videos. Here are a few to choose from:

- Greenville, NC https://www.youtube.com/watch?v=84D8n65TeuI (stop at 2:40)

- Greenways, Please! Buncombe County, NC https://www.youtube.com/watch?v=8p3H0X4SDzI (4:54)
- Houston, TX - Bayou Greenways 2020: A Story of Community Revitalization https://www.youtube.com/watch?v=vUeahhf57yg (4:06)
- Knoxville, TN – Urban Wilderness Park, Greenway system https://www.youtube.com/watch?v=05AoArAsg1A (3:47)

3. ***Explore:*** **EnviroAtlas tutorials.** Next, introduce the students to EnviroAtlas. Start with the EnviroAtlas overview video: https://www.youtube.com/watch?v=ZMU8ZLsCmUM.
   - To get familiar with using the online mapping application, have students watch the EnviroAtlas Video Tutorials, which explain the interactive map components and how to navigate the map. Access those tutorial videos here: https://www.epa.gov/enviroatlas/enviroatlas-training-and-education

4. **How to use the Map.** Go over the Map Guidance document (available online) step-by-step with students. It provides in-depth directions for accessing the "Featured Collection" created for this case study, which provides access to the maps and trailheads used in this case, as well as how to access functions like changing the base map. If students have individual classroom computers, have them follow along with you as you show the Map Guidance document. Find the Map Guidance here: https://www.epa.gov/enviroatlas/building-greenway-case-study

   NOTE: The majority of EnviroAtlas maps have an accompanying fact sheet. These fact sheets provide background information on each map, including why the topic is important, how one might use the data, and a brief description of how the data were created. Have students use these fact sheets to provide additional contextual information for completing the case study and answering the questions in the Understanding Maps Worksheet. Fact sheets can be searched and sorted from here: https://www.epa.gov/enviroatlas/enviroatlas-dynamic-data-matrix

5. ***Explain:*** **EnviroAtlas Exploration.** If students have individual computers or computers for group use, allow them to explore the EnviroAtlas interactive map and other resources and ask questions during class time.

6. **As a homework assignment:** Have the students complete the Understanding Maps Worksheet and their short rationale paragraph for The Public Hearing based on their assigned role. Encourage students to use their knowledge of the interactive map to explore the maps presented in the case study and other available maps.

Class Session 2: Case Study Report-back and Discussion

7. *Elaborate:* Discussion

If individual roles are not assigned:

Start class discussion by asking students to report-back on which maps they found to be most useful in their Public Hearing paragraph. They should highlight their answers to the following questions:

- What maps support your selection? How?
- What were your primary considerations when selecting your route?

- Continue discussion among the class by asking, "What other information/maps would have been useful to have available to help make this decision?" Use the EnviroAtlas interactive map to explore additional maps during the discussion.
- Encourage discussion on the importance of access to information and data. What resources would they have used if they didn't know about EnviroAtlas?

If individual roles are assigned:

- Place students in their assigned group and have them report back their recommendations to their groups. Have students complete the Group Decision portion of the case study and attempt to agree on a pilot route collectively.
- Have student groups report back to the class on the route they decided on collectively. If groups did not come to consensus, have them explain why no consensus could be reached.
- Continue discussion among the class by asking, "What other information/maps would have been useful to have available to help make this decision?" Use the EnviroAtlas interactive map to explore additional maps during the discussion.

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Answers to Comprehension Questions

Answers to "Questions from the Reading"

1. What are overarching goals of the Canton Sustainability Plan?

   The overarching goals of the Sustainability Plan are to support equal access to resources, conservation of open space, and economic development.

2. What are some benefits/services provided by green spaces?

   Recreation, physical activity, positive effects on health, hazard mitigation and buffering, air and water filtration.

3. How are greenways important for preserving natural ecosystems?

   Greenways increase connectivity and biodiversity and encourage conservation.

Answers to "Understanding Maps Worksheet"

1. Do you see any trends related to the elderly population and green space?

   The larger populations of elderly people generally live near green space. Toward the middle of the map there is an area where there are larger elderly populations but lower green space.

2. How does Figure 3 help illustrate why the chosen route would benefit the Parks and Recreation Department? Who else might be interested in access to parks?

   a. *The proposed route would connect three parks and create a pathway for people to go from one park to another, increasing usage. There are also areas along the route that are not within short walking distance to a park; adding the greenway may make it more likely that people in these areas would access existing parks via the greenway. The proposed route is also near waterbodies which will encourage greenway users.*

   b. *Community members, environmental justice advocates, public health workers, fishermen, birders, outdoor enthusiasts, and parents, among others, may be interested in access to parks.*

3. How might connectivity be important in the selection of the pilot section of the greenway? Is the proposed pilot section the best choice for increasing connectivity?

   a. *The greenway could help connect areas that are disconnected by development.*

b. *It depends on what your goals are. The proposed pilot route connects multiple small areas. Other potential routes could connect larger patches.*

4. Looking at Figure 5, what is the most common land cover type in Canton? How might the land cover affect where a trail would be placed? Think about current developed land the presence of local businesses.

   a. *Trees and Forest and Impervious are prominent land cover types.*

   b. *Multiple answers are possible. Some potential answers: Green spaces could be easily converted to a greenway but developed land might be harder to convert. People might want the greenway to be placed next to areas of significant development or where there are businesses so that people will have destinations along the greenway. There needs to be 'green' for a greenway, so if you had to place a greenway route along an area of too much development it might not be well-received. It might be nice to have a greenway next to water so that people could enjoy it. Some land cover types, like wetlands, may be prohibited to develop for a paved trail.*

5. Would the proposed pilot route increase park access to those who have little access comparatively? How?

   Yes, it would. The pilot route goes through several block groups that have at least 97% of people who do not have a park within 500m.

6. When considering where to construct the pilot and subsequent trails, how might intersection density and walkability affect placement?

   Higher intersection density areas may indicate that the residents are more likely to walk or bike places, and therefore more likely also to adopt and use a greenway if placed in the area. Greenways can also pass through areas of lower intersection density, where walkability is lower to improve walkability and connect the more walkable areas.

Resources *(on following pages)*

Alignment of this Lesson Module to State Science Educational Standards—Grades 9-12

Alignment of this Lesson Module to State Science Educational Standards—High School Biology

Alignment of this Lesson Module to State Science Educational Standards—High School Earth and/or Environmental Science

STATE EDUCATIONAL STANDARDS

HIGH SCHOOL GRADES 9-12, SPLIT BY GRADE (AK & PA)

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*. While this document has been reviewed and approved by the U.S. Environmental Protection Agency, its contents do not necessarily reflect the views and policies of the Agency.

State (last updated on this chart, Standards adoption year)	**State Science Educational Standards that apply to the Greenway Lesson, separated by individual grades 9-12**
AK—9th grade (1/2017, 2012)	The student demonstrates an understanding that solving problems involves different ways of thinking by [9] SE2.1 questioning, researching, modeling, simulating, and testing a solution to a problem (L) The student demonstrates an understanding of the bases of the advancement of scientific knowledge by [9] SG2.1 explaining the importance of innovations (i.e., microscope, immunization, computer)
AK—10th grade (1/2017, 2012)	The student demonstrates an understanding that solving problems involves different ways of thinking by [10] SE2.1 questioning, researching, modeling, simulating, and testing multiple solutions to a problem (L)
PA—10th grade (1/2017, 2002)	3.4.10.B1 Compare and contrast how the use of **technology** involves weighing the trade-offs between the positive and negative effects. 3.4.10.B2 Demonstrate how humans devise **technologies** to reduce the negative consequences of other **technologies.**
AK—11th grade (1/2017, 2012)	The student demonstrates an understanding that solving problems involves different ways of thinking by [11] SE2.1 questioning, researching, modeling, simulating, and testing multiple solutions to a problem* (L)
PA—12th grade (1/2017, 2002)	3.3.12.A2 Analyze the availability, location, and extraction of Earth's resources. Evaluate the impact of using renewable and nonrenewable energy resources on the Earth's **system.** 3.4.12.B2 Illustrate how, with the aid of **technology**, various aspects of the environment can be monitored to provide information for decision making.

STATE EDUCATIONAL STANDARDS

ALL HIGH SCHOOL GRADES 9-12, NOT SPLIT BY GRADE

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State (last updated on this chart, Standards adoption year)	**State Science Educational Standards that apply to the Greenway Lesson, separated by all grades (9-12)**
AL (1/2017, 2015)	Separated by subject areas
AK (1/2017, 2012)	Separated by grade, see 9-12 above
AZ (1/2017, 2005)	**Concept 1:** Changes in Environments. Describe the interactions between human populations, natural hazards, and the environment. PO 1. Evaluate how the processes of natural ecosystems affect, and are affected by, humans. **PO 4.** Evaluate the following factors that affect the quality of the environment: • urban development • smoke • volcanic dust
AR (1/2017, 2005)	Separated by subject areas
CA (1/2017, 2009)	**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. **NGSS Science & Engineering Practices (APPENDIX F):** 1. Asking questions (for science) and defining problems (for engineering). 2. Developing and using models. 4. Analyzing and interpreting data. 5. Using mathematic s and computational thinking. 6. Constructing explanations (for science) and designing solutions (for engineering). 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	Separated by subject areas.

CT (1/2017, 2015)	Separated by subject areas.
DC	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	Separated by subject areas.
GA (1/2017, new standards up 2017-2018)	Separated by subject areas.
HI (1/2017, 2005)	Separated by subject areas.
ID (1/2017, 2016)	Separated by subject areas.
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	Separated by subject areas.
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	**HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. **HS-LS4-6.** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
LA	Separated by subject areas.

(1/2017, 2016)	
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity. **HS-ESS3-2.** Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios. **HS-ESS3-3.** Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	**9.1.3.1.1.** Natural and designed systems are made up of components that act within a system and interact with other systems. **9.4.4.2.4.** Personal and community health can be affected by the environment, body functions and human behavior. Explain how environmental factors and personal decisions, such as water quality, air quality and smoking affect personal and community health.
MS (1/2017, 2010)	Separated by subject areas.
MO (1/2017, 2015)	**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity. **HS-ESS3-2.** Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios. **HS-ESS3-3.** Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.
MT (1/2017, 2016)	**1.3** review evidence, communicate and defend results, and recognize that the results of a scientific investigation are always open to revision by further investigations. (e.g., through graphical representation or charts) **1.6** explain how observations of nature form an essential base of knowledge among the Montana American Indians

	5.5 explain how the knowledge of science and technology applies to contemporary Montana American Indian communities (e.g., natural resources development, management and conservation)
NE (1/2017, 2010)	**12.1.1.j** Share information, procedures, results, conclusions, and defend findings to a scientific community (peers, science fair audience, policy makers). **12.1.1.k** Evaluate scientific investigations and offer revisions and new ideas as appropriate. **12.4.2.c** Evaluate the impact of human activity and natural causes on Earth's resources (groundwater, rivers, land, fossil fuels). **12.3.3.d** Analyze factors which may influence environmental quality.
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	**S:LS2:11:1.1** Explain how the amount of life an environment can sustain is restricted by the availability of matter and energy, and the ability of the ecosystem to recycle materials. **S:LS2:11:1.2** Describe how the interrelationships and interdependencies among organisms generate stable ecosystems that fluctuate around a state of rough equilibrium for hundreds or thousands of years. **S:LS2:11:1.3** Identify the factors in an ecosystem that can affect its carrying capacity. **S:LS2:11:1.4** Analyze and describe how environmental disturbances, such as climate changes, natural events, human activity and the introduction of invasive species, can affect the flow of energy or matter in an ecosystem. **S:LS2:11:1.5** Using data from a specific ecosystem, explain relationships or make predictions about how environmental disturbance (human impact or natural events) affects the flow of energy or cycling of matter in an ecosystem. **S:LS2:11:1.6** Explain or evaluate potential bias in how evidence is interpreted in reports concerning a particular environmental factor that impacts the biology of humans. **S:LS3:11:1.1** Identify ways humans can impact and alter the stability of ecosystems, such as habitat destruction, pollution, and consumption of resources; and describe the potentially irreversible effects these changes can cause. **S:LS3:11:1.2** Identify ways of detecting, and limiting or reversing environmental damage. **S:LS3:11:1.3** Analyze the aspects of environmental protection, such as ecosystem protection, habitat management, species conservation and environmental agencies and regulations; and evaluate and justify the need for public policy in guiding the use and management of the environment. **S:LS4:11:3.1** Describe how the length and quality of human life are influenced by many factors, including sanitation, diet, medical care, gender, genes, and environmental conditions and personal health behaviors. **S:LS5:11:1.1** Describe ways in which technology has increased our understanding of the life sciences.

	S:LS5:11:1.2 Understand that technology is designed with a particular function in mind, and principles of life science are useful in creating technology for the life sciences. **S:LS5:11:3.1** Describe ways technology can support and improve our understanding of environmental issues. **S:LS5:11:4.1** Explain the kinds of applications of knowledge and skills necessary for jobs/careers specific to the life sciences. **S:SPS1:12:1.4** Ask questions about relationships between and among observable variables as well as theoretical entities.
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	**Strand II:** The Content of Science Standard II (Life Science): Understand the properties, structures, and processes of living things and the interdependence of living things and their environments. 9-12 Benchmark I: **Ecosystems** 1. Know that an ecosystem is complex and may exhibit fluctuations around a steady state or may evolve over time. 2. Describe how organisms cooperate and compete in ecosystems (e.g., producers, decomposers, herbivores, carnivores, omnivores, predator-prey, symbiosis, mutualism). 3. Understand and describe how available resources limit the amount of life an ecosystem can support (e.g., energy, water, oxygen, nutrients). 4. Critically analyze how humans modify and change ecosystems (e.g., harvesting, pollution, population growth, technology).
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	Separated by subject areas.
ND (1/2017, 2014)	**9-10.2.3.** Identify questions and concepts that guide scientific investigations. **9-10.5.6.** Explain the effects of human activities (e.g., dams, levees, farming practices, deforestation, land-use practices, land management strategies) on the environment. **9-10.6.1.** Use appropriate technologies and techniques to solve a problem (e.g., computer-assisted tools, Internet, research skills). **11-12.2.4.** Formulate and revise explanations based upon scientific knowledge and experimental data. **11-12.2.8.** Communicate and defend a scientific argument. **11-12.6.1.** Select and use appropriate technologies, tools, and techniques to solve a problem (e.g., computer-assisted tools, Internet, research skills, CBL, graphing calculators).

	11-12.6.3. Explain how designing and implementing technology requires weighing trade-offs between positive and negative impacts on humans and the environment. **11-12.7.1.** Explain the impact of environmental laws and policies on the environment and society (e.g., waste/pollutants from industry, carbon dioxide emissions, location and number of animals in a feedlot versus water supply). **11-12.7.2.** Explain ways renewable and nonrenewable resources are managed (e.g., land reclamation, forest management, CRP, hunting licenses, energy –conserving technologies). **11-12.7.3.** Explain the economic and social impact of using alternative energy resources. **11-12.7.4.** Explain how science and technology can influence personal, industrial, and cultural decision-making (e.g., organ transplants, cloning, stem cell research, genetic manipulation, use of genetic profile, archeological discoveries, land management, resource management).
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: See "Biology" and "Earth Science" courses
OK (1/2017, 2014)	Separated by subject areas.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	NGSS (see CA above).
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	Separated by subject areas.
SD (1/2017, 2015)	Separated by subject areas.
TN (1/2017, 2009)	Separated by subject areas.
TX (1/2017, 2014)	Separated by subject areas.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	Separated by subject areas.

VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	Separated by subject areas.
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	**A.12.1** Apply the underlying themes of science to develop defensible visions of the future. **A.12.2** Show how conflicting assumptions about science themes lead to different opinions and decisions about evolution, health, population, longevity, education, and use of resources, and show how these opinions and decisions have diverse effects on an individual, a community, and a country, both now and in the future. **A.12.3** Give examples that show how partial systems, models, and explanations are used to give quick and reasonable solutions that are accurate enough for basic needs. **A.12.5** Show how the ideas and themes of science can be used to make real-life decisions about careers, work places, life-styles, and use of resources. **A.12.6** Identify and, using evidence learned or discovered, replace inaccurate personal models and explanations of science-related events. **A.12.7** Re-examine the evidence and reasoning that led to conclusions drawn from investigations, using the science themes. **B.12.5** Explain how science is based on assumptions about the natural world and themes that describe the natural world. **C.12.5** Use the explanations and models found in the earth and space, life and environmental, and physical sciences to develop likely explanations for the results of their investigations. **C.12.6** Present the results of investigations to groups concerned with the issues, explaining the meaning and implications of the results, and answering questions in terms the audience can understand. **C.12.7** Evaluate articles and reports in the popular press, in scientific journals, on television, and on the Internet, using criteria related to accuracy, degree of error, sampling, treatment of data, and other standards of experimental design. **E.12.4** Analyze the benefits, costs, and limitations of past, present, and projected use of resources and technology and explain the consequences to the environment. **F.12.8** Using the science themes, infer changes in ecosystems prompted by the introduction of new species, environmental conditions, chemicals, and air, water, or earth pollution.

	H.12.1 Using the science themes and knowledge of the earth and space, life and environmental, and physical sciences, analyze the costs, risks, benefits, and consequences of a proposal concerning resource management in the community and determine the potential impact of the proposal on life in the community and the region. **H.12.2** Evaluate proposed policy recommendations (local, state, and/or national) in science and technology for validity, evidence, reasoning, and implications, both short and long-term. **H.12.3** Show how policy decisions in science depend on social values, ethics, beliefs, and time-frames as well as considerations of science and technology. **H.12.4** Advocate a solution or combination of solutions to a problem in science or technology. **H.12.5** Investigate how current plans or proposals concerning resource management, scientific knowledge, or technological development will have an impact on the environment, ecology, and quality of life in a community or region. **H.12.6** Evaluate data and sources of information when using scientific information to make decisions. **H.12.7** When making decisions, construct a plan that includes the use of current scientific knowledge and scientific reasoning.
WY (1/2017, 2016)	**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.

STATE EDUCATIONAL STANDARDS

HIGH SCHOOL BIOLOGY/LIFE SCIENCE

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*. While this document has been reviewed and approved by the U.S. Environmental Protection Agency, its contents do not necessarily reflect the views and policies of the Agency.

State (last updated on this chart, Standards adoption year)	**State Science Educational Standards that apply to the Greenway Lesson, separated by course subject (Biology/Life Science)**
AL (1/2017, 2015)	**7.** Develop and use models to illustrate examples of ecological hierarchy levels, including biosphere, biome, ecosystem, community, population, and organism.
AK (1/2017, 2012)	Separated by grade-level.
AZ (1/2017, 2005)	Separated by "All High School"
AR (1/2017, 2005)	**EBR.9.B.1** Analyze the effects of human population growth and technology on the environment/biosphere. **EBR.9.B.2** Evaluate long range plans concerning resource use and by-product disposal in terms of their environmental, economic, and political impact.
CA (1/2017, 2009)	**HS-LS2-2**. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-7.** Evaluate and assess impacts on the environment and biodiversity in order to refine or design a solution for detrimental impacts or enhancement for positive impacts. **HS-LS4-6**. Create and/or use a simulation to evaluate the impacts of human activity on biodiversity. **NGSS Science & Engineering Practices (APPENDIX F):** 1. Asking questions (for science) and defining problems (for engineering). 2. Developing and using models. 4. Analyzing and interpreting data. 5. Using mathematic s and computational thinking. 6. Constructing explanations (for science) and designing solutions (for engineering). 7. Engaging in argument from evidence. 8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	None.

CT (1/2017, 2015)	NGSS (see CA above).
DC	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	**SC.912.L.17.12** Discuss the political, social, and environmental consequences of sustainable use of land. **SC.912.L.17.13** Discuss the need for adequate monitoring of environmental parameters when making policy decisions.
GA (1/2017, new standards up 2017-2018)	**SB5.** Obtain, evaluate, and communicate information to assess the interdependence of all organisms on one another and their environment. a. Plan and carry out investigations and analyze data to support explanations about factors affecting biodiversity and populations in ecosystems. c. Construct an argument to predict the impact of environmental change on the stability of an ecosystem. d. Design a solution to reduce the impact of a human activity on the environment.
HI (1/2017, 2005)	Common Core.
ID (1/2017, 2016)	**Goal 1.3:** Understand Constancy, Change, and Measurement **9-10.B.1.3.1** Measure changes that can occur in and among systems. (648.03b) **9-10.B.1.3.2** Analyze changes that can occur in and among systems. (648.03b) **9-10.B.1.3.3** Measure and calculate using the metric system. (648.03c) Goal 5.1: Understand Common Environmental Quality Issues, Both Natural and Human Induced **9-10.B.5.1.1** Analyze environmental issues such as water and air quality, hazardous waste, forest health, and agricultural production. (656.01a)
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	**B.3.2** Design, evaluate, and refine a model which shows how human activities and natural phenomena can change the flow of matter and energy in an ecosystem and how those changes impact the environment and biodiversity of populations in ecosystems of different scales, as well as, how these human impacts can be reduced. **B.3.3** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, and identify the impact of changing conditions or introducing non-native species into that ecosystem.
IA (1/2017, 2016)	NGSS (see CA above).

KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	Separated by "All High School"
LA (1/2017, 2016)	**Interdependence of Organisms:** **27.** Analyze positive and negative effects of human actions on ecosystems (LS-H-D4) (SE-H-A7)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	**HS-LS2-6.** Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience. **HS-LS2-7.** Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.*
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	Separated by "All High School"
MS (1/2017, 2010)	**Intro Bio**: **3d.** Predict the impact of human activities (e.g., recycling, pollution, overpopulation) on the environment. (DOK 3) **Biology 1:** b. Provide examples to justify the interdependence among environmental elements. (DOK 2).
MO (1/2017, 2015)	**HS-LS2-6.** Analyze data to show ecosystems tend to maintain relatively consistent numbers and types of organisms even when small changes in conditions occur but that extreme fluctuations in conditions may result in a new ecosystem. Construct an argument supported by evidence that ecosystems with greater biodiversity tend to have greater resistance to change and resilience. **HS-LS2-7.** Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE	Separated by "All High School"

(1/2017, 2010)	
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	Separated into GSEs (Grade Span Expectations), 9-11 so, "By the end of Grade 11, all students will…"
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Separated by "All High School"
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	**Bio.2.2.1** Infer how human activities (including population growth, pollution, global warming, burning of fossil fuels, habitat destruction and introduction of nonnative species) may impact the environment. **Bio.2.2.2** Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.
ND (1/2017, 2014)	Separated by "All High School"
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: Note 3: Constructing food webs/food chains to show interactions between organisms within ecosystems was covered in upper elementary school and middle school; constructing them as a way to demonstrate content knowledge is not appropriate for this grade. Students may use these diagrams to help explain real-world relationships or events within an ecosystem, but not to identify simple trophic levels, consumers, producers, predator-prey and symbiotic relations.
OK (1/2017, 2014)	**HS-LS2-4.** Students who demonstrate understanding can: Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-6.** Students who demonstrate understanding can: Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	NGSS (see CA above).
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**H.B.1A.2.** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others.

	H.B.1A.4. Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions. **H.B.1A.6.** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **H.B.1A.8.** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations. **H.B.6D.1.** Design solutions to reduce the impact of human activity on the biodiversity of an ecosystem.
SD (1/2017, 2015)	**HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms under stable conditions; however, moderate to extreme fluctuations in conditions may result in new ecosystems. **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
TN (1/2017, 2009)	**CLE 3210.Inq.6** Communicate and defend scientific findings. **CLE 3210.T/E.1** Explore the impact of technology on social, political, and economic systems. **CLE 3210.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems. **CLE 3210.2.1** Investigate how the dynamic equilibrium of an ecological community is associated with interactions among its organisms. **CLE 3210.2.3** Predict how global climate change, human activity, geologic events, and the introduction of non-native species impact an ecosystem. **CLE 3216.Inq.1** Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted. **CLE 3216.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems. **CLE 3216.2.1** Describe how the stability of an ecosystem is maintained.
TX (1/2017, 2014)	None.

UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	**Standard 1, Objective 2:** Explain relationships between matter cycles and organisms. **Standard 1, Objective 3:** Describe how interactions among organisms and their environment help shape ecosystems. e. Research and evaluate local and global practices that affect ecosystems.
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	Life Science. **LS.1 d,i,j.** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which: d) models and simulations are constructed and used to illustrate and explain phenomena; i) patterns are identified in data and are interpreted and evaluated; and j) current applications are used to reinforce life science concepts. **LS.6 b-d.** The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include: b) interactions resulting in a flow of energy and matter throughout the system; c) complex relationships within terrestrial, freshwater, and marine ecosystems; and d) energy flow in food webs and energy pyramids. **LS.9 a-c.** The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include: a) differences between ecosystems and biomes; b) characteristics of land, marine, and freshwater ecosystems; and c) adaptations that enable organisms to survive within a specific ecosystem. **LS.10 b-c.** The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include: b) factors that increase or decrease population size; and c) eutrophication, climate changes, and catastrophic disturbances. **LS.11 a-d.** The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include:

	a) food production and harvest; b) change in habitat size, quality, or structure; c) change in species competition; d) population disturbances and factors that threaten or enhance species survival; and e) environmental issues. **BIO.8 a-e.** The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include: a) interactions within and among populations including carrying capacities, limiting factors, and growth curves; b) nutrient cycling with energy flow through ecosystems; c) succession patterns in ecosystems; d) the effects of natural events and human activities on ecosystems; and e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems.
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	Separated by "All High School"
WY (1/2017, 2016)	**HS-LS2-2**. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. **HS-LS2-4.** Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. **HS-LS2-7.** Evaluate and assess impacts on the environment and biodiversity in order to refine or design a solution for detrimental impacts or enhancement for positive impacts. **HS-LS4-6**. Create and/or use a simulation to evaluate the impacts of human activity on biodiversity.

STATE EDUCATIONAL STANDARDS

HIGH SCHOOL EARTH/ENVIRONMENTAL SCIENCE

These Standards have been collected from individual State websites (1/2017). They have been connected to themes that are available in an EPA tool called *EnviroAtlas*. While this document has been reviewed and approved by the U.S. Environmental Protection Agency, its contents do not necessarily reflect the views and policies of the Agency.

State (last updated on this chart, Standards adoption year)	**State Science Educational Standards that apply to the Greenway Lesson, separated by course subject (Earth/Environmental Science)**
AL (1/2017, 2015)	**Environmental Science:** **4.** Engage in argument from evidence to evaluate how biological or physical changes within ecosystems (e.g., ecological succession, seasonal flooding, volcanic eruptions) affect the number and types of organisms, and that changing conditions may result in a new or altered ecosystem. **10.** Design solutions for protection of natural water resources (e.g., bioassessment, methods of water treatment and conservation) considering properties, uses, and pollutants (e.g., eutrophication, industrial effluents, agricultural runoffs, point and nonpoint pollution resources). **11.** Engage in argument from evidence to defend how coastal, marine, and freshwater sources (e.g., estuaries, marshes, tidal pools, wetlands, beaches, inlets, rivers, lakes, oceans, coral reefs) support biodiversity, economic stability, and human recreation. **13.** Obtain, evaluate, and communicate information based on evidence to explain how key natural resources (e.g., water sources, fertile soils, concentrations of minerals and fossil fuels), natural hazards, and climate changes influence human activity (e.g., mass migrations). **14.** Analyze cost-benefit ratios of competing solutions for developing, conserving, managing, recycling, and reusing energy and mineral resources to minimize impacts in natural systems (e.g., determining best practices for agricultural soil use, mining for coal, and exploring for petroleum and natural gas sources). **15.** Construct an explanation based on evidence to determine the relationships among management of natural resources, human sustainability, and biodiversity (e.g., resources, waste management, per capita consumption, agricultural efficiency, urban planning). **16.** Obtain and evaluate information from published results of scientific computational models to illustrate the relationships among Earth's systems and how these relationships may be impacted by human activity (e.g., effects of an increase in atmospheric carbon dioxide on photosynthetic biomass, effect of ocean acidification on marine populations).
AK (1/2017, 2012)	Separated by grade-level.

AZ (1/2017, 2005)	Separated by "All High School"
AR (1/2017, 2005)	Environmental Science: **PD.1.ES.9** Construct and interpret information on topographic maps. **BD.2.ES.8** Describe biodiversity. **BD.2.ES.9** Explain how limiting factors affect populations and ecosystems. **SP.3.ES.1** Explain the reciprocal relationships between Earth's processes (natural disasters) and human activities. **SP.3.ES.5** Evaluate the impact of different points of view on health, population, resource, and environmental issues: • governmental • economic • societal **SP.3.ES.9** Evaluate personal and societal benefits when examining health, population, resource, and environmental issues. **SP.3.ES.10** Predict the long-term societal impact of specific health, population, resource, and environmental issues. **SP.3.ES.11** Investigate the effect of public policy decisions on health, population, resource, and environmental issues.
CA (1/2017, 2009)	**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-3.** Use computational tools to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **HS-ESS3-6.** Use the results of a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. **NGSS Science & Engineering Practices (APPENDIX F):** 1. Asking questions (for science) and defining problems (for engineering). 2. Developing and using models. 4. Analyzing and interpreting data. 5. Using mathematic s and computational thinking. 6. Constructing explanations (for science) and designing solutions (for engineering). 7. Engaging in argument from evidence.

	8. Obtaining, evaluating, and communicating information.
CO (1/2017, 2009)	None.
CT (1/2017, 2015)	NGSS (see CA above).
DC	NGSS (see CA above).
DE (1/2017, 2013)	NGSS (see CA above).
FL (1/2017, 2014)	None.
GA (1/2017, new standards up 2017-2018)	**Earth Science:** **SES6.** Obtain, evaluate, and communicate information about how life on Earth responds to and shapes Earth's systems. c. Ask questions to investigate and communicate how humans depend on Earth's land and water resources, which are distributed unevenly around the planet as a result of past geological and environmental processes. **Environmental Science:** **SEV1.** Obtain, evaluate, and communicate information to investigate the flow of energy and cycling of matter within an ecosystem. a. Develop and use a model to compare and analyze the levels of biological organization including organisms, populations, communities, ecosystems, and biosphere. c. Construct an argument to predict changes in biomass, biodiversity, and complexity within ecosystems, in terms of ecological succession. **SEV4.** Obtain, evaluate, and communicate information to analyze human impact on natural resources. a. Construct and revise a claim based on evidence on the effects of human activities on natural resources: Human Activities, Natural Resources, Agriculture, Forestry, Ranching, Mining, Urbanization, Fishing, Water use, Pollution, Desalination, Waste water treatment, Land, Water, Air, Organisms. **SEV5.** Obtain, evaluate, and communicate information about the effects of human population growth on global ecosystems. a. Construct explanations about the relationship between the quality of life and human impact on the environment in terms of population growth, education, and gross national product. c. Construct an argument from evidence regarding the ecological effects of human innovations (Agricultural, Industrial, Medical, and Technological Revolutions) on global ecosystems. d. Design and defend a sustainability plan to reduce your individual contribution to environmental impacts, taking into account how market forces and societal demands (including political, legal, social, and economic) influence personal choices.
HI (1/2017, 2005)	Common Core.

ID (1/2017, 2016)	**Earth Science: Goal 5.1:** Understand Common Environmental Quality Issues, Both Natural and Human Induced 8-**9.ES.5.1.1** Analyze environmental issues such as water and air quality, hazardous waste, and depletion of natural resources. (656.01a)
IL (1/2017, 2011)	NGSS (see CA above).
IN (1/2017, 2016)	**Env.1.2** Understand and explain that human beings are part of Earth's ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems. **Env.1.7** Identify tools and technologies used to adapt and alter environments and natural resources in order to meet human physical and cultural needs. **Env.2.11** Recognize and describe the role of natural resources in providing the raw materials for an industrial society. **Env.5.2** Explain how the great diversity of species increases the chance that at least some living organisms will survive in the event of major global changes. **Env.5.6** Identify and explain the three levels of biodiversity: genetic, species, and ecosystem. **Env.6.3** Describe and give examples about how the decisions of one generation both provide and limit the range of possibilities open to the next generation. **Env.8.1** Demonstrate a knowledge of the distribution of natural resources in the U.S. and the world, and explain how natural resources influence relationships among nations. **Env.8.2** Understand and describe the concept of integrated natural resource management and the values of managing natural resources as an ecological unit. **Env.8.6** Understand and describe the concept and the importance of natural and human recycling in conserving our natural resources.
IA (1/2017, 2016)	NGSS (see CA above).
KS (1/2017, 2013)	NGSS (see CA above).
KY (1/2017, 2013)	Separated by "All High School"
LA (1/2017, 2016)	**Science and the Environment, Ecological Systems and Interactions** **8.** Explain how species in an ecosystem interact and link in a complex web (SE-HA7) (SE-H-A10) **11.** Explain why biodiversity is essential to the survival of organisms (SE-H-A9) **16.** Evaluate the effectiveness of natural resource management in Louisiana (SE-HB4) (SE-H-B5) **18.** Identify the factors that affect sustainable development (SE-H-B6) **Environmental Awareness and Protection**

	19. Determine the interrelationships of clean water, land, and air to the success of organisms in a given population (SE-H-C1) **20.** Relate environmental quality to quality of life (SE-H-C2) **21.** Analyze the effect of common social, economic, technological, and political considerations on environmental policy (SE-H-C3) **22.** Analyze the risk-benefit ratio for selected environmental situations (SE-H-C4) **23.** Describe the relationship between public support and the enforcement of environmental policies (SE-H-C5) **Personal Choices and Responsible Actions** **26.** Determine local actions that can affect the global environment (SE-H-D4) **27.** Describe how accountability toward the environment affects sustainability (SE-HD5)
ME (1/2017, 2013)	NGSS (see CA above).
MD (1/2017, 2013)	NGSS (see CA above).
MA (1/2017, 2016)	None.
MI (1/2017, 2015)	NGSS (see CA above).
MN (1/2017, 2009)	Separated by "All High School"
MS (1/2017, 2010)	**Earth Science:** **5a.** Draw conclusions about how life on Earth shapes Earth systems and responds to the interaction of Earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3) **Environmental Science:** **3a.** Summarize the effects of human activities on resources in the local environments. (DOK 2) Sources, uses, quality, and conservation of water Renewable and nonrenewable resources' effects of pollution (e.g., water, noise, air, etc.) on the ecosystem. **3b.** Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere and atmosphere and develop a logical argument to support how communities restore ecosystems. (DOK 3) **Spatial Information Science:** **2.** Develop an understanding of geographic information systems. **a.** Demonstrate the basic concepts of global positioning systems (GPS) by determining locations, (e.g., latitude, longitude, and elevation of the school flag pole or a site where a GPS receiver is unable to make an accurate measurement). (DOK 1)

	2f. Explain the basic concepts of data and image processing. (DOK 1) Types of data (e.g., raster, vector, and attribute) Variety of sources for geological data and imaging. **2h.** Explain how data sets are geo-referenced and geo-rectified. (DOK 1) **2i.** Assess the quality and accuracy of GPS and/or remote sensing data. (DOK 2) **2j.** Analyze and apply the basic concepts of geographic information systems. (DOK 2) Compatible geographic data layers of information utilizing computer software Relationships between geographic data Geographic information image showing results of analysis **2k.** Draw conclusions based on analysis and summary of geographic image information results. (DOK 3) **2l.** Research and defend a variety of applications for geographic information systems. (DOK 3) m. Describe the proper use and care of GPS receivers, computers, and other scientific equipment. (DOK 1)
MO (1/2017, 2015)	None.
MT (1/2017, 2016)	Benchmarks at end of 4th grade, 8th grade, and upon graduation from high school
NE (1/2017, 2010)	Separated by "All High School"
NV (1/2017, 2014)	NGSS (see CA above).
NH (1/2017, 2016)	Separated into GSEs (Grade Span Expectations), 9-11 (so, "By the end of Grade 11, all students will…")
NJ (1/2017, 2013)	NGSS (see CA above).
NM (1/2017, 2009)	Separated by "All High School"
NY (1/2017, 2015)	NGSS (see CA above).
NC (1/2017, 2011)	**EEn.2.1.2** Predict the locations of volcanoes, earthquakes, and faults based on information contained in a variety of maps. **EEn.2.4.1** Evaluate human influences on freshwater availability. **EEn.2.4.2** Evaluate human influences on water quality in North Carolina's river basins, wetlands and tidal environments. **EEn.2.5.5** Explain how human activities affect air quality. **EEn.2.6.3** Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation).

	EEn.2.6.4 Attribute changes to Earth's systems to global climate change (temperature change, changes in pH of ocean, sea level changes, etc.). **EEn.2.7.1** Explain how abiotic and biotic factors interact to create the various biomes in North Carolina. **EEn.2.7.3** Explain how human activities impact the biosphere. **EEn.2.8.1** Evaluate alternative energy technologies for use in North Carolina. **EEn.2.8.2** Critique conventional and sustainable agriculture and aquaculture practices in terms of their environmental impacts.
ND (1/2017, 2014)	Separated by "All High School"
OH (1/2017, 2014)	Ohio State Science Standards are not numbered or coded in any way: **EARTH SYSTEMS: INTERCONNECTED SPHERES OF EARTH** • Biosphere • Evolution and adaptation in populations • Biodiversity • Ecosystems (equilibrium, species interactions, stability) • Population dynamics • Atmosphere • Atmospheric properties and currents • Lithosphere • Geologic events and processes • Hydrosphere • Oceanic currents and patterns (as they relate to climate) • Surface and ground water flow patterns and movement • Cryosphere • Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere • Energy transformations on global, regional and local scales • Biogeochemical cycles • Ecosystems • Climate and weather **EARTH'S RESOURCES** • Energy resources • Renewable and nonrenewable energy sources and efficiency • Alternate energy sources and efficiency • Resource availability • Mining and resource extraction • Air and air pollution • Primary and secondary contaminants • Greenhouse gases • Clean Air Act • Water and water pollution • Potable water and water quality • Hypoxia, eutrophication • Clean Water Act • Point source and non-point source contamination • Soil and land • Desertification • Mass wasting and erosion • Sediment contamination • Land use and land management (including food production, agriculture and zoning) • Solid and hazardous waste • Wildlife and wilderness • Wildlife and wilderness management • Endangered species **GLOBAL ENVIRONMENTAL PROBLEMS AND ISSUES** • Human population • Potable water quality, use and availability • Climate change • Sustainability • Species depletion and extinction • Air quality • Food production and availability • Deforestation and loss of biodiversity • Waste management (solid and hazardous)
OK (1/2017, 2014)	**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks and interactions that cause changes to other Earth's systems. **HS-ESS2-5.** Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

	HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing natural resources based on cost-benefit ratios. **HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment biodiversity. **HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing natural resources based on cost-benefit ratios. **HS-ESS3-3.** Create a computational simulation to illustrate the relationship among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems.
OR (1/2017, 2014)	NGSS (see CA above).
PA (1/2017, 2002)	NGSS (see CA above).
RI (1/2017, 2013)	NGSS (see CA above).
SC (1/2017, 2014)	**H.E.1A.1** Ask questions to (1) generate hypotheses for scientific investigations, (2) refine models, explanations, or designs, or (3) extend the results of investigations or challenge scientific arguments or claims. **H.E.1A.2** Develop, use, and refine models to (1) understand or represent phenomena, processes, and relationships, (2) test devices or solutions, or (3) communicate ideas to others. **H.E.1A.4** Analyze and interpret data from informational texts and data collected from investigations using a range of methods (such as tabulation, graphing, or statistical analysis) to (1) reveal patterns and construct meaning, (2) support or refute hypotheses, explanations, claims, or designs, or (3) evaluate the strength of conclusions. **H.E.1A.6** Construct explanations of phenomena using (1) primary or secondary scientific evidence and models, (2) conclusions from scientific investigations, (3) predictions based on observations and measurements, or (4) data communicated in graphs, tables, or diagrams. **H.E.1A.8** Obtain and evaluate scientific information to (1) answer questions, (2) explain or describe phenomena, (3) develop models, (4) evaluate hypotheses, explanations, claims, or designs or (5) identify and/or fill gaps in knowledge. Communicate using the conventions and expectations of scientific writing or oral presentations by (1) evaluating grade-

	appropriate primary or secondary scientific literature, or (2) reporting the results of student experimental investigations. **H.E.3B.2** Construct scientific arguments to support claims that responsible management of natural resources is necessary for the sustainability of human societies and the biodiversity that supports them. **H.E.3B.4** Obtain and evaluate available data on a current controversy regarding human activities which may affect the frequency, intensity, or consequences of natural hazards. **H.E.3B.5** Define problems caused by the impacts of locally significant natural hazards and design possible devices or solutions to reduce the impacts of such natural hazards on human activities. **H.E.6A.2** Obtain and communicate information to explain how location, movement, and energy transfers are involved in making water available for use on Earth's surface (including lakes, surface-water drainage basins, freshwater wetlands, and groundwater zones). **H.E.6A.3** Plan and conduct controlled scientific investigations to determine how a change in stream flow might affect areas of erosion and deposition of a meandering alluvial stream. **H.E.6A.4** Analyze and interpret data of a local drainage basin to predict how changes caused by human activity and other factors influence the hydrology of the basin and amount of water available for use in the ecosystem. **H.E.6A.5** Analyze and interpret data to describe how the quality of the water in drainage basins is influenced by natural and human factors (such as land use, domestic and industrial waste, weather/climate conditions, topography of the river channel, pollution, or flooding).
SD (1/2017, 2015)	**HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **HS-ESS3-6.** Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
TN (1/2017, 2009)	**CLE 3204.Inq.1** Recognize that science is a progressive endeavor that reevaluates and extends what is already accepted. **CLE 3204.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems. **CLE 3260.T/E.1** Explore the impact of technology on social, political, and economic systems. **CLE 3260.2.2** Discuss the roles of biodiversity and coevolution in ecosystems.

	CLE 3260.4.1 Examine common resource use practices in agriculture, forestry, urban/suburban development, mining, and fishing. **CLE 3260.4.2** Explore best management practices related to water and soil resources. **CLE 3260.4.3** Compare and contrast preservation and conservation. **CLE 3260.4.4** Evaluate the impact of human activities on natural resources. **CLE 3260.6.1** Investigate the causes, environmental effects, and methods for controlling/preventing land, air and water pollution. **CLE 3260.6.2** Apply case studies to relate land, air, and water pollution to human health issues. **CLE 3260.6.3** Explore methods used for remediation of land, air and water pollution. **CLE 3260.6.4** Research local and national environmental legislation related to protecting land, air and water resources. **CLE 3260.6.5** Research local and state methods used for solid waste reduction, recycling and disposal; compare them to methods used in other developed countries. **CLE 3255.1.4** Investigate various approaches to maintain biodiversity. **CLE 3255.4.4** Summarize the human impact on ecosystems. **CLE 3255.4.5** Describe how biodiversity relates to stability of an ecosystem. **CLE 3255.5.5** Identify how humans impact biomes. **CLE 3255.6.1** Investigate the role of public lands in sustaining biodiversity. **CLE 3255.6.2** Examine state, national, and international efforts to sustain native species and ecosystems. **CLE 3255.6.3** Evaluate the impact of personal actions on the environment. **CLE 3255.6.4** Identify and explain choices you can make to lessen your impact on the environment.
TX (1/2017, 2014)	**112.37.c3E.** describe the connection between environmental science and future careers **112.37.c4F.** predict how the introduction or removal of an invasive species may alter the food chain and affect existing populations in an ecosystem. **112.37.c4H.** research and explain the causes of species diversity and predict changes that may occur in an ecosystem if species and genetic diversity is increased or reduced **112.37.c5A-F.** (A) summarize methods of land use and management and describe its effects on land fertility; (B) identify source, use, quality, management, and conservation of water; (C) document the use and conservation of both renewable and non-renewable resources as they pertain to sustainability;

	(D) identify renewable and non-renewable resources that must come from outside an ecosystem such as food, water, lumber, and energy; (E) analyze and evaluate the economic significance and interdependence of resources within the environmental system; and (F) evaluate the impact of waste management methods such as reduction, reuse, recycling, and composting on resource availability. **112.37.c6C.** Explain the flow of energy in an ecosystem, including conduction, convection, and radiation. **112.37.c9A-B.** (A) identify causes of air, soil, and water pollution, including point and nonpoint sources; (B) investigate the types of air, soil, and water pollution such as chlorofluorocarbons, carbon dioxide, pH, pesticide runoff, thermal variations, metallic ions, heavy metals, and nuclear waste. **112.37.c9D-G.** (D) describe the effect of pollution on global warming, glacial and ice cap melting, greenhouse effect, ozone layer, and aquatic viability; (E) evaluate the effect of human activities, including habitat restoration projects, species preservation efforts, nature conservancy groups, hunting, fishing, ecotourism, all-terrain vehicles, and small personal watercraft, on the environment; (F) evaluate cost-benefit trade-offs of commercial activities such as municipal development, farming, deforestation, over-harvesting, and mining; (G) analyze how ethical beliefs can be used to influence scientific practices such as methods for increasing food production **112.37.c9I-J.** (I) discuss the impact of research and technology on social ethics and legal practices in situations such as the design of new buildings, recycling, or emission standards; (J) research the advantages and disadvantages of "going green" such as organic gardening and farming, natural methods of pest control, hydroponics, xeriscaping, energy-efficient homes and appliances, and hybrid cars.
UT (1/2017, K-2: 2010, 3-6: 2002, 7-8: 2003, 9-12: 2003, Earth Science: 2012)	**Standard 3, Objective 3:** Examine the natural and human-caused processes that cause Earth's climate to change over intervals of time ranging from decades to millennia. *e. Investigate the current and potential consequences of climate change (e.g., ocean acidification, sea level rise, desertification, habitat loss) on ecosystems, including human communities.* **Standard 4, Objective 2:** Analyze the characteristics and importance of freshwater found on Earth's surface and its effect on living systems.

	b. Plan and conduct an experiment to investigate biotic and abiotic factors that affect freshwater ecosystems. *c. Using data collected from local water systems, evaluate water quality and conclude how pollution can make water unavailable or unsuitable for life.* *d. Research and report how communities manage water resources (e.g., distribution, shortages, quality, flood control) to address social, economic, and environmental concerns.* **Standard 4, Objective 3:** Analyze the physical, chemical, and biological dynamics of the oceans and the flow of energy through the oceans. *e. Evaluate the impact of human activities (e.g., sediment, pollution, overfishing) on ocean systems.* **Standard 5, Objective 2:** Describe how humans depend on Earth's resources. **Standard 5, Objective 3:** Indicate how natural hazards pose risks to humans. *b. Evaluate and give examples of human activities that can contribute to the frequency and intensity of some natural hazards (e.g., construction that may increase erosion, human causes of wildfires, climate change).* *c. Document how scientists use technology to continually improve estimates of when and where natural hazards occur.* *d. Investigate and report how social, economic, and environmental issues affect decisions about human-engineered structures (e.g., dams, homes, bridges, roads).*
VT (1/2017, 2013)	NGSS (see CA above).
VA (1/2017, 2016)	**ES.2a-d.** The student will demonstrate an understanding of the nature of science and scientific reasoning and logic. Key concepts include *a) science explains and predicts the interactions and dynamics of complex Earth systems;* *b) evidence is required to evaluate hypotheses and explanations;* *c) observation and logic are essential for reaching a conclusion; and* *d) evidence is evaluated for scientific theories.* **ES.6a-d.** The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include *a) fossil fuels, minerals, rocks, water, and vegetation;* *b) advantages and disadvantages of various energy sources;* *c) resources found in Virginia; and* *d) environmental costs and benefits.* **ES.8d-f.** The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include

	d) identification of sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle; e) dependence on freshwater resources and the effects of human usage on water quality; and f) identification of the major watershed systems in Virginia, including the Chesapeake Bay and its tributaries.
WA (1/2017, 2009)	NGSS (see CA above).
WV (1/2017, 2016)	NGSS (see CA above).
WI (1/2017, 2012)	Separated by "All High School"
WY (1/2017, 2016)	**HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. **HS-ESS3-1.** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. **HS-ESS3-3.** Use computational tools to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. **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. **HS-ETS1-5.** Evaluate the validity and reliability of claims in a variety of materials.